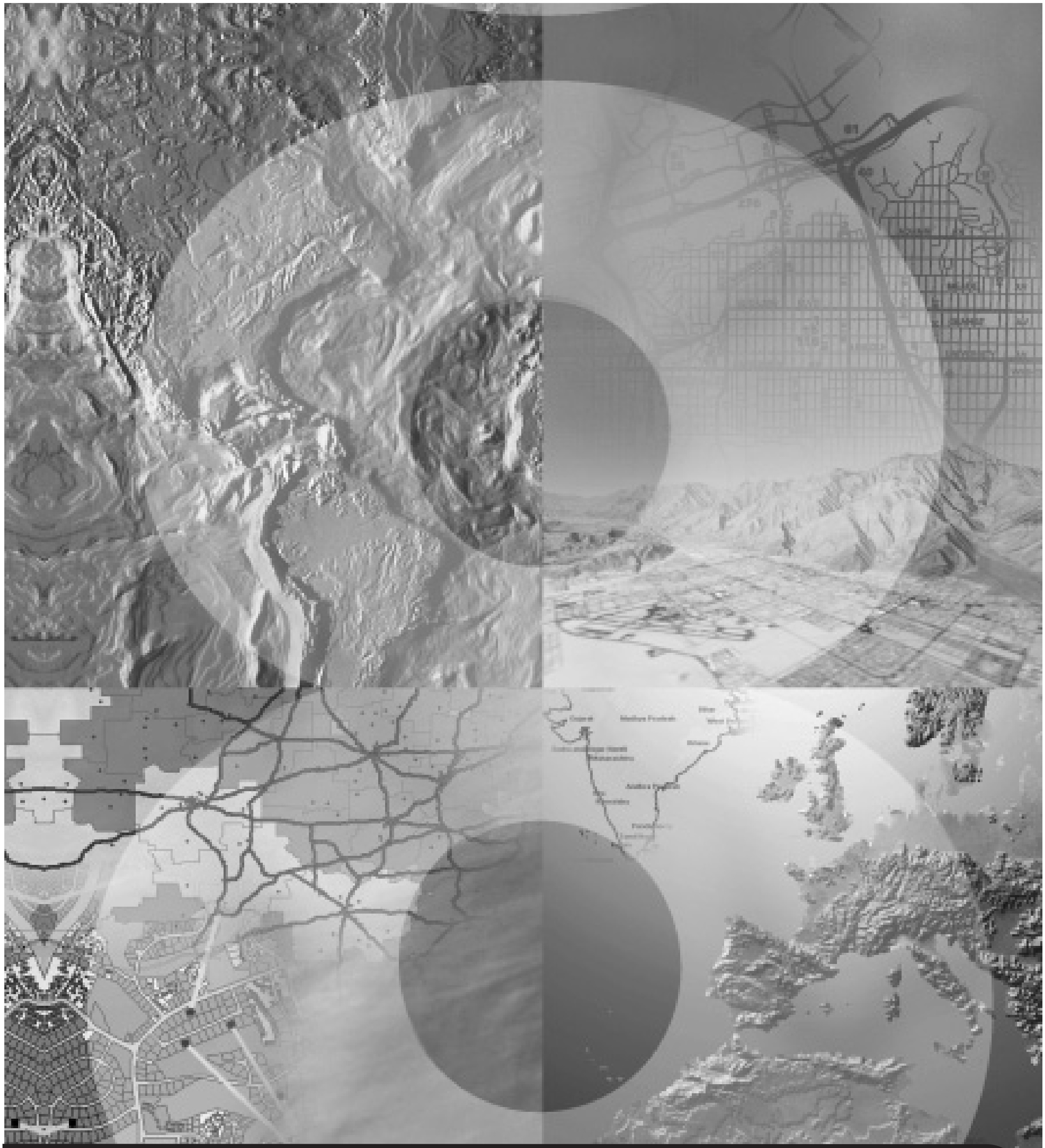

Exploring ArcObjects™ Vol. 1—Applications and Cartography

*GIS by ESRI*ª

Edited by Michael Zeiler

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Contributing Writers
Julio Andrade, Eleanor Blades, Patrick Brennan, Tom Brown, Euan Cameron, Scott Campbell, Jillian Clark, Jim Clarke, Chris Davies, Cory Eicher, Ryan Gatti, Shelly Gill, Erik Hoel, Melita Kennedy, Allan Laframboise, Russell Louks, Keith Ludwig, Gary MacDougall, Glenn Meister, Sud Menon, Jason Pardy, Bruce Payne, Ghislain Prince, Sentha Shanmugam, Brad Taylor, Steve Van Esch, Aleta Vienneau, Michael Waltuch, Steve Wheatley, Larry Young, Michael Zeiler

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1

Introducing ArcObjects

Michael Waltuch, Euan Cameron, Allan Laframboise, Michael Zeiler

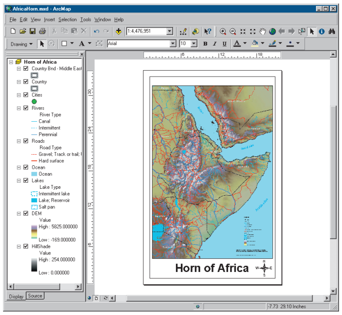
ESRI® ArcObjects™ is the development platform for the ArcGIS™ family of applications such as ArcMap™, ArcCatalog™, and ArcScene™. The ArcObjects software components expose the full range of functionality available in ArcInfo™ and ArcView® to software developers.

ArcObjects is a framework that lets you create domain-specific components from other components. The ArcObjects components collaborate to serve every data management and map presentation function common to most GIS applications. ArcObjects provides an infrastructure for application customization that lets you concentrate on serving the specific needs of your clients.

This chapter discusses: using this book and the other developer resources • reading the object model diagrams • getting started with ArcObjects and VBA • applying an ArcObjects problem-solving guide • examining the most commonly used components in ArcObjects with sample VBA code that solves a set of common tasks

ArcObjects is the development platform for ArcGIS Desktop.

ArcGIS Desktop is a suite of GIS software systems: ArcInfo, ArcEditor™, and ArcView. These systems serve GIS professionals with a spectrum of geographic data management, spatial editing, and cartographic visualization functionality.



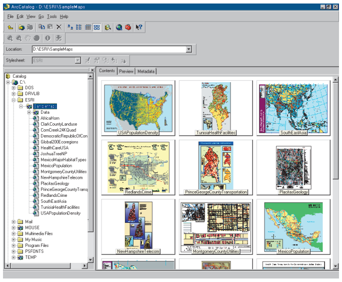
ArcMap is used for mapping and editing tasks as well as map-based analysis.

The ArcGIS Desktop systems each contain a configuration of applications, such as ArcCatalog, ArcMap, ArcToolbox™, and ArcScene, and can host a variety of extension products such as ArcGIS Spatial Analyst, ArcGIS Geostatistical Analyst, ArcGIS 3D Analyst™, and others.

This book documents the core components of ArcObjects that comprise these two core applications: ArcMap and ArcCatalog.

THE ArcObjects FRAMEWORK

ArcObjects is built using Microsoft's Component Object Model (COM) technology. Therefore, it is possible to extend ArcObjects by writing COM components using any COM-compliant development language. You can extend every part of the ArcObjects architecture in exactly the same way as ESRI developers do.


ArcCatalog - D:\ESRI\SampleMaps
File Edit View Go Tools Help
Contents Preview Metadata

ArcCatalog is used for managing your spatial data holdings, defining your geographic data schemas, and recording and viewing metadata.

CUSTOMIZING ArcGIS DESKTOP

The most common way that developers will customize the ArcGIS Desktop applications is through Visual Basic® for Applications (VBA), which is embedded within ArcCatalog and ArcMap.

Through VBA, you can leverage the application framework that already exists in ArcMap and ArcCatalog for general data management and map presentation tasks and extend ArcGIS with your own custom commands, tools, menus, and modules.

Using VBA inside ArcGIS Desktop, you can achieve the majority of your customization needs with relatively little development effort.

More advanced developers can further extend ArcGIS Desktop with custom map layers, renderers, property pages, and data sources.

For more information on the products and applications that form the ArcGIS system, see the ESRI book What is ArcGIS?

For specialized applications, developers with sufficient skill can bypass the application framework of ArcMap and ArcCatalog and instead build their own targeted applications. The Map control, discussed in Appendix D, provides a good point of entry, allowing access to the remainder of ArcObjects.

Exploring ArcObjects is for anyone who wants to customize or extend the ArcMap and ArcCatalog applications.

Everyone should read the first two chapters for an overview of developing with ArcObjects. You can use the remainder of the two volumes as a reference to the core ArcObjects components in ArcMap and ArcCatalog.

To serve the greatest base of developers, most of the code samples in this book are written in VBA. As necessary, some code samples are written in Microsoft® Visual Basic (VB) or Visual C++®. All code is included on the ArcGIS CD at arcexe81\ArcObjects Developer kit\Samples\Exploring ArcObjects.

VOLUME 1—APPLICATIONS AND CARTOGRAPHY

The first volume documents the ArcObjects components directly used by the ArcMap and ArcCatalog applications, as well as the components used for cartographic presentation.

Chapter 1, 'Introducing ArcObjects', gives you an overview of using ArcObjects in the VBA environment, discusses how to read the object model diagrams, contains code examples for common tasks, and presents a problem-solving guide that can help you start with ArcObjects.

Chapter 2, 'Developing with ArcObjects', provides in-depth coverage of everything you need to know about applying COM, VBA, VB, Visual C++, and ATL to ArcObjects development.

Chapter 3, 'Customizing the user interface', discusses the general components and techniques for modifying the user interface of all ArcGIS Desktop applications.

Chapter 4, 'Composing maps', explains how views work in ArcMap and how to manipulate map layers, graphics, and elements of a map.

Chapter 5, 'Displaying graphics', documents the drawing of layers with feature renderers; working with colors, symbols, and annotation; and using the visual feedback components.

Chapter 6, 'Directing map output', describes how to send your maps to printing devices and graphics formats.

Chapter 7, 'Working with the Catalog', gives details on how to customize the ArcCatalog application to work with your geographic data.

VOLUME 2—GEOGRAPHIC DATA MANAGEMENT

The second volume documents the ArcObjects components that manage geographic data and auxiliary component subsystems, such as spatial reference and geometry.

Chapter 8, 'Accessing the geodatabase', provides the foundation for the core geographic data management components in ArcObjects.

Chapter 9, 'Shaping features with geometry', documents the rich geometric subsystem in ArcObjects that supports feature definition and graphic element interaction in ArcMap.

Chapter 10, 'Managing the spatial reference', discusses how to work with geographic data from a variety of coordinate systems.

Chapter 11, 'Editing features', explains how to perform customization of editing tasks in ArcMap.

Chapter 12, 'Solving linear networks', documents how to solve network tracing and allocation problems.

Chapter 13, 'Integrating raster data', discusses the use of raster data objects to provide a background display and perform analysis on image data.

Appendix A, 'Open data access in ArcGIS', discusses the use of universal data-access technology for accessing geographic data outside of ESRI® applications.

Appendix B, 'Geodatabase modeling with UML', gives the conceptual background for using the CASE functionality in ArcCatalog for data modeling.

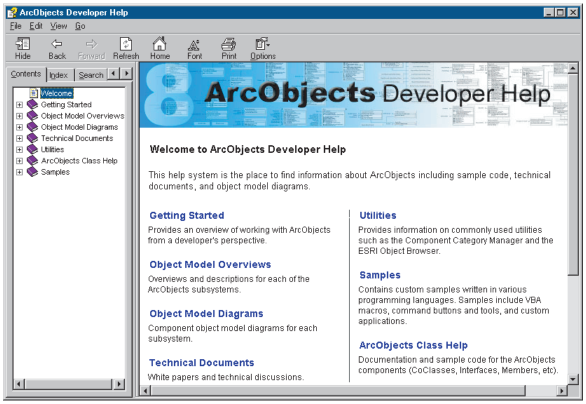
Appendix C, 'Developing for ArcGIS deployments', discusses which functions in ArcObjects are available in the ArcInfo, ArcEditor, and ArcView systems.

Appendix D, 'Developing with the Map control', discusses how you can simplify external application development and access all of ArcObjects.

CORRECTIONS AND UPDATES

It is inevitable that a book of this scope and size will contain some errors of omission and fact. You will find corrections and late-breaking updates for this book at www.esri.com/arcobjectsonline.

You can report errors that you find or suggestions for future editions of this book to ArcObjects@esri.com. This e-mail address is not to be used for technical support queries. You can find resources for technical support on ESRI's Web site, www.esri.com.



Welcome to ArcObjects Developer Help

This help system is the place to find information about ArcObjects including sample code, technical documents, and object model diagrams.

Getting Started

Provides an overview of working with ArcObjects from a developer's perspective.

Object Model Overviews

Overviews and descriptions for each of the ArcObjects subsystems.

Object Model Diagrams

Component object model diagrams for each subsystem.

Technical Documents

White papers and technical discussions.

Utilities

Provides information on commonly used utilities such as the Component Category Manager and the ESRI Object Browser.

Samples

Contains custom samples written in various programming languages. Samples include VBA macros, command buttons and tools, and custom applications.

ArcObjects Class Help

Documentation and sample code for the ArcObjects components (CoClasses, Interfaces, Members, etc).

The ArcObjects Developer Help system main table of contents

The ArcObjects Developer Help system is an essential resource for both beginning and experienced ArcObjects developers. It lets you find detailed reference documentation about every coclass, class, interface, and enumeration within ArcObjects as well as sample code, technical documents, and object model diagrams.

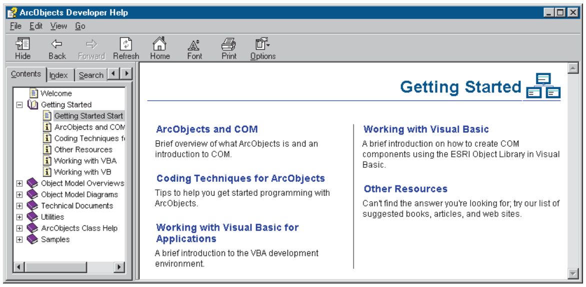
You can start the ArcObjects Developer Help system by clicking the Windows Start button, clicking the Programs menu, pointing to ArcGIS, and clicking ArcObjects Developer Help.

The main table of contents outlines everything that you can find in the ArcObjects Developer Help system. The main table of contents also contains links to ArcObjects Online and ArcSDE™ Online.

Getting started with ArcObjects

The Getting Started page contains links to several documents that give you a conceptual foundation for developing with ArcObjects.

The ArcObjects and Component Object Model (COM) topic covers basic COM and ArcObjects terminology. It can be used as a quick reference for beginning COM programmers because it defines many terms and concepts related to COM programming.



ArcObjects and COM

Brief overview of what ArcObjects is and an introduction to COM.

Coding Techniques for ArcObjects

Tips to help you get started programming with ArcObjects.

Working with Visual Basic for Applications

A brief introduction to the VBA development environment.

Working with Visual Basic

A brief introduction on how to create COM components using the ESRI Object Library in Visual Basic.

Other Resources

Can't find the answer you're looking for; try our list of suggested books, articles, and web sites.

Some of the documents reached through the Getting Started page cover technical topics discussed in Chapter 2, 'Developing with ArcObjects'.

The Coding Techniques for ArcObjects topic describes how to use ArcObjects in VBA; it is a quick reference for beginner to intermediate-level ArcObjects programmers because it explains how to navigate the ArcObjects library and describes the general syntax, structures, and keywords required for COM programming in VBA.

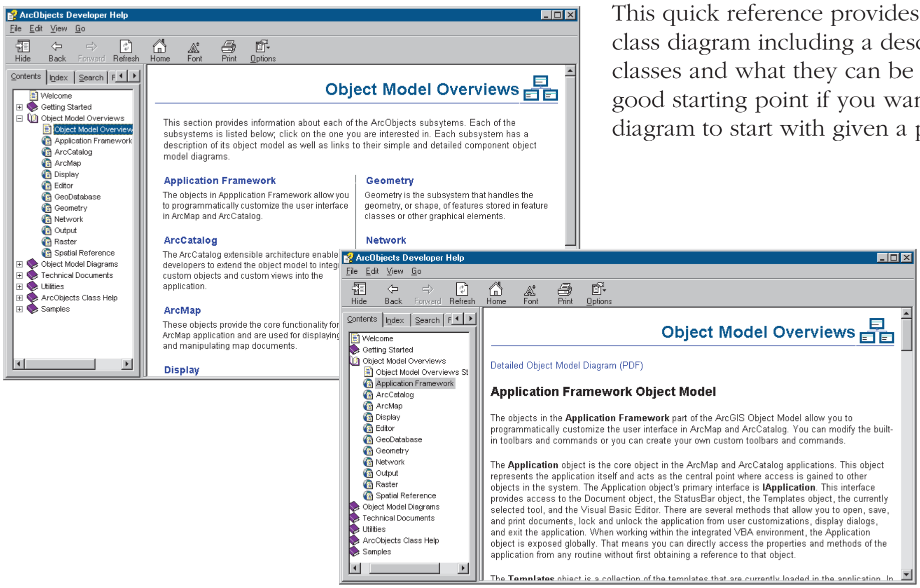
The Working with Visual Basic for Applications topic describes how and where to write custom VBA macros inside ArcMap and ArcCatalog. You can learn about application-level variables and how to integrate VBA macros to control ArcMap and ArcCatalog. You can also learn where to write and save your code in the VBA environment.

The Working with Visual Basic topic is a general discussion about topics related to working with ArcObjects outside of the VBA environment. To get an overview of how to create an ActiveX DLL in VB, reference internal ArcObjects and start ArcMap from an external client.

The Other Resources topic links you to a page that lists recommended COM- and VBA-related books.

Object model overviews

The Object Model Overviews Start Page contains links to textual descriptions for each object model diagram.



Object Model Overviews

This section provides information about each of the ArcObjects subsytems. Each of the subsystems is listed below; click on the one you are interested in. Each subsystem has a description of its object model as well as links to their simple and detailed component object model diagrams.

Application Framework

The objects in Appplication Framework allow you to programmatically customize the user interface in ArcMap and ArcCatalog.

ArcCatalog

The ArcCatalog extensible architecture enable developers to extend the object model to integ custom objects and custom views into the application.

ArcMap

These objects provide the core functionality for ArcMap application and are used for displaying and manipulating map documents.

Display

Geometry

Geometry is the subsystem that handles the geometry, or shape, of features stored in feature classes or other graphical elements.

Network

Object Model Overviews

Detailed Object Model Diagram (PDF)

Application Framework Object Model

The objects in the **Application Framework** part of the ArcGIS Object Model allow you to programmatically customize the user interface in ArcMap and ArcCatalog. You can modify the built-in toolbars and commands or you can create your own custom toolbars and commands.

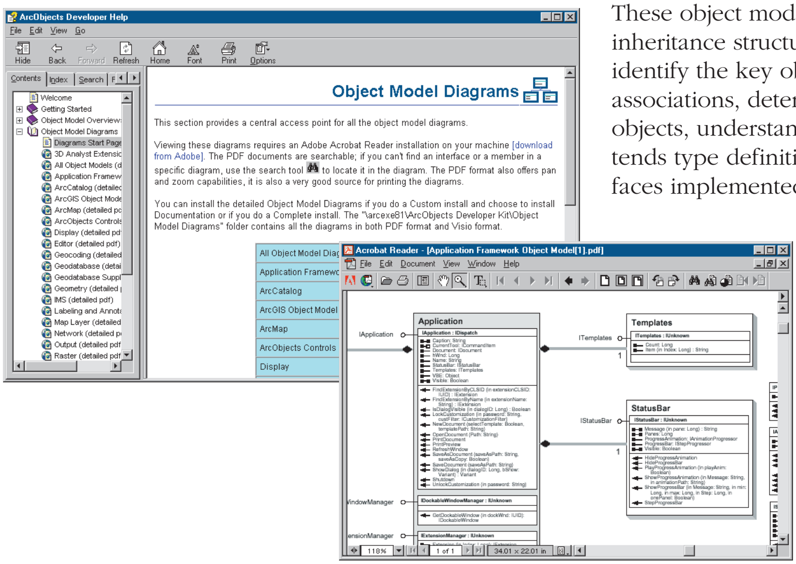
The **Application** object is the core object in the ArcMap and ArcCatalog applications. This object represents the application itself and acts as the central point where access is gained to other objects in the system. The Application object's primary interface is **IApplication**. This interface provides access to the Document object, the StatusBar object, the Templates object, the currently selected tool, and the Visual Basic Editor. There are several methods that allow you to open, save, and print documents, lock and unlock the application from user customizations, display dialogs, and exit the application. When working within the integrated VBA environment, the Application object is exposed globally. That means you can directly access the properties and methods of the application from any routine without first obtaining a reference to that object.

The **Templates** object is a collection of the templates that are currently loaded in the application. In

This quick reference provides an overview of each class diagram including a description of the main classes and what they can be used for. This is a good starting point if you want to know which class diagram to start with given a programming task.

Reading object model diagrams

The Diagrams Start Page in the Object Model Diagrams topic contains a list of links to each detailed object model diagram in PDF format.



Object Model Diagrams

This section provides a central access point for all the object model diagrams.

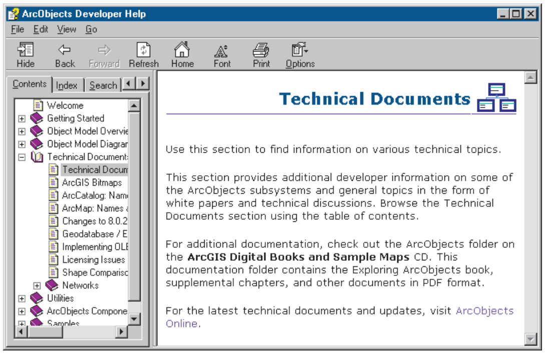
Viewing these diagrams requires an Adobe Acrobat Reader installation on your machine [download from Adobe]. The PDF documents are searchable; if you can't find an interface or a member in a specific diagram, use the search tool 🔍 to locate it in the diagram. The PDF format also offers pan and zoom capabilities, it is also a very good source for printing the diagrams.

You can install the detailed Object Model Diagrams if you do a Custom install and choose to install Documentation or if you do a Complete install. The "\arcexe81\ArcObjects Developer Kit\Object Model Diagrams" folder contains all the diagrams in both PDF format and Visio format.

Acrobat Reader - [Application Framework Object Model[1].pdf]
File Edit Document View Window Help
Application
IApplication
IApplication : IDispatch
Caption: String
CurrentTool: ICommandItem
Document: IDocument
hWnd: Long
Name: String
StatusBar: IStatusBar
Templates: ITemplates
VBE: Object
Visible: Boolean
FindExtensionByCLSID (in extensionCLSID: IUID) : IExtension
FindExtensionByName (in extensionName: String) : IExtension
IsDialogVisible (in dialogID: Long) : Boolean
LockCustomization (in password: String, custFilter: ICustomizationFilter)
NewDocument (selectTemplate: Boolean, templatePath: String)
OpenDocument (Path: String)
PrintDocument
PrintPreview
RefreshWindow
SaveAsDocument (saveAsPath: String, saveAsCopy: Boolean)
SaveDocument (saveAsPath: String)
ShowDialog (in dialogID: Long, bShow: Variant) : Variant
Shutdown
UnlockCustomization (in password: String)
WindowManager
IDockableWindowManager : IUnknown
GetDockableWindow (in dockWnd: IUID): IDockableWindow
ensionManager
IExtensionManager : IUnknown
Templates
ITemplates
ITemplates : IUnknown
Count: Long
Item (in Index: Long) : String
1
StatusBar
IStatusBar
IStatusBar : IUnknown
Message (in pane: Long) : String
Panes: Long
ProgressAnimation: IAnimationProgressor
ProgressBar: IStepProgressor
Visible: Boolean
HideProgressAnimation
HideProgressBar
PlayProgressAnimation (in playAnim: Boolean)
ShowProgressAnimation (in Message: String, in animationPath: String)
ShowProgressBar (in Message: String, in min: Long, in max: Long, in Step: Long, in onePanel: Boolean)
StepProgressBar
1
118%
1 of 1
34.01 x 22.01 in

These object model diagrams visually present the inheritance structure of ArcObjects so that you can identify the key objects, see which objects have associations, determine which objects create other objects, understand how interface inheritance extends type definitions, and find the full list of interfaces implemented by a coclass.

Before studying these object model diagrams, you should read the object model diagram overview descriptions so that you understand the context of that package within the ArcObjects framework.



Technical Documents

Use this section to find information on various technical topics.

This section provides additional developer information on some of the ArcObjects subsystems and general topics in the form of white papers and technical discussions. Browse the Technical Documents section using the table of contents.

For additional documentation, check out the ArcObjects folder on the **ArcGIS Digital Books and Sample Maps** CD. This documentation folder contains the Exploring ArcObjects book, supplemental chapters, and other documents in PDF format.

For the latest technical documents and updates, visit ArcObjects Online.

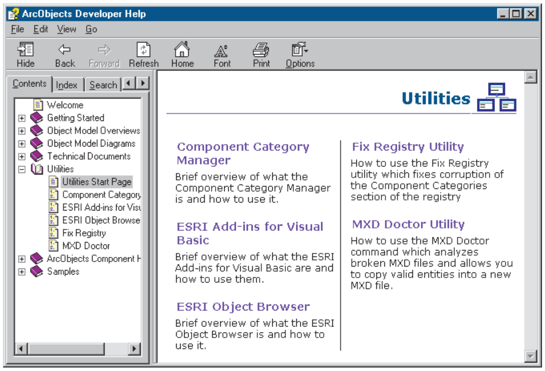
Accessing technical documents

The Technical Documents Start Page provides links to white papers and other technical documents.

You can read these documents to gain background information and knowledge on specific technical concepts. This resource is recommended for all programmers.

Finding utility programs

The Utilities Start Page contains several programs useful to developers.



Utilities

Component Category Manager
Brief overview of what the Component Category Manager is and how to use it.

ESRI Add-ins for Visual Basic
Brief overview of what the ESRI Add-ins for Visual Basic are and how to use them.

ESRI Object Browser
Brief overview of what the ESRI Object Browser is and how to use it.

Fix Registry Utility
How to use the Fix Registry utility which fixes corruption of the Component Categories section of the registry

MXD Doctor Utility
How to use the MXD Doctor command which analyzes broken MXD files and allows you to copy valid entities into a new MXD file.

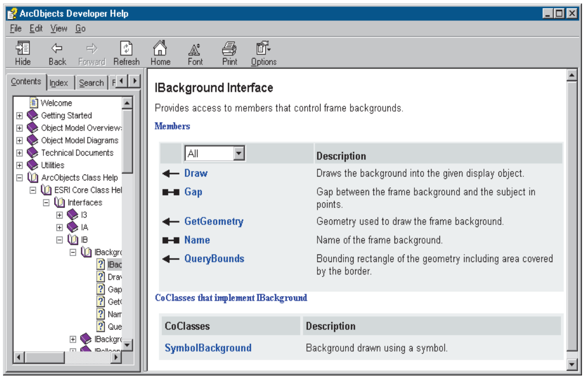
The Components Category Manager lets you associate software components that you have created and compiled into DLLs into the ArcObjects component categories for objects such as commands, snap agents, and extensions. This lets you integrate your custom components within the system.

The ESRI Object Browser is a custom-enhanced object browser that lets you search and locate ArcObjects coclasses, classes, interfaces, and enumerations. For more information, see Chapter 2, 'Developing with ArcObjects'.

These tools are useful for intermediate to advanced ArcObjects developers. The Visual Basic add-ins are discussed further in this section.

Browsing the ArcObjects Component Help

The ArcObjects Component Help system is a comprehensive online reference to all of ArcObjects. This is a vital resource for all ArcObjects programmers.



IBackground Interface

Provides access to members that control frame backgrounds.

Members

All	Description
← Draw	Draws the background into the given display object.
■-■ Gap	Gap between the frame background and the subject in points.
← GetGeometry	Geometry used to draw the frame background.
■-■ Name	Name of the frame background.
← QueryBounds	Bounding rectangle of the geometry including area covered by the border.

CoClasses that implement IBackground

CoClasses	Description
SymbolBackground	Background drawn using a symbol.

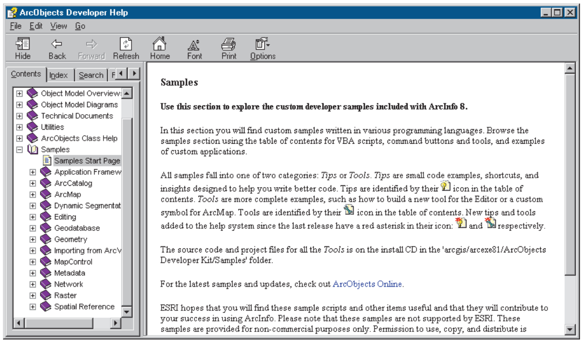
This system helps you find any given interface, coclass, or constant alphabetically. You can also easily find all the objects that implement a given interface.

Using developer samples

The Samples Page documents the structure of the sample code.

This page provides links to examples of how to use an assortment of ArcObjects classes and interfaces to accomplish a given task.

Tip samples provide “cut and paste” style code snippets, while tools provide more complete examples that generally require compilation and registration. These samples invite you to explore the interplay of interfaces and classes to solve real-world problems. These samples are an essential resource for all ArcObjects developers.



Samples

Use this section to explore the custom developer samples included with ArcInfo 8.

In this section you will find custom samples written in various programming languages. Browse the samples section using the table of contents for VBA scripts, command buttons and tools, and examples of custom applications.

All samples fall into one of two categories: *Tips* or *Tools*. *Tips* are small code examples, shortcuts, and insights designed to help you write better code. Tips are identified by their icon in the table of contents. *Tools* are more complete examples, such as how to build a new tool for the Editor or a custom symbol for ArcMap. Tools are identified by their icon in the table of contents. New tips and tools added to the help system since the last release have a red asterisk in their icon: and respectively.

The source code and project files for all the *Tools* is on the install CD in the 'arcgis/arcexe81/ArcObjects Developer Kit/Samples' folder.

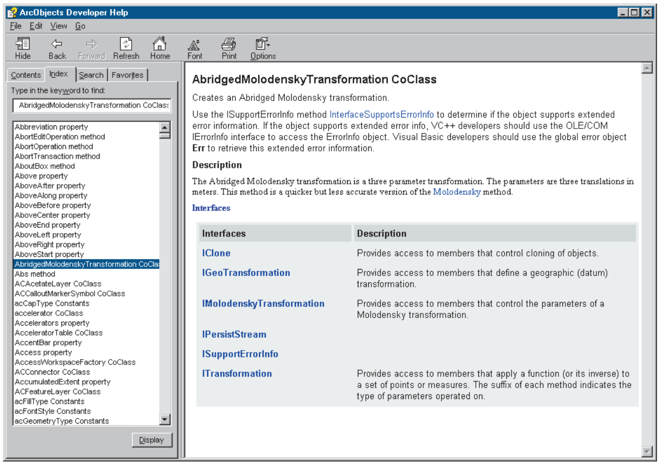
For the latest samples and updates, check out ArcObjects Online.

ESRI hopes that you will find these sample scripts and other items useful and that they will contribute to your success in using ArcInfo. Please note that these samples are not supported by ESRI. These samples are provided for non-commercial purposes only. Permission to use, copy, and distribute is

Finding objects alphabetically

The Index tab lets you search for objects by keywords and find all ArcObjects classes and interfaces through a tree view.

Using this tree view, you can display detailed information on classes, interfaces, methods, properties, and events.



Type in the keyword to find: AbridgedMolodenskyTransformation CoClass

AbridgedMolodenskyTransformation CoClass

Creates an Abridged Molodensky transformation.

Use the ISupportErrorInfo method InterfaceSupportsErrorInfo to determine if the object supports extended error information. If the object supports extended error info, VC++ developers should use the OLE/COM IErrorInfo interface to access the ErrorInfo object. Visual Basic developers should use the global error object **Err** to retrieve this extended error information.

Description

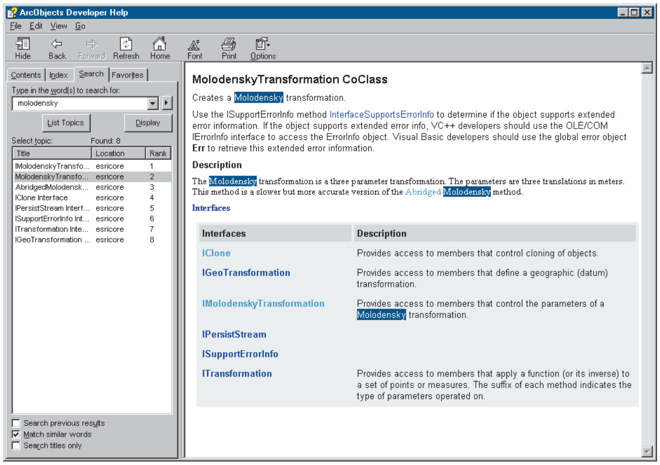
The Abridged Molodensky transformation is a three parameter transformation. The parameters are three translations in meters. This method is a quicker but less accurate version of the Molodensky method.

Interfaces

Interfaces	Description
IClone	Provides access to members that control cloning of objects.
IGeoTransformation	Provides access to members that define a geographic (datum) transformation.
IMolodenskyTransformation	Provides access to members that control the parameters of a Molodensky transformation.
IPersistStream	
ISupportErrorInfo	
ITransformation	Provides access to members that apply a function (or its inverse) to a set of points or measures. The suffix of each method indicates the type of parameters operated on.

Searching by keywords

The Search tab lets you type in a keyword and find all the documents in the ArcObjects Developer Help system containing that keyword.



Type in the word(s) to search for: molodensky

Select topic: Found: 8

Title	Location	Rank
IMolodenskyTransfo...	esricore	1
MolodenskyTransfo...	esricore	2
AbridgedMolodensk...	esricore	3
IClone Interface	esricore	4
IPersistStream Interf...	esricore	5
ISupportErrorInfo Int...	esricore	6
ITransformation Inte...	esricore	7
IGeoTransformation ...	esricore	8

□ Search previous results
☑ Match similar words
□ Search titles only

MolodenskyTransformation CoClass

Creates a Molodensky transformation.

Use the ISupportErrorInfo method InterfaceSupportsErrorInfo to determine if the object supports extended error information. If the object supports extended error info, VC++ developers should use the OLE/COM IErrorInfo interface to access the ErrorInfo object. Visual Basic developers should use the global error object **Err** to retrieve this extended error information.

Description

The Molodensky transformation is a three parameter transformation. The parameters are three translations in meters. This method is a slower but more accurate version of the Abridged Molodensky method.

Interfaces

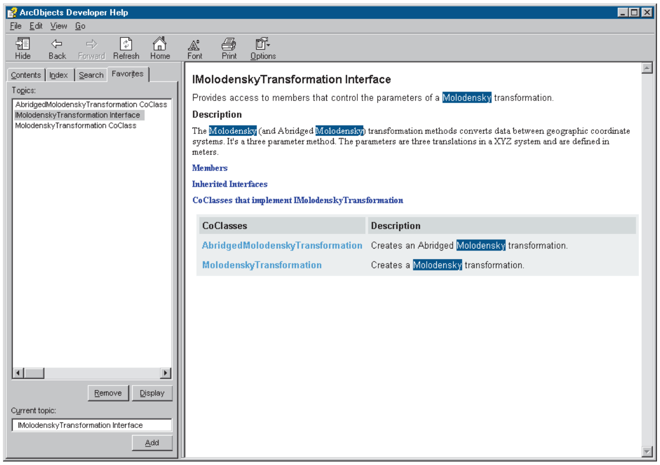
Interfaces	Description
IClone	Provides access to members that control cloning of objects.
IGeoTransformation	Provides access to members that define a geographic (datum) transformation.
IMolodenskyTransformation	Provides access to members that control the parameters of a Molodensky transformation.
IPersistStream	
ISupportErrorInfo	
ITransformation	Provides access to members that apply a function (or its inverse) to a set of points or measures. The suffix of each method indicates the type of parameters operated on.

You can sort the list of documents by title, location, and rank. Selecting a document displays it in the contents view, with the keywords highlighted.

Using the Search tab is an effective way to quickly browse the object documentation and gain familiarity with ArcObjects.

Saving favorite documents

The Favorites tab lets you store and access links to documents of interest to you.



Topics:

AbridgedMolodenskyTransformation CoClass
IMolodenskyTransformation Interface
MolodenskyTransformation CoClass

Current topic: IMolodenskyTransformation Interface

IMolodenskyTransformation Interface

Provides access to members that control the parameters of a Molodensky transformation.

Description

The Molodensky (and Abridged Molodensky) transformation methods converts data between geographic coordinate systems. It's a three parameter method. The parameters are three translations in a XYZ system and are defined in meters.

Members

Inherited Interfaces

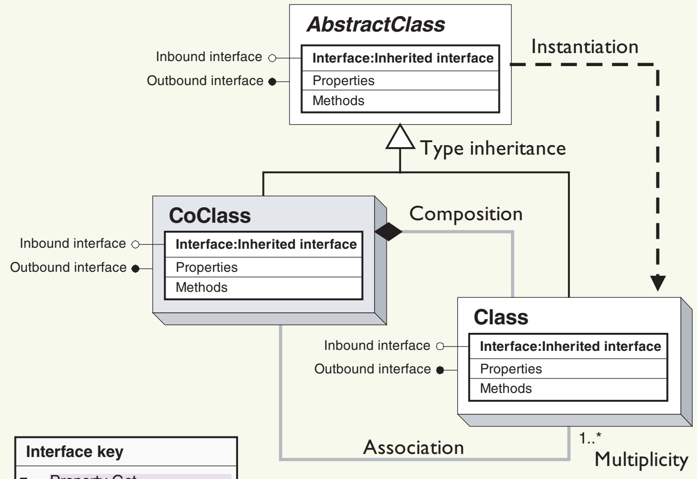
CoClasses that implement IMolodenskyTransformation

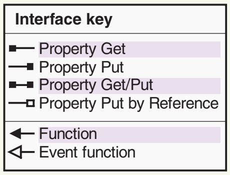
CoClasses	Description
AbridgedMolodenskyTransformation	Creates an Abridged Molodensky transformation.
MolodenskyTransformation	Creates a Molodensky transformation.

This tab has buttons that let you set and save shortcuts to useful help topics.

Reading the object model diagrams

Object model key





Types of Classes

An **abstract class** cannot be used to create new objects, it is a specification for instances of subclasses (through type inheritance.)

A **coclass** can directly create objects by declaring a new object.

A **class** cannot directly create objects, but objects of a class can be created as a property of another class or instantiated by objects from another class.

Types of Relationships

Associations represent relationships between classes. They have defined multiplicities at both ends.

Type inheritance defines specialized classes of objects that share properties and methods with the superclass and have additional properties and methods. Note that interfaces in superclasses are not duplicated in subclasses.

Instantiation specifies that one object from one class has a method with which it creates an object from another class.

Composition is a relationship in which objects from the "whole" class control the lifetime of objects from the "part" class.

An **N-ary association** specifies that more than two classes are associated. A diamond is placed at the intersection of the association branches.

A **Multiplicity** is a constraint on the number of objects that can be associated with another object. Association and composition relationships have multiplicities on both sides. This is the notation for multiplicities:

1 - One and only one (if none shown, one is implied)

0..1 - Zero or one

M..N - From M to N (positive integers)

***** or **0..*** - From zero to any positive integer

1..* - From one to any positive integer

Special Interfaces

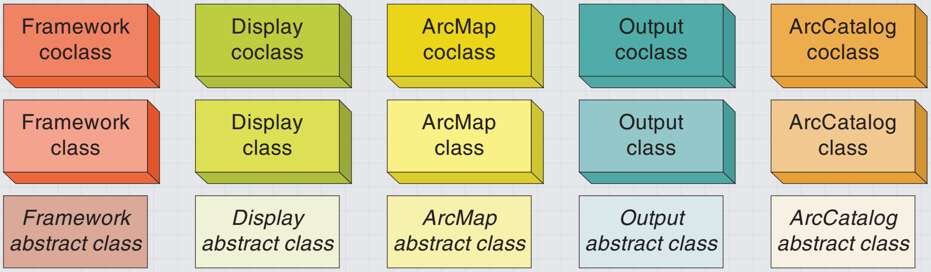
(Optional) represents interfaces that are inherited by some subclasses but not all. The subclasses list the optional interfaces they implement.

(Instance) represents interfaces that are only on specific instances of the class.

(<classname>) indicates the name of the helper class required to support this event interface in Visual Basic.

Volume 1—Applications and cartography

This book and the inserted ArcGIS object model diagrams use this color code to denote the coclasses, classes, and abstract classes in the ArcObjects subsystems.



Chapter 3	Chapter 4	Chapter 5	Chapter 6	Chapter 7
Framework coclass	Display coclass	ArcMap coclass	Output coclass	ArcCatalog coclass
Framework class	Display class	ArcMap class	Output class	ArcCatalog class
Framework abstract class	*Display abstract class*	*ArcMap abstract class*	*Output abstract class*	*ArcCatalog abstract class*

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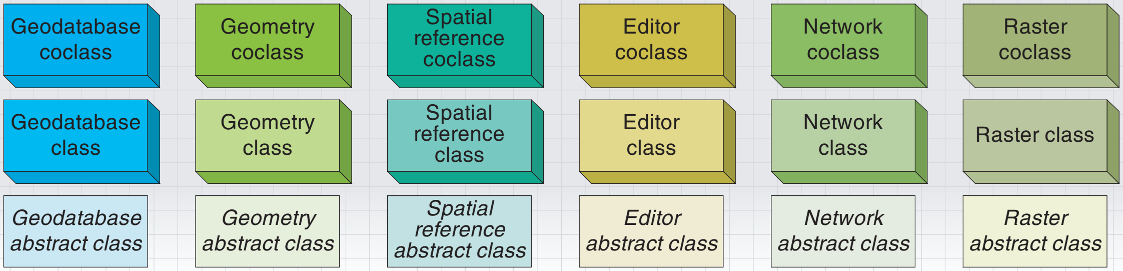


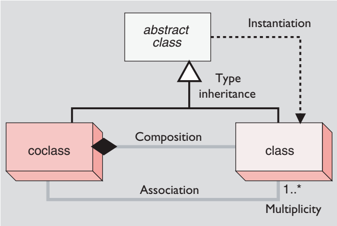
Chapter 8	Chapter 9	Chapter 10	Chapter 11	Chapter 12	Chapter 13
Geodatabase coclass	Geometry coclass	Spatial reference coclass	Editor coclass	Network coclass	Raster coclass
Geodatabase class	Geometry class	Spatial reference class	Editor class	Network class	Raster class
Geodatabase abstract class	*Geometry abstract class*	*Spatial reference abstract class*	*Editor abstract class*	*Network abstract class*	*Raster abstract class*

The diagram notation used in this book and the ArcObjects object model diagrams are based on the Unified Modeling Language (UML) notation, an industry-diagramming standard for object-oriented analysis and design, with some modifications for documenting COM-specific constructs.

The object model diagrams are an important supplement to the information you receive in object browsers. The development environment, Visual Basic or other, lists all of the many classes and members but does not show the structure of those classes. These diagrams complete your understanding of the ArcObjects components.

Classes and objects

There are three types of classes shown in the UML diagrams: abstract classes, coclasses, and classes.



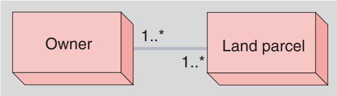
A *coclass* represents objects that you can directly create using the object declaration syntax in your development environment. In Visual Basic, this is written with the *Dim pFoo As New FooObject* syntax.

A *class* cannot directly create new objects, but objects of a class can be created as a property of another class or by functions from another class.

An *abstract class* cannot be used to create new objects, but it is a specification for subclasses. An example is that a “line” could be an abstract class for “primary line” and “secondary line” classes.

Relationships

Among abstract classes, coclasses, and classes, there are several types of class relationships possible.



In this diagram, an owner can own one or many land parcels, and a land parcel can be owned by one or many owners.

Associations represent relationships between classes. They have defined multiplicities at both ends.

A *Multiplicity* is a constraint on the number of objects that can be associated with another object. This is the notation for multiplicities:

1—One and only one. Showing this multiplicity is optional; if none is shown, "1" is implied.

0..1—Zero or one

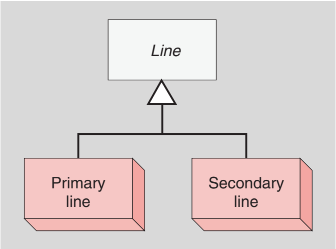
M..N—From M to N (positive integers)

* or 0..*—From zero to any positive integer

1..*—From one to any positive integer

Type inheritance

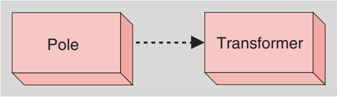
Type inheritance defines specialized classes that share properties and methods with the superclass and have additional properties and methods.



This diagram shows that a primary line (creatable class) and secondary line (creatable class) are types of a line (abstract class).

Instantiation

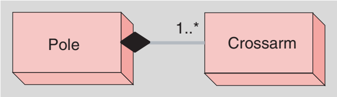
Instantiation specifies that one object from one class has a method with which it creates an object from another class.



A pole object might have a method to create a transformer object.

Composition

Composition is a stronger form of aggregation in which objects from the "whole" class control the lifetime of objects from the "part" class.



A pole contains one or many crossarms. In this design, a crossarm cannot be recycled when the pole is removed. The pole object controls the lifetime of the crossarm object.

The ESRI Object Browser lets you explore the structure of ArcObjects. It is a generic tool that ESRI created to address certain limitations of standard object browsers, such as the Microsoft OLEView tool or the Microsoft Visual Basic object browser.

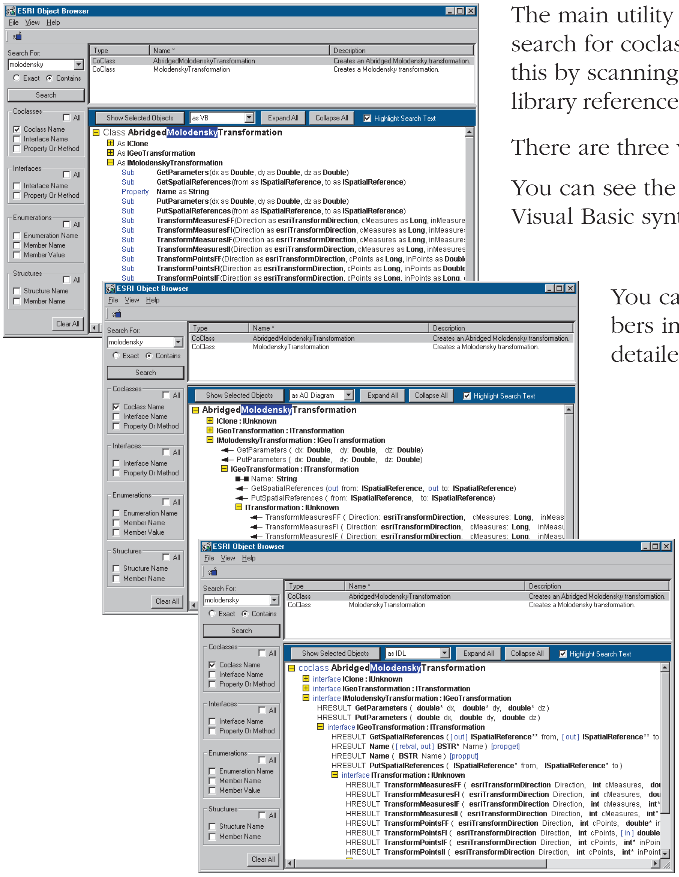
The main utility of the ESRI Object Browser is that it lets you search for coclasses that contain a specified interface. It does this by scanning the type libraries you've selected for object library references.

There are three views for the selected objects.

You can see the objects and their interfaces and members in Visual Basic syntax.

You can also view the objects, interfaces, and members in a style consistent with the notation of the detailed ArcObjects object model diagrams.

Developers using Visual C++ and other languages besides Visual Basic will find the most precise type definitions in the IDL view of the coclasses, interfaces, and members.



Search For: molodensky ○ Exact ● Contains

☑ Coclass Name ☐ Interface Name ☐ Property Or Method ☑ Highlight Search Text

Type	Name *	Description
CoClass	AbridgedMolodenskyTransformation	Creates an Abridged Molodensky transformation.
CoClass	MolodenskyTransformation	Creates a Molodensky transformation.

as VB

```
Class AbridgedMolodenskyTransformation
  As IClone
  As IGeoTransformation
  As IMolodenskyTransformation
    Sub       GetParameters(dx as Double, dy as Double, dz as Double)
    Sub       GetSpatialReferences(from as ISpatialReference, to as ISpatialReference)
    Property  Name as String
    Sub       PutParameters(dx as Double, dy as Double, dz as Double)
    Sub       PutSpatialReferences(from as ISpatialReference, to as ISpatialReference)
    Sub       TransformMeasuresFF(Direction as esriTransformDirection, cMeasures as Long, inMeasure
    Sub       TransformMeasuresFI(Direction as esriTransformDirection, cMeasures as Long, inMeasure
    Sub       TransformMeasuresIF(Direction as esriTransformDirection, cMeasures as Long, inMeasure
    Sub       TransformMeasuresII(Direction as esriTransformDirection, cMeasures as Long, inMeasures
    Sub       TransformPointsFF(Direction as esriTransformDirection, cPoints as Long, inPoints as Doubl
    Sub       TransformPointsFI(Direction as esriTransformDirection, cPoints as Long, inPoints as Double
    Sub       TransformPointsIF(Direction as esriTransformDirection, cPoints as Long, inPoints as Long,
```

as AO Diagram

```
AbridgedMolodenskyTransformation
  IClone : IUnknown
  IGeoTransformation : ITransformation
  IMolodenskyTransformation : IGeoTransformation
    GetParameters ( dx: Double,  dy: Double,  dz: Double)
    PutParameters ( dx: Double,  dy: Double,  dz: Double)
    IGeoTransformation : ITransformation
      Name: String
      GetSpatialReferences (out from: ISpatialReference, out to: ISpatialReference)
      PutSpatialReferences ( from: ISpatialReference,  to: ISpatialReference)
      ITransformation : IUnknown
        TransformMeasuresFF ( Direction: esriTransformDirection,  cMeasures: Long,  inMeas
        TransformMeasuresFI ( Direction: esriTransformDirection,  cMeasures: Long,  inMeasu
        TransformMeasuresIF ( Direction: esriTransformDirection,  cMeasures: Long,  inMeasu
```

as IDL

```
coclass AbridgedMolodenskyTransformation
  interface IClone : IUnknown
  interface IGeoTransformation : ITransformation
  interface IMolodenskyTransformation : IGeoTransformation
    HRESULT GetParameters ( double* dx,  double* dy,  double* dz )
    HRESULT PutParameters ( double dx,  double dy,  double dz )
    interface IGeoTransformation : ITransformation
      HRESULT GetSpatialReferences ( [ out ] ISpatialReference** from, [ out ] ISpatialReference** to
      HRESULT Name ( [ retval, out ] BSTR* Name ) [propget]
      HRESULT Name ( BSTR Name ) [propput]
      HRESULT PutSpatialReferences ( ISpatialReference* from,  ISpatialReference* to )
      interface ITransformation : IUnknown
        HRESULT TransformMeasuresFF ( esriTransformDirection Direction,  int cMeasures,  dou
        HRESULT TransformMeasuresFI ( esriTransformDirection Direction,  int cMeasures,  dou
        HRESULT TransformMeasuresIF ( esriTransformDirection Direction,  int cMeasures,  int*
        HRESULT TransformMeasuresII ( esriTransformDirection Direction,  int cMeasures,  int*
        HRESULT TransformPointsFF ( esriTransformDirection Direction,  int cPoints,  double* ir
        HRESULT TransformPointsFI ( esriTransformDirection Direction,  int cPoints, [ in ] double
        HRESULT TransformPointsIF ( esriTransformDirection Direction,  int cPoints,  int* inPoin
        HRESULT TransformPointsII ( esriTransformDirection Direction,  int cPoints,  int* inPoint
```

Using other languages, such as Visual Basic and Visual C++, is covered in Chapter 2, 'Developing with ArcObjects'.

You can use a variety of development languages with ArcObjects, but the easiest and quickest one to learn is included with your ArcGIS application, VBA. This chapter has many code examples, all of which can be easily executed from within the VBA environment.

What follows is a quick overview that illustrates the steps you will be taking when working with the samples later in this chapter. In this short tutorial you will learn how to add a toolbar to ArcMap, create a macro and execute it, add a command button to a toolbar, and create a tool that will allow you to interact with the display canvas.

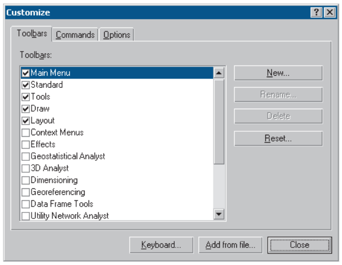
VBA is available in ArcMap, ArcCatalog, and ArcScene applications. The examples in this quick-start tutorial all work within ArcMap, but the process of creating macros and commands for the other applications is the same.

The respective ArcGIS application user guides show how to carry out many of the customization tasks you want to accomplish without writing a single line of code. This tutorial provides a quick, guided tour of some of those same key tasks; details and explanations are left for later so that you can start to work as quickly as possible.

Let's get started.

1. To start this tutorial, click the Windows Start button, point to Programs, point to ArcGIS, and click ArcMap.
2. In the startup dialog box, click Start using ArcMap.
3. Add some sample data or your own data to the map.

Showing and hiding toolbars using the Customize dialog box



Toolbars:
☑ Main Menu
☑ Standard
☑ Tools
☑ Draw
☑ Layout
□ Context Menus
□ Effects
□ Geostatistical Analyst
□ 3D Analyst
□ Dimensioning
□ Georeferencing
□ Data Frame Tools
□ Utility Network Analyst

The Customize dialog box

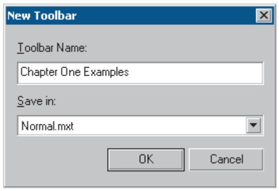
1. Click the Tools menu and click Customize.

   The Customize dialog box appears.

   You can also double-click any unoccupied area of any toolbar to display the Customize dialog box.
2. If it is not visible, click the Toolbars tab.

   The presence or absence of a check mark next to the toolbar name indicates its visible state.
3. Check and uncheck the check boxes.

Creating a new toolbar



Toolbar Name: Chapter One Examples

Save in: Normal.mxt

The New Toolbar dialog box

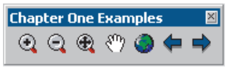
1. In the Toolbars tab of the Customize dialog box, click New.
2. In the dialog box that appears, specify Chapter One Examples as the name of the new toolbar or use the default setting.
3. Store the toolbar in the document by changing the name of the Save in dropdown list from Normal.mxt to Untitled or the name of the current project.
4. Click OK.

The newly created toolbar appears near the top of the application window.

Adding buttons to a toolbar

1. Make sure the toolbar you just created, Chapter One Examples, is visible.
2. If it is not visible, display the Customize dialog box.
3. Click the Commands tab of the Customize dialog box.
4. Select the Pan/Zoom category from the Categories list at the left of the dialog box.
5. Scroll to the bottom of the Commands list at the right of the dialog box.
6. Select the Zoom in command and drag it to the Chapter One Examples toolbar. Release the command when the arrow cursor with a small box below it appears.

Dragging a toolbar



Your Chapter One Examples toolbar might look like this.

7. Continue adding commands from the Pan/Zoom category until you have your own version of the built-in Tools toolbar.

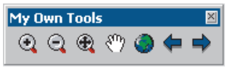
   Note that you may switch to other categories to select commands.
8. Resize the toolbar so that its width allows the display of two commands per row.

   Note that you can dock the toolbar or drag it to any of the toolbar drop sites on the application window.

Renaming a toolbar

1. In the Toolbars tab, click the name of the toolbar whose name you want to change.

   In this case, select Chapter One Examples.
2. Click the Rename button.



My Own Tools toolbar

3. In the dialog box that appears, specify My Own Tools as the new name.

   Note that you can only rename toolbars you've created.
4. Click OK.

   If you decide not to rename the toolbar, click Cancel.

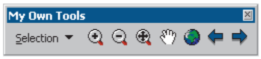
Removing buttons from a toolbar

1. Make sure the toolbar you just renamed, My Own Tools, is visible.
2. If it is not visible, display the Customize dialog box.
3. Drag some of the commands off the toolbar.

Even though you've removed the buttons from the toolbar, they are still available in the Customize dialog box.

Adding a menu to a toolbar

1. Make sure the My Own Tools toolbar is visible.
2. If it is not visible, display the Customize dialog box.
3. Click the Commands tab and choose the Menus category from the Categories list on the left-hand side of the dialog box.
4. In the Commands list at the right-hand side of the dialog box, click Selection.
5. Drag and drop it to the left of the Zoom In button on the My Own Tools toolbar.
6. Click Close in the Customize dialog box.
7. Click Selection on the My Own Tools toolbar and note the menu that appears.



Selection menu on the My Own Tools toolbar

Saving changes to a template

You can save your work to a document or template. Changes saved to a document are specific to the document, whereas changes saved to a template will be reflected in all documents based on the template.

1. Click the File menu and click Save As.
2. Navigate to the Templates folder of the <installation directory>\bin folder.
3. Click the Create New Folder button.

   Type a new name for the folder and double-click it. You'll see the folder name as a tab the next time you create a document from a template.
4. Type the template name, click ArcMap Templates (*.mxt) from the Save as type dropdown menu, then click Save.

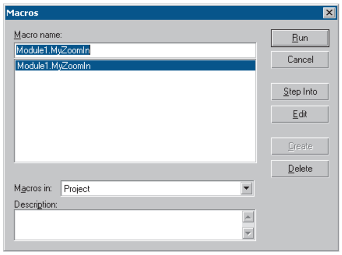
WRITING MACROS IN VBA

You can use the VBA integrated development environment to create macros to help you automate tasks you perform repeatedly or to extend the application's built-in functionality.

Creating a macro

With the Visual Basic Editor, you can edit macros, copy macros from one module to another, rename the modules that store the macros, or rename the macros.

1. Click the Tools menu, point to Macros, then click Macros.
2. In the Macros dialog, type MyZoomIn in the Macro name text box and click Create.


Macros

Macro name: Module1.MyZoomIn

Module1.MyZoomIn

Macros in: Project

Description:

The Macros dialog box

The application creates a new module named Module1 and stubs in the Sub procedure.

3. Enter the following code for *MyZoomIn:*

```
Sub MyZoomIn()
  ‘
  ‘ macro: MyZoomIn
  ‘
  Dim pDoc As IMxDocument
  Dim pEnv As IEnvelope
  Set pDoc = ThisDocument
  Set pEnv = pDoc.ActiveView.Extent
  pEnv.Expand 0.5, 0.5, True
  pDoc.ActiveView.Extent = pEnv
  pDoc.ActiveView.Refresh
End Sub
```

The first line of the macro declares a variable that represents the ArcMap document. At this point, we won’t go into the coding techniques that are used with the ArcInfo COM-based object model. These techniques are discussed in greater detail in Chapter 2, ‘Developing with ArcObjects’.

The second line declares a variable that represents a rectangle with sides parallel to a coordinate system defining the extent of the data. You’ll use *pEnv* to define the visible bounds of the map.

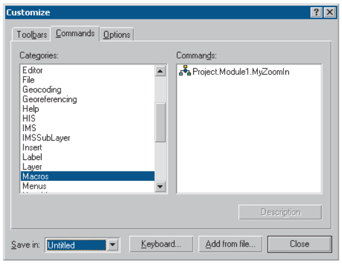
The predefined variable, *ThisDocument*, is the *IDocument* interface to the *MxDocument* object that represents the ArcMap document.

The *ActiveView* property provides an *IActiveView* interface that links the document data to the current screen display of that data.

By reducing the size of the envelope that represents the extent of the map, the macro zooms in on the map’s features once the screen display is refreshed.

4. Switch back to ArcMap by clicking the File menu, clicking Close, and clicking Return to ArcMap.
5. Click the Tools menu, point to Macros, then click Macros.
6. Select the *Module1.MyZoomIn* macro and click Run.

   The display zooms in.



The Customize dialog box

Adding a macro to a toolbar

You’ll want convenient access to the macros you write. You can add a macro to built-in toolbars or toolbars you’ve created.

1. Click the Tools menu and click Customize.
2. In the Toolbars tab, ensure that the toolbar you created is visible.
3. Click the Commands tab and select the Macros category.

4. Click the name of your project in the Save in dropdown menu.

   The commands list to the right of the dialog box lists Project.Module1.MyZoomIn.

5. Drag the macro name to the My Own Tools toolbar you created.

   The macro appears with a default icon.

6. To change its properties, right-click the icon.
7. In the context menu that appears, click Change Button Image and choose a button from the palette of icons.
8. Close the Customize dialog box.
9. Click the button to run the macro.

Invoking the Visual Basic Editor directly

As an alternative to the Create button in the Macros dialog box, you can navigate directly to the Visual Basic Editor and create procedures on your own. In this section, you'll create a macro named *MyZoomOut* in the *Module1* module that will zoom out from the display. You can use the same code that you used for *MyZoomIn*, with only a minor modification to one line.

1. Press Alt+F11, which is the Visual Basic Editor keyboard accelerator.
2. Click Project Explorer in the Visual Basic Editor View menu.
3. In the Project Explorer, click the Project entry, then Modules, then Module1.
4. In the Code Window, copy the *MyZoomIn* code from the beginning of the Sub to the End Sub.
5. Paste the *MyZoomIn* Sub code below the existing code.
6. Change the name of the copied Sub to *MyZoomOut*.
7. Change the line:

   ```
   pEnv.Expand 0.5, 0.5, True
   ```

   to:

   ```
   pEnv.Expand 2.0, 2.0, True
   ```

8. Follow steps 1–9 of the 'Adding a macro to a toolbar' section of the tutorial to add and run your second macro.

Getting help in the Code Window

The two macros you've just completed perform operations similar to the Fixed Zoom In and Fixed Zoom Out commands on the Tools toolbar. You didn't really add any new functionality, but you've perhaps learned something about the object model and how to start to write some useful code. You can learn more about the methods with which you've worked by making use of the ArcObjects Class Help that's available in the Object Browser or in the Code Window.

1. Click the Tools menu, point to Macros, then click Visual Basic Editor.
2. Locate the *Module1* module. In the *MyZoomIn* Sub, click the method name *Expand* in the line:

```
pEnv.Expand 0.5, 0.5, True
```

3. Press F1.

The ArcObjects Class Help window displays the help topic for *Expand*. In addition to ArcObjects Help, consult the ArcObjects Developer Help in the ArcGIS program group for object model diagrams, samples, tips, and tricks.

Calling built-in commands

If you've read any of the ArcGIS user guides, you know that the code you'll be writing will add functionality to what's already a rich environment. There may be instances in which you want to make use of several built-in commands executed in sequence or combine built-in commands with your own code.

Later you will learn that in ArcObjects many things are given unique identifiers.

Calling existing commands involves working with the *ArcID* module. Using the *Find* method, the code locates the unique identifier (UID) of the command in the *ArcID* module. If you want to look at the *ArcID* module in greater detail, it's in the Normal template of your application.

The Name of a command in the ArcID module can be derived using the following formula: Category In Customize Categories List + "_" + Command Caption in Customize Commands List. Any spaces are removed from the name.

The following steps outline how to write a macro that calls existing commands.

1. Click the Tools menu, point to Macros, then click Visual Basic Editor.
2. In the *Module1* module, create a Sub procedure with the following code:

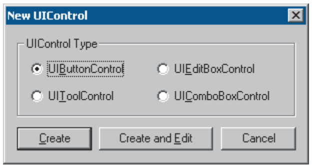
```
Sub FullExtentPlus()
  '
  ' macro: FullExtentPlus
  '
  Dim intAns As Integer
  Dim pItem As ICommandItem
  With ThisDocument.CommandBars
    Set pItem = .Find(ArcID.PanZoom_FullExtent)
    pItem.Execute
    intAns = MsgBox("Zoom to previous extent?", vbYesNo)
    If intAns = vbYes Then
      Set pItem = .Find(ArcID.PanZoom_ZoomToLastExtentBack)
      pItem.Execute
    End If
  End With
End Sub
```

3. Add the *FullExtentPlus* macro to a toolbar or menu.
4. Run the *MyZoomIn* macro and then run *FullExtentPlus*.

Creating a command in VBA

Up to this point in the tutorial, you've only created macros. A command is similar to a macro but allows more customization in the way that it interacts with the user and provides ToolTips, descriptions, and so on. Once invoked, a command usually performs some direct action without user intervention. A command is a type of UIControls. You can read more about all the UIControls in Chapter 3, 'Customizing the user interface'.

1. Click the Tools menu and click Customize.
2. In the Customize dialog box, click the Commands tab and change the Save in dropdown menu to the name of your project or to Untitled.
3. In the Categories list, select UIControls.
4. Click New UIControl.
5. In the dialog box that appears, choose UIButtonControl as the UIControl Type, then click Create and Edit.



New UIControl

UIControl Type

● UIButtonControl ○ UIEditBoxControl

○ UIToolControl ○ UIComboBoxControl

The New UIControl dialog box

Adding code for the UIToolControl

The following code assumes the UIButtonControl *was named* UIButtonControl1. *If another name was used because this name was already in use, make the necessary changes to the code snippets.*

The application adds an entry in the Object Box for the *UIButtonControl* and stubs in an event procedure for the *UIButtonControl*'s *Click* event. You'll add code to this event to zoom the display to the extents of the dataset.

1. Add the following code to the *Click* event:

```
Private Sub UIButtonControl1_Click()
  Dim pDoc As IMxDocument
  Set pDoc = ThisDocument

  pDoc.ActiveView.Extent = pDoc.ActiveView.FullExtent
  pDoc.ActiveView.Refresh
End Sub
```

   So far these is no difference to the macros you developed earlier. You will now add a ToolTip and message for the command.

2. Click Message in the Procedure combo box. This creates a stub function, to which you should add the following code:

```
Private Function UIButtonControl1_Message() As String
  UIButtonControl1_Message = _
    "Zooms the display to the full dataset extents"
End Function
```

3. Click ToolTip in the Procedure combo box. This creates a stub function, to which you should add the following code:

```
Private Function UIButtonControl1_ToolTip() As String
  UIButtonControl1_ToolTip= "Full Extent"
End Function
```

4. Click the Visual Basic Editor's File menu, click Close, then click Return to ArcMap.
5. Click the Tools menu, click Customize, then click the Commands tab.
6. In the Customize dialog box, click the Commands tab and change the Save in dropdown menu to the name of your project or to Untitled.
7. In the Categories list, choose UIControls and drag the *UIButtonControl* you created to a toolbar. Close the Customize dialog box.

Try the new command by zooming in on the map and clicking the button. Also, test the ToolTip and description properties. The ToolTip will display if you pause the cursor over the button, while the description will display in the status bar as the cursor moves over the button.

Creating a tool in VBA

Up to this point in the tutorial, you've only created commands, either with macros or *UIButtonControls*. As you've seen in the built-in toolbars and menus, users interact with other controls in addition to commands. As part of the customization environment, you can add sophisticated controls to toolbars and menus. In this section of the tutorial, you'll create a *UIToolControl* to interact with the ArcMap display.

1. Click the Tools menu and click Customize.
2. Click the Commands tab and change the Save in combo box to the name of your project or Untitled.
3. Choose UIControls from the Categories list.
4. Click New UIControl.
5. In the dialog box that appears, choose UIToolControl as the UIControl Type, then click Create and Edit.

Adding code for the *UIToolControl*

The following code assumes the UIToolControl *was named* UIToolControl1. *If another name was used because this name was already in use, make the necessary changes to the code snippets.*

The application adds an entry in the Object Box for the *UIToolControl* and stubs in an event procedure for the *UIToolControl*'s *Select* event. You won't add any code to the *Select* event procedure at this time; instead, select the *MouseDown* event in the Procedures combo box on the right-hand side of the Code Window. You'll add code to this event to enable you to drag a rectangle on the screen display; the application will zoom to the rectangle's extent.

1. Add the following code to the *MouseDown* event procedure:

```
Dim pDoc As IMxDocument
Dim pScreenDisp As IScreenDisplay
Dim pRubber As IRubberBand
Dim pEnv As IEnvelope
Set pDoc = ThisDocument
Set pScreenDisp = pDoc.ActiveView.ScreenDisplay
Set pRubber = New RubberEnvelope
Set pEnv = pRubber.TrackNew(pScreenDisp, Nothing)
pDoc.ActiveView.Extent = pEnv
pDoc.ActiveView.Refresh
```

The key line of the procedure is the one that contains the *TrackNew* method, which rubber bands a new shape on the specified screen. The code uses the *Envelope* object that the method returns to set the new extent for the map.

When you selected the *MouseDown* event procedure to add code to it, you may have noticed that *UIToolControl* supports several other events. The customization framework handles many of the details of coding for you, so you only have to code the event procedures you need. Later in Chapter 2, 'Developing with ArcObjects', you'll find that this is in contrast to what is required when implementing a tool as part of an ActiveX® DLL. A tool is not appropriate for all occasions. You can control when a tool or command is available by adding code to its Enabled event procedure.

2. Add the following code to the *UIToolControl1*'s *Enabled* event procedure:

```
Private Function UIToolControl1_Enabled() As Boolean
  Dim pDoc As IMxDocument
  Set pDoc = ThisDocument
  UIToolControl1_Enabled = (pDoc.FocusMap.LayerCount <> 0)
End Function
```

3. Add the following code to the *CursorID* event procedure to control the cursor that appears when you use the tool:

```
Private Function UIToolControl1_CursorID() As Variant
  UIToolControl1_CursorID = 3 ‘ Crosshair
End Function
```

4. Add a ToolTip and message for the tool control as you did for *UIButtonControls* in the steps above.
5. Click the Visual Basic Editor File menu, click Close, then click Return to ArcMap.
6. Click the Tools menu, click Customize, then click the Commands tab.
7. In the Customize dialog box, click the Commands tab and change the Save in dropdown menu to the name of your project, or to Untitled.
8. In the Categories list, choose UIControls and drag the *UIToolControl* that you created to a toolbar. Close the Customize dialog box.

Try out the tool by selecting it and dragging a rectangle on the display. You can also see the *Enabled* event procedure code in action if you remove all layers from the map. Once you add data back to the map, the tool will be enabled again.

Changing button properties

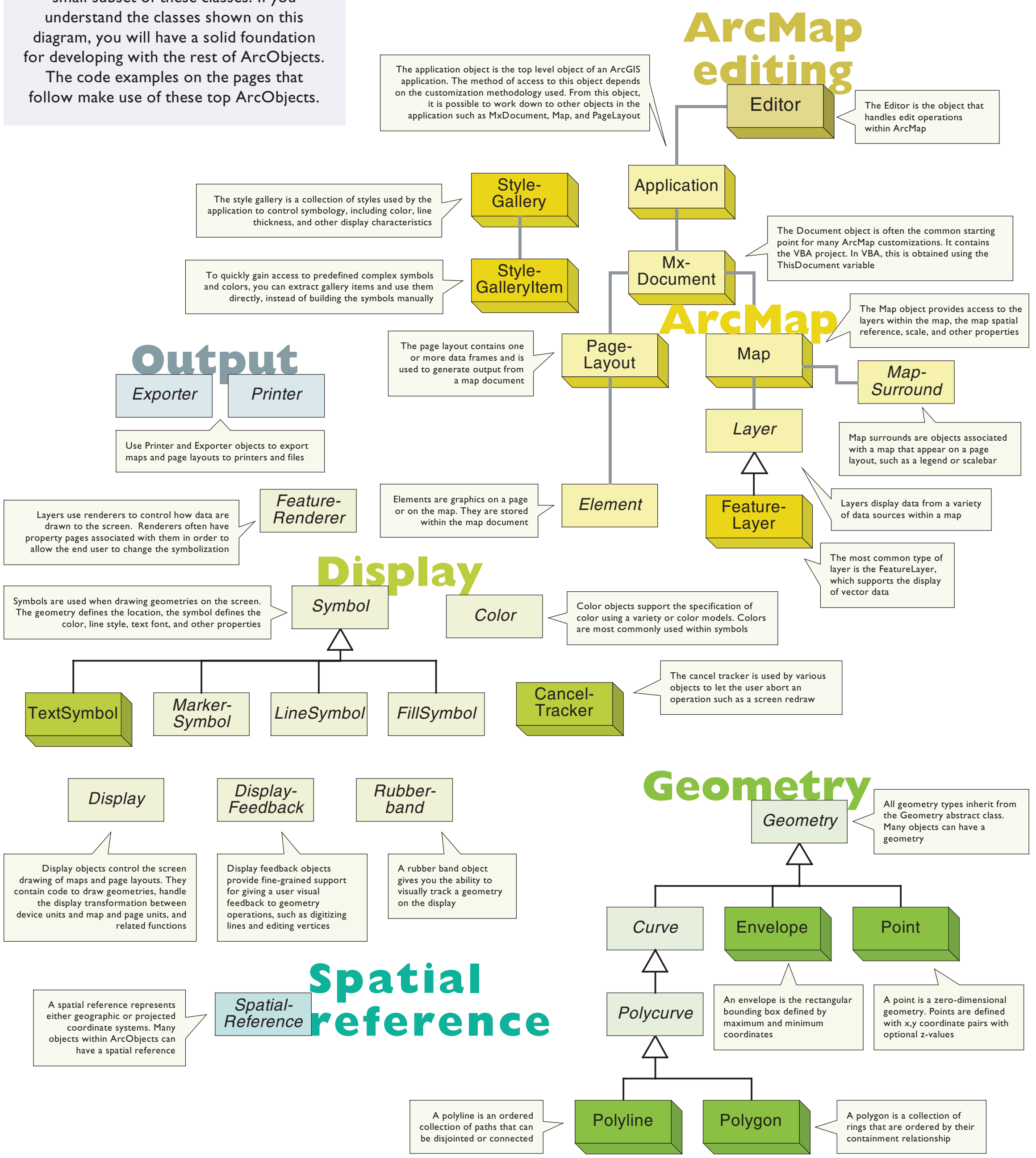
You can change the image on any toolbar button or menu command, except for a button that displays a list or a menu when you click it. You can display text, an icon, or both on a toolbar button. You can also display either an icon and text or text only on a menu command. You can change the image that represents the tool and other properties by right-clicking the button.

1. Right-click any toolbar and click Customize in the context menu that appears. Context menus are available throughout ArcMap, ArcCatalog, and ArcScene. Click the right mouse button to determine whether a context menu is available.
2. Right-click the button whose properties you want to change.
3. In the context menu that appears, click Change Button Image and choose an image. The image you chose appears on the face of the button.
4. Close the Customize dialog box.

Congratulations! You now have the basic knowledge to tackle the example code samples later in this chapter. Along with each of these code samples is a hint about where best to develop the code, either in a macro, command, or tool.

Top

ArcObjects is a large library of COM components containing many hundreds of classes. Fortunately, you can implement many common development tasks using a small subset of these classes. If you understand the classes shown on this diagram, you will have a solid foundation for developing with the rest of ArcObjects. The code examples on the pages that follow make use of these top ArcObjects.



ArcMap editing

Editor

The Editor is the object that handles edit operations within ArcMap

ArcMap

Application

The application object is the top level object of an ArcGIS application. The method of access to this object depends on the customization methodology used. From this object, it is possible to work down to other objects in the application such as MxDocument, Map, and PageLayout

StyleGallery

The style gallery is a collection of styles used by the application to control symbology, including color, line thickness, and other display characteristics

StyleGalleryItem

To quickly gain access to predefined complex symbols and colors, you can extract gallery items and use them directly, instead of building the symbols manually

MxDocument

The Document object is often the common starting point for many ArcMap customizations. It contains the VBA project. In VBA, this is obtained using the ThisDocument variable

PageLayout

The page layout contains one or more data frames and is used to generate output from a map document

Map

The Map object provides access to the layers within the map, the map spatial reference, scale, and other properties

MapSurround

Map surrounds are objects associated with a map that appear on a page layout, such as a legend or scalebar

Layer

Layers display data from a variety of data sources within a map

FeatureLayer

The most common type of layer is the FeatureLayer, which supports the display of vector data

Element

Elements are graphics on a page or on the map. They are stored within the map document

Output

Exporter

Printer

Use Printer and Exporter objects to export maps and page layouts to printers and files

Display

FeatureRenderer

Layers use renderers to control how data are drawn to the screen. Renderers often have property pages associated with them in order to allow the end user to change the symbolization

Symbol

Symbols are used when drawing geometries on the screen. The geometry defines the location, the symbol defines the color, line style, text font, and other properties

TextSymbol

MarkerSymbol

LineSymbol

FillSymbol

Color

Color objects support the specification of color using a variety or color models. Colors are most commonly used within symbols

CancelTracker

The cancel tracker is used by various objects to let the user abort an operation such as a screen redraw

Display

Display objects control the screen drawing of maps and page layouts. They contain code to draw geometries, handle the display transformation between device units and map and page units, and related functions

DisplayFeedback

Display feedback objects provide fine-grained support for giving a user visual feedback to geometry operations, such as digitizing lines and editing vertices

Rubberband

A rubber band object gives you the ability to visually track a geometry on the display

Spatial reference

SpatialReference

A spatial reference represents either geographic or projected coordinate systems. Many objects within ArcObjects can have a spatial reference

Geometry

Geometry

All geometry types inherit from the Geometry abstract class. Many objects can have a geometry

Curve

Envelope

An envelope is the rectangular bounding box defined by maximum and minimum coordinates

Point

A point is a zero-dimensional geometry. Points are defined with x,y coordinate pairs with optional z-values

Polycurve

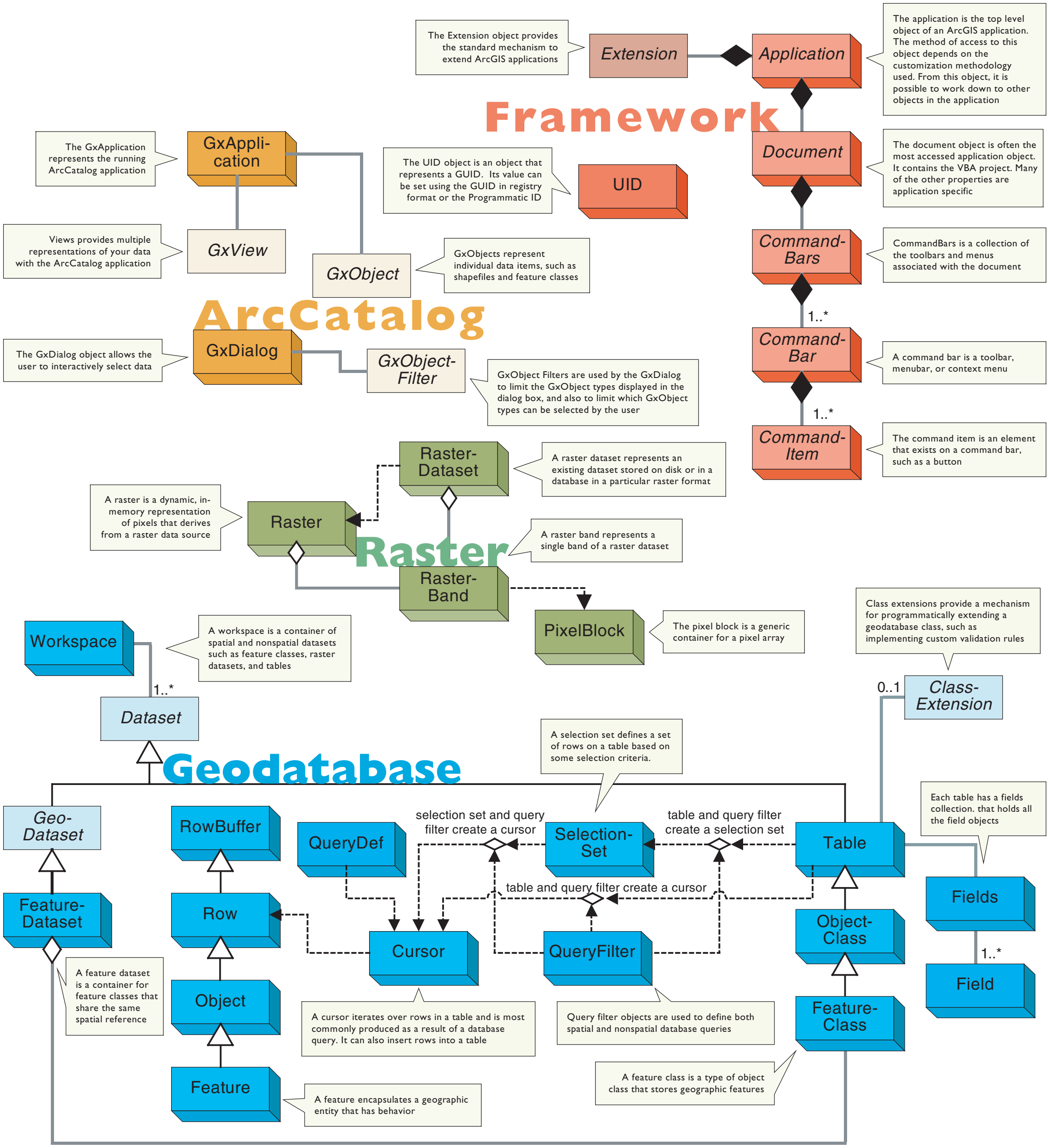
Polyline

A polyline is an ordered collection of paths that can be disjointed or connected

Polygon

A polygon is a collection of rings that are ordered by their containment relationship

ArcObjects



The Extension object provides the standard mechanism to extend ArcGIS applications

The application is the top level object of an ArcGIS application. The method of access to this object depends on the customization methodology used. From this object, it is possible to work down to other objects in the application

The document object is often the most accessed application object. It contains the VBA project. Many of the other properties are application specific

CommandBars is a collection of the toolbars and menus associated with the document

A command bar is a toolbar, menubar, or context menu

The command item is an element that exists on a command bar, such as a button

The UID object is an object that represents a GUID. Its value can be set using the GUID in registry format or the Programmatic ID

The GxApplication represents the running ArcCatalog application

Views provides multiple representations of your data with the ArcCatalog application

GxObjects represent individual data items, such as shapefiles and feature classes

The GxDialog object allows the user to interactively select data

GxObject Filters are used by the GxDialog to limit the GxObject types displayed in the dialog box, and also to limit which GxObject types can be selected by the user

A raster dataset represents an existing dataset stored on disk or in a database in a particular raster format

A raster is a dynamic, in-memory representation of pixels that derives from a raster data source

A raster band represents a single band of a raster dataset

The pixel block is a generic container for a pixel array

A workspace is a container of spatial and nonspatial datasets such as feature classes, raster datasets, and tables

Class extensions provide a mechanism for programmatically extending a geodatabase class, such as implementing custom validation rules

A selection set defines a set of rows on a table based on some selection criteria.

Each table has a fields collection. that holds all the field objects

A feature dataset is a container for feature classes that share the same spatial reference

A cursor iterates over rows in a table and is most commonly produced as a result of a database query. It can also insert rows into a table

Query filter objects are used to define both spatial and nonspatial database queries

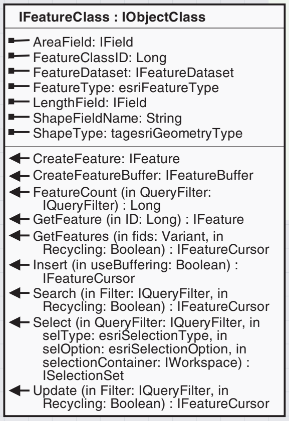
A feature class is a type of object class that stores geographic features

A feature encapsulates a geographic entity that has behavior

Reading the illustrated code samples

The illustrated code samples in this section show you the fundamentals of programming with COM components in ArcObjects. Start by entering the VBA environment in ArcMap or ArcCatalog and type in the code. Step through the code in the VBA debugger. Look at these pages and study the relationships between coclasses and interfaces. A careful reading of the samples in this section gives you all the important concepts you need for developing with ArcObjects, as well as an introduction to the most important ArcObjects components.

The interface

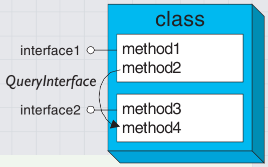

IFeatureClass : IObjectClass
AreaField: IField
FeatureClassID: Long
FeatureDataset: IFeatureDataset
FeatureType: esriFeatureType
LengthField: IField
ShapeFieldName: String
ShapeType: tagesriGeometryType
CreateFeature: IFeature
CreateFeatureBuffer: IFeatureBuffer
FeatureCount (in QueryFilter: IQueryFilter) : Long
GetFeature (in ID: Long) : IFeature
GetFeatures (in fids: Variant, in Recycling: Boolean) : IFeatureCursor
Insert (in useBuffering: Boolean) : IFeatureCursor
Search (in Filter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor
Select (in QueryFilter: IQueryFilter, in selType: esriSelectionType, in selOption: esriSelectionOption, in selectionContainer: IWorkspace) : ISelectionSet
Update (in Filter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor

An interface is a specification of properties and methods. Many coclasses can implement the same interface. Interfaces allow a high degree of interoperability and shared behavior among a set of objects.

AreaField is a return property of type *IField*. *FeatureClassID* is of type *long*.

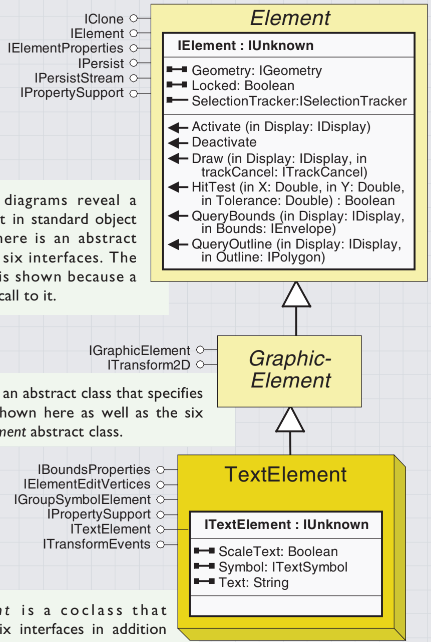
The *CreateFeature* method creates an object of type *IFeature*. *FeatureCount* takes in a query filter and returns a *long*.

QueryInterface



QueryInterface is a method in the *IUnknown* interface, which all COM objects inherit from. This method lets you query for and navigate to methods in other interfaces implemented by an object.

Type inheritance

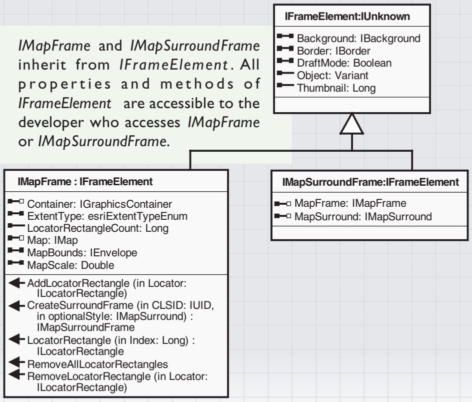


The object model diagrams reveal a structure not evident in standard object browsers. Shown here is an abstract class, *Element,* with six interfaces. The *IElement* interface is shown because a code sample made a call to it.

A *GraphicElement* is an abstract class that specifies the two interfaces shown here as well as the six interfaces on the *Element* abstract class.

TextElement is a coclass that implements six interfaces in addition to the two from *GraphicElement* and six from *Element.*

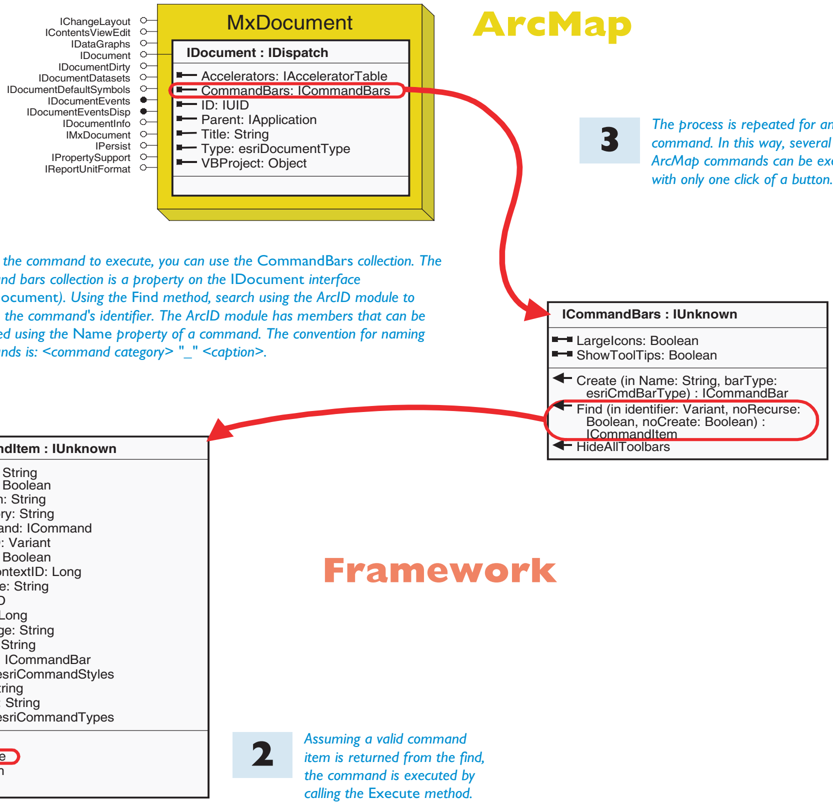
Interface inheritance


IFrameElement:IUnknown
Background: IBackground
Border: IBorder
DraftMode: Boolean
Object: Variant
Thumbnail: Long
IMapFrame : IFrameElement
Container: IGraphicsContainer
ExtentType: esriExtentTypeEnum
LocatorRectangleCount: Long
Map: IMap
MapBounds: IEnvelope
MapScale: Double
AddLocatorRectangle (in Locator: ILocatorRectangle)
CreateSurroundFrame (in CLSID: IUID, in optionalStyle: IMapSurround) : IMapSurroundFrame
LocatorRectangle (in Index: Long) : ILocatorRectangle
RemoveAllLocatorRectangles
RemoveLocatorRectangle (in Locator: ILocatorRectangle)
IMapSurroundFrame:IFrameElement
MapFrame: IMapFrame
MapSurround: IMapSurround

IMapFrame and *IMapSurroundFrame* inherit from *IFrameElement*. All properties and methods of *IFrameElement* are accessible to the developer who accesses *IMapFrame* or *IMapSurroundFrame.*

Locate and Execute Command on Toolbar

This sample illustrates how to programmatically execute existing commands on command bars within ArcMap.



1 *To find the command to execute, you can use the CommandBars collection. The command bars collection is a property on the IDocument interface (ThisDocument). Using the Find method, search using the ArcID module to provide the command's identifier. The ArcID module has members that can be identified using the Name property of a command. The convention for naming commands is: <command category> "_" <caption>.*

2 *Assuming a valid command item is returned from the find, the command is executed by calling the Execute method.*

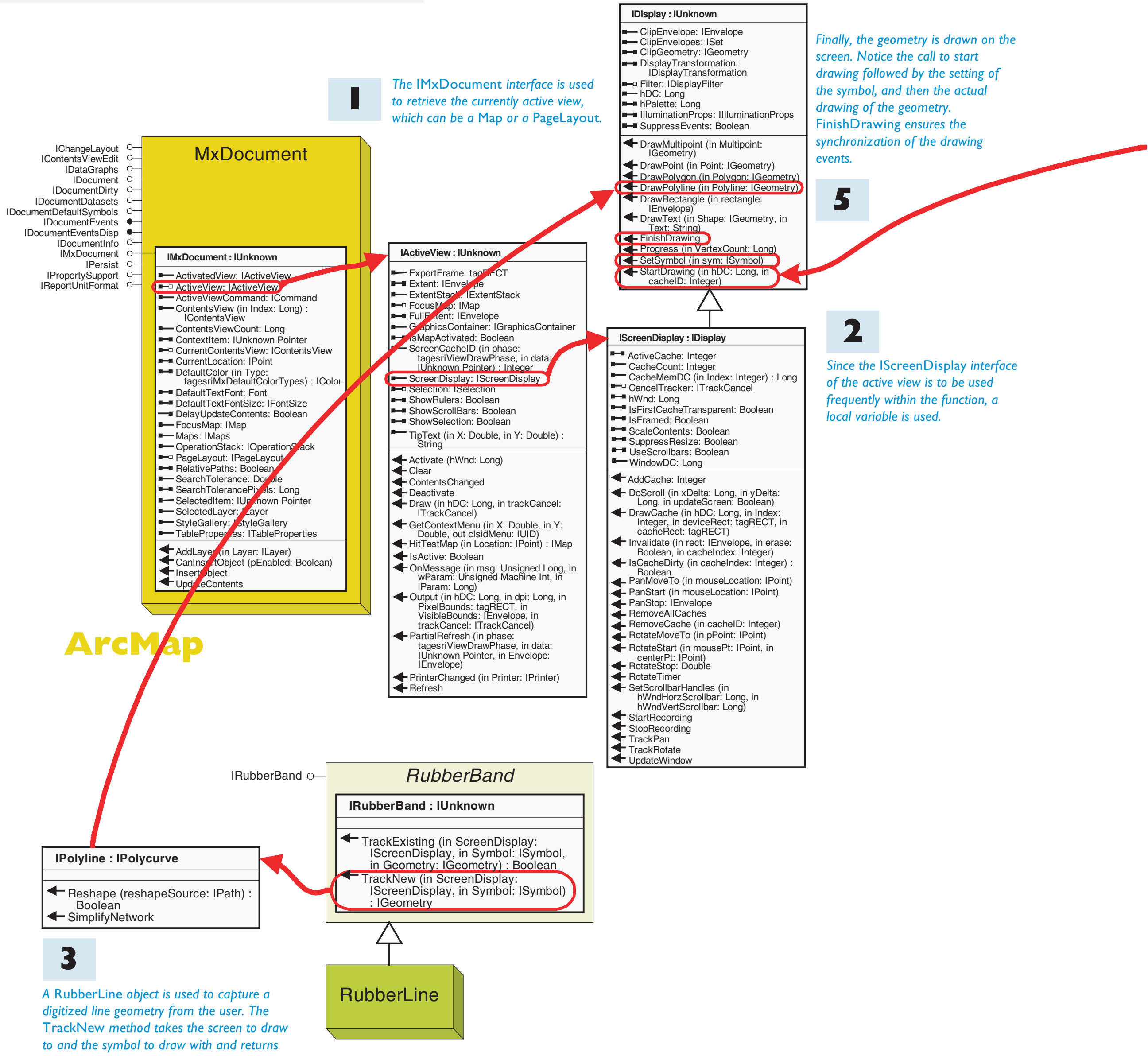
3 *The process is repeated for another command. In this way, several existing ArcMap commands can be executed with only one click of a button.*

Add this code to the Click event of a command in ArcMap.

```
    Dim pCommandItem As ICommandItem

1   Set pCommandItem = ThisDocument.CommandBars.Find(ArcID.Query_ZoomToSelected)
    If (pCommandItem Is Nothing) Then Exit Sub
2   pCommandItem.Execute

3   Set pCommandItem = ThisDocument.CommandBars.Find(ArcID.ReportObject_CreateReport)
    If (pCommandItem Is Nothing) Then Exit Sub
    pCommandItem.Execute
```

Draw digitized line on screen

This sample uses a rubber banding line to obtain a digitized line geometry. With the geometry created, a symbol is created. The symbol is set as the current display symbol and the line is drawn. The color thickness and the style of the line symbol are set.



IChangeLayout
IContentsViewEdit
IDataGraphs
IDocument
IDocumentDirty
IDocumentDatasets
IDocumentDefaultSymbols
IDocumentEvents
IDocumentEventsDisp
IDocumentInfo
IMxDocument
IPersist
IPropertySupport
IReportUnitFormat
MxDocument
IMxDocument : IUnknown
ActivatedView: IActiveView
ActiveView: IActiveView
ActiveViewCommand: ICommand
ContentsView (in Index: Long) : IContentsView
ContentsViewCount: Long
ContextItem: IUnknown Pointer
CurrentContentsView: IContentsView
CurrentLocation: IPoint
DefaultColor (in Type: tagesriMxDefaultColorTypes) : IColor
DefaultTextFont: Font
DefaultTextFontSize: IFontSize
DelayUpdateContents: Boolean
FocusMap: IMap
Maps: IMaps
OperationStack: IOperationStack
PageLayout: IPageLayout
RelativePaths: Boolean
SearchTolerance: Double
SearchTolerancePixels: Long
SelectedItem: IUnknown Pointer
SelectedLayer: ILayer
StyleGallery: IStyleGallery
TableProperties: ITableProperties
AddLayer (in Layer: ILayer)
CanInsertObject (pEnabled: Boolean)
InsertObject
UpdateContents
ArcMap
IActiveView : IUnknown
ExportFrame: tagRECT
Extent: IEnvelope
ExtentStack: IExtentStack
FocusMap: IMap
FullExtent: IEnvelope
GraphicsContainer: IGraphicsContainer
IsMapActivated: Boolean
ScreenCacheID (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer) : Integer
ScreenDisplay: IScreenDisplay
Selection: ISelection
ShowRulers: Boolean
ShowScrollBars: Boolean
ShowSelection: Boolean
TipText (in X: Double, in Y: Double) : String
Activate (hWnd: Long)
Clear
ContentsChanged
Deactivate
Draw (in hDC: Long, in trackCancel: ITrackCancel)
GetContextMenu (in X: Double, in Y: Double, out clsidMenu: IUID)
HitTestMap (in Location: IPoint) : IMap
IsActive: Boolean
OnMessage (in msg: Unsigned Long, in wParam: Unsigned Machine Int, in lParam: Long)
Output (in hDC: Long, in dpi: Long, in PixelBounds: tagRECT, in VisibleBounds: IEnvelope, in trackCancel: ITrackCancel)
PartialRefresh (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer, in Envelope: IEnvelope)
PrinterChanged (in Printer: IPrinter)
Refresh
IDisplay : IUnknown
ClipEnvelope: IEnvelope
ClipEnvelopes: ISet
ClipGeometry: IGeometry
DisplayTransformation: IDisplayTransformation
Filter: IDisplayFilter
hDC: Long
hPalette: Long
IlluminationProps: IIlluminationProps
SuppressEvents: Boolean
DrawMultipoint (in Multipoint: IGeometry)
DrawPoint (in Point: IGeometry)
DrawPolygon (in Polygon: IGeometry)
DrawPolyline (in Polyline: IGeometry)
DrawRectangle (in rectangle: IEnvelope)
DrawText (in Shape: IGeometry, in Text: String)
FinishDrawing
Progress (in VertexCount: Long)
SetSymbol (in sym: ISymbol)
StartDrawing (in hDC: Long, in cacheID: Integer)
IScreenDisplay : IDisplay
ActiveCache: Integer
CacheCount: Integer
CacheMemDC (in Index: Integer) : Long
CancelTracker: ITrackCancel
hWnd: Long
IsFirstCacheTransparent: Boolean
IsFramed: Boolean
ScaleContents: Boolean
SuppressResize: Boolean
UseScrollbars: Boolean
WindowDC: Long
AddCache: Integer
DoScroll (in xDelta: Long, in yDelta: Long, in updateScreen: Boolean)
DrawCache (in hDC: Long, in Index: Integer, in deviceRect: tagRECT, in cacheRect: tagRECT)
Invalidate (in rect: IEnvelope, in erase: Boolean, in cacheIndex: Integer)
IsCacheDirty (in cacheIndex: Integer) : Boolean
PanMoveTo (in mouseLocation: IPoint)
PanStart (in mouseLocation: IPoint)
PanStop: IEnvelope
RemoveAllCaches
RemoveCache (in cacheID: Integer)
RotateMoveTo (in pPoint: IPoint)
RotateStart (in mousePt: IPoint, in centerPt: IPoint)
RotateStop: Double
RotateTimer
SetScrollbarHandles (in hWndHorzScrollbar: Long, in hWndVertScrollbar: Long)
StartRecording
StopRecording
TrackPan
TrackRotate
UpdateWindow
IRubberBand
RubberBand
IRubberBand : IUnknown
TrackExisting (in ScreenDisplay: IScreenDisplay, in Symbol: ISymbol, in Geometry: IGeometry) : Boolean
TrackNew (in ScreenDisplay: IScreenDisplay, in Symbol: ISymbol) : IGeometry
RubberLine
IPolyline : IPolycurve
Reshape (reshapeSource: IPath) : Boolean
SimplifyNetwork

1 *The* IMxDocument *interface is used to retrieve the currently active view, which can be a* Map *or a* PageLayout*.*

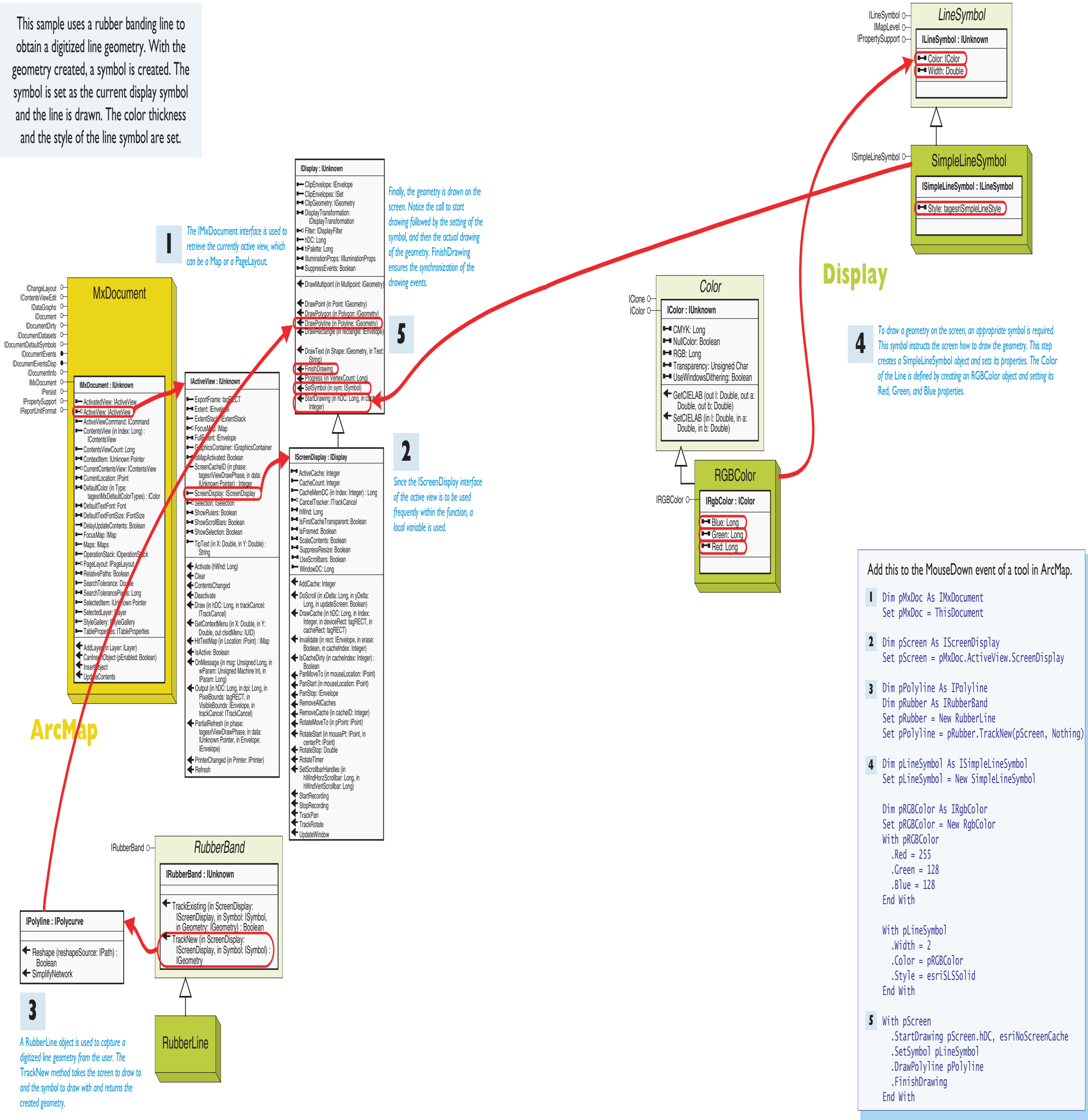
2 *Since the* IScreenDisplay *interface of the active view is to be used frequently within the function, a local variable is used.*

3 *A* RubberLine *object is used to capture a digitized line geometry from the user. The* TrackNew *method takes the screen to draw to and the symbol to draw with and returns the created geometry.*

5 *Finally, the geometry is drawn on the screen. Notice the call to start drawing followed by the setting of the symbol, and then the actual drawing of the geometry.* FinishDrawing *ensures the synchronization of the drawing events.*

Draw Digitized Line on Screen

This sample uses a rubber banding line to obtain a digitized line geometry. With the geometry created, a symbol is created. The symbol is set as the current display symbol and the line is drawn. The color thickness and the style of the line symbol are set.



MxDocument
IChangeLayout
IContentsViewEdit
IDataGraphs
IDocument
IDocumentDirty
IDocumentDatasets
IDocumentDefaultSymbols
IDocumentEvents
IDocumentEventsDisp
IDocumentInfo
IMxDocument
IPersist
IPropertySupport
IReportUnitFormat
IMxDocument : IUnknown
ActivatedView: IActiveView
ActiveView: IActiveView
ActiveViewCommand: ICommand
ContentsView (in Index: Long) : IContentsView
ContentsViewCount: Long
ContextItem: IUnknown Pointer
CurrentContentsView: IContentsView
CurrentLocation: IPoint
DefaultColor (in Type: tagesriMxDefaultColorTypes) : IColor
DefaultTextFont: Font
DefaultTextFontSize: IFontSize
DelayUpdateContents: Boolean
FocusMap: IMap
Maps: IMaps
OperationStack: IOperationStack
PageLayout: IPageLayout
RelativePaths: Boolean
SearchTolerance: Double
SearchTolerancePixels: Long
SelectedItem: IUnknown Pointer
SelectedLayer: ILayer
StyleGallery: IStyleGallery
TableProperties: ITableProperties
AddLayer (in Layer: ILayer)
CanInsertObject (pEnabled: Boolean)
InsertObject
UpdateContents
ArcMap
IActiveView : IUnknown
ExportFrame: tagRECT
Extent: IEnvelope
ExtentStack: IExtentStack
FocusMap: IMap
FullExtent: IEnvelope
GraphicsContainer: IGraphicsContainer
IsMapActivated: Boolean
ScreenCacheID (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer) : Integer
ScreenDisplay: IScreenDisplay
Selection: ISelection
ShowRulers: Boolean
ShowScrollBars: Boolean
ShowSelection: Boolean
TipText (in X: Double, in Y: Double) : String
Activate (hWnd: Long)
Clear
ContentsChanged
Deactivate
Draw (in hDC: Long, in trackCancel: ITrackCancel)
GetContextMenu (in X: Double, in Y: Double, out clsidMenu: IUID)
HitTestMap (in Location: IPoint) : IMap
IsActive: Boolean
OnMessage (in msg: Unsigned Long, in wParam: Unsigned Machine Int, in lParam: Long)
Output (in hDC: Long, in dpi: Long, in PixelBounds: tagRECT, in VisibleBounds: IEnvelope, in trackCancel: ITrackCancel)
PartialRefresh (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer, in Envelope: IEnvelope)
PrinterChanged (in Printer: IPrinter)
Refresh
IDisplay : IUnknown
ClipEnvelope: IEnvelope
ClipEnvelopes: ISet
ClipGeometry: IGeometry
DisplayTransformation: IDisplayTransformation
Filter: IDisplayFilter
hDC: Long
hPalette: Long
IlluminationProps: IIlluminationProps
SuppressEvents: Boolean
DrawMultipoint (in Multipoint: IGeometry)
DrawPoint (in Point: IGeometry)
DrawPolygon (in Polygon: IGeometry)
DrawPolyline (in Polyline: IGeometry)
DrawRectangle (in rectangle: IEnvelope)
DrawText (in Shape: IGeometry, in Text: String)
FinishDrawing
Progress (in VertexCount: Long)
SetSymbol (in sym: ISymbol)
StartDrawing (in hDC: Long, in cacheID: Integer)
IScreenDisplay : IDisplay
ActiveCache: Integer
CacheCount: Integer
CacheMemDC (in Index: Integer) : Long
CancelTracker: ITrackCancel
hWnd: Long
IsFirstCacheTransparent: Boolean
IsFramed: Boolean
ScaleContents: Boolean
SuppressResize: Boolean
UseScrollbars: Boolean
WindowDC: Long
AddCache: Integer
DoScroll (in xDelta: Long, in yDelta: Long, in updateScreen: Boolean)
DrawCache (in hDC: Long, in Index: Integer, in deviceRect: tagRECT, in cacheRect: tagRECT)
Invalidate (in rect: IEnvelope, in erase: Boolean, in cacheIndex: Integer)
IsCacheDirty (in cacheIndex: Integer) : Boolean
PanMoveTo (in mouseLocation: IPoint)
PanStart (in mouseLocation: IPoint)
PanStop: IEnvelope
RemoveAllCaches
RemoveCache (in cacheID: Integer)
RotateMoveTo (in pPoint: IPoint)
RotateStart (in mousePt: IPoint, in centerPt: IPoint)
RotateStop: Double
RotateTimer
SetScrollbarHandles (in hWndHorzScrollbar: Long, in hWndVertScrollbar: Long)
StartRecording
StopRecording
TrackPan
TrackRotate
UpdateWindow
RubberBand
IRubberBand
IRubberBand : IUnknown
TrackExisting (in ScreenDisplay: IScreenDisplay, in Symbol: ISymbol, in Geometry: IGeometry) : Boolean
TrackNew (in ScreenDisplay: IScreenDisplay, in Symbol: ISymbol) : IGeometry
RubberLine
IPolyline : IPolycurve
Reshape (reshapeSource: IPath) : Boolean
SimplifyNetwork
Color
IClone
IColor
IColor : IUnknown
CMYK: Long
NullColor: Boolean
RGB: Long
Transparency: Unsigned Char
UseWindowsDithering: Boolean
GetCIELAB (out l: Double, out a: Double, out b: Double)
SetCIELAB (in l: Double, in a: Double, in b: Double)
RGBColor
IRGBColor
IRgbColor : IColor
Blue: Long
Green: Long
Red: Long
LineSymbol
ILineSymbol
IMapLevel
IPropertySupport
ILineSymbol : IUnknown
Color: IColor
Width: Double
SimpleLineSymbol
ISimpleLineSymbol
ISimpleLineSymbol : ILineSymbol
Style: tagesriSimpleLineStyle
Display

1 *The IMxDocument interface is used to retrieve the currently active view, which can be a Map or a PageLayout.*

2 *Since the IScreenDisplay interface of the active view is to be used frequently within the function, a local variable is used.*

3 *A RubberLine object is used to capture a digitized line geometry from the user. The TrackNew method takes the screen to draw to and the symbol to draw with and returns the created geometry.*

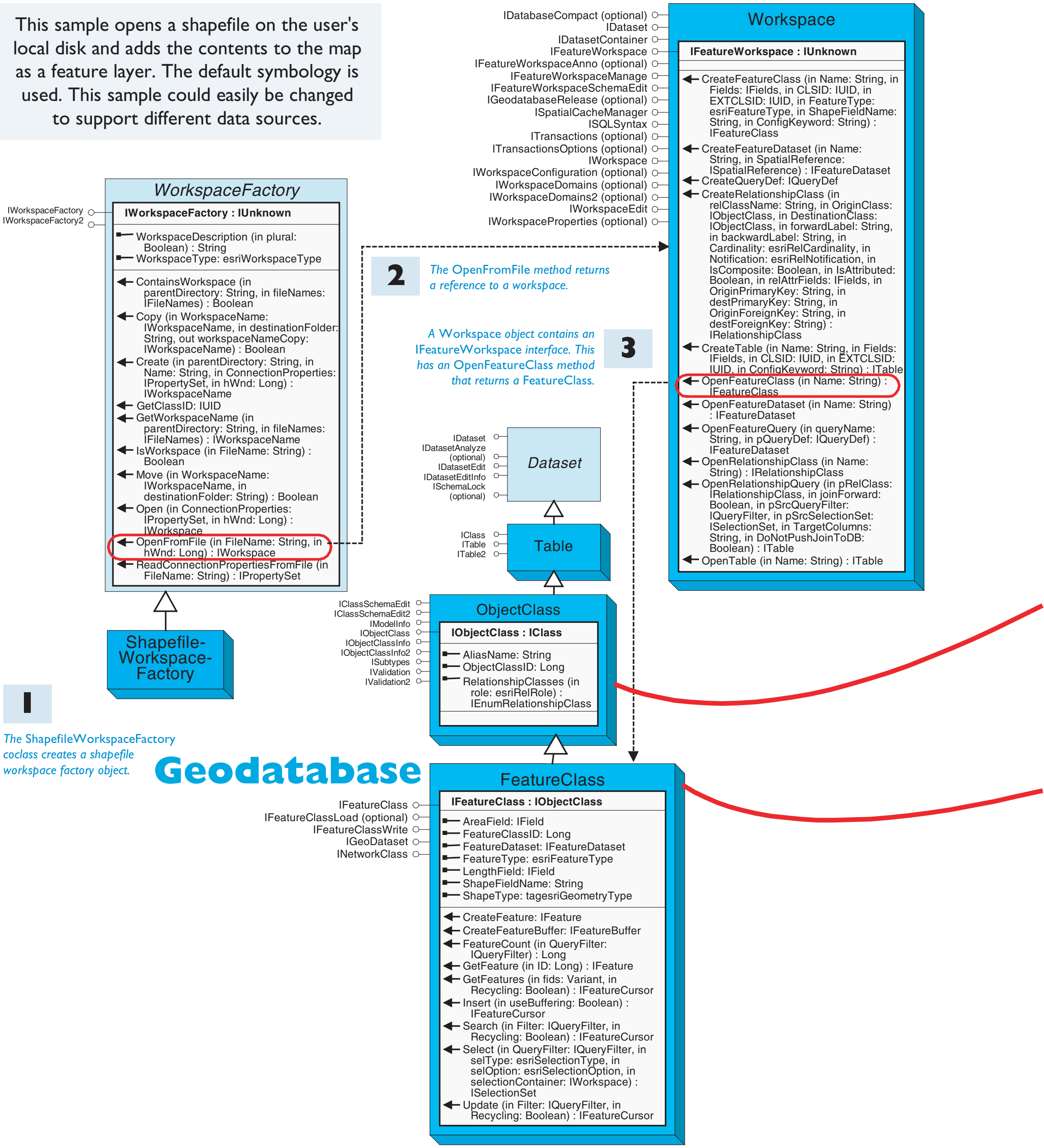
4 *To draw a geometry on the screen, an appropriate symbol is required. This symbol instructs the screen how to draw the geometry. This step creates a SimpleLineSymbol object and sets its properties. The Color of the Line is defined by creating an RGBColor object and setting its Red, Green, and Blue properties.*

5 *Finally, the geometry is drawn on the screen. Notice the call to start drawing followed by the setting of the symbol, and then the actual drawing of the geometry. FinishDrawing ensures the synchronization of the drawing events.*

Add this to the MouseDown event of a tool in ArcMap.

```
1  Dim pMxDoc As IMxDocument
   Set pMxDoc = ThisDocument

2  Dim pScreen As IScreenDisplay
   Set pScreen = pMxDoc.ActiveView.ScreenDisplay

3  Dim pPolyline As IPolyline
   Dim pRubber As IRubberBand
   Set pRubber = New RubberLine
   Set pPolyline = pRubber.TrackNew(pScreen, Nothing)

4  Dim pLineSymbol As ISimpleLineSymbol
   Set pLineSymbol = New SimpleLineSymbol

   Dim pRGBColor As IRgbColor
   Set pRGBColor = New RgbColor
   With pRGBColor
     .Red = 255
     .Green = 128
     .Blue = 128
   End With

   With pLineSymbol
     .Width = 2
     .Color = pRGBColor
     .Style = esriSLSSolid
   End With

5  With pScreen
     .StartDrawing pScreen.hDC, esriNoScreenCache
     .SetSymbol pLineSymbol
     .DrawPolyline pPolyline
     .FinishDrawing
   End With
```

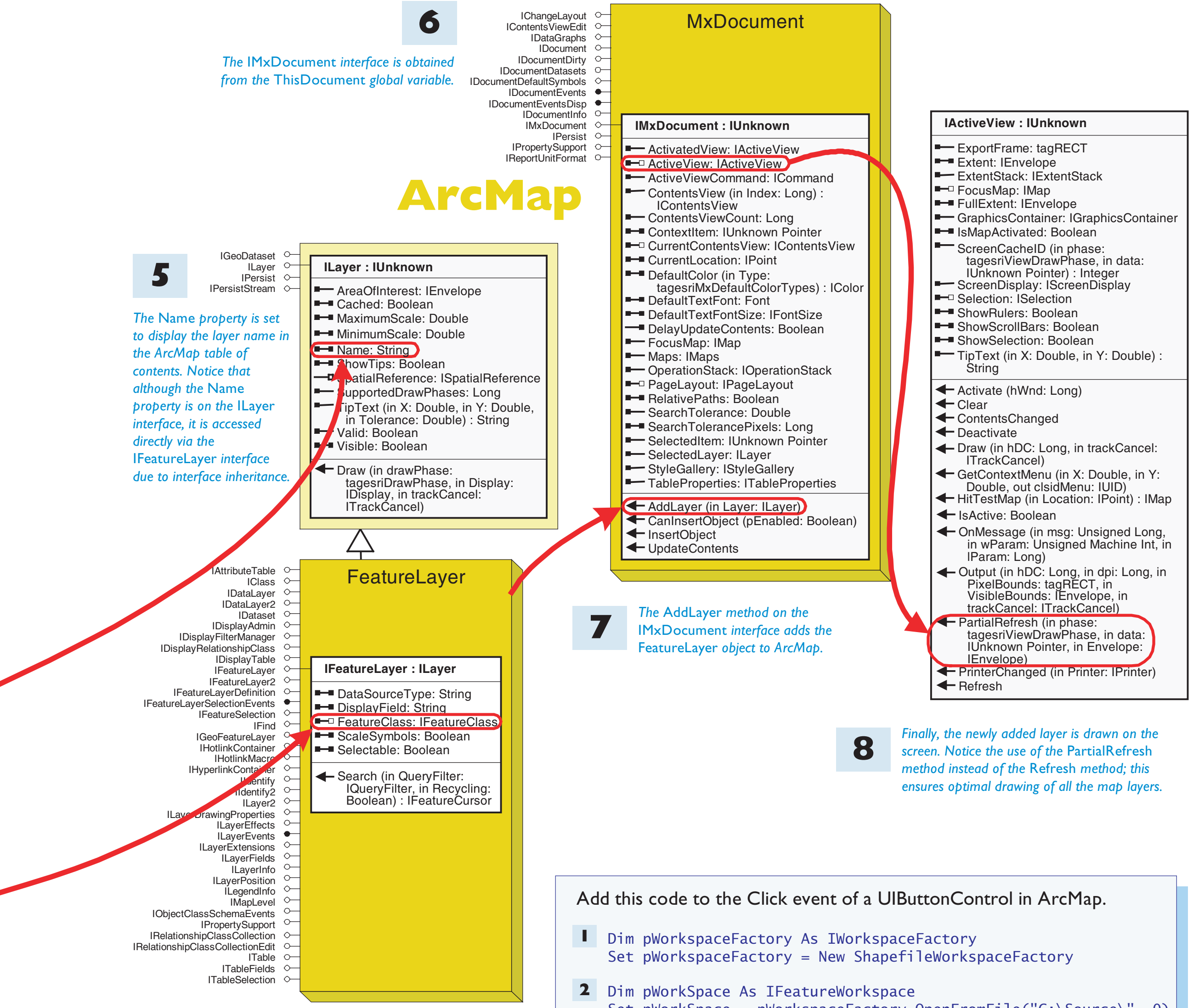
This sample opens a shapefile on the user's local disk and adds the contents to the map as a feature layer. The default symbology is used. This sample could easily be changed to support different data sources.


Workspace
IFeatureWorkspace : IUnknown
IDatabaseCompact (optional)
IDataset
IDatasetContainer
IFeatureWorkspace
IFeatureWorkspaceAnno (optional)
IFeatureWorkspaceManage
IFeatureWorkspaceSchemaEdit
IGeodatabaseRelease (optional)
ISpatialCacheManager
ISQLSyntax
ITransactions (optional)
ITransactionsOptions (optional)
IWorkspace
IWorkspaceConfiguration (optional)
IWorkspaceDomains (optional)
IWorkspaceDomains2 (optional)
IWorkspaceEdit
IWorkspaceProperties (optional)
CreateFeatureClass (in Name: String, in Fields: IFields, in CLSID: IUID, in EXTCLSID: IUID, in FeatureType: esriFeatureType, in ShapeFieldName: String, in ConfigKeyword: String) : IFeatureClass
CreateFeatureDataset (in Name: String, in SpatialReference: ISpatialReference) : IFeatureDataset
CreateQueryDef: IQueryDef
CreateRelationshipClass (in relClassName: String, in OriginClass: IObjectClass, in DestinationClass: IObjectClass, in forwardLabel: String, in backwardLabel: String, in Cardinality: esriRelCardinality, in Notification: esriRelNotification, in IsComposite: Boolean, in IsAttributed: Boolean, in relAttrFields: IFields, in OriginPrimaryKey: String, in destPrimaryKey: String, in OriginForeignKey: String, in destForeignKey: String) : IRelationshipClass
CreateTable (in Name: String, in Fields: IFields, in CLSID: IUID, in EXTCLSID: IUID, in ConfigKeyword: String) : ITable
OpenFeatureClass (in Name: String) : IFeatureClass
OpenFeatureDataset (in Name: String) : IFeatureDataset
OpenFeatureQuery (in queryName: String, in pQueryDef: IQueryDef) : IFeatureDataset
OpenRelationshipClass (in Name: String) : IRelationshipClass
OpenRelationshipQuery (in pRelClass: IRelationshipClass, in joinForward: Boolean, in pSrcQueryFilter: IQueryFilter, in pSrcSelectionSet: ISelectionSet, in TargetColumns: String, in DoNotPushJoinToDB: Boolean) : ITable
OpenTable (in Name: String) : ITable
WorkspaceFactory
IWorkspaceFactory
IWorkspaceFactory2
IWorkspaceFactory : IUnknown
WorkspaceDescription (in plural: Boolean) : String
WorkspaceType: esriWorkspaceType
ContainsWorkspace (in parentDirectory: String, in fileNames: IFileNames) : Boolean
Copy (in WorkspaceName: IWorkspaceName, in destinationFolder: String, out workspaceNameCopy: IWorkspaceName) : Boolean
Create (in parentDirectory: String, in Name: String, in ConnectionProperties: IPropertySet, in hWnd: Long) : IWorkspaceName
GetClassID: IUID
GetWorkspaceName (in parentDirectory: String, in fileNames: IFileNames) : IWorkspaceName
IsWorkspace (in FileName: String) : Boolean
Move (in WorkspaceName: IWorkspaceName, in destinationFolder: String) : Boolean
Open (in ConnectionProperties: IPropertySet, in hWnd: Long) : IWorkspace
OpenFromFile (in FileName: String, in hWnd: Long) : IWorkspace
ReadConnectionPropertiesFromFile (in FileName: String) : IPropertySet
Shapefile-Workspace-Factory
IDataset
IDatasetAnalyze (optional)
IDatasetEdit
IDatasetEditInfo
ISchemaLock (optional)
Dataset
IClass
ITable
ITable2
Table
IClassSchemaEdit
IClassSchemaEdit2
IModelInfo
IObjectClass
IObjectClassInfo
IObjectClassInfo2
ISubtypes
IValidation
IValidation2
ObjectClass
IObjectClass : IClass
AliasName: String
ObjectClassID: Long
RelationshipClasses (in role: esriRelRole) : IEnumRelationshipClass
Geodatabase
FeatureClass
IFeatureClass
IFeatureClassLoad (optional)
IFeatureClassWrite
IGeoDataset
INetworkClass
IFeatureClass : IObjectClass
AreaField: IField
FeatureClassID: Long
FeatureDataset: IFeatureDataset
FeatureType: esriFeatureType
LengthField: IField
ShapeFieldName: String
ShapeType: tagesriGeometryType
CreateFeature: IFeature
CreateFeatureBuffer: IFeatureBuffer
FeatureCount (in QueryFilter: IQueryFilter) : Long
GetFeature (in ID: Long) : IFeature
GetFeatures (in fids: Variant, in Recycling: Boolean) : IFeatureCursor
Insert (in useBuffering: Boolean) : IFeatureCursor
Search (in Filter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor
Select (in QueryFilter: IQueryFilter, in selType: esriSelectionType, in selOption: esriSelectionOption, in selectionContainer: IWorkspace) : ISelectionSet
Update (in Filter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor

2 *The OpenFromFile method returns a reference to a workspace.*

A Workspace object contains an IFeatureWorkspace interface. This has an OpenFeatureClass method that returns a FeatureClass. **3**

1 *The ShapefileWorkspaceFactory coclass creates a shapefile workspace factory object.*


MxDocument
IChangeLayout
IContentsViewEdit
IDataGraphs
IDocument
IDocumentDirty
IDocumentDatasets
IDocumentDefaultSymbols
IDocumentEvents
IDocumentEventsDisp
IDocumentInfo
IMxDocument
IPersist
IPropertySupport
IReportUnitFormat
IMxDocument : IUnknown
ActivatedView: IActiveView
ActiveView: IActiveView
ActiveViewCommand: ICommand
ContentsView (in Index: Long) : IContentsView
ContentsViewCount: Long
ContextItem: IUnknown Pointer
CurrentContentsView: IContentsView
CurrentLocation: IPoint
DefaultColor (in Type: tagesriMxDefaultColorTypes) : IColor
DefaultTextFont: Font
DefaultTextFontSize: IFontSize
DelayUpdateContents: Boolean
FocusMap: IMap
Maps: IMaps
OperationStack: IOperationStack
PageLayout: IPageLayout
RelativePaths: Boolean
SearchTolerance: Double
SearchTolerancePixels: Long
SelectedItem: IUnknown Pointer
SelectedLayer: ILayer
StyleGallery: IStyleGallery
TableProperties: ITableProperties
AddLayer (in Layer: ILayer)
CanInsertObject (pEnabled: Boolean)
InsertObject
UpdateContents
IActiveView : IUnknown
ExportFrame: tagRECT
Extent: IEnvelope
ExtentStack: IExtentStack
FocusMap: IMap
FullExtent: IEnvelope
GraphicsContainer: IGraphicsContainer
IsMapActivated: Boolean
ScreenCacheID (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer) : Integer
ScreenDisplay: IScreenDisplay
Selection: ISelection
ShowRulers: Boolean
ShowScrollBars: Boolean
ShowSelection: Boolean
TipText (in X: Double, in Y: Double) : String
Activate (hWnd: Long)
Clear
ContentsChanged
Deactivate
Draw (in hDC: Long, in trackCancel: ITrackCancel)
GetContextMenu (in X: Double, in Y: Double, out clsidMenu: IUID)
HitTestMap (in Location: IPoint) : IMap
IsActive: Boolean
OnMessage (in msg: Unsigned Long, in wParam: Unsigned Machine Int, in lParam: Long)
Output (in hDC: Long, in dpi: Long, in PixelBounds: tagRECT, in VisibleBounds: IEnvelope, in trackCancel: ITrackCancel)
PartialRefresh (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer, in Envelope: IEnvelope)
PrinterChanged (in Printer: IPrinter)
Refresh
ArcMap
IGeoDataset
ILayer
IPersist
IPersistStream
ILayer : IUnknown
AreaOfInterest: IEnvelope
Cached: Boolean
MaximumScale: Double
MinimumScale: Double
Name: String
ShowTips: Boolean
SpatialReference: ISpatialReference
SupportedDrawPhases: Long
TipText (in X: Double, in Y: Double, in Tolerance: Double) : String
Valid: Boolean
Visible: Boolean
Draw (in drawPhase: tagesriDrawPhase, in Display: IDisplay, in trackCancel: ITrackCancel)
FeatureLayer
IAttributeTable
IClass
IDataLayer
IDataLayer2
IDataset
IDisplayAdmin
IDisplayFilterManager
IDisplayRelationshipClass
IDisplayTable
IFeatureLayer
IFeatureLayer2
IFeatureLayerDefinition
IFeatureLayerSelectionEvents
IFeatureSelection
IFind
IGeoFeatureLayer
IHotlinkContainer
IHotlinkMacro
IHyperlinkContainer
IIdentify
IIdentify2
ILayer2
ILayerDrawingProperties
ILayerEffects
ILayerEvents
ILayerExtensions
ILayerFields
ILayerInfo
ILayerPosition
ILegendInfo
IMapLevel
IObjectClassSchemaEvents
IPropertySupport
IRelationshipClassCollection
IRelationshipClassCollectionEdit
ITable
ITableFields
ITableSelection
IFeatureLayer : ILayer
DataSourceType: String
DisplayField: String
FeatureClass: IFeatureClass
ScaleSymbols: Boolean
Selectable: Boolean
Search (in QueryFilter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor

6 *The IMxDocument interface is obtained from the ThisDocument global variable.*

5 *The Name property is set to display the layer name in the ArcMap table of contents. Notice that although the Name property is on the ILayer interface, it is accessed directly via the IFeatureLayer interface due to interface inheritance.*

7 *The AddLayer method on the IMxDocument interface adds the FeatureLayer object to ArcMap.*

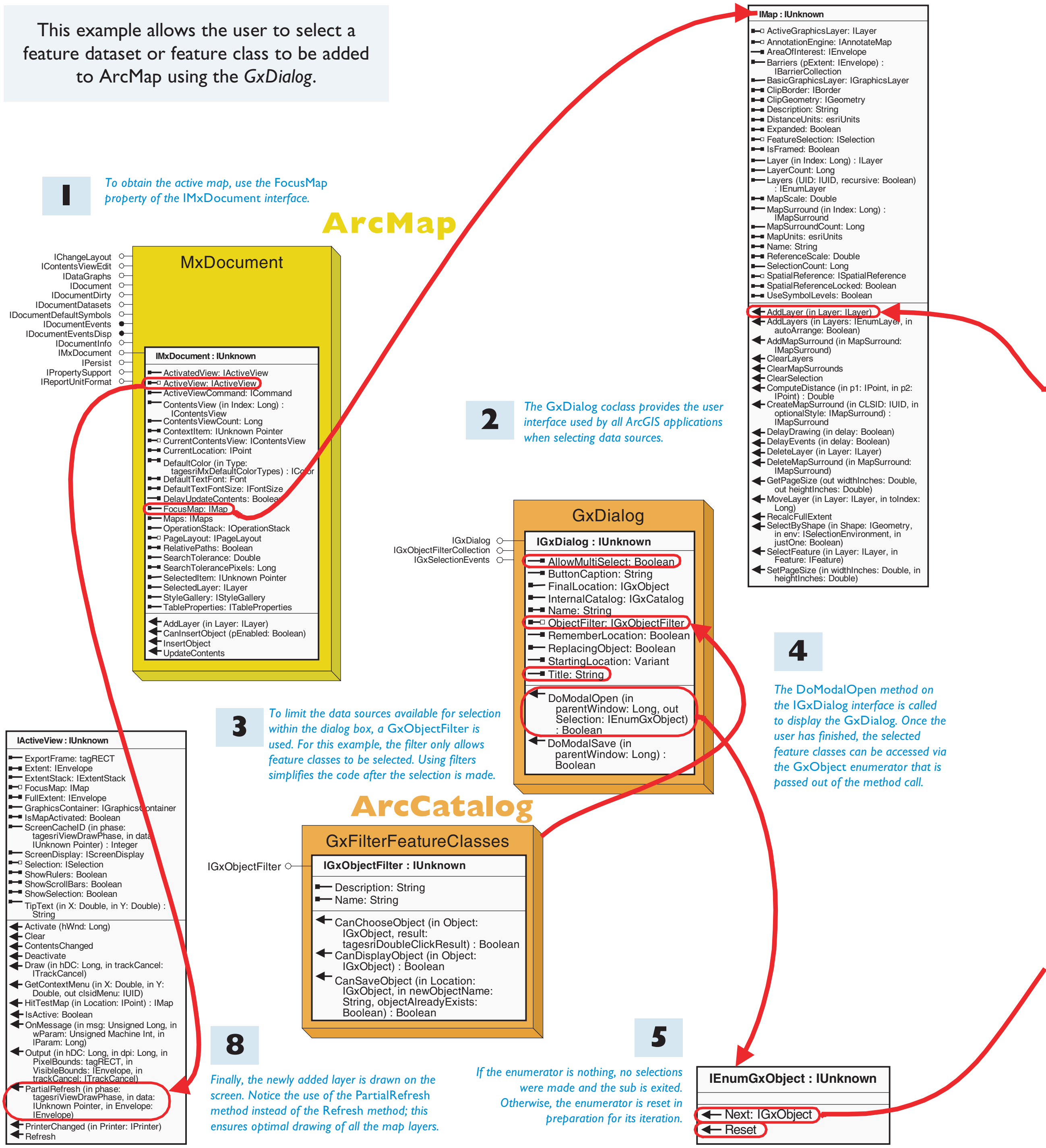
8 *Finally, the newly added layer is drawn on the screen. Notice the use of the PartialRefresh method instead of the Refresh method; this ensures optimal drawing of all the map layers.*

4 *In order to add data to the map, create a FeatureLayer and associate the FeatureClass with it.*

Add this code to the Click event of a UIButtonControl in ArcMap.

```
1  Dim pWorkspaceFactory As IWorkspaceFactory
   Set pWorkspaceFactory = New ShapefileWorkspaceFactory

2  Dim pWorkSpace As IFeatureWorkspace
   Set pWorkSpace = pWorkspaceFactory.OpenFromFile("C:\Source\", 0)

3  Dim pClass As IFeatureClass
   Set pClass = pWorkSpace.OpenFeatureClass("USStates")

4  Dim pLayer As IFeatureLayer
   Set pLayer = New FeatureLayer
   Set pLayer.FeatureClass = pClass
5  pLayer.Name = pClass.AliasName

6  Dim pMxDoc As IMxDocument
   Set pMxDoc = ThisDocument

7  pMxDoc.AddLayer pLayer
8  pMxDoc.ActiveView.PartialRefresh esriViewGeography, pLayer, _
    Nothing
```

This example allows the user to select a feature dataset or feature class to be added to ArcMap using the *GxDialog*.


ArcMap
MxDocument
IChangeLayout
IContentsViewEdit
IDataGraphs
IDocument
IDocumentDirty
IDocumentDatasets
IDocumentDefaultSymbols
IDocumentEvents
IDocumentEventsDisp
IDocumentInfo
IMxDocument
IPersist
IPropertySupport
IReportUnitFormat
IMxDocument : IUnknown
ActivatedView: IActiveView
ActiveView: IActiveView
ActiveViewCommand: ICommand
ContentsView (in Index: Long) : IContentsView
ContentsViewCount: Long
ContextItem: IUnknown Pointer
CurrentContentsView: IContentsView
CurrentLocation: IPoint
DefaultColor (in Type: tagesriMxDefaultColorTypes) : IColor
DefaultTextFont: Font
DefaultTextFontSize: IFontSize
DelayUpdateContents: Boolean
FocusMap: IMap
Maps: IMaps
OperationStack: IOperationStack
PageLayout: IPageLayout
RelativePaths: Boolean
SearchTolerance: Double
SearchTolerancePixels: Long
SelectedItem: IUnknown Pointer
SelectedLayer: ILayer
StyleGallery: IStyleGallery
TableProperties: ITableProperties
AddLayer (in Layer: ILayer)
CanInsertObject (pEnabled: Boolean)
InsertObject
UpdateContents
IMap : IUnknown
ActiveGraphicsLayer: ILayer
AnnotationEngine: IAnnotateMap
AreaOfInterest: IEnvelope
Barriers (pExtent: IEnvelope) : IBarrierCollection
BasicGraphicsLayer: IGraphicsLayer
ClipBorder: IBorder
ClipGeometry: IGeometry
Description: String
DistanceUnits: esriUnits
Expanded: Boolean
FeatureSelection: ISelection
IsFramed: Boolean
Layer (in Index: Long) : ILayer
LayerCount: Long
Layers (UID: IUID, recursive: Boolean) : IEnumLayer
MapScale: Double
MapSurround (in Index: Long) : IMapSurround
MapSurroundCount: Long
MapUnits: esriUnits
Name: String
ReferenceScale: Double
SelectionCount: Long
SpatialReference: ISpatialReference
SpatialReferenceLocked: Boolean
UseSymbolLevels: Boolean
AddLayer (in Layer: ILayer)
AddLayers (in Layers: IEnumLayer, in autoArrange: Boolean)
AddMapSurround (in MapSurround: IMapSurround)
ClearLayers
ClearMapSurrounds
ClearSelection
ComputeDistance (in p1: IPoint, in p2: IPoint) : Double
CreateMapSurround (in CLSID: IUID, in optionalStyle: IMapSurround) : IMapSurround
DelayDrawing (in delay: Boolean)
DelayEvents (in delay: Boolean)
DeleteLayer (in Layer: ILayer)
DeleteMapSurround (in MapSurround: IMapSurround)
GetPageSize (out widthInches: Double, out heightInches: Double)
MoveLayer (in Layer: ILayer, in toIndex: Long)
RecalcFullExtent
SelectByShape (in Shape: IGeometry, in env: ISelectionEnvironment, in justOne: Boolean)
SelectFeature (in Layer: ILayer, in Feature: IFeature)
SetPageSize (in widthInches: Double, in heightInches: Double)
GxDialog
IGxDialog
IGxObjectFilterCollection
IGxSelectionEvents
IGxDialog : IUnknown
AllowMultiSelect: Boolean
ButtonCaption: String
FinalLocation: IGxObject
InternalCatalog: IGxCatalog
Name: String
ObjectFilter: IGxObjectFilter
RememberLocation: Boolean
ReplacingObject: Boolean
StartingLocation: Variant
Title: String
DoModalOpen (in parentWindow: Long, out Selection: IEnumGxObject) : Boolean
DoModalSave (in parentWindow: Long) : Boolean
IActiveView : IUnknown
ExportFrame: tagRECT
Extent: IEnvelope
ExtentStack: IExtentStack
FocusMap: IMap
FullExtent: IEnvelope
GraphicsContainer: IGraphicsContainer
IsMapActivated: Boolean
ScreenCacheID (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer) : Integer
ScreenDisplay: IScreenDisplay
Selection: ISelection
ShowRulers: Boolean
ShowScrollBars: Boolean
ShowSelection: Boolean
TipText (in X: Double, in Y: Double) : String
Activate (hWnd: Long)
Clear
ContentsChanged
Deactivate
Draw (in hDC: Long, in trackCancel: ITrackCancel)
GetContextMenu (in X: Double, in Y: Double, out clsidMenu: IUID)
HitTestMap (in Location: IPoint) : IMap
IsActive: Boolean
OnMessage (in msg: Unsigned Long, in wParam: Unsigned Machine Int, in lParam: Long)
Output (in hDC: Long, in dpi: Long, in PixelBounds: tagRECT, in VisibleBounds: IEnvelope, in trackCancel: ITrackCancel)
PartialRefresh (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer, in Envelope: IEnvelope)
PrinterChanged (in Printer: IPrinter)
Refresh
ArcCatalog
GxFilterFeatureClasses
IGxObjectFilter
IGxObjectFilter : IUnknown
Description: String
Name: String
CanChooseObject (in Object: IGxObject, result: tagesriDoubleClickResult) : Boolean
CanDisplayObject (in Object: IGxObject) : Boolean
CanSaveObject (in Location: IGxObject, in newObjectName: String, objectAlreadyExists: Boolean) : Boolean
IEnumGxObject : IUnknown
Next: IGxObject
Reset

1 *To obtain the active map, use the FocusMap property of the IMxDocument interface.*

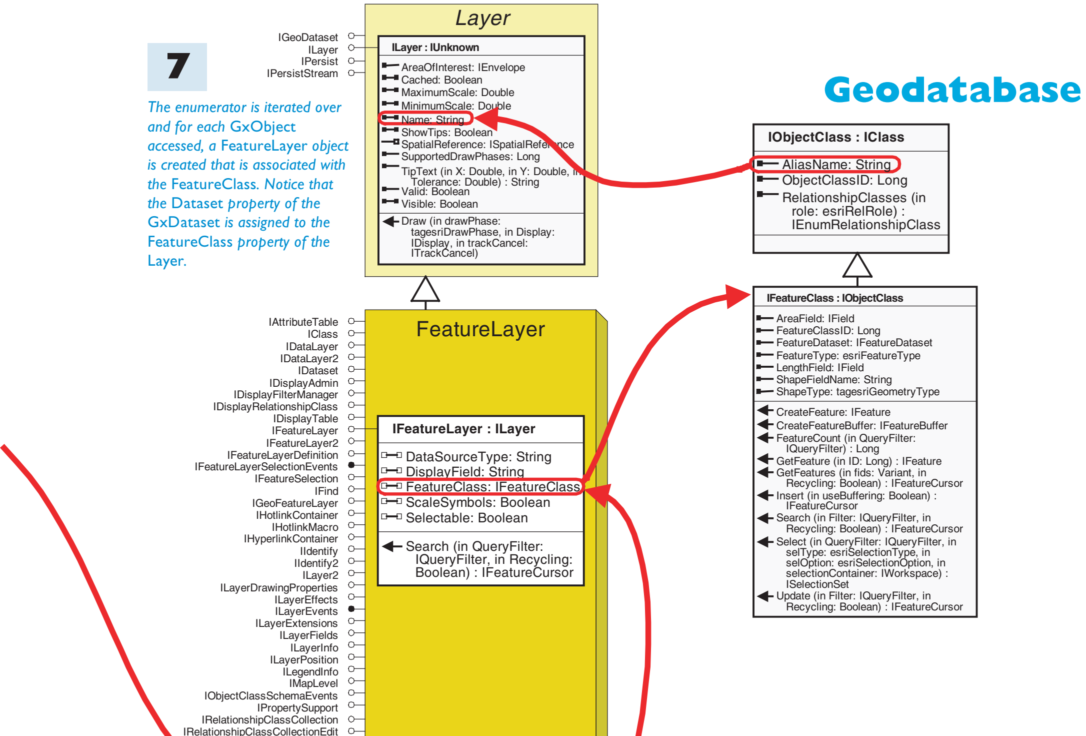
2 *The GxDialog coclass provides the user interface used by all ArcGIS applications when selecting data sources.*

3 *To limit the data sources available for selection within the dialog box, a GxObjectFilter is used. For this example, the filter only allows feature classes to be selected. Using filters simplifies the code after the selection is made.*

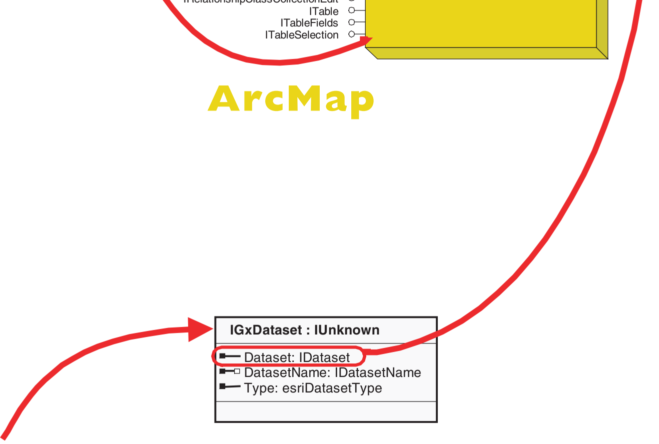
4 *The DoModalOpen method on the IGxDialog interface is called to display the GxDialog. Once the user has finished, the selected feature classes can be accessed via the GxObject enumerator that is passed out of the method call.*

5 *If the enumerator is nothing, no selections were made and the sub is exited. Otherwise, the enumerator is reset in preparation for its iteration.*

8 *Finally, the newly added layer is drawn on the screen. Notice the use of the PartialRefresh method instead of the Refresh method; this ensures optimal drawing of all the map layers.*


Layer
IGeoDataset
ILayer
IPersist
IPersistStream
ILayer : IUnknown
AreaOfInterest: IEnvelope
Cached: Boolean
MaximumScale: Double
MinimumScale: Double
Name: String
ShowTips: Boolean
SpatialReference: ISpatialRefer nce
SupportedDrawPhases: Long
TipText (in X: Double, in Y: Double, in
Tolerance: Double) : String
Valid: Boolean
Visible: Boolean
Draw (in drawPhase: tagesriDrawPhase, in Display: IDisplay, in trackCancel: ITrackCancel)
Geodatabase
IObjectClass : IClass
AliasName: String
ObjectClassID: Long
RelationshipClasses (in role: esriRelRole) : IEnumRelationshipClass
IFeatureClass : IObjectClass
AreaField: IField
FeatureClassID: Long
FeatureDataset: IFeatureDataset
FeatureType: esriFeatureType
LengthField: IField
ShapeFieldName: String
ShapeType: tagesriGeometryType
CreateFeature: IFeature
CreateFeatureBuffer: IFeatureBuffer
FeatureCount (in QueryFilter: IQueryFilter) : Long
GetFeature (in ID: Long) : IFeature
GetFeatures (in fids: Variant, in Recycling: Boolean) : IFeatureCursor
Insert (in useBuffering: Boolean) : IFeatureCursor
Search (in Filter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor
Select (in QueryFilter: IQueryFilter, in selType: esriSelectionType, in selOption: esriSelectionOption, in selectionContainer: IWorkspace) : ISelectionSet
Update (in Filter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor
FeatureLayer
IAttributeTable
IClass
IDataLayer
IDataLayer2
IDataset
IDisplayAdmin
IDisplayFilterManager
IDisplayRelationshipClass
IDisplayTable
IFeatureLayer
IFeatureLayer2
IFeatureLayerDefinition
IFeatureLayerSelectionEvents
IFeatureSelection
IFind
IGeoFeatureLayer
IHotlinkContainer
IHotlinkMacro
IHyperlinkContainer
IIdentify
IIdentify2
ILayer2
ILayerDrawingProperties
ILayerEffects
ILayerEvents
ILayerExtensions
ILayerFields
ILayerInfo
ILayerPosition
ILegendInfo
IMapLevel
IObjectClassSchemaEvents
IPropertySupport
IRelationshipClassCollection
IRelationshipClassCollectionEdit
ITable
ITableFields
ITableSelection
IFeatureLayer : ILayer
DataSourceType: String
DisplayField: String
FeatureClass: IFeatureClass
ScaleSymbols: Boolean
Selectable: Boolean
Search (in QueryFilter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor

7 *The enumerator is iterated over and for each GxObject accessed, a FeatureLayer object is created that is associated with the FeatureClass. Notice that the Dataset property of the GxDataset is assigned to the FeatureClass property of the Layer.*



6 *Since an appropriate GxObjectFilter object was used, the GxObjects returned from the enumerator will support the IGxDataset interface.*

Add this to the Click event of a UIButtonControl in ArcMap.

```
1  Dim pMxDoc As IMxDocument
   Set pMxDoc = ThisDocument

2  Dim pGxDialog As IGxDialog
   Set pGxDialog = New GxDialog
   pGxDialog.AllowMultiSelect = True
   pGxDialog.Title = "Select Feature Classes to Add to Map"

3  Dim pGxFilter As IGxObjectFilter
   Set pGxFilter = New GxFilterFeatureClasses
   Set pGxDialog.ObjectFilter = pGxFilter

4  Dim pGxObjects As IEnumGxObject
   pGxDialog.DoModalOpen ThisDocument.Parent.hWnd, pGxObjects

5  If (pGxObjects Is Nothing) Then Exit Sub
   pGxObjects.Reset

   Dim pLayer As IFeatureLayer
   Dim pGxDataset As IGxDataset
6  Set pGxDataset = pGxObjects.Next
   Do Until (pGxDataset Is Nothing)
7    Set pLayer = New FeatureLayer
     Set pLayer.FeatureClass = pGxDataset.Dataset
     pLayer.Name = pLayer.FeatureClass.AliasName
     pMxDoc.FocusMap.AddLayer pLayer
     Set pGxDataset = pGxObjects.Next
   Loop
8  pMxDoc.ActiveView.PartialRefresh esriViewGeography, _
    Nothing, Nothing
```

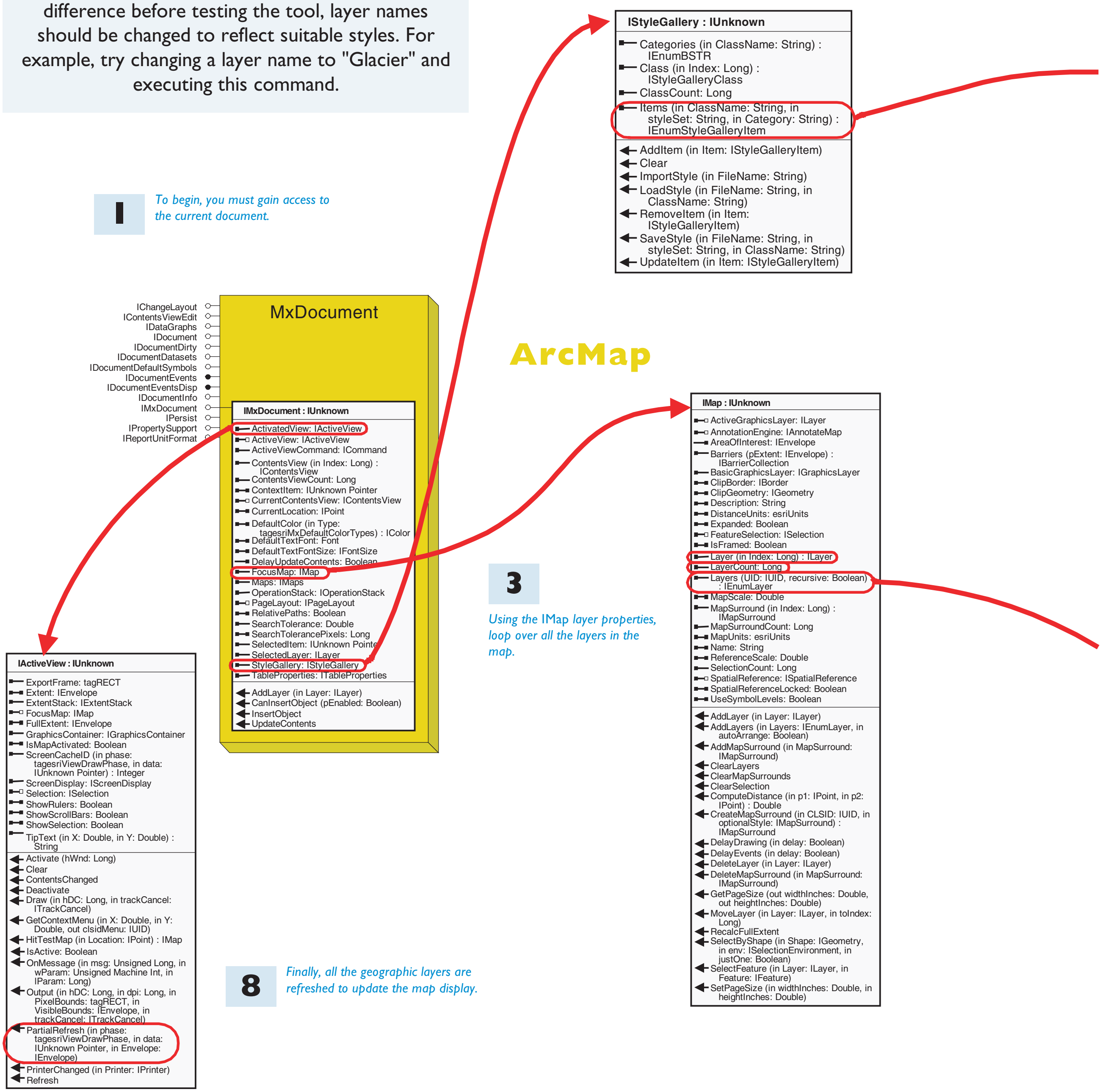
This sample goes through all polygon layers in the map and attempts to match the symbology from the standard style set to the layer name. ArcMap does this by default. Therefore, to see a real difference before testing the tool, layer names should be changed to reflect suitable styles. For example, try changing a layer name to "Glacier" and executing this command.

1 *To begin, you must gain access to the current document.*

2 *An enumerator is obtained from the style gallery for the style gallery's FillSymbol entries that, when accessed, will loop over all the FillSymbols.*

3 *Using the IMap layer properties, loop over all the layers in the map.*

8 *Finally, all the geographic layers are refreshed to update the map display.*



IMxDocument : IUnknown

ActivatedView: IActiveView
ActiveView: IActiveView
ActiveViewCommand: ICommand
ContentsView (in Index: Long) : IContentsView
ContentsViewCount: Long
ContextItem: IUnknown Pointer
CurrentContentsView: IContentsView
CurrentLocation: IPoint
DefaultColor (in Type: tagesriMxDefaultColorTypes) : IColor
DefaultTextFont: Font
DefaultTextFontSize: IFontSize
DelayUpdateContents: Boolean
FocusMap: IMap
Maps: IMaps
OperationStack: IOperationStack
PageLayout: IPageLayout
RelativePaths: Boolean
SearchTolerance: Double
SearchTolerancePixels: Long
SelectedItem: IUnknown Pointer
SelectedLayer: ILayer
StyleGallery: IStyleGallery
TableProperties: ITableProperties

AddLayer (in Layer: ILayer)
CanInsertObject (pEnabled: Boolean)
InsertObject
UpdateContents

IStyleGallery : IUnknown

Categories (in ClassName: String) : IEnumBSTR
Class (in Index: Long) : IStyleGalleryClass
ClassCount: Long
Items (in ClassName: String, in styleSet: String, in Category: String) : IEnumStyleGalleryItem

AddItem (in Item: IStyleGalleryItem)
Clear
ImportStyle (in FileName: String)
LoadStyle (in FileName: String, in ClassName: String)
RemoveItem (in Item: IStyleGalleryItem)
SaveStyle (in FileName: String, in styleSet: String, in ClassName: String)
UpdateItem (in Item: IStyleGalleryItem)

IActiveView : IUnknown

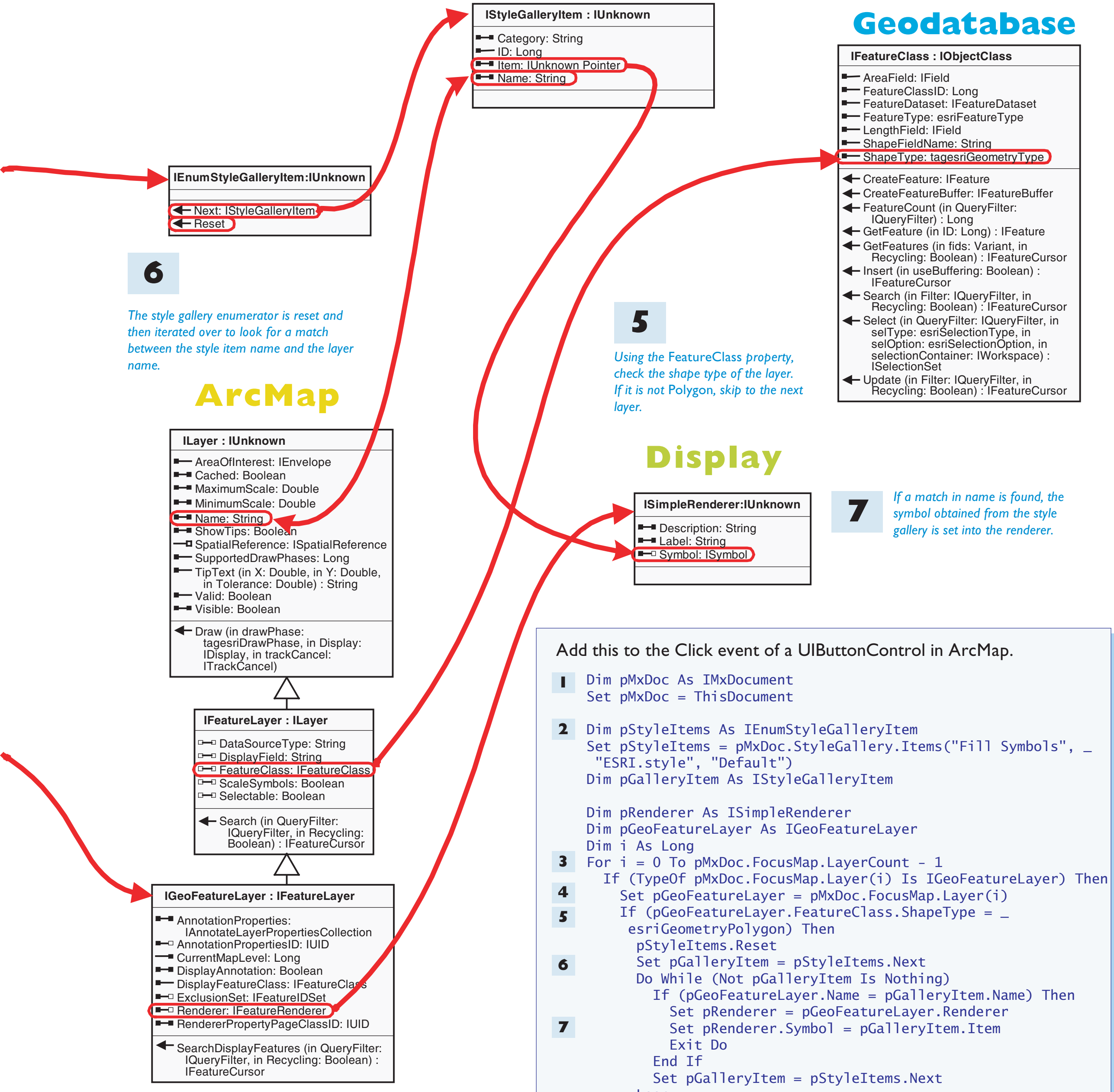
ExportFrame: tagRECT
Extent: IEnvelope
ExtentStack: IExtentStack
FocusMap: IMap
FullExtent: IEnvelope
GraphicsContainer: IGraphicsContainer
IsMapActivated: Boolean
ScreenCacheID (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer) : Integer
ScreenDisplay: IScreenDisplay
Selection: ISelection
ShowRulers: Boolean
ShowScrollBars: Boolean
ShowSelection: Boolean
TipText (in X: Double, in Y: Double) : String

Activate (hWnd: Long)
Clear
ContentsChanged
Deactivate
Draw (in hDC: Long, in trackCancel: ITrackCancel)
GetContextMenu (in X: Double, in Y: Double, out clsidMenu: IUID)
HitTestMap (in Location: IPoint) : IMap
IsActive: Boolean
OnMessage (in msg: Unsigned Long, in wParam: Unsigned Machine Int, in lParam: Long)
Output (in hDC: Long, in dpi: Long, in PixelBounds: tagRECT, in VisibleBounds: IEnvelope, in trackCancel: ITrackCancel)
PartialRefresh (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer, in Envelope: IEnvelope)
PrinterChanged (in Printer: IPrinter)
Refresh

IMap : IUnknown

ActiveGraphicsLayer: ILayer
AnnotationEngine: IAnnotateMap
AreaOfInterest: IEnvelope
Barriers (pExtent: IEnvelope) : IBarrierCollection
BasicGraphicsLayer: IGraphicsLayer
ClipBorder: IBorder
ClipGeometry: IGeometry
Description: String
DistanceUnits: esriUnits
Expanded: Boolean
FeatureSelection: ISelection
IsFramed: Boolean
Layer (in Index: Long) : ILayer
LayerCount: Long
Layers (UID: IUID, recursive: Boolean) : IEnumLayer
MapScale: Double
MapSurround (in Index: Long) : IMapSurround
MapSurroundCount: Long
MapUnits: esriUnits
Name: String
ReferenceScale: Double
SelectionCount: Long
SpatialReference: ISpatialReference
SpatialReferenceLocked: Boolean
UseSymbolLevels: Boolean

AddLayer (in Layer: ILayer)
AddLayers (in Layers: IEnumLayer, in autoArrange: Boolean)
AddMapSurround (in MapSurround: IMapSurround)
ClearLayers
ClearMapSurrounds
ClearSelection
ComputeDistance (in p1: IPoint, in p2: IPoint) : Double
CreateMapSurround (in CLSID: IUID, in optionalStyle: IMapSurround) : IMapSurround
DelayDrawing (in delay: Boolean)
DelayEvents (in delay: Boolean)
DeleteLayer (in Layer: ILayer)
DeleteMapSurround (in MapSurround: IMapSurround)
GetPageSize (out widthInches: Double, out heightInches: Double)
MoveLayer (in Layer: ILayer, in toIndex: Long)
RecalcFullExtent
SelectByShape (in Shape: IGeometry, in env: ISelectionEnvironment, in justOne: Boolean)
SelectFeature (in Layer: ILayer, in Feature: IFeature)
SetPageSize (in widthInches: Double, in heightInches: Double)


IStyleGalleryItem : IUnknown
Category: String
ID: Long
Item: IUnknown Pointer
Name: String
Geodatabase
IFeatureClass : IObjectClass
AreaField: IField
FeatureClassID: Long
FeatureDataset: IFeatureDataset
FeatureType: esriFeatureType
LengthField: IField
ShapeFieldName: String
ShapeType: tagesriGeometryType
CreateFeature: IFeature
CreateFeatureBuffer: IFeatureBuffer
FeatureCount (in QueryFilter: IQueryFilter) : Long
GetFeature (in ID: Long) : IFeature
GetFeatures (in fids: Variant, in Recycling: Boolean) : IFeatureCursor
Insert (in useBuffering: Boolean) : IFeatureCursor
Search (in Filter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor
Select (in QueryFilter: IQueryFilter, in selType: esriSelectionType, in selOption: esriSelectionOption, in selectionContainer: IWorkspace) : ISelectionSet
Update (in Filter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor
IEnumStyleGalleryItem:IUnknown
Next: IStyleGalleryItem
Reset
ArcMap
ILayer : IUnknown
AreaOfInterest: IEnvelope
Cached: Boolean
MaximumScale: Double
MinimumScale: Double
Name: String
ShowTips: Boolean
SpatialReference: ISpatialReference
SupportedDrawPhases: Long
TipText (in X: Double, in Y: Double, in Tolerance: Double) : String
Valid: Boolean
Visible: Boolean
Draw (in drawPhase: tagesriDrawPhase, in Display: IDisplay, in trackCancel: ITrackCancel)
Display
ISimpleRenderer:IUnknown
Description: String
Label: String
Symbol: ISymbol
IFeatureLayer : ILayer
DataSourceType: String
DisplayField: String
FeatureClass: IFeatureClass
ScaleSymbols: Boolean
Selectable: Boolean
Search (in QueryFilter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor
IGeoFeatureLayer : IFeatureLayer
AnnotationProperties: IAnnotateLayerPropertiesCollection
AnnotationPropertiesID: IUID
CurrentMapLevel: Long
DisplayAnnotation: Boolean
DisplayFeatureClass: IFeatureClass
ExclusionSet: IFeatureIDSet
Renderer: IFeatureRenderer
RendererPropertyPageClassID: IUID
SearchDisplayFeatures (in QueryFilter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor

6

The style gallery enumerator is reset and then iterated over to look for a match between the style item name and the layer name.

5

Using the FeatureClass property, check the shape type of the layer. If it is not Polygon, skip to the next layer.

7

If a match in name is found, the symbol obtained from the style gallery is set into the renderer.

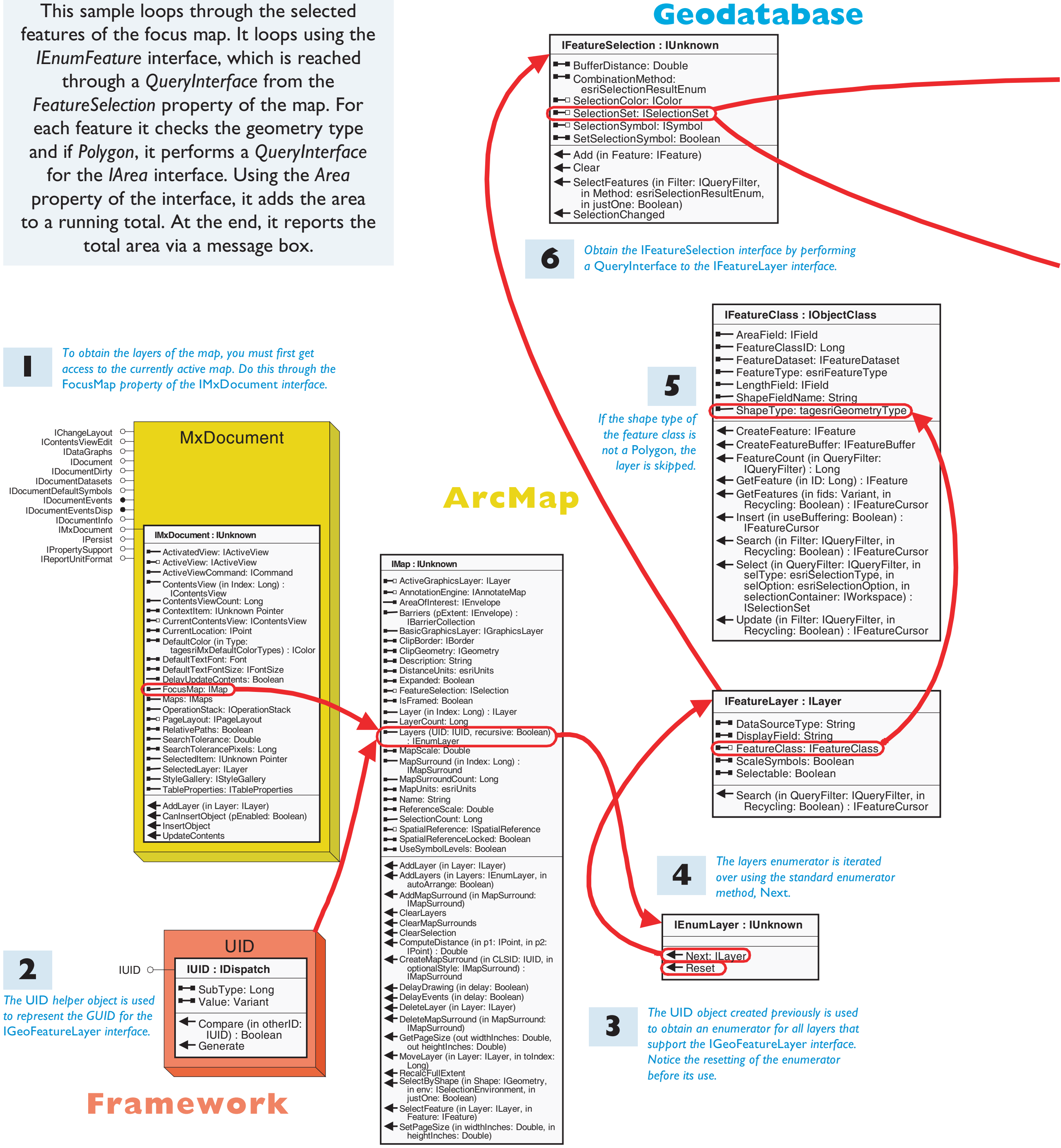
4

If the type of layer is not an IGeoFeatureLayer, continue to the next layer.

Add this to the Click event of a UIButtonControl in ArcMap.

```
1  Dim pMxDoc As IMxDocument
   Set pMxDoc = ThisDocument

2  Dim pStyleItems As IEnumStyleGalleryItem
   Set pStyleItems = pMxDoc.StyleGallery.Items("Fill Symbols", _
    "ESRI.style", "Default")
   Dim pGalleryItem As IStyleGalleryItem

   Dim pRenderer As ISimpleRenderer
   Dim pGeoFeatureLayer As IGeoFeatureLayer
   Dim i As Long
3  For i = 0 To pMxDoc.FocusMap.LayerCount - 1
     If (TypeOf pMxDoc.FocusMap.Layer(i) Is IGeoFeatureLayer) Then
4      Set pGeoFeatureLayer = pMxDoc.FocusMap.Layer(i)
5      If (pGeoFeatureLayer.FeatureClass.ShapeType = _
        esriGeometryPolygon) Then
         pStyleItems.Reset
6        Set pGalleryItem = pStyleItems.Next
         Do While (Not pGalleryItem Is Nothing)
           If (pGeoFeatureLayer.Name = pGalleryItem.Name) Then
             Set pRenderer = pGeoFeatureLayer.Renderer
7            Set pRenderer.Symbol = pGalleryItem.Item
             Exit Do
           End If
           Set pGalleryItem = pStyleItems.Next
         Loop
         End If
       End If
     Next i
8    pMxDoc.ActivatedView.PartialRefresh esriViewGeography, _
      Nothing, Nothing
```

This sample loops through the selected features of the focus map. It loops using the *IEnumFeature* interface, which is reached through a *QueryInterface* from the *FeatureSelection* property of the map. For each feature it checks the geometry type and if *Polygon*, it performs a *QueryInterface* for the *IArea* interface. Using the *Area* property of the interface, it adds the area to a running total. At the end, it reports the total area via a message box.



1 *To obtain the layers of the map, you must first get access to the currently active map. Do this through the* FocusMap *property of the* IMxDocument *interface.*

MxDocument

IChangeLayout
IContentsViewEdit
IDataGraphs
IDocument
IDocumentDirty
IDocumentDatasets
IDocumentDefaultSymbols
IDocumentEvents
IDocumentEventsDisp
IDocumentInfo
IMxDocument
IPersist
IPropertySupport
IReportUnitFormat

IMxDocument : IUnknown

ActivatedView: IActiveView
ActiveView: IActiveView
ActiveViewCommand: ICommand
ContentsView (in Index: Long) : IContentsView
ContentsViewCount: Long
ContextItem: IUnknown Pointer
CurrentContentsView: IContentsView
CurrentLocation: IPoint
DefaultColor (in Type: tagesriMxDefaultColorTypes) : IColor
DefaultTextFont: Font
DefaultTextFontSize: IFontSize
DelayUpdateContents: Boolean
FocusMap: IMap
Maps: IMaps
OperationStack: IOperationStack
PageLayout: IPageLayout
RelativePaths: Boolean
SearchTolerance: Double
SearchTolerancePixels: Long
SelectedItem: IUnknown Pointer
SelectedLayer: ILayer
StyleGallery: IStyleGallery
TableProperties: ITableProperties

AddLayer (in Layer: ILayer)
CanInsertObject (pEnabled: Boolean)
InsertObject
UpdateContents

2 *The* UID *helper object is used to represent the GUID for the* IGeoFeatureLayer *interface.*

UID

IUID

IUID : IDispatch

SubType: Long
Value: Variant

Compare (in otherID: IUID) : Boolean
Generate

IMap : IUnknown

ActiveGraphicsLayer: ILayer
AnnotationEngine: IAnnotateMap
AreaOfInterest: IEnvelope
Barriers (pExtent: IEnvelope) : IBarrierCollection
BasicGraphicsLayer: IGraphicsLayer
ClipBorder: IBorder
ClipGeometry: IGeometry
Description: String
DistanceUnits: esriUnits
Expanded: Boolean
FeatureSelection: ISelection
IsFramed: Boolean
Layer (in Index: Long) : ILayer
LayerCount: Long
Layers (UID: IUID, recursive: Boolean) : IEnumLayer
MapScale: Double
MapSurround (in Index: Long) : IMapSurround
MapSurroundCount: Long
MapUnits: esriUnits
Name: String
ReferenceScale: Double
SelectionCount: Long
SpatialReference: ISpatialReference
SpatialReferenceLocked: Boolean
UseSymbolLevels: Boolean

AddLayer (in Layer: ILayer)
AddLayers (in Layers: IEnumLayer, in autoArrange: Boolean)
AddMapSurround (in MapSurround: IMapSurround)
ClearLayers
ClearMapSurrounds
ClearSelection
ComputeDistance (in p1: IPoint, in p2: IPoint) : Double
CreateMapSurround (in CLSID: IUID, in optionalStyle: IMapSurround) : IMapSurround
DelayDrawing (in delay: Boolean)
DelayEvents (in delay: Boolean)
DeleteLayer (in Layer: ILayer)
DeleteMapSurround (in MapSurround: IMapSurround)
GetPageSize (out widthInches: Double, out heightInches: Double)
MoveLayer (in Layer: ILayer, in toIndex: Long)
RecalcFullExtent
SelectByShape (in Shape: IGeometry, in env: ISelectionEnvironment, in justOne: Boolean)
SelectFeature (in Layer: ILayer, in Feature: IFeature)
SetPageSize (in widthInches: Double, in heightInches: Double)

3 *The* UID *object created previously is used to obtain an enumerator for all layers that support the* IGeoFeatureLayer *interface. Notice the resetting of the enumerator before its use.*

IEnumLayer : IUnknown

Next: ILayer
Reset

4 *The layers enumerator is iterated over using the standard enumerator method,* Next.

IFeatureLayer : ILayer

DataSourceType: String
DisplayField: String
FeatureClass: IFeatureClass
ScaleSymbols: Boolean
Selectable: Boolean

Search (in QueryFilter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor

5 *If the shape type of the feature class is not a* Polygon, *the layer is skipped.*

IFeatureClass : IObjectClass

AreaField: IField
FeatureClassID: Long
FeatureDataset: IFeatureDataset
FeatureType: esriFeatureType
LengthField: IField
ShapeFieldName: String
ShapeType: tagesriGeometryType

CreateFeature: IFeature
CreateFeatureBuffer: IFeatureBuffer
FeatureCount (in QueryFilter: IQueryFilter) : Long
GetFeature (in ID: Long) : IFeature
GetFeatures (in fids: Variant, in Recycling: Boolean) : IFeatureCursor
Insert (in useBuffering: Boolean) : IFeatureCursor
Search (in Filter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor
Select (in QueryFilter: IQueryFilter, in selType: esriSelectionType, in selOption: esriSelectionOption, in selectionContainer: IWorkspace) : ISelectionSet
Update (in Filter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor

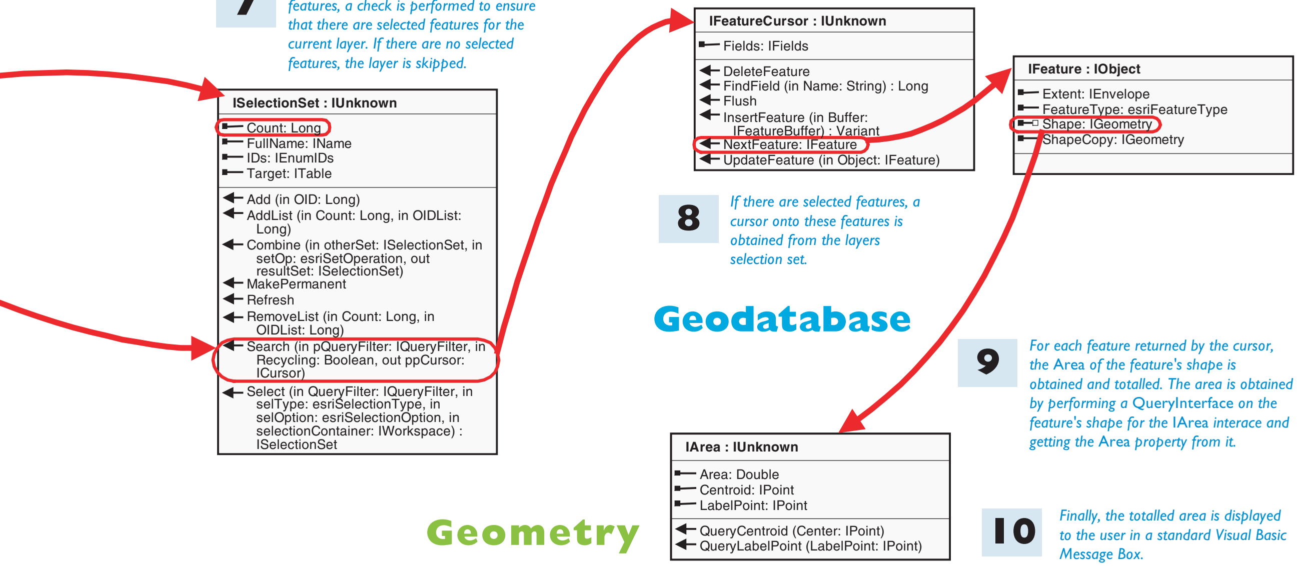
6 *Obtain the* IFeatureSelection *interface by performing a* QueryInterface *to the* IFeatureLayer *interface.*

IFeatureSelection : IUnknown

BufferDistance: Double
CombinationMethod: esriSelectionResultEnum
SelectionColor: IColor
SelectionSet: ISelectionSet
SelectionSymbol: ISymbol
SetSelectionSymbol: Boolean

Add (in Feature: IFeature)
Clear
SelectFeatures (in Filter: IQueryFilter, in Method: esriSelectionResultEnum, in justOne: Boolean)
SelectionChanged

7 Before attempting to loop through selected features, a check is performed to ensure that there are selected features for the current layer. If there are no selected features, the layer is skipped.


ISelectionSet : IUnknown
Count: Long
FullName: IName
IDs: IEnumIDs
Target: ITable
Add (in OID: Long)
AddList (in Count: Long, in OIDList: Long)
Combine (in otherSet: ISelectionSet, in setOp: esriSetOperation, out resultSet: ISelectionSet)
MakePermanent
Refresh
RemoveList (in Count: Long, in OIDList: Long)
Search (in pQueryFilter: IQueryFilter, in Recycling: Boolean, out ppCursor: ICursor)
Select (in QueryFilter: IQueryFilter, in selType: esriSelectionType, in selOption: esriSelectionOption, in selectionContainer: IWorkspace) : ISelectionSet
IFeatureCursor : IUnknown
Fields: IFields
DeleteFeature
FindField (in Name: String) : Long
Flush
InsertFeature (in Buffer: IFeatureBuffer) : Variant
NextFeature: IFeature
UpdateFeature (in Object: IFeature)
IFeature : IObject
Extent: IEnvelope
FeatureType: esriFeatureType
Shape: IGeometry
ShapeCopy: IGeometry
Geodatabase
IArea : IUnknown
Area: Double
Centroid: IPoint
LabelPoint: IPoint
QueryCentroid (Center: IPoint)
QueryLabelPoint (LabelPoint: IPoint)
Geometry

8 If there are selected features, a cursor onto these features is obtained from the layers selection set.

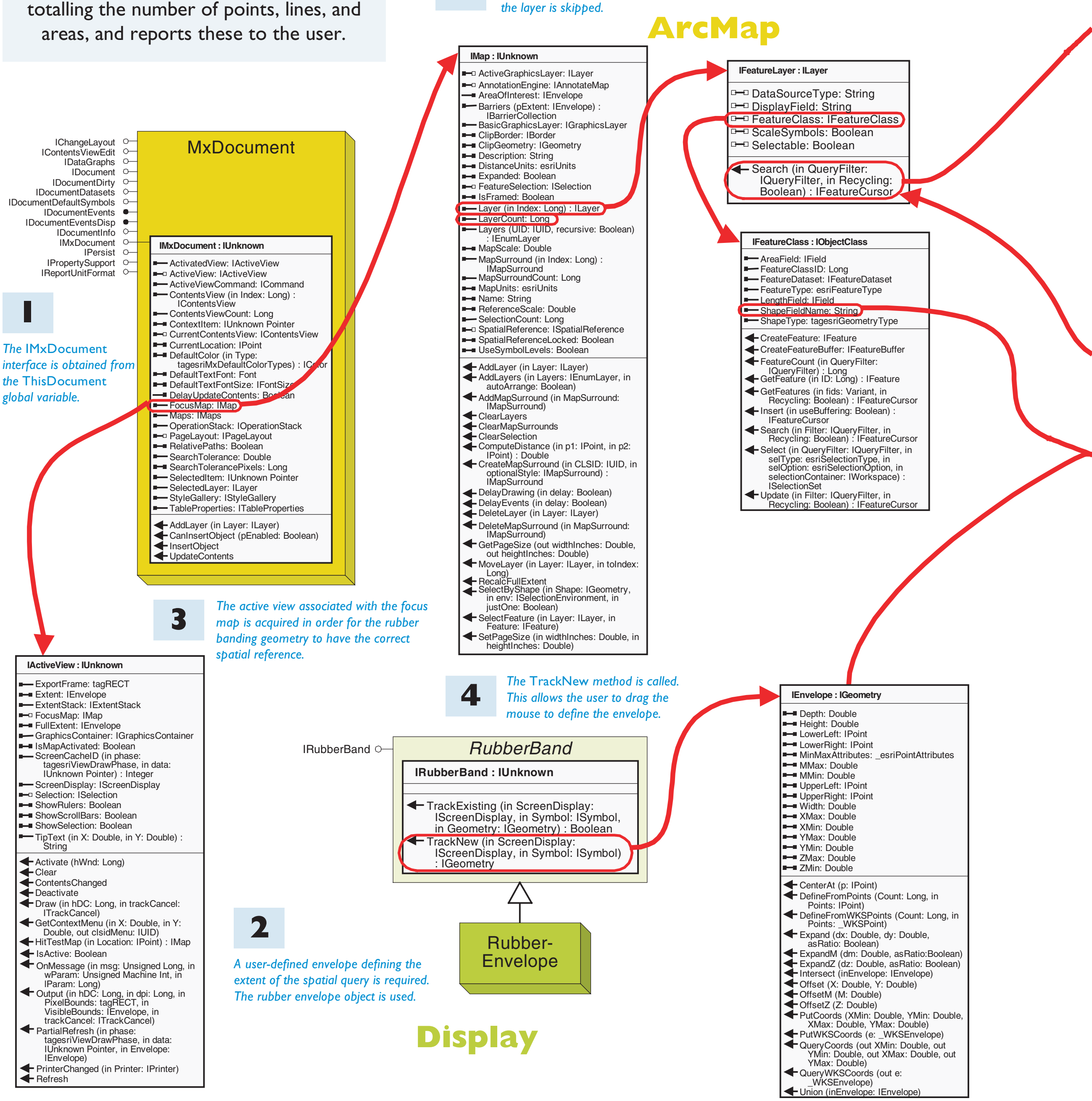
9 For each feature returned by the cursor, the Area of the feature's shape is obtained and totalled. The area is obtained by performing a QueryInterface on the feature's shape for the IArea interace and getting the Area property from it.

10 Finally, the totalled area is displayed to the user in a standard Visual Basic Message Box.

Add this code to the Click event of a UIButtonControl in ArcMap.

```
1  Dim pMxDoc As IMxDocument
   Set pMxDoc = ThisDocument

2  Dim pUID As New UID
   pUID = "{E156D7E5-22AF-11D3-9F99-00C04F6BC78E}" 'IGeoFeatureLayer IID

3  Dim pEnumLayer As IEnumLayer
   Set pEnumLayer = pMxDoc.FocusMap.Layers(pUID, True)
   pEnumLayer.Reset

   Dim pFeatureLayer As IFeatureLayer
   Dim pFeatureSelection As IFeatureSelection
   Dim pFeatureCursor As IFeatureCursor
   Dim pFeature As IFeature
   Dim pArea As IArea
   Dim dTotalArea As Double

4  Set pFeatureLayer = pEnumLayer.Next
   Do Until (pFeatureLayer Is Nothing)
5    If (pFeatureLayer.FeatureClass.ShapeType = esriGeometryPolygon) Then
6      Set pFeatureSelection = pFeatureLayer

7      If (pFeatureSelection.SelectionSet.Count <> 0) Then
         pFeatureSelection.SelectionSet.Search Nothing, True, pFeatureCursor
8        Set pFeature = pFeatureCursor.NextFeature

         Do Until (pFeature Is Nothing)
9          Set pArea = pFeature.Shape
           dTotalArea = dTotalArea + pArea.Area
           Set pFeature = pFeatureCursor.NextFeature
         Loop
       End If
     End If
     Set pFeatureLayer = pEnumLayer.Next
   Loop

10 MsgBox "Total Area for selected polygon features = " & CStr(dTotalArea)
```

This sample builds a spatial query filter, gets a feature cursor based on the filter and then loops over all the features, totalling the number of points, lines, and areas, and reports these to the user.



IMxDocument : IUnknown

ActivatedView: IActiveView
ActiveView: IActiveView
ActiveViewCommand: ICommand
ContentsView (in Index: Long) : IContentsView
ContentsViewCount: Long
ContextItem: IUnknown Pointer
CurrentContentsView: IContentsView
CurrentLocation: IPoint
DefaultColor (in Type: tagesriMxDefaultColorTypes) : IColor
DefaultTextFont: Font
DefaultTextFontSize: IFontSize
DelayUpdateContents: Boolean
FocusMap: IMap
Maps: IMaps
OperationStack: IOperationStack
PageLayout: IPageLayout
RelativePaths: Boolean
SearchTolerance: Double
SearchTolerancePixels: Long
SelectedItem: IUnknown Pointer
SelectedLayer: ILayer
StyleGallery: IStyleGallery
TableProperties: ITableProperties

AddLayer (in Layer: ILayer)
CanInsertObject (pEnabled: Boolean)
InsertObject
UpdateContents

IMap : IUnknown

ActiveGraphicsLayer: ILayer
AnnotationEngine: IAnnotateMap
AreaOfInterest: IEnvelope
Barriers (pExtent: IEnvelope) : IBarrierCollection
BasicGraphicsLayer: IGraphicsLayer
ClipBorder: IBorder
ClipGeometry: IGeometry
Description: String
DistanceUnits: esriUnits
Expanded: Boolean
FeatureSelection: ISelection
IsFramed: Boolean
Layer (in Index: Long) : ILayer
LayerCount: Long
Layers (UID: IUID, recursive: Boolean) : IEnumLayer
MapScale: Double
MapSurround (in Index: Long) : IMapSurround
MapSurroundCount: Long
MapUnits: esriUnits
Name: String
ReferenceScale: Double
SelectionCount: Long
SpatialReference: ISpatialReference
SpatialReferenceLocked: Boolean
UseSymbolLevels: Boolean

AddLayer (in Layer: ILayer)
AddLayers (in Layers: IEnumLayer, in autoArrange: Boolean)
AddMapSurround (in MapSurround: IMapSurround)
ClearLayers
ClearMapSurrounds
ClearSelection
ComputeDistance (in p1: IPoint, in p2: IPoint) : Double
CreateMapSurround (in CLSID: IUID, in optionalStyle: IMapSurround) : IMapSurround
DelayDrawing (in delay: Boolean)
DelayEvents (in delay: Boolean)
DeleteLayer (in Layer: ILayer)
DeleteMapSurround (in MapSurround: IMapSurround)
GetPageSize (out widthInches: Double, out heightInches: Double)
MoveLayer (in Layer: ILayer, in toIndex: Long)
RecalcFullExtent
SelectByShape (in Shape: IGeometry, in env: ISelectionEnvironment, in justOne: Boolean)
SelectFeature (in Layer: ILayer, in Feature: IFeature)
SetPageSize (in widthInches: Double, in heightInches: Double)

IFeatureLayer : ILayer

DataSourceType: String
DisplayField: String
FeatureClass: IFeatureClass
ScaleSymbols: Boolean
Selectable: Boolean

Search (in QueryFilter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor

IFeatureClass : IObjectClass

AreaField: IField
FeatureClassID: Long
FeatureDataset: IFeatureDataset
FeatureType: esriFeatureType
LengthField: IField
ShapeFieldName: String
ShapeType: tagesriGeometryType

CreateFeature: IFeature
CreateFeatureBuffer: IFeatureBuffer
FeatureCount (in QueryFilter: IQueryFilter) : Long
GetFeature (in ID: Long) : IFeature
GetFeatures (in fids: Variant, in Recycling: Boolean) : IFeatureCursor
Insert (in useBuffering: Boolean) : IFeatureCursor
Search (in Filter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor
Select (in QueryFilter: IQueryFilter, in selType: esriSelectionType, in selOption: esriSelectionOption, in selectionContainer: IWorkspace) : ISelectionSet
Update (in Filter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor

IActiveView : IUnknown

ExportFrame: tagRECT
Extent: IEnvelope
ExtentStack: IExtentStack
FocusMap: IMap
FullExtent: IEnvelope
GraphicsContainer: IGraphicsContainer
IsMapActivated: Boolean
ScreenCacheID (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer) : Integer
ScreenDisplay: IScreenDisplay
Selection: ISelection
ShowRulers: Boolean
ShowScrollBars: Boolean
ShowSelection: Boolean
TipText (in X: Double, in Y: Double) : String

Activate (hWnd: Long)
Clear
ContentsChanged
Deactivate
Draw (in hDC: Long, in trackCancel: ITrackCancel)
GetContextMenu (in X: Double, in Y: Double, out clsidMenu: IUID)
HitTestMap (in Location: IPoint) : IMap
IsActive: Boolean
OnMessage (in msg: Unsigned Long, in wParam: Unsigned Machine Int, in lParam: Long)
Output (in hDC: Long, in dpi: Long, in PixelBounds: tagRECT, in VisibleBounds: IEnvelope, in trackCancel: ITrackCancel)
PartialRefresh (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer, in Envelope: IEnvelope)
PrinterChanged (in Printer: IPrinter)
Refresh

IRubberBand : IUnknown

TrackExisting (in ScreenDisplay: IScreenDisplay, in Symbol: ISymbol, in Geometry: IGeometry) : Boolean
TrackNew (in ScreenDisplay: IScreenDisplay, in Symbol: ISymbol) : IGeometry

IEnvelope : IGeometry

Depth: Double
Height: Double
LowerLeft: IPoint
LowerRight: IPoint
MinMaxAttributes: _esriPointAttributes
MMax: Double
MMin: Double
UpperLeft: IPoint
UpperRight: IPoint
Width: Double
XMax: Double
XMin: Double
YMax: Double
YMin: Double
ZMax: Double
ZMin: Double

CenterAt (p: IPoint)
DefineFromPoints (Count: Long, in Points: IPoint)
DefineFromWKSPoints (Count: Long, in Points: _WKSPoint)
Expand (dx: Double, dy: Double, asRatio: Boolean)
ExpandM (dm: Double, asRatio:Boolean)
ExpandZ (dz: Double, asRatio: Boolean)
Intersect (inEnvelope: IEnvelope)
Offset (X: Double, Y: Double)
OffsetM (M: Double)
OffsetZ (Z: Double)
PutCoords (XMin: Double, YMin: Double, XMax: Double, YMax: Double)
PutWKSCoords (e: _WKSEnvelope)
QueryCoords (out XMin: Double, out YMin: Double, out XMax: Double, out YMax: Double)
QueryWKSCoords (out e: _WKSEnvelope)
Union (inEnvelope: IEnvelope)

1

The IMxDocument interface is obtained from the ThisDocument global variable.

2

A user-defined envelope defining the extent of the spatial query is required. The rubber envelope object is used.

3

The active view associated with the focus map is acquired in order for the rubber banding geometry to have the correct spatial reference.

4

The TrackNew method is called. This allows the user to drag the mouse to define the envelope.

6

Each layer in the map is looped over; if the layer is not of type IGeoFeatureLayer, the layer is skipped.

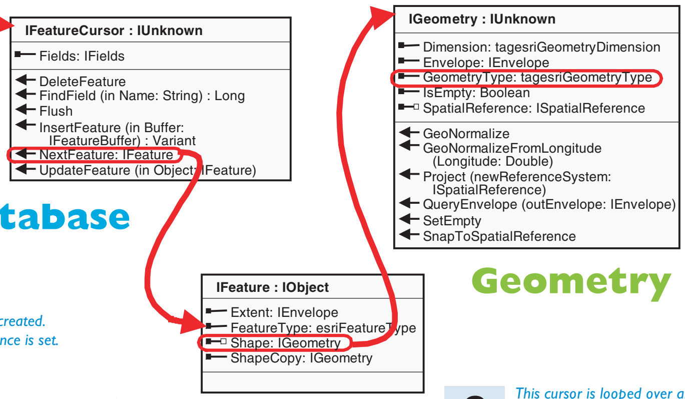
8

A feature cursor is obtained from the layer by calling the Search method passing in the SpatialFilter.

Geodatabase

5

A new spatial filter object is created. The shape and spatial reference is set.



IFeatureCursor : IUnknown

Fields: IFields

DeleteFeature
FindField (in Name: String) : Long
Flush
InsertFeature (in Buffer: IFeatureBuffer) : Variant
NextFeature: IFeature
UpdateFeature (in Object: IFeature)

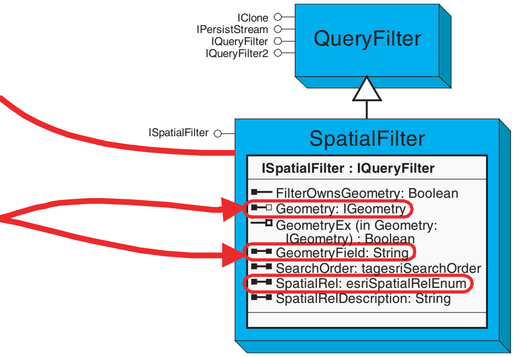
IGeometry : IUnknown

Dimension: tagesriGeometryDimension
Envelope: IEnvelope
GeometryType: tagesriGeometryType
IsEmpty: Boolean
SpatialReference: ISpatialReference

GeoNormalize
GeoNormalizeFromLongitude (Longitude: Double)
Project (newReferenceSystem: ISpatialReference)
QueryEnvelope (outEnvelope: IEnvelope)
SetEmpty
SnapToSpatialReference

IFeature : IObject

Extent: IEnvelope
FeatureType: esriFeatureType
Shape: IGeometry
ShapeCopy: IGeometry



ISpatialFilter : IQueryFilter

FilterOwnsGeometry: Boolean
Geometry: IGeometry
GeometryEx (in Geometry: IGeometry) : Boolean
GeometryField: String
SearchOrder: tagesriSearchOrder
SpatialRel: esriSpatialRelEnum
SpatialRelDescription: String

Geometry

Enumeration tagesriGeometryType

0	esriGeometryNull
1	esriGeometryPoint
2	esriGeometryMultipoint
3	esriGeometryPolyline
4	esriGeometryPolygon
5	esriGeometryEnvelope
6	esriGeometryPath
7	esriGeometryAny
9	esriGeometryMultiPatch
11	esriGeometryRing
13	esriGeometryLine
14	esriGeometryCircularArc
15	esriGeometryBezier3Curve
16	esriGeometryEllipticArc
17	esriGeometryBag
18	esriGeometryTriangleStrip
19	esriGeometryTriangleFan
20	esriGeometryRay
21	esriGeometrySphere

9

This cursor is looped over and the features returned by the cursor are inspected. Based on their geometry type, the totals are updated accordingly.

7

The spatial filter must be told what column in the database table holds the feature shape. This information is retrieved from the feature class.

Enumeration esriSpatialRelEnum

0	esriSpatialRelUndefined
1	esriSpatialRelIntersects
2	esriSpatialRelEnvelopeIntersects
3	esriSpatialRelIndexIntersects
4	esriSpatialRelTouches
5	esriSpatialRelOverlaps
6	esriSpatialRelCrosses
7	esriSpatialRelWithin
8	esriSpatialRelContains
9	esriSpatialRelRelation

10

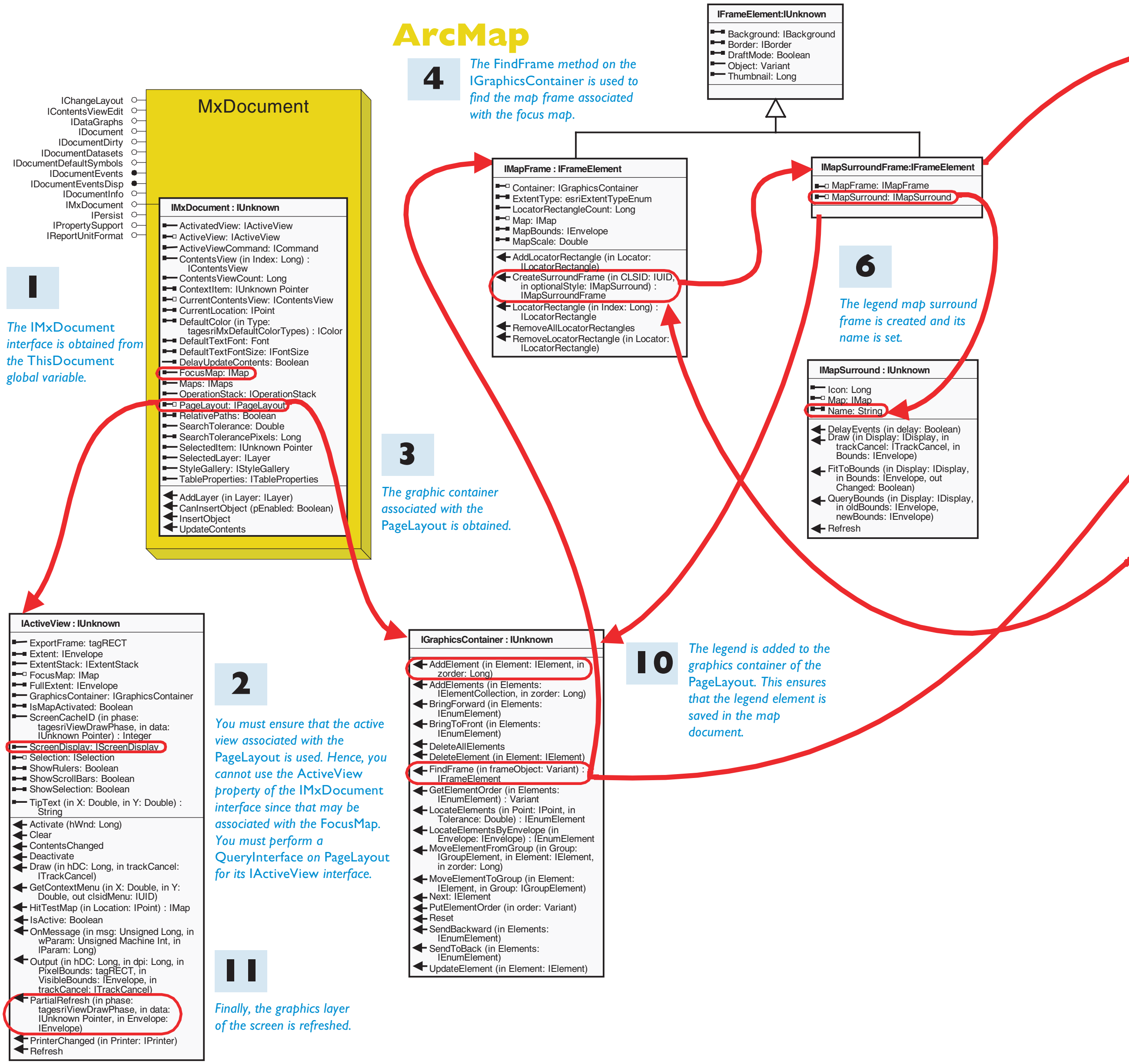
Finally, the results of the selection are displayed in a Visual Basic message box.

Add this to the MouseDown event of a UIToolControl in ArcMap.

```
    Dim pMxDoc As IMxDocument
1   Set pMxDoc = ThisDocument

    Dim pEnv As IEnvelope
    Dim pRubber As IRubberBand
2   Set pRubber = New RubberEnvelope

    Dim pActiveView As IActiveView
3   Set pActiveView = pMxDoc.FocusMap
4   Set pEnv = pRubber.TrackNew(pActiveView.ScreenDisplay, Nothing)

    Dim pSpatialFilter As ISpatialFilter
5   Set pSpatialFilter = New SpatialFilter
    Set pSpatialFilter.Geometry = pEnv
    pSpatialFilter.SpatialRel = esriSpatialRelIntersects

    Dim lPoints As Long, lPolygons As Long, lPolylines As Long
    Dim pLayer As IFeatureLayer
    Dim pFeatureCursor As IFeatureCursor
    Dim pFeature As IFeature
    Dim i As Long
    For i = 0 To pMxDoc.FocusMap.LayerCount - 1
6     If (TypeOf pMxDoc.FocusMap.Layer(i) Is IGeoFeatureLayer) Then
        Set pLayer = pMxDoc.FocusMap.Layer(i)
7       pSpatialFilter.GeometryField = pLayer.FeatureClass.ShapeFieldName

8       Set pFeatureCursor = pLayer.Search(pSpatialFilter, True)
9       Set pFeature = pFeatureCursor.NextFeature
        Do Until (pFeature Is Nothing)
          Select Case pFeature.Shape.GeometryType
            Case esriGeometryPoint
              lPoints = lPoints + 1
            Case esriGeometryPolyline
              lPolylines = lPolylines + 1
            Case esriGeometryPolygon
              lPolygons = lPolygons + 1
          End Select
          Set pFeature = pFeatureCursor.NextFeature
        Loop
      End If
    Next i

10  MsgBox "Features Found:" & vbCrLf & lPoints & " Points " & vbCrLf & _
     lPolylines & " Polylines " & vbCrLf & lPolygons & " Polygons "
```

Add map surround to page layout

This example adds legend map surround to a page layout and fills the legend with the layers of the map. Map surrounds are dynamically linked to their associated map; therefore, any changes to the map are reflected in the map surround.



ArcMap

1

The IMxDocument interface is obtained from the ThisDocument global variable.

2

You must ensure that the active view associated with the PageLayout is used. Hence, you cannot use the ActiveView property of the IMxDocument interface since that may be associated with the FocusMap. You must perform a QueryInterface on PageLayout for its IActiveView interface.

3

The graphic container associated with the PageLayout is obtained.

4

The FindFrame method on the IGraphicsContainer is used to find the map frame associated with the focus map.

6

The legend map surround frame is created and its name is set.

10

The legend is added to the graphics container of the PageLayout. This ensures that the legend element is saved in the map document.

11

Finally, the graphics layer of the screen is refreshed.

MxDocument

IChangeLayout
IContentsViewEdit
IDataGraphs
IDocument
IDocumentDirty
IDocumentDatasets
IDocumentDefaultSymbols
IDocumentEvents
IDocumentEventsDisp
IDocumentInfo
IMxDocument
IPersist
IPropertySupport
IReportUnitFormat

IMxDocument : IUnknown

ActivatedView: IActiveView
ActiveView: IActiveView
ActiveViewCommand: ICommand
ContentsView (in Index: Long) : IContentsView
ContentsViewCount: Long
ContextItem: IUnknown Pointer
CurrentContentsView: IContentsView
CurrentLocation: IPoint
DefaultColor (in Type: tagesriMxDefaultColorTypes) : IColor
DefaultTextFont: Font
DefaultTextFontSize: IFontSize
DelayUpdateContents: Boolean
FocusMap: IMap
Maps: IMaps
OperationStack: IOperationStack
PageLayout: IPageLayout
RelativePaths: Boolean
SearchTolerance: Double
SearchTolerancePixels: Long
SelectedItem: IUnknown Pointer
SelectedLayer: ILayer
StyleGallery: IStyleGallery
TableProperties: ITableProperties

AddLayer (in Layer: ILayer)
CanInsertObject (pEnabled: Boolean)
InsertObject
UpdateContents

IActiveView : IUnknown

ExportFrame: tagRECT
Extent: IEnvelope
ExtentStack: IExtentStack
FocusMap: IMap
FullExtent: IEnvelope
GraphicsContainer: IGraphicsContainer
IsMapActivated: Boolean
ScreenCacheID (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer) : Integer
ScreenDisplay: IScreenDisplay
Selection: ISelection
ShowRulers: Boolean
ShowScrollBars: Boolean
ShowSelection: Boolean
TipText (in X: Double, in Y: Double) : String

Activate (hWnd: Long)
Clear
ContentsChanged
Deactivate
Draw (in hDC: Long, in trackCancel: ITrackCancel)
GetContextMenu (in X: Double, in Y: Double, out clsidMenu: IUID)
HitTestMap (in Location: IPoint) : IMap
IsActive: Boolean
OnMessage (in msg: Unsigned Long, in wParam: Unsigned Machine Int, in lParam: Long)
Output (in hDC: Long, in dpi: Long, in PixelBounds: tagRECT, in VisibleBounds: IEnvelope, in trackCancel: ITrackCancel)
PartialRefresh (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer, in Envelope: IEnvelope)
PrinterChanged (in Printer: IPrinter)
Refresh

IGraphicsContainer : IUnknown

AddElement (in Element: IElement, in zorder: Long)
AddElements (in Elements: IElementCollection, in zorder: Long)
BringForward (in Elements: IEnumElement)
BringToFront (in Elements: IEnumElement)
DeleteAllElements
DeleteElement (in Element: IElement)
FindFrame (in frameObject: Variant) : IFrameElement
GetElementOrder (in Elements: IEnumElement) : Variant
LocateElements (in Point: IPoint, in Tolerance: Double) : IEnumElement
LocateElementsByEnvelope (in Envelope: IEnvelope) : IEnumElement
MoveElementFromGroup (in Group: IGroupElement, in Element: IElement, in zorder: Long)
MoveElementToGroup (in Element: IElement, in Group: IGroupElement)
Next: IElement
PutElementOrder (in order: Variant)
Reset
SendBackward (in Elements: IEnumElement)
SendToBack (in Elements: IEnumElement)
UpdateElement (in Element: IElement)

IFrameElement:IUnknown

Background: IBackground
Border: IBorder
DraftMode: Boolean
Object: Variant
Thumbnail: Long

IMapFrame : IFrameElement

Container: IGraphicsContainer
ExtentType: esriExtentTypeEnum
LocatorRectangleCount: Long
Map: IMap
MapBounds: IEnvelope
MapScale: Double

AddLocatorRectangle (in Locator: ILocatorRectangle)
CreateSurroundFrame (in CLSID: IUID, in optionalStyle: IMapSurround) : IMapSurroundFrame
LocatorRectangle (in Index: Long) : ILocatorRectangle
RemoveAllLocatorRectangles
RemoveLocatorRectangle (in Locator: ILocatorRectangle)

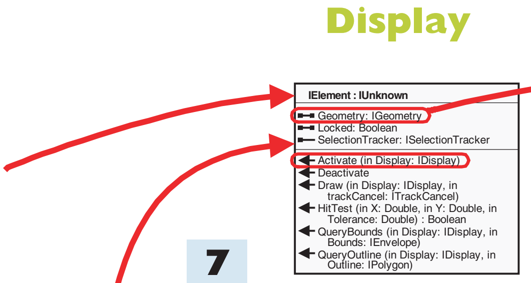
IMapSurroundFrame:IFrameElement

MapFrame: IMapFrame
MapSurround: IMapSurround

IMapSurround : IUnknown

Icon: Long
Map: IMap
Name: String

DelayEvents (in delay: Boolean)
Draw (in Display: IDisplay, in trackCancel: ITrackCancel, in Bounds: IEnvelope)
FitToBounds (in Display: IDisplay, in Bounds: IEnvelope, out Changed: Boolean)
QueryBounds (in Display: IDisplay, in oldBounds: IEnvelope, newBounds: IEnvelope)
Refresh

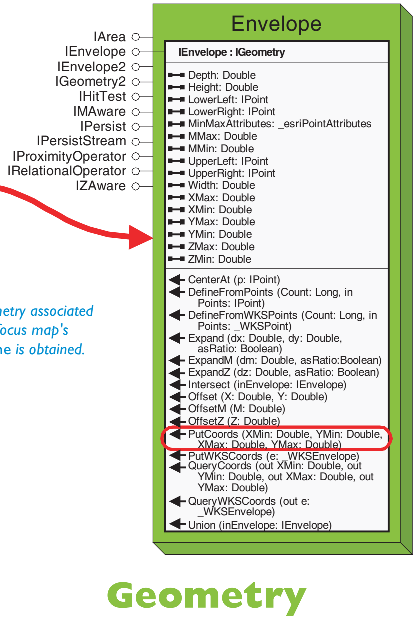

Display
IElement : IUnknown
Geometry: IGeometry
Locked: Boolean
SelectionTracker: ISelectionTracker
Activate (in Display: IDisplay)
Deactivate
Draw (in Display: IDisplay, in trackCancel: ITrackCancel)
HitTest (in X: Double, in Y: Double, in Tolerance: Double) : Boolean
QueryBounds (in Display: IDisplay, in Bounds: IEnvelope)
QueryOutline (in Display: IDisplay, in Outline: IPolygon)

7

The IElement *interface is accessed by a* QueryInterface *from* IMapSurroundFrame. *This interface is required to set the geometry of the frame. The geometry controls the location of the legend on the paper.*

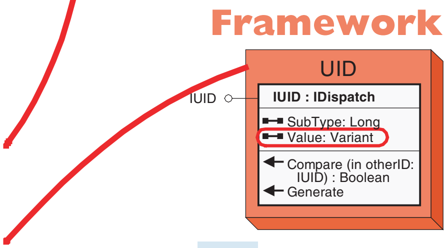
8

The geometry associated with the focus map's MapFrame *is obtained.*


Envelope
IArea
IEnvelope
IEnvelope2
IGeometry2
IHitTest
IMAware
IPersist
IPersistStream
IProximityOperator
IRelationalOperator
IZAware
IEnvelope : IGeometry
Depth: Double
Height: Double
LowerLeft: IPoint
LowerRight: IPoint
MinMaxAttributes: _esriPointAttributes
MMax: Double
MMin: Double
UpperLeft: IPoint
UpperRight: IPoint
Width: Double
XMax: Double
XMin: Double
YMax: Double
YMin: Double
ZMax: Double
ZMin: Double
CenterAt (p: IPoint)
DefineFromPoints (Count: Long, in Points: IPoint)
DefineFromWKSPoints (Count: Long, in Points: _WKSPoint)
Expand (dx: Double, dy: Double, asRatio: Boolean)
ExpandM (dm: Double, asRatio:Boolean)
ExpandZ (dz: Double, asRatio: Boolean)
Intersect (inEnvelope: IEnvelope)
Offset (X: Double, Y: Double)
OffsetM (M: Double)
OffsetZ (Z: Double)
PutCoords (XMin: Double, YMin: Double, XMax: Double, YMax: Double)
PutWKSCoords (e: _WKSEnvelope)
QueryCoords (out XMin: Double, out YMin: Double, out XMax: Double, out YMax: Double)
QueryWKSCoords (out e: _WKSEnvelope)
Union (inEnvelope: IEnvelope)
Geometry

9

A new envelope geometry for the legend is created and positioned relative to the focus map's map frame.



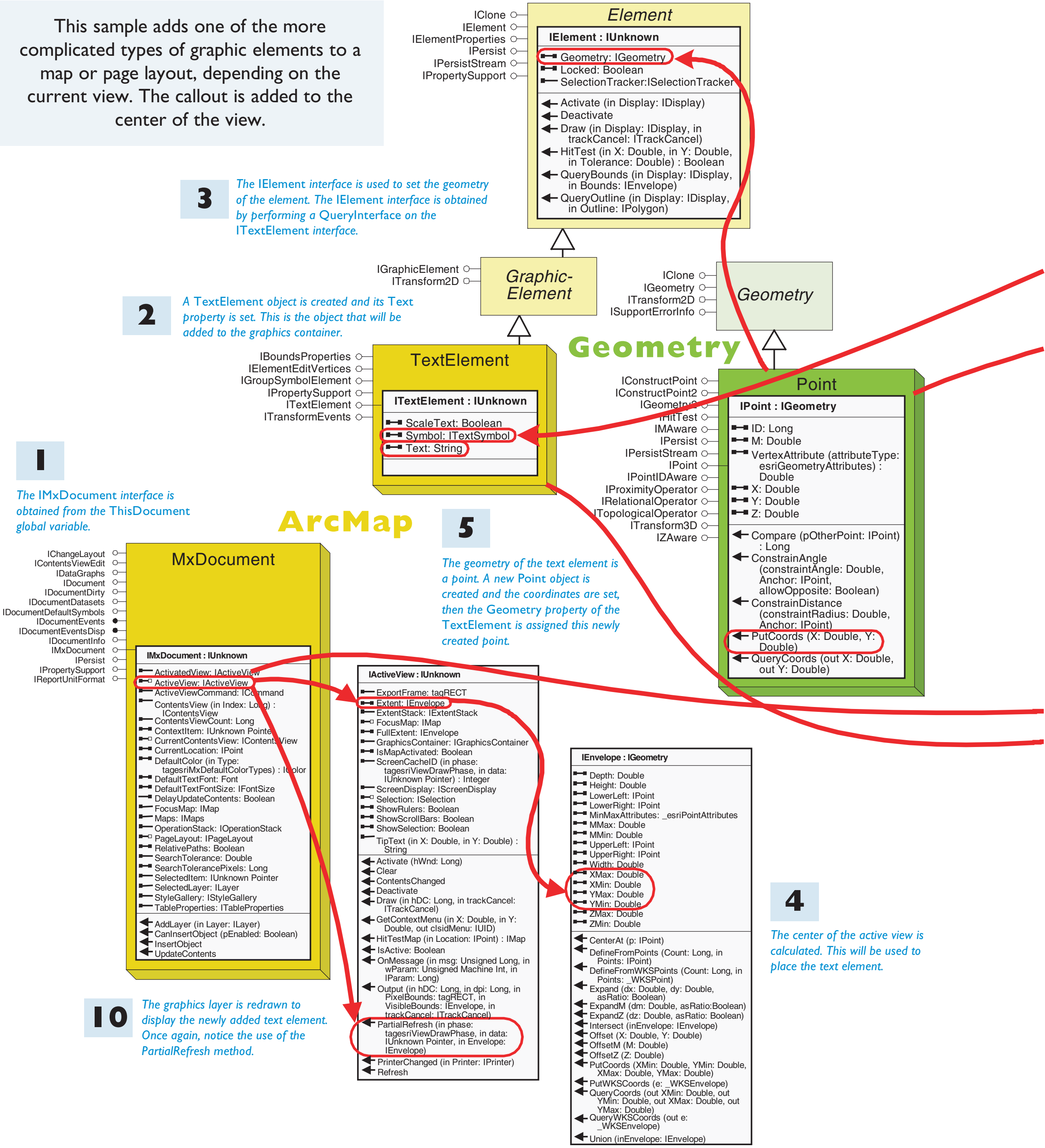
5

The CreateSurroundFrame *method requires the GUID of the surround element type. A* UID *object is created and its value is set to the ID of the legend class.*

Add this to the Click event of a UIButtonControl in ArcMap, and execute the command when in Page View.

```
1   Dim pMxDoc As IMxDocument
    Set pMxDoc = ThisDocument

2   Dim pActiveView As IActiveView
    Set pActiveView = pMxDoc.PageLayout

    Dim pGraphicsContainer As IGraphicsContainer
    Dim pMapFrame As IMapFrame
3   Set pGraphicsContainer = pMxDoc.PageLayout
4   Set pMapFrame = pGraphicsContainer.FindFrame(pMxDoc.FocusMap)

    Dim pMapSurroundFrame As IMapSurroundFrame
    Dim pUID As New UID
    Dim pElement As IElement
5   pUID.Value = "esriCore.Legend"
6   Set pMapSurroundFrame = pMapFrame.CreateSurroundFrame(pUID, Nothing)
    pMapSurroundFrame.MapSurround.Name = "Legend"

7   Set pElement = pMapSurroundFrame

    Dim pMainMapElement As IElement
    Dim pMainEnv As IEnvelope
8   Set pMainMapElement = pMapFrame
    Set pMainEnv = pMainMapElement.Geometry.Envelope

    Dim pEnv As IEnvelope
9   Set pEnv = New Envelope
    pEnv.PutCoords pMainEnv.XMax + 1.5, pMainEnv.YMin + 1.5, _
     pMainEnv.XMax - 1.5, pMainEnv.YMax - 1.5
    pElement.Geometry = pEnv
    pElement.Activate pActiveView.ScreenDisplay
10  pGraphicsContainer.AddElement pElement, 0
11  pActiveView.PartialRefresh esriViewGraphics, Nothing, Nothing
```

This sample adds one of the more complicated types of graphic elements to a map or page layout, depending on the current view. The callout is added to the center of the view.



1 *The* IMxDocument *interface is obtained from the* ThisDocument *global variable.*

2 *A* TextElement *object is created and its* Text *property is set. This is the object that will be added to the graphics container.*

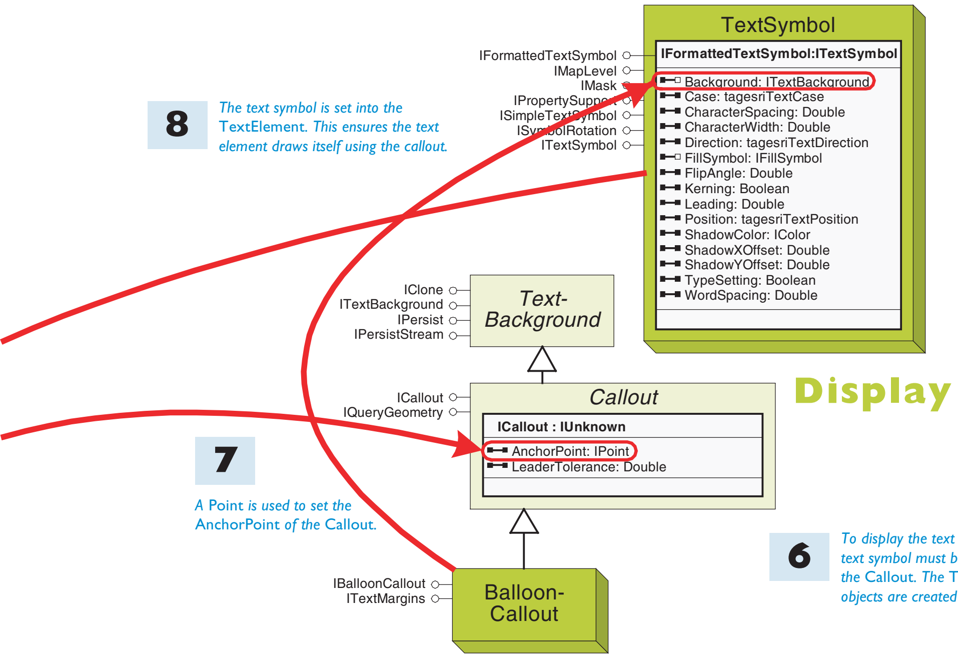
3 *The* IElement *interface is used to set the geometry of the element. The* IElement *interface is obtained by performing a* QueryInterface *on the* ITextElement *interface.*

4 *The center of the active view is calculated. This will be used to place the text element.*

5 *The geometry of the text element is a point. A new* Point *object is created and the coordinates are set, then the* Geometry *property of the* TextElement *is assigned this newly created point.*

10 *The graphics layer is redrawn to display the newly added text element. Once again, notice the use of the* PartialRefresh *method.*

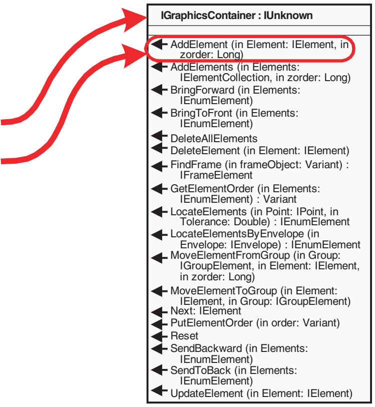
Element
IClone
IElement
IElementProperties
IPersist
IPersistStream
IPropertySupport
IElement : IUnknown
Geometry: IGeometry
Locked: Boolean
SelectionTracker:ISelectionTracker
Activate (in Display: IDisplay)
Deactivate
Draw (in Display: IDisplay, in trackCancel: ITrackCancel)
HitTest (in X: Double, in Y: Double, in Tolerance: Double) : Boolean
QueryBounds (in Display: IDisplay, in Bounds: IEnvelope)
QueryOutline (in Display: IDisplay, in Outline: IPolygon)
Graphic-Element
IGraphicElement
ITransform2D
Geometry
IClone
IGeometry
ITransform2D
ISupportErrorInfo
Geometry
TextElement
IBoundsProperties
IElementEditVertices
IGroupSymbolElement
IPropertySupport
ITextElement
ITransformEvents
ITextElement : IUnknown
ScaleText: Boolean
Symbol: ITextSymbol
Text: String
Point
IConstructPoint
IConstructPoint2
IGeometry2
IHitTest
IMAware
IPersist
IPersistStream
IPoint
IPointIDAware
IProximityOperator
IRelationalOperator
ITopologicalOperator
ITransform3D
IZAware
IPoint : IGeometry
ID: Long
M: Double
VertexAttribute (attributeType: esriGeometryAttributes) : Double
X: Double
Y: Double
Z: Double
Compare (pOtherPoint: IPoint) : Long
ConstrainAngle (constraintAngle: Double, Anchor: IPoint, allowOpposite: Boolean)
ConstrainDistance (constraintRadius: Double, Anchor: IPoint)
PutCoords (X: Double, Y: Double)
QueryCoords (out X: Double, out Y: Double)
ArcMap
MxDocument
IChangeLayout
IContentsViewEdit
IDataGraphs
IDocument
IDocumentDirty
IDocumentDatasets
IDocumentDefaultSymbols
IDocumentEvents
IDocumentEventsDisp
IDocumentInfo
IMxDocument
IPersist
IPropertySupport
IReportUnitFormat
IMxDocument : IUnknown
ActivatedView: IActiveView
ActiveView: IActiveView
ActiveViewCommand: ICommand
ContentsView (in Index: Long) : IContentsView
ContentsViewCount: Long
ContextItem: IUnknown Pointer
CurrentContentsView: IContentsView
CurrentLocation: IPoint
DefaultColor (in Type: tagesriMxDefaultColorTypes) : IColor
DefaultTextFont: Font
DefaultTextFontSize: IFontSize
DelayUpdateContents: Boolean
FocusMap: IMap
Maps: IMaps
OperationStack: IOperationStack
PageLayout: IPageLayout
RelativePaths: Boolean
SearchTolerance: Double
SearchTolerancePixels: Long
SelectedItem: IUnknown Pointer
SelectedLayer: ILayer
StyleGallery: IStyleGallery
TableProperties: ITableProperties
AddLayer (in Layer: ILayer)
CanInsertObject (pEnabled: Boolean)
InsertObject
UpdateContents
IActiveView : IUnknown
ExportFrame: tagRECT
Extent: IEnvelope
ExtentStack: IExtentStack
FocusMap: IMap
FullExtent: IEnvelope
GraphicsContainer: IGraphicsContainer
IsMapActivated: Boolean
ScreenCacheID (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer) : Integer
ScreenDisplay: IScreenDisplay
Selection: ISelection
ShowRulers: Boolean
ShowScrollBars: Boolean
ShowSelection: Boolean
TipText (in X: Double, in Y: Double) : String
Activate (hWnd: Long)
Clear
ContentsChanged
Deactivate
Draw (in hDC: Long, in trackCancel: ITrackCancel)
GetContextMenu (in X: Double, in Y: Double, out clsidMenu: IUID)
HitTestMap (in Location: IPoint) : IMap
IsActive: Boolean
OnMessage (in msg: Unsigned Long, in wParam: Unsigned Machine Int, in lParam: Long)
Output (in hDC: Long, in dpi: Long, in PixelBounds: tagRECT, in VisibleBounds: IEnvelope, in trackCancel: ITrackCancel)
PartialRefresh (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer, in Envelope: IEnvelope)
PrinterChanged (in Printer: IPrinter)
Refresh
IEnvelope : IGeometry
Depth: Double
Height: Double
LowerLeft: IPoint
LowerRight: IPoint
MinMaxAttributes: _esriPointAttributes
MMax: Double
MMin: Double
UpperLeft: IPoint
UpperRight: IPoint
Width: Double
XMax: Double
XMin: Double
YMax: Double
YMin: Double
ZMax: Double
ZMin: Double
CenterAt (p: IPoint)
DefineFromPoints (Count: Long, in Points: IPoint)
DefineFromWKSPoints (Count: Long, in Points: _WKSPoint)
Expand (dx: Double, dy: Double, asRatio: Boolean)
ExpandM (dm: Double, asRatio:Boolean)
ExpandZ (dz: Double, asRatio: Boolean)
Intersect (inEnvelope: IEnvelope)
Offset (X: Double, Y: Double)
OffsetM (M: Double)
OffsetZ (Z: Double)
PutCoords (XMin: Double, YMin: Double, XMax: Double, YMax: Double)
PutWKSCoords (e: _WKSEnvelope)
QueryCoords (out XMin: Double, out YMin: Double, out XMax: Double, out YMax: Double)
QueryWKSCoords (out e: _WKSEnvelope)
Union (inEnvelope: IEnvelope)



8 *The text symbol is set into the* TextElement. *This ensures the text element draws itself using the callout.*

7 *A Point is used to set the* AnchorPoint *of the* Callout.

6 *To display the text element as a callout, an appropriate text symbol must be used with the background set to be the* Callout. *The* TextSymbol *and* BalloonCallout *objects are created and associated with each other.*


IGraphicsContainer : IUnknown

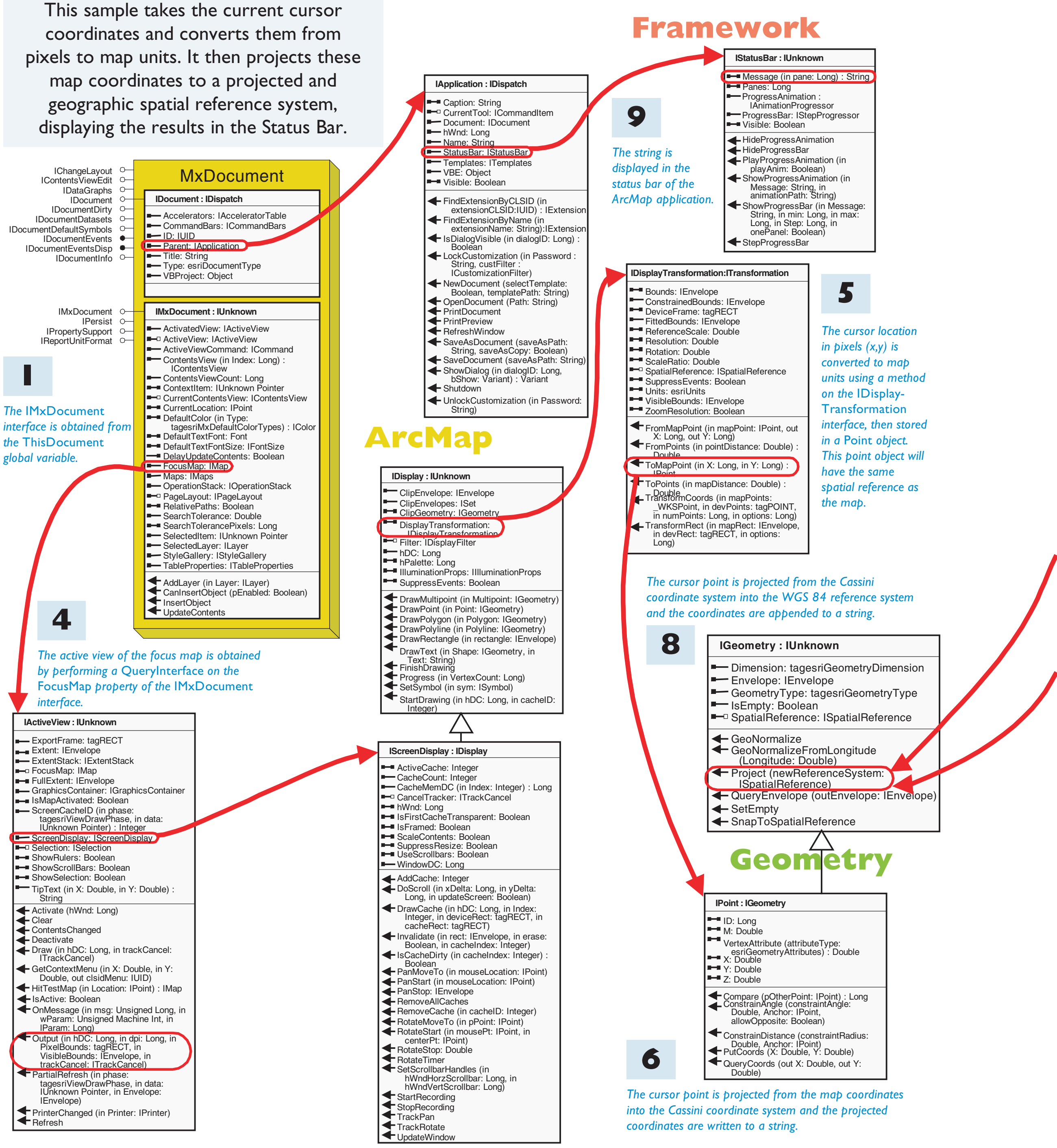
- AddElement (in Element: IElement, in zorder: Long)
- AddElements (in Elements: IElementCollection, in zorder: Long)
- BringForward (in Elements: IEnumElement)
- BringToFront (in Elements: IEnumElement)
- DeleteAllElements
- DeleteElement (in Element: IElement)
- FindFrame (in frameObject: Variant) : IFrameElement
- GetElementOrder (in Elements: IEnumElement) : Variant
- LocateElements (in Point: IPoint, in Tolerance: Double) : IEnumElement
- LocateElementsByEnvelope (in Envelope: IEnvelope) : IEnumElement
- MoveElementFromGroup (in Group: IGroupElement, in Element: IElement, in zorder: Long)
- MoveElementToGroup (in Element: IElement, in Group: IGroupElement)
- Next: IElement
- PutElementOrder (in order: Variant)
- Reset
- SendBackward (in Elements: IEnumElement)
- SendToBack (in Elements: IEnumElement)
- UpdateElement (in Element: IElement)

9 *The graphics container associated with the active view of the document is obtained by performing a* QueryInterface *on the* IActiveView *interface. The* TextElement *is then added to the container. This ensures that the element is saved within the map document.*

Add this code to the Click event of a UIButtonControl in ArcMap.

```
1  Dim pMxDoc As IMxDocument
   Set pMxDoc = ThisDocument

2  Dim pTextElement As ITextElement
   Set pTextElement = New TextElement

3  Dim pElement As IElement
   Set pElement = pTextElement
   pTextElement.Text = "Text in a callout" & vbCrLf & "In middle of screen"

4  Dim dMidX As Double, dMidY As Double, pPoint As IPoint
   dMidX = (pMxDoc.ActiveView.Extent.XMax + pMxDoc.ActiveView.Extent.XMin) / 2
   dMidY = (pMxDoc.ActiveView.Extent.YMax + pMxDoc.ActiveView.Extent.YMin) / 2
5  Set pPoint = New Point
   pPoint.PutCoords dMidX, dMidY
   pElement.Geometry = pPoint

   Dim pTextSymbol As IFormattedTextSymbol
   Set pTextSymbol = New TextSymbol
6  Dim pCallout As ICallout
   Set pCallout = New BalloonCallout
   Set pTextSymbol.Background = pCallout
7  pPoint.PutCoords dMidX - pMxDoc.ActiveView.Extent.Width / 4, _
    dMidY + pMxDoc.ActiveView.Extent.Width / 20
   pCallout.AnchorPoint = pPoint

8  pTextElement.Symbol = pTextSymbol
9  Dim pGraphicsContainer As IGraphicsContainer
   Set pGraphicsContainer = pMxDoc.ActiveView
   pGraphicsContainer.AddElement pElement, 0
   pElement.Activate pMxDoc.ActiveView.ScreenDisplay
10 pMxDoc.ActiveView.PartialRefresh esriViewGraphics, Nothing, Nothing
```

This sample takes the current cursor coordinates and converts them from pixels to map units. It then projects these map coordinates to a projected and geographic spatial reference system, displaying the results in the Status Bar.



MxDocument

IChangeLayout
IContentsViewEdit
IDataGraphs
IDocument
IDocumentDirty
IDocumentDatasets
IDocumentDefaultSymbols
IDocumentEvents
IDocumentEventsDisp
IDocumentInfo

IMxDocument
IPersist
IPropertySupport
IReportUnitFormat

IDocument : IDispatch

Accelerators: IAcceleratorTable
CommandBars: ICommandBars
ID: IUID
Parent: IApplication
Title: String
Type: esriDocumentType
VBProject: Object

IMxDocument : IUnknown

ActivatedView: IActiveView
ActiveView: IActiveView
ActiveViewCommand: ICommand
ContentsView (in Index: Long) : IContentsView
ContentsViewCount: Long
ContextItem: IUnknown Pointer
CurrentContentsView: IContentsView
CurrentLocation: IPoint
DefaultColor (in Type: tagesriMxDefaultColorTypes) : IColor
DefaultTextFont: Font
DefaultTextFontSize: IFontSize
DelayUpdateContents: Boolean
FocusMap: IMap
Maps: IMaps
OperationStack: IOperationStack
PageLayout: IPageLayout
RelativePaths: Boolean
SearchTolerance: Double
SearchTolerancePixels: Long
SelectedItem: IUnknown Pointer
SelectedLayer: ILayer
StyleGallery: IStyleGallery
TableProperties: ITableProperties

AddLayer (in Layer: ILayer)
CanInsertObject (pEnabled: Boolean)
InsertObject
UpdateContents

1

The IMxDocument interface is obtained from the ThisDocument global variable.

4

The active view of the focus map is obtained by performing a QueryInterface on the FocusMap property of the IMxDocument interface.

IActiveView : IUnknown

ExportFrame: tagRECT
Extent: IEnvelope
ExtentStack: IExtentStack
FocusMap: IMap
FullExtent: IEnvelope
GraphicsContainer: IGraphicsContainer
IsMapActivated: Boolean
ScreenCacheID (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer) : Integer
ScreenDisplay: IScreenDisplay
Selection: ISelection
ShowRulers: Boolean
ShowScrollBars: Boolean
ShowSelection: Boolean
TipText (in X: Double, in Y: Double) : String

Activate (hWnd: Long)
Clear
ContentsChanged
Deactivate
Draw (in hDC: Long, in trackCancel: ITrackCancel)
GetContextMenu (in X: Double, in Y: Double, out clsidMenu: IUID)
HitTestMap (in Location: IPoint) : IMap
IsActive: Boolean
OnMessage (in msg: Unsigned Long, in wParam: Unsigned Machine Int, in lParam: Long)
Output (in hDC: Long, in dpi: Long, in PixelBounds: tagRECT, in VisibleBounds: IEnvelope, in trackCancel: ITrackCancel)
PartialRefresh (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer, in Envelope: IEnvelope)
PrinterChanged (in Printer: IPrinter)
Refresh

IApplication : IDispatch

Caption: String
CurrentTool: ICommandItem
Document: IDocument
hWnd: Long
Name: String
StatusBar: IStatusBar
Templates: ITemplates
VBE: Object
Visible: Boolean

FindExtensionByCLSID (in extensionCLSID:IUID) : IExtension
FindExtensionByName (in extensionName: String):IExtension
IsDialogVisible (in dialogID: Long) : Boolean
LockCustomization (in Password : String, custFilter : ICustomizationFilter)
NewDocument (selectTemplate: Boolean, templatePath: String)
OpenDocument (Path: String)
PrintDocument
PrintPreview
RefreshWindow
SaveAsDocument (saveAsPath: String, saveAsCopy: Boolean)
SaveDocument (saveAsPath: String)
ShowDialog (in dialogID: Long, bShow: Variant) : Variant
Shutdown
UnlockCustomization (in Password: String)

ArcMap

IDisplay : IUnknown

ClipEnvelope: IEnvelope
ClipEnvelopes: ISet
ClipGeometry: IGeometry
DisplayTransformation: IDisplayTransformation
Filter: IDisplayFilter
hDC: Long
hPalette: Long
IlluminationProps: IIlluminationProps
SuppressEvents: Boolean

DrawMultipoint (in Multipoint: IGeometry)
DrawPoint (in Point: IGeometry)
DrawPolygon (in Polygon: IGeometry)
DrawPolyline (in Polyline: IGeometry)
DrawRectangle (in rectangle: IEnvelope)
DrawText (in Shape: IGeometry, in Text: String)
FinishDrawing
Progress (in VertexCount: Long)
SetSymbol (in sym: ISymbol)
StartDrawing (in hDC: Long, in cacheID: Integer)

IScreenDisplay : IDisplay

ActiveCache: Integer
CacheCount: Integer
CacheMemDC (in Index: Integer) : Long
CancelTracker: ITrackCancel
hWnd: Long
IsFirstCacheTransparent: Boolean
IsFramed: Boolean
ScaleContents: Boolean
SuppressResize: Boolean
UseScrollbars: Boolean
WindowDC: Long

AddCache: Integer
DoScroll (in xDelta: Long, in yDelta: Long, in updateScreen: Boolean)
DrawCache (in hDC: Long, in Index: Integer, in deviceRect: tagRECT, in cacheRect: tagRECT)
Invalidate (in rect: IEnvelope, in erase: Boolean, in cacheIndex: Integer)
IsCacheDirty (in cacheIndex: Integer) : Boolean
PanMoveTo (in mouseLocation: IPoint)
PanStart (in mouseLocation: IPoint)
PanStop: IEnvelope
RemoveAllCaches
RemoveCache (in cacheID: Integer)
RotateMoveTo (in pPoint: IPoint)
RotateStart (in mousePt: IPoint, in centerPt: IPoint)
RotateStop: Double
RotateTimer
SetScrollbarHandles (in hWndHorzScrollbar: Long, in hWndVertScrollbar: Long)
StartRecording
StopRecording
TrackPan
TrackRotate
UpdateWindow

Framework

IStatusBar : IUnknown

Message (in pane: Long) : String
Panes: Long
ProgressAnimation : IAnimationProgressor
ProgressBar: IStepProgressor
Visible: Boolean

HideProgressAnimation
HideProgressBar
PlayProgressAnimation (in playAnim: Boolean)
ShowProgressAnimation (in Message: String, in animationPath: String)
ShowProgressBar (in Message: String, in min: Long, in max: Long, in Step: Long, in onePanel: Boolean)
StepProgressBar

9

The string is displayed in the status bar of the ArcMap application.

IDisplayTransformation:ITransformation

Bounds: IEnvelope
ConstrainedBounds: IEnvelope
DeviceFrame: tagRECT
FittedBounds: IEnvelope
ReferenceScale: Double
Resolution: Double
Rotation: Double
ScaleRatio: Double
SpatialReference: ISpatialReference
SuppressEvents: Boolean
Units: esriUnits
VisibleBounds: IEnvelope
ZoomResolution: Boolean

FromMapPoint (in mapPoint: IPoint, out X: Long, out Y: Long)
FromPoints (in pointDistance: Double) : Double
ToMapPoint (in X: Long, in Y: Long) : IPoint
ToPoints (in mapDistance: Double) : Double
TransformCoords (in mapPoints: _WKSPoint, in devPoints: tagPOINT, in numPoints: Long, in options: Long)
TransformRect (in mapRect: IEnvelope, in devRect: tagRECT, in options: Long)

5

The cursor location in pixels (x,y) is converted to map units using a method on the IDisplayTransformation interface, then stored in a Point object. This point object will have the same spatial reference as the map.

The cursor point is projected from the Cassini coordinate system into the WGS 84 reference system and the coordinates are appended to a string.

8

IGeometry : IUnknown

Dimension: tagesriGeometryDimension
Envelope: IEnvelope
GeometryType: tagesriGeometryType
IsEmpty: Boolean
SpatialReference: ISpatialReference

GeoNormalize
GeoNormalizeFromLongitude (Longitude: Double)
Project (newReferenceSystem: ISpatialReference)
QueryEnvelope (outEnvelope: IEnvelope)
SetEmpty
SnapToSpatialReference

Geometry

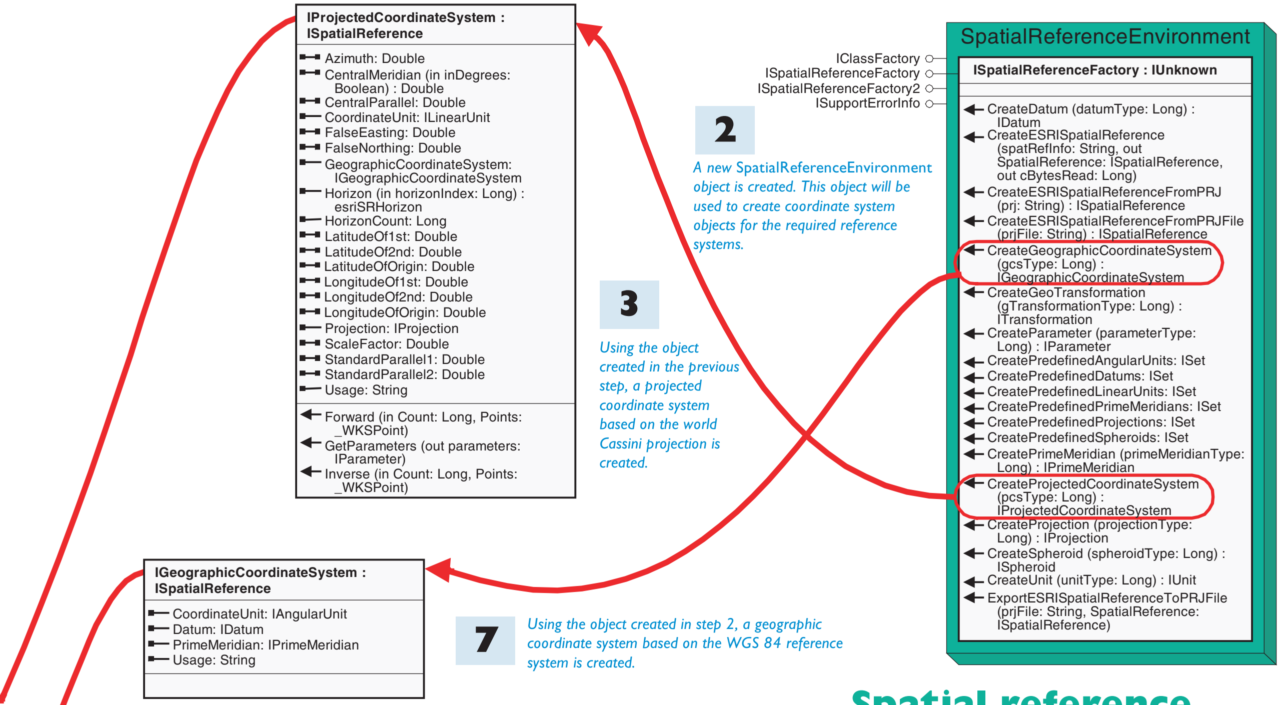
IPoint : IGeometry

ID: Long
M: Double
VertexAttribute (attributeType: esriGeometryAttributes) : Double
X: Double
Y: Double
Z: Double

Compare (pOtherPoint: IPoint) : Long
ConstrainAngle (constraintAngle: Double, Anchor: IPoint, allowOpposite: Boolean)
ConstrainDistance (constraintRadius: Double, Anchor: IPoint)
PutCoords (X: Double, Y: Double)
QueryCoords (out X: Double, out Y: Double)

6

The cursor point is projected from the map coordinates into the Cassini coordinate system and the projected coordinates are written to a string.


IProjectedCoordinateSystem : ISpatialReference
Azimuth: Double
CentralMeridian (in inDegrees: Boolean) : Double
CentralParallel: Double
CoordinateUnit: ILinearUnit
FalseEasting: Double
FalseNorthing: Double
GeographicCoordinateSystem: IGeographicCoordinateSystem
Horizon (in horizonIndex: Long) : esriSRHorizon
HorizonCount: Long
LatitudeOf1st: Double
LatitudeOf2nd: Double
LatitudeOfOrigin: Double
LongitudeOf1st: Double
LongitudeOf2nd: Double
LongitudeOfOrigin: Double
Projection: IProjection
ScaleFactor: Double
StandardParallel1: Double
StandardParallel2: Double
Usage: String
Forward (in Count: Long, Points: _WKSPoint)
GetParameters (out parameters: IParameter)
Inverse (in Count: Long, Points: _WKSPoint)
IGeographicCoordinateSystem : ISpatialReference
CoordinateUnit: IAngularUnit
Datum: IDatum
PrimeMeridian: IPrimeMeridian
Usage: String
SpatialReferenceEnvironment
IClassFactory
ISpatialReferenceFactory
ISpatialReferenceFactory2
ISupportErrorInfo
ISpatialReferenceFactory : IUnknown
CreateDatum (datumType: Long) : IDatum
CreateESRISpatialReference (spatRefInfo: String, out SpatialReference: ISpatialReference, out cBytesRead: Long)
CreateESRISpatialReferenceFromPRJ (prj: String) : ISpatialReference
CreateESRISpatialReferenceFromPRJFile (prjFile: String) : ISpatialReference
CreateGeographicCoordinateSystem (gcsType: Long) : IGeographicCoordinateSystem
CreateGeoTransformation (gTransformationType: Long) : ITransformation
CreateParameter (parameterType: Long) : IParameter
CreatePredefinedAngularUnits: ISet
CreatePredefinedDatums: ISet
CreatePredefinedLinearUnits: ISet
CreatePredefinedPrimeMeridians: ISet
CreatePredefinedProjections: ISet
CreatePredefinedSpheroids: ISet
CreatePrimeMeridian (primeMeridianType: Long) : IPrimeMeridian
CreateProjectedCoordinateSystem (pcsType: Long) : IProjectedCoordinateSystem
CreateProjection (projectionType: Long) : IProjection
CreateSpheroid (spheroidType: Long) : ISpheroid
CreateUnit (unitType: Long) : IUnit
ExportESRISpatialReferenceToPRJFile (prjFile: String, SpatialReference: ISpatialReference)
2
3
7

2 *A new SpatialReferenceEnvironment object is created. This object will be used to create coordinate system objects for the required reference systems.*

3 *Using the object created in the previous step, a projected coordinate system based on the world Cassini projection is created.*

7 *Using the object created in step 2, a geographic coordinate system based on the WGS 84 reference system is created.*

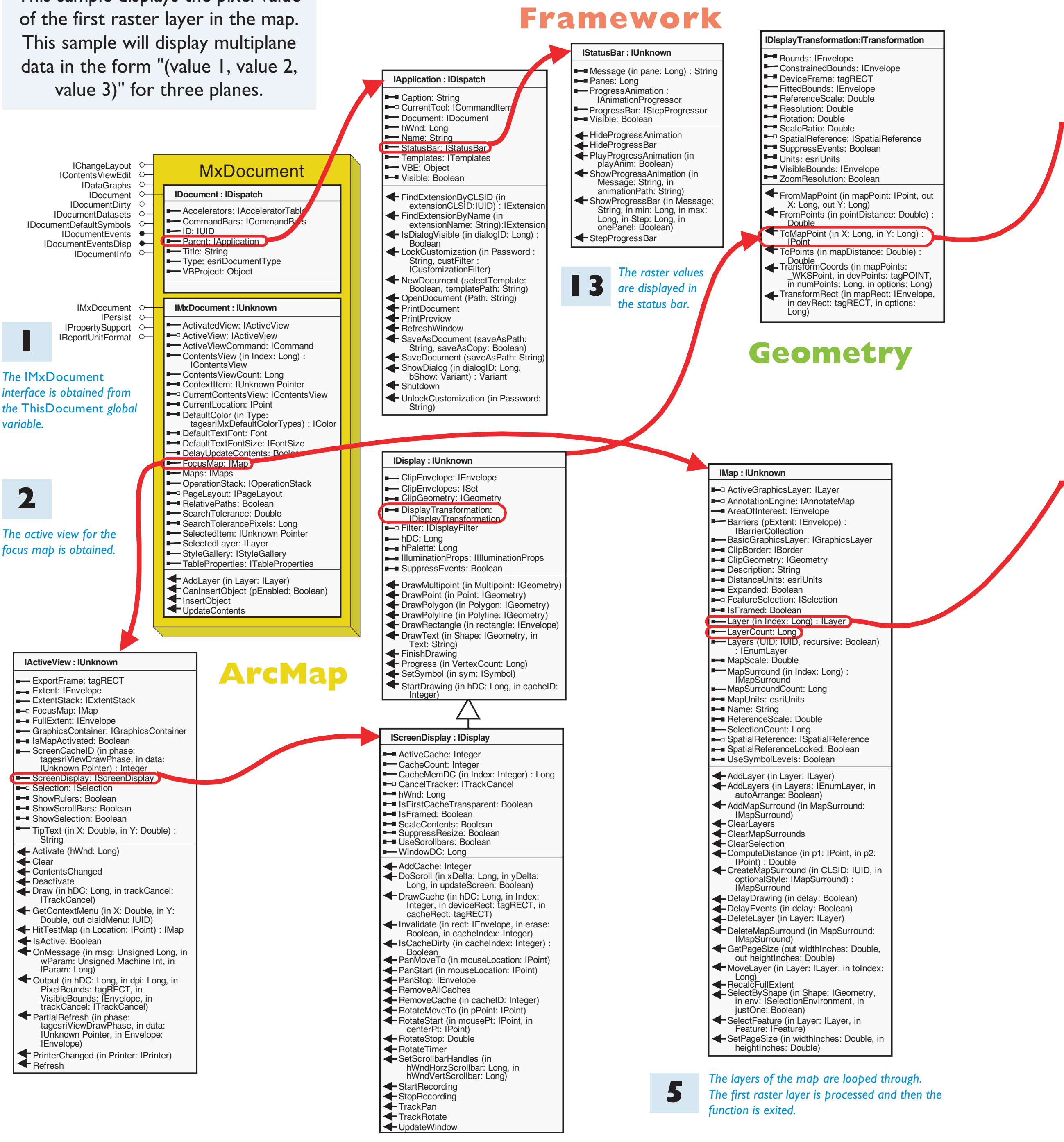
Spatial reference

Add this code to the MouseMove event of a UIToolControl in ArcMap.

```
1  Dim pMxDoc As IMxDocument
   Set pMxDoc = ThisDocument

   Dim pSpatialRefFactory As ISpatialReferenceFactory
2  Set pSpatialRefFactory = New SpatialReferenceEnvironment

   Dim pProjectedCoodinateSystem As IProjectedCoordinateSystem
3  Set pProjectedCoodinateSystem =
   pSpatialRefFactory.CreateProjectedCoordinateSystem(esriSRProjCS_World_Cassini)

4  Dim pActiveView As IActiveView
   Set pActiveView = pMxDoc.FocusMap

5  Dim pPoint As IPoint
   Set pPoint = pActiveView.ScreenDisplay.DisplayTransformation.ToMapPoint(x, y)

6  pPoint.Project pProjectedCoodinateSystem
   Dim sMessage As String
   sMessage = "Cassini : " & CStr(Round(pPoint.x, 2)) & ", " & _
    CStr(Round(pPoint.y, 2))

7  Dim pGeographicCoordinateSystem As IGeographicCoordinateSystem
   Set pGeographicCoordinateSystem = _
    pSpatialRefFactory.CreateGeographicCoordinateSystem(esriSRGeoCS_WGS1984)

8  pPoint.Project pGeographicCoordinateSystem
   sMessage = sMessage & " and WGS84 : " & CStr(Round(pPoint.x, 2)) & ", " &
   CStr(Round(pPoint.y, 2))
9  ThisDocument.Parent.StatusBar.Message(0) = sMessage
```

Display raster cell value in status bar

This sample displays the pixel value of the first raster layer in the map. This sample will display multiplane data in the form "(value 1, value 2, value 3)" for three planes.



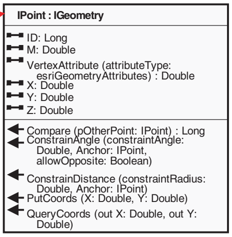
Framework
ArcMap
Geometry
MxDocument
IChangeLayout
IContentsViewEdit
IDataGraphs
IDocument
IDocumentDirty
IDocumentDatasets
IDocumentDefaultSymbols
IDocumentEvents
IDocumentEventsDisp
IDocumentInfo
IMxDocument
IPersist
IPropertySupport
IReportUnitFormat
IDocument : IDispatch
Accelerators: IAcceleratorTabl
CommandBars: ICommandB s
ID: IUID
Parent: IApplication
Title: String
Type: esriDocumentType
VBProject: Object
IMxDocument : IUnknown
ActivatedView: IActiveView
ActiveView: IActiveView
ActiveViewCommand: ICommand
ContentsView (in Index: Long) : IContentsView
ContentsViewCount: Long
ContextItem: IUnknown Pointer
CurrentContentsView: IContentsView
CurrentLocation: IPoint
DefaultColor (in Type: tagesriMxDefaultColorTypes) : IColor
DefaultTextFont: Font
DefaultTextFontSize: IFontSize
DelayUpdateContents: Boolea
FocusMap: IMap
Maps: IMaps
OperationStack: IOperationStack
PageLayout: IPageLayout
RelativePaths: Boolean
SearchTolerance: Double
SearchTolerancePixels: Long
SelectedItem: IUnknown Pointer
SelectedLayer: ILayer
StyleGallery: IStyleGallery
TableProperties: ITableProperties
AddLayer (in Layer: ILayer)
CanInsertObject (pEnabled: Boolean)
InsertObject
UpdateContents
IApplication : IDispatch
Caption: String
CurrentTool: ICommandItem
Document: IDocument
hWnd: Long
Name: String
StatusBar: IStatusBar
Templates: ITemplates
VBE: Object
Visible: Boolean
FindExtensionByCLSID (in extensionCLSID:IUID) : IExtension
FindExtensionByName (in extensionName: String):IExtension
IsDialogVisible (in dialogID: Long) : Boolean
LockCustomization (in Password : String, custFilter : ICustomizationFilter)
NewDocument (selectTemplate: Boolean, templatePath: String)
OpenDocument (Path: String)
PrintDocument
PrintPreview
RefreshWindow
SaveAsDocument (saveAsPath: String, saveAsCopy: Boolean)
SaveDocument (saveAsPath: String)
ShowDialog (in dialogID: Long, bShow: Variant) : Variant
Shutdown
UnlockCustomization (in Password: String)
IStatusBar : IUnknown
Message (in pane: Long) : String
Panes: Long
ProgressAnimation : IAnimationProgressor
ProgressBar: IStepProgressor
Visible: Boolean
HideProgressAnimation
HideProgressBar
PlayProgressAnimation (in playAnim: Boolean)
ShowProgressAnimation (in Message: String, in animationPath: String)
ShowProgressBar (in Message: String, in min: Long, in max: Long, in Step: Long, in onePanel: Boolean)
StepProgressBar
IDisplayTransformation:ITransformation
Bounds: IEnvelope
ConstrainedBounds: IEnvelope
DeviceFrame: tagRECT
FittedBounds: IEnvelope
ReferenceScale: Double
Resolution: Double
Rotation: Double
ScaleRatio: Double
SpatialReference: ISpatialReference
SuppressEvents: Boolean
Units: esriUnits
VisibleBounds: IEnvelope
ZoomResolution: Boolean
FromMapPoint (in mapPoint: IPoint, out X: Long, out Y: Long)
FromPoints (in pointDistance: Double) : Double
ToMapPoint (in X: Long, in Y: Long) : IPoint
ToPoints (in mapDistance: Double) : Double
TransformCoords (in mapPoints: _WKSPoint, in devPoints: tagPOINT, in numPoints: Long, in options: Long)
TransformRect (in mapRect: IEnvelope, in devRect: tagRECT, in options: Long)
IDisplay : IUnknown
ClipEnvelope: IEnvelope
ClipEnvelopes: ISet
ClipGeometry: IGeometry
DisplayTransformation: IDisplayTransformation
Filter: IDisplayFilter
hDC: Long
hPalette: Long
IlluminationProps: IIlluminationProps
SuppressEvents: Boolean
DrawMultipoint (in Multipoint: IGeometry)
DrawPoint (in Point: IGeometry)
DrawPolygon (in Polygon: IGeometry)
DrawPolyline (in Polyline: IGeometry)
DrawRectangle (in rectangle: IEnvelope)
DrawText (in Shape: IGeometry, in Text: String)
FinishDrawing
Progress (in VertexCount: Long)
SetSymbol (in sym: ISymbol)
StartDrawing (in hDC: Long, in cacheID: Integer)
IScreenDisplay : IDisplay
ActiveCache: Integer
CacheCount: Integer
CacheMemDC (in Index: Integer) : Long
CancelTracker: ITrackCancel
hWnd: Long
IsFirstCacheTransparent: Boolean
IsFramed: Boolean
ScaleContents: Boolean
SuppressResize: Boolean
UseScrollbars: Boolean
WindowDC: Long
AddCache: Integer
DoScroll (in xDelta: Long, in yDelta: Long, in updateScreen: Boolean)
DrawCache (in hDC: Long, in Index: Integer, in deviceRect: tagRECT, in cacheRect: tagRECT)
Invalidate (in rect: IEnvelope, in erase: Boolean, in cacheIndex: Integer)
IsCacheDirty (in cacheIndex: Integer) : Boolean
PanMoveTo (in mouseLocation: IPoint)
PanStart (in mouseLocation: IPoint)
PanStop: IEnvelope
RemoveAllCaches
RemoveCache (in cacheID: Integer)
RotateMoveTo (in pPoint: IPoint)
RotateStart (in mousePt: IPoint, in centerPt: IPoint)
RotateStop: Double
RotateTimer
SetScrollbarHandles (in hWndHorzScrollbar: Long, in hWndVertScrollbar: Long)
StartRecording
StopRecording
TrackPan
TrackRotate
UpdateWindow
IActiveView : IUnknown
ExportFrame: tagRECT
Extent: IEnvelope
ExtentStack: IExtentStack
FocusMap: IMap
FullExtent: IEnvelope
GraphicsContainer: IGraphicsContainer
IsMapActivated: Boolean
ScreenCacheID (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer) : Integer
ScreenDisplay: IScreenDisplay
Selection: ISelection
ShowRulers: Boolean
ShowScrollBars: Boolean
ShowSelection: Boolean
TipText (in X: Double, in Y: Double) : String
Activate (hWnd: Long)
Clear
ContentsChanged
Deactivate
Draw (in hDC: Long, in trackCancel: ITrackCancel)
GetContextMenu (in X: Double, in Y: Double, out clsidMenu: IUID)
HitTestMap (in Location: IPoint) : IMap
IsActive: Boolean
OnMessage (in msg: Unsigned Long, in wParam: Unsigned Machine Int, in lParam: Long)
Output (in hDC: Long, in dpi: Long, in PixelBounds: tagRECT, in VisibleBounds: IEnvelope, in trackCancel: ITrackCancel)
PartialRefresh (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer, in Envelope: IEnvelope)
PrinterChanged (in Printer: IPrinter)
Refresh
IMap : IUnknown
ActiveGraphicsLayer: ILayer
AnnotationEngine: IAnnotateMap
AreaOfInterest: IEnvelope
Barriers (pExtent: IEnvelope) : IBarrierCollection
BasicGraphicsLayer: IGraphicsLayer
ClipBorder: IBorder
ClipGeometry: IGeometry
Description: String
DistanceUnits: esriUnits
Expanded: Boolean
FeatureSelection: ISelection
IsFramed: Boolean
Layer (in Index: Long) : ILayer
LayerCount: Long
Layers (UID: IUID, recursive: Boolean) : IEnumLayer
MapScale: Double
MapSurround (in Index: Long) : IMapSurround
MapSurroundCount: Long
MapUnits: esriUnits
Name: String
ReferenceScale: Double
SelectionCount: Long
SpatialReference: ISpatialReference
SpatialReferenceLocked: Boolean
UseSymbolLevels: Boolean
AddLayer (in Layer: ILayer)
AddLayers (in Layers: IEnumLayer, in autoArrange: Boolean)
AddMapSurround (in MapSurround: IMapSurround)
ClearLayers
ClearMapSurrounds
ClearSelection
ComputeDistance (in p1: IPoint, in p2: IPoint) : Double
CreateMapSurround (in CLSID: IUID, in optionalStyle: IMapSurround) : IMapSurround
DelayDrawing (in delay: Boolean)
DelayEvents (in delay: Boolean)
DeleteLayer (in Layer: ILayer)
DeleteMapSurround (in MapSurround: IMapSurround)
GetPageSize (out widthInches: Double, out heightInches: Double)
MoveLayer (in Layer: ILayer, in toIndex: Long)
RecalcFullExtent
SelectByShape (in Shape: IGeometry, in env: ISelectionEnvironment, in justOne: Boolean)
SelectFeature (in Layer: ILayer, in Feature: IFeature)
SetPageSize (in widthInches: Double, in heightInches: Double)

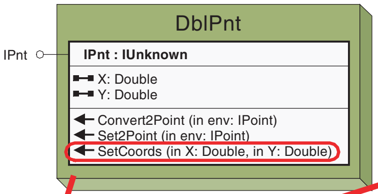
1 *The IMxDocument interface is obtained from the ThisDocument global variable.*

2 *The active view for the focus map is obtained.*

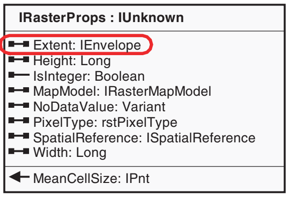
13 *The raster values are displayed in the status bar.*

5 *The layers of the map are looped through. The first raster layer is processed and then the function is exited.*


IPoint : IGeometry
ID: Long
M: Double
VertexAttribute (attributeType: esriGeometryAttributes) : Double
X: Double
Y: Double
Z: Double
Compare (pOtherPoint: IPoint) : Long
ConstrainAngle (constraintAngle: Double, Anchor: IPoint, allowOpposite: Boolean)
ConstrainDistance (constraintRadius: Double, Anchor: IPoint)
PutCoords (X: Double, Y: Double)
QueryCoords (out X: Double, out Y: Double)


DblPnt
IPnt
IPnt : IUnknown
X: Double
Y: Double
Convert2Point (in env: IPoint)
Set2Point (in env: IPoint)
SetCoords (in X: Double, in Y: Double)

4 *A dblPoint object is created and the coordinates are set to 1.0, 1.0. This will be used to define the size of the pixel block used to interrogate the raster.*



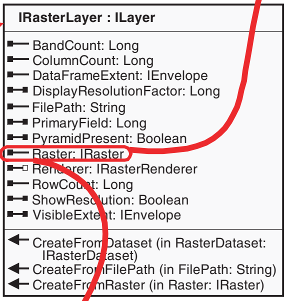
Raster

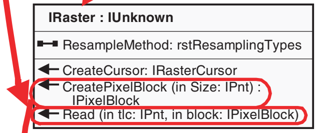
9 *The coordinates of the cursor are calculated in raster pixel units.*

3 *The cursor coordinates, in pixels, must be converted to map units. The* ToMapPoint *method on the* IDisplayTransformation *interface does this.*

8 *The* IRasterProps *interface is obtained. This provides information about the extent of the raster in both real-world units and pixels.*

6 *The* ILayer *interface is accessed through a* QueryInterface *for the* IRasterLayer *interface. This interface gives access to raster-specific properties of the layer.*

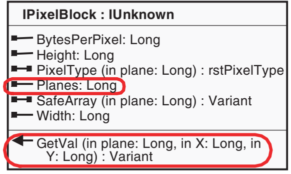

IRasterLayer : ILayer
BandCount: Long
ColumnCount: Long
DataFrameExtent: IEnvelope
DisplayResolutionFactor: Long
FilePath: String
PrimaryField: Long
PyramidPresent: Boolean
Raster: IRaster
Renderer: IRasterRenderer
RowCount: Long
ShowResolution: Boolean
VisibleExtent: IEnvelope
CreateFromDataset (in RasterDataset: IRasterDataset)
CreateFromFilePath (in FilePath: String)
CreateFromRaster (in Raster: IRaster)


IRaster : IUnknown
ResampleMethod: rstResamplingTypes
CreateCursor: IRasterCursor
CreatePixelBlock (in Size: IPnt) : IPixelBlock
Read (in tlc: IPnt, in block: IPixelBlock)

7 *A pixel block the size of one pixel is created.*

11 *The planes or the raster are looped over, extracting the pixel values.*

10 *The pixel block for the raster location is populated.*


IPixelBlock : IUnknown
BytesPerPixel: Long
Height: Long
PixelType (in plane: Long) : rstPixelType
Planes: Long
SafeArray (in plane: Long) : Variant
Width: Long
GetVal (in plane: Long, in X: Long, in Y: Long) : Variant

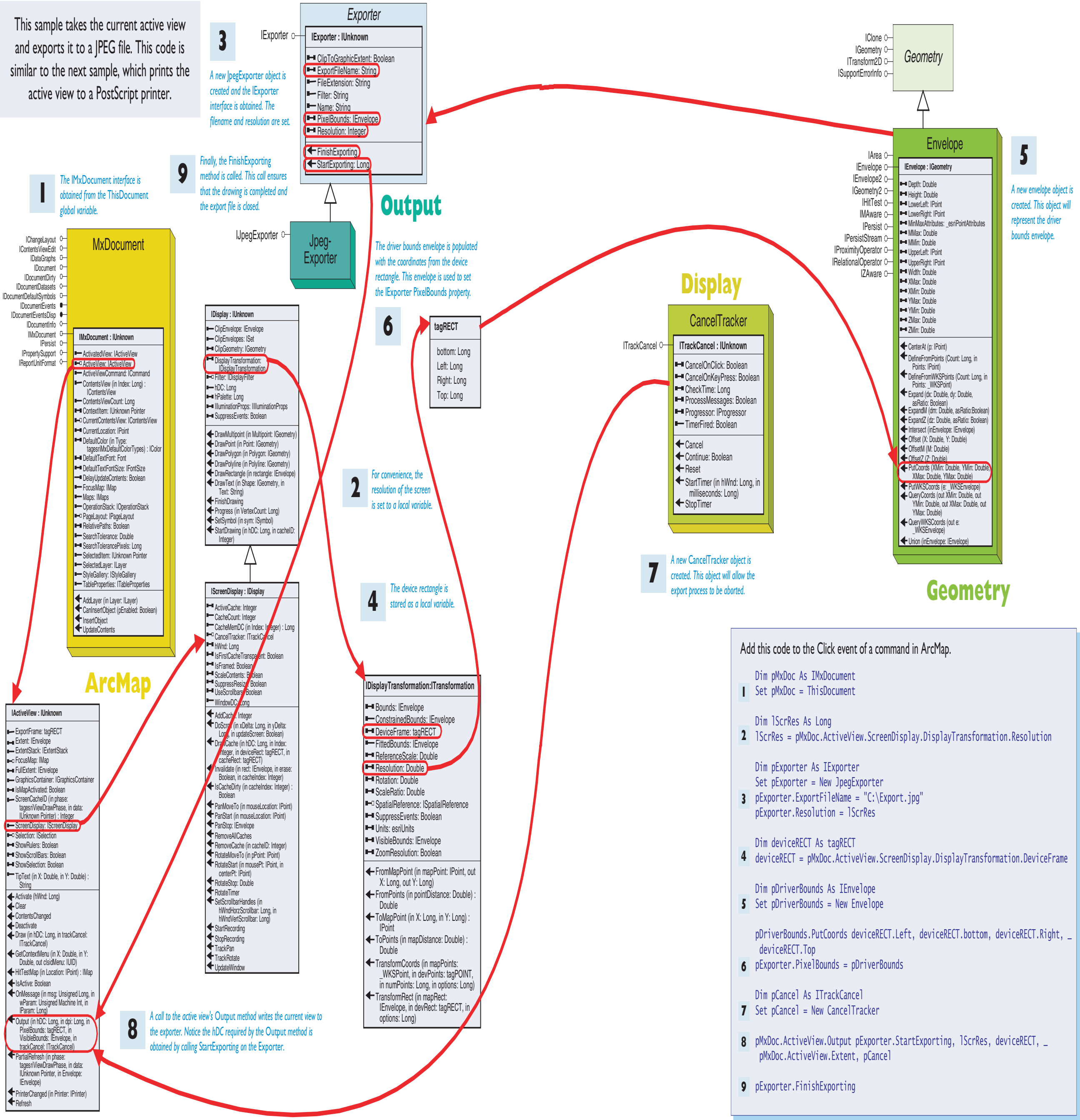
12 *Checks are made to ensure that there are raster values present at the location. If there are, they are appended to the value string.*

Add this code to the MouseMove event of a UIToolControl in ArcMap.

```
1   Dim pMxDoc As IMxDocument
    Set pMxDoc = ThisDocument

    Dim pActiveView As IActiveView
2   Set pActiveView = pMxDoc.FocusMap
    Dim pPoint As IPoint
3   Set pPoint = pActiveView.ScreenDisplay.DisplayTransformation.ToMapPoint(x, y)

    Dim pBlockSize As IPnt
4   Set pBlockSize = New DblPnt
    pBlockSize.SetCoords 1#, 1#

    Dim pLayer As IRasterLayer
    Dim pPixelBlock As IPixelBlock
    Dim vValue As Variant
    Dim i As Long, j As Long
    Dim sPixelVals As String
    sPixelVals = "No Raster"
    Dim pRasterProps As IRasterProps
    Dim dXSize As Double, dYSize As Double
    Dim pPixel As IPnt
    Set pPixel = New DblPnt
5   For i = 0 To pMxDoc.FocusMap.LayerCount - 1
      If (TypeOf pMxDoc.FocusMap.Layer(i) Is IRasterLayer) Then
6       Set pLayer = pMxDoc.FocusMap.Layer(i)
7       Set pPixelBlock = pLayer.Raster.CreatePixelBlock(pBlockSize)

8       Set pRasterProps = pLayer.Raster
        dXSize = pRasterProps.Extent.XMax - pRasterProps.Extent.XMin
        dYSize = pRasterProps.Extent.YMax - pRasterProps.Extent.YMin
        dXSize = dXSize / pRasterProps.Width
        dYSize = dYSize / pRasterProps.Height

9       pPixel.x = (pPoint.x - pRasterProps.Extent.XMin) / dXSize
        pPixel.y = (pRasterProps.Extent.YMax - pPoint.y) / dYSize

10      pLayer.Raster.Read pPixel, pPixelBlock
11      For j = 0 To pPixelBlock.Planes - 1
12        If (sPixelVals = "No Raster") Then
            sPixelVals = "("
          Else
            sPixelVals = sPixelVals & ", "
          End If
          vValue = pPixelBlock.GetVal(j, 0, 0)
          sPixelVals = sPixelVals & CStr(vValue)
        Next j
        If (sPixelVals <> "No Raster") Then sPixelVals = sPixelVals & ")"
13      ThisDocument.Parent.StatusBar.Message(0) = "Raster value = " & sPixelVals
        Exit For
      End If
    Next I
```

Export current view

This sample takes the current active view and exports it to a JPEG file. This code is similar to the next sample, which prints the active view to a PostScript printer.


Exporter
IExporter
IExporter : IUnknown
ClipToGraphicExtent: Boolean
ExportFileName: String
FileExtension: String
Filter: String
Name: String
PixelBounds: IEnvelope
Resolution: Integer
FinishExporting
StartExporting: Long
IJpegExporter
Jpeg-Exporter
Output
IClone
IGeometry
ITransform2D
ISupportErrorInfo
Geometry
Envelope
IArea
IEnvelope
IEnvelope2
IGeometry2
IHitTest
IMAware
IPersist
IPersistStream
IProximityOperator
IRelationalOperator
IZAware
IEnvelope : IGeometry
Depth: Double
Height: Double
LowerLeft: IPoint
LowerRight: IPoint
MinMaxAttributes: _esriPointAttributes
MMax: Double
MMin: Double
UpperLeft: IPoint
UpperRight: IPoint
Width: Double
XMax: Double
XMin: Double
YMax: Double
YMin: Double
ZMax: Double
ZMin: Double
CenterAt (p: IPoint)
DefineFromPoints (Count: Long, in Points: IPoint)
DefineFromWKSPoints (Count: Long, in Points: _WKSPoint)
Expand (dx: Double, dy: Double, asRatio: Boolean)
ExpandM (dm: Double, asRatio:Boolean)
ExpandZ (dz: Double, asRatio: Boolean)
Intersect (inEnvelope: IEnvelope)
Offset (X: Double, Y: Double)
OffsetM (M: Double)
OffsetZ (Z: Double)
PutCoords (XMin: Double, YMin: Double, XMax: Double, YMax: Double)
PutWKSCoords (e: _WKSEnvelope)
QueryCoords (out XMin: Double, out YMin: Double, out XMax: Double, out YMax: Double)
QueryWKSCoords (out e: _WKSEnvelope)
Union (inEnvelope: IEnvelope)
Geometry
Display
CancelTracker
ITrackCancel
ITrackCancel : IUnknown
CancelOnClick: Boolean
CancelOnKeyPress: Boolean
CheckTime: Long
ProcessMessages: Boolean
Progressor: IProgressor
TimerFired: Boolean
Cancel
Continue: Boolean
Reset
StartTimer (in hWnd: Long, in milliseconds: Long)
StopTimer
tagRECT
bottom: Long
Left: Long
Right: Long
Top: Long
MxDocument
IChangeLayout
IContentsViewEdit
IDataGraphs
IDocument
IDocumentDirty
IDocumentDatasets
IDocumentDefaultSymbols
IDocumentEvents
IDocumentEventsDisp
IDocumentInfo
IMxDocument
IPersist
IPropertySupport
IReportUnitFormat
IMxDocument : IUnknown
ActivatedView: IActiveView
ActiveView: IActiveView
ActiveViewCommand: ICommand
ContentsView (in Index: Long) : IContentsView
ContentsViewCount: Long
ContextItem: IUnknown Pointer
CurrentContentsView: IContentsView
CurrentLocation: IPoint
DefaultColor (in Type: tagesriMxDefaultColorTypes) : IColor
DefaultTextFont: Font
DefaultTextFontSize: IFontSize
DelayUpdateContents: Boolean
FocusMap: IMap
Maps: IMaps
OperationStack: IOperationStack
PageLayout: IPageLayout
RelativePaths: Boolean
SearchTolerance: Double
SearchTolerancePixels: Long
SelectedItem: IUnknown Pointer
SelectedLayer: ILayer
StyleGallery: IStyleGallery
TableProperties: ITableProperties
AddLayer (in Layer: ILayer)
CanInsertObject (pEnabled: Boolean)
InsertObject
UpdateContents
ArcMap
IActiveView : IUnknown
ExportFrame: tagRECT
Extent: IEnvelope
ExtentStack: IExtentStack
FocusMap: IMap
FullExtent: IEnvelope
GraphicsContainer: IGraphicsContainer
IsMapActivated: Boolean
ScreenCacheID (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer) : Integer
ScreenDisplay: IScreenDisplay
Selection: ISelection
ShowRulers: Boolean
ShowScrollBars: Boolean
ShowSelection: Boolean
TipText (in X: Double, in Y: Double) : String
Activate (hWnd: Long)
Clear
ContentsChanged
Deactivate
Draw (in hDC: Long, in trackCancel: ITrackCancel)
GetContextMenu (in X: Double, in Y: Double, out clsidMenu: IUID)
HitTestMap (in Location: IPoint) : IMap
IsActive: Boolean
OnMessage (in msg: Unsigned Long, in wParam: Unsigned Machine Int, in lParam: Long)
Output (in hDC: Long, in dpi: Long, in PixelBounds: tagRECT, in VisibleBounds: IEnvelope, in trackCancel: ITrackCancel)
PartialRefresh (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer, in Envelope: IEnvelope)
PrinterChanged (in Printer: IPrinter)
Refresh
IDisplay : IUnknown
ClipEnvelope: IEnvelope
ClipEnvelopes: ISet
ClipGeometry: IGeometry
DisplayTransformation: IDisplayTransformation
Filter: IDisplayFilter
hDC: Long
hPalette: Long
IlluminationProps: IIlluminationProps
SuppressEvents: Boolean
DrawMultipoint (in Multipoint: IGeometry)
DrawPoint (in Point: IGeometry)
DrawPolygon (in Polygon: IGeometry)
DrawPolyline (in Polyline: IGeometry)
DrawRectangle (in rectangle: IEnvelope)
DrawText (in Shape: IGeometry, in Text: String)
FinishDrawing
Progress (in VertexCount: Long)
SetSymbol (in sym: ISymbol)
StartDrawing (in hDC: Long, in cacheID: Integer)
IScreenDisplay : IDisplay
ActiveCache: Integer
CacheCount: Integer
CacheMemDC (in Index: Integer) : Long
CancelTracker: ITrackCancel
hWnd: Long
IsFirstCacheTransparent: Boolean
IsFramed: Boolean
ScaleContents: Boolean
SuppressResize: Boolean
UseScrollbars: Boolean
WindowDC: Long
AddCache: Integer
DoScroll (in xDelta: Long, in yDelta: Long, in updateScreen: Boolean)
DrawCache (in hDC: Long, in Index: Integer, in deviceRect: tagRECT, in cacheRect: tagRECT)
Invalidate (in rect: IEnvelope, in erase: Boolean, in cacheIndex: Integer)
IsCacheDirty (in cacheIndex: Integer) : Boolean
PanMoveTo (in mouseLocation: IPoint)
PanStart (in mouseLocation: IPoint)
PanStop: IEnvelope
RemoveAllCaches
RemoveCache (in cacheID: Integer)
RotateMoveTo (in pPoint: IPoint)
RotateStart (in mousePt: IPoint, in centerPt: IPoint)
RotateStop: Double
RotateTimer
SetScrollbarHandles (in hWndHorzScrollbar: Long, in hWndVertScrollbar: Long)
StartRecording
StopRecording
TrackPan
TrackRotate
UpdateWindow
IDisplayTransformation:ITransformation
Bounds: IEnvelope
ConstrainedBounds: IEnvelope
DeviceFrame: tagRECT
FittedBounds: IEnvelope
ReferenceScale: Double
Resolution: Double
Rotation: Double
ScaleRatio: Double
SpatialReference: ISpatialReference
SuppressEvents: Boolean
Units: esriUnits
VisibleBounds: IEnvelope
ZoomResolution: Boolean
FromMapPoint (in mapPoint: IPoint, out X: Long, out Y: Long)
FromPoints (in pointDistance: Double) : Double
ToMapPoint (in X: Long, in Y: Long) : IPoint
ToPoints (in mapDistance: Double) : Double
TransformCoords (in mapPoints: _WKSPoint, in devPoints: tagPOINT, in numPoints: Long, in options: Long)
TransformRect (in mapRect: IEnvelope, in devRect: tagRECT, in options: Long)

1 The IMxDocument interface is obtained from the ThisDocument global variable.

2 For convenience, the resolution of the screen is set to a local variable.

3 A new JpegExporter object is created and the IExporter interface is obtained. The filename and resolution are set.

4 The device rectangle is stored as a local variable.

5 A new envelope object is created. This object will represent the driver bounds envelope.

6 The driver bounds envelope is populated with the coordinates from the device rectangle. This envelope is used to set the IExporter PixelBounds property.

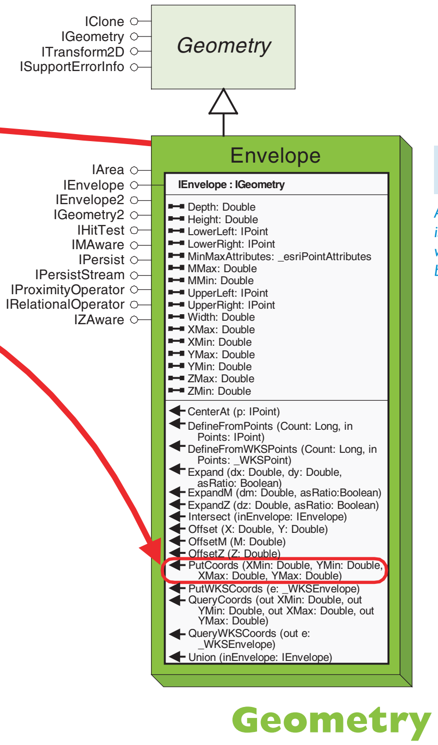
7 A new CancelTracker object is created. This object will allow the export process to be aborted.

8 A call to the active view's Output method writes the current view to the exporter. Notice the hDC required by the Output method is obtained by calling StartExporting on the Exporter.

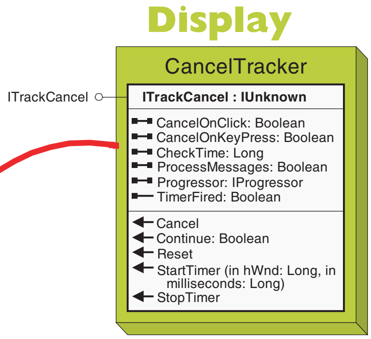
9 Finally, the FinishExporting method is called. This call ensures that the drawing is completed and the export file is closed.

Add this code to the Click event of a command in ArcMap.

```
  Dim pMxDoc As IMxDocument
1 Set pMxDoc = ThisDocument

  Dim lScrRes As Long
2 lScrRes = pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation.Resolution

  Dim pExporter As IExporter
  Set pExporter = New JpegExporter
3 pExporter.ExportFileName = "C:\Export.jpg"
  pExporter.Resolution = lScrRes

  Dim deviceRECT As tagRECT
4 deviceRECT = pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation.DeviceFrame

  Dim pDriverBounds As IEnvelope
5 Set pDriverBounds = New Envelope

  pDriverBounds.PutCoords deviceRECT.Left, deviceRECT.bottom, deviceRECT.Right, _
   deviceRECT.Top
6 pExporter.PixelBounds = pDriverBounds

  Dim pCancel As ITrackCancel
7 Set pCancel = New CancelTracker

8 pMxDoc.ActiveView.Output pExporter.StartExporting, lScrRes, deviceRECT, _
   pMxDoc.ActiveView.Extent, pCancel

9 pExporter.FinishExporting
```


IClone
IGeometry
ITransform2D
ISupportErrorInfo
Geometry
Envelope
IArea
IEnvelope
IEnvelope2
IGeometry2
IHitTest
IMAware
IPersist
IPersistStream
IProximityOperator
IRelationalOperator
IZAware
IEnvelope : IGeometry
Depth: Double
Height: Double
LowerLeft: IPoint
LowerRight: IPoint
MinMaxAttributes: _esriPointAttributes
MMax: Double
MMin: Double
UpperLeft: IPoint
UpperRight: IPoint
Width: Double
XMax: Double
XMin: Double
YMax: Double
YMin: Double
ZMax: Double
ZMin: Double
CenterAt (p: IPoint)
DefineFromPoints (Count: Long, in Points: IPoint)
DefineFromWKSPoints (Count: Long, in Points: _WKSPoint)
Expand (dx: Double, dy: Double, asRatio: Boolean)
ExpandM (dm: Double, asRatio:Boolean)
ExpandZ (dz: Double, asRatio: Boolean)
Intersect (inEnvelope: IEnvelope)
Offset (X: Double, Y: Double)
OffsetM (M: Double)
OffsetZ (Z: Double)
PutCoords (XMin: Double, YMin: Double, XMax: Double, YMax: Double)
PutWKSCoords (e: _WKSEnvelope)
QueryCoords (out XMin: Double, out YMin: Double, out XMax: Double, out YMax: Double)
QueryWKSCoords (out e: _WKSEnvelope)
Union (inEnvelope: IEnvelope)
Geometry

5 *A new envelope object is created. This object will represent the driver bounds envelope.*

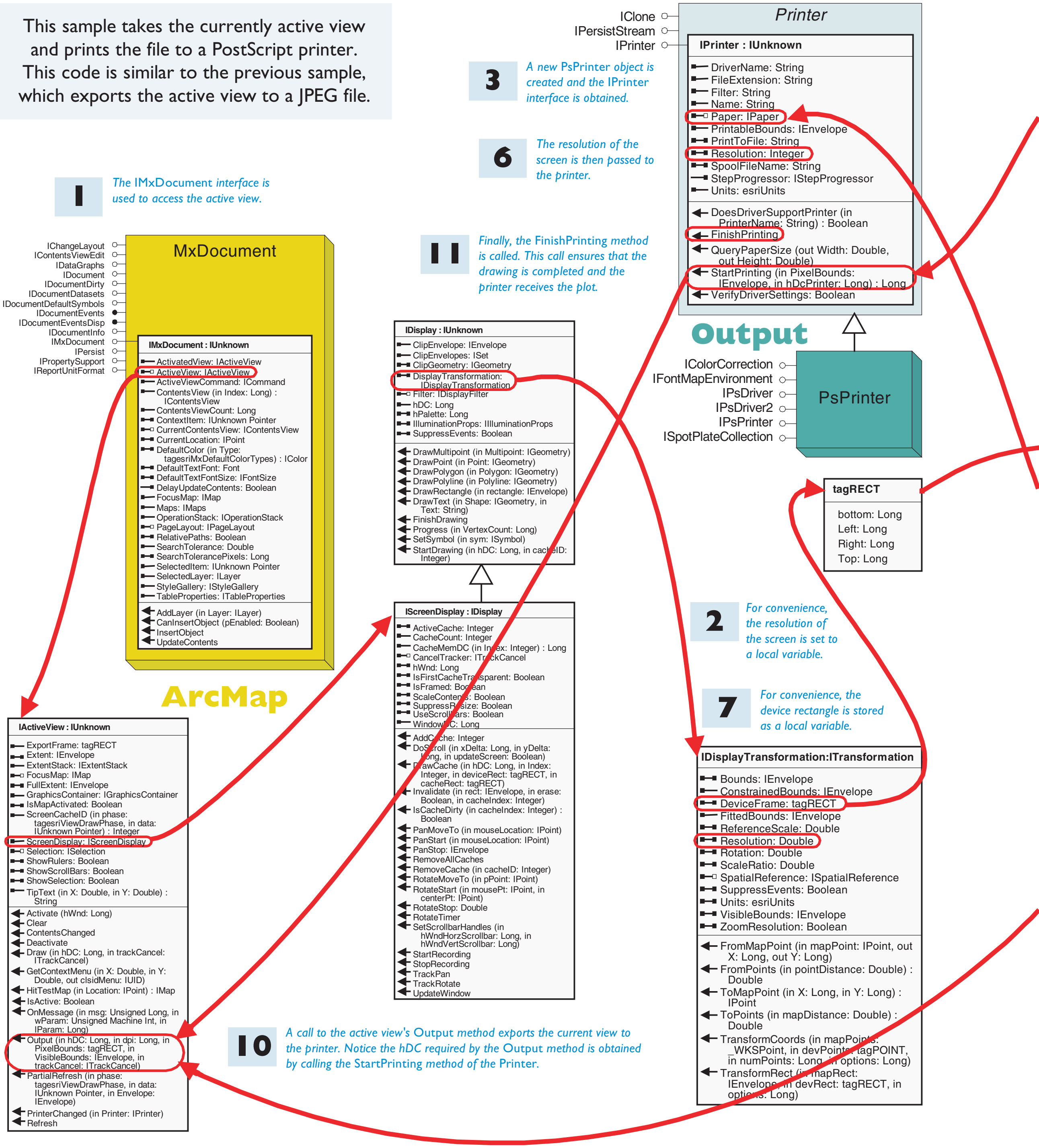


7 *A new CancelTracker object is created. This object will allow the export process to be aborted.*

Add this code to the Click event of a UIButtonControl in ArcMap.

```
  Dim pMxDoc As IMxDocument
1 Set pMxDoc = ThisDocument

  Dim lScrRes As Long
2 lScrRes = pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation.Resolution

  Dim pExporter As IExporter
  Set pExporter = New JpegExporter
3 pExporter.ExportFileName = "C:\Export.jpg"
  pExporter.Resolution = lScrRes

  Dim deviceRECT As tagRECT
4 deviceRECT = pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation.DeviceFrame

  Dim pDriverBounds As IEnvelope
5 Set pDriverBounds = New Envelope

  pDriverBounds.PutCoords deviceRECT.Left, deviceRECT.bottom, deviceRECT.Right, _
   deviceRECT.Top
6 pExporter.PixelBounds = pDriverBounds

  Dim pCancel As ITrackCancel
7 Set pCancel = New CancelTracker

8 pMxDoc.ActiveView.Output pExporter.StartExporting, lScrRes, deviceRECT, _
   pMxDoc.ActiveView.Extent, pCancel

9 pExporter.FinishExporting
```

This sample takes the currently active view and prints the file to a PostScript printer. This code is similar to the previous sample, which exports the active view to a JPEG file.


Printer
IClone
IPersistStream
IPrinter
IPrinter : IUnknown
DriverName: String
FileExtension: String
Filter: String
Name: String
Paper: IPaper
PrintableBounds: IEnvelope
PrintToFile: String
Resolution: Integer
SpoolFileName: String
StepProgressor: IStepProgressor
Units: esriUnits
DoesDriverSupportPrinter (in PrinterName: String) : Boolean
FinishPrinting
QueryPaperSize (out Width: Double, out Height: Double)
StartPrinting (in PixelBounds: IEnvelope, in hDcPrinter: Long) : Long
VerifyDriverSettings: Boolean
Output
IColorCorrection
IFontMapEnvironment
IPsDriver
IPsDriver2
IPsPrinter
ISpotPlateCollection
PsPrinter
tagRECT
bottom: Long
Left: Long
Right: Long
Top: Long
MxDocument
IChangeLayout
IContentsViewEdit
IDataGraphs
IDocument
IDocumentDirty
IDocumentDatasets
IDocumentDefaultSymbols
IDocumentEvents
IDocumentEventsDisp
IDocumentInfo
IMxDocument
IPersist
IPropertySupport
IReportUnitFormat
IMxDocument : IUnknown
ActivatedView: IActiveView
ActiveView: IActiveView
ActiveViewCommand: ICommand
ContentsView (in Index: Long) : IContentsView
ContentsViewCount: Long
ContextItem: IUnknown Pointer
CurrentContentsView: IContentsView
CurrentLocation: IPoint
DefaultColor (in Type: tagesriMxDefaultColorTypes) : IColor
DefaultTextFont: Font
DefaultTextFontSize: IFontSize
DelayUpdateContents: Boolean
FocusMap: IMap
Maps: IMaps
OperationStack: IOperationStack
PageLayout: IPageLayout
RelativePaths: Boolean
SearchTolerance: Double
SearchTolerancePixels: Long
SelectedItem: IUnknown Pointer
SelectedLayer: ILayer
StyleGallery: IStyleGallery
TableProperties: ITableProperties
AddLayer (in Layer: ILayer)
CanInsertObject (pEnabled: Boolean)
InsertObject
UpdateContents
ArcMap
IActiveView : IUnknown
ExportFrame: tagRECT
Extent: IEnvelope
ExtentStack: IExtentStack
FocusMap: IMap
FullExtent: IEnvelope
GraphicsContainer: IGraphicsContainer
IsMapActivated: Boolean
ScreenCacheID (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer) : Integer
ScreenDisplay: IScreenDisplay
Selection: ISelection
ShowRulers: Boolean
ShowScrollBars: Boolean
ShowSelection: Boolean
TipText (in X: Double, in Y: Double) : String
Activate (hWnd: Long)
Clear
ContentsChanged
Deactivate
Draw (in hDC: Long, in trackCancel: ITrackCancel)
GetContextMenu (in X: Double, in Y: Double, out clsidMenu: IUID)
HitTestMap (in Location: IPoint) : IMap
IsActive: Boolean
OnMessage (in msg: Unsigned Long, in wParam: Unsigned Machine Int, in lParam: Long)
Output (in hDC: Long, in dpi: Long, in PixelBounds: tagRECT, in VisibleBounds: IEnvelope, in trackCancel: ITrackCancel)
PartialRefresh (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer, in Envelope: IEnvelope)
PrinterChanged (in Printer: IPrinter)
Refresh
IDisplay : IUnknown
ClipEnvelope: IEnvelope
ClipEnvelopes: ISet
ClipGeometry: IGeometry
DisplayTransformation: IDisplayTransformation
Filter: IDisplayFilter
hDC: Long
hPalette: Long
IlluminationProps: IIlluminationProps
SuppressEvents: Boolean
DrawMultipoint (in Multipoint: IGeometry)
DrawPoint (in Point: IGeometry)
DrawPolygon (in Polygon: IGeometry)
DrawPolyline (in Polyline: IGeometry)
DrawRectangle (in rectangle: IEnvelope)
DrawText (in Shape: IGeometry, in Text: String)
FinishDrawing
Progress (in VertexCount: Long)
SetSymbol (in sym: ISymbol)
StartDrawing (in hDC: Long, in cacheID: Integer)
IScreenDisplay : IDisplay
ActiveCache: Integer
CacheCount: Integer
CacheMemDC (in Index: Integer) : Long
CancelTracker: ITrackCancel
hWnd: Long
IsFirstCacheTransparent: Boolean
IsFramed: Boolean
ScaleContents: Boolean
SuppressResize: Boolean
UseScrollbars: Boolean
WindowDC: Long
AddCache: Integer
DoScroll (in xDelta: Long, in yDelta: Long, in updateScreen: Boolean)
DrawCache (in hDC: Long, in Index: Integer, in deviceRect: tagRECT, in cacheRect: tagRECT)
Invalidate (in rect: IEnvelope, in erase: Boolean, in cacheIndex: Integer)
IsCacheDirty (in cacheIndex: Integer) : Boolean
PanMoveTo (in mouseLocation: IPoint)
PanStart (in mouseLocation: IPoint)
PanStop: IEnvelope
RemoveAllCaches
RemoveCache (in cacheID: Integer)
RotateMoveTo (in pPoint: IPoint)
RotateStart (in mousePt: IPoint, in centerPt: IPoint)
RotateStop: Double
RotateTimer
SetScrollbarHandles (in hWndHorzScrollbar: Long, in hWndVertScrollbar: Long)
StartRecording
StopRecording
TrackPan
TrackRotate
UpdateWindow
IDisplayTransformation:ITransformation
Bounds: IEnvelope
ConstrainedBounds: IEnvelope
DeviceFrame: tagRECT
FittedBounds: IEnvelope
ReferenceScale: Double
Resolution: Double
Rotation: Double
ScaleRatio: Double
SpatialReference: ISpatialReference
SuppressEvents: Boolean
Units: esriUnits
VisibleBounds: IEnvelope
ZoomResolution: Boolean
FromMapPoint (in mapPoint: IPoint, out X: Long, out Y: Long)
FromPoints (in pointDistance: Double) : Double
ToMapPoint (in X: Long, in Y: Long) : IPoint
ToPoints (in mapDistance: Double) : Double
TransformCoords (in mapPoints: _WKSPoint, in devPoints: tagPOINT, in numPoints: Long, in options: Long)
TransformRect (in mapRect: IEnvelope, in devRect: tagRECT, in options: Long)

1 *The IMxDocument interface is used to access the active view.*

3 *A new PsPrinter object is created and the IPrinter interface is obtained.*

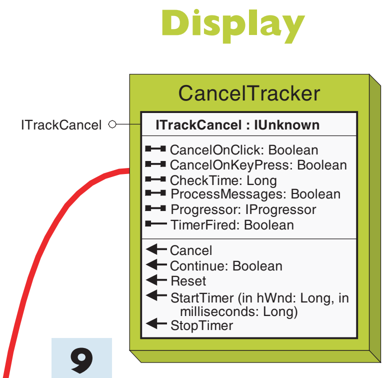
6 *The resolution of the screen is then passed to the printer.*

11 *Finally, the FinishPrinting method is called. This call ensures that the drawing is completed and the printer receives the plot.*

2 *For convenience, the resolution of the screen is set to a local variable.*

7 *For convenience, the device rectangle is stored as a local variable.*

10 *A call to the active view's Output method exports the current view to the printer. Notice the hDC required by the Output method is obtained by calling the StartPrinting method of the Printer.*

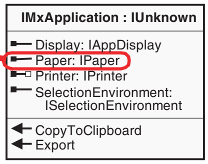


9

A new CancelTracker object is created. This object allows the printing process to be aborted.

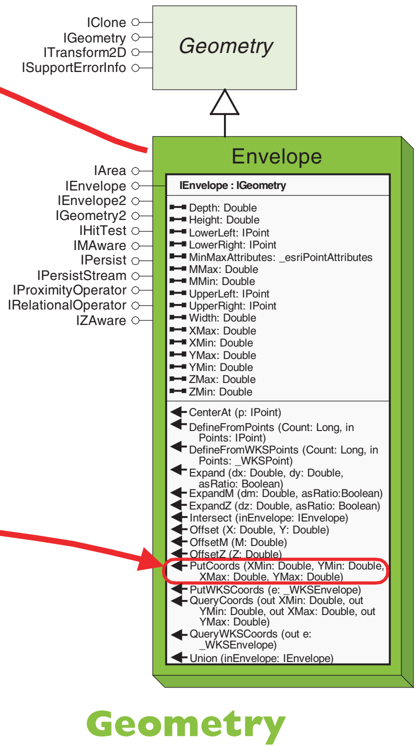
5

The paper object used by the application is set into the printer object.



4

The IMxApplication interface on the application object is required in order to get the page details. This interface is obtained by performing a QueryInterface on the Parent property of the ThisDocument variable.


IClone
IGeometry
ITransform2D
ISupportErrorInfo
Geometry
Envelope
IArea
IEnvelope
IEnvelope2
IGeometry2
IHitTest
IMAware
IPersist
IPersistStream
IProximityOperator
IRelationalOperator
IZAware
IEnvelope : IGeometry
Depth: Double
Height: Double
LowerLeft: IPoint
LowerRight: IPoint
MinMaxAttributes: _esriPointAttributes
MMax: Double
MMin: Double
UpperLeft: IPoint
UpperRight: IPoint
Width: Double
XMax: Double
XMin: Double
YMax: Double
YMin: Double
ZMax: Double
ZMin: Double
CenterAt (p: IPoint)
DefineFromPoints (Count: Long, in Points: IPoint)
DefineFromWKSPoints (Count: Long, in Points: _WKSPoint)
Expand (dx: Double, dy: Double, asRatio: Boolean)
ExpandM (dm: Double, asRatio:Boolean)
ExpandZ (dz: Double, asRatio: Boolean)
Intersect (inEnvelope: IEnvelope)
Offset (X: Double, Y: Double)
OffsetM (M: Double)
OffsetZ (Z: Double)
PutCoords (XMin: Double, YMin: Double, XMax: Double, YMax: Double)
PutWKSCoords (e: _WKSEnvelope)
QueryCoords (out XMin: Double, out YMin: Double, out XMax: Double, out YMax: Double)
QueryWKSCoords (out e: _WKSEnvelope)
Union (inEnvelope: IEnvelope)
Geometry

8

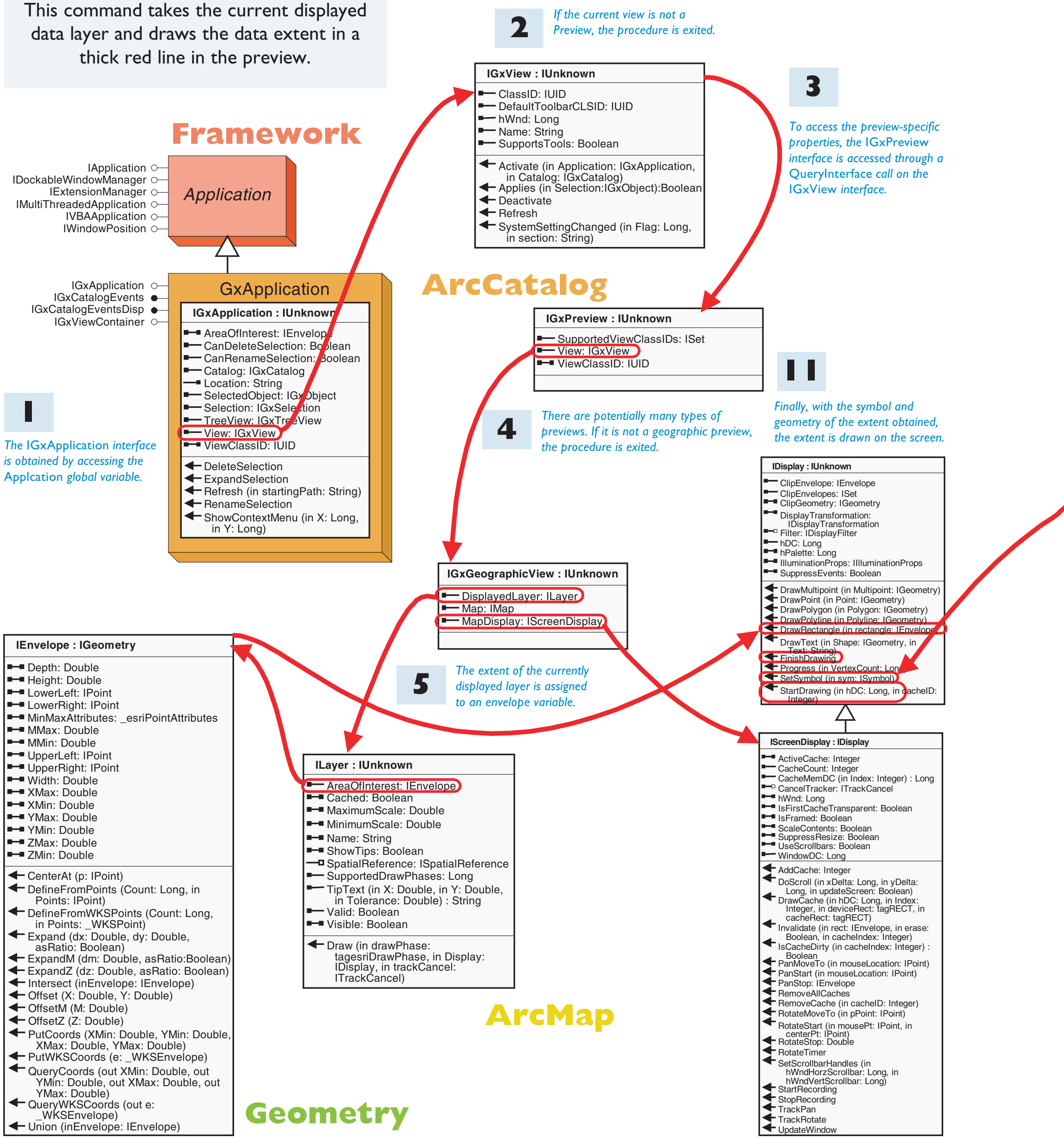
A new envelope object is created. This object will represent the driver bounds. The driver bounds envelope is populated with the coordinates from the device rectangle. This envelope is used to set the IPrinter PixelBounds property.

Add this code to the Click event of a UIButtonControl in ArcMap.

```
    Dim pMxDoc As IMxDocument
1   Set pMxDoc = ThisDocument

    Dim lScrRes As Long
2   lScrRes = pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation.Resolution

    Dim pPrinter As IPrinter
3   Set pPrinter = New PsPrinter

4   Dim pMxApp As IMxApplication
    Set pMxApp = ThisDocument.Parent

5   Set pPrinter.Paper = pMxApp.Paper
6   pPrinter.Resolution = lScrRes

    Dim deviceRECT As tagRECT
7   deviceRECT = pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation.DeviceFrame

    Dim pDriverBounds As IEnvelope
8   Set pDriverBounds = New Envelope
    pDriverBounds.PutCoords deviceRECT.Left, deviceRECT.bottom, deviceRECT.Right, _
     deviceRECT.Top

    Dim pCancel As ITrackCancel
9   Set pCancel = New CancelTracker

10  pMxDoc.ActiveView.Output pPrinter.StartPrinting(pDriverBounds, 0), lScrRes, _
     deviceRECT, pMxDoc.ActiveView.Extent, pCancel
11  pPrinter.FinishPrinting
```

Display map extent in GxView as envelope

This command takes the current displayed data layer and draws the data extent in a thick red line in the preview.



Framework
Application
IApplication
IDockableWindowManager
IExtensionManager
IMultiThreadedApplication
IVBAApplication
IWindowPosition
GxApplication
IGxApplication
IGxCatalogEvents
IGxCatalogEventsDisp
IGxViewContainer
IGxApplication : IUnknown
AreaOfInterest: IEnvelope
CanDeleteSelection: Boolean
CanRenameSelection: Boolean
Catalog: IGxCatalog
Location: String
SelectedObject: IGxObject
Selection: IGxSelection
TreeView: IGxTreeView
View: IGxView
ViewClassID: IUID
DeleteSelection
ExpandSelection
Refresh (in startingPath: String)
RenameSelection
ShowContextMenu (in X: Long, in Y: Long)
IGxView : IUnknown
ClassID: IUID
DefaultToolbarCLSID: IUID
hWnd: Long
Name: String
SupportsTools: Boolean
Activate (in Application: IGxApplication, in Catalog: IGxCatalog)
Applies (in Selection:IGxObject):Boolean
Deactivate
Refresh
SystemSettingChanged (in Flag: Long, in section: String)
ArcCatalog
IGxPreview : IUnknown
SupportedViewClassIDs: ISet
View: IGxView
ViewClassID: IUID
IGxGeographicView : IUnknown
DisplayedLayer: ILayer
Map: IMap
MapDisplay: IScreenDisplay
IEnvelope : IGeometry
Depth: Double
Height: Double
LowerLeft: IPoint
LowerRight: IPoint
MinMaxAttributes: _esriPointAttributes
MMax: Double
MMin: Double
UpperLeft: IPoint
UpperRight: IPoint
Width: Double
XMax: Double
XMin: Double
YMax: Double
YMin: Double
ZMax: Double
ZMin: Double
CenterAt (p: IPoint)
DefineFromPoints (Count: Long, in Points: IPoint)
DefineFromWKSPoints (Count: Long, in Points: _WKSPoint)
Expand (dx: Double, dy: Double, asRatio: Boolean)
ExpandM (dm: Double, asRatio:Boolean)
ExpandZ (dz: Double, asRatio: Boolean)
Intersect (inEnvelope: IEnvelope)
Offset (X: Double, Y: Double)
OffsetM (M: Double)
OffsetZ (Z: Double)
PutCoords (XMin: Double, YMin: Double, XMax: Double, YMax: Double)
PutWKSCoords (e: _WKSEnvelope)
QueryCoords (out XMin: Double, out YMin: Double, out XMax: Double, out YMax: Double)
QueryWKSCoords (out e: _WKSEnvelope)
Union (inEnvelope: IEnvelope)
Geometry
ILayer : IUnknown
AreaOfInterest: IEnvelope
Cached: Boolean
MaximumScale: Double
MinimumScale: Double
Name: String
ShowTips: Boolean
SpatialReference: ISpatialReference
SupportedDrawPhases: Long
TipText (in X: Double, in Y: Double, in Tolerance: Double) : String
Valid: Boolean
Visible: Boolean
Draw (in drawPhase: tagesriDrawPhase, in Display: IDisplay, in trackCancel: ITrackCancel)
ArcMap
IDisplay : IUnknown
ClipEnvelope: IEnvelope
ClipEnvelopes: ISet
ClipGeometry: IGeometry
DisplayTransformation: IDisplayTransformation
Filter: IDisplayFilter
hDC: Long
hPalette: Long
IlluminationProps: IIlluminationProps
SuppressEvents: Boolean
DrawMultipoint (in Multipoint: IGeometry)
DrawPoint (in Point: IGeometry)
DrawPolygon (in Polygon: IGeometry)
DrawPolyline (in Polyline: IGeometry)
DrawRectangle (in rectangle: IEnvelope)
DrawText (in Shape: IGeometry, in Text: String)
FinishDrawing
Progress (in VertexCount: Long)
SetSymbol (in sym: ISymbol)
StartDrawing (in hDC: Long, in cacheID: Integer)
IScreenDisplay : IDisplay
ActiveCache: Integer
CacheCount: Integer
CacheMemDC (in Index: Integer) : Long
CancelTracker: ITrackCancel
hWnd: Long
IsFirstCacheTransparent: Boolean
IsFramed: Boolean
ScaleContents: Boolean
SuppressResize: Boolean
UseScrollbars: Boolean
WindowDC: Long
AddCache: Integer
DoScroll (in xDelta: Long, in yDelta: Long, in updateScreen: Boolean)
DrawCache (in hDC: Long, in Index: Integer, in deviceRect: tagRECT, in cacheRect: tagRECT)
Invalidate (in rect: IEnvelope, in erase: Boolean, in cacheIndex: Integer)
IsCacheDirty (in cacheIndex: Integer) : Boolean
PanMoveTo (in mouseLocation: IPoint)
PanStart (in mouseLocation: IPoint)
PanStop: IEnvelope
RemoveAllCaches
RemoveCache (in cacheID: Integer)
RotateMoveTo (in pPoint: IPoint)
RotateStart (in mousePt: IPoint, in centerPt: IPoint)
RotateStop: Double
RotateTimer
SetScrollbarHandles (in hWndHorzScrollbar: Long, in hWndVertScrollbar: Long)
StartRecording
StopRecording
TrackPan
TrackRotate
UpdateWindow

1 *The IGxApplication interface is obtained by accessing the Applcation global variable.*

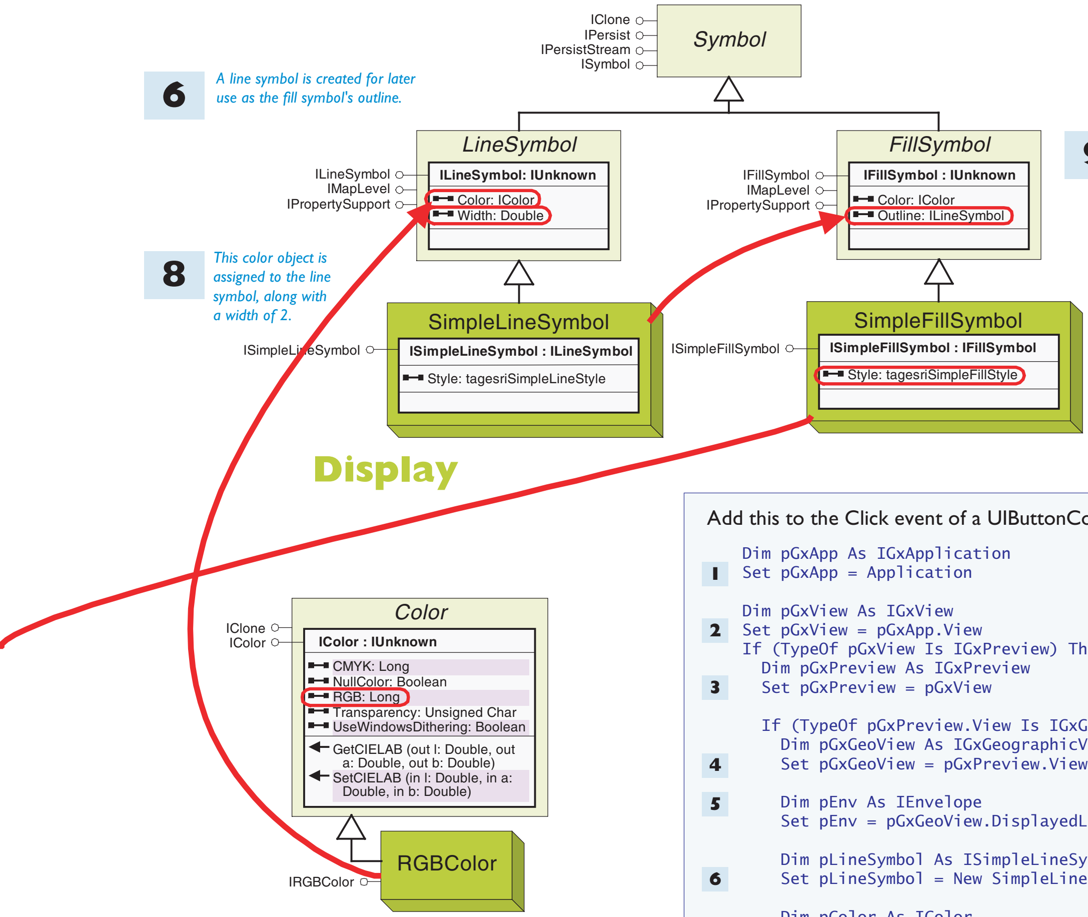
2 *If the current view is not a Preview, the procedure is exited.*

3 *To access the preview-specific properties, the IGxPreview interface is accessed through a QueryInterface call on the IGxView interface.*

4 *There are potentially many types of previews. If it is not a geographic preview, the procedure is exited.*

5 *The extent of the currently displayed layer is assigned to an envelope variable.*

11 *Finally, with the symbol and geometry of the extent obtained, the extent is drawn on the screen.*



6 *A line symbol is created for later use as the fill symbol's outline.*

8 *This color object is assigned to the line symbol, along with a width of 2.*

9 *The fill symbol is created.*

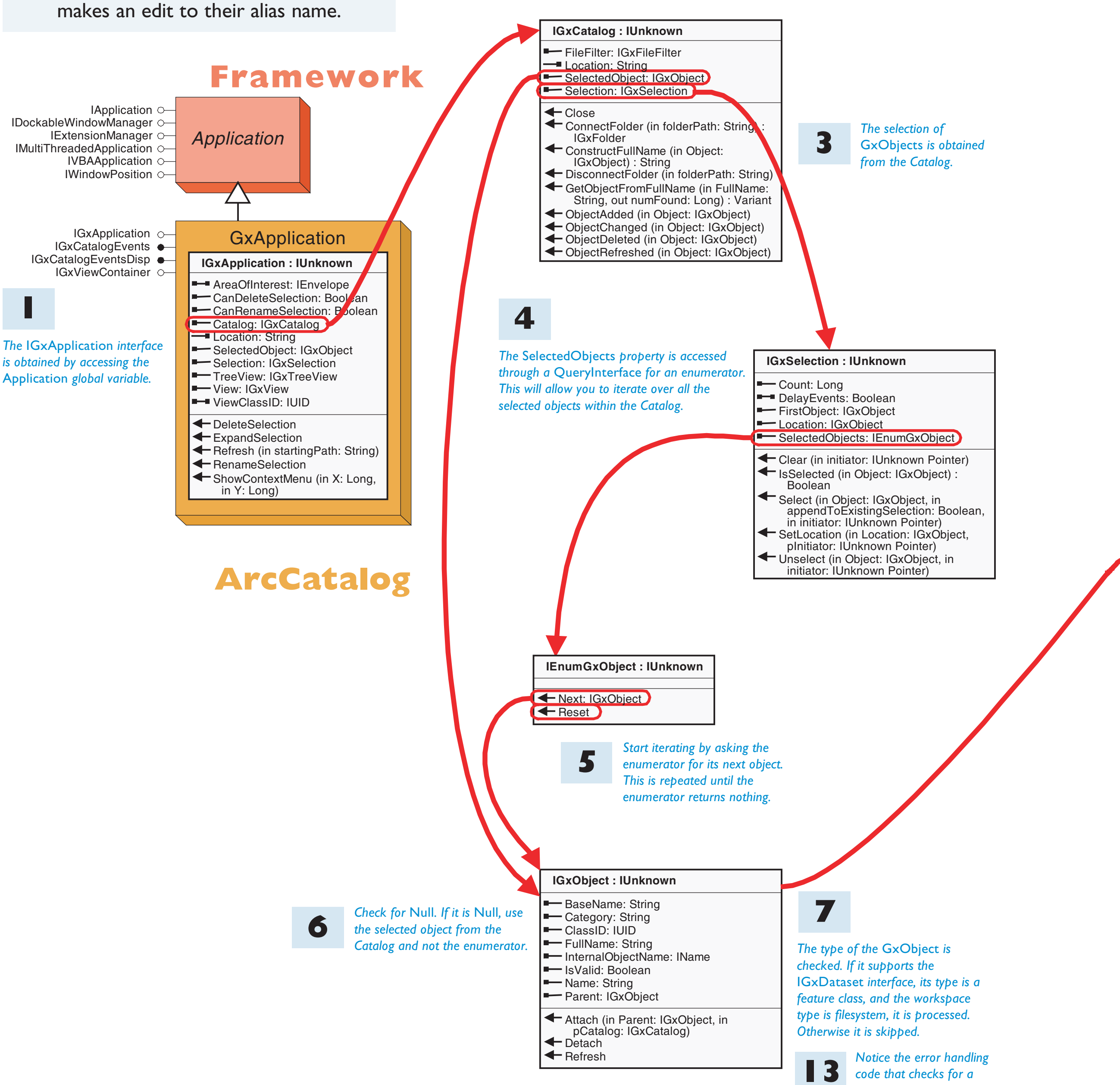
10 *The line symbol created in step 6 is assigned to the fill symbol's outline, and the style of the fill symbol is set to hollow.*

7 *An RGB color object is created and its color set to red.*

Add this to the Click event of a UIButtonControl in ArcCatalog.

```
    Dim pGxApp As IGxApplication
1   Set pGxApp = Application

    Dim pGxView As IGxView
2   Set pGxView = pGxApp.View
    If (TypeOf pGxView Is IGxPreview) Then
      Dim pGxPreview As IGxPreview
3     Set pGxPreview = pGxView

      If (TypeOf pGxPreview.View Is IGxGeographicView) Then
        Dim pGxGeoView As IGxGeographicView
4       Set pGxGeoView = pGxPreview.View

5       Dim pEnv As IEnvelope
        Set pEnv = pGxGeoView.DisplayedLayer.AreaOfInterest

        Dim pLineSymbol As ISimpleLineSymbol
6       Set pLineSymbol = New SimpleLineSymbol

        Dim pColor As IColor
7       Set pColor = New RgbColor

8       pColor.RGB = vbRed
        With pLineSymbol
          .Color = pColor
          .Width = 2
        End With

        Dim pFillSymbol As ISimpleFillSymbol
9       Set pFillSymbol = New SimpleFillSymbol

10      With pFillSymbol
          .Style = esriSFSHollow
          .Outline = pLineSymbol
        End With

11      With pGxGeoView.MapDisplay
          .StartDrawing 0, esriNoScreenCache
          .SetSymbol pFillSymbol
          .DrawRectangle pEnv
          .FinishDrawing
        End With
      End If
    End If
```

This code sample inspects the selected objects in the ArcCatalog browser and if they are feature classes in a geodatabase, makes an edit to their alias name.


Framework
IApplication
IDockableWindowManager
IExtensionManager
IMultiThreadedApplication
IVBAApplication
IWindowPosition
Application
IGxApplication
IGxCatalogEvents
IGxCatalogEventsDisp
IGxViewContainer
GxApplication
IGxApplication : IUnknown
AreaOfInterest: IEnvelope
CanDeleteSelection: Boolean
CanRenameSelection: Boolean
Catalog: IGxCatalog
Location: String
SelectedObject: IGxObject
Selection: IGxSelection
TreeView: IGxTreeView
View: IGxView
ViewClassID: IUID
DeleteSelection
ExpandSelection
Refresh (in startingPath: String)
RenameSelection
ShowContextMenu (in X: Long, in Y: Long)
ArcCatalog
IGxCatalog : IUnknown
FileFilter: IGxFileFilter
Location: String
SelectedObject: IGxObject
Selection: IGxSelection
Close
ConnectFolder (in folderPath: String) : IGxFolder
ConstructFullName (in Object: IGxObject) : String
DisconnectFolder (in folderPath: String)
GetObjectFromFullName (in FullName: String, out numFound: Long) : Variant
ObjectAdded (in Object: IGxObject)
ObjectChanged (in Object: IGxObject)
ObjectDeleted (in Object: IGxObject)
ObjectRefreshed (in Object: IGxObject)
IGxSelection : IUnknown
Count: Long
DelayEvents: Boolean
FirstObject: IGxObject
Location: IGxObject
SelectedObjects: IEnumGxObject
Clear (in initiator: IUnknown Pointer)
IsSelected (in Object: IGxObject) : Boolean
Select (in Object: IGxObject, in appendToExistingSelection: Boolean, in initiator: IUnknown Pointer)
SetLocation (in Location: IGxObject, pInitiator: IUnknown Pointer)
Unselect (in Object: IGxObject, in initiator: IUnknown Pointer)
IEnumGxObject : IUnknown
Next: IGxObject
Reset
IGxObject : IUnknown
BaseName: String
Category: String
ClassID: IUID
FullName: String
InternalObjectName: IName
IsValid: Boolean
Name: String
Parent: IGxObject
Attach (in Parent: IGxObject, in pCatalog: IGxCatalog)
Detach
Refresh

1 *The IGxApplication interface is obtained by accessing the Application global variable.*

2 *For convenience, the IGxCatalog interface is stored as a local variable.*

3 *The selection of GxObjects is obtained from the Catalog.*

4 *The SelectedObjects property is accessed through a QueryInterface for an enumerator. This will allow you to iterate over all the selected objects within the Catalog.*

5 *Start iterating by asking the enumerator for its next object. This is repeated until the enumerator returns nothing.*

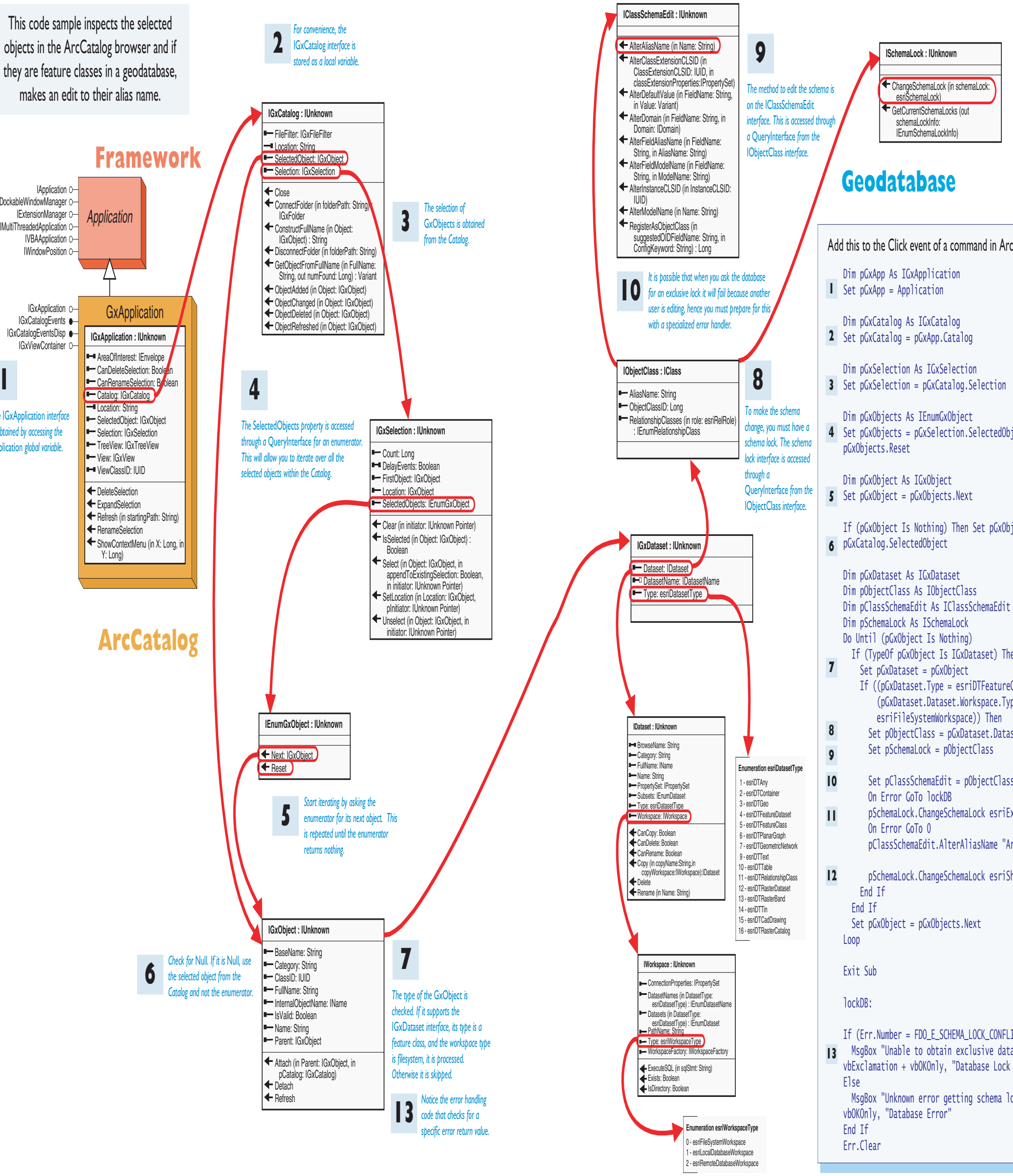
6 *Check for Null. If it is Null, use the selected object from the Catalog and not the enumerator.*

7 *The type of the GxObject is checked. If it supports the IGxDataset interface, its type is a feature class, and the workspace type is filesystem, it is processed. Otherwise it is skipped.*

13 *Notice the error handling code that checks for a specific error return value.*

Edit Feature Class Schema

This code sample inspects the selected objects in the ArcCatalog browser and if they are feature classes in a geodatabase, makes an edit to their alias name.


Framework
IApplication
DockableWindowManager
IExtensionManager
MultiThreadedApplication
IVBAApplication
IWindowPosition
Application
IGxApplication
IGxCatalogEvents
IGxCatalogEventsDisp
IGxViewContainer
GxApplication
IGxApplication : IUnknown
AreaOfInterest: IEnvelope
CanDeleteSelection: Boolean
CanRenameSelection: Boolean
Catalog: IGxCatalog
Location: String
SelectedObject: IGxObject
Selection: IGxSelection
TreeView: IGxTreeView
View: IGxView
ViewClassID: IUID
DeleteSelection
ExpandSelection
Refresh (in startingPath: String)
RenameSelection
ShowContextMenu (in X: Long, in Y: Long)
ArcCatalog
IGxCatalog : IUnknown
FileFilter: IGxFileFilter
Location: String
SelectedObject: IGxObject
Selection: IGxSelection
Close
ConnectFolder (in folderPath: String) : IGxFolder
ConstructFullName (in Object: IGxObject) : String
DisconnectFolder (in folderPath: String)
GetObjectFromFullName (in FullName: String, out numFound: Long) : Variant
ObjectAdded (in Object: IGxObject)
ObjectChanged (in Object: IGxObject)
ObjectDeleted (in Object: IGxObject)
ObjectRefreshed (in Object: IGxObject)
IGxSelection : IUnknown
Count: Long
DelayEvents: Boolean
FirstObject: IGxObject
Location: IGxObject
SelectedObjects: IEnumGxObject
Clear (in initiator: IUnknown Pointer)
IsSelected (in Object: IGxObject) : Boolean
Select (in Object: IGxObject, in appendToExistingSelection: Boolean, in initiator: IUnknown Pointer)
SetLocation (in Location: IGxObject, pInitiator: IUnknown Pointer)
Unselect (in Object: IGxObject, in initiator: IUnknown Pointer)
IEnumGxObject : IUnknown
Next: IGxObject
Reset
IGxObject : IUnknown
BaseName: String
Category: String
ClassID: IUID
FullName: String
InternalObjectName: IName
IsValid: Boolean
Name: String
Parent: IGxObject
Attach (in Parent: IGxObject, in pCatalog: IGxCatalog)
Detach
Refresh
IClassSchemaEdit : IUnknown
AlterAliasName (in Name: String)
AlterClassExtensionCLSID (in ClassExtensionCLSID: IUID, in classExtensionProperties:IPropertySet)
AlterDefaultValue (in FieldName: String, in Value: Variant)
AlterDomain (in FieldName: String, in Domain: IDomain)
AlterFieldAliasName (in FieldName: String, in AliasName: String)
AlterFieldModelName (in FieldName: String, in ModelName: String)
AlterInstanceCLSID (in InstanceCLSID: IUID)
AlterModelName (in Name: String)
RegisterAsObjectClass (in suggestedOIDFieldName: String, in ConfigKeyword: String) : Long
IObjectClass : IClass
AliasName: String
ObjectClassID: Long
RelationshipClasses (in role: esriRelRole) : IEnumRelationshipClass
IGxDataset : IUnknown
Dataset: IDataset
DatasetName: IDatasetName
Type: esriDatasetType
IDataset : IUnknown
BrowseName: String
Category: String
FullName: IName
Name: String
PropertySet: IPropertySet
Subsets: IEnumDataset
Type: esriDatasetType
Workspace: IWorkspace
CanCopy: Boolean
CanDelete: Boolean
CanRename: Boolean
Copy (in copyName:String,in copyWorkspace:IWorkspace):IDataset
Delete
Rename (in Name: String)
Enumeration esriDatasetType
1 - esriDTAny
2 - esriDTContainer
3 - esriDTGeo
4 - esriDTFeatureDataset
5 - esriDTFeatureClass
6 - esriDTPlanarGraph
7 - esriDTGeometricNetwork
9 - esriDTText
10 - esriDTTable
11 - esriDTRelationshipClass
12 - esriDTRasterDataset
13 - esriDTRasterBand
14 - esriDTTin
15 - esriDTCadDrawing
16 - esriDTRasterCatalog
IWorkspace : IUnknown
ConnectionProperties: IPropertySet
DatasetNames (in DatasetType: esriDatasetType) : IEnumDatasetName
Datasets (in DatasetType: esriDatasetType) : IEnumDataset
PathName: String
Type: esriWorkspaceType
WorkspaceFactory: IWorkspaceFactory
ExecuteSQL (in sqlStmt: String)
Exists: Boolean
IsDirectory: Boolean
Enumeration esriWorkspaceType
0 - esriFileSystemWorkspace
1 - esriLocalDatabaseWorkspace
2 - esriRemoteDatabaseWorkspace
ISchemaLock : IUnknown
ChangeSchemaLock (in schemaLock: esriSchemaLock)
GetCurrentSchemaLocks (out schemaLockInfo: IEnumSchemaLockInfo)
Geodatabase

1 : IGxApplication interface btained by accessing the plication global variable.

2 For convenience, the IGxCatalog interface is stored as a local variable.

3 The selection of GxObjects is obtained from the Catalog.

4 The SelectedObjects property is accessed through a QueryInterface for an enumerator. This will allow you to iterate over all the selected objects within the Catalog.

5 Start iterating by asking the enumerator for its next object. This is repeated until the enumerator returns nothing.

6 Check for Null. If it is Null, use the selected object from the Catalog and not the enumerator.

7 The type of the GxObject is checked. If it supports the IGxDataset interface, its type is a feature class, and the workspace type is filesystem, it is processed. Otherwise it is skipped.

8 To make the schema change, you must have a schema lock. The schema lock interface is accessed through a QueryInterface from the IObjectClass interface.

9 The method to edit the schema is on the IClassSchemaEdit interface. This is accessed through a QueryInterface from the IObjectClass interface.

10 It is possible that when you ask the database for an exclusive lock it will fail because another user is editing, hence you must prepare for this with a specialized error handler.

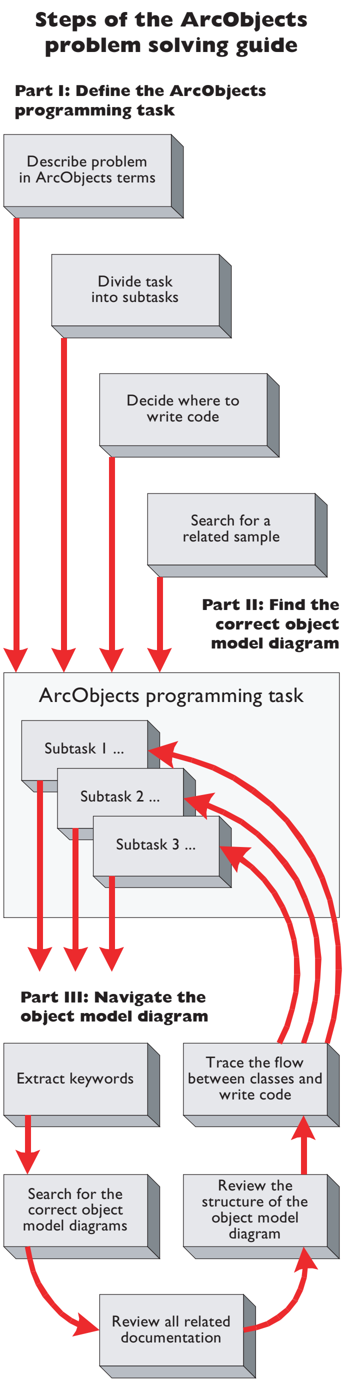
11 The schema edit is made.

12 The exclusive lock is released.

13 Notice the error handling code that checks for a specific error return value.

Add this to the Click event of a command in ArcCatalog.

```
   Dim pGxApp As IGxApplication
1  Set pGxApp = Application

   Dim pGxCatalog As IGxCatalog
2  Set pGxCatalog = pGxApp.Catalog

   Dim pGxSelection As IGxSelection
3  Set pGxSelection = pGxCatalog.Selection

   Dim pGxObjects As IEnumGxObject
4  Set pGxObjects = pGxSelection.SelectedObjects
   pGxObjects.Reset

   Dim pGxObject As IGxObject
5  Set pGxObject = pGxObjects.Next

   If (pGxObject Is Nothing) Then Set pGxObject =
6  pGxCatalog.SelectedObject

   Dim pGxDataset As IGxDataset
   Dim pObjectClass As IObjectClass
   Dim pClassSchemaEdit As IClassSchemaEdit
   Dim pSchemaLock As ISchemaLock
   Do Until (pGxObject Is Nothing)
     If (TypeOf pGxObject Is IGxDataset) Then
7      Set pGxDataset = pGxObject
       If ((pGxDataset.Type = esriDTFeatureClass) And _
         (pGxDataset.Dataset.Workspace.Type <> _
         esriFileSystemWorkspace)) Then
8        Set pObjectClass = pGxDataset.Dataset
9        Set pSchemaLock = pObjectClass

10       Set pClassSchemaEdit = pObjectClass
         On Error GoTo lockDB
11       pSchemaLock.ChangeSchemaLock esriExclusiveSchemaLock
         On Error GoTo 0
         pClassSchemaEdit.AlterAliasName "ArcObjects Updated Alias"

12       pSchemaLock.ChangeSchemaLock esriSharedSchemaLock
       End If
     End If
     Set pGxObject = pGxObjects.Next
   Loop

   Exit Sub

   lockDB:

   If (Err.Number = FDO_E_SCHEMA_LOCK_CONFLICT) Then
13   MsgBox "Unable to obtain exclusive database lock",
   vbExclamation + vbOKOnly, "Database Lock Error"
   Else
     MsgBox "Unknown error getting schema lock", vbExclamation +
   vbOKOnly, "Database Error"
   End If
   Err.Clear
```


Steps of the ArcObjects problem solving guide
Part I: Define the ArcObjects programming task
Describe problem in ArcObjects terms
Divide task into subtasks
Decide where to write code
Search for a related sample
Part II: Find the correct object model diagram
ArcObjects programming task
Subtask 1 ...
Subtask 2 ...
Subtask 3 ...
Part III: Navigate the object model diagram
Extract keywords
Trace the flow between classes and write code
Search for the correct object model diagrams
Review the structure of the object model diagram
Review all related documentation

The ArcObjects library is a comprehensive set of COM components designed to provide developers with the ability to extend and customize ArcGIS applications such as ArcMap and ArcCatalog. The ArcObjects library consists of over 1,000 classes and 2,000 interfaces that are visually documented in several dozen object model diagrams.

With this extensive set of classes, you can create a wide variety of customizations and custom applications to extend existing ArcGIS applications. However, as you begin developing with ArcObjects, you may find the extent of the ArcObjects library overwhelming, and it may be difficult to know where to begin. The goal of this problem-solving guide is to present a methodology to help you solve real-world ArcObjects programming tasks.

The guide helps you describe and categorize your task and documents how to use the help resources and tools to solve the problem programmatically. In the end, the guide will not only help solve individual problems but will also help you understand and navigate the structure of ArcObjects.

The guide is broken into three parts. Part one is designed to help you define the ArcObjects programming task as clearly as possible. Part two illustrates how to use the help resources to locate the correct object model diagram you should start with. Part three provides an example of how to navigate the object model diagrams in order to assemble the code required to solve the task.

The following steps outline each part of the problem-solving guide:

PART ONE: DEFINE THE ArcObjects PROGRAMMING TASK

1. Describe the problem in ArcObjects terms.
2. Identify subtasks.
3. Decide where to write the code.
4. Search for a related sample or recommended methodology.

PART TWO: LOCATE THE CORRECT OBJECT MODEL

1. Identify a subtask.
2. Extract keywords.
3. Search for the correct object model diagrams.
4. Review all related documentation.

PART THREE: NAVIGATE THE OBJECT MODEL DIAGRAM

1. Review the structure of the object model diagram.
2. Trace the flow between classes and assemble code.

Although there are three parts, this type of problem solving is really one continuous process. You may find it necessary to revisit some steps as you gain knowledge about a particular topic by reading the pages in this book and by exploring the wide variety of code samples available.

ARE YOU READY?

Before getting started with this problem-solving guide, you should be familiar with the basic terminology behind COM and ArcObjects, and you should know how to use the available help resources and tools. Here is a checklist of some topics discussed earlier in this chapter that should already be familiar to you:

- How to program with COM interfaces and classes in Visual Basic
- How to use the ArcObjects Developer Help system
- How to read and interpret the ArcObjects object model diagrams with Acrobat® Reader
- How to use ESRI's object browser, *EOBrowser*, to inspect the structure of ArcObjects not visible with other object browsers
- How to navigate this book using the index, table of contents, and inserted ArcGIS object model diagrams
- How to access continually updated information at ESRI's technical resource Web site, www.esri.com/arcobjectsonline

It is particularly important to understand the previous section in this chapter along with the illustrated code samples before starting with this problem-solving guide.

The best way to learn ArcObjects is to first become familiar with the fundamental ArcGIS and COM terminology and concepts, then learn how to effectively use all of the help resources, tools, documentation, and samples that are at your disposal. This book provides a good foundation for the basic terms and concepts, and this section focuses specifically on how to use the help resources to solve ArcObjects-related programming tasks.

If you are not comfortable with any of these topics, concepts, resources, or tools, go back and review the previous sections of this chapter. For more detailed information on Visual Basic and COM programming techniques, you can also reference Chapter 2, 'Developing with ArcObjects'.

This guide does not attempt to provide an all-encompassing method for every ArcObjects programming task. It simply provides a methodology that can help you clearly define your initial objective and make effective use of the many resources and tools available.

USING THE ARCOBJECTS PROBLEM-SOLVING GUIDE

This problem-solving guide uses a real-world ArcObjects programming problem to explain the details of each step. To learn the methodology behind this guide, first follow the instructions and complete the real-world programming task defined below, then define your own problem and use these steps to solve your own development task.

This problem-solving guide will solve this example task: *Add a dataset called States to ArcMap.*

PART ONE: DEFINE THE ARCOBJECTS PROGRAMMING TASK

The most important aspect of successfully using the problem-solving guide is being able to define the task itself. A task may originate from a real-world GIS problem at your workplace or may be the result of an enhancement you would like to make to the existing ArcGIS system. A task may be as simple as adding a *UIToolControl* to the user interface of ArcMap to zoom in on the map or as detailed as creating a custom feature for the geodatabase. In either case, in order to define the task as completely as possible, you should consider the following steps:

1. Describe the problem using ArcGIS terminology.
2. Divide the task into smaller subtasks.
3. Decide where to compile the source code.
4. Find an existing sample or recommended methodology.

To become familiar with basic ArcGIS terminology, refer to these ESRI books: Getting Started with ArcGIS, Building a Geodatabase, *and* Modeling Our World, *as well as the other resources mentioned earlier.*

Describe the problem in ArcGIS terms

When defining the problem, it is useful to frame the task with ArcGIS terminology and to describe the actions as completely as possible. This will help you find topics in the help system and the relevant components in ArcObjects.

In many cases, this step will also force you to go back and review important background topics and reading materials related to the task at hand. From this research, you will gain further insight about how a particular task can be solved.

For this example, the original task description is *Add a dataset called States to ArcMap.*

Using ArcGIS terminology, this statement could be expanded like this: *Access the States feature class from a personal geodatabase and add it to ArcMap.*

The most noticeable change to the description is that it has been expanded by identifying the datasets involved and by using the proper ArcObjects terminology. For example, the dataset named States has been more accurately defined as a feature class that resides in an existing personal geodatabase (stored in a Microsoft Access database).

Another important change is that the actions in the description have also been more completely defined. It now reveals the fact that it will be necessary to open the database first and then add a feature class in it to ArcMap. As you will see in the next step, it is important to identify these actions, as they can be treated as two separate programming tasks when building the final code.

Define subtasks

This step forces you to revisit the original task description and determine if it can be broken down into smaller, more manageable subtasks. This process allows you to focus on smaller parts of the original problem at one time and, therefore, smaller sections of the ArcObjects object model diagrams when it comes time to write code. The easiest way to identify subtasks is to look for verbs or action words that are hidden in the description. From the original task description, two subtasks can be easily identified.

From your expanded statement—*Access the States feature class from a personal geodatabase and add it to ArcMap*—you can identify two subtasks:

- *Access the States feature class.*
- *Add the new layer to the map.*

Each subtask will be solved individually as you traverse through parts two and three of this guide. This is important because it enables you to focus on small parts of the problem and smaller sections of the object model diagrams.

Decide where to write the code

You should always begin by trying to write ArcObjects code in the VBA environment in ArcMap or ArcCatalog. If necessary, this code can be moved to a different development environment before final compilation and distribution.

With the problem description and subtasks defined, you need to decide where to write the code and how to provide the functionality to end users.

Remember that where you test code and where you write the final code are two different issues. During the testing and initial design phase, it is always recommended to start writing code as a VBA macro in either ArcMap or ArcCatalog. There, you can easily assemble, test, and debug the source and experiment with any number of classes or interfaces. After completing the testing phase, you can then decide to leave the code as a VBA macro or move it to another format.

Deciding where to write the final application code can be a complicated matter, and as you gain experience developing with ArcObjects, your decision making will improve. In general, the answer is governed by the type of application you are developing and how you want to deliver the functionality to end users.

In general, there are three ways to write ArcObjects code:

- As a VBA macro in an ArcGIS application
- As an ActiveX COM component such as a DLL or OCX
- As a standalone EXE

You should also note that browsing the samples and associated documentation might help you determine where to locate your code. This is covered in detail in the next step.

Writing VBA macros in ArcGIS applications

For information about how to get started with the VBA environment, see the VBA topic in this chapter as well as related topics in the ArcObjects Developer Help system.

As mentioned, you should start development by using the VBA environment in one of the existing ArcGIS applications. VBA is a simple programming language with many utilities, such as design time code completion and the Object Browser, that will help you assemble code quickly.

Here are some more reasons to choose the VBA environment:

- It's fast and easy to create, test, and debug macros inside ArcMap and ArcCatalog.
- The standard ESRI type libraries are already referenced for you.
- Important global variables, such as the *Application* and *Document*, are available.
- It's simple to assemble UI forms using VBA and ActiveX® components.
- It's straightforward to integrate VBA code with new ArcObjects UIControls.
- It's relatively easy to migrate VBA code to VB ActiveX DLL projects.
- Many code samples available in the help system are macros that can be cut, pasted, and run with the VBA environment.

After the testing phase, you can easily save the VBA code into a Normal.mxt, Project.mxd, or custom Project.mxt file. Projects, documents, and templates can then be delivered to end users so they can take advantage of the new functionality your application provides. (See the topic on customizing with documents and templates in Chapter 3, 'Customizing the user interface'.)

Writing ActiveX COM components

This approach of writing ActiveX COM components must be taken if you wish to extend the existing ArcObjects architecture. Custom components can reside at the application or geodatabase level.

If you wish to use a programming language other than VBA or if you want to package ArcObjects functionality into a COM DLL, EXE, or OCX, you will have to work outside of the VBA development environment. This approach generally requires creating a project, referencing the ArcObjects type library, adding code, then compiling the source into a binary file.

Writing ActiveX COM components should be done when you want to extend the existing ArcObjects architecture by adding new custom components. The process requires implementing one or more ArcObjects interfaces in the new object (see the topic on creating COM components in Chapter 2, 'Developing with ArcObjects').

Unlike working in the VBA environment, all new components require Component Category registration in order to work correctly (see the topic on the Component Category manager in Chapter 2, 'Developing with ArcObjects').

These are some advantages of building custom components:

- They can be easily delivered to end users via custom setup programs.
- You can hide ArcObjects code in a binary file and then deliver the functionality to end users with a setup program.
- You can extend and customize virtually every aspect of the ArcGIS technology.

Components can be broadly categorized into two areas of customization: those that reside at the application level, such as custom buttons, toolbars, windows, and extensions, and those that reside at the geodatabase level, such as custom feature class extensions and custom features. Some of these more advanced customizations cannot be accomplished through the VBA environment.

The main disadvantage of working outside of the VBA environment is that you will have to acquire and use another COM-compliant development tool. Another consideration is the fact that you do not have direct access to the *Application* and *ThisDocument* global variables.

The development tool you choose must support the creation of new components as well as the implementation of COM interfaces in order to acquire a hook back into the ArcGIS applications (for more details, see Chapter 3, 'Customizing the user interface'). Interfaces that provide this functionality will allow you to acquire references to the *Application* and *ThisDocument* global variables, just as if you were working in the VBA environment. Another disadvantage is that it is often more difficult to debug the code (see the topic on getting started with VBA in Chapter 2, 'Developing with ArcObjects').

Standalone applications

ArcObjects can be used to write standalone applications. This generally requires creating a project, referencing the ArcObjects type library, then assembling the required code to support the functionality of the application.

These are some advantages of building standalone applications:

- You can use the ESRI ArcObjects Map control to simplify the embedding of ArcObjects functionality in your application.
- You can design a highly customized user interface specific to your application.
- You can quickly create small, lightweight applications.

These are the disadvantages of building standalone applications:

- You cannot take advantage of the extensive functionality that ESRI has built into the existing ArcGIS applications such as ArcMap or ArcCatalog.
- If you are not using the Map control, you will have to provide your own map display for visual applications.
- You will have to design your own data loading and layer management tools.
- You cannot use ArcMap documents or templates to their fullest capacity.
- You cannot take advantage of the components that give you the ability to extend the existing ArcMap and ArcCatalog framework.
- None of the extensions, including the *Editor*, can be used.

Although it is possible, it is not recommended to create standalone applications if the functionality you desire can be realized by extending existing ArcGIS applications such as ArcMap and ArcCatalog. All ArcGIS applications share the same application framework, designed to be extended by third-party developers.

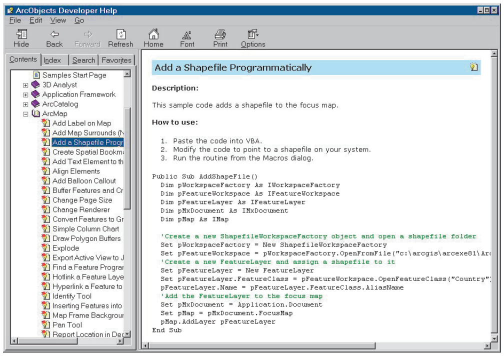
If you create a standalone application, you have a significantly higher development effort. The Map control mitigates, but does not eliminate, this additional effort. Standalone applications are appropriate only for highly specialized implementations.

Of the three options for writing code—as VBA macros in ArcMap or ArcCatalog, as ActiveX COM components, or as standalone applications—the example used in this problem-solving guide, adding a dataset called States to ArcMap, will simply be run as a VBA macro stored in a map document (.mxd file).

Find a related sample or recommended methodology

The last step is to search all of the available resources for a code sample and to look for any documentation that may be related to the task at hand. To accomplish this, you will need to make use of the help resources and tools. As you may already know, there is often more than one way to accomplish a programming task. The recommendation here is to search the available resources for similar implementations in order to help you decide how to go about solving the problem.

The easiest way to locate a sample is to search using the ArcObjects Developer Help system.



Add a Shapefile Programmatically

Description:

This sample code adds a shapefile to the focus map.

How to use:

1. Paste the code into VBA.
2. Modify the code to point to a shapefile on your system.
3. Run the routine from the Macros dialog.

```
Public Sub AddShapeFile()
  Dim pWorkspaceFactory As IWorkspaceFactory
  Dim pFeatureWorkspace As IFeatureWorkspace
  Dim pFeatureLayer As IFeatureLayer
  Dim pMxDocument As IMxDocument
  Dim pMap As IMap

  'Create a new ShapefileWorkspaceFactory object and open a shapefile folder
  Set pWorkspaceFactory = New ShapefileWorkspaceFactory
  Set pFeatureWorkspace = pWorkspaceFactory.OpenFromFile("c:\arcgis\arcexe81\Arc
  'Create a new FeatureLayer and assign a shapefile to it
  Set pFeatureLayer = New FeatureLayer
  Set pFeatureLayer.FeatureClass = pFeatureWorkspace.OpenFeatureClass("Country")
  pFeatureLayer.Name = pFeatureLayer.FeatureClass.AliasName
  'Add the FeatureLayer to the focus map
  Set pMxDocument = Application.Document
  Set pMap = pMxDocument.FocusMap
  pMap.AddLayer pFeatureLayer
End Sub
```

1. Start the ArcObjects Developer Help system.

2. Click the Search tab and type "Add".

3. Sort by clicking the "Title" field. You can sort by location as well.

4. Browse down until you find "samples" and until you locate the "Add a shapefile programmatically" sample. Open the page and study the sample.

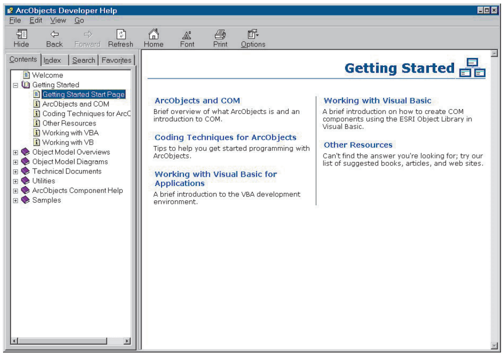
5. Click the Contents tab. This reveals the location of the sample. Browse the other samples in this folder structure. Make note of the location of the sample.

6. Click the Favorites tab, give the current topic a title, and add the sample to your favorites list.

The Samples in the ArcObjects Developer Help system fall into two categories:Tips and Tools. Tips are smaller examples of ArcObjects code that you can generally cut and paste and then run as a VBA script in ArcMap or ArcCatalog. Tools are more complete examples of applications that often require compilation and component category registration. Many of the tools are COM components themselves. If you find a tip or tool that may be useful, be sure to store it in the Favorites tab for future reference.

Unfortunately, in this case it was not possible to find a sample that solves the exact problem, but a sample was found that relates to the problem. The sample found illustrates how to open and load a shapefile into ArcMap. Since you are not ready to write code at this point, the sample was simply stored in the favorites list so that it can be referenced later on. This will still prove to be a valuable step later on when writing code in the final steps.

Whether a sample was located or not, it is a good idea to look for background information related to the current task. The ArcObjects Developer Help system contains some topics that you might find valuable in the Getting Started section. These pages provide some useful information, such as the basic principles related to working with ArcObjects in VB and VBA. Although the documentation doesn't relate to the problem description, it still relates to the overall task since this example will be written as a VBA macro. Therefore, it is a good idea to review this documentation.



Getting Started

ArcObjects and COM
Brief overview of what ArcObjects is and an introduction to COM.

Coding Techniques for ArcObjects
Tips to help you get started programming with ArcObjects.

Working with Visual Basic for Applications
A brief introduction to the VBA development environment.

Working with Visual Basic
A brief introduction on how to create COM components using the ESRI Object Library in Visual Basic.

Other Resources
Can't find the answer you're looking for; try our list of suggested books, articles, and web sites.

1. Open the Getting Started Page in the ArcObjects Develop Help system.

2. Review the documentation related to working with Visual Basic for Applications.

If nothing is found that directly relates to the task at hand, it is a good idea to visit the other documentation available. You can check some other resources, such as the ArcGIS Desktop Help, and ESRI books, such as *What is ArcGIS?*, *Building a Geodatabase*, and *Modeling Our World*.

Summary of part one

Now that you have more clearly defined the various components of the task and have done some research on the topic, it is possible to move on to the next step, which will help identify which object model diagram to start with.

Here is all of the task-related information found in part one of the problem-solving guide for the current example:

Task defined in ArcGIS terminology: *Access the States feature class from an existing Access personal geodatabase and add it to ArcMap.*

Subtask 1: *Access the States feature class.*

Subtask 2: *Add the new layer to the map.*

Where to write the code: *As a VBA macro in ArcMap.*

Located sample: *Add a shapefile to ArcMap programmatically.*

PART TWO: FIND THE CORRECT OBJECT MODEL DIAGRAM

This section explains how to use the help resources and tools to locate the correct object model diagram required to solve a task. As a reminder, the remaining steps in parts two and three are designed to work through one subtask at a time. Therefore, you will need to proceed through all of the remaining steps with subtask 1, then come back here to solve subtask 2.

Identify a subtask

Start with the first subtask defined in part one.

Original task: *Access the States feature class from an existing Access personal geodatabase and add it to ArcMap.*

Subtask 1: *Access the States feature class.*

Subtask 2: *Add the new layer to ArcMap.*

Extract keywords

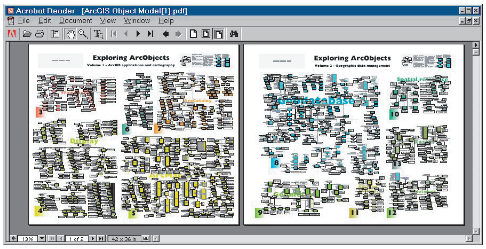
It is important to use the correct ArcObjects terminology when describing the original task so that it is possible to extract meaningful keywords from each subtask. These keywords are important because they can be used later on to search for topics in the help system and to search for classes in the object model diagrams.

This step requires that you extract keywords from the subtask description. This is not an exact science, but the more ArcObjects terms used in the original description, the more success you will have here. Therefore, it should be evident that it is critical to define the initial task correctly in the first step of part one.

Two terms can be extracted from the previously defined subtask: *"Access"* and *"feature class"*.

Search for the correct object model diagram

The objective of this step is to use the keywords defined above to identify the correct object model diagram. The easiest way to find the object model diagram is to use Adobe® Acrobat Reader to search the ArcGIS object model PDF file. Searching the entire ArcGIS object model should lead you to one or more words or classes that are directly associated with an object model diagram.


Acrobat Reader - [ArcGIS Object Model[1].pdf]
File Edit Document View Window Help
Exploring ArcObjects
Volume 1 • ArcGIS applications and cartography
Exploring ArcObjects
Volume 2 • Geographic data management
Geodatabase
13%
1 of 2
42 x 36 in

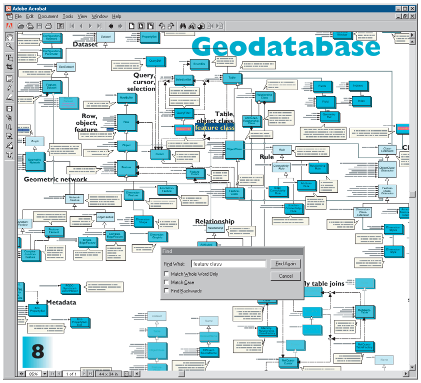
The ArcGIS Object Model.pdf file contains subsystems that contain one or more object model diagrams. This diagram only shows those classes that are documented in the ArcObjects book. To search against the entire ArcObjects library, you can also use the AllOMDs.pdf file.

The ArcGIS object model is a simplified version of the entire ArcObjects library. This object model contains subsystems that are composed of one or more object model diagrams. Each subsystem is clearly marked with a number that associates it with one of the chapters in the two volumes of this book.

The methodology here is to search the object model with the keywords defined in the last step, identify the appropriate subsystem or object model diagram, then go directly to the associated chapter in the book to learn more about the related classes. The chapters of the book provide both a detailed description of the classes and a number of helpful code samples.

Another valuable resource is the AllOMDs.pdf file. This diagram contains all of the object model diagrams with expanded interfaces, members, and enumerations. It can be searched using Acrobat Reader just like the ArcGIS object model diagram, but since it contains considerably more detail, expect the search to point to many more hits. The advantage of using this object model diagram is that it will cover virtually every class and interface in the entire ArcObjects library at one time.

Use the Find tool in Acrobat Reader to search for the keywords in the ArcGIS Object Model PDF.



Find What: feature class
□ Match Whole Word Only
□ Match Case
□ Find Backwards

If you were unsuccessful at finding a diagram, repeat the steps using the AllOMDs.pdf file.

1. Open the ArcGIS Object Model diagram.

2. Use the Find tool to search for each word from the keyword list. Try to search until you identify a class. *Searching for the keywords "Access" and "Feature class" yields hits in the Geodatabase section of the ArcGIS object model diagram.*

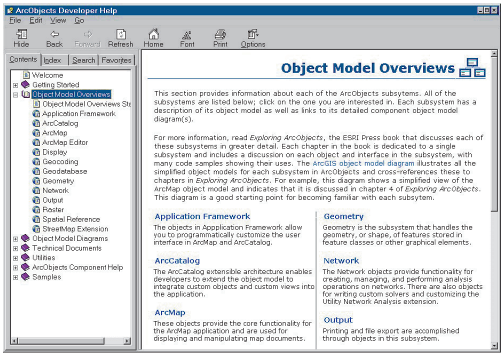
3. Write down the object model diagram or subsystem to which the majority of the searches point. *For this example, both keywords point to the geodatabase object model diagram.*

4. Identify the chapter in the book that is associated with the OMD. *The geodatabase section of the ArcGIS object model diagram is labeled with the number 8; therefore, you can find that subsystem documented in Volume 2, Chapter 8, 'Accessing the geodatabase' .*

In this example, all of the search results point to descriptive text or an actual class associated with the geodatabase object model diagram. Therefore, this clearly indicates that you should start with this diagram to solve the subtask.

Review the documentation

With the object model diagram identified, the last step in part two is to review the available ArcObjects documentation. The best place to start is with the Object Model Overviews section of the ArcObjects Developer Help system. The Object Model Overviews Start Page provides a brief description of each subsystem that composes the ArcObjects library. At a minimum, you will find an overview of each subsystem that provides a description of the main classes associated with each subsystem.



Object Model Overviews

This section provides information about each of the ArcObjects subsytems. All of the subsystems are listed below; click on the one you are interested in. Each subsystem has a description of its object model as well as links to its detailed component object model diagram(s).

For more information, read *Exploring ArcObjects*, the ESRI Press book that discusses each of these subsystems in greater detail. Each chapter in the book is dedicated to a single subsystem and includes a discussion on each object and interface in the subsystem, with many code samples showing their uses. The ArcGIS object model diagram illustrates all the simplified object models for each subsystem in ArcObjects and cross-references these to chapters in *Exploring ArcObjects*. For example, this diagram shows a simplified view of the ArcMap object model and indicates that it is discussed in chapter 4 of *Exploring ArcObjects*. This diagram is a good starting point for becoming familiar with each subsytem.

Application Framework

The objects in Appplication Framework allow you to programmatically customize the user interface in ArcMap and ArcCatalog.

ArcCatalog

The ArcCatalog extensible architecture enables developers to extend the object model to integrate custom objects and custom views into the application.

ArcMap

These objects provide the core functionality for the ArcMap application and are used for displaying and manipulating map documents.

Geometry

Geometry is the subsystem that handles the geometry, or shape, of features stored in feature classes or other graphical elements.

Network

The Network objects provide functionality for creating, managing, and performing analysis operations on networks. There are also objects for writing custom solvers and customizing the Utility Network Analysis extension.

Output

Printing and file export are accomplished through objects in this subsystem.

Review the appropriate Object Model Overview page in the ArcObjects Developer Help system.

1. Go to the ArcObjects Developer Help system and click Object Model Overviews.

2. From the Object Model Overviews Start Page, click the desired object model. *For this example, click Geodatabase.*

3. Read the overview information available to learn about the classes that belong to the selected object model diagram.

The object model diagram overviews provide some background information for the most important classes in each object model diagram. From this, you should be able to identify new keywords that you may have missed or even class names that are directly related to the current subtask. Add these keywords to the existing keyword list to improve your ability to navigate through the object model diagram.

From the Geodatabase overview page, you should have been able to identify the following keywords: “Access”, “Feature class”, “Workspace”, and “Factory”.

Next, go to the *Exploring ArcObjects* book and read the chapter associated with the geodatabase object model diagram. *For this subtask, you should go to Volume 2, Chapter 8, ‘Accessing the geodatabase’.*

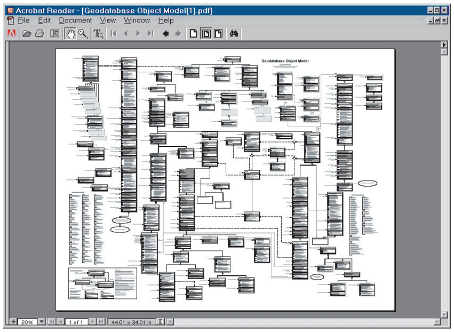
Reviewing this chapter should provide you with a solid understanding of what the main classes and interfaces are for as well as some good code samples. This last step is one of the most important parts of the entire problem-solving guide.

PART THREE: NAVIGATE THE OBJECT MODEL DIAGRAM

The last part of the guide involves navigating the object model diagrams and assembling the required code to solve each subtask. This is generally the most difficult step because it involves the use of many of the help resources and tools and is generally not a linear process. As you become more familiar with the help tools and the object model diagrams, this process will become easier.

Review the structure of the object model diagram

It is a good idea to familiarize yourself with the general structure of the object model diagram before proceeding. The easiest way to accomplish this is to use Acrobat Reader to zoom in and pan around the model.



1. Open the geodatabase object model diagram with Acrobat Reader.

2. Zoom in and pan around the diagram to view the overall structure.

Another way to become familiar with the object model diagram is to examine the relationship between classes and interfaces of an existing sample. It is recommended that you physically trace the flow between the classes and interfaces to understand how the classes relate to one another. This knowledge will be useful as it will help you assemble your own code in the next step.

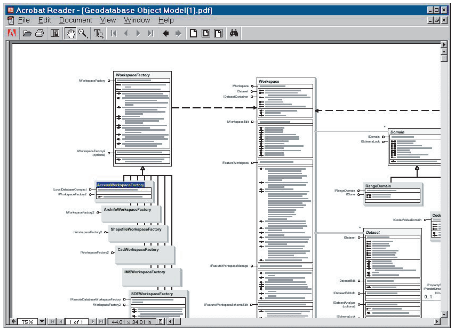
In part one, step 4, the "Add a shapefile to ArcMap programmatically" sample was located. Use this to start exploring the geodatabase object model diagram.

1. Click the Favorites tab where you saved the link to this sample in the ArcObjects Developer Help system. Make note of the classes used in this sample.
2. Open the geodatabase object model diagram and search for the main classes used in the sample.
3. Follow the inheritance symbols all the way to the feature class.
4. Pay special attention to any inheritance relationships that may exist.

When searching the object model diagrams, it is important to pay attention to the UML symbols that identify relationships between classes. If there is no obvious relationship joining two classes, or if they are located in completely different parts of the model, you should keep in mind that they are still likely associated with each other in some way. It's also important to inspect all of the interfaces associated with the classes since they may contain members that are references to other classes.

Trace the flow between the classes and assemble code

In this step you will search for classes in the object model diagram based on the keywords identified for the current subtask. After locating some potential classes to start with, you will go to the ArcObjects Developer Help system and look for any help topics that may be available. The last step is to start writing the code based on the knowledge you have gained from these steps.

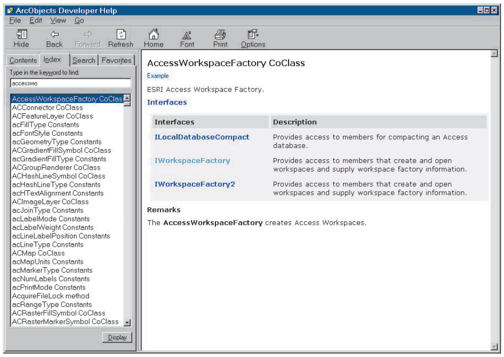


Start with the first subtask by searching for the keywords in the geodatabase object model diagram.

Subtask 1: *Access the States feature class.*

Keyword List: *Access, Feature Class, Workspace, Factory*

1. Using Acrobat Reader, zoom in to about 75 percent and search the geodatabase object model diagram for the first keyword in the list: *Access.*



AccessWorkspaceFactory CoClass

Example

ESRI Access Workspace Factory.

Interfaces

Interfaces	Description
ILocalDatabaseCompact	Provides access to members for compacting an Access database.
IWorkspaceFactory	Provides access to members that create and open workspaces and supply workspace factory information.
IWorkspaceFactory2	Provides access to members that create and open workspaces and supply workspace factory information.

Remarks

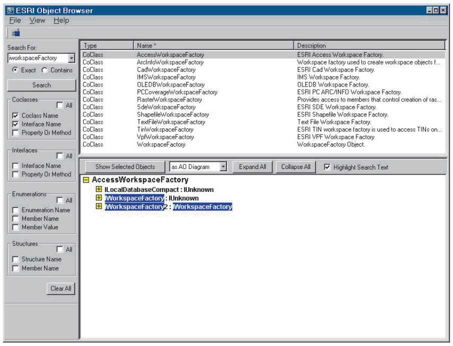
The **AccessWorkspaceFactory** creates Access Workspaces.

You should find the *AccessWorkspaceFactory* class.

2. Once you find the class, go back to the ArcObjects Developer Help system and use the Index tab to search for all instances of *AccessWorkspaceFactory*. Once a help topic is located, browse the available information along with any examples. To determine what interfaces the class supports, expand the Interfaces hyperlink on the page. Identify these below.

AccessWorkspaceFactory supports the following interfaces: *IWorkspaceFactory, IWorkspaceFactory2,* and *ILocalDatabaseCompact*.

If no help topic is available, use the Search tab to find all related help documents in the system, such as samples, you might have missed in the initial steps.



iworkspaceFactory

● Exact ○ Contains

Search

Coclasses ☐ All
☑ Coclass Name
☑ Interface Name
☐ Property Or Method

Interfaces ☐ All
☐ Interface Name
☐ Property Or Method

Enumerations ☐ All
☐ Enumeration Name
☐ Member Name
☐ Member Value

Structures ☐ All
☐ Structure Name
☐ Member Name

Type	Name *	Description
CoClass	AccessWorkspaceFactory	ESRI Access Workspace Factory.
CoClass	ArcInfoWorkspaceFactory	Workspace factory used to create workspace objects f...
CoClass	CadWorkspaceFactory	ESRI Cad Workspace Factory.
CoClass	IMSWorkspaceFactory	IMS Workspace Factory.
CoClass	OLEDBWorkspaceFactory	OLEDB Workspace Factory.
CoClass	PCCoverageWorkspaceFactory	ESRI PC ARC/INFO Workspace Factory.
CoClass	RasterWorkspaceFactory	Provides access to members that control creation of ras...
CoClass	SdeWorkspaceFactory	ESRI SDE Workspace Factory.
CoClass	ShapefileWorkspaceFactory	ESRI Shapefile Workspace Factory.
CoClass	TextFileWorkspaceFactory	Text File Workspace Factory.
CoClass	TinWorkspaceFactory	ESRI TIN workspace factory is used to access TINs on...
CoClass	VpfWorkspaceFactory	ESRI VPF Workspace Factory
CoClass	WorkspaceFactory	WorkspaceFactory Object.

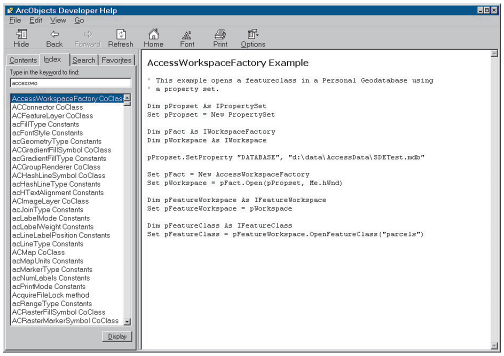
Show Selected Objects | as AO Diagram | Expand All | Collapse All | ☑ Highlight Search Text

```
⊟ AccessWorkspaceFactory
   ⊞ ILocalDatabaseCompact : IUnknown
   ⊞ IWorkspaceFactory : IUnknown
   ⊞ IWorkspaceFactory2 : IWorkspaceFactory
```

3. Now, return to the object model diagram and follow the inheritance symbols that connect the *AccessWorkspaceFactory* class to *WorkspaceFactory*. Note that the abstract class supports the *IWorkspaceFactory* interface. This information is valuable because it indicates that *AccessWorkspaceFactory* also must implement *IWorkspaceFactory*. It is important to note that this inheritance information can only be derived from the object model diagram itself or from the discussions in the associated chapters in this book.

At this point, you might also be interested in discovering what other coclasses implement *IWorkspaceFactory*. The easiest way is to look at the coclasses that inherit from *Workspace* on the object model diagram, but this can also be discovered two other ways. The first is to use the ArcObjects Developer Help system and click the Index tab to search for *IWorkspaceFactory*. Expand the 'CoClasses that implement IWorkspaceFactory' hyperlink to list the classes that support the interface.

This will list all of the coclasses for you. The second way is to use the ESRI EOBrowser application to search for all of the coclasses that implement the same interface. The coclasses are listed below.



AccessWorkspaceFactory Example

```
' This example opens a featureclass in a Personal Geodatabase using
' a property set.

Dim pPropset As IPropertySet
Set pPropset = New PropertySet

Dim pFact As IWorkspaceFactory
Dim pWorkspace As IWorkspace

pPropset.SetProperty "DATABASE", "d:\data\AccessData\SDETest.mdb"

Set pFact = New AccessWorkspaceFactory
Set pWorkspace = pFact.Open(pPropset, Me.hWnd)

Dim pFeatureWorkspace As IFeatureWorkspace
Set pFeatureWorkspace = pWorkspace

Dim pFeatureClass As IFeatureClass
Set pFeatureClass = pFeatureWorkspace.OpenFeatureClass("parcels")
```

4. With the information you have gathered from the object model diagram, the sample, the help system, and the EOBrowser, you should be able write some basic code to cocreate an instance of the *AccessWorkspaceFactory* class. At this point, you could also go back to the ArcObjects Help system and look for an example on the same page that was located for the *AccessWorkspaceFactory* search. With this information and from browsing the object model diagram, the code could be assembled like this:

```
‘ Subtask 1. Access the States feature class
Dim pWSF as IWorkspaceFactory
Set pWSF = New AccessWorkspaceFactory
```

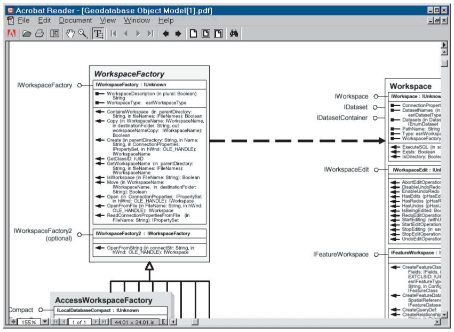
5. Now, inspect the members of the *IWorkspaceFactory* interface and try to identify which one can be used to open the database. Again, this information can be acquired using multiple tools. You can:

- Read and interpret the members on the object model diagram.
- Search for the interface in the ArcObjects Developer Help system by expanding the Members hyperlink.
- Display the members in VB/VBA using IntelliSense or by pressing F2 to view the Object Browser.
- Search for the interface using the ESRI EOBrowser and expand it to inspect all of its members.

It is possible to view the members of an interface by using a number of tools, such as the ArcObjects Developer Help, the VB/VBA IntelliSense or Object Browser, and the ESRI EOBrowser. In most cases, however, it is recommended to use the ArcObjects Developer Help since it provides a more complete description of the members and often provides an example of how to use them.

Although there are many avenues to take, it is generally recommended to use the ArcObjects Developer Help system since it provides a description of each member, the required parameters, and often a code sample.

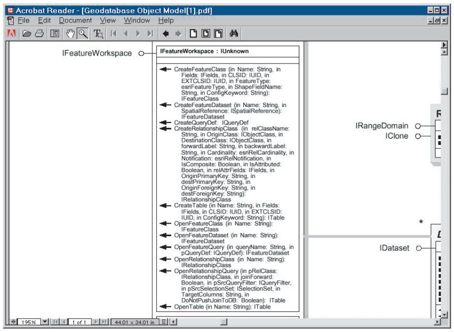
6. After inspecting the members of *IWorkspaceFactory*, it should be obvious that there are multiple members that can be used to open a geodatabase. In this case, since the file path of the database is known to be “C:\data\US.mdb”, the *IWorkspaceFactory::OpenFromFile* member can be used. Since the *IWorkspaceFactory::OpenFromFile* member returns a reference to an *IWorkspace* interface, it will be necessary to store this return value.


Acrobat Reader - [Geodatabase Object Model[1].pdf]
File Edit Document View Window Help
WorkspaceFactory
IWorkspaceFactory : IUnknown
IWorkspaceFactory
IWorkspaceFactory2 (optional)
IWorkspaceFactory2 : IWorkspaceFactory
AccessWorkspaceFactory
ILocalDatabaseCompact : IUnknown
Compact
Workspace
IWorkspace : IUnknown
IWorkspace
IDataset
IDatasetContainer
IWorkspaceEdit
IFeatureWorkspace
155%
1 of 1
44.01 x 34.01 in

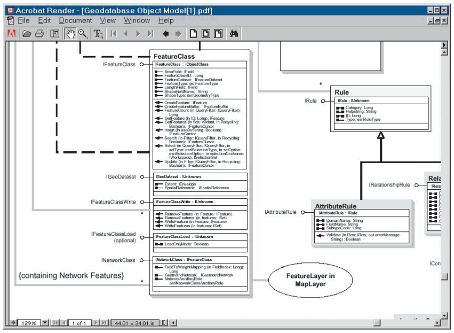
The code so far might look like this:

```
‘ Subtask 1. Access the States feature class
Dim pWSF as IWorkspaceFactory
Dim pWS as IWorkspace

Set pWSF = New AccessWorkspaceFactory
Set pWS = pWSF.OpenFromFile(“c:\data\US.mdb”, 0)
```

7. If you inspect the *IWorkspace* interface, you will see that it will take several calls to search and open the “states” feature class if *IWorkspace::Datasets* or *IWorkspace::DatasetNames* are used. In this case it will be necessary to loop through all of the feature classes available just to identify the “states” feature class in the enumeration. Since you already know the name of the feature class to open, you should look for a way to optimize this process. The best resource at this point would be Volume 2, Chapter 8, ‘Accessing the geodatabase’, but if you inspect the class carefully, you might find it immediately.



8. If you look at the *Workspace* class on the object model diagram or if you review Volume 2, Chapter 8, ‘Accessing the geodatabase’, you will notice that this class also supports the *IFeatureWorkspace* interface. This interface is designed to provide feature class-level access to a workspace. It supports an *IFeatureWorkspace::OpenFeatureClass* member, which takes a string name directly and returns an *IFeatureClass* reference.



Since you can provide the name as a string and directly return a reference, you should use this interface to return a reference to the "states" feature class. To access the interface, it will be necessary to use *QueryInterface* against the *IWorkspace* reference. It should also be noted that the return value must be stored as an *IFeatureClass* reference.

You should recognize that there is often more than one way to solve a problem using the numerous classes and interfaces available in the ArcObjects library. When this is the case, you should research the documentation and test to find out which set of classes and interfaces work most optimally to solve your particular programming task.

After assembling the code it might look like this:

```
‘ Subtask 1. Access the States feature class
Dim pWSF as IWorkspaceFactory
Dim pWS as IWorkspace
Dim pFWS as IFeatureWorkspace
Dim pFC as IFeatureClass

Set pWSF = New AccessWorkspaceFactory
Set pWS = pWSF.OpenFromFile(“c:\data\US.mdb”, 0)
Set pFWS = pWS ‘ QI
Set pFC = pFWS.OpenFeatureClass(“States”)
```

To optimize the code even further, rewrite it as follows:

```
‘ Subtask 1. Access the States feature class
Dim pWSF as IWorkspaceFactory
Dim pFWS as IFeatureWorkspace
Dim pFC as IFeatureClass

Set pWSF = New AccessWorkspaceFactory
Set pFWS = pWSF.OpenFromFile(“c:\data\US.mdb”, 0)
Set pFC = pFWS.OpenFeatureClass(“States”)
```

Now that the code for the first subtask has been completed, you must return to part two of the problem-solving guide to assemble the code for the last subtask.

Return to part two, step 1 of this problem-solving guide and find the correct object model diagram for the next subtask.

Subtask two is "Add the new layer to the map."

Go to part two, step 2 and extract keywords.

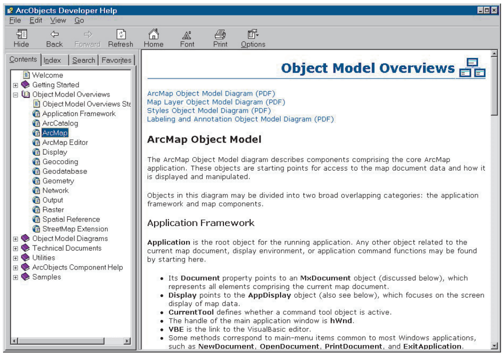
The keywords are "Layer" and "Map".

Go to part two, step 3 and search for the correct object model diagram. Use the Find tool in Acrobat Reader to search for the keywords in the ArcGIS Object Model PDF.

The object model that contains these keywords is the ArcMap object model.

Go to part two, step 4 and identify the chapter in the book that is associated with the object model diagram. *Chapter 4, 'Composing maps', documents the ArcMap object model.*

Go to step 4 and review the appropriate object model overview page.



Object Model Overviews

ArcMap Object Model Diagram (PDF)
Map Layer Object Model Diagram (PDF)
Styles Object Model Diagram (PDF)
Labeling and Annotation Object Model Diagram (PDF)

ArcMap Object Model

The ArcMap Object Model diagram describes components comprising the core ArcMap application. These objects are starting points for access to the map document data and how it is displayed and manipulated.

Objects in this diagram may be divided into two broad overlapping categories: the application framework and map components.

Application Framework

Application is the root object for the running application. Any other object related to the current map document, display environment, or application command functions may be found by starting here.

- Its **Document** property points to an **MxDocument** object (discussed below), which represents all elements comprising the current map document.
- **Display** points to the **AppDisplay** object (also see below), which focuses on the screen display of map data.
- **CurrentTool** defines whether a command tool object is active.
- The handle of the main application window is **hWnd**.
- **VBE** is the link to the VisualBasic editor.
- Some methods correspond to main-menu items common to most Windows applications, such as **NewDocument**, **OpenDocument**, **PrintDocument**, and **ExitApplication**.

1. Start the ArcObjects Developer Help system and click Object Model Overviews.

2. Click the Object Model Overviews Start Page. *For this subtask, select ArcMap.*

3. Read the overview information available to learn about the classes.

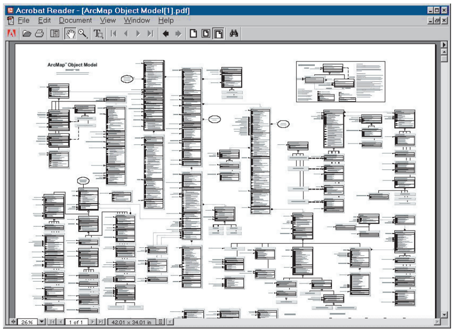
From the overview, it should be obvious that a number of new keywords need to be added to the list. You may want to sort the list as well.

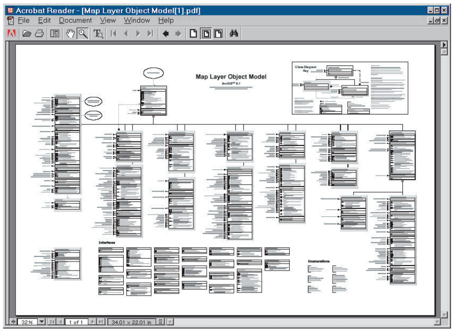
New keyword list: *Application, MxDocument, Map, FeatureLayer, Add*

Go to the *Exploring ArcObjects* book and read the associated chapter. *For this subtask, read Chapter 4, 'Composing maps'.*

With the information gained from the help system and the chapter in the book, you may be able to assemble the required code at this point; otherwise, continue on to the next part.

Return to part three, step 1. Review the structure of the object model diagram.





If you return to the sample that was identified in part one, step 4, you will notice that there are classes and interfaces that have not yet been located on an object model diagram. Take this time to look for these classes on the ArcMap object model diagram.

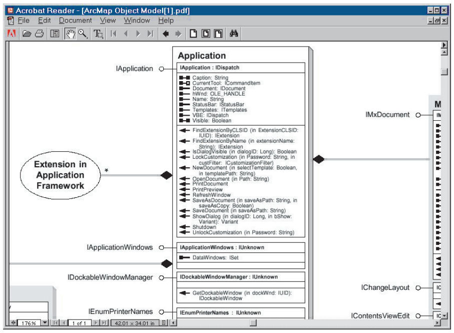
1. Using the ArcObjects Developer Help system, click the Favorites tab where you saved the link to this sample. View the sample.

2. Open the ArcMap object model diagram with Acrobat Reader and start tracing the flow between the classes by searching for the class names with the Find tool. Start with the *Application* class.

3. Follow the classes all the way to the *Map* class. Notice that there is a wormhole associated with the *Map* class that indicates it will be necessary to go to the map layer object model diagram to view the layer classes.

4. Now, open the map layer object model diagram with Acrobat Reader and follow the diagram until you locate the *FeatureLayer* class.

This step reveals that it will be necessary to traverse the map layer object model diagram to access the layers associated with a


Acrobat Reader - [ArcMap Object Model[1].pdf]
File Edit Document View Window Help
Application
IApplication
IApplication : IDispatch
Caption: String
CurrentTool: ICommandItem
Document: IDocument
hWnd: OLE_HANDLE
Name: String
StatusBar: IStatusBar
Templates: ITemplates
VBE: IDispatch
Visible: Boolean
FindExtensionByCLSID (in ExtensionCLSID: IUID): IExtension
FindExtensionByName (in extensionName: String): IExtension
IsDialogVisible (in dialogID: Long): Boolean
LockCustomization (in Password: String, in custFilter: ICustomizationFilter)
NewDocument (in selectTemplate: Boolean, in templatePath: String)
OpenDocument (in Path: String)
PrintDocument
PrintPreview
RefreshWindow
SaveAsDocument (in saveAsPath: String, in saveAsCopy: Boolean)
SaveDocument (in saveAsPath: String)
ShowDialog (in dialogID: Long, in bShow: Variant): Variant
Shutdown
UnlockCustomization (in Password: String)
Extension in Application Framework
*
IApplicationWindows
IApplicationWindows : IUnknown
DataWindows: ISet
IDockableWindowManager
IDockableWindowManager : IUnknown
GetDockableWindow (in dockWnd: IUID): IDockableWindow
IEnumPrinterNames
IEnumPrinterNames : IUnknown
IMxDocument
M
IChangeLayout
IContentsViewEdit
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map. This information is also available from the Overview Start Page in the ArcObjects Developer Help system.

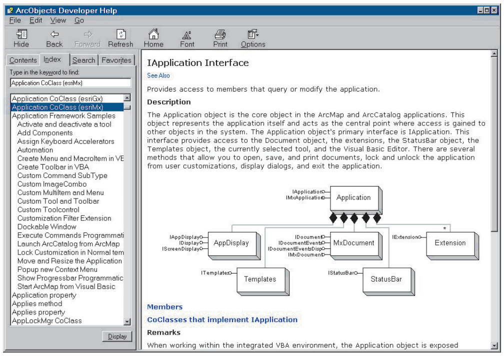
Go to step 2, trace the flow between the classes, and assemble code. Start this process by searching for the keywords for the current subtask.

Subtask 2: *Add the layer to ArcMap*.

Keyword List: *Application, MxDocument, Map, FeatureLayer, Add*

1. Using Acrobat Reader, search the relevant object model diagram for each keyword. *For Application, you should find the Application class.*

Inspect the interfaces that the class supports.


ArcObjects Developer Help
File Edit View Go
Hide
Back
Forward
Refresh
Home
Font
Print
Options
Contents
Index
Search
Favorites
Type in the keyword to find:
Application CoClass (esriMx)
Application CoClass (esriGx)
Application CoClass (esriMx)
Application Framework Samples
Activate and deactivate a tool
Add Components
Assign Keyboard Accelerators
Automation
Create Menu and MacroItem in VE
Create Toolbar in VBA
Custom Command SubType
Custom ImageCombo
Custom MultiItem and Menu
Custom Tool and Toolbar
Custom Toolcontrol
Customization Filter Extension
Dockable Window
Execute Commands Programmati
Launch ArcCatalog from ArcMap
Lock Customization in Normal tem
Move and Resize the Application
Popup new Context Menu
Show Progressbar Programmatic
Start ArcMap from Visual Basic
Application property
Applies method
Applies property
AppLockMgr CoClass
Display

IApplication Interface

See Also

Provides access to members that query or modify the application.

Description

The Application object is the core object in the ArcMap and ArcCatalog applications. This object represents the application itself and acts as the central point where access is gained to other objects in the system. The Application object's primary interface is IApplication. This interface provides access to the Document object, the extensions, the StatusBar object, the Templates object, the currently selected tool, and the Visual Basic Editor. There are several methods that allow you to open, save, and print documents, lock and unlock the application from user customizations, display dialogs, and exit the application.

Members

CoClasses that implement IApplication

Remarks

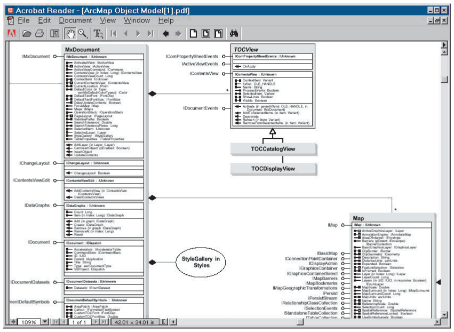
When working within the integrated VBA environment, the Application object is exposed

2. Once you find the class, go back to the ArcObjects Developer Help system and use the Index to search for that class. For this first keyword, click *Application* (esriMx). Read the information available. The help documentation reveals that *Application* is the primary object for ArcMap and ArcCatalog. Select the Interfaces hyperlink and view the interfaces associated with the *Application* class. Click *IApplication* to view the information available. Look for an example and then write code to access the *Application*.

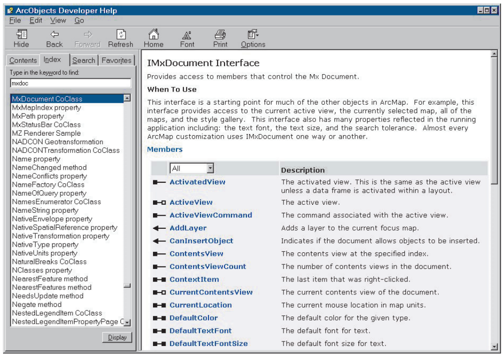
```
‘ Subtask 2. Add the new layer to the map
Dim pApp as IApplication
Set pApp = Application
```

Now expand the members of *IApplication* with the Members hyperlink. This information reveals that it is possible to access the current document with the *IApplication::Document* member. The code could be updated as follows:

```
‘ Subtask 2. Add the new layer to the map
Dim pApp as IApplication
Dim pDoc as IDocument
Set pApp = Application
Set pDoc = pApp.Document
```



3. Now return to the object model diagram and find the *MxDocument* class. Inspect the interfaces associated with this class. Notice that *IDocument* does not provide a member to access the *Map* class, but the *IMxDocument* interface does. Navigate the diagram to find the *Map* class.



Type in the keyword to find:

mxdoc

MxDocument CoClass
MxMapIndex property
MxPath property
MxStatusBar CoClass
MZ Renderer Sample
NADCON Geotransformation
NADCONTransformation CoClass
Name property
NameChanged method
NameConflicts property
NameFactory CoClass
NameOfQuery property
NamesEnumerator CoClass
NameString property
NativeEnvelope property
NativeSpatialReference property
NativeTransformation property
NativeType property
NativeUnits property
NaturalBreaks CoClass
NClasses property
NearestFeature method
NearestFeatures method
NeedsUpdate method
Negate method
NestedLegendItem CoClass
NestedLegendItemPropertyPage C

IMxDocument Interface

Provides access to members that control the Mx Document.

When To Use

This interface is a starting point for much of the other objects in ArcMap. For example, this interface provides access to the current active view, the currently selected map, all of the maps, and the style gallery. This interface also has many properties reflected in the running application including: the text font, the text size, and the search tolerance. Almost every ArcMap customization uses IMxDocument one way or another.

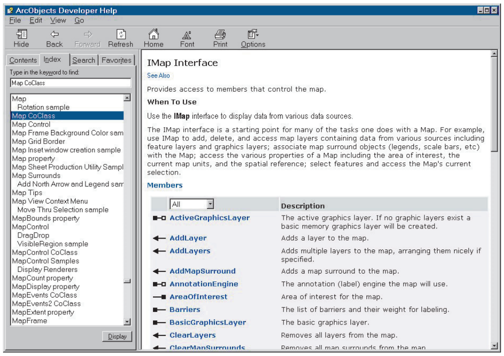
Members

	All	**Description**
■—	ActivatedView	The activated view. This is the same as the active view unless a data frame is activated within a layout.
■—□	ActiveView	The active view.
■—	ActiveViewCommand	The command associated with the active view.
←	AddLayer	Adds a layer to the current focus map.
←	CanInsertObject	Indicates if the document allows objects to be inserted.
■—	ContentsView	The contents view at the specified index.
■—	ContentsViewCount	The number of contents views in the document.
■—■	ContextItem	The last item that was right-clicked.
■—□	CurrentContentsView	The current contents view of the document.
■—■	CurrentLocation	The current mouse location in map units.
■—■	DefaultColor	The default color for the given type.
■—■	DefaultTextFont	The default font for text.
■—■	DefaultTextFontSize	The default font size for text.

4. Go back to the ArcObjects Developer Help system and use the Index to search for *MxDocument*. Read the information available. Click the Interfaces hyperlink. Click *IMxDocument* and expand the members. Notice that the *IMxDocument* interface supports the *FocusMap* member and returns a reference to *IMap*. Use this member to access the *Map* class.

Update the code to get a reference to the document's map.

```
‘ Subtask 2. Add the new layer to the map

Dim pApp as IApplication
Dim pDoc as IDocument
Dim pMxDoc as IMxDocument
Dim pMap as IMap

Set pApp = Application
Set pDoc = pApp.Document
Set pMxDoc = pDoc ‘QI
Set pMap = pMxDoc.FocusMap
```



Type in the keyword to find:

Map CoClass

Map
  Rotation sample
Map CoClass
Map Control
Map Frame Background Color sam
Map Grid Border
Map Inset window creation sample
Map property
Map Sheet Production Utility Sampl
Map Surrounds
  Add North Arrow and Legend sam
Map Tips
Map View Context Menu
  Move Thru Selection sample
MapBounds property
MapControl
  DragDrop
  VisibleRegion sample
MapControl CoClass
MapControl Samples
  Display Renderers
MapCount property
MapDisplay property
MapEvents CoClass
MapEvents2 CoClass
MapExtent property
MapFrame

IMap Interface

See Also

Provides access to members that control the map.

When To Use

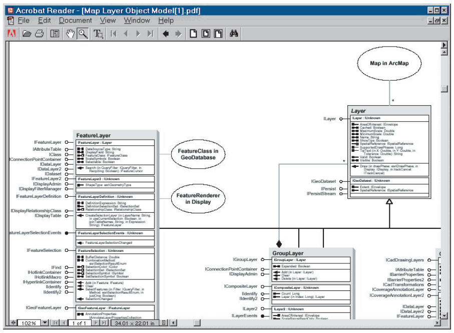
Use the **IMap** interface to display data from various data sources.

The IMap interface is a starting point for many of the tasks one does with a Map. For example, use IMap to add, delete, and access map layers containing data from various sources including feature layers and graphics layers; associate map surround objects (legends, scale bars, etc) with the Map; access the various properties of a Map including the area of interest, the current map units, and the spatial reference; select features and access the Map's current selection.

Members

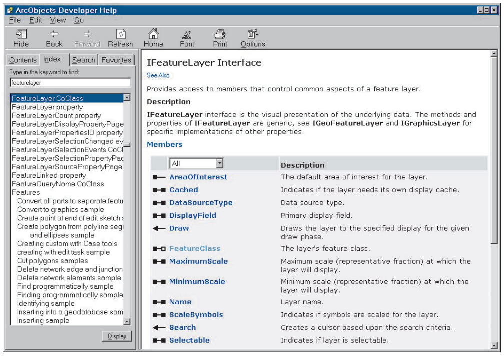
	All	**Description**
■—□	ActiveGraphicsLayer	The active graphics layer. If no graphic layers exist a basic memory graphics layer will be created.
←	AddLayer	Adds a layer to the map.
←	AddLayers	Adds multiple layers to the map, arranging them nicely if specified.
←	AddMapSurround	Adds a map surround to the map.
■—□	AnnotationEngine	The annotation (label) engine the map will use.
—■	AreaOfInterest	Area of interest for the map.
■—	Barriers	The list of barriers and their weight for labeling.
■—	BasicGraphicsLayer	The basic graphics layer.
←	ClearLayers	Removes all layers from the map.
←	ClearMapSurrounds	Removes all map surrounds from the map.

5. Go back to the ArcObjects Developer Help system and use the Index to search for the *Map* coclass. Select the Interfaces hyperlink and the *IMap* interface. Expand the members and locate the *AddLayer* member. This member will be used later to add a layer to the map, but first you need to create the new layer and associate it with the "states" data.


Acrobat Reader - [Map Layer Object Model[1].pdf]
File Edit Document View Window Help
Map in ArcMap
Layer
FeatureLayer
FeatureClass in GeoDatabase
FeatureRenderer in Display
GroupLayer
102%
1 of 1
34.01 x 22.01 in

6. Locate the wormhole in the ArcMap object model diagram that connects the *Map* class to the map layer object model diagram. Open the map layer object model diagram and browse the contents. Search for the "FeatureLayer" keyword until you find the class. Inspect the inheritance relationship between *FeatureLayer* and *Layer*. Also, identify the interface inheritance between *IFeatureLayer* and *ILayer*.

The interface inheritance information can also be acquired if you go back to the ArcObjects Developer Help system and use the Index to search for the *FeatureLayer* coclass. Expand the Interfaces hyperlink and notice that it supports the *ILayer* interface.



Type in the keyword to find:
featurelayer

FeatureLayer CoClass
FeatureLayer property
FeatureLayerCount property
FeatureLayerDisplayPropertyPage
FeatureLayerPropertiesID property
FeatureLayerSelectionChanged ev
FeatureLayerSelectionEvents CoCl
FeatureLayerSelectionPropertyPag
FeatureLayerSourcePropertyPage
FeatureLinked property
FeatureQueryName CoClass
Features
Convert all parts to separate featu
Convert to graphics sample
Create point at end of edit sketch s
Create polygon from polyline segi
and ellipses sample
Creating custom with Case tools
creating with edit task sample
Cut polygons samples
Delete network edge and junction
Delete network elements sample
Find programmatically sample
Finding programmatically sample
Identifying sample
Inserting into a geodatabase sam
Inserting sample

IFeatureLayer Interface

See Also

Provides access to members that control common aspects of a feature layer.

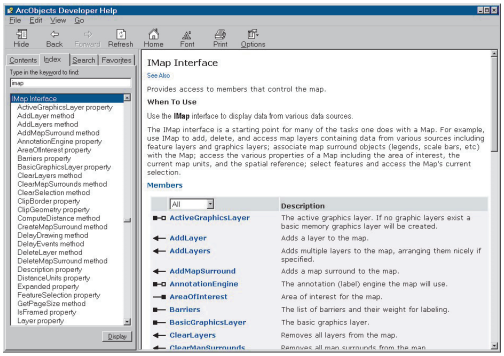
Description

IFeatureLayer interface is the visual presentation of the underlying data. The methods and properties of **IFeatureLayer** are generic, see **IGeoFeatureLayer** and **IGraphicsLayer** for specific implementations of other properties.

Members

All	Description
AreaOfInterest	The default area of interest for the layer.
Cached	Indicates if the layer needs its own display cache.
DataSourceType	Data source type.
DisplayField	Primary display field.
Draw	Draws the layer to the specified display for the given draw phase.
FeatureClass	The layer's feature class.
MaximumScale	Maximum scale (representative fraction) at which the layer will display.
MinimumScale	Minimum scale (representative fraction) at which the layer will display.
Name	Layer name.
ScaleSymbols	Indicates if symbols are scaled for the layer.
Search	Creates a cursor based upon the search criteria.
Selectable	Indicates if layer is selectable.

7. Now, inspect the members of *IFeatureLayer* more closely by using the ArcObjects Developer Help system or the object model diagram. Notice it supports an *IFeatureLayer::FeatureClass* member property. From the documentation and the information in Chapter 4, 'Composing maps', it should be obvious that you need to use this property to connect the *FeatureClass* class to the *FeatureLayer* class. The feature class contains a reference to the "states" dataset that was acquired in Subtask 1. Also, set the name of the layer to *IFeatureClass::AliasName*. The last step is to add the new layer to the *Map*.



Type in the keyword to find:
imap

IMap Interface
ActiveGraphicsLayer property
AddLayer method
AddLayers method
AddMapSurround method
AnnotationEngine property
AreaOfInterest property
Barriers property
BasicGraphicsLayer property
ClearLayers method
ClearMapSurrounds method
ClearSelection method
ClipBorder property
ClipGeometry property
ComputeDistance method
CreateMapSurround method
DelayDrawing method
DelayEvents method
DeleteLayer method
DeleteMapSurround method
Description property
DistanceUnits property
Expanded property
FeatureSelection property
GetPageSize method
IsFramed property
Layer property

IMap Interface

See Also

Provides access to members that control the map.

When To Use

Use the **IMap** interface to display data from various data sources.

The IMap interface is a starting point for many of the tasks one does with a Map. For example, use IMap to add, delete, and access map layers containing data from various sources including feature layers and graphics layers; associate map surround objects (legends, scale bars, etc) with the Map; access the various properties of a Map including the area of interest, the current map units, and the spatial reference; select features and access the Map's current selection.

Members

All	Description
ActiveGraphicsLayer	The active graphics layer. If no graphic layers exist a basic memory graphics layer will be created.
AddLayer	Adds a layer to the map.
AddLayers	Adds multiple layers to the map, arranging them nicely if specified.
AddMapSurround	Adds a map surround to the map.
AnnotationEngine	The annotation (label) engine the map will use.
AreaOfInterest	Area of interest for the map.
Barriers	The list of barriers and their weight for labeling.
BasicGraphicsLayer	The basic graphics layer.
ClearLayers	Removes all layers from the map.
ClearMapSurrounds	Removes all map surrounds from the map.

```
' Subtask 2. Add the new layer to the map

Dim pApp as IApplication
Dim pDoc as IDocument
Dim pMxDoc as IMxDocument
Dim pMap as IMap
Dim pFL as IFeatureLayer

Set pApp = Application
Set pDoc = pApp.Document
Set pMxDoc = pDoc ' QI
Set pMap = pMxDoc.FocusMap
Set pFL = New FeatureLayer
Set pFL.FeatureClass = pFC ' pFC From Subtask 1.
pFL.Name = pFC.AliasName
pMap.AddLayer pFL
```

8. Now that you understand the relationship between the classes and interfaces, the code can be optimized. Rewrite the code as follows:

```
' Subtask 2. Add the new layer to the map

Dim pApp as IApplication
Dim pDoc as IMxDocument
Dim pFL as IFeatureLayer
Set pApp = Application
Set pMxDoc = pApp.Document
Set pFL = New FeatureLayer
Set pFL.FeatureClass = pFC ‘ pFC From Subtask 1.
pFL.Name = pFC.AliasName
pMxDoc.FocusMap.AddLayer pFL
```

9. Now, assemble all of the code from subtasks 1 and 2. It will look like this:

```
‘ Subtask 1. Access the states feature class.
Dim pWSF as IWorkspaceFactory
Dim pFWS as IFeatureWorkspace
Dim pFC as IFeatureClass

Set pWSF = New AccessWorkspaceFactory
Set pFWS = pWSF.OpenFromFile(“c:\data\US.mdb”, 0)
Set pFC = pFWS.OpenFeatureClass(“States”)

‘ Subtask 2. Add the new layer to the map
Dim pApp as IApplication
Dim pMxDoc as IMxDocument
Dim pFL as IFeatureLayer

Set pApp = Application
Set pMxDoc = pApp.Document
Set pFL = New FeatureLayer
Set pFL.FeatureClass = pFC ‘ pFC from Subtask 1.
pFL.Name = pFC.AliasName
pMxDoc.FocusMap.AddLayer pFL
```

SUMMARY

It should be clear now that there are several ways to solve ArcObjects programming problems. The similarities between all of them, however, are being able to use the help documents and resources effectively and being able to read the object model diagrams. Hopefully this guide has provided you with an opportunity to visit the main resources that are available and exercise their use in order to solve this real-world problem.

2 Developing with ArcObjects

Euan Cameron

ArcObjects is based on Microsoft's Component Object Model (COM). End users of ArcGIS applications don't necessarily have to understand COM, but if you're a developer intent on developing applications based on ArcObjects or extending the existing ArcMap and ArcCatalog applications using ArcObjects, an understanding of COM is a requirement. The level of understanding required depends on the depth of customization or development you wish to undertake.

Although this chapter does not cover the entire COM environment, it provides both Visual Basic (VB) and Visual C++ developers with sufficient knowledge to be effective in using ArcObjects. There are many coding tips and guidelines that should make your work with ArcObjects more effective. The chapter ends with a bibliography if you're looking for more indepth detail not offered in this book.

Before discussing COM specifically, it is worth considering the wider use of software components in general. There are a number of factors driving the motivation behind software components, but the principal one is the fact that software development is a costly and time-consuming venture.

In an ideal world, it should be possible to write a piece of code once and then reuse it again and again using a variety of development tools, even in circumstances that the original developer did not foresee. Ideally, changes to the code's functionality made by the original developer could be deployed without requiring existing users to change or recompile their code.

Early attempts at producing reusable chunks of code revolved around the creation of class libraries, usually developed in C++. These early attempts suffered from several limitations, notably difficulty of sharing parts of the system (it is very difficult to share binary C++ components—most attempts have only shared source code), problems of persistence and updating C++ components without recompiling, lack of good modeling languages and tools, and proprietary interfaces and customization tools.

To counteract these and other problems, many software engineers have adopted component-based approaches to system development. A software component is a binary unit of reusable code.

ESRI chose COM as the component technology for ArcGIS because it is a mature technology that offers good performance, many of today's development tools support it, and there are a multitude of third-party components that can be used to extend the functionality of ArcObjects.

Several different but overlapping standards have emerged for developing and sharing components. For building interactive desktop applications, Microsoft's COM is the de facto standard. On the Internet, JavaBeans™ is viable technology. At a coarser grain appropriate for application-level interoperability, the Object Management Group (OMG) has specified the common object request broker architecture (CORBA).

To understand COM (and therefore all COM-based technologies), it's important to realize that it isn't an object-oriented language but a protocol or standard. COM is more than just a technology; it is a methodology of software development. COM defines a protocol that connects one software component, or module, with another. By making use of this protocol, it's possible to build reusable software components that can be dynamically interchanged in a distributed system.

The key to the success of components is that they implement, in a very practical way, many of the object-oriented principles now commonly accepted in software engineering. Components facilitate software reuse because they are self-contained building blocks that can easily be assembled into larger systems.

COM also defines a programming model, known as interface-based programming. Objects encapsulate the manipulation methods and the data that characterize each instantiated object behind a well-defined interface. This promotes structured and safe system development since the client of an object is protected from knowing any of the details of how a particular method is implemented. COM doesn't specify how an application should be structured. As an application programmer working with COM, language, structure, and implementation details are left up to you.

COM does specify an object model and programming requirements that enable COM objects to interact with other COM objects. These objects can be within a single process, in other processes, or even on remote machines. They can be written in other languages and may have been developed in very different ways. That is why COM is referred to as a binary specification or standard—it is a standard that applies after a program has been translated to binary machine code.

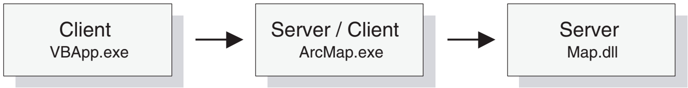
COM allows these objects to be reused at a binary level, meaning that third party developers do not require access to source code, header files, or object libraries in order to extend the system even at the lowest level.

COMPONENTS, OBJECTS, CLIENTS, AND SERVERS

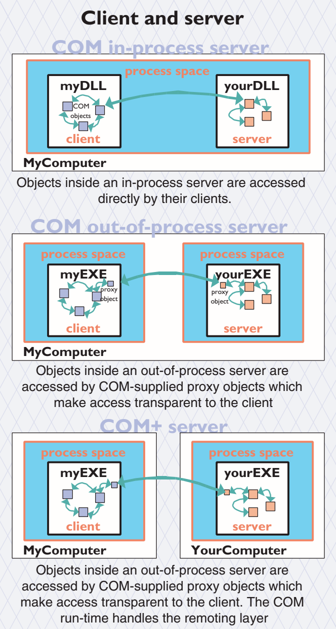
Different texts use the terms components, objects, clients, and servers to mean different things (to add to the confusion, various texts refer to the same thing using all of these terms). Therefore, it is worthwhile to define the terminology that this book will use.

COM is a client/server architecture. The server (or object) provides some functionality, and the client uses that functionality. COM facilitates the communication between the client and the object. An object can at the same time be a server to a client and be a client of some other object's services.

Objects are instances of COM classes that make services available for use by a client. Hence it is normal to talk of clients and objects instead of clients and servers. These objects are often referred to as COM objects and component objects. This book will refer to them simply as objects.



The client and its servers can exist in the same process or in a different process space. In-process servers are packaged in Dynamic Link Library (DLL) form, and these DLLs are loaded into the client's address space when the client first accesses the server. Out-of-process servers are packaged in executables (EXE) and run in their own address space. COM makes the differences transparent to the client.



Objects inside an in-process server are accessed directly by their clients.

Objects inside an out-of-process server are accessed by COM-supplied proxy objects which make access transparent to the client

Objects inside an out-of-process server are accessed by COM-supplied proxy objects which make access transparent to the client. The COM run-time handles the remoting layer

When creating COM objects, the developer must be aware of the type of server that the objects will sit inside, but if the creator of the object has implemented them correctly the packaging does not affect the use of the objects by the client.

There are pros and cons to each method of packaging that are symmetrically opposite. DLLs are faster to load into memory, and calling a DLL function is faster. EXEs, on the other hand, provide a more robust solution (if the server fails, the client will not crash), and security is better handled since the server has its own security context.

In a distributed system, EXEs are more flexible, and it does not matter if the server has a different byte ordering than the client. The majority of ArcObjects servers are packaged as in-process servers (DLLs). Later, you will see the performance benefits associated with in-process servers.

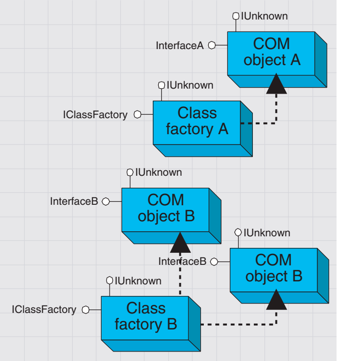
In a COM system, the client, or user of functionality, is completely isolated from the provider of that functionality, the object. All the client needs to know is that the functionality is available; with this knowledge, the client can make method calls to the object and expect the object to honor them. In this way, COM is said to act as a contract between client and object. If the object breaks that contract, the behavior of the system will be unspecified. In this way, COM development is based on trust between the implementer and the user of functionality.

In the ArcGIS applications there are many objects that provide, via their interfaces, thousands of properties and methods. When you use the ESRI object libraries you can assume that all these properties and interfaces have been fully implemented, and if they are present on the object diagrams, they are there to use.

CLASS FACTORY

Within each server there is an object called a class factory that the COM runtime interacts with in order to instantiate objects of a particular class. For every corresponding COM class there is a class factory. Normally, when a client requests an object from a server, the appropriate class factory creates a new object and passes out that object to the client.

While this is the normal implementation, it is not the only implementation possible. The class factory can also create an instance of the object the first time and, with subsequent calls, pass out the same object to clients. This type of implementation creates what is known as a singleton object since there is only one instance of the object per process.



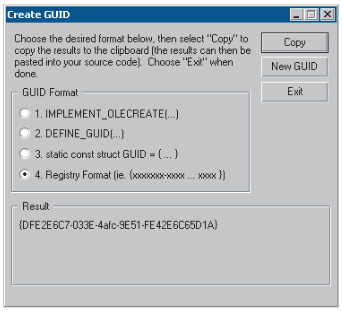
A server is a binary file that contains all the code required by one or more COM classes. This includes both the code that works with COM to instantiate objects into memory and the code to perform the methods supported by the objects contained within the server.

GLOBALLY UNIQUE IDENTIFIERS

A distributed system potentially has many thousands of interfaces, classes, and servers, all of which must be referenced when locating and binding clients and objects together at runtime. Clearly, using human-readable names would lead to the potential for clashes, hence COM uses Globally Unique Identifiers (GUIDs), 128 bit numbers that are virtually guaranteed to be unique in the world. It is possible to generate 10 million GUIDs per second until the year 5770 A.D., and each one would be unique.

The COM API defines a function that can be used to generate GUIDs; in addition, all COM-compliant development tools automatically assign GUIDs when appropriate. GUIDs are the same as Universally Unique Identifiers (UUIDs), defined by the Open Group's Distributed Computing Environment (DCE) specification. Below is a sample GUID in registry format.

```
{E6BDAA76-4D35-11D0-98BE-00805F7CED21}
```



Create GUID

Choose the desired format below, then select "Copy" to copy the results to the clipboard (the results can then be pasted into your source code). Choose "Exit" when done.

GUID Format

○ 1. IMPLEMENT_OLECREATE(...)
○ 2. DEFINE_GUID(...)
○ 3. static const struct GUID = { ... }
● 4. Registry Format (ie. {xxxxxxx-xxxx ... xxxx })

Result

{DFE2E6C7-033E-4afc-9E51-FE42E6C65D1A}

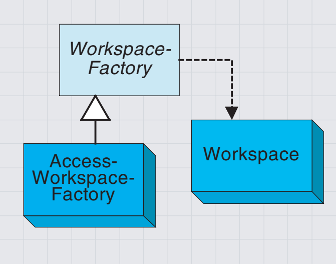
GUIDGEN.EXE is a utility that ships with Microsoft's Visual Studio and provides an easy-to-use user interface for generating GUIDs. It can be found in the directory <VS Install Dir>\Common\Tools.

The acronym GUID is commonly pronounced "gwid".

COM CLASSES AND INTERFACES

Developing with COM means developing using interfaces, the so-called interface-based programming model. All communication between objects is made via their interfaces. COM interfaces are abstract, meaning there is no implementation associated with an interface; the code associated with an interface comes from a class implementation. The interface sets out what requests can be made of an object that chooses to implement the interface.

How an interface is implemented differs between objects. Thus the objects inherit the type of interface, not its implementation, which is called type inheritance. Functionality is modeled abstractly with the interfaces and implemented within a class implementation. Classes and interfaces are often referred to as the "What" and "How" of COM. The interface defines what an object can do, and the class defines how it is done.

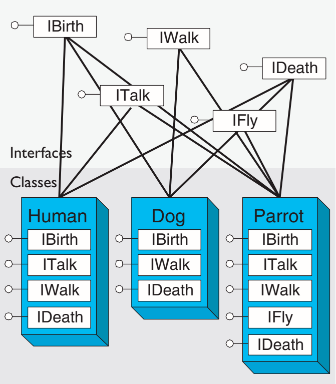


This is a simplified portion of the geodatabase object model showing type inheritance among abstract classes and coclasses and instantiation of classes.

COM classes provide the code associated with one or more interfaces, thus encapsulating the functionality entirely within the class. Two classes can both have the same interface, but they may implement them quite differently. By implementing these interfaces in this way, COM displays classic object-oriented polymorphic behavior. COM does not support the concept of multiple inheritance; however, this is not a shortcoming since individual classes can implement multiple interfaces. See the diagram to the left on polymorphic behavior.

Within ArcObjects are three types of classes that the developer must be aware of: abstract classes, coclasses, and classes. An abstract class cannot be created; it is solely a specification for instances of subclasses (through type inheritance). ArcObjects Dataset or Geometry classes are examples of abstract classes. An object of type Geometry cannot be created, but an object of type Polyline can. This Polyline object in turn implements the interfaces defined within the Geometry base class, hence any interfaces defined within object-based classes are accessible from the coclass.

A coclass is a publicly creatable class. In other words, it is possible for COM to create an instance of that class and give the resultant object to the client in order for the client to use the services defined by the interfaces of that class. A class cannot be publicly created, but objects of this class can be created by other objects within ArcObjects and given to clients to use.



This diagram shows how common behavior, expressed as interfaces, can be shared among multiple objects, animals in this example, to support polymorphism.

To the left is a diagram that illustrates the polymorphic behavior exhibited in COM classes when implementing interfaces. Notice that both the *Human* and *Parrot* classes implement the *ITalk* interface. The *ITalk* interface defines the methods and properties, such as *StartTalking, StopTalking,* or *Language*, but clearly the two classes implement these differently.

INSIDE INTERFACES

COM interfaces are how COM objects communicate with each other. When working with COM objects, the developer never works with the COM object directly but gains access to the object via one of its interfaces. COM interfaces are designed to be a grouping of logically related functions. The virtual functions are called by the client and implemented by the server; in this way an object's interfaces are the contract between the client and object. The client of an object is holding an interface pointer onto that object. This interface pointer is referred to as an opaque pointer since the client cannot gain any knowledge of the implementation details within an object or direct access to an object's state data. The client must communicate through the member functions of the interface. This allows COM to provide a binary standard through which all objects can effectively communicate.

Interfaces allow developers to model functionality abstractly. Visual C++ developers see interfaces as a collection of pure virtual functions, while Visual Basic developers see an interface as a collection of properties, functions, and sub routines.

The concept of the interface is fundamental in COM. The COM Specification (Microsoft, 1995) emphasizes these four points when discussing COM interfaces:

1. An interface is not a class. An interface cannot be instantiated by itself since it carries no implementation.
2. An interface is not an object. An interface is a related group of functions and is the binary standard through which clients and objects communicate.
3. Interfaces are strongly typed. Every interface has its own interface identifier, thereby eliminating the possibility of a collision between interfaces of the same human-readable name.
4. Interfaces are immutable. Interfaces are never versioned. Once defined and published, an interface cannot be changed.

An interface's permanence is not restricted to simply its method signatures, but it extends to its semantic behavior as well. For example, an interface defines two methods, A and B, with no restrictions placed on their use. It breaks the COM contract if at a subsequent release Method A requires that Method B be executed first. A change like this would force possible recompilations of clients.

Once an interface has been published, it is not possible to change the external signature of that interface. It is possible at any time to change the implementation details of an object that exposes an interface. This change may be a minor bug fix or a complete reworking of the underlying algorithm; the clients of the interface do not care since the interface appears the same to them. This means that when upgrades to the servers are deployed in the form of new DLLs and EXEs, existing clients need not be recompiled to make use of the new functionality. If the external signature of the interface is no longer sufficient, a new interface is created to expose the new functions. Old or deprecated interfaces are not removed from a class to ensure all existing client applications can continue to communicate with the newly upgraded server. Newer clients will have the choice of using the old or new interfaces.

THE *IUNKNOWN* INTERFACE

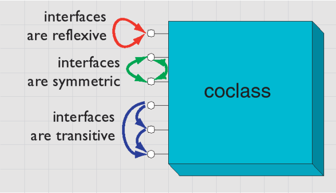
The name IUnknown *came from a 1988 internal Microsoft paper called* Object Architecture: Dealing with the Unknown *– or –* Type Safety in a Dynamically Extensible Class Library.

All COM interfaces derive from the *IUnknown* interface, and all COM objects must implement this interface. The *IUnknown* interface performs two tasks: it controls object lifetime and provides run-time type support. It is through the *IUnknown* interface that clients maintain a reference on an object while it is in use—leaving the actual lifetime management to the object itself.

Object lifetime is controlled with two methods, *AddRef* and *Release*, and an internal reference counter. Every object must have an implementation of *IUnknown* in order to control its own lifetime. Anytime an interface pointer is created or duplicated, the *AddRef* method is called, and when the client no longer requires this pointer, the corresponding *Release* method is called. When the reference count reaches zero, the object destroys itself.

Clients also use *IUnknown* to acquire other interfaces on an object. *QueryInterface* is the method that a client calls when another interface on the object is required. When a client calls *QueryInterface,* the object provides an interface and calls *AddRef*. In fact, it is the responsibility of any COM method that returns an interface to increment the reference count for the object on behalf of the caller. The client must call the *Release* method when the interface is no longer needed. The client calls *AddRef* explicitly only when an interface is duplicated.

When developing a COM object, the developer must obey the rules of *QueryInterface*. These rules dictate that interfaces for an object are symmetric, transitive, and reflexive and are always available for the lifetime of an object. For the client this means that, given a valid interface to an object, it is always valid to ask the object, via a call to *QueryInterface*, for any other interface on that object including itself. It is not possible to support an interface and later deny access to that interface, perhaps because of time or security constraints. Other mechanisms must be used to provide this level of functionality. Some classes support the concept of optional interfaces. Depending on the coclass, they may optionally implement an interface; this does not break this rule since the interface is either always available or always not available on the class.



The rules of QueryInterface *dictate that interfaces of an object are reflexive, symmetric, and transitive. It is always possible, holding a valid interface pointer on an object, to get any other interface on that object.*

When requested for a particular interface, the *QueryInterface* method can return an already assigned piece of memory for that requested interface, or it can allocate a new piece of memory and return that. The only case when the same piece of memory must be returned is when the *IUnknown* interface is requested. When comparing two interface pointers to see if they point to the same object, it is important that a simple comparison not be performed. To correctly compare two interface pointers to see if they are for the same object, they both must be queried for their *IUnknown*, and the comparison must be performed on the *IUnknown* pointers. In this way, the *IUnknown* interface is said to define a COM object's identity.

The method QueryInterface *is often referred to by the abbreviation* QI*.*

It's good practice in Visual Basic to call *Release* explicitly by assigning an interface equal to *Nothing* to release any resources it's holding. Even if you don't call *Release*, Visual Basic will automatically call it when you no longer need the object—that is, when it goes out of scope. With global variables, you must explicitly call *Release*. In Visual Basic, the system performs all these reference-counting operations for you, making the use of COM objects relatively straightforward.

Since IUnknown *is fundamental to all COM objects, in general there are no references to* IUnknown *in any of the ArcObjects documentation and class diagrams.*

In C++, however, you must increment and decrement the reference count to allow an object to correctly control its own lifetime. Likewise, the *QueryInterface* method must be called when asking for another interface. In C++ the use of smart pointers simplifies much of this. These smart pointers are class-based and hence have appropriate constructors, destructors, and overloaded operators to automate much of the reference counting and query interface operations.

Smart pointers are a class-based smart type and are covered in detail later in this chapter.

INTERFACE DEFINITION LANGUAGE

Microsoft Interface Definition Language (MIDL) is used to describe COM objects including their interfaces. This MIDL is an extension of the IDL defined by the Distributed Computing Environment (DCE), where it used to define

MIDL is commonly referred to simply as IDL.

The IDL defines the public interface that developers use when working with ArcObjects. When compiled, the IDL creates a type library.

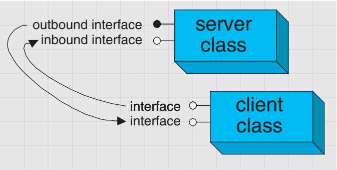
remote procedure calls between clients and servers. The MIDL extensions include most of the Object Definition Language (ODL) statements and attributes. ODL was used in the early days of OLE Automation for the creation of type libraries.

TYPE LIBRARY

A type library is best thought of as a binary version of an Interface Definition Language (IDL) file. It contains a binary description of all coclasses, interfaces, methods, and types contained within a server or servers.

There are several COM interfaces provided by Microsoft that work with type libraries. Two of these interfaces are *ITypeInfo* and *ITypeLib*. By utilizing these standard COM interfaces, various development tools and compilers can gain information about the coclasses and interfaces supported by a particular library.

In order to support the concept of a language-independent development set of components, all relevant data concerning the ArcObjects libraries is shipped inside type libraries. There are no header files, source files, or object files supplied or needed by external developers.



In the diagrams in this book and the ArcObjects object model diagrams, outbound interfaces are depicted with a solid circle on the interface jack.

INBOUND AND OUTBOUND INTERFACES

Interfaces can be either inbound or outbound. An inbound interface is the most common kind—the client makes calls to functions within the interface contained on an object. An outbound interface is one where the object makes calls to the client—a technique analogous to the traditional callback mechanism.

There are differences in the way these interfaces are implemented. The implementer of an inbound interface must implement all functions of the interface; failure to do so breaks the contract of COM. This is also true for outbound interfaces. If you use Visual Basic, you don’t have to implement all functions present on the interface since it provides stub methods for the methods you don’t implement. On the other hand, if you use C++ you must implement all the pure virtual functions to compile the class.

Connection points is a specific methodology for working with outbound COM interfaces. The connection point architecture defines how the communication between objects is set up and taken down. Connection points are not the most efficient way of initializing bidirectional object communication, but they are in common use because many development tools and environments support them.

Dispatch event interfaces

There are some objects with ArcObjects that support two outbound event interfaces that look similar to the methods they support. An example of two such interfaces are the *IDocumentEvents* and the *IDocumentEventsDisp*. The “Disp” suffix denotes a pure Dispatch interface. These dispatch interfaces are used by VBA when dealing with certain application events, such as loading documents. A VBA programmer works with the dispatch interfaces, while a developer using another development language uses the nonpure dispatch interface. Since these dispatch event interfaces are application specific, the details are discussed in the application chapters of the book, not the framework chapter.

Default interfaces

Every COM object has a default interface that is returned when the object is created if no other interface is specified. All the objects within the ESRI object libraries have *IUnknown* as their default interface, with a few exceptions.

The reason for making IUnknown *the default interface is because the VB object browser hides information for the default interface. The fact that it hides* IUnknown *is not important for VB developers.*

The default interface of the *Application* object for both ArcCatalog and ArcMap is the *IApplication* interface. These uses of non*IUnknown* default interfaces are a requirement of Visual Basic for Applications and are found on the ArcMap and ArcCatalog application-level objects.

This means that variables that hold interface pointers must be declared in a certain way. For more details, see the coding sections later in this chapter. When COM objects are created, any of the supported interfaces can be requested at creation time.

IDispatch interface

COM supports three types of binding:

Binding is the term given to the process of matching the location of a function given a pointer to an object.

1. Late. This is where type discovery is left until runtime. Method calls made by the client but not implemented by the object will fail at execution time.
2. ID. Method IDs are stored at compile time, but execution of the method is still performed through a higher-level function.
3. Custom vTable (early). Binding is performed at compile time. The client can then make method calls directly into the object.

The *IDispatch* interface supports late- and ID-binding languages. The *IDispatch* interface has methods that allow clients to ask the object what methods it supports.

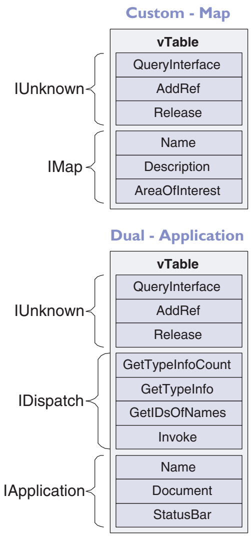
Binding type	In process DLL	Out of process DLL
Late binding	22,250	5,000
Custom vTable binding	825,000	20,000

This table shows the number of function calls that can be made per second on a typical Pentium® III machine.

Assuming the required method is supported, the client executes the method by calling the *IDispatch::Invoke* method. This method, in turn, calls the required method and returns the status and any parameters back to the client on completion of the method call.

Clearly, this is not the most efficient way to make calls on a COM object. Late binding requires a call to the object to retrieve the list of method IDs; the client must then construct the call to the *Invoke* method and call it. The *Invoke* method must then unpack the method parameters and call the function.

All these steps add significant overhead to the time it takes to execute a method. In addition, every object must have an implementation for *IDispatch*, which makes all objects larger and adds to their development time.



These diagrams summarize the custom and IDispatch *interfaces for two classes in ArcObjects.The layout of the vTable displays the differences. It also illustrates the importance of implementing all methods—if one method is missing, the vTable will have the wrong layout, and hence the wrong function pointer would be returned to the client, resulting in a system crash.*

Interfaces that directly inherit from an interface other than IUnknown *cannot be implemented in VB.*

ID binding offers a slight improvement over late binding in that the method IDs are cached at compile time, which means the initial call to retrieve the IDs is not required. However, there is still significant call overhead because the *IDispatch::Invoke* method is still called in order to execute the required method on the object.

Early binding, often referred to as custom vTable binding, does not use the *IDispatch* interface. Instead, a type library provides the required information at compile time to allow the client to know the layout of the server object. At runtime, the client makes method calls directly into the object. This is the fastest method of calling object methods and also has the benefit of compile-time type checking.

Objects that support both *IDispatch* and custom vTable are referred to as dual interface objects. The object classes within the ESRI object libraries do not implement the *IDispatch* interface; this means that these object libraries cannot be used with late-binding scripting languages such as JavaScript™ or VBScript since these languages require that all COM servers accessed support the *IDispatch* interface.

Careful examination of the ArcGIS class diagrams indicates that the *Application* objects support *IDispatch* because there is a requirement in VBA for the *IDispatch* interface.

All ActiveX controls support *IDispatch*. This means it is possible to use the various ActiveX controls shipped with ArcObjects to access functionality from within scripting environments.

INTERFACE INHERITANCE

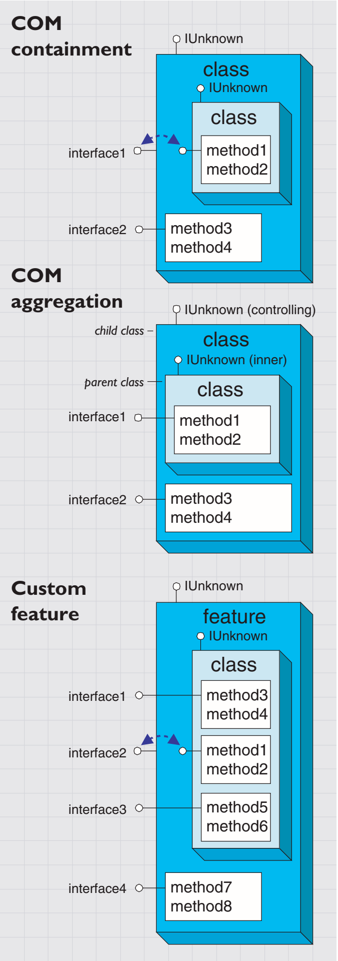
An interface consists of a group of methods and properties. If one interface inherits from another, then all of the methods and properties in the parent are directly available in the inheriting object.

The underlying principle here is interface inheritance, rather than the implementation inheritance you may have seen in languages such as SmallTalk and C++. In implementation inheritance, an object inherits actual code from its parent; in interface inheritance, it's the definitions of the methods of the object that are passed on. The coclass that implements the interfaces must provide the implementation for all inherited interfaces.

Implementation inheritance is not supported in a heterogeneous development environment because of the need to access source and header files. For reuse of code, COM uses the principles of aggregation and containment. Both of these are binary-reuse techniques.

AGGREGATION AND CONTAINMENT

For a third-party developer to make use of existing objects, using either containment or aggregation, the only requirement is that the server housing the contained or aggregated object is installed on both the developer and target release machines. Not all development languages support aggregation.



The simplest form of binary reuse is containment. Containment allows modification of the original object's method behavior but not the method's signature. With containment, the contained object (inner) has no knowledge that it is contained within another object (outer). The outer object must implement all the interfaces supported by the inner. When requests are made on these interfaces, the outer object simply delegates them to the inner. To support new functionality, the outer object can either implement one of the interfaces without passing the calls on or implement an entirely new interface in addition to those interfaces from the inner object.

COM aggregation involves an outer object that controls which interfaces it chooses to expose from an inner object. Aggregation does not allow modification of the original object's method behavior. The inner object is aware that it is being aggregated into another object and forwards any *QueryInterface* calls to the outer (controlling) object so that the object as a whole obeys the laws of COM.

To the clients of an object using aggregation, there is no way to distinguish which interfaces the outer object implements and which interfaces the inner object implements.

Custom features make use of both containment and aggregation. The developer aggregates the interfaces where no customizations are required and contains those that are to be customized. The individual methods on the contained interfaces can then either be implemented in the customized class, thus providing custom functionality, or the method call can be passed to the appropriate method on the contained interface.

Aggregation is important in this case since there are some hidden interfaces defined on a feature that cannot be contained. For more information on custom features, see Volume 2, Chapter 8, 'Accessing the geodatabase'.

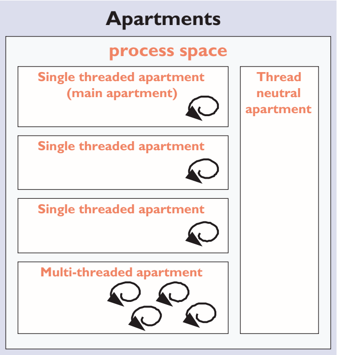
Visual Basic 6 does not support aggregation, so it can't be used to create custom features.

THREADS, APARTMENTS, AND MARSHALLING

Although an understanding of apartments and threading is not essential in the use of ArcObjects, basic knowledge will help you understand some of the implications with certain development environments highlighted later in this chapter.

A thread is a process flow through an application. There are potentially many threads within Windows applications. An apartment is a group of threads that work with contexts within a process. With COM+, a context belongs to one apartment. There are potentially many types of context; security is an example of a type of context. Before successfully communicating with each other, objects must have compatible contexts.

COM supports two types of apartments: single-threaded apartment (STA) and multithreaded apartment (MTA). COM+ supports the additional thread-neutral apartment (TNA). A process can have any number of STAs; each process creates one STA called the main apartment. Threads that are created as apartment threaded are placed in an STA. All user-interface code is placed in an STA to prevent deadlock situations. A process can only have one MTA. A thread that is started as multithreaded is placed in the MTA. The TNA has no threads permanently associated with it; rather, threads enter and leave the apartment when appropriate.


Apartments
process space
Single threaded apartment (main apartment)
Single threaded apartment
Single threaded apartment
Multi-threaded apartment
Thread neutral apartment

Think of the SCM (pronounced scum) as the COM runtime environment. The SCM interacts with objects, servers, and the operating system and provides the transparency between clients and the objects that they work with.

In-process objects have an entry in the registry, the ThreadingModel, that informs the COM Service Control Manager (SCM) into which apartment to place the object. If the object's requested apartment is compatible with the creator's apartment, the object is placed in that apartment; otherwise, the SCM will find or create the appropriate apartment. If no threading model is defined, the object will be placed in the main apartment of the process. The ThreadingModel registry entry can have the following values:

1. *Apartment*. Object must be executed within the STA. Normally used by UI objects.
2. *Free*. Object must be executed within the MTA. Objects creating threads are normally placed in the MTA.
3. *Both*. Object is compatible with all apartment types. The object will be created in the same apartment as the creator.
4. *Neutral*. Objects must execute in the TNA. Used by objects to ensure there is no thread switch when called from other apartments. This is only available under COM+.

Marshalling enables a client to make interface-function calls to objects in other apartments transparently. Marshalling can occur between COM apartments on different machines, between COM apartments in different process spaces, and between COM apartments in the same process space (STA to MTA, for example). COM provides a standard marshaller that handles function calls that use automation-compliant data types (see table below). Nonautomation data types can be handled by the standard marshaller as long as proxy stub code is generated; otherwise, custom-marshalling code is required.

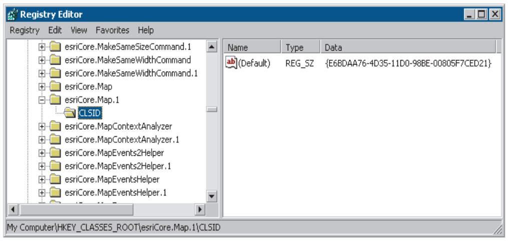
Type	Description
Boolean	Data item that can have the value True or False
unsigned char	8-bit unsigned data item
double	64-bit IEEE floating-point number
float	32-bit IEEE floating-point number
int	Signed integer, whose size is system dependent
long	32-bit signed integer
short	16-bit signed integer
BSTR	Length-prefixed string
CURRENCY	8-byte, fixed-point number
DATE	64-bit, floating-point fractional number of days since Dec 30, 1899
SCODE	For 16-bit systems - Built-in error that corresponds to VT_ERROR
Typedef enum myenum	Signed integer, whose size is system dependent
Interface IDispatch *	Pointer to the IDispatch interface
Interface IUnknown *	Pointer to an interface that does not derive from IDispatch
dispinterface Typename *	Pointer to an interface derived from IDispatch
Coclass Typename *	Pointer to a coclass name (VT_UNKNOWN)
[oleautomation] interface Typename *	Pointer to an interface that derives from IDispatch
SAFEARRAY(TypeName)	TypeName is any of the above types. Array of these types
TypeName*	TypeName is any of the above types. Pointer to a type
Decimal	96-bit unsigned binary integer scaled by a variable power of 10. A decimal data type that provides a size and scale for a number (as in coordinates)

COMPONENT CATEGORY

Component categories are used by client applications to find all COM classes of a particular type that are installed on the system efficiently. For example, a client application may support a data export function in which you can specify the output format—a component category could be used to find all the data export classes for the various formats. If component categories are not used, the application has to instantiate each object and interrogate it to see if it supports the required functionality, which is not a practical approach. Component categories support the extensibility of COM by allowing the developer of the client application to create and work with classes that belong to a particular category. If at a later date a new class is added to the category, the client application need not be changed to take advantage of the new class; it will automatically pick up the new class the next time the category is read.

COM AND THE REGISTRY

COM makes use of the Windows® system registry to store information about the various parts that compose a COM system. The classes, interfaces, DLLs, EXEs, type libraries, and so forth, are all given unique identifiers (GUIDs) that the SCM uses when referencing these components. To see an example of this, run regedit, then open HKEY_CLASSES_ROOT. This opens a list of all the classes registered on the system.



```
esriCore.MakeSameSizeCommand.1
esriCore.MakeSameWidthCommand
esriCore.MakeSameWidthCommand.1
esriCore.Map
esriCore.Map.1
    CLSID
esriCore.MapContextAnalyzer
esriCore.MapContextAnalyzer.1
esriCore.MapEvents2Helper
esriCore.MapEvents2Helper.1
esriCore.MapEventsHelper
esriCore.MapEventsHelper.1
```

Name	Type	Data
(Default)	REG_SZ	{E6BDAA76-4D35-11D0-98BE-00805F7CED21}

My Computer\HKEY_CLASSES_ROOT\esriCore.Map.1\CLSID

ESRI keys in the Windows system registry

The function DllGetClassObject *is the function that makes a DLL a COM DLL. Other functions, such as* DllRegisterServer *and* DllUnregisterServer*, are nice to have but not essential for a DLL to function as a COM DLL.*

COM makes use of the registry for a number of housekeeping tasks, but the most important and most easily understood is the use of the registry when instantiating COM objects into memory. In the simplest case, that of an in-process server, the steps are as follows:

1. Client requests the services of a COM object.
2. SCM looks for the requested objects registry entry by searching on the class ID (a GUID).
3. DLL is located and loaded into memory. The SCM calls a function within the DLL called *DllGetClassObject*, passing the desired class as the first argument.
4. The class object normally implements the interface *IClassFactory*. The SCM calls the method *CreateInstance* on this interface to instantiate the appropriate object into memory.
5. Finally, the SCM asks the newly created object for the interface that the client requested and passes that interface back to the client. At this stage, the SCM drops out of the equation, and the client and object communicate directly.

From the above sequence of steps, it is easy to imagine how changes in the object's packaging (DLL versus EXE) make little difference to the client of the object. COM handles these differences.

AUTOMATION

Automation is the technology used by individual objects or entire applications to provide access to their encapsulated functionality via a late-bound language. Commonly, automation is thought of as writing macros, where these macros can access many applications in order for a task to be done. ArcObjects, as already stated, does not support the *IDispatch* interface; hence, it cannot be used alone by an automation controller.

It is possible to instantiate an instance of ArcMap by cocreating the document object and then making calls into ArcMap via the document object or one of its connected objects. There are, however, problems with this approach since the automation controller instance and the ArcMap instance are running in separate processes. Many of the objects contained within ArcObjects are process dependent, and therefore simple Automation will not work. Using other techniques outlined in Chapter 4, 'Composing maps', it is possible to interact with ArcMap in a way analogous to OLE Automation.

Any language that supports COM can be used to develop with ArcObjects. The guidelines and advice in this section are useful for any programmer working with ArcObjects. The subsequent sections of this chapter deal specifically with Visual Basic, Visual Basic for Applications, and Visual C++. The main reason for this is that the majority of the samples accompanying the software are written in these environments, and these development tools are well suited for the creation of COM software components.

CODING STANDARDS

Each of the language-specific sections begins with a section on coding standards for that language. These standards are used internally at ESRI and are followed by the samples that ship with the software.

For simplicity, some samples will not follow the coding standards. As an example, it is recommended that when coding in Visual Basic, all types defined within the ESRI object library are prefixed with the library name esriCore*. This is only done in samples where a name clash will occur. Omitting this text makes the code easier to understand for developers new to ArcObjects.*

To understand why standards and guidelines are important, consider that in any large software development project, there are many backgrounds represented by the team members. Each programmer has personal opinions concerning how code should look and be built. If each programmer engineers code differently, it becomes increasingly difficult to share work and ideas. On a successful team, the developers adapt their coding styles to the tone set by the group. Often, this means adapting one's code to match the style of existing code in the system.

Initially, this may seem burdensome, but adopting a uniform programming style and set of techniques invariably increases software quality. When all the code in a project conforms to a standard set of styles and conventions, less time is wasted learning the particular syntactic quirks of individual programmers, and more time can be spent reviewing, debugging, and extending the code. Even at a social level, uniform style encourages team-oriented, rather than individualist, outlooks—leading to greater team unity, productivity and, ultimately, better software.

GENERAL CODING TIPS AND RESOURCES

This section on general coding tips will benefit all developers working with ArcObjects no matter what language they are using.

Class diagrams

Getting help with the object model is fundamental to successfully working with ArcObjects. Chapter 1, 'Introducing ArcObjects', started the process of introducing the class diagrams and showing many of the common routes through the objects. The class diagrams are most useful if viewed in the early learning process in printed form. This allows developers to appreciate the overall structure of the object model implemented by ArcObjects. When you are comfortable with the overall structure, the PDF files included with the software distribution can be more effective to work with. The PDF files are searchable; you can use the Search dialog box in Acrobat Reader to find classes and interfaces quickly.

Object browsers

In addition to the class diagram PDF files, the type library information can be viewed using a number of object browsers. Visual Basic has a built-in Object Browser; OLEView (a free utility from Microsoft) also displays type library information. The best object viewer to use is the ESRI object viewer. This object viewer can be used to view type information for any type library but defaults to the ESRI Object Library. Information on the classes and interfaces can be displayed in Visual Basic, Visual C++, or object diagram format.

The object browsers can view coclasses and classes but cannot be used to view abstract classes. Abstract classes are only viewable on the object diagrams, where their use is solely to simplify the models.

Component help

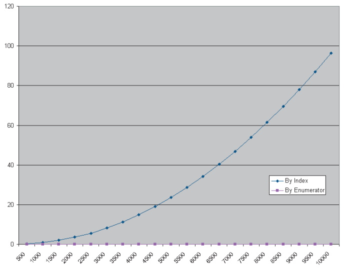
All interfaces and coclasses are documented in the component help file. This is a compiled HTML file that can be viewed by itself or when using an integrated developer environment (IDE). In Visual C++ and Visual Basic, if the cursor is over an ESRI type when the F1 key is pressed, the appropriate page in the ArcObjects Class Help in the ArcObjects Developer Help system is displayed in the compiled HTML viewer. Ultimately, this will be the help most commonly accessed when you get to know the object models better.

Code wizards

There are a number of Code Generation Wizards available to help with the creation of boiler plate code, both in Visual C++ and Visual Basic. While these wizards are useful in removing the tediousness in common tasks, they do not excuse you as the developer from understanding the underlying principles of the generated code. The main objective should be to read the accompanying documentation and understand the limitations of these tools.

Indexing of collections

All collection-like objects in ArcObjects are zero-based for their indexing. This is not the case with all development environments; Visual Basic has both zero- and one-based collections. As a general rule, if the collection base is not known, assume that the collection base is zero. This ensures that a runtime error will be raised when the collection is first accessed (assuming the access of the collection does not start at zero). Assuming a base of one means the first element of a zero-based collection would be missed and an error would only be raised if the end of the collection were reached when the code is executed.



This graph shows the performance benefits of accessing a collection using an enumerator opposed to the elements index. As expected, the graph shows a classic power trend line (y=cx^b). The client (VB) and Server (VC++) code used to generate these metrics are included in the book samples.

Accessing collection elements

When accessing elements of a collection sequentially, it is best to use an enumerator interface. This provides the fastest method of walking through the collection. The reason for this is that each time an element is requested by index, internally an enumerator is used to locate the element. Hence, if the collection is looped over getting each element in turn, the time taken increases by power ($y=cx^b$).

Enumerator use

When requesting an enumerator interface from an object, the client has no idea how the object has implemented this interface. The object may create a new enumerator, or it may decide for efficiency to return a previously created enumerator. If a previous enumerator is passed to the client, the position of the element pointer will be at the last accessed element. To ensure that the enumerator is at the start of the collection, the client should reset the enumerator before use.

Error handling

Exception handling is language specific and, since COM is language neutral, exceptions are not supported.

All methods of interfaces, in other words, methods callable from other objects, should handle internal errors and signify success or failure via an appropriate *HRESULT*. COM does not support passing exceptions out of interface method calls. COM supports the notion of a COM exception. A COM exception utilizes the COM error object by populating it with relevant information and then returning an appropriate *HRESULT* to signify failure. Clients, on receiving the *HRESULT*, can then interrogate the COM *Error* object for contextual information about the error. Languages such as Visual Basic implement their own form of exception handling. For more information, see the section on the Visual Basic Virtual Machine.

Notification interfaces

There are a number of interfaces in ArcObjects that have no methods. These are known as notification interfaces. Their purpose is to inform the application framework that the class that implements them supports a particular set of functionality. For instance, the Application Framework uses these interfaces to determine if a menu object is a root-level menu (*IRootLevelMenu*) or a context menu (*IShortcutMenu*).

Clientside storage

Some ArcObjects methods expect interface pointers to point to valid objects prior to making the method call. This is known as client storage since the client allocates the memory needed for the object before the method call. Let's say you have a polygon and you want to get its bounding box. To do this, use the *QueryEnvelope* method on *IPolygon*. If you write the following code:

```
Dim pEnv As IEnvelope
pPolygon.QueryEnvelope pEnv
```

you'll get an error because the *QueryEnvelope* method expects you (the client) to create the *Envelope*. The method will modify the envelope you pass in and return the changed one back to you. The correct code is shown below.

```
Dim pEnv As IEnvelope
Set pEnv = New Envelope
```

```
pPolygon.QueryEnvelope pEnv
```

How do you know when to create and when not to create? In general, all methods that begin with “Query”, such as *QueryEnvelope*, expect you to create the object. If the method name is *GetEnvelope*, then an object will be created for you. The reason for this clientside storage is performance. Where it is anticipated that the method on an object will be called in a tight loop, the parameters need only be created once and simply populated. This is faster than creating new objects inside the method each time.

Property by value and by reference

Occasionally, you will see a property that can be set by value or by reference, meaning that it has both a *put_XXX* and a *putref_XXX* method. On first appearance this may seem odd—why does a property need to support both? A Visual C++ developer sees this as simply giving the client the opportunity to pass ownership of a resource over to the server (using the *putref_XXX* method). A Visual Basic developer will see this as quite different; indeed, it is likely because of the Visual Basic developer that both *By Reference* and *By Value* are supported on the property.

To illustrate this, assume there are two text boxes on a form, Text1 and Text2. With a *propput*, it is possible to do the following in Visual Basic:

```
Text1.text = Text2.text
```

It is also possible to write this:

```
Text1.text = Text2
```

or this:

```
Text1 = Text2
```

DISPIDs *are unique IDs given to properties and methods in order for the* IDispatch *interface to efficiently call the appropriate method using the* Invoke *method.*

All these cases make use of the *propput* method to assign the text string of text box Text2 to the text string of text box Text1. The second and third cases work because since no specific property is stated, Visual Basic looks for the property with a *DISPID* of 0.

This all makes sense assuming that it is the text string property of the text box that is manipulated. What happens if the actual object referenced by the variable Text2 is to be assigned to the variable Text1? If there was only a *propput* method it would not be possible, hence the need for a *propputref* method. With the *propputref* method, the following code will achieve the setting of the object reference.

Notice the use of the “Set”.

```
Set Text1 = Text2
```

Initializing Outbound interfaces

When initializing an Outbound interface, it is important to only initialize the variable if the variable does not already listen to events from the server object. Failure to follow this rule will result in an infinite loop.

As an example, assume there is a variable *ViewEvents* that has been dimensioned as:

```
Private WithEvents ViewEvents As Map
```

To correctly sink this event handler, you can write code within the *OnClick* event of a UI button control, like this:

```
Private Sub UIButtonControl1_Click()
  Dim pMxDoc As IMxDocument
  Set pMxDoc = ThisDocument

  ' Check to see that the map is different than what is currently connected
  If (Not ViewEvents Is pMxDoc.FocusMap) Then
    ' Sink the event since listener has not been initialised with this map
    Set ViewEvents = pMxDoc.FocusMap
  End If
End Sub
```

Notice in the above code the use of the *Is* keyword to check for object identity.

DATABASE CONSIDERATIONS

When programming against the database, there are a number of rules that must be followed to ensure that the code will be optimal. These rules are detailed below.

If you are going to edit data programmatically, that is, not use the editing tools in ArcMap, you need to follow these rules in order to ensure that custom object behavior (such as network topology maintenance or triggering of custom-feature-defined methods) is correctly invoked in response to the changes your application makes to the database. You must also follow these rules in order to ensure that your changes are made within the multiuser editing (long transaction) framework.

Edit sessions

Make all changes to the geodatabase within an edit session, which is bracketed between *StartEditing* and *StopEditing* method calls on the *IEditWorkspace* interface found on the*Workspace* object.

This behavior is required for any multiuser update of the database. Starting an edit session gives the application a state of the database that is guaranteed not to change, except for changes made by the editing application.

In addition, starting an edit session turns on behavior in the geodatabase such that a query against the database is guaranteed to return a reference to an existing object in memory if the object was previously retrieved and is still in use.

This behavior is required for correct application behavior when navigating between a cluster of related objects while making modifications to objects. In other words, when you are not within an edit session, the database can create a new instance of a COM object each time the application requests a particular object from the database.

Edit operations

Group your changes into edit operations, which are bracketed between the *StartEditOperation* and *StopEditOperation* method calls on the *IEditWorkspace* interface.

You may make all your changes within a single edit operation if so required. Edit operations can be undone and redone. If you are working with data stored in ArcSDE, creating at least one edit operation is a requirement. There is no additional overhead to creating an edit operation.

Recycling and nonrecycling cursors

Use nonrecycling search cursors to select objects or fetch objects that are to be updated. Recycling cursors should only be used for read-only operations, such as drawing and querying features.

Nonrecycling cursors within an edit session create new objects only if the object to be returned does not already exist in memory.

Fetching properties using query filters

Always fetch all properties of the object; query filters should always use "*". For efficient database access, the number of properties of an object retrieved from the database can be specified. As an example, drawing a feature requires only the *OID* and the *Shape* of the feature, hence the simpler renderers only retrieve these two columns from the database. This optimization speeds up drawing but is not suitable when editing features.

If all properties are not fetched, then object-specific code that is triggered may not find the properties that the method requires. For example, a custom feature developer might write code to update attributes A and B whenever the geometry of a feature changes. If only the geometry was retrieved, then attributes A and B would be found to be missing within the *OnChanged* method. This would cause the *OnChanged* method to return an error, which would cause the *Store* to return an error and the edit operation to fail.

Marking changed objects

After changing an object, mark the object as changed (and guarantee that it is updated in the database) by calling *Store* on the object. Delete an object by calling the *Delete* method on the object. Set versions of these calls also exist and should be used if the operation is being performed on a set of objects to ensure optimal performance.

Calling these methods guarantees that all necessary polymorphic object behavior built into the geodatabase is executed (for example, updating of network topology or updating of specific columns in response to changes in other columns in ESRI-supplied objects). It also guarantees that developer-supplied behavior is correctly triggered.

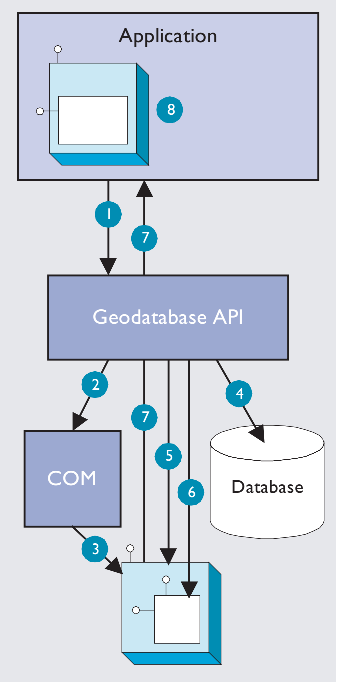
Update and insert cursors

Never use update cursors or insert cursors to update or insert objects into object and feature classes in an already loaded geodatabase that has active behavior.

Update and insert cursors are bulk cursor APIs for use during initial database loading. If used on an object or feature class with active behavior, they will bypass all object-specific behavior associated with object creation (such as topology creation) and with attribute or geometry updating (such as automatic recalculation of other dependent columns).

Shape and ShapeCopy geometry property

Make use of a *Feature* object's *Shape* and *ShapeCopy* properties to optimally retrieve the geometry of a feature. To better understand how these properties relate to a feature's geometry, refer to the diagram to the left to see how features coming from a data source are instantiated into memory for use within an application.



The diagram above clearly shows that the Feature, *which is a COM object, has another COM object for its geometry. The* Shape *property of the feature simply passes the* IGeometry *interface pointer to this geometry object out to the caller that requested the shape. This means that if more than one client requested the shape, all clients point to the same geometry object. Hence, this geometry object must be treated as read-only. No changes should be performed on the geometry returned from this property, even if the changes are temporary. Anytime a change is to be made to a feature's shape, the change must be made on the geometry returned by the* ShapeCopy *property, and the updated geometry should subsequently be assigned to the* Shape *property.*

Features are instantiated from the data source using the following sequence:

1. The application requests a *Feature* object from a data source by calling the appropriate geodatabase API method calls.
2. The geodatabase makes a request to COM to create a vanilla COM object of the desired COM class (normally this class is *esriCore.Feature*).
3. COM creates the *Feature* COM object.
4. The geodatabase gets attribute and geometry data from a data source.
5. The vanilla *Feature* object is populated with appropriate attributes.
6. The *Geometry* COM object is created and a reference is set in the *Feature* object.
7. The *Feature* object is passed to the application.
8. The *Feature* object exists in the application until it is no longer required.

USING A TYPE LIBRARY

Since objects from ArcObjects do not implement *IDispatch,* it is essential to make use of a type library in order for the compiler to early-bind to the correct data types. This applies to all development environments, although for both Visual Basic and Visual C++ there are wizards that help you set this reference.

The type library required by the core ArcObjects is located in the ArcGIS install\bin folder and is called esriCore.olb. Many different files can contain type library information, including EXEs, DLLs, OCXs, and OLBs.

COM DATA TYPES

COM objects talk via their interfaces, and hence all data types used must be supported by IDL. IDL supports a large number of data types; however, not all languages that support COM support these data types. Because of this, ArcObjects does not make use of all the data types available in IDL but limits the majority of interfaces to the data type supported by Visual Basic. The table below shows the data types supported by IDL and their corresponding types in a variety of languages.

Language	IDL	Microsoft C++	Visual Basic	Microsoft Java
Base types	boolean	unsigned char	unsupported	char
	byte	unsigned char	unsupported	char
	small	char	unsupported	char
	short	short	Integer	short
	long	long	Long	int
	hyper	__int64	unsupported	long
	float	float	Single	float
	double	double	Double	double
	char	unsigned char	unsupported	char
	wchar_t	wchar_t	Integer	short
	enum	enum	Enum	int
	Interface Pointer	Interface Pointer	Interface Ref.	Interface Ref.
Extended types	VARIANT	VARIANT	Variant	ms.com.Variant
	BSTR	BSTR	String	java.lang.String
	VARIANT_BOOL	short (-1/0)	Boolean	[true/false]

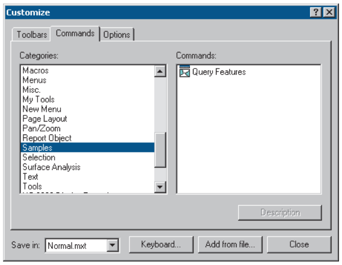
Note the extended data types at the bottom of the table: *VARIANT, BSTR,* and *VARIANT_BOOL*. While it is possible to pass strings using data types like *char* and *wchar_t*, these are not supported in languages such as Visual Basic. Visual Basic uses *BSTRs* as its text data type. A *BSTR* is a length-prefixed wide character array, where the pointer to the array points to the text contained within it and not the length prefix. Visual C++ maps *VARIANT_BOOL* values onto 0 and –1 for the *False* and *True* values, respectively. This is different from the normal mapping of 0 and 1. Hence, when writing C++ code, be sure to use the correct macros—*VARIANT_FALSE* and *VARIANT_TRUE*—not *False* and *True*.

USING COMPONENT CATEGORIES

Component categories are used extensively in ArcObjects so that developers can extend the system without requiring any changes to the ArcObjects code that will work with the new functionality.

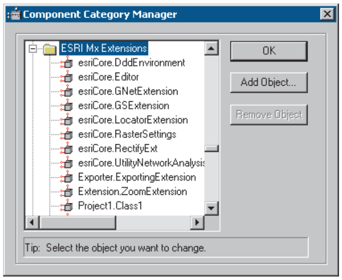
ArcObjects uses component categories in two ways. The first requires classes to be registered in the respective component category at all times, for example, ESRI Mx Extensions. Classes, if present in that component category, have an object that implements *IExtension* interface and are instantiated when the ArcMap application is started. If the class is removed from the component category, the extension will not load, even if the map document (MXD file) is referencing that extension.

The second use is when the application framework uses the component category to locate classes and display them to a user to allow some user customization to occur. Unlike the first method, the application remembers (inside its map document) the objects being used and will subsequently load them from the map document. An example of this is the commands used within ArcMap. ArcMap reads the ESRI Mx Commands category when the Customization dialog box is displayed to the user. This is the only time the category is read. Once the user selects a command and adds it to a toolbar, the map document is used to determine what commands should be instantiated. Later, when this chapter covers debugging Visual Basic code, you'll see the importance of this.



The Customize dialog box in ArcMap and ArcCatalog

Now that you've seen two uses of component categories, you will see how to get your classes registered into the correct component category. Development environments have various levels of support for component categories; ESRI provides two ways of adding classes to a component category. The first can only be used for Commands and command bars that are added to either ArcMap or ArcCatalog. Using the Add From File button on the Customize dialog box (shown to the left), it is possible to select a server. All classes in that server are then added to either the ESRI Gx Commands or the ESRI Mx Commands, depending on the application being customized. While this utility is useful, it is limited since it adds all the classes found in the server. It is not possible to remove classes, and it only supports two of the many component categories implemented within ArcObjects.



The Component Category Manager

Distributed with ArcGIS applications is a utility application called the Component Category Manager, shown to the left. This small application allows you to add and remove classes from any of the component categories on your system, not just ArcObjects ones. Expanding a category displays a list of classes in the category. You can then use the Add Object button to display a checklist of all the classes found in the server. You check the required classes, and these checked classes are then added to the category.

Using these ESRI tools is not the only method to interact with component categories. During the installation of the server on the target user's machine, it is possible to add the relevant information to the Registry using a registry script. Below is one such script. The first line tells windows for which version of regedit this script is intended. The last line, starting with "[HKEY_LOCAL_", executes the registry command—all the other lines are comments in the file.

```
REGEDIT4
; This Registry Script enters coclasses into their appropriate Component Category
; Use this script during installation of the components

; Coclass: Exporter.ExportingExtension
; CLSID: {E233797D-020B-4AD4-935C-F659EB237065}
; Component Category: ESRI Mx Extensions
[HKEY_LOCAL_MACHINE\SOFTWARE\Classes\CLSID\{E233797D-020B-4AD4-935C-
F659EB237065}\Implemented Categories\{B56A7C45-83D4-11D2-A2E9-080009B6F22B}]
```

The last line in the code above is one continuous line in the script.

The last method is for the self-registration code off the server to add the relevant classes within the server to the appropriate categories. Not all development environments allow this to be set up. Visual Basic has no support for component categories, although there is an add-in that adds this functionality. See the sections on Visual Basic Developer Add-ins and ATL later in this chapter.

WHICH DEVELOPMENT ENVIRONMENT

You have already learned that developing with ArcObjects does not restrict you to a proprietary development environment and that any compiler capable of working with COM can be used. This section highlights some of the considerations when choosing a development environment. The choice is not restricted to which compiler; there are broader issues including which application framework to use—ArcMap, ArcCatalog, or your own. These broader issues are not within the scope of this book.

The choice of development environment is not a simple task and is influenced by many factors. Many developers will be selecting either Visual Basic for Applications, Visual Basic, or Visual C++, while others will use Delphi, C++ Builder, and so on. The primary driving force is the experience and skill level of the developers that will write the code. Other issues worth considering are the requirements, performance, development process, and security of code.

The performance issues of choosing the development language are not as significant as you might think. Since the majority of the work will be performed within the ArcObjects objects, which are all written in C++, the developer's customization language is for the most part used to control the program flow and user interface interaction. Since Visual Basic uses the same optimized back-end compiler technology that Visual C++ uses, the generated machine code performs at a comparable level. Tests have shown that to perform typical actions on features contained within a database (drawing, querying, editing, and so on), Visual Basic is approximately 2 percent slower than optimized Visual C++ code, and Visual Basic for Applications is 2 percent slower than Visual Basic.

Visual Basic is a very productive tool, especially for user interface development, but there are limitations to what can be done in Visual Basic. In the majority of cases, these limitations will not affect developers customizing and extending ArcObjects, with the exception of Custom Features. Many of the limitations have to do with the development environment itself. Debugging Visual Basic code is not as flexible as Visual C++. Using Visual Basic in a large development environment with many developers is not as productive as Visual C++ since partial compilations of projects are not supported. If one file is changed in a Visual Basic project, all the files must be recompiled. Since Visual Basic hides much of the interaction with COM away inside the Visual Basic Virtual Machine, low-level COM plumbing code cannot be written in Visual Basic.

Since Visual Basic for Applications does not support the creation of DLLs, all the source code must be shipped inside a document. It is possible to lock the source code projects with a document to stop third parties from seeing the customization code; however, this locking of the project also prevents third parties from using VBA to customize the application further. VBA is an ideal prototyping environment that provides the means for deploying lightweight customizations but, for other more involved customizations, Visual Basic should be considered. VBA also suffers from having its own form designer, meaning the UI source cannot be shared between VBA and Visual Basic. In addition, the controls used by VBA do not expose their window handles, which further limits their use.

The tables below summarize suggested naming standards for the various elements of your Visual Basic projects.

Module Type	Prefix
Form	frm
Class	cls
Standard	bas
Project	prj

Name your modules according to the overall function they provide; do not leave any with default names (such as "Form1", "Class1", or "Module1"). Additionally, prefix the names of forms, classes, and standard modules with three letters that denote the type of module, as shown in the table above.

Control Type	Prefix
Check box	chk
Combo box	cbo
Command button	cmd
Common dialog	cdl
Form	frm
Frame	fra
Graph	gph
Grid	grd
Image	img
Image list	iml
Label	lbl
List box	lst
List view	lvw
Map control	map
Masked edit	msk
Menu	mnu
OLE client	ole
Option button	opt
Picture box	pic
Progress bar	pbr
Rich text box	rtf
Scroll bar	srl
Slider	sld
Status bar	sbr
Tab strip	tab
Text box	txt
Timer	tmr
Tool bar	tbr
Tree view	tvw

As with modules, name your controls according to the function they provide; do not leave them with default names since this leads to decreased maintainability. Use the three-letter prefixes above to identify the type of the control.

This section is intended for both VB and VBA developers. Differences in the development environments are clearly marked throughout the text.

USER-INTERFACE STANDARDS

Consider preloading forms to increase the responsiveness of your application. Be careful not to preload too many (preloading three or four forms is fine).

Use resource files (.res) instead of external files when working with bitmap files, icons, and related files.

Make use of constructors and destructors to set variable references that are only set when the class is loaded. These are the VB functions: *Class_Initialize()* and *Class_Terminate()*, or *Form_Load()* and *Form_Unload()*. Set all variables to *Nothing* when the object is destroyed.

Make sure the tab order is set correctly for the form. Do not add scroll bars to the tabbing sequence; it is too confusing.

Add access keys to those labels that identify controls of special importance on the form (use the *TabIndex* property).

Use system colors where possible instead of hard-coded colors.

Variable declaration

- Always use *Option Explicit* (or turn on Require Variable Declaration in the VB Options dialog box). This forces all variables to be declared before use and thereby prevents careless mistakes.
- Use *Public* and *Private* to declare variables at module scope and *Dim* in local scope. (*Dim* and *Private* mean the same at *Module* scope; however, using *Private* is more informative.) Do not use *Global* anymore; it is available only for backward compatibility with VB 3.0 and earlier.
- Always provide an explicit type for variables, arguments, and functions. Otherwise, they default to *Variant*, which is less efficient.
- Only declare one variable per line unless the type is specified for each variable.

This line causes *count* to be declared as a *Variant*, which is likely to be unintended.

```
Dim count, max As Long
```

This line declares both *count* and *max* as *Long*, the intended type.

```
Dim count As Long, max As Long
```

These lines also declare *count* and *max* as *Long* and are more readable.

```
Dim count As Long
Dim max As Long
```

Parentheses

Use parentheses to make operator precedence and logic comparison statements easier to read.

Use the following notation for naming variables and constants:

[<libraryName.>][<scope_>]<type><name>

<name> describes how the variable is used or what it contains.The <scope> and <type> portions should always be lowercase, and the <name> should use mixed case.

Library Name	Library
esriCore	ESRI Object Library
stdole	Standard OLE COM Library
<empty>	Simple variable datatype

<libraryName>

Prefix	Variable scope
c	constant within a form or class
g	public variable defined in a class form or standard module
m	private variable defined in a class or form
<empty>	local variable

<scope>

Prefix	Data Type
b	Boolean
by	byte or unsigned char
d	double
fn	function
h	handle
i	int (integer)
l	long
p	a pointer
s	string

<type>

```
Result = ((x * 24) / (y / 12)) + 42
If ((Not pFoo Is Nothing) And (Counter > 200)) Then
```

Order of conditional determination

Visual Basic, unlike languages such as C and C++, performs conditional tests on all parts of the condition, even if the first part of the condition is *False*. This means you must not perform conditional tests on objects and interfaces that had their validity tested in an earlier part of the conditional statement.

```
' The following line will raise a runtime error if pFoo is NULL
If ((Not pFoo Is Nothing) And (TypeOf pFoo.Thing Is IBar)) then
End If

' The correct way to test this code is
If (Not pFoo Is Nothing) Then
 If (TypeOf pFoo.Thing Is IBar) Then
  ' Perform action on IBar thing of Foo
 End If
End If
```

Indentation

Use two spaces for indentation or a tab width of two. Since there is only ever one editor for VB code, formatting is not as critical an issue as it is for C++ code.

Default properties

Avoid using default properties except for the most common cases. They lead to decreased legibility.

Intermodule referencing

When accessing intermodule data or functions, always qualify the reference with the module name. This makes the code more readable and results in more efficient runtime binding.

Multiple property operations

When performing multiple operations against different properties of the same object, use a *With … End With* statement. It is more efficient than specifying the object each time.

```
With frmHello
 .Caption = "Hello world"
 .Font = "Playbill"
 .Left = (Screen.Width - .Width) / 2
 .Top  = (Screen.Height - .Height) / 2
End With
```

Arrays

For arrays, never change *Option Base* to anything other than zero (which is the default). Use *LBound* and *UBound* to iterate over all items in an array.

```
myArray = GetSomeArray
For i = LBound(myArray) To UBound(myArray)
  MsgBox cstr(myArray(i))
Next I
```

Bitwise operators

Since *And, Or,* and *Not* are bitwise operators, ensure that all conditions using them test only for Boolean values (unless, of course, bitwise semantics are what is intended).

```
If (Not pFoo Is Nothing) Then
  ' Valid Foo do something with it
End If
```

Type suffixes

Refrain from using type suffixes on variables or function names (such as *myString$* or *Right$(myString)*), unless they are needed to distinguish 16-bit from 32-bit numbers.

Ambiguous type matching

For ambiguous type matching, use explicit conversion operators (such as *CSng, CDbl,* and *CStr*), instead of relying on VB to pick which one will be used.

Simple image display

Use an *ImageControl* rather than a *PictureBox* for simple image display. It is much more efficient.

Error handling

Always use *On Error* to ensure fault-tolerant code. For each function that does error checking, use *On Error* to jump to a single error handler for the routine that deals with all exceptional conditions that are likely to be encountered. After the error handler processes the error—usually by displaying a message—it should proceed by issuing one of the recovery statements shown on the table to the left.

Recovery Statement	Frequency	Meaning
Exit Sub	usually	Function failed, pass control back to caller
Raise	often	Raise a new error code in the caller's scope
Resume	rarely	Error condition removed, re-attempt offending statement
Resume Next	very rarely	Ignore error and continue with next statement

Error handling in Visual Basic is not the same as general error handling in COM (see the section 'Working with HRESULTs').

Event functions

Refrain from placing more than a few lines of code in event functions to prevent highly fractured and unorganized code. Event functions should simply dispatch to reusable functions elsewhere.

Memory management

To ensure efficient use of memory resources, the following points should be considered:

- Unload forms regularly. Do not keep many forms loaded but invisible since this consumes system resources.

- Be aware that referencing a form-scoped variable causes the form to be loaded.
- Set unused objects to *Nothing* to free up their memory.
- Make use of *Class_Initialize()* and *Class_Terminate()* to allocate and destroy resources.

While Wend constructs

Avoid *While … Wend* constructs. Use the *Do While … Loop* or *Do Until … Loop* instead because you can conditionally branch out of this construct.

```
pFoos.Reset
Set pFoo = pFoos.Next
Do While (Not pFoo Is Nothing)
  If (pFoo.Answer = "Done") Then Exit Loop
  Set pFoo = pFoos.Next
Loop
```

The Visual Basic Virtual Machine

The VBVM was called the VB Runtime in earlier versions of the software.

The Visual Basic Virtual Machine (VBVM) contains the intrinsic Visual Basic controls and services, such as starting and ending a Visual Basic application, required to successfully execute all Visual Basic developed code.

The VBVM is packaged as a DLL that must be installed on any machine wanting to execute code written with Visual Basic, even if the code has been compiled to native code. If the dependencies of any Visual Basic compiled file are viewed, the file msvbvm60.dll is listed; this is the DLL housing the Virtual Machine.

For more information on the services provided by the VBVM, see the sections 'Interacting with the *IUnknown* interface' and 'Working with HRESULTs' in this chapter.

Interacting with the *IUnknown* interface

The section on COM contains a lengthy section on the *IUnknown* interface and how it forms the basis on which all of COM is built. Visual Basic hides this interface from developers and performs the required interactions (*QueryInterface, AddRef,* and *Release* function calls) on the developer's behalf. It achieves this because of functionality contained within the VBVM. This simplifies development with COM for many developers, but to work successfully with ArcObjects you must understand what the VBVM is doing.

Visual Basic developers are used to dimensioning variables as follows:

```
Dim pColn as New Collection  'Create a new collection object
PColn.Add "Foo", "Bar"       'Add element to collection
```

It is worth considering what is happening at this point. From a quick inspection of the code it looks like the first line creates a collection object and gives the developer a handle on that object in the form of *pColn*. The developer then calls a method on the object *Add*. Earlier in the chapter you learned that objects talk via their interfaces, never through a direct handle on the object itself. Remember, objects expose their services via their interfaces. If this is true, something isn't adding up.

What is actually happening is some "VB magic" performed by the VBVM and some trickery by the Visual Basic Editor in the way that it presents objects and interfaces. The first line of code instantiates an instance of the collection class, then assigns the default interface for that object, *_Collection*, to the variable *pColn*. It is this interface, *_Collection*, that has the methods defined on it. Visual Basic has hidden the fact of interface-based programming to simplify the developer experience. This is not an issue if all the functionality implemented by the object can be accessed via one interface, but it is an issue when there are multiple interfaces on an object that provides services.

The Visual Basic editor backs this up by hiding default interfaces from the IntelliSense completion list and the object browser. By default, any interfaces that begin with an underscore, "_", are not displayed in the object browser (to display these interfaces turn Show Hidden Member on, although this will still not display default interfaces).

You have already learned that the majority of ArcObjects have *IUnknown* as their default interface and that Visual Basic does not expose any of *IUnknown*'s methods, namely, *QueryInterface, AddRef,* and *Release*. Assume you have a class *Foo* that supports three interfaces, *IUnknown* (the default interface), *IFoo,* and *IBar*. This means that if you were to dimension the variable *pFoo* as below, the variable *pFoo* would point to the *IUnknown* interfaces.

```
Dim pFoo As New Foo     ' Create a new Foo object
pFoo.??????
```

Since Visual Basic does not allow direct access to the methods of *IUnknown,* you would immediately have to *QI* for an interface with methods on it that you can call. Because of this, the correct way to dimension a variable that will hold pointers to interfaces is as follows:

```
Dim pFoo As IFoo   ' Variable will hold pointer to IFoo interface
Set pFoo = New Foo ' Create Instance of Foo object and QI for IFoo
```

Now that you have a pointer to one of the object's interfaces, it is an easy matter to request from the object any of its other interfaces.

```
Dim pBar as IBar  'Dim variable to hold pointer to interface
Set pBar = pFoo   'QI for IBar interface
```

By convention, most classes have an interface with the same name as the class with an "I" prefix; this tends to be the interface most commonly used when working with the object. You are not restricted to which interface you request when instantiating an object; any supported interface can be requested, hence the code below is valid.

```
Dim pBar as IBar
Set pBar = New Foo  'CoCreate Object
Set pFoo = pBar     'QI for interface
```

Objects control their own lifetime, which requires clients to call *AddRef* anytime an interface pointer is duplicated by assigning it to another variable and to call *Release* anytime the interface pointer is no longer required. Ensuring that there are a matching number of *AddRefs* and *Releases* is important and, fortunately, Visual Basic performs these calls automatically. This ensures that objects do not “leak”. Even when interface pointers are reused, Visual Basic will correctly call release on the old interface before assigning the new interface to the variable. The code below illustrates these concepts; note the reference count on the object at the various stages of code execution.

See Visual Basic Magic sample on the disk for this code. You are encouraged to run the sample and step though the code. This object also uses an ATL C++ project to define the SimpleObject *and its interfaces; you are encouraged to look at this code to learn a simple implementation of a C++ ATL object.*

```
Private Sub VBMagic()
  ' Dim a variable to the IUnknown interface on the simple object
  Dim pUnk As IUnknown

  ' Co Create simpleobject asking for the IUnknown interface
  Set pUnk = New SimpleObject 'refCount = 1

  ' We need access to methods lets QI for a useful interface
  ' Define the interface we are to request
  Dim pMagic As ISimpleObject

  ' Perform the QI operation
  Set pMagic = punk 'refCount = 2

  ' Dim another variable to hold another interface on the object
  Dim pMagic2 As IAnotherInterface

  ' QI for that interface
  Set pMagic2 = pMagic 'refCount = 3

  ' Release the interface pointer
  Set pMagic2 = Nothing 'refCount = 2

  ' Release the interface
  Set pMagic = Nothing 'refCount = 1

  ' Now reuse the pUnk variable - what will VB do for this?
  Set pUnk = New SimpleObject 'refCount = 1, then 0, then 1

  ' Let the interface variable go out of scope and VB to tidy up
End Sub   'refCount = 0
```

Often interfaces have properties that are actually pointers to other interfaces. Visual Basic allows you to access these properties in a shorthand fashion by chaining interfaces together. For instance, assume that you have a pointer to the *IFoo* interface, and that interface has a property called *Gak* that is an *IGak* interface with the method *DoSomething()*. You have a choice on how to access the *DoSomething* method. The first method is the long-handed way.

```
Dim pGak as IGak
Set pGak = pFoo      'Assign IGak interface to local variable
pGak.DoSomething     'Call method on IGak interface
```

Alternatively, you can chain the interfaces and accomplish the same thing on one line of code.

```
pFoo.Gak.DoSomething  'Call method on IGak interface
```

When looking at the sample code, you will see both methods. Normally the former method is used on the simpler samples, as it explicitly tells you what interfaces are being worked with. More complex samples use the shorthand method.

This technique of chaining interfaces together can always be used to get the value of a property, but it cannot always be used to set the value of a property. Interface chaining can only be used to set a property if all the interfaces in the chain are set by reference. For instance, the code below would execute successfully.

```
Dim pMxDoc As ImxDocument
Set pMxDoc = ThisDocument
pMxDoc.FocusMap.Layers(0).Name = "Foo"
```

The above example works because both the *Layer* of the *Map* and the *Map* of the document are returned by reference. The lines of code below would not work since the *Extent* envelope is set by value on the active view.

```
pMxDoc.ActiveView.Extent.Width = 32
```

The reason that this does not work is that the VBVM expands the interface chain in order to get the end property. Because an interface in the chain is dealt with by value, the VBVM has its own copy of the variable, not the one chained. To set the *Width* property of the extent envelope in the above example, the VBVM must write code similar to this:

```
Dim pActiveView as IActiveView
Set pActiveView = pMxDoc.ActiveView

Dim pEnv as IEnvelope
Set pEnv = pActiveView.Extent  ' This is a get by value,

PEnv.Width = 32   ' The VBVM has set its copy of the Extent and not
                 ' the copy inside the ActiveView
```

For this to work the VBVM requires the extra line below.

```
pActiveView.Extent = pEnv  ' This is a set by value,
```

Accessing ArcObjects

You will now see some specific uses of the create instance and query interface operations that involve ArcObjects. To use an ArcGIS object in Visual Basic or VBA, you must first reference the ESRI object library. In a standalone Visual Basic application, always reference esriCore.olb. Inside of ArcMap or ArcCatalog, a reference is automatically made to the esriMx.olb and esriGx.olb libraries when you start the application, so no external referencing to esriCore.olb is required.

You will start by identifying a simple object and an interface that it supports. In this case, you will use a *Point* object and the *IPoint* interface. One way to set the coordinates of the point is to invoke the *PutCoords* method on the *IPoint* interface and pass in the coordinate values.

```
Dim pPt As IPoint
Set pPt = New Point
pPt.PutCoords 100, 100
```

IID is short for Interface Identifier, a GUID.

The first line of this simple code fragment illustrates the use of a variable to hold a reference to the interface that the object supports. The line reads the *IID* for the *IPoint* interface from the ESRI object library. You may find it less ambiguous (as per the coding guidelines), particularly if you reference other object libraries in the same project to precede the interface name with the library name, for example:

```
Dim pPt As esriCore.IPoint
```

That way, if there happens to be another *IPoint* referenced in your project, there won't be any ambiguity as to which one you are referring.

Coclass is an abbreviation of component object class.

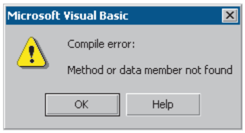
The second line of the fragment creates an instance of the object or coclass, then performs a *QI* operation for the *IPoint* interface that it assigns to *pPt*.

A QI is required since the default interface of the object is IUnknown*. Since the pPt variable was declared as type* IPoint*, the default* IUnknown *interface was QI'd for the* IPoint *interface.*

With a name for the coclass as common as *Point*, you may want to precede the coclass name with the library name, for example:

```
Set pPt = New esriCore.Point
```

The last line of the code fragment invokes the *PutCoords* method. If a method can't be located on the interface, an error will be shown at compile time.



Compile error:

Method or data member not found

This is the compilation error message shown when a method or property is not found on an interface.

Working with HRESULTs

So far you have seen that all COM methods signify success or failure via an *HRESULT* that is returned from the method; no exceptions are raised outside of the interface. You have also learned that Visual Basic raises exceptions when errors are encountered. In Visual Basic, *HRESULTs* are never returned from method calls and, to confuse you further when errors do occur, Visual Basic throws an exception. How can this be? The answer lies with the Visual Basic Virtual Machine. It is the VBVM that receives the *HRESULT*; if this is anything other than *S_OK*, the VBVM throws the exception. If it was able to retrieve any worthwhile error information from the COM error object, it populates the Visual Basic *Err* object with that information. In this way, the VBVM handles all *HRESULTs* returned from the client.

When implementing interfaces in Visual Basic, it is good coding practice to raise an *HRESULT* error to inform the caller that an error has occurred. Normally, this is done when a method has not been implemented.

```
' Defined in Module
Const E_NOTIMPL = &H80004001 'Constant that represents HRESULT
```

```
 'Added to any method not implemented
 On Error GoTo 0
 Err.Raise E_NOTIMPL
```

You must also write code to handle the possibility that an *HRESULT* other than *S_OK* is returned. When this happens, an error handler should be called and the error dealt with. This may mean simply telling the user, or perhaps it may mean automatically dealing with the error and continuing with the function. The choice depends on the circumstances. Below is a very simple error handler that will catch any error that occurs within the function and report it to the user. Note the use of the *Err* object to provide the user with some description of the error.

```
Private Sub Test()
 On Error GoTo ErrorHandler
 ' Do something here
 Exit Sub    ' Must exit sub here before error handler
ErrorHandler:
 Msgbox "Error In Application – Description " & Err.Description
End Sub
```

Working with properties

Some properties refer to specific interfaces in the ESRI object library, and other properties have values that are standard data types, such as strings, numeric expressions, Boolean values, and so forth. For interface references, declare an interface variable and use the *Set* statement to assign the interface reference to the property. For other values, declare a variable with an explicit data type or use Visual Basic's *Variant* data type. Then, use a simple assignment statement to assign the value to the variable.

Properties that are interfaces can either be set by reference or set by value. Properties that are set by value do not require the *Set* statement.

```
 Dim pEnv As IEnvelope
 Set pEnv = pActiveView.Extent  'Get extent property of view
 pEnv.Expand 0.5, 0.5, True     'Shrink envelope
 pActiveView.Extent = pEnv      'Set By Value extent back on IActiveView

 Dim pFeatureLayer as IfeatureLayer
 Set pFeatureLayer = New FeatureLayer    'Create New Layer
 Set pFeatureLayer.FeatureClass = pClass 'Set ByRef a class into layer
```

As you might expect, some properties are read-only, others are write-only, and still others are read–write. All the object browsers and the ArcObjects Class Help (found in the ArcObjects Developer Help system) provide this information. If you attempt to use a property and either forget or misuse the *Set* keyword, Visual Basic will fail the compilation of the source code with a method or data member not found error message. This error may seem strange since it may be given for trying to assign a value to a read-only property. The reason for the message is that Visual Basic is attempting to find a method in the type library that maps to the property name. In the above examples, the underlying method calls in the type library are *put_Extent* and *putref_FeatureClass*.

Working with methods

Methods perform some action and may or may not return a value. In some instances, a method returns a value that's an interface; for example, in the code fragment below, *EditSelection* returns an enumerated feature interface:

```
Dim pApp As IApplication
Dim pEditor As IEditor
Dim pEnumFeat As IEnumFeature 'Holds the selection
Dim pID As New UID
'Get a handle to the Editor extension
pID = "esriCore.Editor"
Set pApp = Application
Set pEditor = pApp.FindExtensionByCLSID(pID)
'Get the selection
Set pEnumFeat = pEditor.EditSelection
```

In other instances, a method returns a Boolean value that reflects the success of an operation or writes data to a parameter; for example, the *DoModalOpen* method of *GxDialog* returns a value of *True* if a selection occurs and writes the selection to an *IEnumGxObject* parameter.

Be careful not to confuse the idea of a Visual Basic return value from a method call with the idea that all COM methods must return an *HRESULT*. The VBVM is able to read type library information and set up the return value of the VB method call to be the appropriate parameter of the COM method.

Working with events

Events let you know when something has occurred. You can add code to respond to an event. For example, a command button has a *Click* event. You add code to perform some action when the user clicks the control. You can also add events that certain objects generate. VBA and Visual Basic let you declare a variable with the keyword *WithEvents*. *WithEvents* tells the development environment that the object variable will be used to respond to the object's events. This is sometimes referred to as an "event sink". The declaration must be made in a class module or a form. Here's how you declare a variable and expose the events of an object in the *Declarations* section:

```
Private WithEvents m_pViewEvents as Map
```

Visual Basic only supports one outbound interface (marked as the default outbound interface in the IDL) per coclass. To get around this limitation, the coclasses that implement more than one outbound interface have an associated dummy coclass that allows access to the secondary outbound interface. These coclasses have the same name as the outbound interface they contain, minus the I.

```
Private WithEvents m_pMapEvents as MapEvents
```

Once you've declared the variable, search for its name in the Object combo box at the top left of the Code window. Then, inspect the list of events you can attach code to in the Procedure/Events combo box at the top right of the Code window.

Not all procedures of the outbound event interface need to be stubbed out, as Visual Basic will stub out any unimplemented methods. This is different from inbound interfaces, where all methods must be stubbed out for compilation to occur.

Before the methods are called, the hookup between the event source and sink must be made. This is done by setting the variable that represents the sink to the event source.

```
  Set m_pMapEvents = pMxDoc.FocusMap
```

Pointers to valid objects as parameters

Some ArcGIS methods expect interfaces for some of their parameters. The interface pointers passed can point to an instanced object before the method call or after the method call is completed.

For example, if you have a polygon (*pPolygon*) whose center point you want to find, you can write code like this:

```
  Dim pArea As IArea
  Dim pPt As IPoint
  Set pArea = pPolygon       ' QI for IArea on pPolygon
  Set pPt = pArea.Center
```

You don't need to create *pPt* because the *Center* method creates a *Point* object for you and passes back a reference to the object via its *IPoint* interface. Only methods that use clientside storage require you to create the object prior to the method call.

Passing data between modules

When passing data between modules it is best to use accessor and mutator functions that manipulate some private member variable. This provides data encapsulation, which is a fundamental technique in object-oriented programming. Public variables should never be used.

For instance, you might have decided that a variable has a valid range of 1–100. If you were to allow other developers direct access to that variable, they could set the value to an illegal value. The only way of coping with these illegal values is to check them before they get used. This is both error prone and tiresome to program. The technique of declaring all variables private member variables of the class and providing accessor and mutator functions for manipulating these variables will solve this problem.

In the example below, these properties are added to the default interface of the class. Notice the technique used to raise an error to the client.

```
Private m_lPercentage As Long

Public Property Get Percentage() As Long
```

```
  Percentage = m_lPercentage
End Property

Public Property Let Percentage(ByVal lNewValue As Long)
  If (lNewValue >= 0) And (lNewValue <= 100) Then
    m_lPercentage = lNewValue
  Else
    Err.Raise vbObjectError + 29566, "MyProj.MyObject", _
    "Invalid Percentage Value. Valid values (0 -> 100)"
  End If
End Property
```

When you write code to pass an object reference from one form, class, or module to another, for example:

```
  Private Property Set PointCoord(ByRef pPt As IPoint)
    Set m_pPoint = pPt
  End Property
```

your code passes a pointer to an instance of the *IPoint* interface. This means that you are only passing the reference to the interface, not the interface itself; if you add the *ByVal* keyword (as follows), the interface is passed by value.

```
  Private Property Let PointCoord(ByVal pPt As IPoint)
    Set m_pPoint = pPt
  End Property
```

In both of these cases the object pointed to by the interfaces is always passed by reference. In order to pass the object by value, a clone of the object must be made, and that is passed.

Using the *TypeOf* keyword

To check whether an object supports an interface, you can use Visual Basic's *TypeOf* keyword. For example, given an item selected in the ArcMap table of contents, you can test whether it is a *FeatureLayer* using the following code:

```
  Dim pDoc As IMxDocument
  Dim pUnk As IUnknown
  Dim pFeatLyr As IGeoFeatureLayer
  Set pDoc = ThisDocument
  Set pUnk = pDoc.SelectedItem
  If TypeOf pUnk Is IGeoFeatureLayer Then  ' can we QI for IGeoFeatureLayer?
    Set pFeatLyr = pUnk                    ' actually QI happens here
    ' Do something with pFeatLyr
  End If
```

Using the *Is* operator

If your code requires you to compare two interface reference variables, you can use the *Is* operator. Typically, you can use the *Is* operator in the following circumstances:

To check if you have a valid interface.

```
Dim pPt As IPoint
Set pPt = New Point
If (Not pPt Is Nothing) Then 'a valid pointer?
  ...   ' do something with pPt
End If
```

To check if two interface variables refer to the same actual object, say you've got two interface variables of type *IPoint*, *pPt1*, and *pPt2*. Are they pointing to the same object? If they are, then *pPt1* Is *pPt2*.

The *Is* keyword works with the COM identity of an object. Below is an example that illustrates the use of the *Is* keyword when finding out if a certain method on an interface returns a copy of or a reference to the same real object.

In the following example, the *Extent* property on a map (*IMap*) returns a copy, while the *ActiveView* property on a document (*IMxDocument*) always returns a reference to the real object.

```
Dim pDoc As IMxDocument
Dim pEnv1 As IEnvelope, pEnv2 as IEnvelope
Dim pActView1 As IActiveView
Dim pActView2 as IActiveView
Set pDoc = ThisDocument
Set pEnv1 = pDoc.ActiveView.Extent
Set pEnv2 = pDoc.ActiveView.Extent
Set pActView1 = pDoc.ActiveView
Set pActView2 = pDoc.ActiveView
' Extent returns a copy,
' so pEnv1 Is pEnv2 returns False
Debug.Print pEnv1 Is pEnv2
' ActiveView returns a reference,
' so pActView1 Is pActView2
Debug.Print pActView1 Is pActView2
```

Iterating through a collection

Enumerators can support other methods, but these two methods are common amongst all enumerators.

In your work with ArcMap and ArcCatalog, you'll discover that in many cases you'll be working with collections. You can iterate through these collections with an enumerator. An enumerator is an interface that provides methods for traversing a list of elements. Enumerator interfaces typically begin with *IEnum* and have two methods: *Next* and *Reset*. *Next* returns the next element in the set and advances the internal pointer, and *Reset* resets the internal pointer to the beginning.

Here is some VBA code that loops through the selected features (*IEnumFeature*) in a map. To try the code, add the States sample layer to the map and use the Select tool to select multiple features (drag a rectangle to do this). Add the code to a VBA macro, then execute the macro. The name of each selected state will be printed in the debug window.

```
Dim pDoc As IMxDocument
Dim pEnumFeat As IEnumFeature
Dim pFeat As IFeature
Set pDoc = ThisDocument
Set pEnumFeat = pDoc.FocusMap.FeatureSelection
Set pFeat = pEnumFeat.Next
Do While (Not pFeat Is Nothing)
  Debug.Print pFeat.Value(pFeat.Fields.FindField("state_name"))
  Set pFeat = pEnumFeat.Next
Loop
```

Some collection objects, the Visual Basic Collection being one, implement a special interface called *_NewEnum*. This interface, because of the _ prefix, is hidden, but Visual Basic developers can still use it to simplify iterating through a collection. The Visual Basic *For Each* construct works with this interface to perform the *Reset* and *Next* steps through a collection.

```
Dim pColn as Collection
Set pColn = GetCollection()' Collection returned from some function

Dim thing as Variant      ' VB uses methods on _NewEnum to step through
For Each thing in pColn  ' an enumerator.
  MsgBox Cstr(thing)
Next
```

This section of the chapter discusses how to program in the VBA environment to control either ArcMap, ArcCatalog, or ArcScene by accessing the objects they expose. Your code manipulates the objects by getting and setting properties on their interfaces, such as setting the *MaximumScale* and *MinimumScale* of a *Map*'s *FeatureLayer*, invoking methods on the interfaces, such as adding a vertex to a polyline, or setting a field's value. The code runs when an event occurs, for example, when a user opens a document, clicks a button, or alters data by modifying an edit sketch.

First, though, you'll see the aspects of the VBA development environment in which you'll do your work that are specific to the ESRI applications. Consult the Visual Basic Reference, the online help file that displays when you click Microsoft Visual Basic Help in the Help menu of the VBA Editor for generic help on the user interface, conceptual topics, how-to topics, language reference topics, customizing the Visual Basic Editor, and user forms and controls.

In the VBA development environment you can add modules, class modules, and user forms to the default project contained in every ArcGIS application document. A project can consist of as many modules, class modules, and user forms as your work requires. A project is a collection of items to which you add code. A module is a set of declarations followed by procedures—a list of instructions that your code performs. A class module is a special type of module that contains the definition of a class, including its property and method definitions. A user form is a container for user interface controls, such as command buttons and text boxes.

ArcMap has a default project associated with its document that's listed in the Project Explorer as Project followed by its filename. In addition, you'll see another project listed in the Project Explorer called Normal (Normal.mxt).

Normal is, in fact, a template for all documents. It's always loaded into the document. It contains all the user-interface elements that users see, as well as the class module named ArcID, which contains all the UIDs for the application's commands.

Since any modifications made to Normal will be reflected every time you create or open a document, you should be careful when making changes to Normal.

In ArcMap, users can start by opening a template other than the default template. These templates are available to them in the New dialog box. From a developer's perspective this is a base template, a document that loads an additional project into the document; it is listed in the Project Explorer as the *TemplateProject* followed by its filename. This project can store code in modules, class modules, forms, and any other customizations, such as maps with data, page layout frames, and so on. Any modifications or changes made to this base template are reflected only in documents that are derived from it.

In ArcCatalog, Normal (Normal.gxt) is the only project that appears in the Project Explorer. There is no default Project in ArcCatalog, and you can't load any templates. You can, of course, add code to Normal.gxt inside modules, class modules, or forms, but again, be careful when making changes.

Once you've invoked the Visual Basic Editor, you can insert a module, class module, or user form. Then you insert a procedure or enter code for an existing event procedure in the item's Code window, where you can write, display, and edit code. You can open as many Code windows as you have modules, class modules, and user forms, so you can easily view the code and copy and paste between Code windows. In addition to creating your own modules, you can import other modules, class modules, or user forms from disk.

If your work requires it, you can add an external object library or type library reference to your project. This makes another application's objects available in your code. Once a reference is set, the referenced objects are displayed in the development environment's Object Browser.

Getting started with VBA

To begin programming with VBA in ArcMap or ArcCatalog, you start the Visual Basic Editor.

To start the Visual Basic Editor

1. Start ArcMap or ArcCatalog.
2. Click the Tools menu, point to Macros, then click Visual Basic Editor. You can also use the shortcut keys Alt+F11 to display the Visual Basic Editor. To navigate among the projects in the Visual Basic Editor, use the Project Explorer. It displays a list of the document's modules, class modules, and user forms.

To add a macro to a module

ArcMap and ArcCatalog both provide a shortcut for creating a simple macro in a module.

1. Click the Tools menu, point to Macros, then click Macros.
2. Type the name of the macro you want to create in the Macro name text box. If you don't specify a module name, the application creates a module called *modulexx* and stores the macro in that module. If no module is specified after you specify a module, and a module is already active, the macro is placed in that module. Preceding a macro's name with a name and a dot stores it in a module with the specified name. If the module doesn't exist, the application creates it.
3. Click the dropdown arrow of the Macros in the combo box and choose the VBA project in which you want to create the macro.
4. Press the Enter key or click Create.
5. The stub for a Sub procedure for the macro appears in the Code window.

Adding modules and class modules

All ArcGIS application documents contain the class module *ThisDocument*, a custom object that represents the specific document associated with a VBA project. The document object is called *MxDocument* in ArcMap and *GxDocument* in ArcCatalog. The *IDocument* interface provides access to the document's title, type, accelerator table, command bars collection, parent application, and Visual Basic project.

Modules and class modules can contain more than one type of procedure: sub, function, or property. You can choose the procedure type and its scope when you insert a procedure. Inserting a procedure is like creating a code template into which you enter code.

Every procedure has either private or public scope. Procedures with private scope are limited to the module that contains them—only a procedure within the same module can call a private procedure. If you declare the procedure public, other programs and modules can call it.

Variables in your procedures may either be local or global. Global variables exist during the entire time the code executes, whereas local variables exist only while the procedure in which they are declared is running. The next time you execute a procedure, all local variables are reinitialized. However, you can preserve the value of all local variables in a procedure for the code's lifetime by declaring them static, thereby fixing their value.

To add a procedure to an existing module

1. In the Project Explorer, double-click the ArcMap Objects, ArcCatalog Objects, or Modules folder, then choose the name of a module. Ensure that the code view of the module is active by clicking the View Code button.
2. Click the Insert menu and click Procedure.
3. Type the name of the procedure in the Name text box.
4. Click the Type dropdown arrow and click the type of procedure: Sub, Function, or Property.
5. Click the Scope dropdown arrow and click Public or Private.
6. To declare all local variables static, check the All Local variables as Statics check box.
7. Click OK. VBA stubs in a procedure into the item's Code window into which you can enter code. The stub contains the first and last lines of code for the type of procedure you've added.
8. Enter code into the procedure.

For more information about procedures, see the Microsoft Visual Basic online help reference.

Adding user forms

If you want your code to prompt the user for information, or you want to display the result of some action performed when the user invokes an ArcGIS application command or tool or in response to some other event, use VBA's user forms. User forms provide a context in which you can provide access to a rich set of integrated controls. Some of these controls are similar to the *UIControls* that are available as part of the Customize dialog box's Commands tab. In addition to text boxes or command buttons, you have access to a rich set of additional controls. A user form is a container for user-interface controls, such as command buttons and text boxes. A control is a Visual Basic object you place on a user form that has its own properties, methods, and events. You use controls to receive user input, display output, and trigger event procedures. You can set the form to be either modal, in which case the user must respond before using any other part of the application, or modeless, in which case subsequent code is executed as it's encountered.

To add and start coding in a user form

1. In the Project Explorer, select the Project to which you want to add a user form.
2. Click the Insert menu and click UserForm.
3. VBA inserts a user form into your project and opens the Controls Toolbox.
4. Click the controls that you want to add to the user interface from the Controls Toolbox.
5. Add code to the user form or to its controls.

For more information about adding controls, see the Microsoft Visual Basic online help reference.

To display the Code window for a user form or control, double-click the user form or control. Then, choose the event you want your code to trigger from the dropdown list of events and procedures in the Code window and start typing your code. Or, just as in a module or class module, insert a procedure and start typing your code.

To display the form during an ArcMap or ArcCatalog session in response to some action, invoke its *Show* method, as in this example:

```
UserForm1.Show vbModeless 'show modeless
```

Some VBA project management techniques

To work efficiently in the ArcGIS application's VBA development environment and reduce the amount of work you have to do every time you start a new task, make use of several techniques that will streamline your work:

Reusing modules, class modules, and user forms

To add an existing module or form to the Normal template, the Project, or a TemplateProject, click the name of the destination in the Project Explorer, then choose Import File from the File menu. You can choose any VBA module, user form, or class module to add a copy of the file to your project. To export an item from your project so that it is available for importing into other projects, select the item you want to export in the Project Explorer, choose Export File from the File menu, then navigate to where you want to save the file. Exporting an item does not remove it from your project.

Removing project items

When you remove an item, it is permanently deleted from the project list—you can't undo the Remove action; however, this action doesn't delete a file if it exists on disk. Before removing an item, make sure the remaining code in other modules and user forms doesn't refer to code in the removed item. To remove an item, select it in the Project Explorer, then choose Remove <Name> from the File menu. Before you remove the item, you'll be asked whether you want to export it. If you click Yes in the message box, the Export File dialog box opens. If you click No, VBA deletes the item.

Protecting your code

To protect your code from alteration and viewing by users, you can lock a Project, a TemplateProject, or even Normal. When you lock one of these items, you set a password that must be entered before it can be viewed in the Project Explorer. To lock one of these items, right-click Project, TemplateProject, or Normal in the Project Explorer, then click the Properties item in the context menu that appears. In the Properties dialog box, click the Protection tab and click the option to Lock Project for Viewing. Enter a password and confirm it. Finally, save your ArcMap or ArcCatalog file and close it. The next time you or anyone else opens the file, the project is locked. If anyone wants to view or edit the project, they must enter the password.

Saving a VBA project

VBA projects are stored in a file that can be a base template (*.mxt), the Normal template, or a document (*.mxd). When a user creates a new ArcMap document from a base template, the new document references the base template's VBA project and its items. To save your ArcMap document and your VBA project, click Save from the ArcMap File menu or Save <File Name> from the File menu in the Visual Basic Editor. Both commands save your file with the project and any items stored in it. After saving the file, its filename is displayed in the Project Explorer in parentheses after the project name. To save the document as a template, click Save As from the ArcMap File menu and specify ArcMap Templates (*.mxt) as the File type.

Running VBA code

As you build and refine your code, you can run it within VBA to test and debug it. This section discusses running your code in the Visual Basic Editor during design time. For more information about running and debugging a VBA program, such as adding break points, adding watch expressions, and stepping into and out of execution, see Microsoft Visual Basic online help.

To run your code in the Visual Basic Editor or from the Macros dialog box

1. Click the Tools menu and click Macros.
2. In the Macro list, click the macro you want and click Run.

If the macro you want is not listed, make sure you've chosen the appropriate item: either Normal, Project, or TemplateProject in the Macros In box. Private procedures do not appear in any menus or dialog boxes.

To run only one procedure in the Visual Basic Editor

1. In the Project Explorer, open the module that contains the procedure that you want to run.
2. In the Code window, click an insertion point in the procedure code.
3. Click the Run menu and click Run Sub/UserForm.

Only the procedure in which your cursor is located runs.

After you've finished writing your code

After you have finished writing code, users can run it from ArcMap or ArcCatalog. To do this, they choose Macros and then Macros from the Tools menu. You can also associate the code with a command or tool, or it can run in response to events or in other ways that you design.

Using the Global Application objects

Since ArcCataog does not support the use of documents, the ThisDocument *global variable is not available to developers. However, the* Application *variable is available if a developer wishes to access* IGxApplication *or* IApplication*.*

Application and *ThisDocument* are examples of global system variables that can be accessed by any module or class in the VBA environment while ArcMap is running. This variable is automatically set to reference the current document when ArcMap opens the document. You can use *ThisDocument* as a shortcut when programming in VBA to access the current document. Here is an example of how to use both the *Application* and *ThisDocument*:

```
 Dim pMxDoc as IMxDocument
 Set pMxDoc = Application.Document
'or
 Set pMxDoc = ThisDocument
```

Both methods illustrated above result in a reference being set to the local document.

In the previous section of this chapter, we focused primarily on how to write code in the VBA development environment embedded within ArcMap and ArcCatalog. This section focuses on particular issues related to creating ActiveX DLLs that can be added to the applications and writing external standalone applications using the Visual Basic development environment. More details of using Visual Basic are given with the documentation that accompanies ArcObjects Developer Controls.

Creating COM components

Most developers use Visual Basic to create a COM component that works with ArcMap or ArcCatalog. Earlier in this chapter you learned that since the ESRI applications are COM clients—their architecture supports the use of software components that adhere to the COM specification—you can build components with different languages including Visual Basic. These components can then be added to the applications easily. For information about packaging and deploying COM components that you've built with Visual Basic, see the last section of this chapter.

This section is not intended as a Visual Basic tutorial; rather, it highlights aspects of Visual Basic that you should know in order to be effective when working with ArcObjects.

In Visual Basic you can build a COM component that will work with ArcMap or ArcCatalog by creating an ActiveX DLL. This section will review the rudimentary steps involved. Note that these steps are not all-inclusive. Your project may involve other requirements.

1. Start Visual Basic. In the New Project dialog box, create an ActiveX DLL Project.
2. In the Properties window, make sure that the Instancing property for the initial class module and any other class modules you add to the Project is set to 5—MultiUse.
3. Reference the ESRI Object Library.
4. Implement the required interfaces. When you implement an interface in a class module, the class provides its own versions of all the public procedures specified in the type library of the interface. In addition to providing a mapping between the interface prototypes and your procedures, the *Implements* statement causes the class to accept COM *QueryInterface* calls for the specified interface ID. You must include all the public procedures involved. A missing member in an implementation of an interface or class causes an error. If you don't put code in one of the procedures in a class you are implementing, you can raise the appropriate error (*Const E_NOTIMPL* = &H80004001). That way, if someone else uses the class, they'll understand that a member is not implemented.
5. Add any additional code that's needed.

The ESRI VB Add-In interface implementer can be used to automate steps 3 and 4.

6. Establish the Project Name and other properties to identify the component. In the Project Properties dialog box, the Project Name you specify will be used as the name of the component's type library. It can be combined with the name of each class the component provides to produce unique class names (these names are also called ProgIDs). These names appear in the Component Category Manager. Save the project.

Visual Basic automatically generates the necessary GUIDs for the classes, interfaces, and libraries. Setting binary compatibility forces VB to reuse the GUIDs from a previous compilation of the DLL. This is essential since ArcMap stores the GUIDs of commands in the document for subsequent loading.

7. Compile the DLL.

8. Set the component's Version Compatibility to binary. As your code evolves, it's good practice to set the components to Binary Compatibility so, if you make changes to a component, you'll be warned that you're breaking compatibility. For additional information, see the 'Binary compatibility mode' help topic in the Visual Basic online help.

9. Save the project.

10. Make the component available to the application. You can add a component to a document or template by clicking the Add from file button in the Customize dialog box's Commands tab. In addition, you can register a component in the Component Category Manager.

Implementing interfaces

You implement interfaces differently in Visual Basic depending if they are inbound or outbound interfaces. An outbound interface is seen by Visual Basic as an event source and is supported through the *WithEvents* keyword. To handle the outbound interface, *IActiveViewEvents*, in Visual Basic (the default outbound interface of the *Map* class), use the *WithEvents* keyword and provide appropriate functions to handle the events.

```
  Private WithEvents ViewEvents As Map

  Private Sub ViewEvents_SelectionChanged()
    ' User changed feature selection update my feature list form
    UpdateMyFeatureForm
  End Sub
```

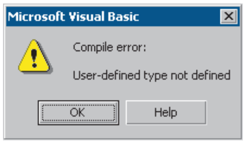
Inbound interfaces are supported with the *Implements* keyword. However, unlike the outbound interface, all the methods defined on the interface must be stubbed out. This ensures that the vTable is correctly formed when the object is instantiated. Not all of the methods have to be fully coded, but the stub functions must be there. If the implementation is blank, an appropriate return code should be given to any client to inform them that the method is not implemented (see the section *Working with HRESULTs*). To implement the *IExtension* interface, code similar to that below is required. Note that all the methods are implemented.

```
Private m_pApp As IApplication
Implements IExtension
```

```
 Private Property Get IExtension_Name() As String
  IExtension_Name = "Sample Extension"
End Property

Private Sub IExtension_Startup(ByRef initializationData As Variant)
  Set m_pApp = initializationData
End Sub

Private Sub IExtension_Shutdown()
  Set m_pApp = Nothing
End Sub
```

Setting references to the ESRI object libraries

The principal difference between working with the VBA development environment embedded in the applications and working with Visual Basic is that the latter environment requires that you load the appropriate object libraries so that any object variables that you declare can be found. If you don't add the reference, you'll get the error message to the left. In addition, the global variables *ThisDocument* and *Application* are not available to you.


Microsoft Visual Basic

Compile error:

User-defined type not defined

To add a reference to an object library

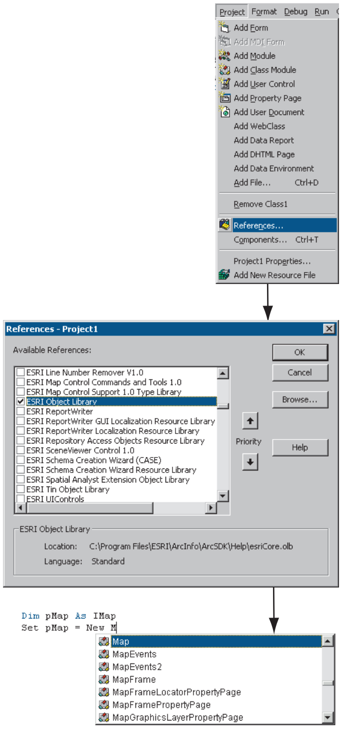
In all cases, you'll need to load the ESRI Object Library esriCore.olb. Depending on what you want your code to do, you may add other ESRI object libraries, perhaps for one of the extensions.

To display the References dialog box in which you can set the references you need, select References in the Visual Basic Project menu.

After you set a reference to an object library by selecting the check box next to its name, you can find a specific object and its methods and properties in the Object Browser.

If you are not using any objects in a referenced library, you should clear the check box for that reference to minimize the number of object references Visual Basic must resolve, thus reducing the time it takes your project to compile. You should not remove a reference for an item that is used in your project.

You can't remove the "Visual Basic for Applications" and "Visual Basic objects and procedures" references because they are necessary for running Visual Basic.



References - Project1

Available References:

- □ ESRI Line Number Remover V1.0
- □ ESRI Map Control Commands and Tools 1.0
- □ ESRI Map Control Support 1.0 Type Library
- ☑ ESRI Object Library
- □ ESRI ReportWriter
- □ ESRI ReportWriter GUI Localization Resource Library
- □ ESRI ReportWriter Localization Resource Library
- □ ESRI Repository Access Objects Resource Library
- □ ESRI SceneViewer Control 1.0
- □ ESRI Schema Creation Wizard (CASE)
- □ ESRI Schema Creation Wizard Resource Library
- □ ESRI Spatial Analyst Extension Object Library
- □ ESRI Tin Object Library
- □ ESRI UIControls

ESRI Object Library

Location: C:\Program Files\ESRI\ArcInfo\ArcSDK\Help\esriCore.olb

Language: Standard

```
Dim pMap As IMap
Set pMap = New M
```

After the ESRI Object Library is referenced, all the types contained within it are available to Visual Basic. IntelliSense will also work with the contents of the object library.

Referring to a document

Each VBA project (Normal, Project, TemplateProject) has a class called *ThisDocument*, which represents the document object. Anywhere you write code in VBA you can reference the document as *ThisDocument*. Further, if you are writing your code in the *ThisDocument* Code window, you have direct access to all the methods and properties on *IDocument*. This is not available in Visual Basic. You must first get a reference to the *Application* and then the document. When adding both extensions and commands to ArcGIS applications, a pointer to the *IApplication* interface is provided. For code samples that show you how to get a handle on the application, see Chapter 3, 'Customizing the user interface'.

```
Implements IExtension
Private m_pApp As IApplication

Private Sub IExtension_Startup(ByRef initializationData As Variant)
  Set m_pApp = initializationData   ' Assign IApplication
End Sub

Implements ICommand
Private m_pApp As IApplication

Private Sub ICommand_OnCreate(ByVal hook As Object)
  Set m_pApp = hook                 ' QI for IApplication
End Sub
```

Now that a reference to the application is in an *IApplication* pointer member variable, the document, and hence all other objects, can be accessed from any method within the class.

```
  Dim pDoc as IDocument
  Set pDoc = m_pApp.Document
  MsgBox pDoc.Name
```

Getting to an object

In the previous example, navigating around the objects within ArcMap is a straightforward process since a pointer to the *Application* object, the root object of most of the ArcGIS application's objects, is passed to the object via one of its interfaces. This, however, is not the case with all interfaces that are implemented within the ArcObjects application framework. There are cases when you may implement an object that exists within the framework and there is no possibility to traverse the object hierarchy from that object. This is because very few objects support a reference to their parent object (the *IDocument* interface has a property named *Parent* that references the *IApplication* interface). In order to give developers access to the application object, there is a singleton object that provides a pointer to the running application object. The code below illustrates its use.

Singletons are objects that only support one instance of the object.These objects have a class factory that ensures that anytime an object is requested, a pointer to an already existing object is returned.

```
  Dim pAppRef As New AppRef
  Dim pApp as IApplication
  Set pApp = pAppRef
```

You must be careful to ensure that this object is only used where the implementation will only ever run within ArcMap and ArcCatalog. For instance, it would not be a good idea to make use of this function from within a custom feature since that would restrict what applications could be used to view the feature class.

Running ArcMap with a command line argument

You can start ArcMap from the command line and pass it an argument that is either the pathname of a document (.mxd) or the pathname of a template (.mxt). In the former case, ArcMap will open the document; in the latter case, ArcMap will create a new document based on the template specified.

In Visual Basic, it is not possible to determine the command line used to start the application. There is a sample on disk that provides this functionality. It can be found at \arcgis\arcexe81\ArcObjects Developer Kit\samples\COMTechniques\Command Line.

You can also pass an argument and create an instance of ArcMap by supplying arguments to the Win32 API's *ShellExecute* function or Visual Basic's *Shell* function as follows:

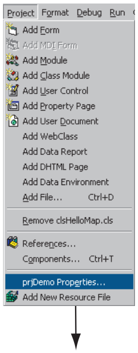
```
Dim ret As Variant
ret = Shell("d:\arcexe81\bin\arcmap.exe _
  d:\arcexe80\bin\templates\LetterPortrait.mxt", vbNormalFocus)
```

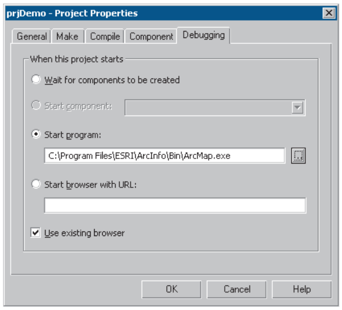
By default, *Shell* runs other programs asynchronously. This means that ArcMap might not finish executing before the statements following the *Shell* function are executed.

To execute a program and wait until it is terminated, you must call three Win32 API functions. First, call the *CreateProcessA* function to load and execute ArcMap. Next, call the *WaitForSingleObject* function, which forces the operating system to wait until ArcMap has been terminated. Finally, when the user has terminated the application, call the *CloseHandle* function to release the application's 32-bit identifier to the system pool.

DEBUGGING VISUAL BASIC CODE

Visual Basic has a debugger integrated into its development environment. This is in many cases a valuable tool when debugging Visual Basic code; however, in some cases it is not possible to use the VB debugger. The use of the debugger and these special cases are discussed below.




prjDemo - Project Properties

General | Make | Compile | Component | Debugging

When this project starts

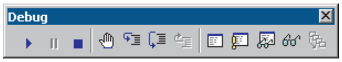
○ Wait for components to be created

○ Start component:

● Start program: C:\Program Files\ESRI\ArcInfo\Bin\ArcMap.exe

○ Start browser with URL:

☑ Use existing browser



Running the code within an application

It is possible to use the Visual Basic debugger to debug your ArcObjects-based source code even when ActiveX DLLs are the target server. The application that will host your DLL must be set as the Debug application. To do this, select the appropriate application, ArcMap.exe, for instance, and set it as the Start Program in the Debugging Options of the Project Properties.

Using commands on the Debug toolbar, ArcMap can be started and the DLL loaded and debugged. Break points can be set, lines stepped over, functions stepped into, and variables checked. Moving the line pointer in the left-hand margin can also set the current execution line.

Visual Basic debugger issues

In many cases, the Visual Basic debugger will work without any problems; however, there are two problems when using the debugger that is supplied with Visual Basic 6. Both of these problems exist because of the way that Visual Basic implements its debugger.

Normally when running a tool within ArcMap, the DLL is loaded into ArcMap address space, and calls are made directly into the DLL. When debugging, this is not the case. Visual Basic makes changes to the registry so that the CLSID for your DLL does not point to your DLL but, instead, it points to the Visual Basic Debug DLL (VB6debug.dll). The Debug DLL must then support all the interfaces implemented by your class on the fly. With the VB Debug DLL loaded into ArcMap, any method calls that come into the DLL are forwarded on to Visual Basic, where the code to be debugged is executed. The two problems with this are caused by the changes made to the Registry and the cross-process space method calling. When these restrictions are first encountered, it can be confusing since the object works outside the debugger or at least until it hits the area of problem code.

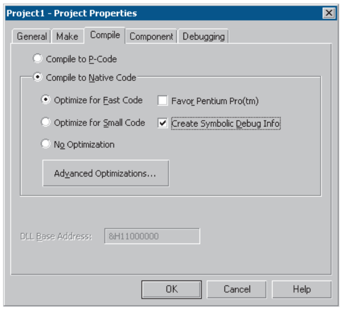
Since the method calls made from ArcMap to the custom tool are across apartments, there is a requirement for the interfaces to be marshalled. This marshalling causes problems in certain circumstances. Most data types can be automatically marshaled by the system, but there are a few that require custom code because the standard marshaler does not support the data types. If one of these data types is used by an interface within the custom tool and there is no custom marshalling code, the debugger will fail with an “Interface not supported error”.

The registry manipulation also breaks the support for component categories. Any time there is a request on a component category, the category manager within COM will be unable to find your component because, rather than asking whether your DLL belongs to the component category, COM is asking whether the VB debugger DLL belongs to the component category, which obviously it doesn’t. What this means is that anytime a component category is used to automate the loading of a DLL, the DLL cannot be debugged using the Visual Basic debugger.

This obviously causes problems for many of the ways to extend the framework. The most common way to extend the framework is to add a command or tool. Previously it was discussed how component categories were used in this instance. Remember the component category was only used to build the list of commands in the dialog box. This means that if the command to be debugged is already present on a toolbar, the Visual Basic debugger can be used. Hence, the procedure for debugging Visual Basic objects that implement the *ICommand* interface is to ensure that the command is added to a toolbar when ArcMap is executed standalone and then, after saving the document, loading ArcMap through the debugger.

In some cases, such as extensions and property pages, it is not possible to use the Visual Basic debugger. If you have access to the Visual C++ Debugger, you can use one of the options outlined below. Fortunately, there are a number of ESRI Visual Basic Add-ins that make it possible to track down the problem quickly and effectively. The add-ins described below, in the section ‘Visual Basic Developer Add-Ins’, provide error log information including line and module details. A sample output from an error log is given below; note the call stack information along with line numbers.

```
Error Log saved on : 8/28/2000 - 10:39:04 AM
Record Call Stack Sequence - Bottom line is error line.

   chkVisible_MouseUp C:\Source\MapControl\Commands\frmLayer.frm Line : 196
   RefreshMap C:\Source\MapControl\Commands\frmLayer.frm Line : 20

Description
   Object variable or With block variable not set
```



○ Compile to P-Code
● Compile to Native Code
● Optimize for Fast Code
□ Favor Pentium Pro(tm)
○ Optimize for Small Code
☑ Create Symbolic Debug Info
○ No Optimization
DLL Base Address: &H11000000

Create Debug Symbol information using the Create Symbolic Debug info option on the Compile tab of the Project Properties dialog box.

Alternatives to the Visual Basic debugger

If the Visual Basic debugger and add-ins do not provide enough information, the Visual C++ debugger can be used, either on its own or with C++ ATL wrapper classes. The Visual C++ debugger does not run the object to be debugged out of process from ArcMap, which means that none of the above issues apply. Common debug commands are given in the section 'Debugging tips in Visual Studio'. Both of the techniques below require the Visual Basic project to be compiled with Debug Symbol information.

The Visual C++ Debugger can work with this symbolic debug information and the source files.

Visual C++ Debugger

It is possible to use the Visual C++ debugger directly by attaching to a running process that has the Visual Basic object to be debugged loaded and then setting a break point in the Visual Basic file. When the line of code is reached, the debugger will halt execution and step you into the source file at the correct line. The required steps are shown below.

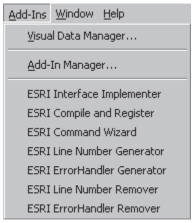
1. Start an appropriate application, such as ArcMap.exe.
2. Start Microsoft Visual C++.
3. Attach to the ArcMap process using Menu option Build -> Start Debug -> Attach to process.
4. Load the appropriate Visual Basic Source file into the Visual C++ debugger and set the break point.
5. Call the method within ArcMap.

No changes can be made to the source code within the debugger, and variables cannot be inspected, but code execution can be viewed and altered. This is often sufficient to determine what is wrong, especially with logic-related problems.

ATL Wrapper Classes

Using the Active Template Library (ATL), you can create a class that implements the same interfaces as the Visual Basic Class. When you create the ATL Object, you create the Visual Basic object. All method calls are then passed to the Visual Basic Object for execution. You debug the contained object by setting a break point in the appropriate C++ wrapper method, and when the code reaches the break point, the debugger is stepped into the Visual Basic Code. For more information on this technique, look at the ATL Debugger sample in the Developer Samples of the ArcObjects Developer Help system.

The ESRI add-ins automate some of the tasks performed by the software engineer when developing with ArcObjects, as well as provide tools that make debugging code easier.

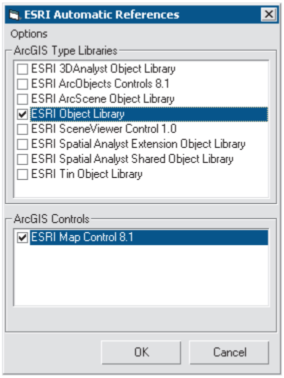

Add-Ins
Window
Help
Visual Data Manager…
Add-In Manager…
ESRI Interface Implementer
ESRI Compile and Register
ESRI Command Wizard
ESRI Line Number Generator
ESRI ErrorHandler Generator
ESRI Line Number Remover
ESRI ErrorHandler Remover

The Add-Ins menu provides access to numerous developer tools that help ArcObjects developers be more productive.

What is a Visual Basic add-in?

A Visual Basic add-in extends the functionality provided through the MS Visual Basic Integrated Development Environment (IDE). An add-in typically automates repetitive tasks performed by a software engineer.

Add-ins register themselves with Visual Basic. After an add-in is installed it will appear automatically on the Add-Ins menu. The menu to the left shows the Add-In menu with the ESRI add-ins loaded.



ArcGIS Type Libraries

- ☐ ESRI 3DAnalyst Object Library
- ☐ ESRI ArcObjects Controls 8.1
- ☐ ESRI ArcScene Object Library
- ☑ ESRI Object Library
- ☐ ESRI SceneViewer Control 1.0
- ☐ ESRI Spatial Analyst Extension Object Library
- ☐ ESRI Spatial Analyst Shared Object Library
- ☐ ESRI Tin Object Library

ArcGIS Controls

- ☑ ESRI Map Control 8.1

This dialog box is displayed faster than the Visual Basic Reference dialog box, making it the interface of choice when setting references to ESRI type libraries and controls.

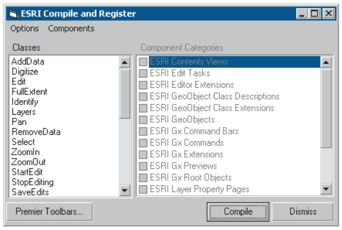
Automatic references

When you develop with Visual Basic, you must reference all the external type libraries in order for the compiler to locate all the object types, interface types, and so on. The IntelliSense mechanism also makes use of this type library information.

In all cases when developing ArcObjects-based applications, you'll need to load the ESRI Object Library esriCore.olb. Depending on what you want your code to do, you may add other ESRI object libraries, perhaps for one of the extensions.

Normally, to add references to external libraries in Visual Basic you would display the References dialog box in the Visual Basic Project menu, then check on the required libraries. Depending on the number of libraries installed on your system, it can take a few seconds to display the References dialog box and locate the appropriate libraries. This Visual Basic add-in simplifies the process, and, if enabled, will automate this reference setting for all Visual Basic Projects.

To access the add-in, click ESRI Automatic References on the Add-Ins pulldown menu. Only the ArcObjects type libraries and controls are listed in the interface. To the left is the add-in's user interface.



Classes

AddData
Digitize
Edit
FullExtent
Identify
Layers
Pan
RemoveData
Select
ZoomIn
ZoomOut
StartEdit
StopEditing
SaveEdits

Component Categories

- ☐ ESRI Contents Views
- ☐ ESRI Edit Tasks
- ☐ ESRI Editor Extensions
- ☐ ESRI GeoObject Class Descriptions
- ☐ ESRI GeoObject Class Extensions
- ☐ ESRI GeoObjects
- ☐ ESRI Gx Command Bars
- ☐ ESRI Gx Commands
- ☐ ESRI Gx Extensions
- ☐ ESRI Gx Previews
- ☐ ESRI Gx Root Objects
- ☐ ESRI Layer Property Pages

The Compile and Register add-in enhances VB by adding support for component categories.

Compile and register

This Visual Basic add-in supports the building of components and the subsequent registration of these components into the appropriate component category. To access the add-in, click ESRI Compile and Register on the Add-Ins pulldown menu. Not all the ESRI component categories are supported; however, the add-in supports the categories that are used commonly by the application framework and the geodatabase. To the left is the add-in's user interface.

The add-in lists all the classes defined within the VB project in the left column and lists all the available component categories in the right column. The developer selects a class in the left column and checks the appropriate component categories in the right. When a project is loaded, the interface updates to reflect the project's classes, and if these classes are within component categories, the categories list also updates. If the class has not been registered in a category, all items in the list will be unchecked.

It is not a good idea to have classes that have a ProgID *of* project1.class1. *This will be the result if the default project name and class name are not changed before compilation.Any classes that have a* ProgID *that is* project1.class1 *will not automatically be loaded in the right column of the form.*

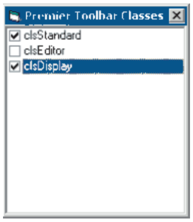
When each class has the appropriate component category selected, the project can be built. Clicking the Compile button builds the project. Upon completion of a successful compile, the classes are registered into the required component category. If a class' component category changes, the class is removed from the old component category. If a class is not marked as a member of any category, it will be removed from any of the supported categories in which it is currently registered. If the developer has displayed the form once or the class already exists within the category, the Compile command can be executed directly by holding down the Ctrl key when selecting the add-in from the menu.

The Options menu has three items: Display Dialogs, Unregister on Error, and Set Binary Compatibility. Display Dialogs, if enabled, displays dialog boxes informing the developer of the operations that are being performed: saving the source files, compiling and registering the component, and so on. Unregister On Error sets the behavior if an error is encountered during the compilation and registration process. If checked when an error occurs at any time during the execution of the add-in, the component is unregistered from the system. Set Binary Compatibility, if checked, will automatically set the project's component compatibility to be Binary with the newly compiled DLL. The states of these menu items are saved in the registry and loaded on subsequent uses of the tool. By default, they are all enabled.

Remember, component categories are used by client applications to efficiently find all components of a particular type that are installed on the system.For example,ArcMap uses component categories extensively to efficiently locate installed components on a user's system. Component categories support the extensibility of COM by allowing the developer of the client application to create and work with classes that belong to a particular category. If at a later date a new class is added to the category, the client application need not be changed to take advantage of the new class; it will automatically pick up the new class the next time the category is read.

Before compiling the project, all source files within the project are saved. If a module has never been saved, the developer is prompted to save the project via the standard VB interface. This ability to save source files prior to a compile gives functionality that is not present in Visual Basic. Visual Basic only saves source files prior to building executables; it does not save source files when building DLLs.

If the current Visual Basic project has a class that is marked to go into either the ESRI Mx Command Bars or ESRI Gx Command Bars, the class can be marked as a premier toolbar.



Premier Toolbar Classes

☑ clsStandard
☐ clsEditor
☑ clsDisplay

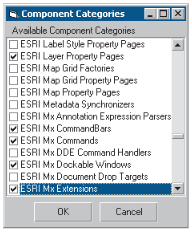
Premier toolbars are toolbars that are displayed the first time ArcMap or ArcCatalog is started after installation. Once the user has hidden them for the first time, they are no longer displayed. This is good way of highlighting the installation of customizations to the user.

To flag a toolbar class as a premier toolbar, you must display the Premier Toolbar Classes check list by clicking the Premier Toolbars button. This displays the list box shown on the left. All classes that are in the appropriate component category will be placed in this list. If the classes are already in the registry as premier toolbars, they will be automatically checked. To remove them from the registry, uncheck the class and compile the project. All classes checked will be added to the registry as premier toolbars. When developing the project, you must be aware that after every compile the toolbar will act like a fresh install when ArcMap or ArcCatalog is next started (that is, even if the toolbar was previously hidden, it will appear).

The required changes to the registry are made at compile time. An entry is also made in the registry script to ensure that the class is also marked as a Premier toolbar at install time.

Since the process of component category registration is tied to the compilation, these classes will only be registered in the categories on the developer's machine. To help with the installation of components on third-party machines, the compilation process also generates a Registry Script file. The file has the same name as the project with a .reg extension and is located in the VB Project directory. A sample script is shown below.

```
REGEDIT4

; This Registry Script enters CoClasses Into their appropriate Component
Category ; Use this script during installation of the components

; Coclass: prjDisplay.ZoomIn ; CLSID: {FC7EC05F-6B1B-4A59-B8A2-37CE33738728}
; Component Category: ESRI Mx Commands
[HKEY_LOCAL_MACHINE\SOFTWARE\Classes\CLSID\{FC7EC05F-6B1B-4A59-B8A2-
37CE33738728}\Implemented Categories\{B56A7C42-83D4-11D2-A2E9-080009B6F22B}]
; Coclass: prjDisplay.ZoomOut ; CLSID: {2C120434-0248-43DB-AD8E-
BD4523A93DF8} ; Component Category: ESRI Mx Commands
[HKEY_LOCAL_MACHINE\SOFTWARE\Classes\CLSID\{2C120434-0248-43DB-AD8E-
BD4523A93DF8}\Implemented Categories\{B56A7C42-83D4-11D2-A2E9-080009B6F22B}]
```



□ ESRI Label Style Property Pages
☑ ESRI Layer Property Pages
□ ESRI Map Grid Factories
□ ESRI Map Grid Property Pages
□ ESRI Map Property Pages
□ ESRI Metadata Synchronizers
□ ESRI Mx Annotation Expression Parsers
☑ ESRI Mx CommandBars
☑ ESRI Mx Commands
□ ESRI Mx DDE Command Handlers
☑ ESRI Mx Dockable Windows
□ ESRI Mx Document Drop Targets
☑ ESRI Mx Extensions

The Component Categories dialog box allows you to configure the component categories supported by the add-in.

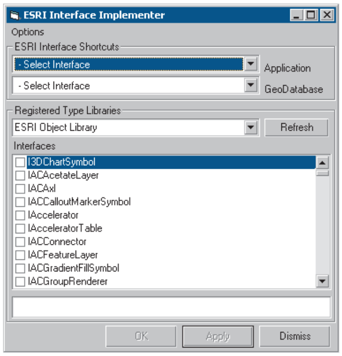
The Components menu has two items. Select Component Categories displays the dialog box shown on the left. Using this dialog box, it is possible to select the Component Categories that the add-in displays in its Component Categories list. To reset the list back to the default settings, use the Reset Component Categories menu command.

Interface implementer

When implementing interfaces in Visual Basic, the developer is forced to stub out all the methods of the interface; unfortunately, Visual Basic does not automate this process. Thus, when you implement two interfaces, such as *ICommand* and *ITool*, it can mean carrying out a repetitive task for more than 20 method calls. Fortunately, this add-in automates this task.

To access the add-in, select the ESRI Interface Implementer menu item on the Add-Ins pulldown menu. When creating a COM server, this add-in can be used to generate the stub functions. In addition to generating the stub functions, the DLL also adds a reference to the ESRI Object Library and adds a module that contains a generic error-handling routine. For more details on this error-handling module, see the Error Handler add-in. A reference to the error handler is also added to the project.

By default, all stub functions are created with an error handler; this can be overridden by unchecking Generate Error Handlers on the Options menu. The state of this menu is saved in the registry. The Options menu has one other entry, Raise E_NOTIMPL, that defaults to unchecked. When this is checked, all functions disable error handling and raise the standard error *E_NOTIMPL* to indicate to clients that the function has



ESRI Interface Implementer

Options

ESRI Interface Shortcuts

- Select Interface — Application

- Select Interface — GeoDatabase

Registered Type Libraries: ESRI Object Library

Interfaces

□ I3DChartSymbol
□ IACAcetateLayer
□ IACAxl
□ IACCalloutMarkerSymbol
□ IAccelerator
□ IAcceleratorTable
□ IACConnector
□ IACFeatureLayer
□ IACGradientFillSymbol
□ IACGroupRenderer

The Interface Implementer dialog box has facilities to select interfaces from shortcut combo boxes, a full list of the interfaces in the selected type library, and a search facility.

not been implemented. A constant is also added to the module that defines the variable *E_NOTIMPL*. The two lines of code added when this option is checked are shown below.

```
 On Error GoTo 0
  Err.Raise E_NOTIMPL
```

Developers must remove these two lines when they implement the function.

The interface implementer interface can be seen to the left. The two combo boxes at the top of the form offer a shortcut to many of the ArcObjects interfaces that are commonly implemented. The combo boxes divide the interfaces into two broad groups: application and geodatabase interfaces.

If the required interface is not in one of the combo boxes, all the interfaces that are available in the selected type library are listed in the list below. You can scroll down the list, selecting all the interfaces required, then click OK or Apply. This will add the stub functions for all selected interfaces in one action.

You can also search the list using the search facility. To search the interface the developer types the name of the required interface in the text box below the list. The first interface that matches the entered text is displayed at the top of the list box. The search is not case sensitive by default. A popup menu, available on the text entry field, can enable a case-sensitive search if required. Click OK or Apply with an interface highlighted to implement the interface. You don’t have to check the check box; the first selected interface is automatically selected. Thus, by simply typing in the text box and clicking Apply, multiple interfaces can be implemented very quickly.

Interfaces can only be generated in class modules. The module used is the currently selected module in the project browser, not necessarily the currently active code window. If the selected module and code window do not match, the developer is warned that the code will be placed in the selected class module and not the current window.

The tool will only implement an interface once per module.

If an error-handling module already exists within the project, a new one will not be added. If the error-handling module is an out-of-date version, the tool updates the module to match the latest installed error handler.

When the add-in displays the form, the text search field allows you to start searching for the required interface immediately.

Command Creation Wizard

The Command Creation Wizard facilitates the creation of a command or tool for use within ArcMap, ArcCatalog, the Map control, or a combination of these. For instance, a tool written for ArcMap may also be suitable for the Map control. It is possible to quickly develop commands and tools without this wizard using the interface implementer and the Compile and Register Add-ins, but this wizard has many features that make the addition of commands straightforward.

To access the add-in, click ESRI Command Wizard from the Add-Ins pulldown menu. An introduction screen will display.

This screen has information about the wizard. When you complete the wizard, it compiles and registers the project automatically. The project will only be saved to file if you select this option at the start of the wizard.

The first step of the wizard displays only if the project was not saved prior to executing the wizard. It is advisable to save the project at the start of the wizard, as this will also ensure that the project is saved on completion.

When you save a project using the wizard, if no filenames have been assigned to modules, you are prompted to enter the filenames. In addition, you can elect to check for default names. If you enabled these options, the wizard checks the names of modules and, if a default name is detected, you are prompted to enter a new name. Default names are not a good idea since there is less chance that the programmable ID will be unique.

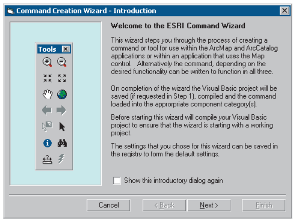
The wizard always performs the next step, project compilation, either after you save the project or when the wizard starts. If the project fails to compile, the wizard displays step 2. You have no other choice but to fix the compilation error and rerun the wizard.

The next step involves selecting the target application in which the command will operate. Not all commands are suitable for all application environments. For example, a Select tool used to select features on a map could be used within the Map control or the ArcMap application since the topmost object that must be accessed is the *Map*, and both these environments expose a map object; however, a Select tool may not be suitable for ArcCatalog since it does not expose a *Map* object.

The graphic panel on the left illustrates the choices made. You must select at least one application in order to continue on to the next step.

Step 4 of the wizard allows you to determine various properties of the code that the wizard generates.

You can add the generated source code to an existing class within your project. This option is only enabled if there is a suitable class module within your active project. The wizard disregards any class that already implements the *ICommand* interface. If the wizard does create a new class, it assigns the class the name of the Commands caption, minus any spaces, preceded by “cls”.



Welcome to the ESRI Command Wizard

This wizard steps you through the process of creating a command or tool for use within the ArcMap and ArcCatalog applications or within an application that uses the Map control. Alternatively the command, depending on the desired functionality can be written to function in all three.

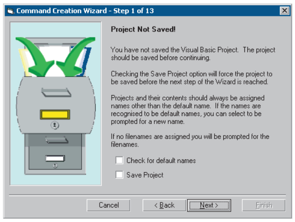
On completion of the wizard the Visual Basic project will be saved (if requested in Step 1), compiled and the command loaded into the approrpriate component category(s).

Before starting this wizard will compile your Visual Basic project to ensure that the wizard is starting with a working project.

The settings that you chose for this wizard can be saved in the registry to form the default settings.

☐ Show this introductory dialog again

Introduction screen



Project Not Saved!

You have not saved the Visual Basic Project. The project should be saved before continuing.

Checking the Save Project option will force the project to be saved before the next step of the Wizard is reached.

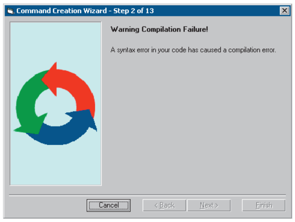
Projects and their contents should always be assigned names other than the default name. If the names are recognised to be default names, you can select to be prompted for a new name.

If no filenames are assigned you will be prompted for the filenames.

☐ Check for default names

☐ Save Project

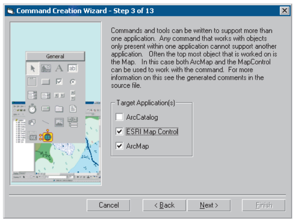
Step 1



Warning Compilation Failure!

A syntax error in your code has caused a compilation error.

Step 2



Commands and tools can be written to support more than one application. Any command that works with objects only present within one application cannot support another application. Often the top most object that is worked on is the Map. In this case both ArcMap and the MapControl can be used to work with the command. For more information on this see the generated comments in the source file.

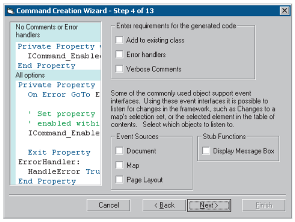
Target Application(s)

☐ ArcCatalog

☑ ESRI Map Control

☑ ArcMap

Step 3



No Comments or Error handlers

```
Private Property
  ICommand_Enable
End Property
```

All options

```
Private Property
  On Error GoTo E

  ' Set property
  ' enabled withi
  ICommand_Enable

  Exit Property
ErrorHandler:
  HandleError Tru
End Property
```

Enter requirements for the generated code

☐ Add to existing class

☐ Error handlers

☐ Verbose Comments

Some of the commonly used object support event interfaces. Using these event interfaces it is possible to listen for changes in the framework, such as Changes to a map's selection set, or the selected element in the table of contents. Select which objects to listen to.

Event Sources

☐ Document

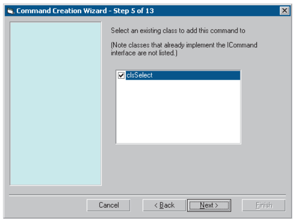
☐ Map

☐ Page Layout

Stub Functions

☐ Display Message Box

Step 4

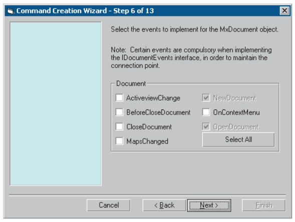

Command Creation Wizard - Step 5 of 13

Select an existing class to add this command to

(Note classes that already implement the ICommand interface are not listed.)

☑ clsSelect

Step 5


Command Creation Wizard - Step 6 of 13

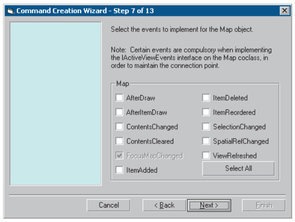
Select the events to implement for the MxDocument object.

Note: Certain events are compulsory when implementing the IDocumentEvents interface, in order to maintain the connection point.

Document

☐ ActiveviewChange ☑ NewDocument
☐ BeforeCloseDocument ☐ OnContextMenu
☐ CloseDocument ☑ OpenDocument
☐ MapsChanged

Step 6


Command Creation Wizard - Step 7 of 13

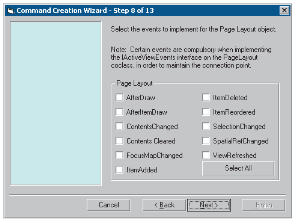
Select the events to implement for the Map object.

Note: Certain events are compulsory when implementing the IActiveViewEvents interface on the Map coclass, in order to maintain the connection point.

Map

☐ AfterDraw ☐ ItemDeleted
☐ AfterItemDraw ☐ ItemReordered
☐ ContentsChanged ☐ SelectionChanged
☐ ContentsCleared ☐ SpatialRefChanged
☑ FocusMapChanged ☐ ViewRefreshed
☐ ItemAdded

Step 7


Command Creation Wizard - Step 8 of 13

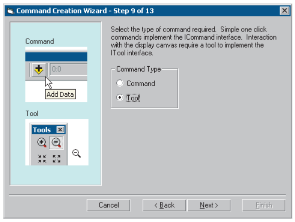
Select the events to implement for the Page Layout object.

Note: Certain events are compulsory when implementing the IActiveViewEvents interface on the PageLayout coclass, in order to maintain the connection point.

Page Layout

☐ AfterDraw ☐ ItemDeleted
☐ AfterItemDraw ☐ ItemReordered
☐ ContentsChanged ☐ SelectionChanged
☐ Contents Cleared ☐ SpatialRefChanged
☐ FocusMapChanged ☐ ViewRefreshed
☐ ItemAdded

Step 8


Command Creation Wizard - Step 9 of 13

Select the type of command required. Simple one click commands implement the ICommand interface. Interaction with the display canvas require a tool to implement the ITool interface.

Command Type

○ Command
● Tool

Step 9

The Error Handlers option controls whether the wizard adds error-handling code to the functions. All functions should have an error handler, but if you do not wish to use the generic ESRI error handler you can disable the creation of the error handlers and add your own.

Verbose comments can be helpful when starting out with Command development. With this option enabled, several hundred lines of comment code are added.

A number of objects within the ArcObjects object model support outbound event interfaces. To work with these interfaces, a certain amount of plumbing code is required to ensure that the event source and sink are connected. The wizard supports all three common event sources: the *MxDocument, PageLayout,* and *Map* objects. None of these options are available if ArcCatalog is set as a target application. When the Map control is selected, the choice is limited to the *Map* object. ArcMap supports all three event sources.

The stub functions the wizard creates will, by default, contain no lines of code other than error-handling code. The exceptions to this are the functions where code was added because it was required to perform an action, such as setting member variables when the command is created. If the function does not contain automatically generated code, you can add a message box to the function. This allows you to see when the application framework calls the function. This can be very helpful when you start to work with events. If the wizard creates a tool, a message box is not added to the *OnClick* event.

The wizard displays step 5 only if you chose to add the code to a class already in the project. If there is only one class, the wizard displays the class in the list with its check box selected; otherwise, you must select a class before continuing.

The wizard displays step 6 only if you chose to listen to *Document* events in step 4. The *NewDocument* and *OpenDocument* events are mandatory as these are required to maintain the source sink connection as new documents are created or loaded.

If you do not select an event to implement, it is straightforward to add the event later. You must select the variable *DocumentEvents* in the Object combo box of the Visual Basic editor, and the required event is selected in Visual Basic's Procedure combo box.

The wizard displays step 7 only if you chose to listen to *Map* events in step 4. The wizard assigns the event handler to the variable *MapActiveViewEvents*.

The wizard displays step 8 only if you chose to listen to PageLayout events in step 4. The wizard assigns the event handler to the variable *PageActiveViewEvents*.

Step 9 allows you to select whether to create a command or a tool. A command has the majority of the functionality coded within the *OnClick* event, whereas a tool is used to handle user interaction with the

ActiveView (*Map* or *PageLayout*). Typically this involves handling mouse events, such as mouse down, mouse move, and mouse up.

Both commands and tools must implement the *ICommand* interface. Step 10 allows you to specify the properties of the *ICommand* interface. The name of the command is automatically generated from the category and caption entries. This can be changed if required. If the command has a bitmap, it can be added by selecting a bitmap file. If the bitmap uses a masking color, this can also be selected by clicking in the Mask color box on the form.

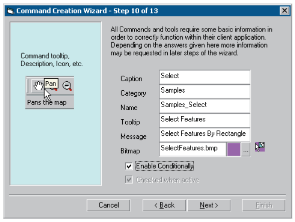
The bitmap is added to an image list named using the class name prepended with "iml", and the image is keyed with the string "Bitmap". The image list is added to a form module with the name *frmResources*. If the module is not present in the project, the wizard adds a form module. The wizard remembers the path of the bitmap file and will open the bitmap file browser at that path on subsequent calls.

The option to Enable conditionally allows you to select when the command will be enabled with the application based on some preset conditions. Step 11 covers these options. The Checked when active option is only available for commands since tools are automatically checked by the application when they are the active tool. When a button on a toolbar is checked, the button appears depressed; when the button is on a menu, a small checkmark is placed to the left of the caption.

The wizard displays step 11 only if you selected the option to Enable conditionally in step 10. These conditions are Data View, Layout View, Data Present, and Edit Status. Data View and Layout View are mutually exclusive. The conditions that you can choose to base the enabling on can be AND'd or OR'd together. If some other combination is required, you must edit the generated source code.

The wizard displays step 12 if you are creating a tool. It is a common function of a tool to generate a geometry object through input from the user; the object is then used in a subsequent action. To support this, you can elect to support Display Feedback, which can be in one of the four geometry types. Pressing the mouse button down and moving the cursor creates the *Envelope* and *Circle* geometries. When you release the mouse, the wizard creates the geometry. You can create polygon and polyline geometries by pressing the mouse button; each successive button press creates a vertex on the geometry. Double-clicking creates the geometry.

A tool normally is in one of two states: passive or active. When the user interacts with the tool, normally by pressing a key or mouse button, the tool is in its active state. When the user is not directly interacting with the tool and the tool is simply the current tool in use, the tool is in its passive state. You can associate cursors with these two states. The cursors are added to an image list named using the class name preceded with "iml", and the images are keyed with the strings "Active" and "Passive". The wizard adds the image list to a form module with the name


Command Creation Wizard - Step 10 of 13

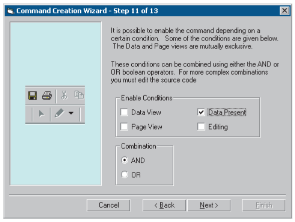
All Commands and tools require some basic information in order to correctly function within their client application. Depending on the answers given here more information may be requested in later steps of the wizard.

Command tooltip, Description, Icon, etc.

Caption: Select
Category: Samples
Name: Samples_Select
Tooltip: Select Features
Message: Select Features By Rectangle
Bitmap: SelectFeatures.bmp

☑ Enable Conditionally
☑ Checked when active

Step 10


Command Creation Wizard - Step 11 of 13

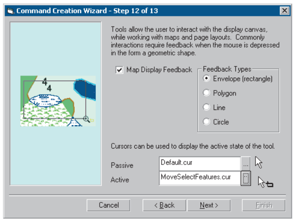
It is possible to enable the command depending on a certain condition. Some of the conditions are given below. The Data and Page views are mutually exclusive.

These conditions can be combined using either the AND or OR boolean operators. For more complex combinations you must edit the source code

Enable Conditions
☐ Data View ☑ Data Present
☐ Page View ☐ Editing

Combination
● AND
○ OR

Step 11


Command Creation Wizard - Step 12 of 13

Tools allow the user to interact with the display canvas, while working with maps and page layouts. Commonly interactions require feedback when the mouse is depressed in the form a geometric shape.

☑ Map Display Feedback

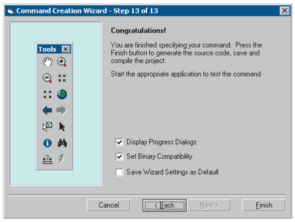
Feedback Types
● Envelope (rectangle)
○ Polygon
○ Line
○ Circle

Cursors can be used to display the active state of the tool.

Passive: Default.cur
Active: MoveSelectFeatures.cur

Step 12

frmResources. If the module is not present in the project, a form module is added. The wizard remembers the path of the cursor file and will open the cursor file browser at that path on subsequent calls.



Command Creation Wizard - Step 13 of 13

Congratulations!

You are finished specifying your command. Press the Finish button to generate the source code, save and compile the project.

Start the appropriate application to test the command

☑ Display Progress Dialogs
☑ Set Binary Compatibility
□ Save Wizard Settings as Default

Step 13

The last panel of the wizard has two options that control the compiling and registration stage and an option to save all the settings selected during the wizard execution as the defaults. These settings include all check boxes and options but do not include the command string properties or the bitmap and icons.

After the wizard generates all the source code, it compiles the project into a DLL. The wizard then registers the DLL on the system and places the newly created class in the appropriate component categories. Only the newly created command is placed in a component category. If there are other classes, the Compile and Register Wizard can be used to register these and create the Registry script for use later with an install program. If required after the successful compile, you can direct the wizard to set the project's version compatibility mode to the newly compiled DLL by checking the Set Binary Compatibility option. You can view the progress of these various stages by checking the Display Progress Dialogs check box.

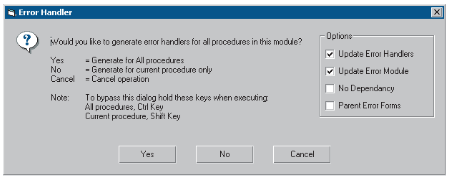
Error handler generator

This Visual Basic add-in automates the generation of error handling code. To access the add-in select the ESRI ErrorHandler Generator menu item on the Add-Ins menu. There are two parts to this add-in: the generation of the error handling code and the execution of the code when a runtime error is created.

The add-in creates the error handlers automatically; you don't ever have to write the error handler manually (unless a specialized handler is required). It is often better to wrap particular function calls with a specialized handler but still have the generic handler in use for the majority of the function.

The DLL can generate the error handlers in one of three ways:

1. Generate an error handler for the current function.
2. Generate error handlers for all the functions within the current module.
3. Generate error handlers for all source files within the active project.



Error Handler

Would you like to generate error handlers for all procedures in this module?

```
Yes     = Generate for All procedures
No      = Generate for current procedure only
Cancel  = Cancel operation

Note:   To bypass this dialog hold these keys when executing:
        All procedures, Ctrl Key
        Current procedure, Shift Key
```

Options
☑ Update Error Handlers
☑ Update Error Module
□ No Dependancy
□ Parent Error Forms

Error Handler add-in dialog box

The message box shown to the left asks for the method to use. This message box can be bypassed by pressing a combination of the Ctrl and Shift keys when executing the tool. The message box also allows the setting of four options.

- Update Error Handlers—Default is *True*. Forces the error handlers, generated by the add-in, in the function(s) to be rewritten even if they are already there. Use this option to ensure that the error handlers match the latest version or if you make a change to the dependency requirements. This ensures the correct arguments are passed to the *ErrorHandler* function.

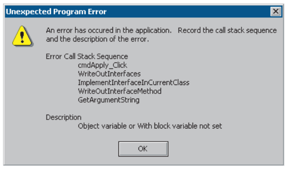
- Update Error Module—Default is *True*. Regenerates the ErrorHandler.bas module added to the project each time the add-in is executed. Typically this would be toggled off if you change the strings used by the various user interfaces. This should be toggled on if there is a change in the dependency requirements.
- No Dependency—Default is *False*. Error handler has no runtime dependency on the ErrorHandlerUI.DLL file. The error log user interface is not available, but the error is simply handled and the call stack displayed to the user in a message box.
- Parent Error Forms—Default is *False*. Parents the various forms using the *m_ParentHWND* module variable.

In addition to the error handler it adds to the functions, the add-in, depending on the options, declares one or two variables in the module: *c_ModuleFileName* and *m_ParentHWND*. The first, a constant, holds a string identifying the filename of the module on disk. If the add-in is executed before the file is saved, this string will be blank. To update the constant you can either enter the name manually or run the add-in again—this will update the constant value. The second is a variable that can hold a window handle that will be used to parent the various user interfaces used by the runtime error handlers. By default, all the error handler interfaces use the desktop as their parent window. Setting the member variable *m_ParentHWND*, defined at the top of the module, to a valid window handle will parent the error dialogs to this window. By default, the member variable *m_ParentHWND* is not added to the module, and all interfaces use the desktop as their parent.

The error handling code makes use of the same generic error handler module that is included with the Interface implementation tool. By default, every time the Error Handler tool executes, this module is regenerated. This means that any changes made to the module will be lost. The generic error handling function *HandleError* takes ten arguments.

Name	Data type	Description
bTopProcedure	Boolean	States whether the error handling function was called from a top-level function or not. Public methods, events and properties and friends are all top-level functions. Private methods called from within the same module are not top-level functions
sProcedureName	string	Encapsulates the function and module name, and any line number information available
lErrNumber	long	ErrorNumber (retrieved from Err object)
sErrSource	string	ErrorSource (retrieved from Err object)
sErrDescription	string	ErrorDescription (retrieved from Err object)
version	long	VersionOfFunction (optional Default 1)
parentHWND	long	Parent hWnd for error dialogs, NULL is valid (option is NULL)
reserved1	variant	Reserved
reserved2	variant	Reserved
reserved3	variant	Reserved

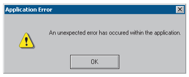
Depending on the first parameter, the *HandleError* function either presents the error to the user using a variety of interfaces or raises the error. A top-level error handler will eventually catch this raised error. In this way, the call stack can be created. For this mechanism to function correctly, all functions should implement this error handler.



```
An error has occured in the application.   Record the call stack sequence
and the description of the error.

Error Call Stack Sequence
            cmdApply_Click
            WriteOutInterfaces
            ImplementInterfaceInCurrentClass
            WriteOutInterfaceMethod
            GetArgumentString

Description
            Object variable or With block variable not set
```

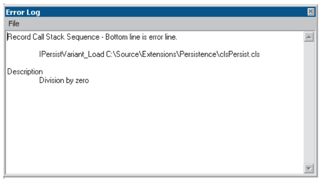
Version 1 error log

The sixth parameter controls the user interface. You can choose to display either a simple Message Box, as shown in the figure to the left, with the error information contained within it (Version 1), or a more comprehensive error handling facility (Version 3). Version 2 is provided for backward compatibility, but its use is deprecated. The message box displayed when an error is raised using Version 1 is shown in the dialog box on the left. Notice the call stack and the original error description.



An unexpected error has occured within the application.

Version 4 information message box

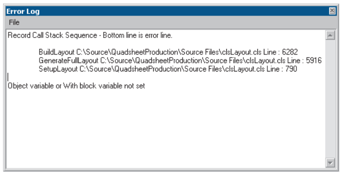


```
Record Call Stack Sequence - Bottom line is error line.

          IPersistVariant_Load C:\Source\Extensions\Persistence\clsPersist.cls

Description
          Division by zero
```

Version 4 error log

Version 4 of the Error Handler displays a message box to the user informing the user that an unexpected error has occurred, along with the error log showing the error message, number, and call stack. Neither of these forms are modal. The forms are implemented as singleton objects, meaning that no matter how many modules make use of the error handler, the errors will all be written to the same error log. If the error log is already displayed, the information message box is not shown. The error log is brought to the front of the display and the error appended to the text already there.

The contents of the error log can either be saved to a text file for later viewing or printed out. Save and Print options are available on the File menu.



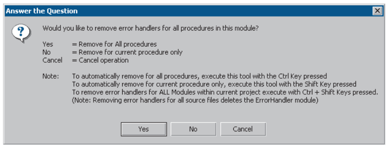
```
Record Call Stack Sequence - Bottom line is error line.

          BuildLayout C:\Source\QuadsheetProduction\Source Files\clsLayout.cls Line : 6282
          GenerateFullLayout C:\Source\QuadsheetProduction\Source Files\clsLayout.cls Line : 5916
          SetupLayout C:\Source\QuadsheetProduction\Source Files\clsLayout.cls Line : 790

Object variable or With block variable not set
```

Error log with line number information

Although the call stack information is useful, the error log displays the most information when combined with Line numbers. In order to obtain line number information in the error log, the source files must be annotated using the Line Number Generator add-in. If line number information is available, the error log displays data similar to that shown to the left.

Error Handler Remover

This add-in removes the error handlers from the source files. To access the add-in, click the Add-Ins menu and click ESRI Error Handler Remover. The add-in displays the message box to the left, which allows the developer to select the files within a project that should have their error handlers removed. You can bypass the dialog box by pressing the Shift and Ctrl keys when the add-in is executed.



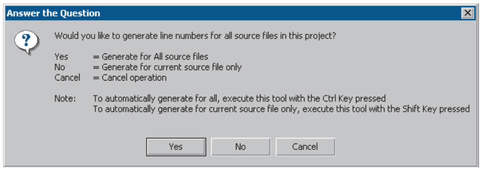
```
Would you like to remove error handlers for all procedures in this module?

Yes       = Remove for All procedures
No        = Remove for current procedure only
Cancel    = Cancel operation

Note:     To automatically remove for all procedures, execute this tool with the Ctrl Key pressed
          To automatically remove for current procedure only, execute this tool with the Shift Key pressed
          To remove error handlers for ALL Modules within current project execute with Ctrl + Shift Keys pressed.
          (Note: Removing error handlers for all source files deletes the ErrorHandler module)
```

Error Handler Remover dialog box

Only ESRI error handlers are removed. If all the handlers for a module are removed, the two constants added to the top of the source file are also removed. If the error handlers are removed from all the source files of a project, the error handler module is removed from the project, but the file is not deleted from disk.

Line Number Generator

The Error Handler add-in can display line number information if there is any line number data available within the source file. Visual Basic supports the extraction of line number information, but only when lines are explicitly labeled with line numbers. This add-in adds line numbers to the appropriate lines within the source files of the active project. Line numbers are added only to those lines that support labeling.



Answer the Question

Would you like to generate line numbers for all source files in this project?

```
Yes      = Generate for All source files
No       = Generate for current source file only
Cancel   = Cancel operation

Note:    To automatically generate for all, execute this tool with the Ctrl Key pressed
         To automatically generate for current source file only, execute this tool with the Shift Key pressed
```

Line Number Generator dialog box

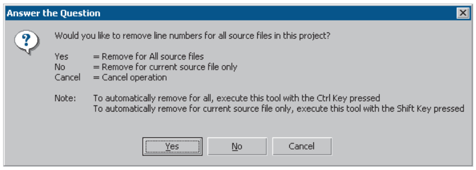
To access the add-in, click the Add-Ins menu and click ESRI Line Number Generator. The add-in displays the dialog box to the left, which lets you select to which files within a project line numbers should be added. You can bypass the dialog box by pressing the Shift and Ctrl keys when the add-in is executed. To update the line number information after edits have been made, reexecute the add-in.

Line number labels in the source code can be obtrusive, making the code difficult to read. Hence you should only add them to debug code when tracing down a problem; remove them after the problem is found. A sample of these labels placed in the source code is shown below.

```
Dim pSourceFeature As IFeature
Dim pTargetFeature As IFeature
Dim i As Long
53: Set pSourceFeature = pFeatureCursor.NextFeature

55: Do While (Not pSourceFeature Is Nothing)
56: Set pTargetFeature = pTargetClass.CreateFeature

58: Set pTargetFeature.Shape = pSourceFeature.ShapeCopy

60: For i = 0 To pTargetClass.Fields.FieldCount - 1
61: If ((pTargetClass.Fields.Field(i).Type <> esriFieldTypeGeometry) And _
(pTargetClass.Fields.Field(i).Type <> esriFieldTypeOID)) Then

63: pTargetFeature.Value(i) = Now End If

65: Next i
66: pTargetFeature.Store

68: Set pSourceFeature = pFeatureCursor.NextFeature
69: Loop
```

Using a combination of the error handler add-in and this line number generator, it is possible to ship software that will provide rich error information in the event of runtime errors within a released product. Even if the line number labels are not placed in the source code during the majority of the development, it is valid to create the release build with the line numbers in place. In this way, if an end user encounters an error, rich context error information is available to investigate the error.

Line Number Remover



Answer the Question

Would you like to remove line numbers for all source files in this project?

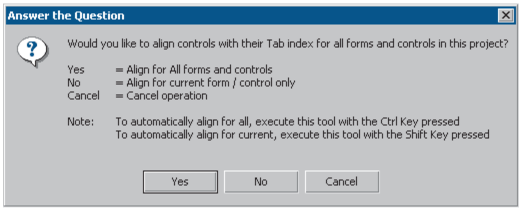
```
Yes      = Remove for All source files
No       = Remove for current source file only
Cancel   = Cancel operation

Note:    To automatically remove for all, execute this tool with the Ctrl Key pressed
         To automatically remove for current source file only, execute this tool with the Shift Key pressed
```

Line Number Remover dialog box

This add-in removes the line numbers from the source files. To access the add-in, click the Add-Ins menu and click ESRI Line Number Remover. The add-in displays the message box to the left to let you select the files within a project whose line number labels should be removed. You can bypass the dialog box by pressing the Shift and Ctrl keys when the add-in is executed.

Align Control Creation with Tab index

When hosting VB user interfaces within applications not created by VB, the Tab index of forms may not be honored. To correct this problem, the controls within a form should be created in their Tab index order.



Answer the Question

Would you like to align controls with their Tab index for all forms and controls in this project?

Yes = Align for All forms and controls
No = Align for current form / control only
Cancel = Cancel operation

Note: To automatically align for all, execute this tool with the Ctrl Key pressed
To automatically align for current, execute this tool with the Shift Key pressed

This add-in ensures that the creation of controls in a form occurs in the same order as the control's Tab index. To access the add-in, click the Add-Ins menu and click ESRI Align Controls with Tab Index. The add-in displays the message box on the left to let you select the modules within a project that have a user interface whose controls you want to align. You can bypass the dialog box by pressing the Shift and Ctrl keys when the add-in is executed.

To achieve the correct creation sequence, the z order of the controls are altered to match the Tab index. Therefore, if you have controls containing controls, you must ensure that you have the Tab index correct, otherwise the controls may "disappear" behind other controls.

In some cases, it may not be possible to change the creation sequence because of the z ordering restriction. In these cases, you must write code within the load sequence of the user interface component that sets the tab sequence.

This section provides coding guidelines when using C++. It also has useful information when debugging projects in Visual Studio. It finishes with a section on developing using the ATL.

Naming conventions

Type names

All type names (*class, struct, enum,* and *typedef*) begin with an uppercase letter and use mixed case for the rest of the name:

```
class Foo : public CObject { . . .};
struct Bar { . . .};
enum ShapeType { . . . };
typedef int* FooInt;
```

Typedefs for function pointers (callbacks) append Proc to the end of their names.

```
typedef void (*FooProgressProc)(int step);
```

Enumeration values all begin with a lowercase string that identifies the project; in the case of ArcObjects this is esri, and each string occurs on separate lines:

```
typedef enum esriQuuxness
 {
  esriQLow,
  esriQMedium,
  esriQHigh
} esriQuuxness;
```

Function names

Name functions using the following conventions:

For simple accessor and mutator functions, use Get<Property> and Set<Property>:

```
int GetSize();
void SetSize(int size);
```

If the client is providing storage for the result, use Query<Property>:

```
void QuerySize(int& size);
```

For state functions, use Set<State and Is<State> or Can<State>:

```
bool IsFileDirty();
void SetFileDirty(bool dirty);
bool CanConnect();
```

Where the semantics of an operation are obvious from the types of arguments, leave type names out of the function names.

Instead of:

```
AddDatabase(Database& db);
```

consider using:

```
Add(Database& db);
```

Name variables and constants using the following format (this is an abridged Hungarian notation):

[<scope>_]<type><name>

Prefix	Variable scope
m	Instance class members
c	Static class member (including constants)
g	Globally static variable
<empty>	local variable or struct or public class member

<type>

Prefix	Data Type
b	Boolean
by	byte or unsigned char
cx / cy	short used as size
d	double
dw	DWORD, double word or unsigned long
f	float
fn	function
h	handle
i	int (integer)
ip	smart pointer
l	long
p	a pointer
s	string
sz	ASCIIZ null-terminated string
w	WORD unsigned int
x, y	short used as coordinates

<name> describes how the variable is used or what it contains.The <scope> and <type> portions should always be lowercase, and the <name> should use mixed case:

Variable Name	Description
m_hWnd	a handle to a HWND
ipEnvelope	a smart pointer to a COM interface
m_pUnkOuter	a pointer to an object
c_isLoaded	a static class member
g_pWindowList	a global pointer to an object

Instead of:

```
ConvertFoo2Bar(Foo* foo, Bar* bar);
```

consider using:

```
Convert(Foo* foo, Bar* bar)
```

If a client relinquishes ownership of some data to an object, use Give<Property>. If an object relinquishes ownership of some data to a client, use Take<Property>:

```
void GiveGraphic(Graphic* graphic);
Graphic* TakeGraphic(int itemNum);
```

Use function overloading when a particular operation works with different argument types:

```
void Append(const CString& text);
void Append(int number);
```

Argument names

Use descriptive argument names in function declarations. The argument name should clearly indicate what purpose the argument serves:

```
bool Send(int messageID, const char* address, const char* message);
```

True and false

There are at least three different sets of keywords for indicating the truth value of an expression. C++ has a built-in data-type *bool*, with keywords *true* and *false*. Win32 defines *TRUE* and *FALSE* macros. VB compatible COM programming requires the use of the Automation type *VARIANT_BOOL*, with macros *VARIANT_TRUE* and *VARIANT_FALSE*.

These keyword macros have one thing in common. *True* evaluates to a nonzero value, and *False* evaluates to zero. *VARIANT_TRUE* is defined as -1, which means that the correct macros and keywords must be used when comparing variables.

Class design

Conforming to a class design standard leads to easy-to-use and maintainable C++ class implementations.

Class layout

Organize class definitions in the following manner:

```
class MyClass : public CObject, private MyPrivateClass
 {
  // The public description of the class goes here. It describes what
  // the class represents (from a client's perspective), and highlights
  // which methods are the most important. Optionally, it shows examples
  // of how to use the class.

public:
  // Nested class and struct definitions.
  // Enumerations, typedefs and constants.
  MyClass()        {}
  virtual ~MyClass() {}

  // Public operations.

  // Public accessor/mutator functions.

protected:
  // Protected description of the class goes here. This documentation
  // usually consists of instructions to potential subclassers on how to
  // subclass the class correctly.

  // Nested class and struct definitions.
  // Enumerations, typedefs and constants.
  // Protected data members.

  // Subclass-accessible operations. These are usually virtual.

private:
  // Nested class definitions.
  // Enumerations, typedefs, and constants.
  // Private data members.

  // Private operations.
 };
```

Organizing classes this way helps clients of the class since it groups public operations and functions at the beginning. All the proprietary implementation details occur at the end of the class definition since clients do not need to know about them.

Public data

Do not make data members public unless the class is intended to be a semi-intelligent structure. One of the major benefits to using objects is the ability to encapsulate and hide implementation details from clients.

Class size

Keep classes small to decrease their complexity and increase their reusability. If you cannot summarize what the class does in a paragraph or less, chances are it is too complex and should be broken up into multiple classes.

Inline methods

Use inline methods only for empty implementations or for those containing only a few statements. Do not add a semicolon after the function body, but do add spaces to offset the brackets when there are statements in the function body. When several methods are inlined, line up the function bodies on the same column.

```
MyClass() : m_count(0)          {}
void SetCount(int count)        { m_count = count; }
```

Comments

To increase class legibility, add comments after the method or data member. If the comment fits to the right, place it there; otherwise, add it afterwards as an indented comment.

```
public:
  void SetCount(int count);
  //
  // Sets the count property of the object. Use this method only
  // when you are resetting the object.

  int GetCount();        // Gets the current count.

private:
  int     m_count;       // The current count.
  bool    m_inited;
   //
   // This property indicates whether or not the object is
   // currently being inited.
```

Construction

Be sure to provide a copy constructor and overload for the operator if the default structurewise copy will result in an invalid object. Alternatively, consider hiding both by making them private.

```
MyClass(const MyClass& rhs);
MyClass& operator=(const MyClass& rhs);
```

Initialization versus assignment in constructors

When the constructor is invoked for an instance of a class, the following operations occur in the following order (storage is allocated for the entire instance):

- The constructor is invoked for the base class (in superclass to subclass order for all classes in the hierarchy).
- The constructors for any data members that are class variables are invoked in the order of their declaration in the interface specification.
- Execution of code defined within the constructor body occurs.

To avoid redundant operators, the following approach to constructor definition is suggested:

- Explicitly specify the call to the base class in the initialized list even if the default constructor is intended. This makes it more likely that errors can be detected during walk-throughs.
- Always initialize data members that are class variables using the initialization list, and initialize them in the order in which they are declared in the interface specification. This avoids unnecessary calls to default constructors and prevents unexpected side effects due to order of initialization.

- Initialize any primitive data types and pointers in either the initializer list or the body of the constructor.

Assignment operators

The assignment operators (=) should be explicitly defined for all classes. The automatic memberwise copy provided by the compiler is adequate only for shallow copy situations. Even if it works for initial development, it is likely to be inadequate when maintenance is performed. The following precautions should always be taken:

- The assignment operator should always return a reference to itself. The return type will be Type&, and the return value will be *this.
- The "other" assignment operators (+=, -=, *=, and so on) should conform to the same behavior as the primary assignment operator.
- Always check for self-assignment. The following example format should always be used for the simple assignment operator.

```
Type& Type::operator = (const Type& rhs)
 {
  if (this != &rhs)
   {
    ... code to perform copy goes here ...
   }
  return *this;
 }
```

- Assign base variables by invoking the base assignment operator. The following example indicates appropriate behavior:

```
DerivedType& DerivedType::operator = (const DerivedType& rhs)
 {
  if (this != &rhs)
   {
   BaseType::operator = (rhs);
    ... code to perform copy goes here ...
   }
  return *this;
 }
```

Casting

In general, all casts should now use one of the following explicit castings.

```
static_cast<>()
const_caset<>()
dynamic_cast<>()
reinterpret_cast<>()
```

The new style casts are preferred because they are more explicit and more visible.

const Methods

Make methods *const* when they do not change the object in any way.

```
int GetCount() const              { return m_count; }
```

If a method is conceptually *const* from the client's viewpoint, but internally the implementation needs to adjust some private data member, make the function *const* but cast away its *const*-like quality in the implementation.

```
int GetCount() const;

int MyClass::GetCount() const
 {
  MyClass*  self = const_cast<MyClass*> this;  // Cast away const-ness

  if (self->m_countLoaded)
    self->LoadCount();

  return m_count;
 }
```

The keyword *mutable* can explicitly exempt data elements from *const*-like quality.

Using the *const* modifier

The *const* modifier is used in variable declaration to indicate that the variable cannot be modified after initialization. If the variable is declared with program, file, or function scope, it must be initialized when it is declared. When a pointer variable is declared, there are five possible options, as shown to the left.

Statement	Meaning
Foo* pFoo	Both the pointer and the referenced data may be modified
const Foo* pFoo	The pointer may be modified, but not the referenced data
const Foo& pFoo	The referenced data may not be modified
Foo* const pFoo	The referenced data may be modified, but not the pointer
const Foo* const pFoo	Neither the pointer or referenced data may be modified

const *options for pointer variables*

When using reference variables, the reference may never be modified. The *const* modifier only refers to the referenced data.

When *const* is used as a keyword following a class-member function, it indicates that the member function will not modify any class member variables. The *const* keyword must be used in both the interface definition and the implementation.

Type definitions and constants

If a constant or a type definition (*class, struct, enum,* or *typedef*) conceptually belongs to another class (that is, its only use is within the interface or implementation of another class), place it within the public, protected, or private scope of that class.

```
class Foo : public CObject
 {
public:
  struct Bar
   {
    int   width;
    int   height;
   };

  typedef int ProgressLevel;
protected:
  typedef enum esriProgress
  {
   esriPIdle,
   esriPRunning,
   esriPCompleted
  } esriProgress;
 };
```

Syntactic guidelines

The following syntactic guidelines make code more readable; they help maintainability and group development.

Indentation

Use tabs for indentation and set the tab size equal to two spaces. Do not replace tabs with spaces.

Implementation organization

Organize .cpp files as follows:

```
// Include precompiled header.
// Other includes.

// Macro definitions.

// Global data.
// Static class members.

// Constructor(s).
// Destructor.

// Public operations.
//   These should occur in the same order as the class definition.

// Protected operations.
//   These should occur in the same order as the class definition.

// Private operations.
//   These should occur in the same order as the class definition.
```

Avoid macros

Where possible, use *const* definitions instead of macros.

Instead of:

```
#define MAX_COUNT    10
```

use:

```
const int    g_maxCount    = 10;
```

Instead of:

```
#define DEFAULT_USER TEXT("Moe")
```

use:

```
const TCHAR* g_defaultUser = TEXT("Moe");
```

Comments

Use C++-style comments rather than C comments, unless you are writing a file that needs to be compiled by the C compiler.

```
// This is a C++ comment and should be used in all C++ code.
/* This is a C comment and should only be used in C code. */
```

White space

Arguments should be separated by a comma and single space. Spaces should not occur between the function name and the initial parenthesis or between the parentheses and the arguments.

```
result = MyFunction(count, name, &context);
```

Separate functions with at least one blank line.

```
void MyClass::MyFunction1()
 {
 }

void MyClass::MyFunction2()
 {
 }
```

Operators

Surround all operators with a space to the left and right.

```
size += sizeof(address);
 i = j / 10 - 25;
```

Do not use extra spaces with these operators: !, #, ->, ., ++, and -.

```
if (!fileIsDirty) return;
#define DEBUG_ME
AfxGetApp()->ParseCommandLine(cmdInfo);
theConnection.Close();
 if (i++ > 10 && j– < 100)
```

Operator precedence

Where operator precedence is not immediately obvious, use parentheses to indicate order of execution.

```
 result = (i - (10 - count)) / 42;
```

Nested *if* statements

Avoid deeply nested blocks of *if* statements. They are difficult to read and debug.

```
 if (i < 10)
 {
   if (i != 5)
   {
     if (j == 42)
     {
      MyFunc(i, j);
     }
   }
 }
```

Instead, use algorithmically equivalent *else-if* blocks that check the reverse conditions and are not deeply nested:

```
if (i >= 10)
 {
 }
else if (i == 5)
 {
 }
else if (j == 42)
 {
  MyFunc(i, j);
 }
```

Function declarations

Whenever possible, place function declarations on a single line:

```
bool ConnectToDatabase(const char* machineName, const char* databaseName);
```

If the declaration is too long, break it up into multiple indented lines, with all argument names positioned in the same column:

```
bool Connection::ConnectToDatabase(
        const char*         machineName,
        const char*         databaseName,
        const char*         userName,
        const char*         password,
        unsigned long       timeout,
        int&                connectionID);
```

When calling functions, try to place all arguments on a single line. If this is not possible, break them up into multiple lines, with each line indented one tab stop in from the leftmost character of the function name:

```
bool connectionResult = myConnection.ConnectToDatabase(machine, database,
                              user, password, timeout,
                              connectionID);
```

Global scope

Use :: to indicate global scope.

```
result = ::AfxMessageBox(errMsg, MB_OK, 0);
```

Brackets

Brackets should occupy an entire line by themselves.

```
for (int i = 0; i < 10; i++)
 {
 }

if (i <= 10)
 {
 }
else
 {
 }
```

Variable declaration

Where possible, declare variables where they are used, rather than grouping them together at the beginning of a function.

```
void MyFunc()
{
  . . .
 CString database;
 theDB.QueryDatabaseName(database);
  . . .
}
```

Where possible, declare loop variables in the first line of a *for* statement.

```
for (int i = 0; i < 10; i++)
{
  . . .
}
```

Avoid declaring multiple local variables on a single line.

```
int   connCount, connSuccess, passwordHandle, securityAttributes;
```

Instead, put them on separate lines, or at least group together only those that are logically related.

```
int   connCount, connSuccess;
int   passwordHandle, securityAttributes;
```

When declaring pointers, place the asterisk directly next to the type and leave a space before the variable, argument, or function name.

Instead of:

```
char *myText;
```

use:

```
char* myText;
```

Instead of:

```
void *MyFunc(int *arg);
```

use:

```
void* MyFunc(int* arg);
```

Bit-fields

Use bit-fields where possible to promote efficiency.

```
unsigned                           m_flagA:1;
unsigned                           m_flagB:1;
unsigned:0;                                  // pads to integer boundary
```

Nested headers

Avoid including headers in other headers. Use forward declarations where possible.

```
class Bar;
class Foo
{
public:
    Bar*        m_bar;
  };
```

Switch Statements

Construct a switch statement as follows. Note that the case and break keywords are indented one level, and the statements are all indented two levels.

```
switch (code)
 {
  case firstCase:
    . . .
   break;

  case secondCase:
    . . .
   break;

  default:
    . . .
   break;
 }
```

When an individual case contains many statements, move them into a separate function or enclose them with additional brackets.

```
case nthCase:
 {
   . . .
 }
break;
```

Always provide a default case within switch statements, even if the result is to log an error message and terminate. Always provide a break or return statement for each case path or an explicit comment on the justification for fall-through behavior.

Use references

Use references instead of pointers unless a NULL pointer value is needed. This is because the semantics of passing a pointer in C and C++ is very ambiguous.

```
void MyFunc(int* s);
```

The parameters of the function above could represent any of the following:

- A single *int*
- An array of *int* of a certain length
- An input-only parameter
- An output-only parameter
- Both an input and an output parameter

By using references (and const), these ambiguities are avoided.

```
void MyFunc(int& s);
void MyFunc(const int[]& s);
void MyFunc(const int& s);
void MyFunc(int& s);
```

Initialization

Use initialization syntax to initialize all data members to their default values, unless the initialization is conditional. Do not leave any members uninitialized. Place each data member on its own separate line.

```
MyClass()
  : m_count(0),
    m_name(0)
 {
 }
```

NULL initialization

Use 0 instead of *NULL*. In C++, the value 0 can be used to initialize any numeric or pointer variable.

Exceptions

A class should handle the exceptions thrown by objects that it uses and should define and throw its own exceptions when an unrecoverable situation occurs.

Avoid global data

Global data is inherently dangerous in a multithreaded environment. Where possible, try to embed all data in objects. In situations where data represents a shared resource, be sure to protect access to it with a critical section.

Avoid macros

C++ provides language constructs that in many cases obviate the need for macros. The constructs are integrated into the compiler and debugger. Thus, you gain type safety and ease of debugging.

Instead of doing this:

```
#define MyConstant 10
```

do this:

```
const long s_MyConstant  = 10
```

Instead of doing this:

```
#define MyHelper(a, b) \
 a = 1;              \
 b = 2;              \
 a = b + a;          \
```

do this:

```
inline double MyHelper(double a, double b) {…}
```

About the only time you need macros is to adjust behavior in accordance with build settings:

```
#ifdef _DEBUG
OutputDebugString("I'm Here");
#endif
```

Using C++ with MFC and Win32

Standard C++ data types

Windows Type	Description
BYTE	unsigned char
SHORT	signed 16-bit integer
LONG	signed 32-bit integer
WORD	unsigned 16-bit integer
DWORD	unsigned 32-bit integer

Windows data types

Use standard C++ data types (*int, short, long, bool, void,* and others) unless the exact size of the data is critical to the behavior of the function, as with serialization or file I/O. In these cases, use Windows data types that are explicitly signed/unsigned and have an unambiguous size.

Use *ASSERT* and *VERIFY*

The *ASSERT* and *VERIFY* macros are invaluable debugging aids that should be used liberally throughout your code to check for entry and exit conditions or any other exceptional situations.

```
ASSERT(pWnd);
VERIFY(loading && userCount > 2);
```

Use *ASSERT* during the development phase to ensure that clients are adhering to rules for your interfaces. An assertion failure during development indicates that the contract between caller and callee has been broken.

The *VERIFY* macro does not go away in release builds. Use this only to check for catastrophic failure.

ASSERT and *VERIFY* behave identically in debug builds. However, in release builds, *ASSERT* compiles into nothing, whereas the arguments to *VERIFY* get treated as regular statements.

```
ASSERT(wnd && loading);               // NOP in release build.
VERIFY(contents->LoadContextMenu());  // LoadContextMenu happens in
                                      // release build!
```

Use WIN32_ASSERT

If MFC is not available, consider using one of the string smart types covered later in this chapter.

Any Win32 call that sets an error code can use *WIN32_ASSERT* to throw an exception that displays the result of *GetLastError()*. However, this macro behaves the same as *VERIFY*, in that the side effect remains even in a release build, so be sure that this is the behavior you want.

Character strings

Consider using *CString* for all string data that you track and manipulate, instead of managing your own character arrays.

- Since *CString* is entirely *TCHAR*-based, Unicode is handled transparently with no extra work on your part.
- *CString* is very efficient with memory—where the same string value is passed from one *CString* to the next, no new storage is allocated until the second string is modified.

Application settings

Use the Windows registry to store and retrieve application settings. Do not use .ini files.

Windows and MFC function calls

Calls to all Windows and global MFC functions should use :: to indicate global scope.

Localization requirements

When developing an application intended for use in more than one language, a number of issues must be considered that will make the localization of the software an easier process.

Use string resources

Never place string constants in the code; instead, define them in a resource file from which they are loaded at runtime.

```
CString errorMessage;
errorMessage.LoadString(IDS_FILE_NOT_FOUND);
```

The only exceptions are debugging strings—they may reside directly in the code since they do not affect the released product and need not be localized.

Store all string constants together in a standard module to facilitate translation to other languages.

Support Unicode

All code should be Unicode-compliant; therefore, use arrays of *TCHAR* (instead of *char*) to represent character strings. Depending on the compilation settings, *TCHAR* expands either into single-character strings (ANSI) or wide-character strings (Unicode).

For string literals, use the *TEXT* macro to force the string or character to be Unicode compliant.

```
TCHAR dirSep = TEXT('\');
CString driveName(TEXT("C:"), 2);
```

Instead of the standard ANSI string functions, use the generic text mapping macros. A list of the more common string-handling functions, along with the correct macro to use, appears on the table to the left.

ANSI Function	Unicode-compliant macro
strlen	_tcslen
strcat	_tcscat
strncpy	_tcsncpy
strchr	_tcschr
strncmp	_tcsncmp
strstr	_tcsstr
atoi	_ttoi
atol	_ttol
splitpath	_tsplitpath

For a complete list of generic text-mapping macros, refer to the Visual C++ online help, in C/C++ Run-Time Library Reference, in the 'Generic Text Mappings' chapter.

SMART TYPES

Smart types are objects that behave like types. They are C++ class implementations that encapsulate a data type, wrapping it with operators and functions that make working with the underlying type easier and less error prone but transparent. When these smart types encapsulate an interface pointer, they are referred to as smart pointers. Smart pointers work by working with the *IUnknown* interface to ensure that resource allocation and deallocation are correctly managed. They accomplish this by various functions, construct and destruct methods, and overloaded operators. There are numerous smart types available to the C++ programmer. The two main types of smart types covered here are defined by Direct-To-COM (DTC) and the Active Template Library. The relevant Direct-To-COM compiler extensions for the ArcObjects developer will be covered in the Active Template Library section later in this chapter.

DTC was an initiative from Microsoft to make COM C++ programming more like Visual Basic. To achieve this, DTC provides a set of classes and compiler extensions that shipped initially with Visual Studio 5.

Smart types can make the task of working with COM interfaces and data types easier since many of the API calls are moved into a class implementation; however, they must be used with caution and never without a clear understanding of how they are interacting with the encapsulated data type.

Direct-To-COM

The smart type classes supplied with DTC are known as the Compiler COM Support Classes and consist of:

- *_com_error*—this class represents an exception condition in one of the COM support classes. This object encapsulates the *HRESULT* and the *IErrorInfo* COM exception object.
- *_com_ptr_t*—this class encapsulates a COM interface pointer. See below for common uses.
- *_bstr_t*—this class encapsulates the *BSTR* data type. The functions and operators on this class are not as rich as the ATL *BSTR* smart type, hence this is not normally used.
- *_variant_t*—this class encapsulates the *VARIANT* data type. The functions and operators on this class are not as rich as the ATL *VARIANT* smart type, hence this is not normally used.

To define a smart pointer for an interface, you can use the macro *_COM_SMARTPTR_TYPEDEF* like this:

```
_COM_SMARTPTR_TYPEDEF(IFoo, __uuidof(IFoo));
```

The compiler expands this as such:

```
typedef _com_ptr_t<_com_IIID<IFoo, __uuidof(IFoo)> > IFooPtr;
```

Once declared, it is simply a matter of declaring a variable as the type of the interface and appending *Ptr* to the end of the interface. Below are some common uses of this smart pointer that you will see in the numerous C++ samples.

```
// Get a CLSID GUID constant
extern "C" const GUID __declspec(selectany) CLSID_Foo = \
   {0x2f3b470c,0xb01f,0x11d3,{0x83,0x8e,0x00,0x00,0x00,0x00,0x00,0x00}};

// Declare Smart Pointers for IFoo, IBar and IGak interfaces
_COM_SMARTPTR_TYPEDEF(IFoo, __uuidof(IFoo));
_COM_SMARTPTR_TYPEDEF(IBar, __uuidof(IBar));
_COM_SMARTPTR_TYPEDEF(IGak, __uuidof(IGak));
```

```
STDMETHODIMP SomeClass::Do ()
 {
  // Create Instance of Foo class and QI for IFoo interface
  IFooPtr      ipFoo(CLSID_Foo);
  if (ipFoo == 0) return E_NOMEMORY

  // Call method on IFoo to get IBar
  IBarPtr     ipBar;
  HRESULT hr = ipFoo->get_Bar(&ipBar);
  if (FAILED(hr)) return hr;

  // QI IBar interface for IGak interface
  IGakPtr      ipGak(ipBar);

  // Call method on IGak
  hr  = ipGak->DoSomething()
  if (FAILED(hr)) return hr;

  // Explicitly call Release()
   ipGak = 0
   ipBar = 0

  // Let destructor call IFoo's Release
  return S_OK;
 }
```

ActiveTemplate Library

ATL defines various smart types, as seen in the list below. You are free to combine both the ATL and DTC smart types in your code.

ATL smart types:

- *CComPtr*—class encapsulates a COM interface pointer by wrapping the *AddRef* and *Release* methods of the *IUnknown* interface.
- *CComQIPtr*—class encapsulates a COM interface and supports all three methods of the *IUnknown* interface: *QueryInterface, AddRef,* and *Release*.
- *CComBSTR*—class encapsulates the *BSTR* data type.
- *CComVariant*—class encapsulates the *VARIANT* data type.
- *CRegKey*—class provides methods for manipulating Windows registry entries.
- *CComDispatchDriver*—class provides methods for getting and setting properties and calling methods through an object's *IDispatch* interface.
- *CSecurityDescriptor*—Class provides methods for setting up and working with the Discretionary Access Control List (DACL).

This section examines the first four smart types and their uses. The example code below, written with ATL smart pointers, looks like the following:

```
// Get a CLSID GUID constant
extern "C" const GUID __declspec(selectany) CLSID_Foo = \
   {0x2f3b470c,0xb01f,0x11d3,{0x83,0x8e,0x00,0x00,0x00,0x00,0x00,0x00}};

STDMETHODIMP SomeClass::Do ()
 {
  // Create Instance of Foo class and QI for IFoo interface
  CComPtr<IFoo>      ipFoo;
  HRESULT hr = CoCreateInstance(CLSID_Foo, NULL, CLSCTX_INPROC_SERVER,
                                IID_IFoo, (void **)& ipFoo);
   if (FAILED(hr)) return hr

  // Call method on IFoo to get IBar
  CComPtr<IBar>     ipBar;
  HRESULT hr = ipFoo->get_Bar(&ipBar);
  if (FAILED(hr)) return hr;

  // IBar interface for IGak interface
  CComQIPtr<IGak>      ipGak(ipBar);

  // Call method on IGak
  hr  = ipGak->DoSomething()
  if (FAILED(hr)) return hr;

  // Explicitly class Release()
   ipGak = 0
   ipBar = 0

  // Let destructor call Foo's Release
  return S_OK;
 }
```

When reassigning an ATL smart pointer, a debug ASSERT is raised if the previous interface pointer is not explicitly released.

The most common smart pointer seen in the samples is the *DTC* type. In the examples below, which illustrate the *BSTR* and *VARIANT* data types, the *DTC* pointers are used. When working with *CComBSTR*, use the text mapping L"<string>", for example, L"name", to declare constant *OLECHAR* strings. *CComVariant* derives directly from the *VARIANT* data type, meaning that there is no overloading with its implementation, which in turn simplifies its use. It has a rich set of constructors and functions that make working with *VARIANTs* straightforward; there are even methods for reading and writing from streams. Be sure to call the *Clear* method before reusing the variable.

```
IFeaturePtr  ipFeature(GetControllingUnknown()); // Get IFeature interface

// Get IFields interface and find index of Name field
 long*        lIndex;
```

```
IFieldsPtr   ipFields;
HRESULT hr;

hr = ipFeature->get_Fields(&ipFields);
if (FAILED(hr)) return hr;

hr = ipFields->FindField(CComBSTR(L"Name"), &lIndex);
if (FAILED(hr)) return hr;

// Get OID change its type to String and set Name
// then set it back onto the feature
CComVariant  vID;
hr = ipFeature->get_Value(0, &vID);
if FAILED(hr)) return hr;

// Change its data type
hr = vID.ChangeType(VT_BSTR);
if (FAILED(hr)) return hr;

hr = ipFeature->put_Value(lIndex, vID);
if (FAILED(hr)) return hr;
hr = ipFeature->Store();
if (FAILED(hr)) return hr;
```

When working with *CComBSTR* and *CComVariant*, the *Detach()* function returns the underlying data type and should be used when passing a pointer as an [out] parameter of a method. The use of the *Detach* method is shown below.

```
void GetName(BSTR* name)
 {
  CComBSTR bsName(L"FooBar");
  *name = bsName.Detach();
 }
```

USEFUL C++ TIPS

These C++ tips are included here as tips for better development and should not be seen as a set of rules.

A better callback model

Instead of passing function pointers and opaque context data to implement callbacks, consider defining an abstract notification class that encapsulates the various notification events that can be fired. Clients can then subclass and instantiate this class to register for notification.

To see how this might work, consider the following example. It shows how to implement a traditional callback mechanism between an object (*Bar*) and a client (*Foo*).

```
class Foo : public CObject
 {
public:
 Foo(Bar& bar) { bar.m_client = this; bar.m_clientProc = BarStub; }
 int Bar(char* string)  { printf("%s", string); }

 static int BarStub(void* client, char* string)
                 { ((Foo*)client) ->Bar(string); }
};

class Bar
{
public:
 typedef int (*BarProc)(void* client, char* string);

 void*     m_client;
 BarProc   m_clientProc;

 void InvokeCallback()
   { if (m_clientProc) (*m_clientProc)(m_client, string); }
};
```

The *Bar* class defines the prototype for the callback function and has two member variables: the address of the function to invoke and the object (stored as a *void**) to pass along to the callback. Furthermore, at the *Foo* end, an additional static stub routine (*BarStub*) is needed that casts the opaque pointer to a *Foo* object before the real *Foo* method (*Bar*) is invoked. This seems like a lot of overhead for such a simple task. It is also dangerous because it casts the *void** into a *Foo**.

However, there is a better way. By taking advantage of abstract classes in C++, the relationship between *Foo* and *Bar* can be much more cleanly implemented:

```
class Foo : public CObject, public BarInterface
{
public:
  Foo(Bar& bar)        { bar.m_client = this; }
 int Bar(char* string) { printf("%s", string); }
};

class BarInterface
{
public:
 virtual int Bar(void* client, char* string) = 0;
};

class Bar
{
public:
 BarInterface*   m_client;

 void InvokeCallback() { if (m_client) m_client->Bar(string); }
};
```

The difference in this solution is that an abstract class, *BarInterface*, has been introduced. It lives alongside the *Bar* class, like before, and contains virtual methods that must be overridden by subclasses. These methods represent the events (callbacks) that the *Bar* class sends. The events are handled when a client provides a subclass that implements them. In this example, *Foo* derives both from *CObject* and from *BarInterface* and implements the *BarInterface* method, *Bar*.

There are several advantages to this approach. First of all, type safety is always maintained, unlike the former example; objects are never cast to *void** and then cast back to objects. Also, when a class provides multiple callbacks (which is often the case), they can all be encapsulated together in the abstract callback class. Some or all of them may be tagged with = 0, indicating that they must be overridden; this prevents clients from unwittingly implementing one callback while forgetting another, which is vital for proper functioning. One can also provide default implementations for the callbacks, should a subclass choose not to implement one. (Providing defaulted functions under the traditional model is difficult and error-prone.) Lastly, by using virtual functions directly, there is no need for static stub functions.

DEBUGGING TIPS IN DEVELOPER STUDIO

Visual C++ comes with a feature-rich debugger. These tips will help you get the most from your debugging session.

Backing up after failure

When a function call has failed and you'd like to know why (by stepping into it), you don't have to restart the application. Use the Set Next Statement command to reposition the program cursor back to the statement that failed (right-click on the statement to bring up the debugging context menu). Then, just step into the function.

Unicode string display

Set your debugger options to display Unicode strings (click the Tools menu, click Options, click Debug, then check the Display Unicode Strings check box).

Variable value display

Pause the cursor over a variable name in the source code to see its current value. If it is a structure, click it and bring up the QuickWatch dialog box (the Eyeglasses icon or Shift+F9) or drag and drop it into the Watch window.

Undocking windows

If the Output window (or any docked window, for that matter) seems too small to you, try undocking it to make it a real window. Just right-click it and toggle the Docking View item.

Conditional break points

Use conditional break points when you need to stop at a break point only once some condition is reached (a for-loop reaching a particular counter value). To do so, set the break point normally, then bring up the Breakpoints window (Ctrl+B or Alt+F9). Select the specific break point you just set and then click the Condition button to display a dialog in which you specify the break point condition.

Preloading DLLs

You can preload DLLs that you wish to debug before executing the program. This allows you to set break points up front rather than wait until the DLL has been loaded during program execution. (Click Project, click Settings, click Debug, click Category, then click Additional DLLs.) Then, click in the list area below to add any DLLs you wish to have preloaded.

Changing display formats

You can change the display format of variables in the QuickWatch dialog box or in the Watch window using the formatting symbols in the following table.

Symbol	Format	Value	Displays
d, i	signed decimal integer	0xF000F065	-268373915
u	unsigned decimal integer	0x0065	101
o	unsigned octal integer	0xF065	0170145
x, X	hexadecimal integer	61541	0x0000F065
l, h	long or short prefix for d, I, u, o, x, X	00406042, hx	0x0C22
f	signed floating-point	3./2.	1.500000
e	signed scientific notation	3./2.	1.500000e+00
g	e or f, whichever is shorter	3./2.	1.5
c	single character	0x0065	'e'
s	string	0x0012FDE8	"Hello"
su	Unicode string		"Hello"
hr	string	0	S_OK

To use a formatting symbol, type the variable name followed by a comma and the appropriate symbol. For example, if var has a value of 0x0065, and you want to see the value in character form, type var,c in the Name column on the tab of the Watch window. When you press ENTER, the character-format value appears: var,c = 'e'. Likewise, assuming that *hr* is a variable holding *HRESULTS*, view a human-readable form of the *HRESULT* by typing "hr,hr" in the Name column.

You can use the formatting symbols shown in the following table to format the contents of memory locations.

You can apply formatting symbols to structures, arrays, pointers, and objects as unexpanded variables only. If you expand the variable, the specified formatting affects all members. You cannot apply formatting symbols to individual members.

Symbol	Format	Value
ma	64 ASCII characters	0x0012ffac .4...0...".0W&.. .....1W&.0.:W..1 ....."..1.JO&.1.2 .."..1...0y....1
m	16 bytes in hex, followed by 16 ASCII characters	0x0012ffac B3 34 CB 00 84 30 94 80 FF 22 8A 30 57 26 00 00 .4...0....".0W&..
mb	16 bytes in hex, followed by 16 ASCII characters	0x0012ffac B3 34 CB 00 84 30 94 80 FF 22 8A 30 57 26 00 00 .4...0...".0W&..
mw	8 words	0x0012ffac 34B3 00CB 3084 8094 22FF 308A 2657 0000
md	4 double-words	0x0012ffac 00CB34B3 80943084 308A22FF 00002657
mu	2-byte characters (Unicode)	0x0012fc60 8478 77f4 ffff ffff 0000 0000 0000 0000

With the memory location formatting symbols, you can type any value or expression that evaluates to a location. To display the value of a character array as a string, precede the array name with an ampersand, *&yourname*. A formatting character can also follow an expression:

- *rep+1,x*
- *alps[0],mb*
- *xloc,g*
- *count,d*

To watch the value at an address or the value pointed to by a register, use the *BY, WO,* or *DW* operator:

- *BY* returns the contents of the byte pointed at.
- *WO* returns the contents of the word pointed at.
- *DW* returns the contents of the doubleword pointed at.

Follow the operator with a variable, register, or constant. If the *BY, WO,* or *DW* operator is followed by a variable, then the environment watches the byte, word, or doubleword at the address contained in the variable.

You can also use the context operator *{ }* to display the contents of any location.

To display a Unicode string in the Watch window or the QuickWatch dialog box, use the su format specifier. To display data bytes with Unicode characters in the Watch window or the QuickWatch dialog box, use the mu format specifier.

MFC Class Autoexpand

Microsoft Developer Studio has an autoexpand capability for Microsoft Foundation Class library classes. The string (or other information) between the braces ({ }) is automatically expanded.

Keyboard shortcuts

There are numerous keyboard shortcuts that make working with the Visual Studio editor faster. Some of the more useful keyboard shortcuts follow.

The text editor uses many of the standard shortcut keys used by Windows applications, such as Word. Some specific source code editing shortcuts are listed below.

Shortcut	Action
Alt+F8	Correct indent selected code based on surrounding lines.
Ctrl+]	Find the matching brace.
Ctrl+J	Display list of members.
Ctrl+Spacebar	Complete the word, once the number of letters entered allows the editor to recognize it. Use full when completing function and variable names.
Tab	Indents selection one tab stop to the right.
Shift+Tab	Indents selection one tab to the left.

Below is a table of common keyboard shortcuts used in the debugger.

Shortcut	Action
F9	Add or remove breakpoint from current line.
Ctrl+Shift+F9	Remove all breakpoints.
Ctrl+F9	Disable breakpoints.
Ctrl+Alt+A	Display auto window and move cursor into it.
Ctrl+Alt+C	Display call stack window and move cursor into it.
Ctrl+Alt+L	Display locals window and move cursor into it.
Ctrl+Alt+A	Display auto window and move cursor into it.
Shift+F5	End debugging session.
F11	Execute code one statement at a time, stepping into functions.
F10	Execute code one statement at a time, stepping over functions.
Ctrl+Shift+F5	Restart a debugging session.
Ctrl+F10	Resume execution from current statement to selected statement.
F5	Run the application.
Ctrl+F5	Run the application without the debugger.
Ctrl+Shift+F10	Set the next statement.
Ctrl+Break	Stop execution.

Loading the following shortcuts can greatly increase your productivity with the Visual Studio development environment.

Shortcut	Action
ESC	Close a menu or dialog box, cancel an operation in progress, or place focus in the current document window.
CTRL+SHIFT+N	Create a new file.
CTRL+N	Create a new project.
CTRL+F6 or CTRL+TAB	Cycle through the MDI child windows one window at a time.
CTRL+ALT+A	Display the auto window and move the cursor into it.
CTRL+ALT+C	Display the call stack window and move the cursor into it.
CTRL+ALT+T	Display the document outline window and move the cursor into it.
CTRL+H	Display the find window.
CTRL+F	Display the find window. If there is no current Find criteria, put the word under your cursor in the find box.
CTRL+ALT+I	Display the immediate window and move the cursor into it. Not available if you are in the text editor window.
CTRL+ALT+L	Display the locals window and move the cursor into it.
CTRL+ALT+O	Display the output window and move the cursor into it
CTRL+ALT+J	Display the project explorer window and move the cursor into it.
CTRL+ALT+P	Display the properties window and move the cursor into it.
CTRL+SHIFT+O	Open a file.
CTRL+O	Open a project.
CTRL+P	Print all or part of the document.
CTRL+SHIFT+S	Save all of the files, projects, or documents.
CTRL+S	Select all.
CTRL+A	Save the current document or selected item or items.

Navigating through online Help topics

Right-click a blank area of a toolbar to display a list of all the available toolbars. The Infoviewer toolbar contains up and down arrows that allow you to cycle through help topics in the order in which they appear in the table of contents. The left and right arrows cycle through help topics in the order that you visited them.

This section on the ATL cannot hope to cover all the topics that a developer working with ATL should know in order to become an effective ATL C++ developer, but it will serve as an introduction to getting started with ATL. ATL helps you implement COM objects, and it saves typing, but it does not excuse you from knowing C++ and how to develop COM objects.

This section will introduce ATL by working through the creation of a project that implements one object to Zoom In to the ArcMap display by a factor of 2. Each stage of the project is explained including how to automatically generate code. You are encouraged to look at the bibliography at the end of this chapter in order to seek more in depth reference materials.

ATL IN BRIEF

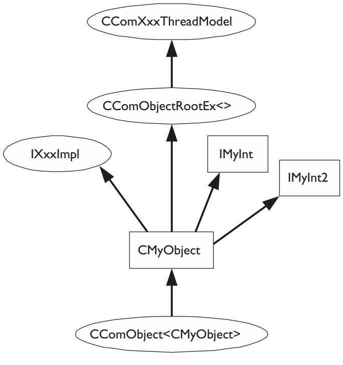
ATL is a set of C++ template classes designed to be small, fast, and extensible, based loosely on the Standard Template Library (STL). ATL provides a set of wizards that extend the Visual Studio development environment. These wizards automate some of the tedious plumbing code that all ATL projects must have. The wizards include, but are not limited to, the following:

- Application—used to initialize an ATL C++ project.
- Object—used to create COM objects. Both C++ and IDL code is generated, along with the appropriate code to support the creation of the objects at runtime.
- Property—used to add properties to interfaces.
- Method—used to add methods to interfaces; both the Property and Method Wizards require you to know some IDL syntax.
- Interface Implementation—used to implement stub functions for existing interfaces.

ATL provides base classes for implementing COM objects, as well as implementations for some of the common COM interfaces, including *IUnknown, IDispatch,* and *IClassFactory*. There are also classes that provide support for ActiveX controls and their containers.

ATL provides the required services for exposing ATL-based COM objects—these being registration, server lifetime, and class objects.

These template classes build a hierarchy that sandwiches your class. These inheritances are shown below. The *CComxxxThreadModel* supports thread-safe access to global, instance, and static data. The *CComObjectRootEx* provides the behavior for the *IUnknown* methods. The interfaces at the second level represent the interfaces that the class will implement; these come in two varieties. The *IxxxImpl* is an ATL-supplied interface that also includes an implementation; the other interfaces have pure virtual functions that must be fully implemented within your class. The *CComObject* class inherits your class; this class provides the implementation of the *IUnknown* methods along with the object instantiation and lifetime control.



The hierarchical layers of ATL

This layer structure allows changes to be made that affect the interaction of the Object and COM, with only minimal changes to your source files. Only the inherited classes must change.

ATL AND DTC

In addition to the smart types covered earlier in this chapter, DTC provides some useful compiler extensions you can use when creating ATL-based objects. The functions *__declspec* and *__uuidof* are two such functions, but the most useful is the *#import* command.

COM interfaces are defined in IDL, then compiled by the Microsoft IDL compiler (MIDL.exe). This results in the creation of a type library and header files. The project uses these files automatically when compiling software that references these interfaces. This approach is limited in that when working with interfaces you must have access to the IDL files. As a developer of ArcObjects, you only have access to the type library information contained in the esriCore.olb or equivalent file. While it is possible to engineer a header file from a type library, it is a tedious process, especially when using a large type library such as the ESRI Object Library. The *#import* command automates the creation of the necessary files required by the compiler. Since the command was developed to support DTC when using it to import the ESRI Object Library, there are a number of parameters that must be passed so that the correct import takes place.

```
#import "esriCore.olb" \          \\ Typelib to generate C++ mapping
raw_interfaces_only, \            \\ Don't add raw_ to method names
raw_native_types, \               \\ Don't map to DTC smart types
no_namespace, \                   \\ Don't wrap with C++ name space
named_guids, \                    \\ Named guids and declspecs
exclude("OLE_COLOR", "OLE_HANDLE") \\ Exclude conflicting types
```

This importing of the type library creates the smart pointers and CLSID constants seen in the section on Smart Types. The exclude (“OLE_COLOR”, “OLE_HANDLE”) is required because Windows defines these to be unsigned longs, which conflicts with the ArcObjects definition of long—this was required to support Visual Basic as a client of ArcObjects since Visual Basic has no support for unsigned types. There are no issues with excluding these.

HANDLING ERRORS IN ATL

If possible, you should always raise these COM exceptions to ensure that clients have access to this rich error information if required.

It is possible to return an *HRESULT* as the only signaling of failure in a method; however, as we saw with Visual Basic, not all development environments have comprehensive support for *HRESULT*s. In addition, simply returning *HRESULT*s to Visual Basic clients raises the “Automation Error – Unspecified Error”. ATL provides a simple mechanism for working with the COM exception object in order to provide more context when methods fail.

When creating an ATL object, the Object Wizard has an option to support *ISupportErrorInfo*. If you toggle the option on, when the wizard runs your object will implement the interface *ISupportErrorInfo*, and a method will be added that looks something like this:

```
STDMETHODIMP MyClass::InterfaceSupportsErrorInfo(REFIID riid)
 {
  static const IID* arr[] =
   {
    &IID_IMyClass,
   };

  for (int i = 0; i < sizeof(arr) / sizeof(arr[0]); i++)
   {
    if (InlineIsEqualGUID(*arr[i], riid))
      return S_OK;
   }

  return S_FALSE;
 }
```

It is now possible to return rich error messages by calling one of the ATL error functions. These functions even work with resource files to ensure easy internationalization of the message strings.

```
// Return a simple string
AtlReportError(CLSID_MyClass, _T("No connection to Database."),
  IID_IMyClass, E_FAIL);

   // Get the Error Text from a resource string
AtlReportError(CLSID_MyClass, IDS_DBERROR, IID_IMyClass, E_FAIL,
  _Module.m_hInstResource);
```

LINKING ATL CODE

One of the primary purposes of ATL is to support the creation of small fast objects for distribution over the Internet. To support this, the ATL development team gives the developer a number of choices when compiling and linking the source code. Choices must be made about how to link or dynamically access the C runtime (CRT) libraries, the registration code, and the various ATL utility functions. If no CRT calls are made in the code, this can be removed from the link. If CRT calls are made and the linker switch *_ATL_MIN_CRT* is not removed from the link line, the error shown below will generate during the link stage of the build. When compiling a debug build, there will probably not be a problem; however, depending on the code written, there may be problems when compiling a release build. If you receive this error, either remove the CRT calls or change the linker switches.

```
LIBCMT.lib(crt0.obj) : error LNK2001: unresolved external symbol _main
ReleaseMinSize/History.dll : fatal error LNK1120: 1 unresolved externals
Error executing link.exe.
```

If the Utilities code is dynamically loaded at runtime, you must ensure that the appropriate DLL (ATL.DLL) is installed and registered on the user's system. The following table shows the various choices and the related linker switches.

	Symbols	CRT	Utilities	Registrar
Debug		yes	static	dynamic
RelMinDepend	_ATL_MIN_CRT _ATL_STATIC_REGISTRY	no	static	static
RelMinSize	_ATL_MIN_CRT _ATL_DLL	no	dynamic	dynamic

DEBUGGING ATL CODE

In addition to the standard Visual Studio facilities, ATL provides a number of debugging options that provide specific support for debugging COM objects. The output of these debugging options is displayed in the Visual C++ Output window. The *QueryInterface* call can be debugged by setting the symbol *_ATL_DEBUG_QI, AddRef*, and *Release* calls with the symbol *_ATL_DEBUG_INTERFACES*, and leaked objects can be traced by monitoring the list of leaked interfaces at termination time when the *_ATL_DEBUG_INTERFACES* symbol is defined. The leaked interfaces list has entries like the following:

```
INTERFACE LEAK: RefCount = 1, MaxRefCount = 3, {Allocation = 10}
```

On its own, this does not tell you much apart from the fact that one of your objects is leaking because an interface pointer has not been released. However, the *Allocation* number allows you to automatically break when that interface is obtained by setting the *m_nIndexBreakAt* member of the *CComModule* at server startup time. This, in turn, calls the function *DebugBreak()* to force the execution of the code to stop at the relevant place in the debugger. For this to work the program flow must be the same, but it can be very useful.

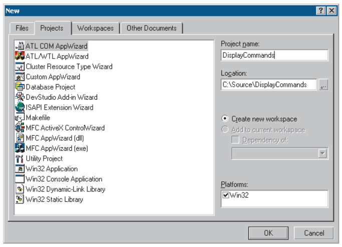
```
extern "C"
BOOL WINAPI DllMain(HINSTANCE hInstance, DWORD dwReason, LPVOID /
  *lpReserved*/)
 {
    if (dwReason == DLL_PROCESS_ATTACH)
      {
        _Module.Init(ObjectMap, hInstance, &LIBID_HISTORYLib);
        DisableThreadLibraryCalls(hInstance);
        _Module.m_nIndexBreakAt = 10
      }
    else if (dwReason == DLL_PROCESS_DETACH)
      {
        _Module.Term();
      }
     return TRUE;    // ok
 }
```

CREATING AN ATL COM SERVER AND OBJECT

This example will create a COM in-process server, a DLL, and add one object to that server that implements the *ICommand* interface to allow it to be used within ArcMap. Not all aspects of the process or options available will be explained; you are encouraged to use the Visual Studio online Help to find more information.

1. Start Visual C++.
2. Open the New Project form by clicking File and clicking New.
3. Click ATL COM AppWizard, then enter the project name and location of the source files. The project name will be the name given to the server file. Click OK.

This example uses the project name DisplayCommands.



New

Project name: DisplayCommands

Location: C:\Source\DisplayCommands

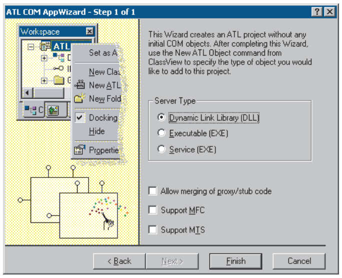
● Create new workspace

○ Add to current workspace

□ Dependency of:

Platforms: ☑ Win32

Application Wizard



ATL COM AppWizard - Step 1 of 1

This Wizard creates an ATL project without any initial COM objects. After completing this Wizard, use the New ATL Object command from ClassView to specify the type of object you would like to add to this project.

Server Type

● Dynamic Link Library (DLL)

○ Executable (EXE)

○ Service (EXE)

□ Allow merging of proxy/stub code

□ Support MFC

□ Support MTS

Server-type step in the Application Wizard

4. On the next dialog box, accept the defaults and click OK. Click OK on the Information dialog box. The skeleton project is now created and loaded into the editor.
5. Close inspection of the file view in the workspace window will show that an IDL file, along with a CPP file, has been created for the server, along with files to support precompiled header files and resources. The server file has the implementations of the exported DLL functions:

- *DllMain*
- *DllCanUnloadNow*
- *DllGetClassObject*
- *DllRegisterServer*
- *DllUnregisterServer*

The majority of these functions simply delegate to the *CComModule* class, defined as *_Module*.

```
/////////////////////////////////////////////////////////////////
// DllRegisterServer - Adds entries to the system registry

STDAPI DllRegisterServer(void)
 {
   // registers object, typelib and all interfaces in typelib
   return _Module.RegisterServer(TRUE);
 }
```

The IDL file only contains the library GUID and two importlibs for the standard COM API calls.

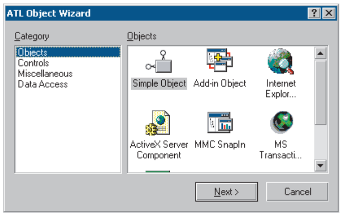
```
 [
  uuid(D8FBD63B-E107-43BE-A493-E71A8A467561),
  version(1.0),
  helpstring("DisplayCommands 1.0 Type Library")
 ]
library DISPLAYCOMMANDSLib
 {
  importlib("stdole32.tlb");
  importlib("stdole2.tlb");

 };
```

The wizard can also be accessed via the ATL toolbar or the context menu in the class view of the workspace window.

6. With the Server code present the ATL COM objects can be added. This is done using the ATL Object Wizard. Start this wizard by clicking the Insert menu and clicking New ATL Object. Click Next to define a simple object.

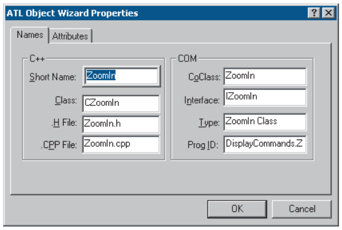
This example names the coclass ZoomIn.

7. Give the object a name and confirm that the automatically generated names are concise but informative.



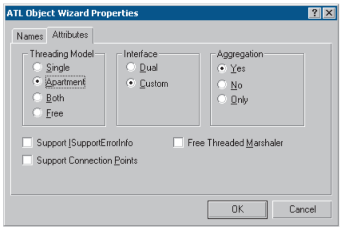
ATL Object Wizard

8. Click the Attributes tab and set the Interface type to Custom. This ensures that the interface *IZoomIn* inherits directly from *IUnknown* and not *IDispatch*, which is the default—in this way it is the same as all the other ArcObjects interfaces. While this is not necessary, it reduces the size of the COM object when it is instantiated for better memory management.



Short Name: ZoomIn
Class: CZoomIn
.H File: ZoomIn.h
.CPP File: ZoomIn.cpp
CoClass: ZoomIn
Interface: IZoomIn
Type: ZoomIn Class
Prog ID: DisplayCommands.Z

Name allocation step of the ATL Object Wizard



Threading Model: ○ Single ● Apartment ○ Both ○ Free
Interface: ○ Dual ● Custom
Aggregation: ● Yes ○ No ○ Only
□ Support ISupportErrorInfo
□ Free Threaded Marshaler
□ Support Connection Points

Defining the characteristics of your COM object

9. Click OK when finished. This creates three new files, ZoomIn.cpp, ZoomIn.h, and ZoomIn.rgs, and changes the existing files, DisplayCommands.idl, DisplayCommands.cpp, DisplayCommands.rc, and Resource.h.

   The *ZoomIn* coclass and the *IZoomIn* interfaces are added to the IDL, and the coclass is added to the DisplayCommands.cpp file to the object map. This table has an entry for every coclass in the server. ATL makes extensive use of tables to hold information about the COM object and has various macros that initialize and add entries to these tables.

```
BEGIN_OBJECT_MAP(ObjectMap)
OBJECT_ENTRY(CLSID_ZoomIn, CZoomIn)
END_OBJECT_MAP()
```

   The three *ZoomIn* files that are specific to the *ZoomIn* class are the registry script, the header, and the implementation files. The registry script file ZoomIn.rgs is shown below. This registry script will be executed when the server is registered and unregistered. If required, you can enter other information into the registry by editing this script.

The registry script parser is very particular, hence care must be exercised when editing this file.

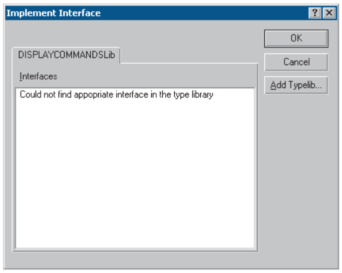
```
HKCR
 {
  DisplayCommands.ZoomIn.1 = s 'ZoomIn Class'
   {
   CLSID = s '{52442231-E144-4B7C-94EF-70ABB17476E5}'
   }
  DisplayCommands.ZoomIn = s 'ZoomIn Class'
   {
   CLSID = s '{52442231-E144-4B7C-94EF-70ABB17476E5}'
   CurVer = s 'DisplayCommands.ZoomIn.1'
   }
  NoRemove CLSID
   {
  ForceRemove {52442231-E144-4B7C-94EF-70ABB17476E5} = s 'ZoomIn Class'
 {
  ProgID = s 'DisplayCommands.ZoomIn.1'
  VersionIndependentProgID = s 'DisplayCommands.ZoomIn'
  InprocServer32 = s '%MODULE%'
   {
   val ThreadingModel = s 'Apartment'
   }
  'TypeLib' = s '{D8FBD63B-E107-43BE-A493-E71A8A467561}'
  }
 }
}
```

At this stage, the CPP implementation file is empty, except for some includes. The header file contains the C++ class definition. Notice the inheritance list of the class.

All publicly created classes (coclasses) must inherit from the class CComCoClass.

```
//////////////////////////////////////////////////////////////
// CZoomIn
class ATL_NO_VTABLE CZoomIn :
..public CComObjectRootEx<CComSingleThreadModel>,
..public CComCoClass<CZoomIn, &CLSID_ZoomIn>,
..public IZoomIn
 {
public:
..CZoomIn()
 ..{
 ..}

DECLARE_REGISTRY_RESOURCEID(IDR_ZOOMIN)

DECLARE_PROTECT_FINAL_CONSTRUCT()

BEGIN_COM_MAP(CZoomIn)
..COM_INTERFACE_ENTRY(IZoomIn)
END_COM_MAP()

// IZoomIn
public:
 };
```

A map is used to drive the query interface implementation. The interface map must list all the interfaces supported by the object. ATL's implementation of *QueryInterface* uses these entries in the COM_MAP. Two other macros are present: *DECLARE_REGISTRY_RESOURCEID (IDR_ZOOMIN)*, which binds the registry script to the class, and *DECLARE_PROTECT_FINAL_CONSTRUCT()*, which stops reference counting problems during the execution of the *FinalConstruct* method, primarily when aggregating objects.

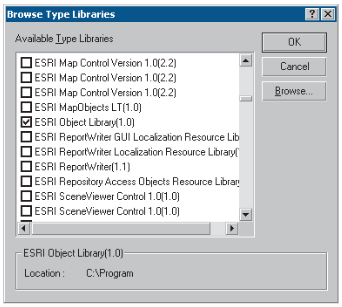


Could not find appropriate interface in the type library

Interface Implementation Wizard

10. Confirm that everything has been successful by pressing F7 to compile the project.

11. Click Class View in the Workspace browser.



Browse Type Libraries

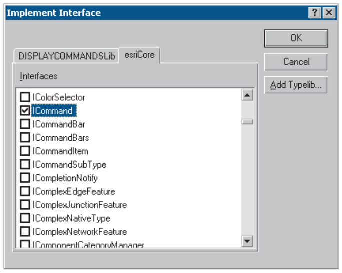
Available Type Libraries

- ☐ ESRI Map Control Version 1.0(2.2)
- ☐ ESRI Map Control Version 1.0(2.2)
- ☐ ESRI Map Control Version 1.0(2.2)
- ☐ ESRI MapObjects LT(1.0)
- ☑ ESRI Object Library(1.0)
- ☐ ESRI ReportWriter GUI Localization Resource Lib
- ☐ ESRI ReportWriter Localization Resource Library(
- ☐ ESRI ReportWriter(1.1)
- ☐ ESRI Repository Access Objects Resource Librar
- ☐ ESRI SceneViewer Control 1.0(1.0)
- ☐ ESRI SceneViewer Control 1.0(1.0)

ESRI Object Library(1.0)

Location : C:\Program

Additional type libraries can be selected to access their interfaces.



Implement Interface

DISPLAYCOMMANDSLib | esriCore

Interfaces

- ☐ IColorSelector
- ☑ ICommand
- ☐ ICommandBar
- ☐ ICommandBars
- ☐ ICommandItem
- ☐ ICommandSubType
- ☐ ICompletionNotify
- ☐ IComplexEdgeFeature
- ☐ IComplexJunctionFeature
- ☐ IComplexNativeType
- ☐ IComplexNetworkFeature
- ☐ IComponentCategoryManager

Locate and check required interfaces and click OK.

12.Select the class *CZoomIn* and display the context menu. This menu allows access to various wizards including the Method and Property Wizards. Click Implement Interface to display the list of available type libraries.

You will be implementing the *ICommand* interface defined within the ESRI Object Library; this means you must select this type library before continuing by clicking the Add Typelib button.

Next, select the *ICommand* interface and click OK. Changes are made to the ZoomIn.h file.

The Interface Implementation tool only updates the header file for the class. Therefore, the interface that has just been implemented should also be added to the coclass *ZoomIn* defined in the IDL file. You can also take this opportunity to mark the IUnknown interface as the default interface of the coclass.

```
coclass ZoomIn
 {
  [default] interface IUnknown;
  interface IZoomIn;
  interface ICommand;
 };
```

If you try to compile the IDL file at this point (using the Workspace Browser context menu with the IDL file selected in the Workspace Browser), an error will be raised stating there is an unresolved forward declaration *ICommand*. The esriCore.olb file must be included in the library section of the IDL, in a similar way that the standard COM libraries are. Another cause of the forward declaration error that you may encounter in your ATL development is that an interface method uses a type included within the ESRI Object Library. By default, interface definitions are placed before the library section of the IDL file. To fix the compile error, the interface definition must be moved inside the library section after the importlib directive.

```
library DISPLAYCOMMANDSLib
 {
  importlib("stdole32.tlb");
  importlib("stdole2.tlb");
  importlib("C:\arcexe81\ArcObjects Developer Kit\Help\esriCore.olb");
```

This path will vary depending on your installation.

13.The header file is where most of the code has been placed. Several changes must be made: some are required, while others are simply good coding practices.

The *ICommand* interface has been added to the inheritance list of the C++ class as well as the COM_MAP.

```
class ATL_NO_VTABLE CZoomIn :
  public CComObjectRootEx<CComSingleThreadModel>,
  public CComCoClass<CZoomIn, &CLSID_ZoomIn>,
 public IZoomIn,
 public ICommand
 {
```

```
public:
  CZoomIn()
   {
   }

DECLARE_REGISTRY_RESOURCEID(IDR_ZOOMIN)

DECLARE_PROTECT_FINAL_CONSTRUCT()

BEGIN_COM_MAP(CZoomIn)
  COM_INTERFACE_ENTRY(IZoomIn)
  COM_INTERFACE_ENTRY(ICommand)
END_COM_MAP()
```

14.The wizard also added the stub functions for the *ICommand* interface to the header file. These functions should be moved to the CPP file, leaving only the function prototypes in the header file. The listing below shows the changes required for each function.

The wizard creates this function in the header file.

```
STDMETHOD(get_Enabled)(VARIANT_BOOL * Enabled)
 {
  if (Enabled == NULL)
    return E_POINTER;

  return E_NOTIMPL;
 }
```

The header file prototype should look like this:

```
STDMETHOD(get_Enabled)(VARIANT_BOOL * Enabled);
```

The implementation file should look like this:

```
STDMETHODIMP CZoomIn::get_Enabled(VARIANT_BOOL * Enabled)
 {
  if (Enabled == NULL)
    return E_POINTER;

  return E_NOTIMPL;
 }
```

15.Next, the #import that imports the ESRI Object Library into the class must be edited. The reverse engineering of the type library takes a few seconds so, for more efficient compilation in the future, remove this #import line from the header and add it to the precompiled header file stdafx.h. Remember to exclude both OLE_COLOR and OLE_HANDLE from the import.

This path will vary depending on your installation.

```
#pragma warning(push)
#pragma warning(disable : 4146)
#pragma warning(disable : 4192)
#import "C:\arcexe81\ArcObjects Developer Kit\Help\esriCore.olb" \
    raw_interfaces_only, \
    raw_native_types, \
    no_namespace, \
    named_guids, \
   exclude("OLE_COLOR", "OLE_HANDLE")
#pragma warning(pop)
```

Several warnings will appear. These can be safely disabled using the #pragma statement. It is advisable to push and pop the warning stack so that the warnings are only disabled for this import.

16.Add a member variable to hold a bitmap resource used by the Command button; this involves changes to the *ZoomIn* header file and the creation of a Bitmap resource in the resource editor. From the main menu, click Insert, click Resource, then click Import. Navigate to the .bmp file you wish to use as the *ZoomIn* icon. Click OK when finished. Using the properties for the resource, set the name of the resource to “IDB_ZOOMIN”. Add the following member variable to the ZoomIn.h header file.

```
private:
  HBITMAP           m_hBitmap;
```

This member variable is initialized in the class constructor and released in the class destructor. Notice the use of the *_Module* for access to the application instance handle. The IDB_ZOOMIN is a bitmap resource defined in the resource editor.

```
CZoomIn()
  {
    m_hBitmap = ::LoadBitmap(_Module.m_hInst, MAKEINTRESOURCE(IDB_ZOOMIN));
  }

~CZoomIn()
  {
    DeleteObject(m_hBitmap);
  }
```

17.Next, add a member variable that will hold a reference to the application. This reference is the *IApplication* interface, which is passed to the command when it is created.

```
IApplicationPtr       m_ipApp;
```

The member variable does not need to be initialized in the class initialization list since it is a smart pointer. Smart pointers are initialized, by default, to *NULL*. If this were a standard interface pointer, it would have to be initialized in the constructor’s initialization list.

18.The final change to the header file involves the automatic registration of the class into the appropriate Component Category. This is an optional step, but one that makes installation of the server easier. It means that the end user will see the new command in the Customize dialog box the first time ArcMap is started after the DLL is registered.

For your convenience, a header file is provided that defines constants for all the CATIDs used by ArcGIS. You could also have retrieved this information from the registry and created your own constants.

This path will vary depending on your installation.

```
#include "C:\arcexe81\ArcObjects Developer Kit\Kits\CATIDS\h\ArcCATIDs.h"
```

The category map is used to drive this registration information:

```
BEGIN_CATEGORY_MAP(CZoomIn)
  IMPLEMENTED_CATEGORY(__uuidof(CATID_MxCommands))
END_CATEGORY_MAP()
```

19.Now all that is left to do is for the implementation code to be added to the cpp file.

Below are some of the methods of the *ICommand* interface, with a comment.

Note the use of *VARIANT_TRUE*.

```
STDMETHODIMP CZoomIn::get_Enabled(VARIANT_BOOL * Enabled)
{
  if (Enabled == NULL)
    return E_POINTER;

  *Enabled = VARIANT_TRUE;   // Enable the tool always

  return S_OK;
}
```

Note the use of the API calls used to create a *BSTR*.

```
STDMETHODIMP CZoomIn::get_Name(BSTR * Name)
{
  if (Name == NULL)
    return E_POINTER;

  *Name = ::SysAllocString(L"Exploring ArcObjects_Zoom In");
  return S_OK;
}
```

A simple cast is all that is required here to coerce the bitmap handle into an *OLE_HANDLE* variable.

```
STDMETHODIMP CZoomIn::get_Bitmap(OLE_HANDLE * Bitmap)
{
  if (Bitmap == NULL)
    return E_POINTER;

  *Bitmap = (OLE_HANDLE) m_hBitmap;

  return S_OK;
}
```

The *OnCreate* method is passed the *IDispatch* interface of the object. Using the *QueryInterface* support of the smart pointer, it is a simple matter to set the member variable to be the hook. The smart pointer handles the *QI*.

```
STDMETHODIMP CZoomIn::OnCreate(IDispatch * hook)
{
  m_ipApp = hook;
  return S_OK;
}
```

The *OnClick* method is implemented to zoom the display by a factor of two. There is no error checking to simplify the code.

```
STDMETHODIMP CZoomIn::OnClick()
{
  // HRESULT checking omitted for clarity
  IDocumentPtr      ipDoc;
  m_ipApp->get_Document(&ipDoc);

  IMxDocumentPtr    ipMxDoc(ipDoc);
  IActiveViewPtr    ipActiveView;

  ipMxDoc->get_ActiveView(&ipActiveView);

  IEnvelopePtr      ipEnv;
  ipActiveView->get_Extent(&ipEnv);

  ipEnv->Expand(0.5, 0.5, VARIANT_TRUE);

  ipActiveView->put_Extent(ipEnv);

  ipActiveView->Refresh();

  return S_OK;
}
```

20.Now, compile the project by pressing F7. Load the command into ArcMap and test.

The above example illustrates many of the tasks that you will perform when implementing COM objects using ATL. You are encouraged to look at the other samples included with the software.

This section looks at what is involved with packaging developments and deploying these on other machines. Exactly what must be packaged depends on the type of development; the typical steps are outlined below.

WHAT GETS PACKAGED

The obvious things to package are the server DLLs; however, you should also consider the following:

- With VBA developments, all code required is packaged in the *Map* document file.
- Type Libraries. If the DLLs do not have type information contained within them, the type libraries associated with the DLLs should also be packaged.
- Object Diagrams. Since you have developed using COM, other developers are free to work with your code in the same way that you work with ArcObjects. Object diagrams and help within the DLLs are good ways of supplying developers with information.
- Other files to package can include data files, help files, documentation, and so on.

Both Visual Basic- and ATL-generated DLLs contain type library information. Often when many DLLs are involved it is better to extract the type library information into one file, which is exactly what is done with the esriCore.olb. This means that when working with many DLLs, only one reference is required.

The server deployment is the most involved, so the rest of this section will cover the process of packaging and deploying a DLL server that contains one or more coclass implementations.

It is very important not to package any of the core ArcObjects DLLs or type libraries into your package. If you did this and the user uninstalled your software, there would be a danger that they might uninstall some of the files ArcGIS requires to function correctly.

JUST THE DLL

It is possible to simply give the user a copy of the DLL with instructions on how to register the DLL on the system. Normally, this involves the use of the Windows Utility RegSvr32.EXE. To register a DLL, the user must type a command line similar to that below.

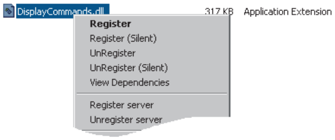
```
RegSvr32 MyServer.DLL
```

To unregister a server, the command is run with the /U switch.

```
RegSvr32 /U MyServer.DLL
```

A dialog box appears when the operation completes. When running regsvr32 on several files, it is advisable to run it in silent mode with the /S switch—this disables the dialog box.

Depending on how the DLL was developed, registering the DLL may not be the only task. The coclasses contained with the DLL may have to be added to the appropriate component categories. If ATL was used, as shown in the ATL section, this can be made automatic on server registration. Other alternatives include the facility in the applications for commands; the Category Manager utility application; and the *ComponentCategoryManager* coclass, which is part of the framework subsystem or the creation of a registry script.



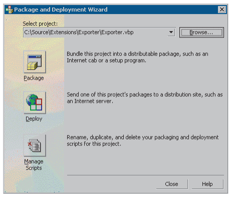
Included in the Utilities directory of the ArcObjects Developers Kit folder is a small registry script called reg_in_menu.reg. The registry script adds options to the Windows Explorer context menu when DLL, EXE, OLB, and OCX files are selected. The five options provide support for registering and unregistering the files. The context menu is shown in the figure to the left.

Although the Package and Deployment Wizard only works with Visual Basic projects, it is possible to create an empty project and add files of any type in order to package non-Visual Basic developments.

USING REGISTRY SCRIPTS

After the server is registered on the system, registry scripts provide a good mechanism for adding supplemental information about the server to the registry including the component category information. These registry scripts can either be written by hand or generated from the Compile and Register Visual Basic Add-In. A sample script is shown below. The lines beginning "[HKEY" must all be on one line in the file.

```
REGEDIT4

; This Registry Script enters CoClasses Into their appropriate Component
Category ; Use this script during installation of the components

; Coclass: prjDisplay.ZoomIn ; CLSID: {FC7EC05F-6B1B-4A59-B8A2-37CE33738728}
; Component Category: ESRI Mx Commands
[HKEY_LOCAL_MACHINE\SOFTWARE\Classes\CLSID\{FC7EC05F-6B1B-4A59-B8A2-
37CE33738728}\Implemented Categories\{B56A7C42-83D4-11D2-A2E9-080009B6F22B}]
; Coclass: prjDisplay.ZoomOut ; CLSID: {2C120434-0248-43DB-AD8E-
BD4523A93DF8} ; Component Category: ESRI Mx Commands
[HKEY_LOCAL_MACHINE\SOFTWARE\Classes\CLSID\{2C120434-0248-43DB-AD8E-
BD4523A93DF8}\Implemented Categories\{B56A7C42-83D4-11D2-A2E9-080009B6F22B}]
```



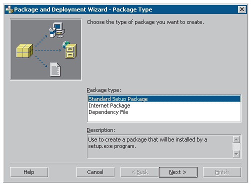
Select project: C:\Source\Extensions\Exporter\Exporter.vbp

Bundle this project into a distributable package, such as an Internet cab or a setup program.

Send one of this project's packages to a distribution site, such as an Internet server.

Rename, duplicate, and delete your packaging and deployment scripts for this project.

Step 1

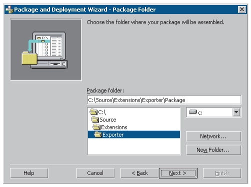


Choose the type of package you want to create.

Package type:
Standard Setup Package
Internet Package
Dependency File

Description:
Use to create a package that will be installed by a setup.exe program.

Step 2



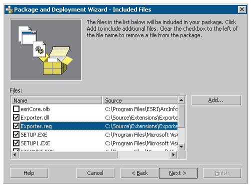
Choose the folder where your package will be assembled.

Package folder: C:\Source\Extensions\Exporter\Package

C:\
Source
Extensions
Exporter

c:

Step 3



The files in the list below will be included in your package. Click Add to include additional files. Clear the checkbox to the left of the file name to remove a file from the package.

Files:

Name	Source
□ esriCore.olb	C:\Program Files\ESRI\ArcInfo
☑ Exporter.dll	C:\Source\Extensions\Exporte
☑ Exporter.reg	C:\Source\Extensions\Exporte
☑ SETUP.EXE	C:\Program Files\Microsoft Vis
☑ SETUP1.EXE	C:\Program Files\Microsoft Vis

Step 4

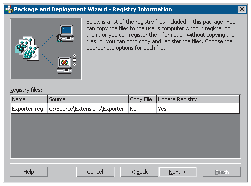
USING AN INSTALLATION PROGRAM

Most setup packages work well with registry scripts. For example, the Visual Basic Package and Deployment Wizard provides a straightforward way of creating setup programs. To create a setup program for your server follow the following steps:

1. Click the Start menu and click the Package and Deployment Wizard. The dialog box to the left is displayed. Select the Visual Basic project to be packaged and choose the package option. This will build the setup program and gather all files required by the setup program into a support directory for easy regeneration of the package. The wizard then performs some checks to ensure that the server created by the Visual Basic project is up-to-date with its source files. If not, you are given the option to recompile the project.
2. Next, the package type is selected; this will normally be a Standard Setup Package.
3. The next step allows you to specify the folder where the package is created. This folder will contain the Setup executable and cabinet files and a supporting folder with all the files used to build the package.
4. Ensure that the files list shown doesn't include any Core ArcObjects files and that any other files required by the installation are added.

The additional files normally include a registry script to perform advanced registration, along with help files, and so on. Notice in the illustration that the esriCore.olb file has been unchecked, and the registry script has been added.

5. The next panel depends on whether a registry file was added in the previous step. If the file was added, the dialog box to the left is shown. If no file was added, go to step 6. The simplest option is to accept the default. This will cause the registry script to be executed when the setup program has registered the servers on the target machine but will not copy the registry script to the machine.



Package and Deployment Wizard - Registry Information

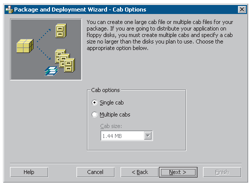
Below is a list of the registry files included in this package. You can copy the files to the user's computer without registering them, or you can register the information without copying the files, or you can both copy and register the files. Choose the appropriate options for each file.

Registry files:

Name	Source	Copy File	Update Registry
Exporter.reg	C:\Source\Extensions\Exporter	No	Yes

Step 5

6. The wizard then asks if one or multiple cabinet files will be created. This depends on whether or not the setup program will span multiple floppy disks.



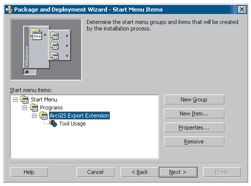
Package and Deployment Wizard - Cab Options

You can create one large cab file or multiple cab files for your package. If you are going to distribute your application on floppy disks, you must create multiple cabs and specify a cab size no larger than the disks you plan to use. Choose the appropriate option below.

Cab options
● Single cab
○ Multiple cabs
Cab size: 1.44 MB

Step 6

7. Next, follow a couple of panels asking for the Installation Screen title and where on the Windows Start menu the setup program should group files. Often when installing DLLs it is not appropriate to define an entry on the Start menu. Sometimes, even with DLLs, it may be desirable to add access to documents containing help information.



Package and Deployment Wizard - Start Menu Items

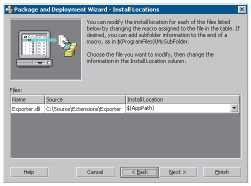
Determine the start menu groups and items that will be created by the installation process.

Start menu items:

- Start Menu
  - Programs
    - ArcGIS Export Extension
      - Tool Usage

Step 7

8. The next panel allows the user to define the location of the various files after they have been installed. Various macros are defined that will point to different locations, depending on the configuration of the target machine.



Package and Deployment Wizard - Install Locations

You can modify the install location for each of the files listed below by changing the macro assigned to the file in the table. If desired, you can add subfolder information to the end of a macro, as in $(ProgramFiles)\MySubFolder.

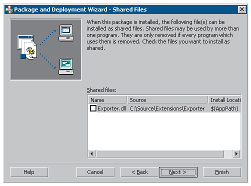
Choose the file you want to modify, then change the information in the Install Location column.

Files:

Name	Source	Install Location
Exporter.dll	C:\Source\Extensions\Exporter	$(AppPath)

Step 8

9. The next panel allows files to be marked as shared. Any files of the installation that will be used by other programs or installations must be marked as shared. This ensures that the uninstall program does not remove them automatically, which would break the other programs.



Package and Deployment Wizard - Shared Files

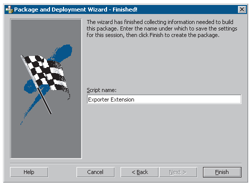
When this package is installed, the following file(s) can be installed as shared files. Shared files may be used by more than one program. They are only removed if every program which uses them is removed. Check the files you want to install as shared.

Shared files:

Name	Source	Install Locati
□ Exporter.dll	C:\Source\Extensions\Exporter	$(AppPath)

Step 9

10.Finally, the Finish panel is displayed. Click Finish to assemble the package. The three files in the package directory—setup, cabinet, and list files—can then be given to third parties for a seamless install.



Package and Deployment Wizard - Finished!

The wizard has finished collecting information needed to build this package. Enter the name under which to save the settings for this session, then click Finish to create the package.

Script name: Exporter Extension

Step 10

This is just one method of packaging COM developments. Whatever method you use, the setup procedure must be as simple as possible and involve as few decisions as possible in order to avoid user frustration.

This bibliography is not intended as a complete resource, but it does contain many of the everyday references that ESRI developers use when developing C++ and Visual Basic code and ArcObjects. It is not necessary to buy all these books before starting to program in COM; rather, look at these books and others that are available, and perhaps buy the one most suitable to your development track. The books listed below cover COM and developing with COM in Visual C++, mainly using ATL and Visual Basic. The books listed are from various companies; however, there are many other companies producing books for developers of COM components. You are encouraged to look at these other books, too.

ATL

Grimes, Richard. *ATL COM Programmer's Reference*. Chicago: Wrox Press Inc., 1998.

Grimes, Richard. *Professional ATL COM Programming*. Chicago: Wrox Press Inc., 1998.

Grimes, Richard, and Reilly Stockton, and Alex Stockton, and Julian Templeman. *Beginning ATL 3 COM Programming*. Chicago: Wrox Press Inc., 1999.

King, Brad and George Shepherd. *Inside ATL*. Redmond, WA: Microsoft Press, 1999.

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C++

Lippman, Stanley. *C++ Primer: Second Edition*. Reading, MA: Addison–Wesley, 1991.

Lippman, Stanley. *Inside the C++ Object Model*. Reading, MA: Addison–Wesley, 1996.

Meyers, Scott. *Effective C++: 50 Specific Ways to Improve Your Programs and Designs*. Reading, MA: Addison–Wesley, 1992.

Meyers, Scott. *More Effective C++: 35 New Ways to Improve Your Programs and Designs*. Reading, MA: Addison–Wesley, 1996.

Shepard, George and David Kruglinski. *Inside Visual C++: Fifth Edition*. Redmond, WA: Microsoft Press, 1998.

Stroustrup, Bjarne. *The C++ Programming Language: Third Edition*. Reading, MA: Addison–Wesley, 1997.

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Box, Don. *Essential COM*. Reading, MA: Addison–Wesley, 1998.

Chappell, David. *Understanding ActiveX and OLE: A Guide for Developers and Managers*. Redmond, WA: Microsoft Press, 1996.

Effective COM: 50 Ways to Improve Your COM and MTS-Based Applications. Edited by Don Box, Keith Brown, Tim Ewald, and Chris Sells. Reading, MA: Addison–Wesley, 1998.

Major, Al. *COM IDL and Interface Design*. Chicago: Wrox Press Inc., 1999.

Platt, David S. *Understanding COM+*. Redmond, WA: Microsoft Press, 1999.

Rogerson, Dale. *Inside COM: Microsoft's Component Object Model*. Redmond, WA: Microsoft Press, 1997.

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Gamma, Erich, and Richard Helm, and Ralph Johnson, and John Vlissides. *Design Patterns: Elements of Reusable Object-Oriented Software*. Reading, MA: Addison–Wesley, 1995.

The New Hacker's Dictionary: Second Edition. Edited by Eric Raymond. Cambridge, MA: MIT Press, 1993.

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Cummings, Steve. *VBA For Dummies*. New York: IDG Books Worldwide, 1999.

Getz, Ken and Mike Gilbert. *VBA Developer's Handbook*. San Francisco: Sybex, 1997.

Lomax, Paul. *VB and VBA in a Nutshell: The Language*. Sebastopol, CA: O'Reilly & Associates, 1998.

VISUAL BASIC

Lewis, Thomas. *VB COM*. Chicago: Wrox Press Inc., 1999.

Microsoft Visual Basic 6.0 Programmer's Guide. Redmond, WA: Microsoft Press, 1998.

Pattison, Ted. *Programming Distributed Applications with COM and Microsoft Visual Basic 6.0*. Redmond, WA: Microsoft Press, 1998.

Wright, Peter. *Beginning Visual Basic 6 Objects*. Chicago: Wrox Press Inc., 1998.

WINDOWS DEVELOPMENT

Petzold, Charles. *Programming Windows 95: The Definitive Developer's Guide to the Windows 95 API*. Redmond, WA: Microsoft Press, 1996.

Shepard, George and Scot Wingo. *MFC Internals: Inside the Microsoft Foundation Class Architecture*. Reading, MA: Addison–Wesley, 1996.

3 Customizing the user interface

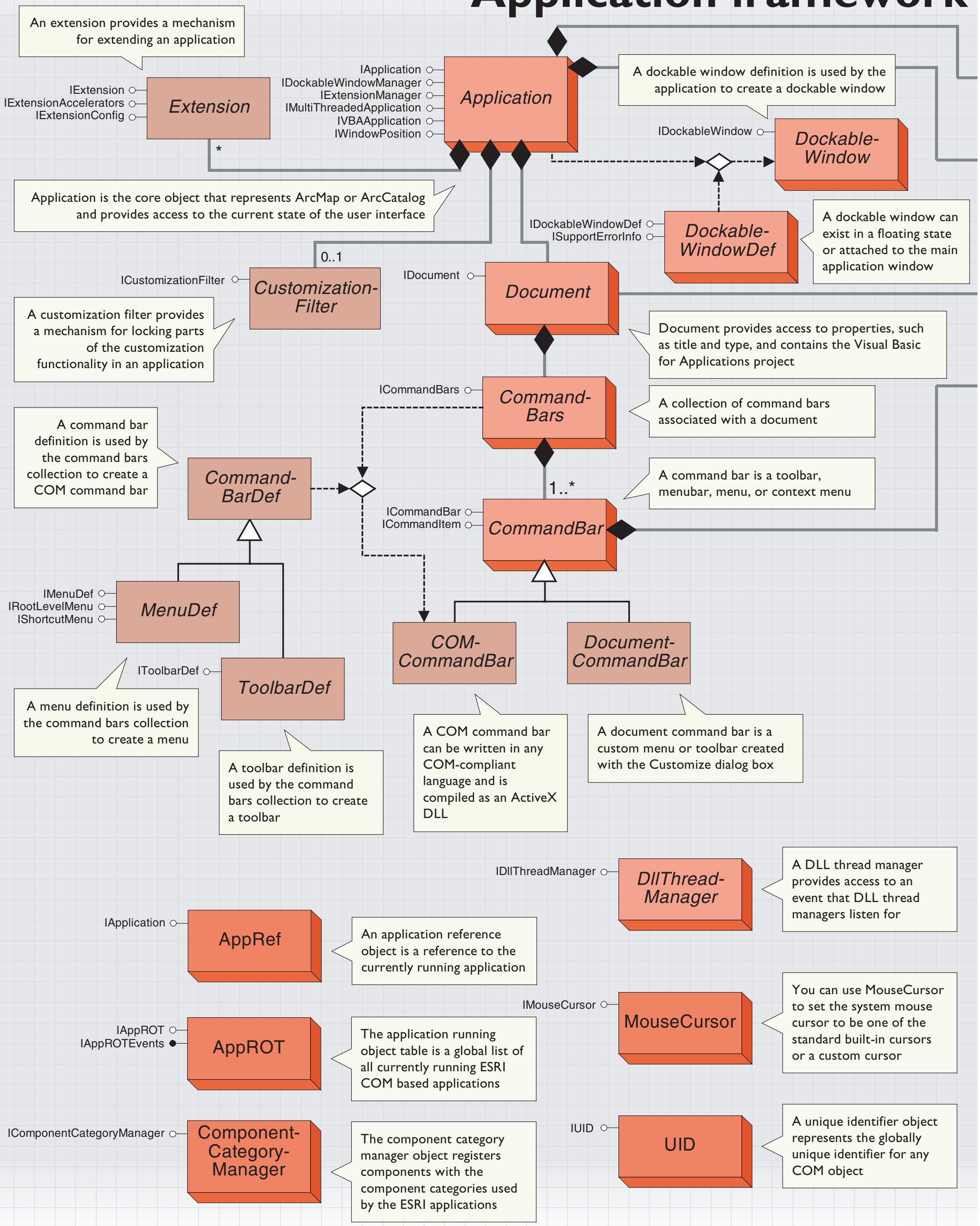
Eleanor Blades, Euan Cameron

The ArcGIS applications are engineered for ease of use and powerful geographic display, query, and analysis. By their design, they are generic and serve a broad audience of users.

With the ArcObjects application framework, you have unlimited freedom to customize the user interface for your users' business needs. You can add new toolbars, buttons, tools, commands, and other elements. You can deliver advanced functions through custom commands. You can augment the functionality of applications through extensions, and you can selectively propagate customizations through templates.

This chapter discusses the application framework object model and how to employ these objects to deliver custom applications that are at once simple and powerful.

Application framework



An extension provides a mechanism for extending an application

A dockable window definition is used by the application to create a dockable window

Application is the core object that represents ArcMap or ArcCatalog and provides access to the current state of the user interface

A dockable window can exist in a floating state or attached to the main application window

A customization filter provides a mechanism for locking parts of the customization functionality in an application

Document provides access to properties, such as title and type, and contains the Visual Basic for Applications project

A collection of command bars associated with a document

A command bar definition is used by the command bars collection to create a COM command bar

A command bar is a toolbar, menubar, menu, or context menu

A menu definition is used by the command bars collection to create a menu

A toolbar definition is used by the command bars collection to create a toolbar

A COM command bar can be written in any COM-compliant language and is compiled as an ActiveX DLL

A document command bar is a custom menu or toolbar created with the Customize dialog box

A DLL thread manager provides access to an event that DLL thread managers listen for

An application reference object is a reference to the currently running application

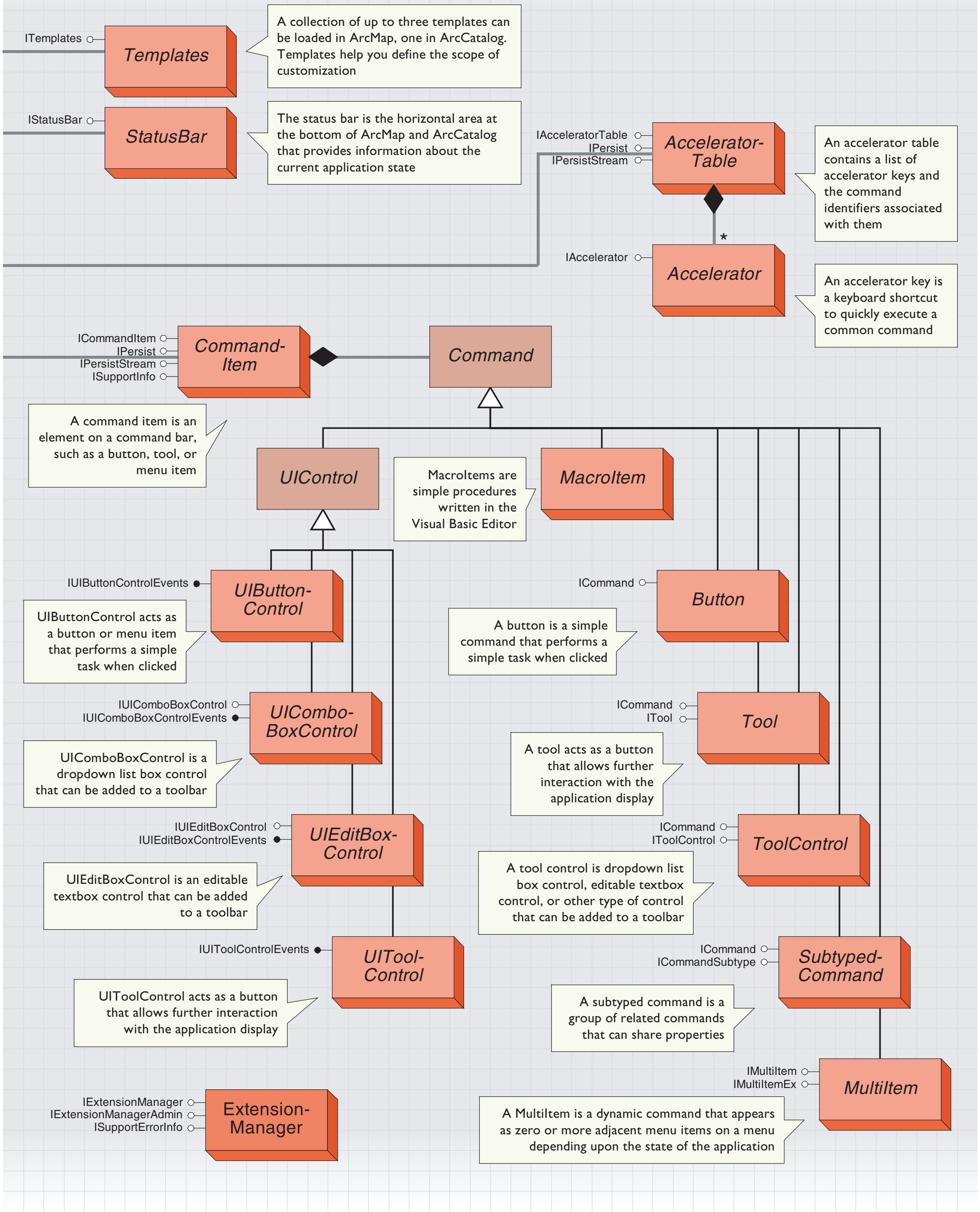
You can use MouseCursor to set the system mouse cursor to be one of the standard built-in cursors or a custom cursor

The application running object table is a global list of all currently running ESRI COM based applications

The component category manager object registers components with the component categories used by the ESRI applications

A unique identifier object represents the globally unique identifier for any COM object

objects



A collection of up to three templates can be loaded in ArcMap, one in ArcCatalog. Templates help you define the scope of customization

The status bar is the horizontal area at the bottom of ArcMap and ArcCatalog that provides information about the current application state

An accelerator table contains a list of accelerator keys and the command identifiers associated with them

An accelerator key is a keyboard shortcut to quickly execute a common command

A command item is an element on a command bar, such as a button, tool, or menu item

MacroItems are simple procedures written in the Visual Basic Editor

UIButtonControl acts as a button or menu item that performs a simple task when clicked

A button is a simple command that performs a simple task when clicked

UIComboBoxControl is a dropdown list box control that can be added to a toolbar

A tool acts as a button that allows further interaction with the application display

UIEditBoxControl is an editable textbox control that can be added to a toolbar

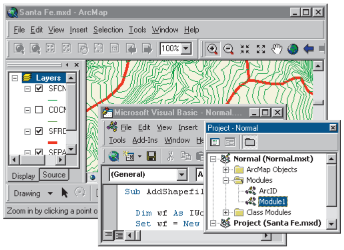
A tool control is dropdown list box control, editable textbox control, or other type of control that can be added to a toolbar

UIToolControl acts as a button that allows further interaction with the application display

A subtyped command is a group of related commands that can share properties

A MultiItem is a dynamic command that appears as zero or more adjacent menu items on a menu depending upon the state of the application

You can help your users work more quickly and efficiently by building a custom user interface that rearranges the standard user interface and adds new custom commands.

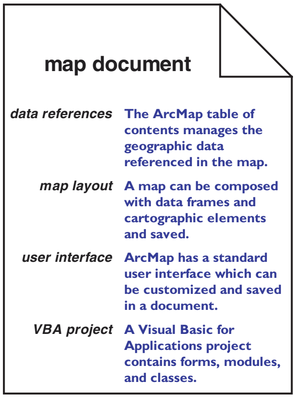


The customization framework in ArcObjects lets you programmatically customize the user interface of ArcMap, ArcCatalog, and other ArcGIS applications. You can manipulate the elements of the user interface—toolbars, menus, commands, and so on—and customize your application in accordance with the Windows user interface guidelines.

Most of the objects in the customization framework correspond to items in the various applications.

DOCUMENTS AND TEMPLATES

Whenever you are using ArcMap, you have a map document open. The document stores the map state, custom user interface settings, and a Visual Basic for Applications project.



map document

data references **The ArcMap table of contents manages the geographic data referenced in the map.**

map layout **A map can be composed with data frames and cartographic elements and saved.**

user interface **ArcMap has a standard user interface which can be customized and saved in a document.**

VBA project **A Visual Basic for Applications project contains forms, modules, and classes.**

Understanding documents and templates is the key to understanding customization with ArcObjects in ArcGIS applications.

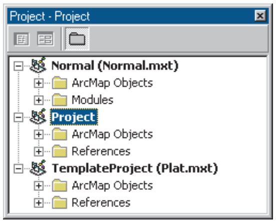
Each document and template contains a persistent state of the user interface, a Visual Basic for Applications project, and other application-specific information, such as cartographic layouts for ArcMap documents.

The structure and function of documents and templates vary from one application to another. Because of this variation, it is best to discuss them in the context of each respective application. ArcMap employs the full structure of documents and templates.

CUSTOMIZING ARCMAP

You can customize ArcMap in several ways:

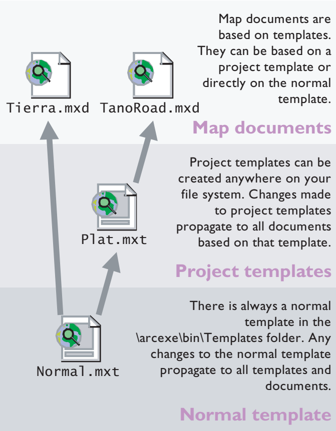
- You can add references to geographic data and define how the data is displayed.
- You can create a map layout with a spatial reference and ancillary cartographic elements.
- You can add, remove, or rearrange elements of the standard user interface.
- You can write code in a Visual Basic for Applications project.



All customization in ArcMap is stored in a map document or a map template.

The changes you make to the ArcMap table of contents, the layout of a map, the toolbars and their command items, and the VBA code you write all get saved to the map document.

A map document can reside anywhere on your file system; it has a file extension of .mxd.



Map documents are based on templates. They can be based on a project template or directly on the normal template.

Map documents

Project templates can be created anywhere on your file system. Changes made to project templates propagate to all documents based on that template.

Project templates

There is always a normal template in the \arcexe\bin\Templates folder. Any changes to the normal template propagate to all templates and documents.

Normal template

ArcMap automatically creates a Normal template if one does not exist. If you have applied unintended customizations, such as removing toolbars and command items, you can simply remove the Normal.mxt file and a new one with the standard user interface will be generated. This is easier than undoing a set of unintended customizations.

Map templates

You can use map templates to disseminate customization throughout an organization—globally, by project, or by document.

A map template is a kind of map document. In nearly every respect, map templates are structurally identical to map documents. The functional difference is that ArcMap recognizes and uses templates as a starting point to create new map documents. This is similar to how you work with templates in Microsoft Office applications.

Any customization of the user interface or the VBA project becomes part of the newly created map document. Furthermore, any changes to a template will propagate to template-based documents when they are next loaded.

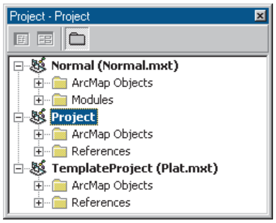
There are three levels of templates and documents in ArcMap. You can save changes to any level to control how widely your customizations are used.

Custom map documents

When you are working with a map, you are setting references to data, designing a map layout, customizing the user interface, and writing VBA code, all with the lifetime of the document.

Selective customization with project templates

Other projects and other users can share the customizations that you make through templates. A template is a kind of map document that is specified to be a starting point for a new map document. The new map document will inherit all of the customizations from the template (data references, map layout, user interface state, and VBA project).



Project - Project

- Normal (Normal.mxt)
  - ArcMap Objects
  - Modules
- Project
  - ArcMap Objects
  - References
- TemplateProject (Plat.mxt)
  - ArcMap Objects
  - References

This is how the three loaded templates in ArcMap—normal, project template, and project (current document)—appear in the VBA project explorer.

Global customizations with the normal template

ArcMap has a special template called Normal that stores any personal settings you have made to the user interface that you want loaded every time you start ArcMap. Any customizations that you save to the Normal template will get propagated to all the other map documents when they are next opened.

When you first start ArcMap after installing the software, a Normal template is automatically created and put in your profiles location, which is one of the following folders depending on your operating system.

For Windows NT®:

`C:\WINNT\Profiles\<your username>\Application Data\ESRI\ArcMap\Templates\`

For Windows 2000:

```
C:\Documents and Settings\<your username>\Application
Data\ESRI\ArcMap\Templates\
```

This is the default Normal template that contains all the standard toolbars and commands and places the toolbars and the table of contents in their default positions. Any customizations that you save in your Normal template get saved to this file.

If you want to make changes that appear every time you open ArcMap, save them in the Normal template.

Suppose your administrator has custom toolbars or tools to which she would like everyone in your organization to have access. Your administrator could create a customized Normal template and allow everyone in your organization to use that Normal template instead of the default Normal template. To accomplish this, your administrator would customize her Normal template and then copy that Normal.mxt file to the \ArcGIS\arcexe81\bin\Templates folder. Everyone would then start with this Normal template instead of the default Normal template. The following is an explanation of how this works.

If there is no Normal.mxt file in your profiles location when you start ArcMap, the application will look in the \ArcGIS\arcexe81\bin\Templates folder. If a Normal.mxt file exists in the \ArcGIS\arcexe81\bin\Templates folder, that file will be copied to your profiles location and will then be treated as your personal Normal template. Therefore, you start off with a copy of your organization's customized Normal template, but from that point on you can save your own customizations to it.

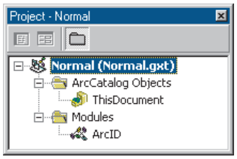
If a Normal.mxt file is not found in your profiles location or in the \ArcGIS\arcexe81\bin\Templates folder, then a new default Normal.mxt file will be created and placed in your profiles location.

CUSTOMIZING ArcCatalog

You can customize ArcCatalog in several ways:

- You can add, remove, or rearrange elements of the standard user interface.
- You can write code in a Visual Basic for Applications project.

ArcCatalog does not employ the full structure of documents and templates like ArcMap does. The ArcCatalog application does not use documents or base templates; it only uses a Normal template. Therefore, all customizations to the ArcCatalog user interface are stored in the Normal template.



This is how the Normal template appears in the VBA project explorer.

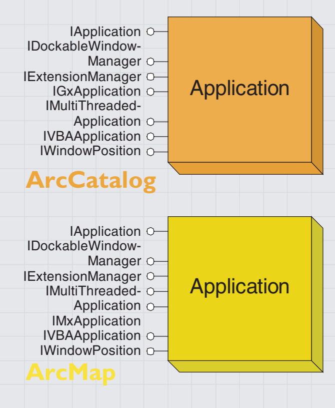
When you first start ArcCatalog after installing the software, a Normal template called Normal.gxt is automatically created and put in your profiles location, which is one of the following folders depending on your operating system.

For Windows NT:

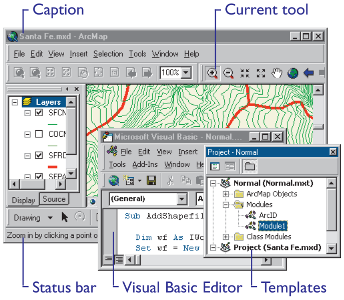
`C:\WINNT\Profiles\<your username>\Application Data\ESRI\ArcCatalog\`

For Windows 2000:

`C:\Documents and Settings\<your username>\Application Data\ESRI\ArcCatalog\`



Application is the core object that represents an ArcGIS application (ArcMap, ArcCatalog, or other). Through this object, you can access properties and methods for the application and navigate to other elements, such as the document, window handle, and status bar.



Extensions are subsystems that add significant functionality to an application. ArcGIS Spatial Analyst is an example of an extension to an application.

Documents contain custom user interface settings, a VBA project, and other settings, such as layers and map extent. You can open or save documents.

Each running ArcGIS application is represented by an instance of an *Application* object—ArcCatalog by *Application* from the ESRI ArcCatalog object library (esriGx.olb), and ArcMap by *Application* from the ESRI ArcMap object library (esriMx.olb).

The *IGxApplication* is documented in Chapter 7, 'Working with the Catalog'. The *IMxApplication* is documented in Chapter 4, 'Composing maps'. The *IApplication* interface is shared by both *Application* classes.

The *Application* object is instantiated in VBA when an ArcGIS application is launched. It is always available as a global object, and you can inspect properties of *Application* in this way:

```
MsgBox Application.Caption
```

You can also launch the ArcMap application in Visual Basic or other COM-compliant language. For example, to launch ArcMap from VB, create a new project, add a reference to the ESRI core library (esriCore), add this code to a Sub, then execute the Sub:

```
Dim m_doc As IDocument
Set  m_doc = New MxDocument 'start ArcMap
```

Visual C++ programmers use the #import directive to obtain type information. Importing esriCore.olb will automatically build "smart pointer" classes for ArcGIS interfaces. With smart pointers, an instance of ArcMap can then be created in C++ as follows:

```
// Example : Creating an instance of ArcMap
IDocumentPtr ipDoc (CLSID_MxDocument);
```

IApplication : IDispatch	*Provides access to members that query or modify the application.*
Caption: String	*The caption of this application.*
CurrentTool: ICommandItem	*The currently selected tool.*
Document: IDocument	*The document that is currently loaded in the application.*
hWnd: Long	*The handle of the application's window.*
Name: String	*The name of this application.*
StatusBar: IStatusBar	*The statusbar of this application.*
Templates: ITemplates	*The templates collection.*
VBE: Object	*The Visual Basic Environment.*
Visible: Boolean	*Indicates if the application window is visible.*
FindExtensionByCLSID (in extensionCLSID: IUID) : IExtension	*Finds an extension by its CLSID.*
FindExtensionByName (in extensionName: String) : IExtension	*Finds an extension by its name.*
IsDialogVisible (in dialogID: Long) : Boolean	*Indicates if the specified dialog is visible in the application.*
LockCustomization (in Password: String, custFilter: ICustomizationFilter)	*Locks the application's user interface against any customizations.*
NewDocument (selectTemplate: Boolean, templatePath: String)	*Creates a new document in this application.*
OpenDocument (Path: String)	*Opens a document in this application.*
PrintDocument	*Displays the Print dialog.*
PrintPreview	*Displays how the document will look like when it is printed.*
RefreshWindow	*Redraws the application window.*
SaveAsDocument (saveAsPath: String, saveAsCopy: Boolean)	*Saves the document that is currently open in this application to a different file.*
SaveDocument (saveAsPath: String)	*Saves the document that is currently open in this application.*
ShowDialog (in dialogID: Long, bShow: Variant) : Variant	*Displays the specified dialog in the application.*
Shutdown	*Terminates the application.*
UnlockCustomization (in Password: String)	*Unlocks previous user interface customization lock.*

The *IApplication* interface provides access to the *Document* object, the extensions, the *StatusBar* object, the *Templates* object, the currently selected tool, and the Visual Basic Editor.

There are several methods that allow you to open, save, and print documents; lock and unlock the application from user customizations; display dialog boxes; and exit the application.

The *NewDocument, OpenDocument, PrintDocument, PrintPreview,* and *SaveAsDocument* methods are not implemented in ArcCatalog. The *SaveDocument* method in ArcCatalog saves the Normal template rather than saving a document.

IVbaApplication : IUnknown	***Provides access to members that modify the VBA projects in this application.***
← CreateCodeModule (in docName: String, in moduleName: String)	*Creates a code module in the specified VBA project.*
← InsertCode (in docName: String, in moduleName: String, in codeText: String)	*Inserts code into the specified module.*
← RemoveCodeModule (in docName: String, in moduleName: String)	*Removes a code module from the specified VBA project.*
← RunVBAMacro (in docName: String, in moduleName: String, in MacroName: String, in arguments: Variant) : Variant	*Runs the specified VBA macro.*

The *Application* object implements the *IVbaApplication* interface, which allows you to programmatically insert, remove, and run VBA code without actually opening the Visual Basic Editor.

To get access to this interface, do a *QueryInterface* (*QI*) on *Application*. The *IVbaApplication* interface has methods to create a new module, insert code into a specific module, remove a module, and run a macro.

The following code shows how to create a new VBA module, insert a VBA macro into that module, and run the macro.

```
Dim pVbaApp As IVbaApplication
Dim s As String
Set pVbaApp = Application
pVbaApp.CreateCodeModule "Project", "MyModule"
s = "Public Sub MyMacro" & vbNewLine & _
  "  Msgbox Application.Document.Title" & vbNewLine & "End Sub"
pVbaApp.InsertCode "Project", "MyModule", s
pVbaApp.RunVBAMacro "Project", "MyModule", "MyMacro", Nothing
```

IMultiThreadedApplication : IUnknown	***Provides access to members that control DLL thread managers.***
← GetProcessID: Long	*The process ID for the application.*
← RegisterThreadManager (in pThreadMgr: IDllThreadManager) : Long	*Registers a DLL thread manager with the application.*
← UnregisterThreadManager (in mgrCookie: Long)	*Unregisters a DLL thread manager with the application.*

For more information on threading, read Threads, Apartments, and Marshalling *in Chapter 2, 'Developing with ArcObjects'.*

The *IMultiThreadedApplication* interface has methods for registering and unregistering thread managers with the application and returning the process ID of the application.

Multithreading refers to a software configuration where independent paths of execution are in use simultaneously in an application. Each thread has its own stack and its own CPU state.

The *Application* object implements the *IMultiThreadedApplication* interface, which provides a simple callback mechanism for registering user created thread manager objects. A thread manager object is any object that implements the *IDllThreadManager* interface. The thread manager object will be notified prior to application shutdown so that all currently running threads can be exited cleanly before the *Application* process actually shuts down.

If you are developing components that will create threads and will be used in any of the ArcGIS application processes, the DLL that contains these components must also contain an object that implements *IDllThreadManager*. Also, you must use the *IMultiThreadedApplication* interface to register this thread manager object with that application.

IDllThreadManager : IUnknown	***Provides access to an event that DLL thread managers listen for.***
← OnShutdown	*Occurs when the application is shutting down. DLL threads should be terminated upon receiving this message.*

The *IDllThreadManager* interface has an *OnShutdown* method that notifies the DLL thread manager object that the application is shutting down so that the DLL thread manager can terminate any threads that were created by the components in that DLL.

IWindowPosition : IUnknown	***Provides access to members that query or modify a window's position, size and state.***
■—■ Height: Long	*The height of the window.*
■—■ Left: Long	*The distance between the internal left edge of the window and screen.*
■—■ State: tagesriWindowState	*The state of the window.*
■—■ Top: Long	*The distance between the internal top edge of the window and screen.*
■—■ Width: Long	*The width of the window.*
← Move (in Left: Long, in Top: Long, Width: Long, Height: Long)	*Moves and optionally resizes the windows in a single function.*

The *IWindowPosition* interface has methods to move and resize a window. Any window object can implement this interface. All the ArcGIS application windows implement this interface; you can *QI* from the application to *IWindowPosition*.

The *Left* and *Top* properties determine the position of the window in screen coordinates relative to the upper-left corner of the display screen.

The *Height* and *Width* properties determine the size of the window.

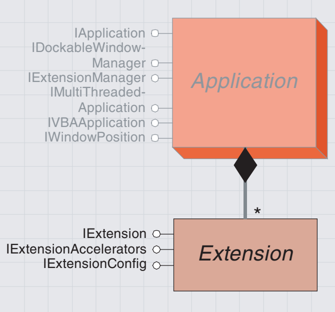
Use the *Move* method to set these four properties at the same time.

Enumeration tagesriWindowState	*Application window states.*
0 - esriWSNormal	*The window is restored.*
1 - esriWSMinimize	*The window is minimized.*
2 - esriWSMaximize	*The window is maximized.*

The *esriWindowState* enumeration specifies whether the window is normal, minimized, or maximized.

The following code in the *ThisDocument* code window in the Normal template forces the application window to always open with the specified size and position.

```
Private Function MxDocument_NewDocument() As Boolean
  Dim pWindPos As IWindowPosition
  Set pWindPos = Application
  pWindPos.Move 10, 10, 600, 500
End Function

Private Function MxDocument_OpenDocument() As Boolean
  Dim pWindPos As IWindowPosition
  Set pWindPos = Application
  pWindPos.Move 10, 10, 600, 500
End Function
```



An extension provides a mechanism for extending an application.

Extensions provide the developer with a powerful mechanism for extending the core functionality of the ArcGIS applications. An extension can provide a toolbar with new tools, listen for and respond to events, perform feature validation, and so on.

Extensions act as a central point of reference for developers when they are creating commands and tools for use within the applications. Often these commands and tools must share data or access common UI components. An extension is the logical place to store this data and develop the UI components. The main reason for this is that there is only ever one instance of an extension per running application and, given an *IApplication* interface, it is always possible to locate the extension and work with it.

Any extension that is registered with an application is automatically loaded and unloaded by the application; the end user does nothing to load or unload. For example, an extension that has been added to the "ESRI Mx Extensions" component category will be started when ArcMap is started and shut down when ArcMap is shut down.

These two environments, Generic and Locked Down, are often referred to as Extension and OEM products.There is much more to the creation of an OEM product besides writing software, which is beyond the scope of this book. For more details on OEM development, you should contact ESRI.

When customizing an ArcGIS application, you can deliver these customizations in a generic or locked down user environment. Generic and locked down environments are often referred to as Extension and OEM products, respectively.

With a generic environment, you, as a developer, have no control over the end user's environment. Your customizations must live harmoniously with potentially many other ArcGIS customizations that the user has installed. This is the type of extension that ESRI supplies. With a locked down environment, you, as the developer of that environment, have complete control over the setup of the application and how the user interacts with that environment.

Because the mechanisms for customization are the same for both of the above environments, it is important to follow a set of rules when developing a generic application. If, as a developer, you initially develop customizations for a locked down environment for a custom application, you cannot deliver these customizations to a generic ArcGIS user. In order to deliver this functionality to generic ArcGIS users, you must develop a generic solution in addition to the locked down solution.

GENERIC APPLICATION DEVELOPMENT RULES

Extensions are the best mechanism for delivering professionally built application customizations. However, any customizations you make must follow the rules given here to ensure that conflicting customizations are not created.

If in doubt about whether a rule applies to your development or not, you should not remove anything that does not belong to you. In this way, generic customizations act as extensions to a user's ArcGIS system. Below are the rules for creating generic customizations:

- Do not remove UI components, including buttons, tools, and property pages, that do not belong to you.
- Your extension should not use customization filters unless the filter is applied to a specific document.

- Do not make changes in document persistence that will invalidate previously saved documents.
- Do not abort document events by returning *True* from these events.
- If your extension works with a license, your extension must implement *IExtensionConfig* and follow the conventions used by the ArcGIS extension. For more information, refer to the discussion on *IExtensionConfig* later in this chapter.

LOCKED DOWN APPLICATION DEVELOPMENT RULES

Although none of the generic application rules apply to the creation of a locked down application, it is good programming practice to write your code defensively. That way, the code will fail gracefully if a conflict does occur.

As an example, extensions designed for locked applications can use customization filters. However, when applying a customization filter you should always be prepared for the case of a filter already being in operation. The following code displays an error message if the attempt to apply the customization filter fails.

```
Private Function m_pDoc_OpenDocument() As Boolean
  On Error GoTo FilterErr

  ' Reset the Lock when a document is opened.
  m_pApp.LockCustomization "mylock", m_MyFilter
  Exit Function
FilterErr:
  MsgBox "Attempt To Lock Document With Filter Failed", _
   vbOKOnly + vbExclamation, "Extension Error"
End Function
```

WORKING WITH AND CREATING EXTENSIONS

The *Application* object implements the *IExtensionManager* interface, which has properties to get a reference to a particular extension and to get a count of how many extensions are currently loaded.

IExtensionManager : IUnknown	*Provides access to members that query extension.*
■— Extension (in Index: Long) : IExtension	*The extension at the specified index.*
■— ExtensionCount: Long	*The number of extensions loaded in the application.*

To get access to the application extension manager, do a *QI* for *IExtensionManager* on *Application*. Note that other types of objects can also implement *IExtensionManager*. For example, the Editor toolbar in ArcMap is an extension that manages editor extensions. Therefore, the *Editor* object also implements *IExtensionManager*.

This VBA code uses the application extension manager to loop through all of the extensions that are currently loaded in the application, then reports the name of the extensions.

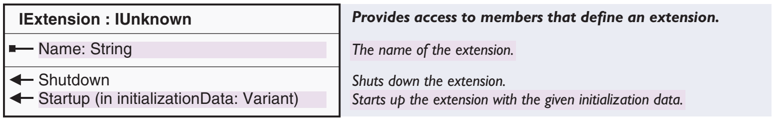
```
  Dim pExtMgr As IExtensionManager, pExt As IExtension
  Dim i as Integer
```

```
Set pExtMgr = Application
For i = 0 To pExtMgr.ExtensionCount - 1
  Set pExt = pExtMgr.Extension(i)
  MsgBox pExt.Name
Next
```

To ensure that there is not the potential for a name clash, the use of the FindExtensionByCLSID method is encouraged.

This is not the only way to get a reference to an extension; the *IApplication* interface has *FindExtensionByCLSID* and *FindExtensionByName* methods.

To create your own extension, implement the *IExtension* interface. You can also optionally implement *IExtensionConfig* and *IExtensionAccelerators*.



IExtension : IUnknown

Name: String

Shutdown

Startup (in initializationData: Variant)

Provides access to members that define an extension.

The name of the extension.

Shuts down the extension.

Starts up the extension with the given initialization data.

For more information on creating COM components, see Chapter 2, 'Developing with ArcObjects'.

The *IExtension* interface allows you to set the name of the extension and specify what action takes place when the extension is started or shut down.

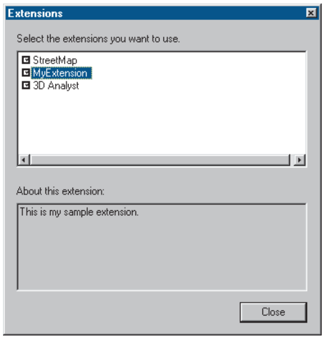
To use this extension in ArcMap, register it in the "ESRI Mx Extensions" component category.

The following code demonstrates how to create a custom ArcMap extension that can perform some action when the document events occur. When this extension is loaded, a message box appears when a new document is created and when a document is opened.

```
Implements IExtension
Dim m_pDoc as IDocument
Dim m_pApp As IApplication
' Need to listen for the MxDocument events
Dim WithEvents m_pDocEvents As MxDocument

Private Property Get IExtension_Name() As String
  IExtension_Name = "My Extension"
End Property

Private Sub IExtension_Shutdown()
  ' Clear the reference to the Application and MxDocument
  Set m_pApp = Nothing
  Set m_pDocEvents = Nothing
  Set m_pDoc = Nothing
End Sub

Private Sub IExtension_Startup(initializationData As Variant)
  Set m_pApp = initializationData
  'Start listening for the MxDocument events.
  Set m_pDocEvents = m_pApp.Document
  Set m_pDoc = m_pApp.Document
End Sub

Private Function m_pDocEvents_NewDocument() As Boolean
  MsgBox "Creating a new document."
End Function
```

```
Private Function m_pDocEvents_OpenDocument() As Boolean
  MsgBox "Opening a document"
End Function
```

IExtensionConfig : IUnknown	Provides access to members that describe an extension.
Description: String	Detailed description of the extension.
ProductName: String	Name of the extension.
State: esriExtensionState	The state of the extension.



Extensions

Select the extensions you want to use.

☒ StreetMap
☒ MyExtension
☒ 3D Analyst

About this extension:

This is my sample extension.

The Extensions dialog box allows you to turn extensions on and off.

If you want your extension to be exposed in the Extensions dialog box, you should implement the *IExtensionConfig* interface. The Extensions dialog box allows users to turn extensions on and off. The *IExtensionConfig* interface provides the Extension dialog box with the name of the extension and a description of the extension; it also specifies the state of the extension.

Enumeration esriExtensionState	Extension availability states.
1 - esriESEnabled	Enabled for use.
2 - esriESDisabled	Disabled by the user.
4 - esriESUnavailable	Unavailable - not licensed.

The *esriExtensionState* enumeration is used to specify whether the extension is enabled, disabled, or unavailable. The state of the extension is user-based. When an extension is installed, its default state is unchecked (*esriESDisabled*), and the user must knowingly check the extension on in the Extensions dialog box.

With a custom extension, you have full control over what happens when your extension is turned on or off. However, it is a good idea to follow the same design as the ArcGIS extensions. The following notes explain how the ArcGIS extensions work when they are turned on or off in the Extensions dialog box.

When a user checks one of the ArcGIS extensions in the Extensions dialog box, the following things occur:

- The checked state of the extension is saved to the user settings in the registry. (This occurs automatically by the application—it is not something a developer needs to do.)
- The extension requests a license from the license manager.
- If a license is available, the tools are enabled on the toolbar delivered by the extension.
- If a license is not available, the tools are disabled on the toolbar delivered by the extension. Also, text stating that the license is unavailable is displayed to the right of the extension name in the Extensions dialog box.

When a user unchecks one of the ArcGIS extensions in the Extensions dialog box, the following things occur:

- The extension verifies that it is not being used within that application.
- If the extension is being used within the application, the extension does not allow itself to be unchecked and a warning message is given.
- If the extension is not being used within the application, the uncheck completes successfully and the remaining steps occur.
- The unchecked state for the extension is saved in the user settings in the registry. (This occurs automatically by the application—it is not something a developer needs to do.)
- If the toolbar for the extension is active, the appropriate tools are disabled.
- The *Extension* lets the license manager know it is no longer using the extension license within the application, and the license manager releases the license for that extension.

The *IExtensionConfig* interface is independent of ESRI's licensing approach, so as a developer you can incorporate a custom licensing solution. Alternatively, if your extension doesn't work with a license manager, you don't have to worry about requesting and releasing a license. You can implement *IExtensionConfig* to enable and disable the tools on your extension's toolbar accordingly.

The following excerpt of code from a class module that also implements *IExtension* shows you how you can use the *IExtensionConfig* interface.

```
Implements IExtensionConfig
Private m_pExtState As esriExtensionState

Private Property Get IExtensionConfig_Description() As String
  IExtensionConfig_Description = "This is the sample extension."
End Property

Private Property Let IExtensionConfig_State(ByVal RHS As _
    esriCore.esriExtensionState)
  m_pExtState = RHS
End Property

Private Property Get IExtensionConfig_ProductName() As String
  IExtensionConfig_ProductName = "Sample Extension"
End Property

Private Property Get IExtensionConfig_State() As _
    esriCore.esriExtensionState
  IExtensionConfig_State = m_pExtState
```

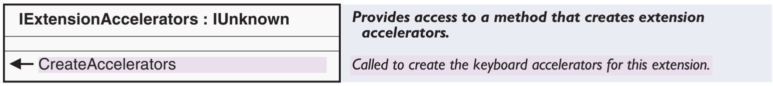
```
End Property
```

The application has a mechanism for dealing with extension-specific data in an ArcMap document. For example, some of the ArcGIS extensions have their own types of layers saved in the document. When a user opens such a document and the extension-specific layer is loaded, an attempt is made to create the layer. Creation may fail for one of three reasons:

- The extension has not been installed.
- The extension is not checked on in the Extension dialog box.
- The extension is checked on, but a license for the extension is currently not available.

In each of these failure cases, a warning will be issued stating what the problem is. The document is then opened but without the extension-specific layer. However, if the extension is installed, checked on in the Extension dialog box, and an extension license was successfully obtained, the document opens successfully.

If you want any of the commands in your extension to have keyboard accelerators associated with them, your extension needs to implement *IExtensionAccelerators*.


IExtensionAccelerators : IUnknown
CreateAccelerators
Provides access to a method that creates extension accelerators.
Called to create the keyboard accelerators for this extension.

The *IExtensionAccelerators* interface has one method called *CreateAccelerators* that creates the accelerators for the extension. This method is called when the accelerator table is created during application startup, when a new document is created, or when a document is opened. Accelerators and the accelerator table are discussed later in this chapter.

When you use the *CreateAccelerators* method to assign an accelerator to one of the commands in your extension, check to make sure that no other command is currently using the key combination that you want to use.

The following code excerpt from a class module that also implements *IExtension* shows you how you can use the *IExtensionAccelerators* interface.

```
Implements IExtensionAccelerators

Private m_pDoc As IDocument

Private Sub IExtensionAccelerators_CreateAccelerators()
  Dim pAccelTable As IAcceleratorTable
  Dim pAccel As IAccelerator
  Dim u As New UID
  Set pAccelTable = m_pDoc.Accelerators
```

If one of the ArcGIS applications fails to start after you have registered a custom extension in one of the ESRI extension component categories, then you should check for errors in your extension. If there are any problems in your extension, this may cause the application startup sequence to abort.

```
  Set pAccel = pAccelTable.FindByKey(vbKeyH, True, False, False)
  ' Create accelerator only if nothing else is using it
  If pAccel Is Nothing Then
    'The clsid of one of the commands in the ext
    u.Value = "CustomCOMCommands.clsICommand"
    pAccelTable.Add u, vbKeyH, True, False, False
  End If
End Sub
```

APPLICATION STARTUP SEQUENCE

When working with extensions, customization filters, and document events, it is important to have an understanding of the application startup sequence. The basic startup sequence is:

1. User starts application.
2. *Application* object created.
3. *Document* object created.
4. Extensions are loaded.
5. If a document file is specified on the command line or if ArcMap is started by double-clicking a document file, then the document is loaded. If not, a new document is created. If the user then chooses to open an existing document, that document is loaded.
6. Application startup completed.

The order of extension loading cannot be controlled. The extensions are loaded in CLSID order using the appropriate component category. In certain circumstances, you may want to share data between extensions. In such circumstances, the data should not be associated with one extension but with another helper class. Each extension can check to see if the helper object has been created, and if not, the extension can create it. Once the helper object is created by the first initialized extension, the other extensions can access the data it contains.

Any document-specific code, such as customization filters, should not be placed in the extension-loading stage. The extensions are loaded before any map document is opened. This ensures that any extensions referred to in the map document are present when the document is opened. If you had a customization filter that was initialized during its extension startup, it would only operate until a document was opened or a new document was created. This is because customization filters are tied to individual documents. To get around this problem, event handlers can be initialized during extension startup, and the document-specific code can be added to the appropriate events. For example, when the open or new document events occur, the customization filter can be applied.

HANDLING GLOBAL APPLICATION DATA

When developing components for use within the ArcGIS suite of applications, it is often desirable to share data between components. As stated in the introduction, an extension is the logical place to store this data. For example, you might define public variables in the extension class and then access these variables directly.

Using public variables is not a good practice, since as creator of the variable you lose control over that variable when you add your component into the system. A better technique is to provide accessor and mutator functions. This allows for data encapsulation within the extension.

In Visual Basic, these functions are defined as a property on the default interface of the class. To locate the property, you must locate the extension, then *QI* the *Extension* object for its default interface. Then, you can call the properties on that interface.

The following VB code shows a class that implements the *IExtension* interface with a member variable that holds a Zoom Percentage, which has a valid range of 0–100. Also, a piece of code from the *OnClick* event of a command that uses that percentage to Zoom the display is provided.

This is a piece of code for *clsDisplayExtension*:

```
Implements IExtension

Private m_lZoomPercentage As Long
Private m_pApp As IApplication

Private Property Get IExtension_Name() As String
  IExtension_Name = "Display Extension"
End Property

Private Sub IExtension_Startup(ByRef initializationData As Variant)
  Set m_pApp = initializationData

  ' Initialize the Percentage value
  m_lZoomPercentage = 50
End Sub

Private Sub IExtension_Shutdown()
  Set m_pApp = Nothing
End Sub

Public Property Get ZoomPercentage() As Long
  ZoomPercentage = m_lZoomPercentage
End Property

Public Property Let ZoomPercentage(ByVal lPercentage As Long)
  If (lPercentage >= 0) And (lPercentage <= 100) Then
    m_lZoomPercentage = lPercentage
  Else
```

```
    Err.Raise vbObjectError + 29566, "MyProj.MyObject", _
    "Invalid Percentage Value. Valid values (0 -> 100)"
  End If
End Property
```

The following code is for the *OnClick* event of the command:

```
Private Sub ICommand_OnClick()
  Dim pExtension As clsDisplayExtension

  Dim pUID As New UID
  pUID.Value = "prjDisplay.clsDisplayExtension"

  ' QI IExtension for interface _clsDisplayExtension
  Set pExtension = m_pApp.FindExtensionByCLSID(pUID)

  ' Get Extent
  Dim pActiveView As IActiveView
  Set pActiveView = m_pMxDoc.ActiveView

  Dim pEnv As IEnvelope
  Set pEnv = pActiveView.Extent

  ' Zoom Extent and refresh the screen
  pEnv.Expand pExtension.ZoomPercentage / 100, _
    pExtension.ZoomPercentage / 100, True
  pActiveView.Extent pEnv
  pActiveView.Refresh
End Sub
```

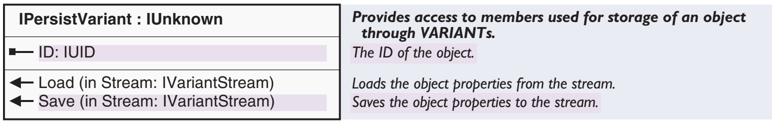
PERSISTENCE

The state of the application is persisted inside an OLE2 document. For instance, ArcMap saves its state in an .mxd file and its various template files, which are documents themselves.

Not every object is given the opportunity to save information within the document. The application framework knows which objects can be saved. When the user clicks Save on the File menu, the application framework creates a document storage and then asks these objects to save themselves to the document.

The framework works with the objects by calling *QueryInterface* for an appropriate persistence interface; if it finds a suitable interface, it calls the appropriate methods, passing a suitable storage medium—normally a stream. The object is then responsible for serializing its state into the storage medium. The framework is not concerned with what is written to the medium; this is the sole concern of the object. When loading the state of an object from the storage medium, the object is able to read the serialized data and rehydrate itself.

An ArcObjects developer has two methods of saving data into the document—through an *Extension* or through a supported persistable object class. Persistable objects classes are classes such as layers, renderers, and so on. Commands and tools are not given the opportunity to persist information they are maintaining. For these and other objects which the framework will not automatically persist, an application extension must be used. When creating an extension, you need to implement a suitable persistence interface in addition to the *IExtension* interface. The persistence interface is *IPersistStream* if developing in Visual C++ or *IPersistVariant* if developing in Visual Basic.



IPersistVariant : IUnknown	*Provides access to members used for storage of an object through VARIANTs.*
ID: IUID	*The ID of the object.*
Load (in Stream: IVariantStream)	*Loads the object properties from the stream.*
Save (in Stream: IVariantStream)	*Saves the object properties to the stream.*

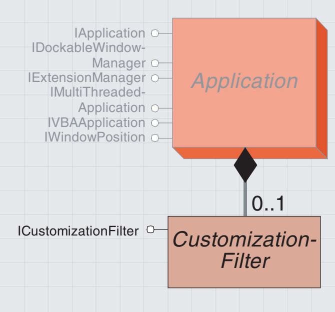
The *IPersistVariant* interface has one property, the class ID of the object being persisted, and two methods—*Load* and *Save*—that perform the loading and saving from the stream. It is good practice to version the persisted data so that the data can evolve over time in a way that allows backwards compatibility. It is important to load and save the data in the same order since access to the stream is always sequential. Below is a very simple example of an extension that implements persistence. It displays a message box when a document is opened that informs the user how many times the document has been saved.

```
Option Explicit

Implements IExtension
Implements IPersistVariant

Const c_lVersion = 1
Private m_lNumSaves As Long
Private m_pApp As IApplication

Private Property Get IExtension_Name() As String
  IExtension_Name = "Persistence Example Extension"
End Property

Private Sub IExtension_Startup(ByRef initializationData As Variant)
  Set m_pApp = initializationData
End Sub

Private Sub IExtension_Shutdown()
  Set m_pApp = Nothing
End Sub

Private Property Get IPersistVariant_ID() As esriCore.IUID
  IPersistVariant_ID.Value = "PersistenceSample.clsPersistExtension"
End Property

Private Sub IPersistVariant_Load(ByVal Stream As esriCore.IVariantStream)
```

```
  Dim version As Long
  version = Stream.Read

  If (version > c_lVersion) Then Exit Sub

  m_lNumSaves = Stream.Read
  MsgBox "Document Saved " & CStr(m_lNumSaves) & " Times"
End Sub

Private Sub IPersistVariant_Save(ByVal Stream As esriCore.IVariantStream)
  Stream.Write c_lVersion

  m_lNumSaves = m_lNumSaves + 1
  Stream.Write m_lNumSaves
End Sub
```

IVariantStream : IUnknown	***Provides access to members that store values to and retrieve values from a stream.***
← Read: Variant	*Reads a value from a stream.*
← Write (in Value: Variant)	*Writes a value to a stream.*

Notice the use of the *Write* and *Read* methods on the *IVariantStream* interfaces in the above code. These methods take variants, meaning they can save most data types. If an object, such as a layer, has a persistence interface, the object can be passed to these methods via one of its interfaces, and the object will be persisted.



A customization filter locks parts of customized functionality of ArcGIS applications.

A customization filter provides a mechanism to lock parts of the customization functionality in the ArcGIS applications. If you use an extension to enable a customization filter, you should do so only in locked down applications where you have complete control over the application setup and how the users interact with that application. In generic applications, you can use customization filters if they are applied to a specific document.

To create a customization filter, implement the *ICustomizationFilter* interface in a class module. To activate your customization filter, pass it into the *IApplication::LockCustomization* method. You can make the call to *LockCustomization* in a simple VBA macro, in the *MxDocument_OpenDocument* or *MxDocument_NewDocument* event in VBA, or in an extension. If this is done in a macro or the open document event in VBA, make sure that the VBA project has a reference to the class that implements the customization filter.

If the customization filter is applied in an extension, you must be aware of the application startup sequence in order for this to work correctly. Refer to the Application startup sequence discussion earlier in this chapter. Also, be aware that if your customization filter is applied by an extension, it may override other locking logic that might be saved in an existing ArcMap document; also, another extension might activate a customization filter before your extension is even loaded. There can only be one active customization filter in a running application.

ICustomizationFilter : IUnknown	***Provides access to members that define a customization filter.***
← OnCustomizationEvent (in custEventType: esriCustomizationEvent, in eventCtx: Variant) : Boolean	*Occurs when certain types of customization occur.*

The *ICustomizationFilter* interface has an *OnCustomizationEvent* event that occurs whenever a user attempts any type of customization.

The *custEventType* parameter of *OnCustomizationEvent* specifies what type of customization event has just happened. The types of customization events are defined by the *esriCustomizationEvent* constants.

Enumeration esriCustomizationEvent	***Customization event types.***
0 - esriCEAddCategory	*Occurs when the Categories list on the Customize dialog is populated.*
1 - esriCEAddCommand	*Occurs when the Commands list on the Customize dialog is populated.*
2 - esriCEShowCustDlg	*Occurs when the Customize dialog is requested to be opened.*
3 - esriCEShowVBAIDE	*Occurs when the Visual Basic Editor is requested to be opened.*
4 - esriCEInvokeCommand	*Occurs when a command on a commandbar is about to be executed.*
5 - esriCEShowCustCtxMenu	*Occurs when the Customize context menu is popped up for a command item.*

The following lists additional things that the customization events can be used for:

- *esriCEAddCategory* can be used to remove categories from the Categories list in the Customize dialog box.
- *esriCEAddCommand* can be used to remove commands from the Commands list in the Customize dialog box.
- *esriCEShowCustDlg* can be used to prevent the Customize dialog box from being opened.
- *esriCEShowVBAIDE* can be used to prevent the Visual Basic Editor from being opened.
- *esriCEInvokeCommand* can be used to prevent a particular command from being executed.
- *esriCEShowCustCtxMenu* can be used to prevent the Customize context menu from being displayed when you right-click a command item when the Customize dialog box is open.

The *eventCtx* parameter of *OnCustomizationEvent* provides event context information for each type of customization event. To see what type of information is provided by *eventCtx* for each customization event type, refer to the table below.

Use the IApplication::LockCustomization *method to activate the customization filter.*

CustEventType	eventCtx
esriCEAddCategory	string representing category name
esriCEAddCommand	UID or string identifying a command
esriCEShowCustDlg	nothing
esriCEShowVBAIDE	nothing
esriCEInvokeCommand	CommandItem
esriCEShowCustCtxMenu	nothing

The following VB class module defines a customization filter. This filter locks the following three areas of customization:

- Prevents the Visual Basic Editor from being opened.
- Locks the Map and Edit categories. These categories will not appear in the Categories list on the Commands panel of the Customize dialog box. This prevents users from dragging the commands in these categories onto toolbars.
- Locks the What's This command. This command will not show up in the Commands list for the Help category on the Commands panel of the Customize dialog box. This prevents users from dragging this command onto a toolbar but still gives them access to the other commands in the Help category.

```
Implements ICustomizationFilter

Private Function ICustomizationFilter_OnCustomizationEvent _
     (ByVal custEventType As esriCore.esriCustomizationEvent, _
      ByVal eventCtx As Variant) As Boolean
    ' Lock the Visual Basic editor.
    ' custEventType is esriCEShowVBAIDE
    ' eventCtx is nothing
    If custEventType = esriCEShowVBAIDE Then
      ICustomizationFilter_OnCustomizationEvent = True

    ' Lock the Map and Edit categories.
    ' custEventType is esriCEAddCategory
    ' eventCtx is a string representing the category name
    ElseIf custEventType = esriCEAddCategory Then
      Select Case eventCtx
      Case "Map"
        ICustomizationFilter_OnCustomizationEvent = True
      Case "Edit"
        ICustomizationFilter_OnCustomizationEvent = True
      Case Else
        ICustomizationFilter_OnCustomizationEvent = False
      End Select
    ' Lock the What's This Help command.
    ' custEventType is esriCEAddCommand
    ' eventCtx can be either a UID or a string identifier
    ' for a command.
    ElseIf custEventType = esriCEAddCommand Then
      'UID for What's This Help command
      Dim u As New UID
      u.Value = "esriCore.HelpTool"
      If u = eventCtx Then
        ICustomizationFilter_OnCustomizationEvent = True
      End If
     End If
End Function
```

Another common use of a customization filter is to restrict access to functionality by trapping *Invoke* calls. For example, the customization filter can prevent the execution of a command when a user tries to execute that command. To simplify the coding, a collection of disallowed commands can be created; then, when each command is invoked, it can be tested against this collection. These collections can be built on a user-by-user basis to provide user-level customization locking.

Below is an example of a class that implements the *ICustomizationFilter* to support this functionality.

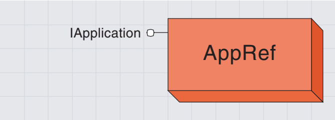
```
Option Explicit
Implements ICustomizationFilter

Private m_pBlockedCommands As Collection

Private Sub Class_Initialize()
  Set m_pBlockedCommands = New Collection

  Dim pUID As IUID
  ' Add Commands to Disable
  Set pUID = New UID
  pUID.Value = "esriCore.StartEditingCommand"
  m_pBlockedCommands.Add pUID.Value, pUID.Value
  Set pUID = New UID
  pUID.Value = "esriCore.AddDataCommand"
  m_pBlockedCommands.Add pUID.Value, pUID.Value
End Sub

Private Sub Class_Terminate()
  Set m_pBlockedCommands = Nothing
End Sub

Private Function IsCommandBlocked(pItemUID As IUID) As Boolean
  IsCommandBlocked = True

  Dim tmpStr As String
  On Error GoTo Missing
  tmpStr = m_pBlockedCommands.Item(pItemUID.Value)
  Exit Function
Missing:
  IsCommandBlocked = False
  Err.Clear
End Function

Private Function ICustomizationFilter_OnCustomizationEvent _
  (ByVal custEventType As esriCore.esriCustomizationEvent, _
   ByVal eventCtx As Variant) As Boolean
  If (custEventType = esriCEInvokeCommand) Then
    Dim pItem As ICommandItem
    Set pItem = eventCtx
    ICustomizationFilter_OnCustomizationEvent = IsCommandBlocked(pItem.ID)
  End If
End Function
```

If you wanted to create an extension to apply one of these customization filters, the class of the extension could be coded as follows:

```
Implements IExtension

Dim m_pApp As IApplication
Dim m_MyFilter As ICustomizationFilter

' Need to listen for the MxDocument events so that the Lock
' can be set on OpenDocument and NewDocument events.
Dim WithEvents m_pDoc As MxDocument

Private Property Get IExtension_Name() As String
  IExtension_Name = "MyFilterExt"
End Property

Private Sub IExtension_Shutdown()
  Set m_pApp = Nothing
  Set m_pDoc = Nothing
```

To use this extension in ArcMap, register it in the ESRI Mx Extensions component category.

```
End Sub

Private Sub IExtension_Startup(initializationData As Variant)
  If TypeOf initializationData Is IMxApplication Then
    Set m_pApp = initializationData

    'Start listening for the MxDocument events.
    If Not m_pDoc Is m_pApp.Document Then
      Set m_pDoc = m_pApp.Document
    End If
    ' Replace MyFilter with the class name of your filter
    Set m_MyFilter = New clsMyFilter
  End If
End Sub

Private Function m_pDoc_NewDocument() As Boolean
  On Error GoTo FilterErr

  ' Set the Lock when a new document is created.
   m_pApp.LockCustomization "mylock", m_MyFilter

  Exit Function
FilterErr:
  MsgBox "Attempt To Lock Document With Filter Failed", _
   vbOKOnly + vbExclamation, "Extension Error"
End Function

Private Function m_pDoc_OpenDocument() As Boolean
  On Error GoTo FilterErr

  ' Reset the Lock when a document is opened.
  m_pApp.LockCustomization "mylock", m_MyFilter

  Exit Function
FilterErr:
  MsgBox "Attempt To Lock Document With Filter Failed", _
   vbOKOnly + vbExclamation, "Extension Error"
End Function
```



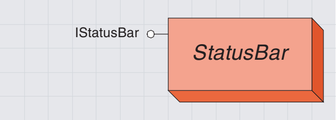
The application reference object, AppRef, *is a reference to the currently running ArcGIS application.*

If for some reason you can't easily get a reference to the *Application* object in your code, you can create a new *AppRef* object. For example, there are cases where you may implement an object that exists within the application framework, but there is no way to traverse the application hierarchy from that object.

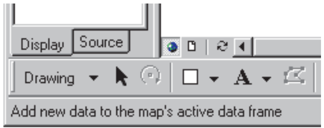
In order to provide developers with access to the *Application* object, there is a singleton object that provides a pointer to the running application object. The code below illustrates its use.

```
Dim pApp As IApplication
Set pApp = New AppRef
```

You can only use the *AppRef* object if your code is running inside one of the ArcGIS application processes.



The status bar is the horizontal area at the bottom of an ArcGIS application window. It provides information about the current state of the application.



Add new data to the map's active data frame

The status bar provides information about the selected command. For example, if you select a layer in the table of contents in ArcMap, the status bar will tell you how many features are currently selected. It may also display a progress bar while something is being processed.

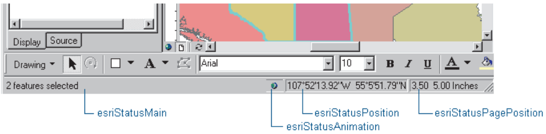
The *StatusBar* property on the *IApplication* interface can be used to get a reference to the *StatusBar* object.

IStatusBar : IUnknown	**Provides access to members that define the application statusbar.**
Message (in pane: Long) : String	The message displayed by one of the status bar panes.
Panes: Long	Indicates which standard panes are shown by the status bar. Use a combination of esriStatusBarPanes constants.
ProgressAnimation: IAnimationProgressor	The progress animation object on the statusbar.
ProgressBar: IStepProgressor	The progress bar object on the statusbar.
Visible: Boolean	Indicates if the statusbar is visible.
HideProgressAnimation	Hides the progress animation.
HideProgressBar	Hides the progress bar.
PlayProgressAnimation (in playAnim: Boolean)	Plays the progress animation if the parameter is true; otherwise stops it.
ShowProgressAnimation (in Message: String, in animationPath: String)	Makes the progress animation visible.
ShowProgressBar (in Message: String, in min: Long, in max: Long, in Step: Long, in onePanel: Boolean)	Makes the progress bar visible.
StepProgressBar	Steps the progress bar to the next position.

The *IStatusBar* interface allows you to set the properties of the status bar. The status bar is divided into sections called panes. The *Panes* property specifies which panes of the status bar are currently visible.

Enumeration esriStatusBarPanes	**Status bar panes.**
0 - esriStatusMain	Leftmost pane where application messages are displayed.
1 - esriStatusAnimation	Pane showing an animated icon.
2 - esriStatusPosition	Pane showing mouse position in map coordinates.
4 - esriStatusPagePosition	Pane showing mouse position in page coordinates.
8 - esriStatusSize	Pane showing object size.
16 - esriStatusCapsLock	Pane showing caps lock indicator.
32 - esriStatusNumLock	Pane showing num lock indicator.
64 - esriStatusScrollLock	Pane showing scroll lock indicator.
128 - esriStatusClock	Pane showing clock.

The *esriStatusBarPanes* constants define which panes are shown. The *Panes* property is a bit field; this means that you can use a combination of the *esriStatusBarPanes* constants. Add up the values of the panes you want shown and set the *Panes* property to the total.

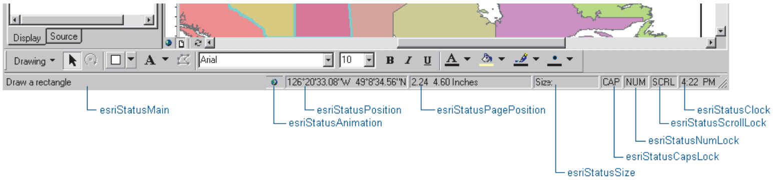


2 features selected

107°52'13.92"W 55°5'51.79"N 3.50 5.00 Inches

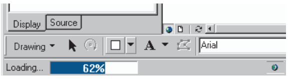
Only the default panes are shown in the status bar.

The default value of *Panes* is 7; this means that the main (0), animation (1), position (2), and page position (4) panes are visible (0 + 1 + 2 + 4 = 7). You can set the *Panes* property to 255 to show all panes.



All the panes are shown in the status bar.

The *Message* property allows you to display text in the status bar. Most commonly, the main pane is used for the display of messages; however, any pane can be used.



The step progressor bar is the blue moving line that displays the percentage of completeness.

The *ProgressBar* property and the *HideProgressBar, ShowProgressBar,* and *StepProgressBar* methods are used to control the step progress bar on the status bar. The step progress bar displays in the main status bar pane.

IProgressor : IUnknown	***Provides access to members that report progress.***
Message: String	*The message displayed by the progressor.*
Hide	*Hides the progressor.*
Show	*Shows the progressor.*
Step	*Animates or steps the progressor.*

The *IProgressor* interface is a generic interface for progressors. There are methods to show, step, and hide the progressor and a property to set the message of the progressor.

IStepProgressor : IProgressor	***Provides access to memebers that report progress in stepped increments.***
MaxRange: Long	*The maximum range of the progression.*
MinRange: Long	*The minimum range of the progression.*
Position: Long	*The current position of the progression.*
StepValue: Long	*The step increment of the progression.*
OffsetPosition (in offsetValue: Long) : Long	*Offsets the position of the progression.*

The *IStepProgressor* interface has properties for setting the properties of the step progress bar, such as the message, the minimum and maximum values, and the step size. Use the *IStatusBar::ProgressorBar* interface to get access to the step progress bar. Alternatively, the *IStatusBar::ShowProgressBar* method provides shortcuts to the properties of the step progress bar. This method allows you to set the message, minimum and maximum values, and the step size of the step progress bar and also display the step progress bar. Therefore, it is unnecessary to use *IStepProgressor* to do this.

The following code displays a step progress bar and steps in a loop from 1 to 900,000.

```
Public Sub StepProg()
  Dim pStatusBar As IStatusBar
  Dim i As Long
  Dim pProgbar As IStepProgressor
  Set pStatusBar = Application.StatusBar
  Set pProgbar = pStatusBar.ProgressBar
```

The animation progressor is the spinning globe on the status bar.You could also display a custom animation here.

```
  pProgbar.Position = 0
  pStatusBar.ShowProgressBar "Loading...", 0, 900000, 1, True
  For i = 0 To 900000
    pStatusBar.StepProgressBar
  Next
  pStatusBar.HideProgressBar
End Sub
```

On the *IStatusBar* interface, the *ProgressAnimation* property and the *HideProgressAnimation, ShowProgressAnimation,* and *PlayProgressAnimation* methods control the animation progressor (spinning globe) on the status bar. The animation progressor displays in the animation pane. You can use the default spinning globe for the animation progressor or specify your own animation file (.avi).

IAnimationProgressor : IProgressor	Provides access to members that report progress using an animation.
■—■ Animation: esriAnimations	The animation displayed by the progressor as one of the esriAnimation constants. (Not implemented).
← OpenPath (in animationPath: String)	Opens the AVI file specified in the path and displays its first frame. The AVI file specified must not contain audio.
← Play (frameFrom: Long, frameTo: Long, repeat: Long)	Plays the animation.
← Seek (in frameTo: Long)	Moves to the specified frame of the animation. The animation starts at this frame the next time it is played.
← Stop	Stops the animation.

The *IProgressAnimation* interface has methods for controlling the animation progressor, such as setting the path to the avi file and showing and playing the animation progressor.

Use the *IStatusBar::AnimationProgressor* interface to get access to the animation progressor.

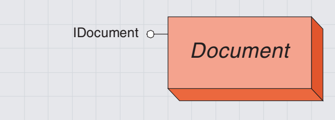
Alternatively, the *IStatusBar::ShowProgressAnimation* method provides a shortcut to the *OpenPath* and *Show* methods of the animation progressor.

The *IStatusBar::PlayProgressAnimation* method provides a shortcut to the *Play* and *Stop* methods of the animation progressor.

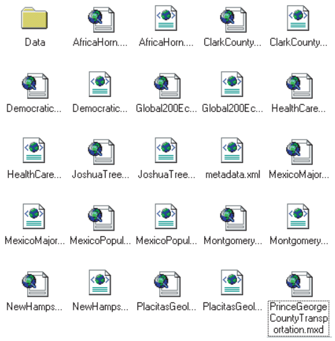
The *Animation* property on *IAnimationProgressor* is not implemented.

The following code plays the animation progressor on the status bar.

```
Public Sub AnimProg()
  Dim pStatusBar As IStatusBar
  Dim i As Long
  Dim pProgAnim As IAnimationProgressor
  Set pStatusBar = Application.StatusBar
  Set pProgAnim = pStatusBar.ProgressAnimation
  pProgAnim.Show
  pStatusBar.PlayProgressAnimation True
  For i = 0 To 10000
    pStatusBar.Message(0) = "Counting..." & Str(i)
  Next
  pStatusBar.PlayProgressAnimation False
  pProgAnim.Hide
End Sub
```



The document in ArcMap stores objects such as map layers and elements. The document in ArcCatalog is actually default user interface settings in the Normal template.



This *Document* object only represents the generic document properties common to all ArcGIS applications. Each application has its own document object.

The document object in ArcMap is called *MxDocument*; for further discussion, see Chapter 4, 'Composing maps'. The document object in ArcCatalog is called *GxDocument*; for further discussion, see Chapter 7, 'Working with the Catalog'.

Even though ArcCatalog doesn't use documents, it has a document object associated with it. The document provides access to the user interface elements and the VBA project. The *GxDocument* is really just the Normal template, Normal.gxt.

Use the *Document* property of the *IApplication* interface to get a reference to the document.

In the Visual Basic Editor, each VBA project contains a VBA class module called *ThisDocument*. This class represents the document object. When you are working in the *ThisDocument* code window in VBA, you have direct access to the properties and methods on the *IDocument* interface.

IDocument : IDispatch	***Provides access to other objects in the document.***
Accelerators: IAcceleratorTable	*The accelerator table for this document.*
CommandBars: ICommandBars	*The commandbars collection in this document.*
ID: IUID	*The unique id for this document.*
Parent: IApplication	*The application in which this document is open.*
Title: String	*The title of this document.*
Type: esriDocumentType	*The type of this document.*
VBProject: Object	*The VBProject for this document.*

The *IDocument* interface provides access to the document's title, type, accelerator table, command bars collection, parent application, and Visual Basic for Applications project.

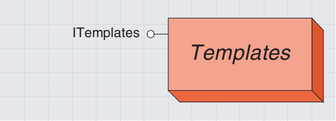
Use the *Document* property of the *IApplication* interface to get a reference to the document.

The following VBA code will report the title of the document:

```
Dim pDoc As IDocument
Set pDoc = Application.Document
MsgBox pDoc.Title
```

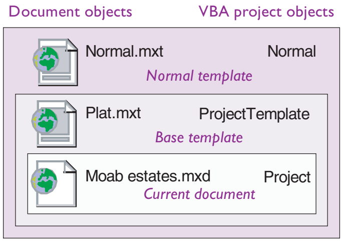
Enumeration esriDocumentType	***Document types.***
0 - esriDocumentTypeNormal	*The Normal template.*
1 - esriDocumentTypeTemplate	*The base template.*
2 - esriDocumentTypeDocument	*The current document.*

The *esriDocumentType* enumeration is used by the *Type* property on the *IDocument* interface. Use this enumeration to determine whether the document object is the current document, a base template, or the Normal template.



The templates collection references the template objects that are currently loaded with the application.

Scope of applying customizations



The ArcMap package contains an object called Template that is unrelated to the Templates collection.

A template is a document that is used as a starting point for creating new documents. It carries customizations of several types—user interface, VBA project, and application-specific data.

ArcMap has two or three templates loaded with an application. If the document is based on the Normal template, two items are in the templates collection. If the document is based on a project template, three items are in the templates collection. ArcCatalog always has one item in the templates collection; this item represents Normal.gxt.

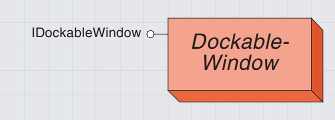
ITemplates : IUnknown	***Provides access to members that query the templates collection.***
Count: Long	*The number of templates associated with the current document.*
Item (in Index: Long) : String	*The pathname to the template at the given index.*

The *ITemplates* interface has a *Count* property that returns the number of currently loaded templates. The *Item* property returns the full filename of the specified template. This provides a convenient way to find out where the Normal template, project template, or document is stored on disk.

This VBA code will report the name of the project template that is loaded in ArcMap, if there is one loaded:

```
Dim pTemplates As ITemplates
Set pTemplates = Application.Templates
If pTemplates.Count = 3 Then
  MsgBox pTemplates.Item(1)
End If
```

DockableWindow and DockableWindowDef classes



A dockable window is an auxiliary window that can display data. This window is treated as a modeless child window of the application.

A dockable window is a window that can exist in a floating state or attached to the main application window. The table of contents in ArcMap and the tree view in ArcCatalog are examples of dockable windows.

IDockableWindowManager : IUnknown	**Provides access to a method that finds a dockable window in the application.**
← GetDockableWindow (in dockWnd: IUID) : IDockableWindow	*Finds a dockable window looking first in the collection and then in the category.*

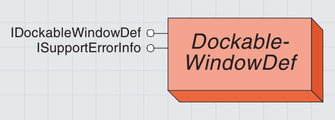
The *Application* object implements the *IDockableWindowManager* interface that is used to get access to a particular dockable window. The *GetDockableWindow* method finds a dockable window using the *UID* of the dockable window. To get access to this interface, do a *QI* on *Application*.

IDockableWindow : IUnknown	**Provides access to members that define and control a dockable window.**
■—■ Caption: String	*The caption of the dockable window.*
■— ID: IUID	*The unique id for this dockable window.*
■— Name: String	*The name of the dockable window.*
■— UserData: Variant	*User defined data.*
← Dock (in dockFlags: esriDockFlags)	*Docks or undocks this docking window.*
← IsVisible: Boolean	*Indicates if this docking window is visible.*
← Show (in Show: Boolean)	*Hides or shows the dockable window.*

The *IDockableWindow* interface queries the properties of a dockable window, such as the *Caption, Name,* and *ID*. This interface also has methods to return whether the window is currently visible, to display the window, and to dock the window in a particular location on the application.

The following VBA code finds the ArcMap table of contents and, if it's currently visible, docks it on the right side of the application.

```
Dim pDocWinMgr As IDockableWindowManager
Dim pTOC As IDockableWindow
Set pDocWinMgr = Application  'QI
Set pTOC = pDocWinMgr.GetDockableWindow(arcid.TableofContents)
If pTOC.IsVisible Then
  pTOC.Dock esriDockRight
End If
```



A dockable window definition is used by the application to create a dockable window.

IDockableWindowDef : IUnknown	**Provides access to members that define a dockable window.**
■— Caption: String	*The caption of the dockable window.*
■— ChildHWND: Long	*The hWnd of the window to be embedded in a dockable window.*
■— Name: String	*The name of the dockable window.*
■— UserData: Variant	*User defined data.*
← OnCreate (in hook: Object)	*Occurs when this dockable window is created and provides access to the application.*
← OnDestroy	*Occurs when the docking window is about to be destroyed.*

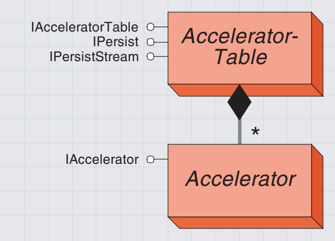
To create your own dockable window, implement the *IDockableWindowDef* interface. This interface allows you to set properties, such as caption and name. You use the *ChildHWND* property to define what the window will consist of by passing in an *hWnd* of a control, such as a form, listbox, and so on. The *OnCreate* method provides a hook to the application and allows you to perform any necessary initialization of the window. The *OnDestroy* method is called when the window is about to be destroyed.

The class you create is a definition for a dockable window; it is not actually a dockable window object. Once your class is registered in one of the dockable window component categories, the application uses the definition of the dockable window in your class to create the actual dockable window.

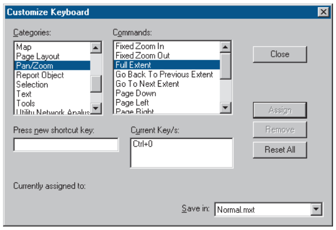
The following VB class module defines a dockable window that displays a list of layers with their selection count and updates that list whenever the selection changes.

To use your dockable window in one of the ArcGIS applications, you have to register it in the appropriate component category. For example, if your dockable window was designed to be used in ArcMap, you would register it in the ESRI Mx Dockable Windows component category. You also have to have code to display that window in ArcMap. Use the IDockableWindowManager *and* IDockableWindow *interfaces to do this.*

```
Implements IDockableWindowDef
Dim m_pApp As IApplication
Dim m_pMXDoc As IMxDocument
Dim WithEvents m_pMapEvent As Map

Private Property Get IDockableWindowDef_Caption() As String
  IDockableWindowDef_Caption = "Selected Features Count"
End Property

Private Property Get IDockableWindowDef_ChildHWND() As _
esriCore.OLE_HANDLE
  IDockableWindowDef_ChildHWND = frmDockWin.lstDockWin.hWnd
End Property

Private Property Get IDockableWindowDef_Name() As String
  IDockableWindowDef_Name = "Selection Count"
End Property

Private Sub IDockableWindowDef_OnCreate(ByVal hook As Object)
  Set m_pApp = hook
  Set m_pMXDoc = m_pApp.Document
  Set m_pMapEvent = m_pMXDoc.FocusMap
End Sub

Private Sub IDockableWindowDef_OnDestroy()
  Set m_pMapEvent = Nothing
  Set m_pMXDoc = Nothing
  Set m_pApp = Nothing
End Sub

Private Property Get IDockableWindowDef_UserData() As Variant
End Property

Private Sub m_pMapEvent_SelectionChanged()
  Dim pMap As IMap
  Dim i As Integer
  Dim pFLayer As IFeatureLayer
  Dim pSel As IFeatureSelection
  Set pMap = m_pMapEvent
  frmDockWin.lstDockWin.Clear
  For i = 0 To pMap.LayerCount - 1
    If TypeOf pMap.Layer(i) Is IFeatureSelection Then
      Set pFLayer = pMap.Layer(i)
      Set pSel = pFLayer
      frmDockWin.lstDockWin.AddItem pFLayer.Name & ": " &
pSel.SelectionSet.Count
    End If
  Next
End Sub
```



An accelerator is a mapping between a particular keyboard combination and a command. When you press the combination of keys on the keyboard, the command is executed. For example, Ctrl+C is a well-known accelerator for copying something in Windows.



Current Key/s: Ctrl+0

Save in: Normal.mxt

Accelerator table

Accelerator

Some commands in the application already have accelerators assigned to them, but you can also assign additional accelerators to these commands.

The *AcceleratorTable* is an object with a list of accelerator keys and the command identifiers associated with them. You can get a reference to the *AcceleratorTable* of a document using the *Accelerators* property of *IDocument*.

IAcceleratorTable : IUnknown	***Provides access to members that modify the accelerator table.***
Count: Long	*The count of accelerator items in the table.*
Item (in Index: Long) : IAccelerator	*The accelerator object at the specified index.*
Add (in ID: Variant, in Key: Long, bCtrl: Boolean, bAlt: Boolean, bShift: Boolean) : Boolean	*Adds a new accelerator to the accelerator table.*
Find (in ID: Variant) : IArray	*Finds the accelerator object/s currently associated with the specified command ID.*
FindByKey (in Key: Long, bCtrl: Boolean, bAlt: Boolean, bShift: Boolean) : IAccelerator	*Finds the accelerator object associated with the specified key combination.*

The *IAcceleratorTable* interface is used to add or find accelerators in an *AcceleratorTable*.

The following VBA code assigns the Ctrl+Shift+A accelerator to the Add Data command if this accelerator is not already assigned to another command.

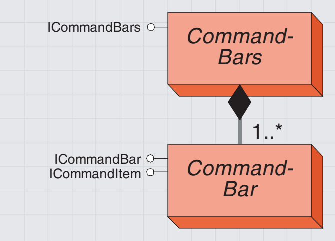
```
Dim pAccelTbl As IAcceleratorTable
Set pAccelTbl = Application.Document.Accelerators
If pAccelTbl.FindByKey(vbKeyA, True, False, True) Is Nothing Then
  pAccelTbl.Add ArcID.File_AddData, vbKeyA, True, False, True
End If
```

IAccelerator : IUnknown	***Provides access to members that define an accelerator.***
Alt: Boolean	*Indicates if the Alt key is pressed for this accelerator.*
CommandID: Variant	*The identifier of the command that this accelerator activates.*
Ctrl: Boolean	*Indicates if the Ctrl key is pressed for this accelerator.*
Key: Long	*The keycode for this accelerator.*
Shift: Boolean	*Indicates if the Shift key is pressed for this accelerator.*
Delete	*Removes this accelerator from the accelerator table.*

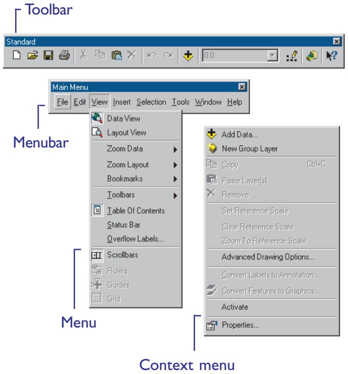
The *IAccelerator* interface defines the properties of an accelerator. Use the *Add* method in the *IAcceleratorTable* interface to create an accelerator.

The following VBA code removes all accelerators currently assigned to the Add Data command. The *Find* method on the *IAcceleratorTable* interface returns an array of all the accelerators for a particular command.

```
Dim pAccelTbl As IAcceleratorTable
Dim pAccelArray As IArray, pAccel As IAccelerator
Dim i as Integer
Set pAccelTbl = Application.Document.Accelerators
Set pAccelArray = pAccelTbl.Find(ArcID.File_AddData)

For i = 0 To pAccelArray.Count - 1
  Set pAccel = pAccelArray.Element(i)
  pAccel.Delete
Next
```



A command bar is a toolbar, menubar, menu, or context menu. CommandBars *is a collection of all the toolbars available to a document.*



CommandBars is a collection of the command bars associated with a document.

CommandBar represents a toolbar, menubar, menu, or context menu.

ICommandBars : IUnknown	*Provides access to members that work on the collection of commandbars.*
LargeIcons: Boolean	*Indicates if large icons should be shown.*
ShowToolTips: Boolean	*Indicates if tooltips should be shown.*
Create (in Name: String, barType: esriCmdBarType) : ICommandBar	*Creates a new blank toolbar or shortcut menu.*
Find (in identifier: Variant, noRecurse: Boolean, noCreate: Boolean) : ICommandItem	*Searches for the item specified by identifier.*
HideAllToolbars	*Hides all visible bars.*

The *ICommandBars* interface allows you to set properties for the *CommandBars* and to create, find, or hide *CommandBars*. Use the *CommandBars* property of *IDocument* to get a reference to the *CommandBars* collection.

Enumeration esriCmdBarType	*Commandbar types.*
0 - esriCmdBarTypeToolbar	*Toolbar commandbar type.*
1 - esriCmdBarTypeMenu	*Menu commandbar type.*
2 - esriCmdBarTypeShortcutMenu	*Context menu commandbar type.*

The *esriCmdBarType* enumeration specifies the type of command bar. Use this enumeration with the *ICommandBars::Create* method to create a new toolbar or shortcut menu. Do not use the *esriCmdBarTypeMenu* enumeration with the *ICommandBars::Create* method to create a new menu; use the *ICommandBar::CreateMenu* method instead.

Use the *Find* method in *ICommandBars* to get a reference to a particular *CommandBar*.

There is a built-in module called *ArcID* in the VBA project for the Normal template in both ArcMap and ArcCatalog. This module is a utility for finding the UID of the built-in commands and toolbars. Pass the name of a command or toolbar in as an argument to *ArcID*, and the *UID* of that item is returned. The *ArcID* module is regenerated every time the Normal template is loaded; the registry is read to get the GUIDs of all the commands and toolbars that are currently used by the application.

The following code shows how you can use the ArcID module to find the Standard toolbar in ArcMap.

```
Dim pCmdBars As ICommandBars
Dim pStdBar As ICommandBar
Set pCmdBars = Application.Document.CommandBars
Set pStdBar = pCmdBars.Find(arcid.Standard_Toolbar)
```

ICommandBar : IUnknown	*Provides access to members that modify a commandbar.*
■— Count: Long	*The number of items contained within this commandbar.*
■— Item (in Index: Long) : ICommandItem	*The command item on this commandbar at the specified index.*
◀— Add (in cmdID: IUID, Index: Variant) : ICommandItem	*Adds a new command to this commandbar.*
◀— CreateMacroItem (in Name: String, FaceID: Variant, Action: String, Index: Variant) : ICommandItem	*Creates a new macro item on this commandbar at the specified position.*
◀— CreateMenu (in Name: String, Index: Variant) : ICommandBar	*Creates a new blank menu on this commandbar at the specified position.*
◀— Dock (in dockFlags: esriDockFlags, referenceBar: ICommandBar)	*Docks or undocks this commandbar.*
◀— Find (in identifier: Variant, noRecurse: Boolean) : ICommandItem	*Finds a command on this commandbar.*
◀— IsVisible: Boolean	*Indicates if this commandbar is visible.*
◀— Popup (X: Long, Y: Long) : ICommandItem	*Displays this commandbar as a popup menu at the specified location.*

The *ICommandBar* interface lets you modify a *CommandBar* by adding a command, menu, or macro item to it.

The *Count* property returns the number of command items on the command bar, and the *Item* property allows you get a reference to the command item at the specified index.

The *IsVisible* method determines whether or not the command bar is currently visible.

Use the *Dock* method to show or hide the command bar and to put it in a floating state or place it in a particular location on the application window.

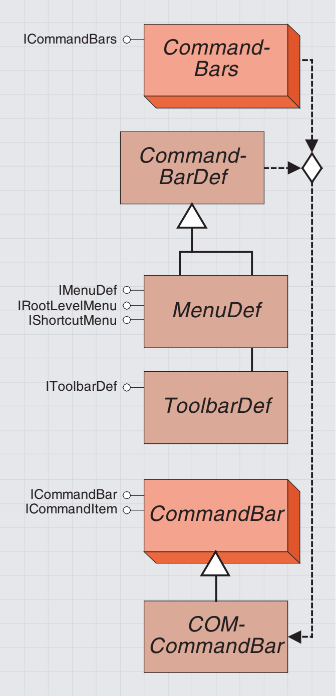
Enumeration esriDockFlags	*Toolbar docking flags.*
0 - esriDockHide	*Hides the toolbar.*
1 - esriDockShow	*Shows the toolbar.*
2 - esriDockLeft	*Docks the toolbar on the left side of the application.*
4 - esriDockRight	*Docks the toolbar on the right side of the application.*
8 - esriDockTop	*Docks the toolbar on the top of the application.*
16 - esriDockBottom	*Docks the toolbar on the bottom of the application.*
32 - esriDockFloat	*Floats the toolbar.*
64 - esriDockToggle	*Toggles the toolbar visibility.*

The *esriDockFlags* enumeration is used with the *Dock* method to specify where the command bar should be placed.

You can write VBA code to create custom toolbars or menus; however, these toolbars and menus are only stored in memory; they are never written out to any document or template. Use the *Create* method in *ICommandBars* to create a new toolbar or shortcut menu. Use the *CreateMenu* method in *ICommandBar* to create a new menu.

The following VBA macro creates a new toolbar, puts a new menu on it, adds an item to the menu, and places the toolbar at the top of the application below the Standard toolbar.

```
Sub CreateBar()
  Dim pCommandBars As ICommandBars
  Dim pNewBar As ICommandBar
  Dim pNewMenu As ICommandBar
  Dim pCmdBars As ICommandBars
  Set pCommandBars = Application.Document.CommandBars
  'Create the new toolbar
  Set pNewBar = pCommandBars.Create("MyToolbar", esriCmdBarTypeToolbar)
  'Create the new menu on the new toolabr
  Set pNewMenu = pNewBar.CreateMenu("MyMenu")
  'Add an item to the menu
  pNewMenu.Add arcid.File_AddData
  Set pCmdBars = Application.Document.CommandBars
  'Place the new toolbar at the top of the app below the Standard toolbar
  pNewBar.Dock esriDockBottom, pCmdBars.Find(arcid.Standard_Toolbar)
End Sub
```



You can create custom document command bars using the Customize dialog box in ArcMap or ArcCatalog. To create a custom toolbar, use the New button on the Toolbars panel. To create a custom menu, go to the New Menu category on the Commands panel and drag the New Menu command to any toolbar or menu. These types of toolbars and menus are stored in a specific document or template and can only be used in that document or template.

There are two basic types of custom command bars that you can create—document command bars and COM command bars. Document command bars can be created using built-in functionality in the applications. COM command bars can be created by defining menus or toolbars in any COM-compliant language and compiling them into an ActiveX DLL.

The command bars collection uses command bar definitions (either *ToolBarDef* or *MenuDef*) to create command bars. For example, a class that implements *IToolbarDef* is only a definition for a toolbar; it is not actually a toolbar object. Once this class is registered in one of the command bar component categories, the command bars collection uses the definition of the toolbar in your class to create the actual command bar.

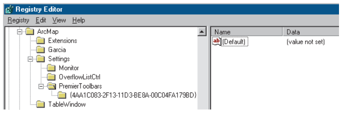
IToolBarDef: IUnknown	*Provides access to members that define a toolbar.*
Caption: String	*The caption of this toolbar.*
ItemCount: Long	*The number of items in this toolbar.*
Name: String	*The name of this toolbar.*
GetItemInfo (in pos: Long, in itemDef: IItemDef)	*The CLSID for the item on this toolbar at the specified index.*

To create a custom toolbar, implement *IToolbarDef*. The *IToolbarDef* interface is used to define the properties of a custom toolbar. You can set the caption and name of the toolbar and specify what command items are on the toolbar.

IItemDef : IUnknown	*Provides access to members that define an item on a commandbar.*
Group: Boolean	*Indicates if the defined item should start a group on the menu or toolbar.*
ID: String	*The CLSID or PROGID of the item being defined.*
SubType: Long	*The subtype of the item being defined.*

The *IItemDef* interface defines a command item on a toolbar or menu. Use the *IItemDef* interface with the *GetItemInfo* method on either the *IToolbarDef* or the *IMenuDef* interface to define the items on the toolbar or menu. This interface specifies the identifier (CLSID or ProgID) of the command and its subtype if there is one. It also determines whether this item begins a group on the toolbar or menu.

```
Implements IToolBarDef

Private Property Get IToolBarDef_Caption() As String
  IToolBarDef_Caption = "MyToolbar"
End Property

Private Sub IToolBarDef_GetItemInfo(ByVal pos As Long, _
      ByVal itemDef As esriCore.IItemDef)
   Select Case pos
   Case 0
    itemDef.ID = "esriCore.AddDataCommand"
    itemDef.Group = False
  Case 1
   itemDef.ID = "esriCore.FullExtentCommand"
   itemDef.Group = True
  End Select
 End Sub

Private Property Get IToolBarDef_ItemCount() As Long
  IToolBarDef_ItemCount = 2
End Property

Private Property Get IToolBarDef_Name() As String
  IToolBarDef_Name = "MyToolbar"
End Property
```



Name	Data
(Default)	(value not set)

In the registry, a custom toolbar has been added to PremierToolbars.

When an end user installs your custom toolbar, you may want this toolbar immediately available in the application so that the user doesn't have to manually display that toolbar before using it. You can add a registry setting to make this toolbar automatically appear the first time the application is run after the installation of your toolbar. In the setup program for your toolbar, create a new key under:

```
HKEY_CURRENT_USER\Software\ESRI\ArcMap\Settings\PremierToolbars
```

The key name should be the CLSID of the toolbar. You don't have to set a value for this key.

If you are working in Visual Basic, you can use the ESRI Compile and Register Add-in to set up this registry key. For more information, refer to Chapter 2, 'Developing with ArcObjects'.

The PremierToolbars setting is only used the first time the application is started; if the user subsequently hides the toolbar, no further attempts will be made to show the toolbar on application startup. After the application is started, the value of your PremierToolbars key is set to 1 and is then ignored by the application.

IMenuDef : IUnknown	***Provides access to members that define a menu.***
Caption: String	*The caption of this menu.*
ItemCount: Long	*The number of items in this menu.*
Name: String	*The name of this menu.*
GetItemInfo (in pos: Long, in itemDef: IItemDef)	*The CLSID for the item on this menu at the specified index.*

To create a custom menu, implement *IMenuDef*. The *IMenuDef* interface is identical to the *IToolbarDef* interface except that it is used to indicate to the application that this is a menu.

IRootLevelMenu : IUnknown	***Identifies a root level menu.***

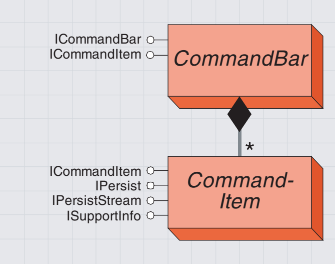
If you are creating a root menu (a menu that will appear in the Menus command category in the Customize dialog box), implement both *IMenuDef* and *IRootLevelMenu*. *IRootLevelMenu* is an indicator interface that is only used to indicate to the application that the menu should be treated as a root menu.

IShortcutMenu : IUnknown

Identifies a context menu.

If you are creating a context menu, implement both *IMenuDef* and *IShortcutMenu*. *IShortcutMenu* is an indicator interface that is only used to indicate to the application that this menu should be treated as a context menu.

CommandItem class



A command item is any item on a command bar. For example, button, tools, and menu items that appear on command bars are all command items.

A *CommandItem* class represents any item on a command bar.

ICommandItem : IUnknown	***Provides access to members that define a command item.***
Action: String	*The name of the VBA macro this command should run when pressed.*
BuiltIn: Boolean	*Indicates whether this command item is built-in or if it was implemented through VBA.*
Caption: String	*The caption of this command item.*
Category: String	*The name of the category with which this command item is associated.*
Command: ICommand	*A reference to the internal command object.*
FaceID: Variant	*The bitmap that is used as the icon on this command item.*
Group: Boolean	*Indicates if this command item begins a menu or toolbar group.*
HelpContextID: Long	*The help context ID associated with this command item.*
HelpFile: String	*The help file associated with this command item.*
ID: IUID	*The unique integer ID associated with this command item.*
Index: Long	*The positional index of this command item within its menu or toolbar.*
Message: String	*The status bar message for this command item.*
Name: String	*The name of this command item.*
Parent: ICommandBar	*The menu or toolbar that this command item currently resides on.*
Style: esriCommandStyles	*The display style of this command item.*
Tag: String	*The tag for this command item.*
Tooltip: String	*The tooltip for this command item.*
Type: esriCommandTypes	*The type of this command item.*
Delete	*Removes this object from the commandbar.*
Execute	*Causes the command to execute.*
Refresh	*Causes the command to be redrawn.*
Reset	*Restores this command item's properties to that of the original.*

The *ICommandItem* interface allows you to get or set the properties of the *CommandItem*, such as caption, button image, status bar message, ToolTip, display style, help context ID, and so on. You can obtain a reference to the command on which this item is based. The *ICommandItem* interface also provides methods to execute, delete, refresh, and reset the *CommandItem*.

Use the *Find* method from either *ICommandBars* or *ICommandBar* to obtain a reference to a particular *CommandItem*.

This VBA code changes the caption, button image, and display style of the Add Data button on the Standard toolbar. To change the button image, set the FaceID property to a custom bitmap on disk.

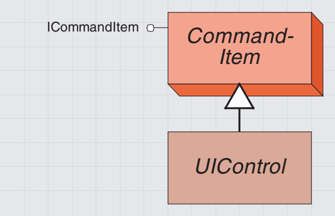
```
Dim pStdBar As ICommandBar
Dim pCmdItem As ICommandItem
Set pStdBar= Application.Document.CommandBars.Find(ArcID.Standard_Toolbar)
Set pCmdItem = pStdBar.Find(ArcID.File_AddData)
pCmdItem.Caption = "Add Layer..."
pCmdItem.FaceID = LoadPicture("c:\bitmaps\layer.bmp")
pCmdItem.Style = esriCommandStyleIconAndText
```

Enumeration esriCommandStyles	***Command display styles.***
0 - esriCommandStyleTextOnly	*Display text only.*
1 - esriCommandStyleIconOnly	*Display icon only.*
2 - esriCommandStyleIconAndText	*Display icon and text.*
4 - esriCommandStyleMenuBar	*Display bar as main menu.*

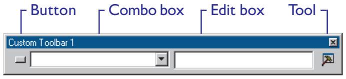
The *esriCommandStyles* enumeration is used with the *Style* property to set whether the *CommandItem* is displayed on a command bar using its caption, image, or both.

Enumeration esriCommandTypes	*Command types.*
0 - esriCmdTypeCommand	*Built in command.*
1 - esriCmdTypeMenu	*Menu.*
2 - esriCmdTypeToolbar	*Toolbar.*
3 - esriCmdTypeMacro	*Macro Item.*
4 - esriCmdTypeUIButtonCtrl	*UIButtonControl.*
5 - esriCmdTypeUIToolCtrl	*UIToolControl.*
6 - esriCmdTypeUIComboBoxCtrl	*UIComboBoxControl.*
7 - esriCmdTypeUIEditBoxCtrl	*UIEditBoxControl.*

The *esriCommandTypes* enumeration is used with the *Type* property to specify whether the *CommandItem* is a command, macro, or UI control.



UI Controls represent buttons, combo boxes, edit boxes, or tools in a custom dialog box.

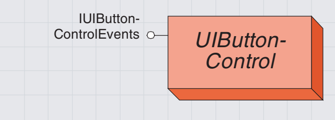


UIControls are VBA-based commands. This means that VBA code stored in a document or template defines and determines the behavior of this type of command. If a *UIControl* was created in a document, it can only be accessed in that document. If a *UIControl* was created in a template, it can be accessed in the template and any document that uses the template. If a *UIControl* was created in the Normal template, it can be accessed at all levels. There are four different types of *UIControl*: *UIButtonControl, UIComboBoxControl, UIEditBoxControl,* and *UIToolControl*.

To create a new *UIControl*, use the New *UIControl* button on the Customize dialog box in the ArcGIS applications; this creates a *UIControl* stub. While the Customize dialog box is still open, you can drag the new *UIControl* to any toolbar. You can then write the code that defines and determines the behavior of the *UIControl*. This code is written in the Visual Basic Editor in the *ThisDocument* code window for the document or template in which you created the *UIControl*.

The new *UIControl* is listed in the Object Box on the code window; select the *UIControl* in this list. Then, click one of the functions listed in the Procedures/Events box on the code window. This will stub out the function in the code window. You can now write your code. When the Visual Basic Editor is open, your *UIButtonControl* is in design mode. To fully test your button in ArcMap or ArcCatalog, you need to close the Visual Basic Editor.

The interfaces for *UIControls* are usable only in Visual Basic for Applications.



A UI button control acts as a button or menu item that performs a simple task when clicked. You can set properties such as status bar message, ToolTip, enabled state, and checked state.

A *UIButtonControl* acts as a button or menu item that performs a simple task when clicked.

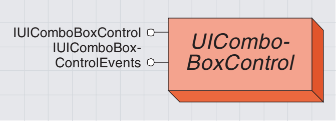
IUIButtonControlEvents :	*UIButtonControl Events interface*
← Checked: Boolean	*Requests whether the specified item is checked.*
← Click	*The specified item was clicked.*
← Enabled: Boolean	*Requests whether the specified item is enabled.*
← Message: String	*Requests the current message text for the specified item.*
← ToolTip: String	*Requests the current Tooltip text for the specified item.*

The *IUIButtonControlEvents* interface defines the properties of a *UIButtonControl*, such as the enabled state, checked state, ToolTip, and status bar message. This interface also has a *Click* method that defines what action occurs when the button is clicked.

The following VBA code is a full implementation of a *UIButtonControl* that reports the number of selected features in all the layers. This control is enabled only when there are layers in the map.

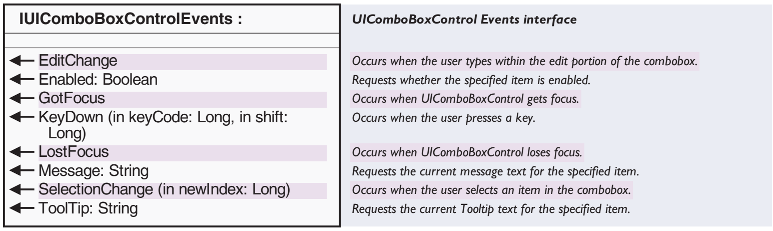
```
Private Function UIButtonControl1_Checked() As Boolean
  UIButtonControl1_Checked = False
End Function

Private Sub UIButtonControl1_Click()
  Dim pMxDoc As IMxDocument
  Dim SelCount As Long
  Set pMxDoc = Application.Document
  SelCount = pMxDoc.FocusMap.SelectionCount
  MsgBox SelCount
End Sub

Private Function UIButtonControl1_Enabled() As Boolean
  Dim pMxDoc As IMxDocument
  Dim LayerCount As Long
  Set pMxDoc = Application.Document
  LayerCount = pMxDoc.FocusMap.LayerCount
  If LayerCount > 0 Then
    UIButtonControl1_Enabled = True
  Else
    UIButtonControl1_Enabled = False
  End If
End Function

Private Function UIButtonControl1_Message() As String
  UIButtonControl1_Message = "Return selection count for all layers"
End Function

Private Function UIButtonControl1_ToolTip() As String
  UIButtonControl1_ToolTip = "Selection Count"
End Function
```

UICOMBOBOXCONTROL CLASS



A UIComboBox control is a dropdown list box control that can be added to a toolbar.

A *UIComboBoxControl* has properties and methods that allow you to change, add, and remove items in the combo box list. The *EditChange*, *SelectionChange*, and *Keydown* events allow you to control what happens when a user changes the text or selection in the combo box.

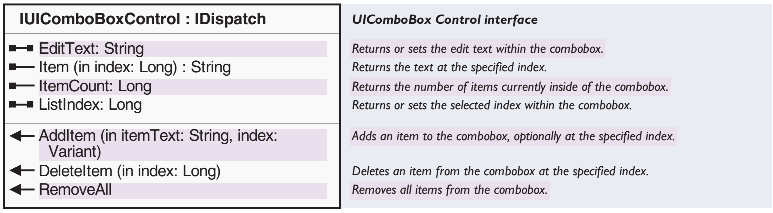


IUIComboBoxControlEvents :	*UIComboBoxControl Events interface*
← EditChange	*Occurs when the user types within the edit portion of the combobox.*
← Enabled: Boolean	*Requests whether the specified item is enabled.*
← GotFocus	*Occurs when UIComboBoxControl gets focus.*
← KeyDown (in keyCode: Long, in shift: Long)	*Occurs when the user presses a key.*
← LostFocus	*Occurs when UIComboBoxControl loses focus.*
← Message: String	*Requests the current message text for the specified item.*
← SelectionChange (in newIndex: Long)	*Occurs when the user selects an item in the combobox.*
← ToolTip: String	*Requests the current Tooltip text for the specified item.*

The *IUIComboBoxControlEvents* interface defines the properties of a *UIComboBoxControl*, such as the enabled state, ToolTip, and status bar message. This interface also has *EditChange, KeyDown,* and *SelectionChange* methods that allow you to control what happens when a user changes the text or selection in the combo box.

The following VBA code displays a message box that reports the currently selected item when the selection changes in the combo box.

```
Private Sub UIComboBoxControl1_SelectionChange(ByVal newIndex As Long)
  MsgBox UIComboBoxControl1.Item(newIndex)
End Sub
```

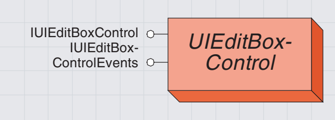


IUIComboBoxControl : IDispatch	*UIComboBox Control interface*
■—■ EditText: String	*Returns or sets the edit text within the combobox.*
■— Item (in index: Long) : String	*Returns the text at the specified index.*
■— ItemCount: Long	*Returns the number of items currently inside of the combobox.*
■—■ ListIndex: Long	*Returns or sets the selected index within the combobox.*
← AddItem (in itemText: String, index: Variant)	*Adds an item to the combobox, optionally at the specified index.*
← DeleteItem (in index: Long)	*Deletes an item from the combobox at the specified index.*
← RemoveAll	*Removes all items from the combobox.*

The *IUIComboBoxControl* interface has properties and methods that allow you to change, edit, and remove items in the combo box list.

The following VBA macro adds items to *UIComboBoxControl1* and selects the first item in the list.

```
Public Sub PopulateComboBox()
  UIComboBoxControl1.AddItem "Red"
  UIComboBoxControl1.AddItem "Green"
  UIComboBoxControl1.AddItem "Blue"
  UIComboBoxControl1.AddItem "Yellow"
  UIComboBoxControl1.ListIndex = 0
End Sub
```



A UI edit box control is an editable text box control that can be added to a toolbar.

A *UIEditBox* has a property to set the text that appears in the edit box. The *Change* and *Keydown* events allow you to control what happens when a user changes the text in the edit box.

IUIEditBoxControlEvents :	*UIEditBoxControl Events interface*
← Change	*Occurs when the user types within the editbox.*
← Enabled: Boolean	*Requests whether the specified item is enabled.*
← GotFocus	*Occurs when UIEditBoxControl gets focus.*
← KeyDown (in keyCode: Long, in shift: Long)	*Occurs when the user presses a key.*
← LostFocus	*Occurs when UIEditBoxControl loses focus.*
← Message: String	*Requests the current message text for the specified item.*
← ToolTip: String	*Requests the current Tooltip text for the specified item.*

The *IUIEditBoxControlEvents* interface defines the properties of a *UIEditBoxControl*, such as the enabled state, ToolTip, and status bar message.

This interface also has *Change* and *KeyDown* methods that allow you to control what happens when a user changes the text in the edit box.

The following VBA code uses the *KeyDown* method to report the current text in the edit box if the Return key is pressed.

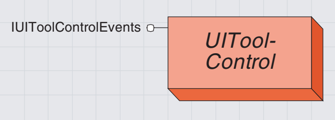
```
Private Sub UIEditBoxControl1_KeyDown(ByVal keyCode As Long, ByVal shift As
Long)
  If keyCode = vbKeyReturn Then
    MsgBox UIEditBoxControl1.Text
  End If
End Sub
```

IUIEditBoxControl : IDispatch	*UIEditBoxControl interface*
■—■ Text: String	*Returns or sets the editbox text.*
← Clear	*Clears the contents of the editbox.*

The *IUIEditBoxControl* interface has a *Text* property for getting and setting the text in the *UIEditBox* control and a *Clear* method for deleting the text.

The following VBA macro sets the text in a *UIEditBoxControl* called *UIEditBoxControl1*.

```
Public Sub SetText()
  UIEditBoxControl1.Text = "Hello"
End Sub
```



A UI tool control interacts with the application's display.

A *UIToolControl* is similar to a COM command that implements the *ITool* interface. This type of control can interact with the application's display. You can set all the properties that *UIButtonControls* have and define what occurs on events, including mouse move, mouse button press and release, keyboard key press and release, double-click, and right-click.

IUIToolControlEvents :	***UIToolControl Events interface***
← ContextMenu (in x: Long, in y: Long) : Boolean	*Occurs when the user clicks the right mouse button.*
← CursorID: Variant	*Requests the cursor ID of the specified item.*
← DblClick	*Occurs when the user double clicks the mouse.*
← Deactivate: Boolean	*Occurs when the tool is deactivated.*
← Enabled: Boolean	*Requests whether the specified item is enabled.*
← KeyDown (in keyCode: Long, in shift: Long)	*Occurs when the user presses a key.*
← KeyUp (in keyCode: Long, in shift: Long)	*Occurs when the user releases a key.*
← Message: String	*Requests the current message text for the specified item.*
← MouseDown (in button: Long, in shift: Long, in x: Long, in y: Long)	*Occurs when the user presses a mouse button.*
← MouseMove (in button: Long, in shift: Long, in x: Long, in y: Long)	*Occurs when the user moves the mouse.*
← MouseUp (in button: Long, in shift: Long, in x: Long, in y: Long)	*Occurs when the user releases a mouse button.*
← Refresh (in hDC: Long)	*Occurs when the map is refreshed.*
← Select	*Occurs when the tool is selected.*
← ToolTip: String	*Requests the current Tooltip text for the specified item.*

The *IUIToolControlEvents* interface defines the properties of a *UIToolControl*, such as the enabled state, cursor, ToolTip, and status bar message. This interface also has methods that allow you to control what happens on events, including mouse move, mouse button press and release, keyboard key press and release, double-click, and right-click.

The following VBA code displays the x,y coordinates of the left mouse button click in the ArcMap status bar message.

```
Private Sub UIToolControl1_MouseDown(ByVal button As Long, _
 ByVal shift As Long, ByVal x As Long, ByVal y As Long)
  ' Check for left button press
  If button = 1 Then
    ' Convert x and y to map units.
    Dim pPoint As IPoint
    Dim pMxApp As IMxApplication
    Set pMxApp = Application
    Set pPoint = pMxApp.Display.DisplayTransformation.ToMapPoint(x, y)
    ' Set the statusbar message
    Application.StatusBar.Message(0) = Str(pPoint.x) & "," & Str(pPoint.y)
  End If
End Sub
```

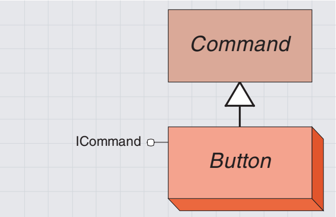
You can create COM commands in any development environment that supports COM—for example, Visual Basic, Visual C++, or Delphi®. COM-based commands are distributed in the form of ActiveX DLLs.

For more information on creating COM components, see Chapter 2,'Developing with ArcObjects'.

The interfaces discussed in this section (*ICommand, ITool, IToolControl, ICommandSubtype,* and *IMultiItem*) are generally implemented to create custom commands. It is very rare that you would use these interfaces to query the properties of the command. In the application, all commands are exposed through command items, so you would use the *ICommandItem* interface to query the properties or to override some of the properties of the underlying command.

You can create the following types of commands: *Button, Tool, ToolControl, SubtypedCommand,* and *MultiItem*.

Buttons can be put on toolbars and menus. To create a custom button, you only have to implement *ICommand*.



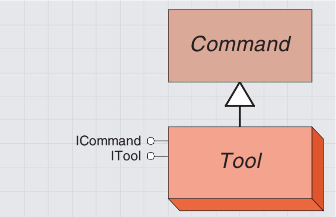
Buttons are simple commands that act as button or menu items and perform simple actions when clicked.

ICommand : IUnknown	Provides access to members that define a COM command.
Bitmap: Long	The bitmap that is used as the icon on this command.
Caption: String	The caption of this command.
Category: String	The name of the category with which this command is associated.
Checked: Boolean	Indicates if this command is checked.
Enabled: Boolean	Indicates if this command is enabled.
HelpContextID: Long	The help context ID associated with this command.
HelpFile: String	The name of the help file associated with this command.
Message: String	The statusbar message for this command.
Name: String	The name of this commmand.
Tooltip: String	The tooltip for this command.
OnClick	Occurs when this command is clicked.
OnCreate (in hook: Object)	Occurs when this command is created.

The *ICommand* interface must be implemented by all COM-based commands (except for *MultiItems*). This interface determines the behavior and properties of simple commands, such as buttons and menu items. For example, the *ICommand* interface sets command properties, such as caption, name, category, bitmap, status bar message, ToolTip, help context ID and help file, enabled state, and checked state. It also defines what action happens when the command is clicked.

The main concept to understand about implementing *ICommand* is the *OnCreate* method. This method occurs when the command is instantiated and provides a hook to the application object that instantiated the command. Once you have this reference to the application object, you can access the other objects in the application. The following VB code fragment from a class file that implements *ICommand* gets a reference to the application object and, from that, gets a reference to the document object.

```
Dim m_pApp As IApplication
Dim m_pMxDoc As IMxApplication
Private Sub ICommand_OnCreate(ByVal hook As Object)
  Set m_pApp = hook
  Set m_pMxDoc = m_pApp.Document
End Sub
```



A tool acts as a button that allows further interaction with the application display.Tools can only be put on toolbars.

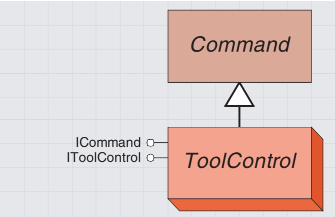
To create a custom *Tool* object, implement both *ICommand* and *ITool*. The Zoom In tool is a good example of a tool—you click or drag a rectangle over the map display to define the area on which to zoom.

ITool : IUnknown	***Provides access to members that define a tool.***
■— Cursor: Long	*The mouse pointer for this tool.*
← Deactivate: Boolean	*Causes the tool to no longer be the active tool.*
← OnContextMenu (in X: Long, in Y: Long) : Boolean	*Context menu event occured at the given xy location.*
← OnDblClick	*Occurs when a mouse button is double clicked when this tool is active.*
← OnKeyDown (in keyCode: Long, in Shift: Long)	*Occurs when a key on the keyboard is pressed when this tool is active.*
← OnKeyUp (in keyCode: Long, in Shift: Long)	*Occurs when a key on the keyboard is released when this tool is active.*
← OnMouseDown (in Button: Long, in Shift: Long, in X: Long, in Y: Long)	*Occurs when a mouse button is pressed when this tool is active.*
← OnMouseMove (in Button: Long, in Shift: Long, in X: Long, in Y: Long)	*Occurs when the mouse is moved when this tool is active.*
← OnMouseUp (in Button: Long, in Shift: Long, in X: Long, in Y: Long)	*Occurs when a mouse button is released when this tool is active.*
← Refresh (in hDC: Long)	*Occurs when a screen display in the application is refreshed.*

The *ITool* interface is implemented by specialized commands that can interact with the application's display. Only one tool can be active in the application at a time. With the *ITool* interface, you can define what occurs on events, such as mouse move, mouse button press and release, keyboard key press and release, double-click, and right-click.

The following is a code excerpt from a class that implements *ICommand* and *ITool*. This ArcMap tool displays the x,y coordinates of the left moust button click in the status bar. The x,y coordinates that are passed in as arguments to this subprocedure are converted to map coordinates.

```
Private Sub ITool_OnMouseDown(ByVal Button As Long, ByVal Shift As Long, _
                                       ByVal X As Long, ByVal Y As Long)
   ' Check to see if left button is pressed
  If Button = 1 Then
    ' Convert x and y to map units. m_pApp is set in ICommand_OnCreate.
    Dim pPoint As IPoint
    Dim pMxApp As IMxApplication
    Set pMxApp = m_pApp
    Set pPoint = pMxApp.Display.DisplayTransformation.ToMapPoint(x, y)
    ' Set the statusbar message.
    m_pApp.StatusBar.Message(0) = Str(pPoint.X) & "," & Str(pPoint.Y)
  End If
End Sub
```



A tool control is a dropdown list box control, editable textbox control, or other type of control that can be added to a toolbar.

To create a custom ToolControl *object, implement both* ICommand *and* IToolControl*.*

Only one instance of a particular tool control is allowed to exist in the application at any one time.

A command that implements the *IToolControl* interface passes its window handle to the application using the *hWnd* property. The *OnDrop* method is used to specify on which type of command bar this tool control can be put. In most cases, tool controls can only be used on toolbars.

IToolControl : IUnknown	***Provides access to members that define a toolcontrol.***
hWnd: Long	*The handle of the control.*
OnDrop (in barType: esriCmdBarType) : Boolean	*Indicates if the drag-drop operation is valid.*
OnFocus (in complete: ICompletionNotify)	*Occurs when the control gains focus.*

The *IToolControl* interface is implemented by commands that act as edit box controls or combo box controls. A command that implements *IToolControl* passes its window handle to the application.

ICompletionNotify : IUnknown	***Provides access to a method that advises the framework that the control user has indicated completion.***
SetComplete	*Advises the framework that the control user has indicated completion.*

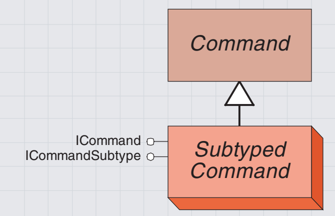
The *ICompletionNotify* interface provides the *IToolControl* interface with a mechanism to report to the application that the tool control no longer needs focus.

When the *ToolControl* object gains focus, an *ICompletionNotify* object is passed to the tool control as the *complete* parameter in the *IToolControl OnFocus* method. The tool control needs to call the *ICompletionNotify SetComplete* method to let the application know that the control should lose focus.

In the following VB code, the *hWnd* property passes back the window handle of a combo box control on a form in the VB project. The *OnDrop* method specifies that the tool control can only be dropped onto toolbars. In the *OnFocus* method, a variable is set to the *ICompletionNotify* object so that *SetComplete* can be called when the tool control no longer needs focus. For example, if a combo box control loses focus after a user selects an item in the combo box, the combo box *Click* event calls *SetComplete*.

```
Implements IToolControl
Public pCompNotify As ICompletionNotify
Private Property Get IToolControl_hWnd  () As esriCore.OLE_HANDLE
  IToolControl_hWnd = Form1.Combo1.hWnd
End Property

Private Function IToolControl_OnDrop  (ByVal barType As _
                                       esriCore.esriCmdBarType) As Boolean
  If barType = esriCmdBarTypeToolbar Then IToolControl_OnDrop = True
End Function

Private Sub IToolControl_OnFocus  (ByVal complete As _
                                   esriCore.ICompletionNotify)
  Set pCompNotify = complete
End Sub
```

SubtypedCommand custom class



A subtyped command object is a group of related commands that can share properties. Subtyped commands can be put on toolbars and menus.

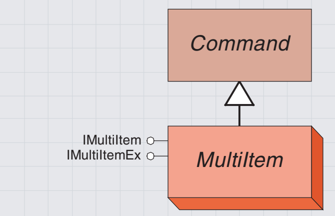
To create a custom *SubtypedCommand* class, implement the *ICommand* and *ICommandSubtype* interfaces.

ICommandSubType: IUnknown	***Provides access to members that define a subtyped command.***
← GetCount: Long	*The number of commands defined with this CLSID.*
← SetSubType (in SubType: Long)	*The subtype of the command.*

The *ICommandSubType* interface is used when you want more than one command in a single class. You would implement both *ICommand* and *ICommandSubType* in your class. The *ICommandSubType* interface lets you specify how many subtypes there are. Then, within the implementation of each *ICommand* property, you set the property for each subtype instead of implementing the *ICommand* interface multiple times.

This VB code fragment is from a class that implements *ICommand* and *ICommandSubType*; it specifies that the subtyped command contains two subtypes. In the *Caption* property of *ICommand*, a case statement is used to determine which subtype is being queried.

```
 Dim m_lSubType As Long
 Private Function ICommandSubType_GetCount() As Long
  ICommandSubType_GetCount = 2
 End Function

 Private Sub ICommandSubType_SetSubType(ByVal SubType As Long)
  m_lSubType = SubType
 End Sub
 Private Property Get ICommand_Caption() As String
  Select Case m_lSubType
  Case 1
    ICommand_Caption = "Command 1"
  Case 2
    ICommand_Caption = "Command 2"
  End Select
End Property
```



A MultiItem *object is a dynamic command that appears as zero or more adjacent menu items on a menu, depending on the state of the application.*

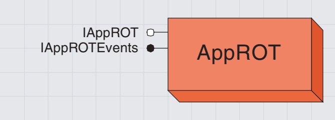
A *MultiItem* can be used when items on a menu can't be determined prior to run time or the items need to be modified based on the state of the system. The menu items at the bottom of the File menu, which represent the most recently used files, are a good example of this.

IMultiItem : IUnknown	***Provides access to members that define a multiItem.***
Caption: String	*The caption of the multiItem.*
HelpContextID: Long	*The help context ID associated with this multiItem.*
HelpFile: String	*The name of the help file associated with this multiItem.*
ItemBitmap (in Index: Long) : Long	*The bitmap for the item at the specified index.*
ItemCaption (in Index: Long) : String	*The caption of the item at the specified index.*
ItemChecked (in Index: Long) : Boolean	*Indicates if item at the specified index is checked.*
ItemEnabled (in Index: Long) : Boolean	*Indicates if the item at the specified index is enabled.*
Message: String	*The status bar message for all items on the multiItem.*
Name: String	*The name of the multiItem.*
OnItemClick (in Index: Long)	*Occurs when the item at the specified index is clicked.*
OnPopup (in hook: Object) : Long	*Occurs when the menu that contains the multiItem is about to be displayed.*

The *IMultiItem* interface allows a single object to act like several adjacent menu items. During run time, the framework notifies *MultiItem* commands when their host menu is about to be shown. At this point, all the commands implementing *IMultiItem* can query the system to determine how many items should be represented and how each should appear. The *IMultiItem* interface allows you to assign properties, such as caption, bitmap, enabled state, and checked state, to each item. You do not implement the *ICommand* interface when creating a *MultiItem*.

The main concept to understand about implementing *IMultiItem* is the *OnPopup* method. This method occurs just before the menu containing the *MultiItem* is displayed. *OnPopup* provides a hook to the application object that instantiated the *MultiItem* and is also used to set the number of items in the *MultiItem*. The following VB code fragment gets a reference to the application object, document object, and map object. This particular *MultiItem* will contain an item corresponding to each layer in the map, so the map layer count is returned to specify the number of items.

```
Dim m_pApp As IApplication 'ArcMap application
Dim m_pMxDoc As IMxDocument     'ArcMap document
Dim m_pMap As IMap         'Current focus map
Dim m_pLayerCnt As Long     'Number of layers in the map

Private Function IMultiItem_OnPopup(ByVal hook As Object) As Long
  Set m_pApp = hook
  Set m_pMxDoc = m_pApp.Document
  Set m_pMap = m_pMxDoc.FocusMap
  m_pLayerCnt = m_pMap.LayerCount
  IMultiItem_OnPopup = m_pLayerCnt
End Function
```



The application running object table is an instantiable class that gives you access to a list of all running ArcGIS applications.

The *AppROT* object represents the application running object table, which is a global list of all the currently running ArcGIS applications. *AppROT* only contains references to application objects that implement the *IApplication* interface. ArcMap, ArcCatalog, and other ArcGIS applications automatically register themselves in the running object table when starting and remove themselves from the table when terminating. (The *AppROT* object should not be confused with Microsoft's running object table, which contains all running COM objects.)

Advanced developers can create custom standalone applications with ArcObjects by creating their own implementation of *IApplication*. They can register and expunge application references in *AppROT* through the *Add* and *Remove* methods.

You can return the count of running applications and return application references. You can also add and remove application references.

IAppROT : IUnknown	*Provides access to members that manipulate the ESRI application running object table, AppROT.*
■— Count: Long	*The count of application references within the running object table.*
■— Item (in Index: Long) : IApplication	*The application reference at the specified index in the running object table.*
← Add (in pApp: IApplication) : Long	*Adds an application reference to the running object table.*
← Remove (in cookie: Long)	*Removes an application reference from the running object table.*

The *Add* method returns a long value called a cookie, which is a reference to an application. It should be kept by the client application for eventual use in the *Remove* method.

This VBA code iterates through all running applications and lists captions.

```
Dim pAppROT as AppROT
Set pAppRot = New AppROT
Dim i as Integer
For i = 0 to pApprot.Count - 1
  msgbox pAppROT.Item(i).Caption
Next
```

Whenever an ArcGIS application is started or dismissed, you can add custom code whenever that event is fired. Through this code, you can synchronize the behavior of many running applications.

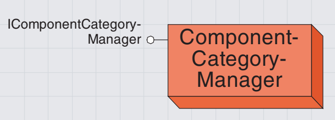
IAppROTEvents : IUnknown	*Provides access to events that occur on the ESRI application running object table.*
← AppAdded (in pApp: IApplication)	*Occurs when an application reference is added to the table.*
← AppRemoved (in pApp: IApplication)	*Occurs when an application reference is removed from the table.*

The *AppROT* events let interested applications and components know when an ArcGIS application has been started or terminated. When an instance of an application starts or terminates, an event will automatically fire from *AppROT* to let all listeners know about it. This may be useful if listening components or applications need to maintain switch-to lists or if they want to synchronize representations between all running instances so that if something happens in one application, all others can be informed and update themselves appropriately. Such coordinating components need to know when new instances start and when existing ones terminate.

In the following VB code, the *StartListening* routine initializes the *m_pAppROT* variable, which will listen to the *IAppRotEvents*. The code in the events uses the *TypeOf* keyword to determine which application was started or shutdown, and reports a message with that information.

```
Dim WithEvents m_pAppROTEvents As AppROT

Public Sub StartListening()
  Set m_pAppROTEvents = New AppROT
End Sub

Private Sub m_pAppROTEvents_AppAdded(ByVal pApp As IApplication)
  If TypeOf pApp Is IMxApplication Then
    MsgBox "ArcMap started"
  ElseIf TypeOf pApp Is IGxApplication Then
    MsgBox "ArcCatalog started"
  End If
End Sub

Private Sub m_pAppROTEvents_AppRemoved(ByVal pApp As IApplication)
  If TypeOf pApp Is IMxApplication Then
    MsgBox "ArcMap shut down"
  ElseIf TypeOf pApp Is IGxApplication Then
    MsgBox "ArcCatalog shut down"
  End If
End Sub
```

ComponentCategoryManager coclass



Component categories are used by client applications to efficiently find all components of a particular type that are installed on the system.

The *ComponentCategoryManager* object provides a mechanism for you to programmatically add or remove new components to a particular category and create new component categories.

For example, ArcMap only supports commands that implement the *ICommand* interface. A component category, ESRI Mx Commands, is used to find all the command components that can be used inside ArcMap.

If component categories were not used, the application would have to instantiate each COM component and interrogate it to see if it supported the required functionality, which is not a practical approach. Component categories support the extensibility of COM by allowing the developer of the client application to create and work with classes that belong to a particular category. If at a later date a new class is added to the category, the client application need not be changed to take advantage of the new class; it will automatically pick up the new class the next time the category is read.

IComponentCategoryManager : IUnknown

Provides access to members that work with the component category manager.

← Create (in Name: String, in Category: IUID) — *Creates a component category.*

← Setup (in PathName: String, in ObjectType: IUID, in Category: IUID, in install: Boolean) — *Installs or uninstalls the objects that match the object type into the given category.*

← SetupObject (in PathName: String, in obj: IUID, in Category: IUID, in install: Boolean) — *Installs or uninstalls the given object into the given category.*

The *IComponentCategoryManager* interface has methods that allow you to create a new component category, add or remove a particular object to a category, and add or remove all objects of a certain type to a category. To get access to the *IComponentCategoryManager* interface, create a new instance of a *ComponentCategoryManager* object.

The following Visual Basic code registers a specific command contained in a DLL with the ArcMap commands component category.

```
Public Sub RegObj()
```

Set the path to the dll. Change this to the location of your dll.

```
  Dim dllPath As String
  dllPath = "D:\MyTools\MyCustomTool.dll"
```

Get a reference to the component category manager.

```
  Dim pCCMgr As IComponentCategoryManager
  Set pCCMgr = New ComponentCategoryManager
```

Get the UID for the object. This will be the UID for your command, the ProgID of your class.

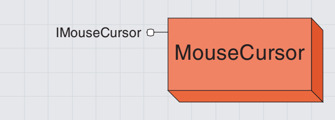
```
  Dim objUID As New UID
  objUID.Value = "MyCustomTool.MyTool"
```

Get the UID of the category.

```
  Dim catUID As New UID
  catUID.Value = "{B56A7C42-83D4-11D2-A2E9-080009B6F22B}"
```

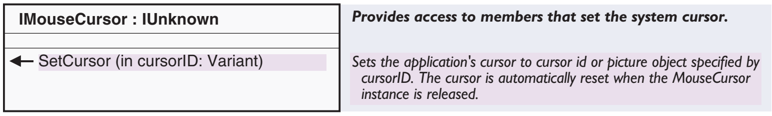
Register the objects with the category.

```
  pCCMgr.SetupObject dllPath, objUID, catUID, True
End Sub
```



The mouse cursor object is a reference to the system mouse cursor object.

You can use *MouseCursor* to set the system mouse cursor to be one of the standard built-in cursors or a custom cursor. This is useful if you want to display a wait cursor while your code performs a large process.



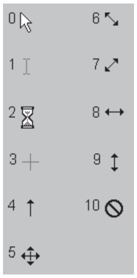
IMouseCursor : IUnknown

Provides access to members that set the system cursor.

SetCursor (in cursorID: Variant)

Sets the application's cursor to cursor id or picture object specified by cursorID. The cursor is automatically reset when the MouseCursor instance is released.

The *IMouseCursor* interface has one method, *SetCursor*, which sets the system's cursor to the cursor ID or picture object specified by the *cursorID* parameter. The cursor is automatically reset when the *MouseCursor* instance is released. The instance is released when the calling procedure ends; when the variable that references the mouse cursor is set to nothing; or when something, such as the display of a message box, overrides Windows messaging.



The values of cursorID *that can be used to set the mouse cursor to one of the built-in cursors.*

The following VBA example uses the built-in wait cursor. The cursor is automatically reset when this subprocedure ends.

```
Public Sub WaitCurs()
  Dim pMouseCursor As IMouseCursor
  Dim i As Integer

  Set pMouseCursor = New MouseCursor
  pMouseCursor.SetCursor 2

  For i = 0 To 10000
    Application.StatusBar.Message(0) = Str(i)
  Next
End Sub
```

Instead of using one of the built-in cursors, you can set the cursor to a custom cursor; it can be either a cursor file (.cur) or icon file (.ico). You can store your custom cursor in an Image control on a form or use the Visual Basic *LoadPicture* function to load the cursor.

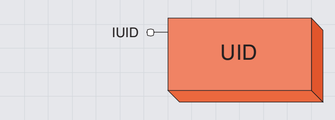
The following VBA example sets the cursor to the *Picture* property of an *Image* control called *Image1*, which is on *UserForm1*.

```
  Dim pMouseCursor As IMouseCursor
  Set pMouseCursor = New MouseCursor
  pMouseCursor.SetCursor UserForm1.Image1.Picture
```

The following VBA example uses the *LoadPicture* function to set the cursor.

```
  Dim pMouseCursor As IMouseCursor
  Set pMouseCursor = New MouseCursor
  pMouseCursor.SetCursor LoadPicture("D:\Cursors\Bullseye.cur")
```

UID coclass



A unique identifier represents the globally unique identifier for all COM objects.

A unique identifier object, or *UID*, represents the globally unique identifier (GUID) for any COM object.

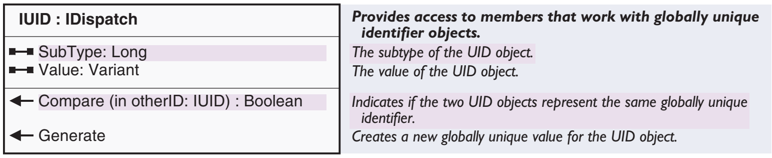
COM interfaces and coclasses are identified by a GUID.

The GUID for an interface is called an interface ID (IID).

The GUID for a coclass is called a class ID (CLSID).

A ProgID is a text alias for a CLSID; the ProgID is a string composed of the project name and the class name of the coclass.

The *UID* object can be used to represent the GUID of an object.



IUID : IDispatch	*Provides access to members that work with globally unique identifier objects.*
SubType: Long	*The subtype of the UID object.*
Value: Variant	*The value of the UID object.*
Compare (in otherID: IUID) : Boolean	*Indicates if the two UID objects represent the same globally unique identifier.*
Generate	*Creates a new globally unique value for the UID object.*

The *IUID* interface has properties and methods that allow you to set the value of a *UID* object, set the subtype of the *UID* object, generate a new globally unique value, and compare two *UID* objects.

In the following VB example, *u* is defined as a new *UID* object and is set to the CLSID of the ArcMap AddData command. That way, *u* can be used in any of the methods that require an *IUID* object.

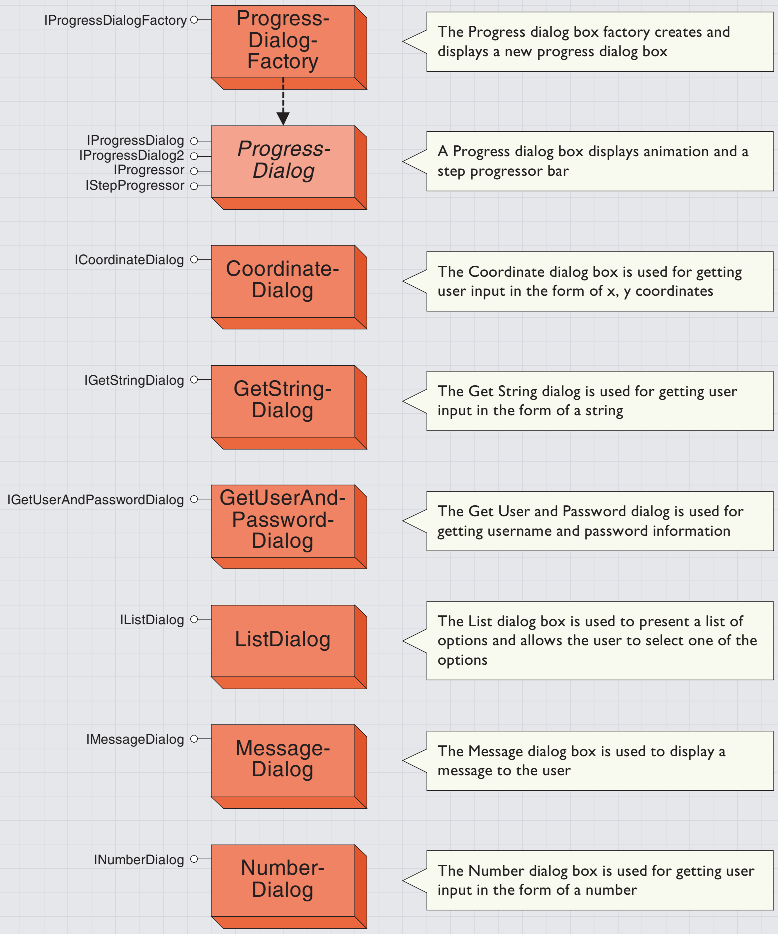
The *IUID* interface is the default interface for the UID coclass—you don't need to Dim the interface; you can cocreate this object in Visual Basic, as shown in the following code.

```
Dim u As New UID
u.Value = "{E1F29C6B-4E6B-11D2-AE2C-080009EC732A}"
```

In the following example, *u* is set to the ProgID of the ESRI Object Editor extension.

```
Dim u As New UID
u.Value = "esriCore.Editor"
```

Framework dialog box objects



The Progress dialog box factory creates and displays a new progress dialog box

A Progress dialog box displays animation and a step progressor bar

The Coordinate dialog box is used for getting user input in the form of x, y coordinates

The Get String dialog is used for getting user input in the form of a string

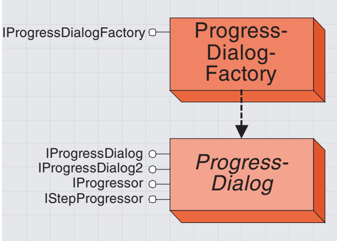
The Get User and Password dialog is used for getting username and password information

The List dialog box is used to present a list of options and allows the user to select one of the options

The Message dialog box is used to display a message to the user

The Number dialog box is used for getting user input in the form of a number

The ArcGIS applications provide a set of simple dialog boxes for getting input from the user or for displaying information. For more elaborate dialog boxes, you can create your own forms in VB or VBA.



A progress dialog box displays an animation and a step progressor bar.

Instead of reporting the progress of an operation in the status bar, you can display a progress dialog box instead. The progress dialog box displays an animation and a step progress bar. The *ProgressDialogFactory* coclass creates and displays a new progress dialog box.

IProgressDialogFactory : IUnknown	Provides access to a method that creates a progress dialog.
← Create (in trackCancel: ITrackCancel, in hWnd: Long) : IStepProgressor	Creates a progress dialog.

The *IProgressDialogFactory* interface has one method, *Create*, which creates and displays a progress dialog box. You can pass a *CancelTracker* object into this method to allow the user to cancel the process.

IProgressDialog2 : IUnknown	Provides access to members that work with a progress dialog.
■—■ Animation: esriProgressAnimationTypes	The animation type displayed in the dialog.
■—■ CancelEnabled: Boolean	Indicates if the Cancel button is enabled.
■—■ Description: String	The description displayed in the dialog.
■—■ Title: String	The caption displayed in the dialog.
← HideDialog	Hides the progress dialog.
← ShowDialog	Shows the progress dialog.

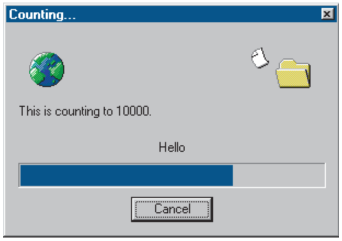
The *IProgressDialog* interface is the original interface for the progress dialog box. However, you should use the more recent *IProgressDialog2* interface instead. The *IProgressDialog2* interface has methods for hiding and showing the progress dialog box.

The *Title* and *Description* properties can be used to provide the user with information about the process that the dialog box is tracking.

The *CancelEnabled* property specifies if the Cancel button is enabled. If *CancelEnabled* is set to *True*, you can use the *Continue* method on the *CancelTracker* object to determine if the user hit *Cancel* and the operations should be stopped.

The *Animation* property specifies the type of animation displayed in the dialog box.

Enumeration esriProgressAnimationTypes	Progress animation types.
0 - esriProgressGlobe	Spinning globe animation.
1 - esriDownloadFile	Downloading file animation.



This is counting to 10000.

Hello

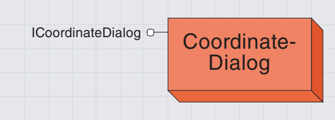
The progress dialog box

The animation in the dialog box can either be the spinning globe animation or the downloading file animation.

The following VBA code creates and displays a progress dialog box and shows the progress of a loop counting to 10,000.

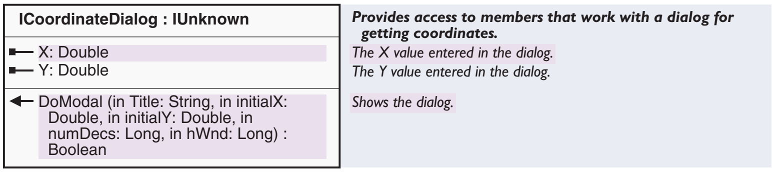
```
Sub ProgDialog()
  Dim pProDlgFact As IProgressDialogFactory
  Dim pStepPro As IStepProgressor
  Dim pProDlg As IProgressDialog2
  Dim pTrkCan As ITrackCancel
  Dim boolCont As Boolean
  Dim i As Long
```

```
 '  Create a CancelTracker
 Set pTrkCan = New CancelTracker

 ' Create the ProgressDialog. This automatically displays the dialog
 Set pProDlgFact = New ProgressDialogFactory
 Set pProDlg = pProDlgFact.Create(pTrkCan, Application.hWnd)

 ' Set the properties of the ProgressDialog
 pProDlg.CancelEnabled = True
 pProDlg.Description = "This is counting to 10000."
 pProDlg.Title = "Counting..."
 pProDlg.Animation = esriDownloadFile

 ' Set the properties of the Step Progressor
 Set pStepPro = pProDlg
 pStepPro.MinRange = 0
 pStepPro.MaxRange = 10000
 pStepPro.StepValue = 1
 pStepPro.Message = "Hello"

 ' Step. Do your big process here.
 boolCont = True
 For i = 0 To 10000
   Application.StatusBar.Message(0) = Str(i)
   'Check if the cancel button was pressed. If so, stop process
   boolCont = pTrkCan.Continue
   If Not boolCont Then
     Exit For
   End If
 Next i

 ' Done

 Set pTrkCan = Nothing
 Set pStepPro = Nothing
 Set pProDlg = Nothing
End Sub
```



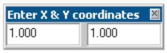
The Coordinate dialog box gets user input in the form of x,y coordinates.

To get access to the *ICoordinateDialog* interface, instantiate a new *CoordinateDialog* object.



ICoordinateDialog : IUnknown — ***Provides access to members that work with a dialog for getting coordinates.***

- X: Double — *The X value entered in the dialog.*
- Y: Double — *The Y value entered in the dialog.*
- DoModal (in Title: String, in initialX: Double, in initialY: Double, in numDecs: Long, in hWnd: Long) : Boolean — *Shows the dialog.*

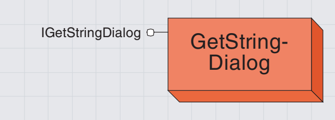


The GetCoordinateDialog

The *ICoordinateDialog* interface has a *DoModal* method for displaying the dialog box. There are parameters on this method for setting the dialog box title, the initial x-value, the initial y-value, and the number of decimal places in the values. If nonnumeric values were entered or if the dialog box was cancelled, the *DoModal* method returns *False*. The x and y properties allow you to get the x- and y-values that were entered in the dialog box.

The following VBA code shows a *CoordinateDialog* and reports the x- and y-values.

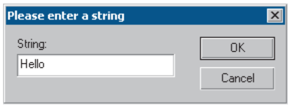
```
Public Sub CoordDlg()
  Dim pCoordDlg As ICoordinateDialog
  Dim boolValid As Boolean
  Set pCoordDlg = New CoordinateDialog
  boolValid = pCoordDlg.DoModal("Enter X & Y coordinates", 1, 1, _
        3, Application.hWnd)
  If boolValid Then
    MsgBox "X: " & pCoordDlg.X & vbNewLine & _
            "Y: " & pCoordDlg.Y
  Else
    MsgBox "Bad entries."
  End If
End Sub
```



The get string dialog box gets user input in the form of a string.

To get access to the *IGetStringDialog* interface, instantiate a new *GetStringDialog* object.

IGetStringDialog : IUnknown	***Provides access to members that work with a dialog for getting a string.***
Value: String	*The value of the string.*
DoModal (in dialogTitle: String, in getStringLabel: String, in initialValue: String, in hWnd: Long) : Boolean	*Shows the dialog.*


Please enter a string

String:

Hello

The get string dialog box

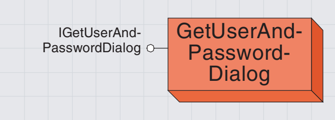
The *IGetStringDialog* interface has a *DoModal* method for displaying the dialog box. There are parameters on this method for setting the dialog box title, the label for the string, and the initial value for the string. If the dialog box was cancelled, the *DoModal* method returns *False*.

The *Value* property allows you to get the value of the string that was entered in the dialog box.

The following VBA code shows a *GetStringDialog* and reports the string value that was entered in the dialog box.

```
Public Sub GetStrDlg()
  Dim pGetStrDlg As IGetStringDialog
  Dim boolOK As Boolean
  Set pGetStrDlg = New GetStringDialog
  boolOK = pGetStrDlg.DoModal("Please enter a string", _
      "String:", "Hello", Application.hWnd)
  If boolOK Then
    MsgBox pGetStrDlg.Value
  Else
    MsgBox "Cancelled."
  End If
End Sub
```

GetUserAndPasswordDialog coclass



The get user and password dialog box gets username and password information.

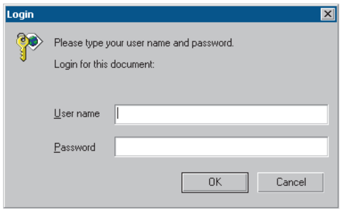
To get access to the *IGetUserAndPasswordDialog* interface, instantiate a new *GetUserAndPasswordDialog* object.

IGetUserAndPasswordDialog : IUnknown	Provides access to members that work with a dailog for getting user and password information.
Password: String	The password entered in the dialog.
UserName: String	The user name entered in the dialog.
DoModal (in dialogTitle: String, in stringLabel: String, in hWnd: Long) : Boolean	Shows the dialog.

The *IGetUserAndPasswordDialog* interface has a *DoModal* method for displaying the dialog box. There are parameters on this method for setting the dialog box title and a message to be displayed in the dialog box. If the dialog box was cancelled, the *DoModal* method returns *False*.

The *UserName* property allows you to get the username that was entered in the dialog box.

The *Password* property allows you to get the password that was entered in the dialog box.



Login

Please type your user name and password.

Login for this document:

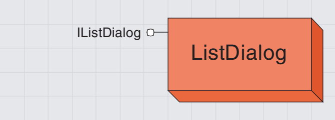
User name

Password

The get user and password dialog box

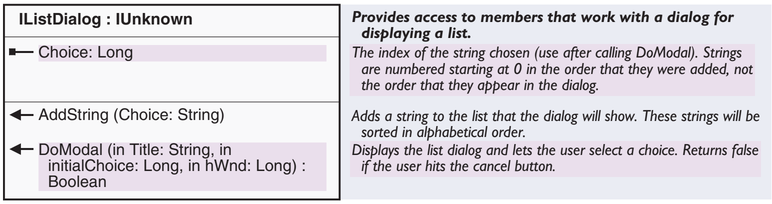
The following VBA code shows a *GetUserAndPasswordDialog* and validates the username and password that were entered in the dialog box.

```
Public Sub GetUserPassDlg()
  Dim pGetUserPassDlg As IGetUserAndPasswordDialog
  Dim boolOK As Boolean
  Set pGetUserPassDlg = New GetUserAndPasswordDialog
  boolOK = pGetUserPassDlg.DoModal("Login", _
      "Login for this document:", Application.hWnd)
  If boolOK Then
    If pGetUserPassDlg.UserName = "GISTeam" And _
    pGetUserPassDlg.Password = "guru" Then
      MsgBox "You're in!"
    Else
      MsgBox "Wrong username or password."
    End If
  Else
    MsgBox "Cancelled."
  End If
End Sub
```



The list dialog box presents a list of options and allows the user to select one of the options.

To get access to the *IListDialog* interface, instantiate a new *ListDialog* object.

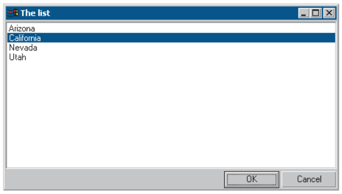


IListDialog : IUnknown

Provides access to members that work with a dialog for displaying a list.

Choice: Long	*The index of the string chosen (use after calling DoModal). Strings are numbered starting at 0 in the order that they were added, not the order that they appear in the dialog.*
AddString (Choice: String)	*Adds a string to the list that the dialog will show. These strings will be sorted in alphabetical order.*
DoModal (in Title: String, in initialChoice: Long, in hWnd: Long) : Boolean	*Displays the list dialog and lets the user select a choice. Returns false if the user hits the cancel button.*

The *IListDialog* interface has an *AddString* method for populating the list that is displayed in the dialog box, and a *DoModal* method for displaying the dialog box. The *DoModal* method has parameters for setting the title of the dialog and the initial selection. This method returns *False* if the dialog box was cancelled. When the dialog box is displayed, the items in the list are sorted in alphabetical order.

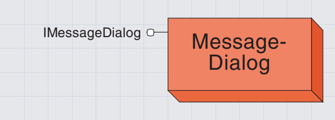


The ListDialog

The *Choice* property returns the index of the selected item in the list. The items are numbered starting at zero in the order that they were added, not in the order in which they appear in the dialog box.

The following VBA code shows a list in the dialog box, then reports the string associated with the selected item.

```
Public Sub ListDlg()
  Dim pListDlg As IListDialog
  Dim boolOK As Boolean
  Set pListDlg = New ListDialog
  pListDlg.AddString "California"
  pListDlg.AddString "Arizona"
  pListDlg.AddString "Utah"
  pListDlg.AddString "Nevada"
  boolOK = pListDlg.DoModal("The list", 0, Application.hWnd)
  If boolOK Then
    Select Case pListDlg.Choice
    Case 0
      MsgBox "California"
    Case 1
      MsgBox "Arizona"
    Case 2
      MsgBox "Utah"
    Case 3
      MsgBox "Nevada"
    End Select
  Else
    MsgBox "Cancelled."
  End If
End Sub
```



The message dialog box displays a message to the user.

To get access to the *IMessageDialog* interface, instantiate a new *MessageDialog* object.

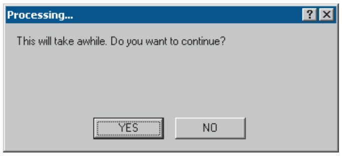
IMessageDialog : IUnknown

← DoModal (in Title: String, in Message: String, in OKButtonMessage: String, in CANCELButtonMessage: String, in hWnd: Long) : Boolean

Provides access to a method that works with a dialog for displaying a message.

Shows the dialog with a message.

The *IMessageDialog* interface has a *DoModal* method for displaying the dialog box. There are parameters on this method for setting the dialog box title, the message, the caption for the OK button, and the caption for the Cancel button. If the dialog box was cancelled, the *DoModal* method returns *False*.



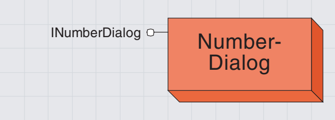
Processing...

This will take awhile. Do you want to continue?

The message dialog box

The following VBA code shows a *MessageDialog* and checks whether the user clicked OK or Cancel.

```
Public Sub MsgDlg()
  Dim pMsgDlg As IMessageDialog
  Dim boolYes As Boolean
  Set pMsgDlg = New MessageDialog
  boolYes = pMsgDlg.DoModal("Processing...", _
     "This will take awhile. Do you want to continue?", "YES", _
     "NO", Application.hWnd)
  If boolYes Then
    MsgBox "Continuing"
  Else
    MsgBox "Stopping."
  End If
End Sub
```

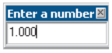


The number dialog box gets user input in the form of a number.

To get access to the *INumberDialog* interface, instantiate a new *NumberDialog* object.

INumberDialog : IUnknown	*Provides access to members that work with a dialog for getting a number.*
Value: Double	*The number value entered in the dialog.*
DoModal (in Title: String, in initialValue: Double, in numDecs: Long, in hWnd: Long) : Boolean	*Shows the dialog.*

The *INumberDialog* interface has a *DoModal* method for displaying the dialog box. There are parameters on this method for setting the dialog box title, an initial value for the number, and the number of decimal places. If a nonnumeric value was entered or if the dialog box was cancelled, the *DoModal* method returns *False*.



1.000

The number dialog box

The *Value* property allows you to get the number that was entered in the dialog box.

The following VBA code shows a *NumberDialog* and reports the number that was entered in the dialog box.

```
Public Sub NumbDlg()
  Dim pNumbDlg As INumberDialog
  Dim boolValid As Boolean
  Set pNumbDlg = New NumberDialog
  boolValid = pNumbDlg.DoModal("Enter a number", 1, 3, _
        Application.hWnd)
  If boolValid Then
    MsgBox pNumbDlg.Value
  Else
    MsgBox "Bad entry."
  End If
End Sub
```

4

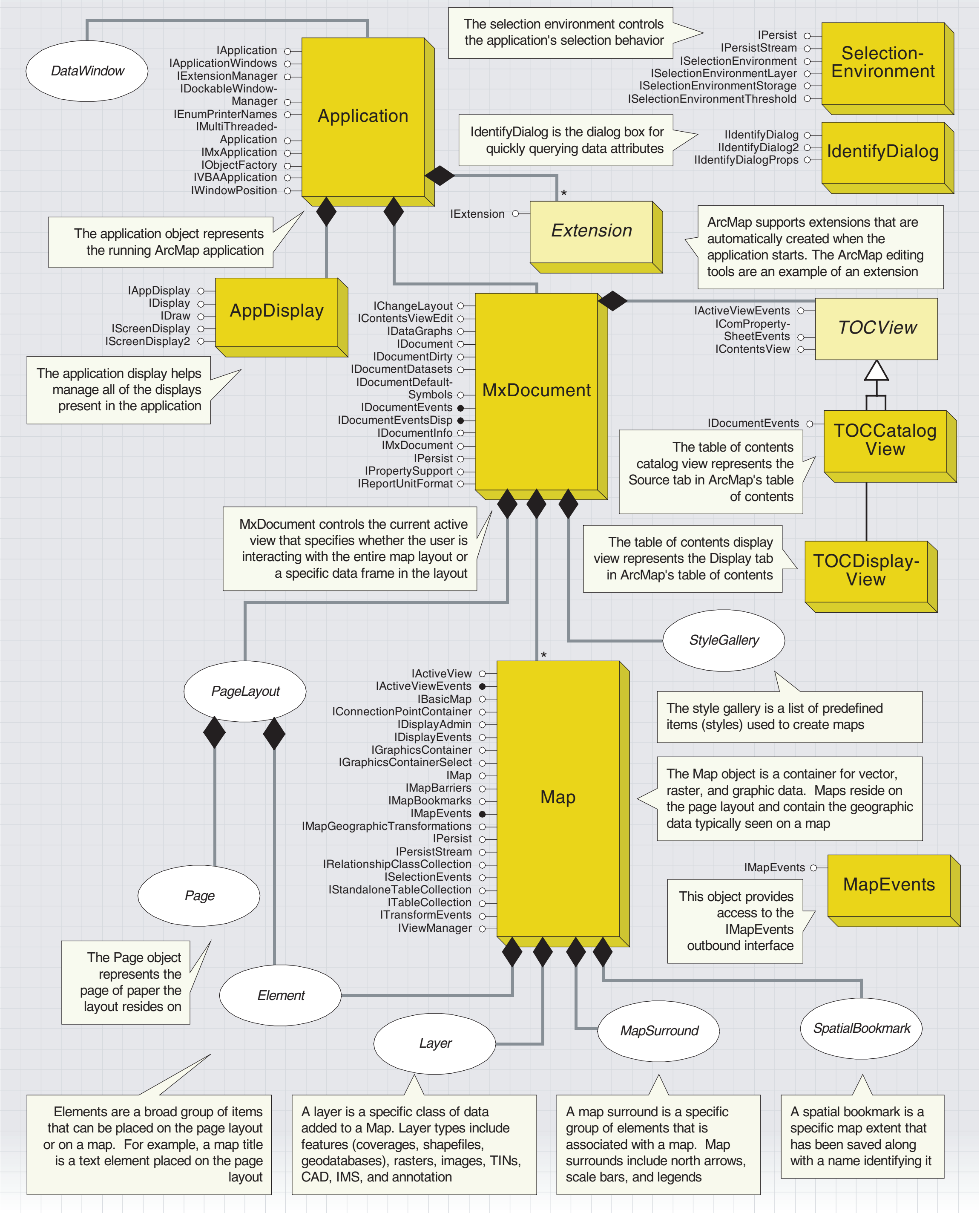
Composing maps

Steve Van Esch, Eleanor Blades, Sentha Shanmugam, Scott Campbell, Larry Young

The ArcMap application employs a presentation model that closely parallels our everyday experience of reading maps. You can customize the geographic expression of your user interface by programming the ArcMap object model.

The topics covered in this chapter include: controlling the application through the core map objects • affecting the ArcMap layout view with the page layout objects • adding graphics with the map element objects • augmenting the cartographic display with data window objects • drawing map features with the layer objects • providing spatial context to the map with map surround objects • standardizing symbology with style gallery objects • providing a visual measurement framework with map grid objects • showing quantitative information with the number objects • annotating the map with labeling objects

ArcMap core objects



The selection environment controls the application's selection behavior

IdentifyDialog is the dialog box for quickly querying data attributes

The application object represents the running ArcMap application

ArcMap supports extensions that are automatically created when the application starts. The ArcMap editing tools are an example of an extension

The application display helps manage all of the displays present in the application

The table of contents catalog view represents the Source tab in ArcMap's table of contents

MxDocument controls the current active view that specifies whether the user is interacting with the entire map layout or a specific data frame in the layout

The table of contents display view represents the Display tab in ArcMap's table of contents

The style gallery is a list of predefined items (styles) used to create maps

The Map object is a container for vector, raster, and graphic data. Maps reside on the page layout and contain the geographic data typically seen on a map

This object provides access to the IMapEvents outbound interface

The Page object represents the page of paper the layout resides on

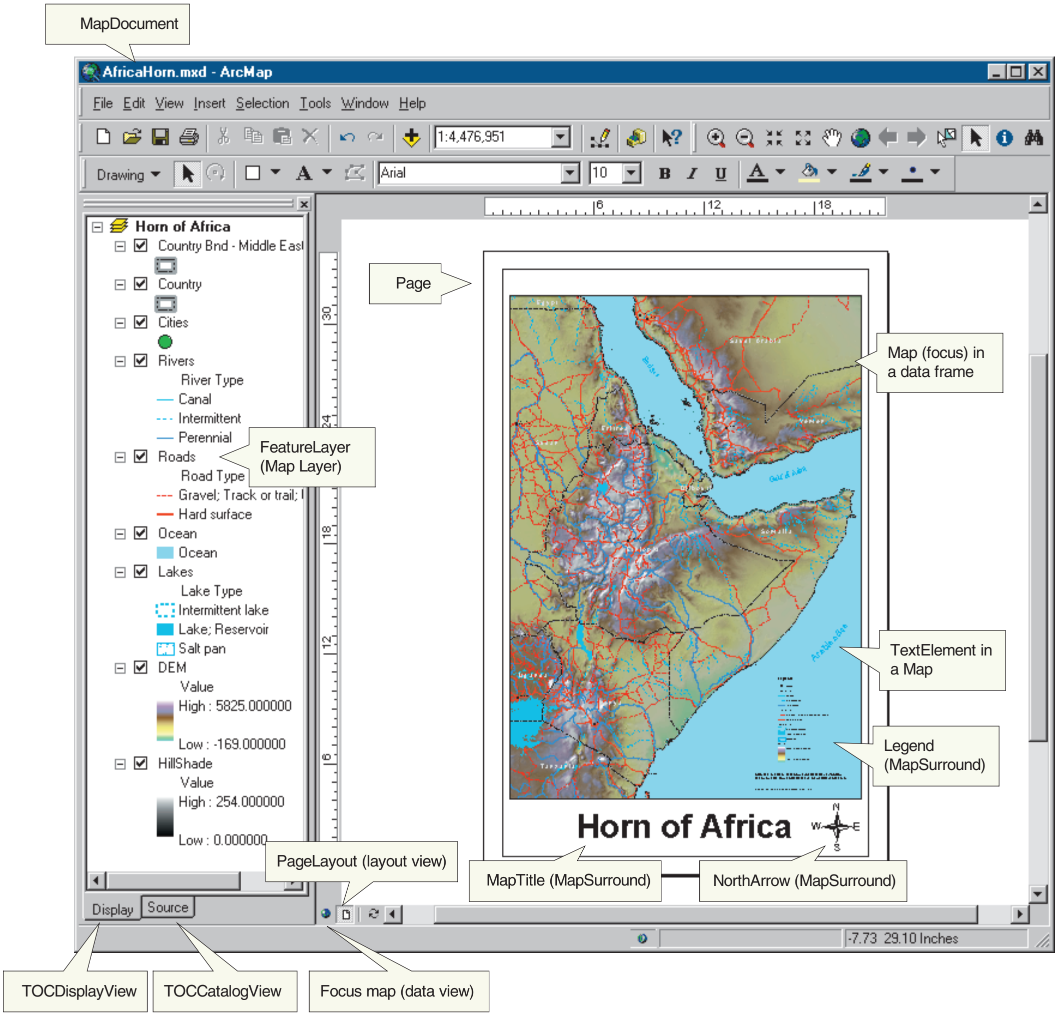
Elements are a broad group of items that can be placed on the page layout or on a map. For example, a map title is a text element placed on the page layout

A layer is a specific class of data added to a Map. Layer types include features (coverages, shapefiles, geodatabases), rasters, images, TINs, CAD, IMS, and annotation

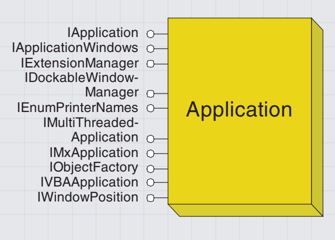
A map surround is a specific group of elements that is associated with a map. Map surrounds include north arrows, scale bars, and legends

A spatial bookmark is a specific map extent that has been saved along with a name identifying it

To better comprehend programming against the ArcMap object model, it helps to understand the relationship between the ArcMap objects and the user interface. This illustration shows several important parts of the map that you can control with key objects. Compare this to the object model diagram on the facing page.


MapDocument
Page
Map (focus) in a data frame
FeatureLayer (Map Layer)
TextElement in a Map
Legend (MapSurround)
PageLayout (layout view)
MapTitle (MapSurround)
NorthArrow (MapSurround)
TOCDisplayView
TOCCatalogView
Focus map (data view)

For more information about ArcMap user interface concepts, see *Using ArcMap*.



This object represents the running application and is the initial point of access to many other objects in the ArcMap application.

The *Application* object directly manages a collection of objects, including *MxDocument*, *AppDisplay*, *SelectionEnvironment*, and any registered extensions; it also manages a *StatusBar*, *Templates*, *Paper*, and printer object. For more information, see Chapter 3, 'Customizing the user interface', and Chapter 5, 'Displaying graphics'. When you first start ArcMap, the *Application* object is first created, and then it in turn instantiates all of the objects it manages.

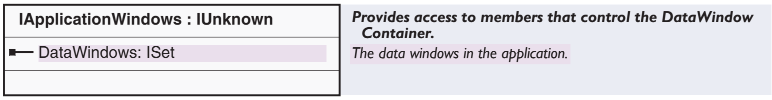
IApplication : IDispatch	***Provides access to members that query or modify the application.***
Caption: String	*The caption of this application.*
CurrentTool: ICommandItem	*The currently selected tool.*
Document: IDocument	*The document that is currently loaded in the application.*
hWnd: Long	*The handle of the application's window.*
Name: String	*The name of this application.*
StatusBar: IStatusBar	*The statusbar of this application.*
Templates: ITemplates	*The templates collection.*
VBE: Object	*The Visual Basic Environment.*
Visible: Boolean	*Indicates if the application window is visible.*
FindExtensionByCLSID (in extensionCLSID: IUID) : IExtension	*Finds an extension by its CLSID.*
FindExtensionByName (in extensionName: String) : IExtension	*Finds an extension by its name.*
IsDialogVisible (in dialogID: Long) : Boolean	*Indicates if the specified dialog is visible in the application.*
LockCustomization (in Password: String, custFilter: ICustomizationFilter)	*Locks the application's user interface against any customizations.*
NewDocument (selectTemplate: Boolean, templatePath: String)	*Creates a new document in this application.*
OpenDocument (Path: String)	*Opens a document in this application.*
PrintDocument	*Displays the Print dialog.*
PrintPreview	*Displays how the document will look like when it is printed.*
RefreshWindow	*Redraws the application window.*
SaveAsDocument (saveAsPath: String, saveAsCopy: Boolean)	*Saves the document that is currently open in this application to a different file.*
SaveDocument (saveAsPath: String)	*Saves the document that is currently open in this application.*
ShowDialog (in dialogID: Long, bShow: Variant) : Variant	*Displays the specified dialog in the application.*
Shutdown	*Terminates the application.*
UnlockCustomization (in Password: String)	*Unlocks previous user interface customization lock.*

The *IApplication* interface provides access to the *MxDocument* object, the extensions, the *StatusBar* object, the *Templates* object, the currently selected tool, and the Visual Basic Editor. There are several methods that allow you to open, save, and print documents; lock and unlock the application from user customizations; display dialog boxes; and exit the application. For more details, see Chapter 3, 'Customizing the user interface'.

IMxApplication : IUnknown	***Provides access to members that control the Mx Application.***
Display: IAppDisplay	*The application display.*
Paper: IPaper	*The current paper settings.*
Printer: IPrinter	*The current printer settings.*
SelectionEnvironment: ISelectionEnvironment	*The selection environment.*
CopyToClipboard	*Copies the current view to the clipboard.*
Export	*Exports the current document.*

The *IMxApplication* interface provides access to the remainder of the objects the *Application* automatically creates, including *AppDisplay*, *Paper* coclass, *Printer*, and *SelectionEnvironment*. Additionally, *IMxApplication* exposes methods for exporting the current map document or copying it to the system clipboard.

```
  Dim pMxApp As IMxApplication
  Set pMxApp = Application 'Query Interface
  MsgBox pMxApp.SelectionEnvironment.SearchTolerance
```

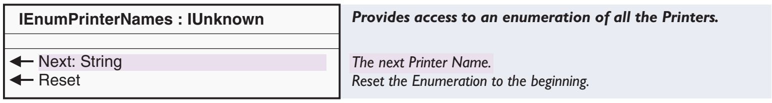


IApplicationWindows : IUnknown — *Provides access to members that control the DataWindow Container.*

- DataWindows: ISet — *The data windows in the application.*

IApplicationWindows provides access to the application's data windows. This interface has one property, *DataWindows*, which returns an *ISet* reference to a *Set* object. The *Set* object is used because it can hold a collection of heterogeneous objects and, as is the case here, one data window may be a magnifier window and another an overview window. All data windows implement the *IDataWindows* interface. The example below moves the first data window found to the top-left corner of the terminal display and makes it 500 x 500 screen pixels.

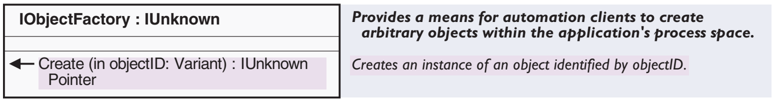
```
Public Sub AccessDataWindows()
  Dim pAppWindows As IApplicationWindows
  Dim pDataWindow As IDataWindow
  Dim pWindowsSet As ISet
  Set pAppWindows = Application 'QI
  Set pWindowsSet = pAppWindows.DataWindows
  pWindowsSet.Reset
  Set pDataWindow = pWindowsSet.Next
  If pDataWindow Is Nothing Then Exit Sub
  pDataWindow.PutPosition 0, 0, 500, 500
End Sub
```



IEnumPrinterNames : IUnknown — *Provides access to an enumeration of all the Printers.*

- Next: String — *The next Printer Name.*
- Reset — *Reset the Enumeration to the beginning.*

Use *IEnumPrinterNames* to loop through all of the available printers currently configured on your machine. The *Next* property returns the name of a printer, which can be passed to *IPaper::PrinterName* on the *Paper* object to change the current target printer.



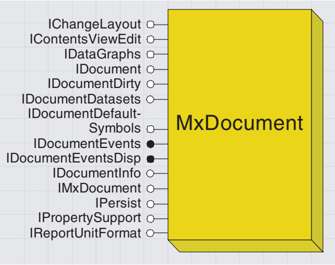
IObjectFactory : IUnknown — *Provides a means for automation clients to create arbitrary objects within the application's process space.*

- Create (in objectID: Variant) : IUnknown Pointer — *Creates an instance of an object identified by objectID.*

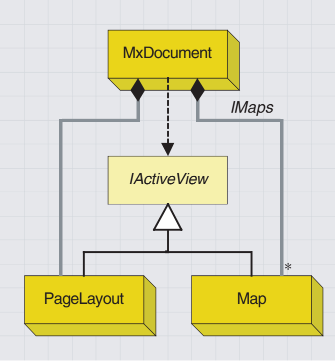
For more information, see the topic on customizing ArcMap through automation at the end of this chapter.

The *IObjectFactory* interface is a new interface released at ArcGIS 8.1 that allows users driving ArcMap through automation to create objects in the ArcMap process space. This eliminates marshalling between objects created in, for example, a Visual Basic application and ArcMap. Eliminating marshalling greatly improves performance as ArcMap can work directly with new objects instead of through intra-application communication.

For documentation on the *IDockableWindowManager, IExtensionManager, IMultiThreadedApplication,* and *IVBAApplication* interfaces, see Chapter 3, 'Customizing the user interface'.



Each running instance of ArcMap works with a current map document, which is represented by MxDocument.



MxDocument *controls the current active view, which specifies whether the user is interacting with the map as a whole through its page layout, or whether the user is viewing one of the maps in data view.*

The ArcMap document is called *MxDocument*; its role is to control the representation of data. The ArcMap application automatically creates this object when the application first starts.

In the ArcMap object model, the *MxDocument* is cocreatable in case you are not customizing within an ArcMap session—instantiating a new *MxDocument* creates a new instance of the *Application* object, which in turn creates the *MxDocument* object. There is one *MxDocument* per session of ArcMap.

MxDocument specifically creates and manages the following objects: an empty *Map*, a *PageLayout*, the *TOCCatalogView*, the *TOCDisplayView*, the *StyleGallery*, and the *TableProperties*. You can obtain a reference to the *MxDocument* through *IApplication::Document*.

One of the most important aspects of *MxDocument* is the notion of its views. You can think of the view as the main application window, or the place where all data is drawn. ArcMap currently has two different views, data view and layout view—developers using C++ can create additional ones.

Objects implement the *IActiveView* interface to establish themselves as views. The data view corresponds to a *Map* object, and the layout view corresponds to the *PageLayout* object. Either of these objects can be set as the document's active view, and only one view is visible at a time. A map document can contain several *Map* objects, one per data frame. The data view always corresponds to the *Map* currently in focus.

Each view consists of a *ScreenDisplay* object, which performs the actual drawing. Each *ScreenDisplay* object in turn has a *DisplayTransformation* object, which manages the map-to-device transformation. When you need to draw features or get at a *Map*'s spatial reference, for example, it is very important you get a handle to the correct *ScreenDisplay*.

To help with this, ArcMap exposes the *AppDisplay* object, which has a handy property for returning the *ScreenDisplay* with focus. In addition, this object has its own implementation of *IScreenDisplay* and, in this case, if you draw or pan, the results will appear in all of the displays currently instantiated in the application. For more details, see the documentation on the *AppDisplay* object later in this chapter.

IMxDocument is a starting point for accessing most of the other ArcMap objects including the views, the collection of maps, the page layout, the style gallery, and the table properties. This interface also manages many properties reflected in the running application including the current table of contents, the currently selected item in the table of contents, and the current mouse location.

IMxDocument : IUnknown	Provides access to members that control the Mx Document.
ActivatedView: IActiveView	The activated view. This is the same as the active view unless a data frame is activated within a layout.
ActiveView: IActiveView	The active view.
ActiveViewCommand: ICommand	The command associated with the active view.
ContentsView (in Index: Long) : IContentsView	The contents view at the specified index.
ContentsViewCount: Long	The number of contents views in the document.
ContextItem: IUnknown Pointer	The last item that was right-clicked.
CurrentContentsView: IContentsView	The current contents view of the document.
CurrentLocation: IPoint	The current mouse location in map units.
DefaultColor (in Type: tagesriMxDefaultColorTypes) : IColor	The default color for the given type.
DefaultTextFont: Font	The default font for text.
DefaultTextFontSize: IFontSize	The default font size for text.
DelayUpdateContents: Boolean	Indicates document update notifications should be ignored.
FocusMap: IMap	The current focus map.
Maps: IMaps	The collection of maps in the document.
OperationStack: IOperationStack	The operation stack.
PageLayout: IPageLayout	The page layout.
RelativePaths: Boolean	Indicates if path names are stored relative to the document.
SearchTolerance: Double	The global search tolerance in geographic units for selection.
SearchTolerancePixels: Long	The global search tolerance in pixels for selection.
SelectedItem: IUnknown Pointer	The selected item in the layer control.
SelectedLayer: ILayer	The selected layer in the layer control.
StyleGallery: IStyleGallery	Reference to the document's Style Gallery.
TableProperties: ITableProperties	Table properties, for Layers and Tables in ArcMap.
AddLayer (in Layer: ILayer)	Adds a layer to the current focus map.
CanInsertObject (pEnabled: Boolean)	Indicates if the document allows objects to be inserted.
InsertObject	Inserts an object into the document. Displays the insert object dialog.
UpdateContents	Notifies the document that the contents have been updated.

IMxDocument is also useful when working with content views—the different tabs in the table of contents. Some members that work with content views are SelectedItem, ContextItem, and UpdateContents. Here are some common problems and solutions.

I need to know what items are selected in the active content view. *Use the SelectedItem property to obtain a reference to the selected item in the TOC. This property returns an IUnknown because an item in the TOC can be any number of things. For example, when working in the Display tab, the reference could be to a Map object if you have a data frame selected, one of the Layer objects (FeatureLayer, FDOGraphicsLayer, or other) if you have a layer selected, or a LegendGroup if you have a unique value or heading selected. In the Source tab, the reference can be to any of the above objects plus a Table, FeatureDataset, or Workspace. In the case where more than one item is selected, the reference is to the Set object.*

I need to refresh the TOC because of changes I have made programmatically. *Use UpdateContents to automatically refresh the active TOC. Alternatively, you can use CurrentContentsView to get a reference to the active TOC and call IContentsView::Refresh.*

I'm creating a content menu and need to know which item was right-clicked. *ContextItem returns the last item that was right-clicked; it works the same as SelectedItem. The Map also has an Expanded property to collapse or open or close the map tree in the Contents view.*

The following VBA code checks the type of active view:

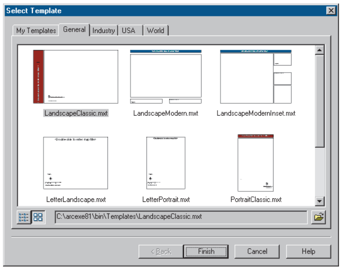
```
Dim pMxDoc As IMxDocument
Set pMxDoc = Application.Document
If TypeOf pMxDoc.ActiveView Is IMap Then
  MsgBox "Active View is a Map"
ElseIf TypeOf pMxDoc.ActiveView Is IPageLayout Then
  MsgBox "Active view is the PageLayout"
End If
```

The following VBA code returns the total number of maps managed by the document:

```
Dim pMxDoc As IMxDocument
Set pMxDoc = Application.Document
MsgBox pMxDoc.Maps.Count
```

The following VBA code accesses the document's map, which has focus (though this is not necessarily the active view):

```
Dim pMxDoc As IMxDocument
Dim pMap As IMap
Set pMxDoc = Application.Document
Set pMap = pMxDoc.FocusMap
MsgBox pMap.LayerCount
```



C:\arcexe81\bin\Templates\LandscapeClassic.mxt

The Change Layout dialog box in ArcMap

IChangeLayout : IUnknown	***Provides access to members that control changing the document's layout.***
← ChangeLayout: Boolean	*Indicates if the wizard used to select a new layout is shown.*

Use the *IChangeLayout* interface to change the template the document is currently based on. A template is a type of map document that provides a quick way to create a new map. Templates often contain data, a custom interface, and a predefined layout that arranges map elements such as North arrows, scale bars, and logos. *IChangeLayout* has one member called *ChangeLayout* that launches a wizard from which a new template can be selected.

IContentsViewEdit : IUnknown	***Provides access to members that control Contents View Edit.***
← AddContentsView (in ContentsView: IContentsView)	*Adds a contents view object to the TOC.*
← ClearContentsViews	*Removes all current contents views.*

Use the *IContentsViewEdit* interface to manage the content views (tabs) in the table of contents. This interface has methods for adding new content views and removing existing ones. Custom content views are created by implementing the *IContentsView* interface. *IContentsViewEdit* also has a member that clears all of the content views. ArcMap ships with two content views, Display and Source. Use *IMxDocument::ContentsView* or *IMxDocument::CurrentContentsView* to obtain a reference to a particular contents view.

IDataGraphs : IUnknown	***Provides access to members that control the datagraph collection.***
■— Count: Long	*Number of graphs.*
■— Item (in Index: Long) : IDataGraph	*The graph at the given index.*
← Add (in graph: IDataGraph)	*Adds a graph to the collection.*
← Create: IDataGraph	*Creates a new graph and returns it.*
← Remove (in graph: IDataGraph)	*Removes a graph from the collection.*
← RemoveAt (in Index: Long)	*Removes a graph at the specified index.*
← Reset	*Removes all graphs from the collection.*

The *IDataGraphs* interface manages the collection of data graphs currently associated with the document. Use *IDataGraphs* to create new data graphs, clear old ones, or obtain a reference to a specific graph.

IDocumentDatasets : IUnknown	***Provides access to members that control the Dataset Container.***
■— Datasets: IEnumDataset	*The datasets in the document.*

Use the *IDocumentDatasets* interface to access the datasets currently loaded in the document. *IDocumentDatasets* has only one member, *Datasets,* which returns an *IEnumDataset* reference, which can be used to cycle through all of the datasets in the document.

```
Public Sub DocumentDatasets()
  Dim pDocumentDatasets As IDocumentDatasets
  Dim pEnumDataset As IEnumDataset
  Dim pDataset As IDataset
  Set pDocumentDatasets = Application.Document
  Set pEnumDataset = pDocumentDatasets.Datasets
  pEnumDataset.Reset
  Set pDataset = pEnumDataset.Next
  Do While Not pDataset Is Nothing
    MsgBox pDataset.Name
    Set pDataset = pEnumDataset.Next
  Loop
End Sub
```

IDocumentDefaultSymbols : IUnknown	Provides access to members that control Default Symbols for the document.
AreaPatch: IAreaPatch	Default Area Patch.
Callout: IFormattedTextSymbol	Default Callout.
CustomTOCFont: Font	Custom TOC Font.
CustomTOCFontSize: Double	Custom TOC Font Size in Points.
FillSymbol: IFillSymbol	Default Fill Symbol.
LinePatch: ILinePatch	Default Line Patch.
LineSymbol: ILineSymbol	Default Line Symbol.
MarkerSymbol: IMarkerSymbol	Default Marker Symbol.
PatchHeight: Double	Default Patch Height in Points.
PatchWidth: Double	Default Patch Width in Points.
TextSymbol: ITextSymbol	Default Text Symbol.

The *IDocumentDefaultSymbols* interface provides a central point for accessing and managing symbols used by many tools. For example, layout tools, such as the New Rectangle tool, rely on the symbols managed by this interface to symbolize the graphics they create; in this case, the New Rectangle tool creates a polygon graphic using the fill symbol stored in *IDocumentDefaultSymbols::FillSymbol*. The example below shows one method to change the default fill symbol.

```
Public Sub ChangeDefaultFillSymbol()
  Dim pDefaultSymbols As IDocumentDefaultSymbols
  Dim pFillSymbol As IFillSymbol
  Dim pColor As IRgbColor

  Set pDefaultSymbols = Application.Document
  Set pFillSymbol = pDefaultSymbols.FillSymbol
  Set pColor = New RgbColor
  pColor.Red = 255
  pFillSymbol.Color = pColor
  pDefaultSymbols.FillSymbol = pFillSymbol
End Sub
```

IDocumentEvents : IUnknown	Provides access to events that occur in ArcMap.
ActiveViewChanged	Fired when the active view changes.
BeforeCloseDocument: Boolean	Fired before a document is closed. Return True to abort the close process.
CloseDocument	Fired when a document is closed.
MapsChanged	Fired when a change is made to the map collection.
NewDocument	Fired when a new document is created.
OnContextMenu (in X: Long, in Y: Long, out handled: Boolean)	Indicates if a context menu should be displayed at the given xy location. Return true if handled.
OpenDocument	Fired when a document is opened.

IDocumentEvents is the outbound interface on the *MxDocument* object. Use this interface to listen for specific events related to map documents.

For example, an event is fired whenever a map document is opened. For more details on map document events, see *IDocumentEventsDisp* below.

IDocumentEventsDisp : IDispatch	*Provides access to events that occur in ArcMap.*
← ActiveViewChanged: Boolean	*Fired when the active view has changed.*
← BeforeCloseDocument: Boolean	*Fired before a document is closed. Return True to abort the close process.*
← CloseDocument: Boolean	*Fired when a document is closed.*
← MapsChanged: Boolean	*Fired when a change is made to the map collection.*
← NewDocument: Boolean	*Fired when a new document is created.*
← OnContextMenu (in X: Long, in Y: Long) : Boolean	*Indicates if a context menu should be displayed at the given xy location. Return true if handled.*
← OpenDocument: Boolean	*Fired when a document is opened.*
← VBAReset: Boolean	*Fired when VBA is reset.*

IDocumentEvents and *IDocumentEventsDisp* are nearly identical except the latter is exposed automatically in the ArcMap VBA editor. When working in VBA, an *MxDocument* object is defined in all *ThisDocument* class modules. After selecting this object in the Object Box, you can select any of the *IDocumentEventsDisp* events by clicking them in Procedure/Method Box. Selecting one of the events stubs out the event procedure in the class module.

In ArcMap, there can be up to three VBA projects (*Project, TemplateProject,* and *Normal*) loaded; each one has a *ThisDocument* class module. You can write code for each document event in each *ThisDocument* code window. It is important to know the order in which the document events for each VBA project get fired. For example, when the *NewDocument* event occurs, the code in the *MxDocument_NewDocument* function in *Project.ThisDocument* executes first, followed by code in *TemplateProject.ThisDocument*, and finally code in *Normal.ThisDocument*.

If an event function in *Project.ThisDocument* returns *True*, then the code for this event in *TemplateProject.ThisDocument* and *Normal.ThisDocument* does not get executed. This provides a mechanism for a document to override any code that might be in the base template or the *Normal* template.

The sample below asks the user for a username and password before providing complete access to the document. This sample's intent is to show how the open document event works, not how to secure a document.

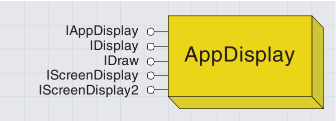
```
Private Function MxDocument_OpenDocument() As Boolean
  Dim pGetUser As IGetUserAndPasswordDialog
  Dim pTemplates As ITemplates
  Dim sUserName As String
  Dim sPassword As String

  Set pTemplates = Application.Templates

  Set pGetUser = New GetUserAndPasswordDialog
  If pGetUser.DoModal("Enter Username and Password", " ", _
      Application.hWnd) Then
    sUserName = pGetUser.UserName
    sPassword = pGetUser.Password
    If Not UCase(sUserName) = UCase("GIS") Or _
      Not UCase(sPassword) = UCase("opensaysme") Then
      'Open new document
      MsgBox "Sorry, you do not have access to this document."
      Application.NewDocument False, pTemplates.Item(0)
    End If
  Else
    Application.NewDocument False, pTemplates.Item(0)
  End If
End Function
```

IDocumentInfo : IUnknown	*Provides access to members that control the Document Info.*
Author: String	*The author of the document.*
Category: String	*The category of the document.*
Comments: String	*Comments for the document.*
DocumentTitle: String	*The title of the document.*
HyperlinkBase: String	*The hyperlink base of the document.*
Keywords: String	*The keywords for the document.*
SavePreview: Boolean	*Indicates if a preview of the document is saved when the document is saved.*
Subject: String	*The subject of the document.*

All map documents have properties, such as who authored the document and what the document represents. The *IDocumentInfo* interface conveniently provides properties for entering map document metadata. *IDocumentInfo* also manages a few map document properties that are not metadata type information.

The *SavePreview* property specifies whether or not a thumbnail image of the layout is displayed in ArcCatalog when browsing map documents.

The *HyperlinkBase* property specifies the root Web address for hyperlink fields. For example, you can set a map document's *HyperlinkBase* property to www.esri.com and a Web-linked field on a feature to ArcObjectsOnline. When you turn on field hyperlinks for a layer and use the *Hyperlink* tool, the two are put together, and www.esri.com/ArcObjectsOnline becomes the hyperlink.



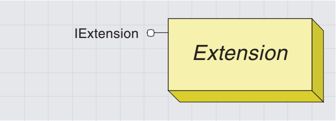
Because there are potentially multiple objects, each with its own ScreenDisplay *object, the* Application *object also has an* AppDisplay *object to help manage all of these.*

The *AppDisplay* object has its own implementation of *IScreenDisplay* whereby the properties and methods get applied to all of the display objects currently instantiated in the application. For example, if you draw or pan in this screen display, all of the screen displays in the application are forwarded the same call.

IAppDisplay : IScreenDisplay	Provides access to members that control the Mx Display.
Count: Long	The number of ScreenDisplays associated with the application.
FocusScreen: IScreenDisplay	The ScreenDisplay associated with the window the mouse is over. May be a lens window or the main window.
MainScreen: IScreenDisplay	The ScreenDisplay associated with the main application window. Set this property before using the other properties and methods.
ScreenDisplay (in idx: Long) : IScreenDisplay	Return the nth ScreenDisplay associated with the application.

Views are not the only objects that have a *ScreenDisplay*; each *MapInsetWindow* has its own *ScreenDisplay* object. The *Pan* tool uses the *AppDisplay* object to pan the active view and all magnifier windows if they are not in snapshot mode. This *AppDisplay* object can also pass references to any individual *ScreenDisplay* object, the *ScreenDisplay* object currently with focus, or the main *ScreenDisplay* belonging to active view.

For documentation on the *IDisplay, IScreenDisplay,* and *IDraw* interfaces, see Chapter 5, 'Displaying graphics'.



An extension is registered with an ArcGIS application to augment the application.

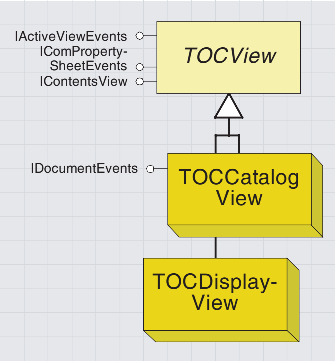
The *Application* object directly manages the life of all application extensions. Application extensions are those extensions registered in the ESRI *MxExtension* objects; the editing tools in ArcMap are an example of an *MxExtension*. All extensions are automatically created and destroyed in synchronization with an *Application* object.

IExtension : IUnknown	Provides access to members that define an extension.
Name: String	Returns the name of the extension.
Shutdown	Shuts down the extension.
Startup (in initializationData: Variant)	Starts up the extension with the given initialization data.

Use the *IExtension* interface to query the properties of an extension or implement this interface to create your own custom extension. There are other categories for extensions, such as ESRI Editor Extensions, that are not managed by the *Application* object, but they work in much the same fashion.

Use *IApplication::FindExtension* to get a reference to a particular extension.

```
Public Sub CheckEditState()
  Dim pEditor As IEditor
  Dim pUID As New UID

  pUID = "esriCore.Editor"
  Set pEditor = Application.FindExtensionByCLSID(pUID)

  If pEditor.EditState = esriStateEditing Then
    MsgBox "Active Edit Session Present"
  End If
End Sub
```



The Display tab in the ArcMap table of contents shows all the layers on the map and what the features in each layer represent.

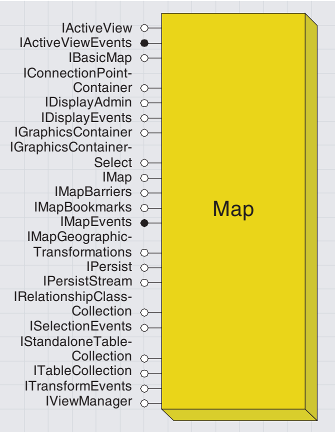
The Source tab in the ArcMap table of contents shows all the layers on the map and from where they originate.

Contents views are tabs in the ArcMap table of contents. ArcMap ships with two contents views: display view and source view. The Display tab is the *TOCDisplayView* object, and the Source tab is the *TOCCatalogView* object. Developers can add new contents views by creating their own custom object that implements the *IContentsView* interface. All contents views must be registered in the 'ESRI Contents Views' component category.

All contents views are managed by the *MxDocument* object. All contents views registered in the contents views component category are automatically created by an *MxDocument* object when it is first created. However, only one contents view can be active at a time. Use the *IMxDocument::CurrentContentsView* property to set the current contents view and to get a reference to the current contents view.

Setting the current contents view automatically refreshes the table of contents (*IContentsView::Refresh*). The *MxDocument* objects has two additional members for accessing the contents views: *IMxDocument::ContentsView,* which takes an index, and *IMxDocument::ContentsViewCount.*

Contents views implement *IActiveViewEvents*. These objects are not sources for *IActiveViewEvents*; however, they are sinks. These objects are clients responding to the active view events fired by the *PageLayout* and *Map* objects.



IContentsView : IUnknown	***Provides access to members that control table of contents views.***
ContextItem: Variant	*The context item (could be an enumerator).*
hWnd: Long	*The HWND of the contents view.*
Name: String	*The name of the contents view.*
ProcessEvents: Boolean	*Indicates if the view is currently responding to events.*
SelectedItem: Variant	*The selected item (could be an enumerator).*
ShowLines: Boolean	*Indicates if lines are shown in the TOC tree.*
Visible: Boolean	*Indicates if the view is visible.*
Activate (in parentHWnd: Long, in Document: IMxDocument)	*Activates the contents view.*
AddToSelectedItems (in Item: Variant)	*Adds to the selected items.*
Deactivate	*Deactivates the contents view.*
Refresh (in Item: Variant)	*Refreshes the contents view. If a non-null item is specified, it refreshes only that item and its children.*
RemoveFromSelectedItems (in Item: Variant)	*Removes an item from the selected items.*

The *IContentsView* interface provides the contract for the minimum behavior all contents views must support. Each contents view implements this interface slightly differently. For more information on their custom implementation, see the documentation on *TOCDisplayView* and *TOCSourceView.*

Aside from implementing this interface to create a new contents view, this interface is rarely accessed by applications and, in many cases, contents views do not provide an implementation for several of the members. More commonly used members on this interface are *Name, SelectedItem,* and *Visible.* In fact, accessing the currently selected item is actually much easier via *IMxDocument::SelectedItem* off the *MxDocument* object. This property will return the currently selected item on the active contents view.

When you work with the *SelectedItem* property, remember that it returns a reference to the currently selected item in the contents view you are working with. The return is a variant because there are several possible objects the selected item can be.

When working with the *TOCDisplayView* object, the reference could be to a *Map* object if you have a data frame selected, one of the *Layer* objects (*FeatureLayer, FDOGraphicsLayer,* or other) if you have a layer selected, or a *LegendGroup* if you have a unique value or heading selected.

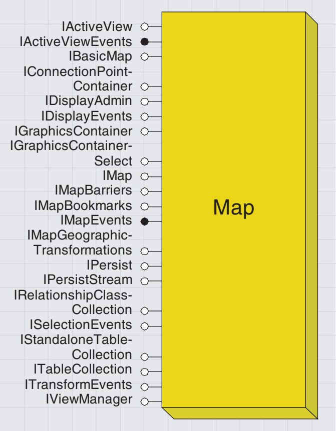
If you are working with the *TOCSourceView* object, the reference can be to any of the above objects plus a *Table, FeatureDataset,* or *Workspace*.

If more than one item is selected, the reference is to a *Set* object. Again, it is much easier to use *IMxDocument::SelectedItem,* which returns an *IUnknown* instead of *IContentsView::SelectedItem*, which returns a *Variant*.

The *TOCDisplayView* object represents the Display tab in the ArcMap table of contents. For information about the capabilities inside the Display tab, see *Using ArcMap*. This object is creatable strictly because the *MxDocument* needs to create one when it is first created; there is generally no need for developers to create or access this object.

TOCDisplayView and *TOCSourceView* currently do not provide an implementation for these members: *IContentsView::put_SelectedItem*, *IContentsView::AddToSelectedItems*, *IContentsView::RemoveFromSelectedItems*, and *IActiveViewEvents::SelectionChanged*.

The *TOCSourceView* object represents the Source tab in the ArcMap table of contents. For information about this tab including its capabilities, consult *Using ArcMap*. Like the *TOCDisplayView* object, this object is creatable because the *MxDocument* creates one when it is first created; there is generally no need for developers to create or access this object. See the note in *TOCDisplayView* about which members are not currently implemented by this object.



The Map *object is a container for map data—it manages layers of feature and graphic data. The* Map *object is a primary point for customization tasks because it not only manages layers of data, but it is also a view and has to manage the drawing of all its data. Typical tasks with the* Map *object include adding a new layer, panning the display, changing the view extent (zooming functions), changing the spatial reference, and getting the currently selected features and elements.*

Every map document contains at least one *Map* object. Only one *Map* can have focus at a time, and this *Map* is called the focus map. *IMxDocument* provides access to all of the *Map* objects loaded in the document; *IMxDocument::FocusMap* returns a reference to the *Map* currently with focus, and *IMxDocument.Maps* returns the entire collection of *Map* objects.

ArcMap comes with two different views: data view and layout view. Data view relates to a *Map* object, and layout view relates to the *PageLayout* object. A map document can contain any number of *Map* objects—the focus *Map* always represents the data view.

All of the layers in a map share the same spatial reference. A *Map*'s spatial reference is automatically set to the spatial reference of the first layer loaded. New layers loaded into a *Map* are projected to the *Map* object's spatial reference if their spatial reference is different.

In ArcMap, *Map* objects are always contained by *MapFrame* objects—the *PageLayout* object actually manages all the *MapFrame* objects, a type of element, and each *MapFrame* manages a *Map*. Note that for convenience, the *MxDocument* object passes a reference to the focus map and the *Map*'s collection. In reality, however, the *PageLayout* object manages these. Each *Map* object, in turn, manages a collection of *Layer* objects. Types of *Layer* objects include *FeatureLayers, FDOGraphicsLayers,* and *GroupLayers*.

Every *Map* also manages a *CompositeGraphicsLayer* object, which contains a collection of graphics layers. The default graphics layer is a *Map* object's basic graphics layer where all graphics, including labels, are drawn by default. The *Map* provides direct access to this layer with the property *IMap::BasicGraphicsLayer*. A *Map* object's basic graphics layer cannot be deleted from the *CompositeGraphicsLayer* object, though new graphics layers can be added and deleted.

The layer collection returned from the *IMap::Layers* property does not include the *Map* object's *CompositeGraphicsLayer*; to access this object, you must use the *IMap::BasicGraphicsLayer* property. The *Map* also has a shortcut to the basic graphics layer *IGraphicsContainer* interface; you can query an interface from any of the *Map* interfaces, for example, *IMap*, to *IGraphicsLayers*.

MapSurround objects are elements that are related to a *Map*. Types of map surrounds include *Legends, NorthArrows,* and *ScaleBars*. The *Map* object exposes several properties and methods for accessing the map surrounds associated with it. All map surrounds are actually contained by a *MapSurroundFrame* which, like a *MapFrame*, is ultimately managed by the *PageLayout* object.

The *Map* object is cocreatable so that new *Map* objects can be created and added to the document. Instantiating a new *Map* object automatically creates the following related objects on which it relies: a *ScreenDisplay* object, which every view uses to manage the drawing window, and a new *CompositeGraphicsLayer*, as discussed above.

IMap is the main interface to the Map coclass and is used for controlling the Map's data and associated elements.

IMap : IUnknown	***Provides access to members that control the map.***
■—□ ActiveGraphicsLayer: ILayer	*The active graphics layer. If no graphic layers exist a basic memory graphics layer will be created.*
■—□ AnnotationEngine: IAnnotateMap	*The annotation (label) engine the map will use.*
—■ AreaOfInterest: IEnvelope	*Area of interest for the map.*
■— Barriers (pExtent: IEnvelope) : IBarrierCollection	*The list of barriers and their weight for labeling.*
■— BasicGraphicsLayer: IGraphicsLayer	*The basic graphics layer.*
■—■ ClipBorder: IBorder	*An optional border drawn around ClipGeometry.*
■—■ ClipGeometry: IGeometry	*A shape that layers in the map are clipped to.*
■—■ Description: String	*Description of the map.*
■—■ DistanceUnits: esriUnits	*The distance units for the map.*
■—■ Expanded: Boolean	*Indicates if the Map is expanded.*
■—□ FeatureSelection: ISelection	*The feature selection for the map.*
■—■ IsFramed: Boolean	*Indicates if map is drawn in a frame rather than on the whole window.*
■— Layer (in Index: Long) : ILayer	*The layer at the given index.*
■— LayerCount: Long	*Number of layers in the map.*
■— Layers (UID: IUID, recursive: Boolean) : IEnumLayer	*The layers in the map of the type specified in the uid. If recursive is true it will return layers in group layers.*
■—■ MapScale: Double	*The scale of the map as a representative fraction.*
■— MapSurround (in Index: Long) : IMapSurround	*The map surround at the given index.*
■— MapSurroundCount: Long	*Number of map surrounds associated with the map.*
■—■ MapUnits: esriUnits	*The units for the map.*
■—■ Name: String	*Name of the map.*
■—■ ReferenceScale: Double	*The reference scale of the map as a representative fraction.*
■— SelectionCount: Long	*Number of selected features.*
■—□ SpatialReference: ISpatialReference	*The spatial reference of the map.*
■—■ SpatialReferenceLocked: Boolean	*Prevents the spatial reference from being changed.*
■—■ UseSymbolLevels: Boolean	*Indicates if the Map draws using symbol levels.*
← AddLayer (in Layer: ILayer)	*Adds a layer to the map.*
← AddLayers (in Layers: IEnumLayer, in autoArrange: Boolean)	*Adds multiple layers to the map, arranging them nicely if specified.*
← AddMapSurround (in MapSurround: IMapSurround)	*Adds a map surround to the map.*
← ClearLayers	*Removes all layers from the map.*
← ClearMapSurrounds	*Removes all map surrounds from the map.*
← ClearSelection	*Clears the map selection.*
← ComputeDistance (in p1: IPoint, in p2: IPoint) : Double	*Computes the distance between two points on the map and returns the result.*
← CreateMapSurround (in CLSID: IUID, in optionalStyle: IMapSurround) : IMapSurround	*Create and initialize a map surround. An optional style from the style gallery may be specified.*
← DelayDrawing (in delay: Boolean)	*Suspends drawing.*
← DelayEvents (in delay: Boolean)	*Used to batch operations together to minimize notifications.*
← DeleteLayer (in Layer: ILayer)	*Deletes a layer from the map.*
← DeleteMapSurround (in MapSurround: IMapSurround)	*Deletes a map surround from the map.*
← GetPageSize (out widthInches: Double, out heightInches: Double)	*Gets the page size for the map.*
← MoveLayer (in Layer: ILayer, in toIndex: Long)	*Moves a layer to another position.*
← RecalcFullExtent	*Forces the full extent to be recalculated.*
← SelectByShape (in Shape: IGeometry, in env: ISelectionEnvironment, in justOne: Boolean)	*Selects features in the map given a shape and a selection environment (optional).*
← SelectFeature (in Layer: ILayer, in Feature: IFeature)	*Selects a feature.*
← SetPageSize (in widthInches: Double, in heightInches: Double)	*Sets the page size for the map (optional).*

The *IMap* interface is a starting point for many of the tasks one does with a *Map*. For example, you can use *IMap* to add, delete, and access map layers containing data from various sources, including feature layers and graphics layers; associate map surround objects (legends, scale bars, and so on) with the *Map*; access the various properties of a *Map*, including the area of interest, the current map units, and the spatial reference; and select features and access the *Map* object's current selection.

```
Public Sub AddShapeFile()
  Dim pWorkspaceFactory As IWorkspaceFactory
  Dim pFeatureWorkspace As IFeatureWorkspace
  Dim pFeatureLayer As IFeatureLayer
  Dim pMxDocument As IMxDocument
  Dim pMap As IMap

  ' Create a new ShapefileWorkspaceFactory object and
  ' open a shapefile folder
  Set pWorkspaceFactory = New ShapefileWorkspaceFactory
  Set pFeatureWorkspace = pWorkspaceFactory.OpenFromFile _
   ("c:\arcgis\arcexe81\ArcObjects Developer Kit\Samples\Data\USA", 0)
  'Create a new FeatureLayer and assign a shapefile to it
  Set pFeatureLayer = New FeatureLayer
  Set pFeatureLayer.FeatureClass = _
    pFeatureWorkspace.OpenFeatureClass("States")
  pFeatureLayer.Name = pFeatureLayer.FeatureClass.AliasName
  'Add the FeatureLayer to the focus map
  Set pMxDocument = Application.Document
  Set pMap = pMxDocument.FocusMap
  pMap.AddLayer pFeatureLayer
End Sub
```

Use this code to get the currently selected feature.

```
Public Sub GetSelectedFeature()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pEnumFeature As IEnumFeature
  Dim pFeature As IFeature
  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pEnumFeature = pMap.FeatureSelection
  pEnumFeature.Reset
  Set pFeature = pEnumFeature.Next
End Sub
```

This code shows how to select features by shape.

To use this sample, paste the code into a new UIToolControl's MouseDown event. Completely close VBA so that mouse events fire. Select the tool and drag out an envelope.

```
Private Sub UIToolControl1_MouseDown(ByVal button As Long, _
    ByVal shift As Long, ByVal x As Long, ByVal y As Long)
  Dim pMxApp As IMxApplication
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pActiveView As IActiveView
  Dim pRubberEnv As IRubberBand
  Dim pEnvelope As IEnvelope

  Set pMxApp = Application 'QI
  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pActiveView = pMap 'QI
  Set pRubberEnv = New RubberEnvelope
  'Flag the area of the old selection to invalidate
  pActiveView.PartialRefresh esriViewGeoSelection, Nothing, Nothing
  'Use TrackNew to prompt user to drag out a square on the display
  Set pEnvelope = pRubberEnv.TrackNew(pActiveView.ScreenDisplay, Nothing)
  'Perform the selection
  pMap.SelectByShape pEnvelope, pMxApp.SelectionEnvironment, False
  'Flag the area of the new selection to invalidate
  pActiveView.PartialRefresh esriViewGeoSelection, Nothing, Nothing
End Sub
```

IBasicMap : IUnknown	***Provides access to members that control the basic map.***
■—□ ActiveGraphicsLayer: ILayer	*The active graphics layer. If no graphic layers exist a basic memory graphics layer will be created.*
—■ AreaOfInterest: IEnvelope	*Area of interest for the map.*
■— BasicGraphicsLayer: IGraphicsLayer	*The basic graphics layer.*
■—■ Description: String	*Description of the map.*
■—□ FeatureSelection: ISelection	*The map's feature selection.*
■— Layer (in Index: Long) : ILayer	*The layer at the given index.*
■— LayerCount: Long	*Number of layers in the map.*
■— Layers (UID: IUID, recursive: Boolean) : IEnumLayer	*The layers in the map of the type specified in the uid. If recursive is true it will return layers in group layers.*
■—■ Name: String	*Name of the map.*
■— SelectionCount: Long	*Number of selected features in the map.*
■—□ SpatialReference: ISpatialReference	*The spatial reference of the map.*
◄— AddLayer (in pLayer: ILayer)	*Adds a layer to the map.*
◄— AddLayers (in pLayers: IEnumLayer, in autoArrange: Boolean)	*Adds multiple layers to the map, arranging them nicely if specified.*
◄— ClearLayers	*Removes all layers from the map.*
◄— ClearSelection	*Clears the map selection.*
◄— DeleteLayer (in pLayer: ILayer)	*Deletes a layer from the map.*
◄— SelectByShape (in Shape: IGeometry, in env: ISelectionEnvironment, in justOne: Boolean)	*Selects features in the map given a shape and a selection environment (optional).*

IBasicMap is a subset of *IMap* that provides support for ArcScene. Both *Map* (2D) and *Scene* (3D) components implement this interface. These components are used by both ArcMap and ArcScene (such as *Table* coclass) *QI* for *IBasicMap* rather than *IMap*.

IGraphicsContainer : IUnknown	*Provides access to members that control the Graphics Container.*
← AddElement (in Element: IElement, in zorder: Long)	*Add a new graphic element to the layer.*
← AddElements (in Elements: IElementCollection, in zorder: Long)	*Add new graphic elements to the layer.*
← BringForward (in Elements: IEnumElement)	*Move the specified elements one step closer to the top of the stack of elements.*
← BringToFront (in Elements: IEnumElement)	*Make the specified elements draw in front of all other elements.*
← DeleteAllElements	*Delete all the elements.*
← DeleteElement (in Element: IElement)	*Delete the given element.*
← FindFrame (in frameObject: Variant) : IFrameElement	*Find the frame that contains the specified object.*
← GetElementOrder (in Elements: IEnumElement) : Variant	*Private order object. Used to undo ordering operations.*
← LocateElements (in Point: IPoint, in Tolerance: Double) : IEnumElement	*Returns the elements at the given coordinate.*
← LocateElementsByEnvelope (in Envelope: IEnvelope) : IEnumElement	*Returns the elements that intersect with the given envelope.*
← MoveElementFromGroup (in Group: IGroupElement, in Element: IElement, in zorder: Long)	*Move the element from the group to the container.*
← MoveElementToGroup (in Element: IElement, in Group: IGroupElement)	*Move the element from the container to the group.*
← Next: IElement	*Returns the next graphic in the container.*
← PutElementOrder (in order: Variant)	*Private order object. Used to undo ordering operations.*
← Reset	*Reset internal cursor so that Next returns the first element.*
← SendBackward (in Elements: IEnumElement)	*Move the specified elements one step closer to the bottom of the stack of elements.*
← SendToBack (in Elements: IEnumElement)	*Make the specified elements draw behind all other elements.*
← UpdateElement (in Element: IElement)	*The graphic element's properties have changed.*

The *Map* object is a graphics container somewhat like the *PageLayout* object.

Elements, such as a text element (label), can be added directly to a *Map*, or they can be stored in a database. For those elements stored in a *Map*, the *Map* actually manages a *CompositeGraphicsLayer* object to store all the elements. *CompositeGraphicsLayer* objects can have multiple layers in them.

One layer is the *Map*'s basic graphics layer, which is also the default graphics layer. Access this layer using *IMap::BasicGraphicsLayer*. The basic graphics layer is a special layer that cannot be deleted and is not reported in the *CompositeGraphicsLayer*'s layer count. Further, this layer's element count reports the total number of elements in all the *CompositeGraphicsLayer*'s layers. If you delete all elements in the *Map*'s basic graphics layer, you delete all elements in all target layers (annotation groups) in the *CompositeGraphicsLayer*. In the case where the *Map*'s *CompositeGraphicsLayer* does have multiple layers, use *IMap::ActiveGraphicsLayer* to set or get a reference to the active layer.

The active graphics layer does not always reference a layer in the *Map*'s *CompositeGraphicsLayer*; this is the case when a database layer containing elements is set as the active graphics layer. A feature-linked annotation layer (*FDOGraphicsLayer*) is a good example of this.

The *Map*'s *IGraphicsContainer* always returns a reference to the *Map*'s active graphics layer. Again, this can either be the basic graphics layer, a layer in the *Map*'s *CompositeGraphicsLayer*, or a feature layer such as an *FDOGraphicsLayer*.

IGraphicsContainerSelect : IUnknown	**Provides access to members that control graphic container selection.**
■—□ DominantElement: IElement	Dominant element.
■— ElementSelectionCount: Long	Returns the number of selected elements.
■— SelectedElements: IEnumElement	Returns the selected elements.
■— SelectionBounds (in Display: IDisplay) : IEnvelope	Returns the bounds of the selection.
◀— ElementSelected (in Element: IElement) : Boolean	Indicates if the element is selected.
◀— SelectAllElements	Selects all elements.
◀— SelectedElement (in Index: Long) : IElement	Returns the nth selected element. Use Selection count to get the number of selected elements.
◀— SelectElement (in Element: IElement)	Selects the specified element.
◀— SelectElements (in Elements: IEnumElement)	Selects the specified elements.
◀— SelectionTracker (in Index: Long) : ISelectionTracker	Returns the tracker for the nth selected element. Use Selection count to get the number of selected elements.
◀— UnselectAllElements	Unselects all elements.
◀— UnselectElement (in Element: IElement)	Unselects the specified element.
◀— UnselectElements (in Elements: IEnumElement)	Unselects the specified elements.

The *IGraphicsContainerSelect* interface is documented with the *PageLayout* object later in this chapter.

IActiveView : IUnknown	**Provides access to members that control the active view - the main application window.**
■— ExportFrame: tagRECT	The device rectangle to export.
■—■ Extent: IEnvelope	The visible extent rectangle.
■— ExtentStack: IExtentStack	The extent stack.
■—□ FocusMap: IMap	The map that tools and controls act on.
■—■ FullExtent: IEnvelope	The full extent rectangle.
■— GraphicsContainer: IGraphicsContainer	The active graphics container.
■—■ IsMapActivated: Boolean	Indicates if the focus map is activated.
■— ScreenCacheID (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer) : Integer	The screen cache ID that is used to draw the specified phase.
■— ScreenDisplay: IScreenDisplay	The screen display used by the view.
■—□ Selection: ISelection	The selection.
■—■ ShowRulers: Boolean	Indicates if rulers are visible.
■—■ ShowScrollBars: Boolean	Indicates if scrollbars are visible.
■—■ ShowSelection: Boolean	Indicates if selection is visible.
■— TipText (in X: Double, in Y: Double) : String	The tip text to display at the given location.
◀— Activate (hWnd: Long)	Gives this view control of the specified window.
◀— Clear	Empties the view contents.
◀— ContentsChanged	Called by clients when view objects are modified.
◀— Deactivate	Another view takes over the associated window.
◀— Draw (in hDC: Long, in trackCancel: ITrackCancel)	Draws the view to the specified device context. TrackCancel is optional.
◀— GetContextMenu (in X: Double, in Y: Double, out clsidMenu: IUID)	Called when a context menu should be displayed at the given xy location. Return menu that should be displayed.
◀— HitTestMap (in Location: IPoint) : IMap	Returns any maps present in the view at the given location. Return value may be zero if there are no maps or the coordinate is not over a map.
◀— IsActive: Boolean	Indicates if view is active or not.
◀— OnMessage (in msg: Unsigned Long, in wParam: Unsigned Machine Int, in lParam: Long)	Call from your application's message loop to enable automatic resizing and keyboard accelerators.
◀— Output (in hDC: Long, in dpi: Long, in PixelBounds: tagRECT, in VisibleBounds: IEnvelope, in trackCancel: ITrackCancel)	Renders the view to the specified DC.
◀— PartialRefresh (in phase: tagesriViewDrawPhase, in data: IUnknown Pointer, in Envelope: IEnvelope)	Draws the specified view phase. Use an envelope of zero to draw the entire phase.
◀— PrinterChanged (in Printer: IPrinter)	Called by application when printer changes.
◀— Refresh	Causes the entire view to draw.

The *IActiveView* interface controls the main application window, including all drawing operations. Use this interface to change the extent of the view, access the associated *ScreenDisplay* object, show or hide rulers and scroll bars, and refresh the view. The *Map* object's implementation of the *IActiveView* is different from the *PageLayout* object's implementation. For more information about the different views, see the *MxDocument* topic in this chapter.

Two important methods on this interface are *Refresh* and *PartialRefresh*; see the discussion comparing these two methods later in this chapter.

This VBA script lets the user zoom in on the current active view:

```
Public Sub ZoomInCenter()
  Dim pMxDocument As IMxDocument
  Dim pActiveView As IActiveView
  Dim pDisplayTransform As IDisplayTransformation
  Dim pEnvelope As IEnvelope
  Dim pCenterPoint As IPoint

  Set pMxDocument = Application.Document
  Set pActiveView = pMxDocument.FocusMap
  Set pDisplayTransform = _
    pActiveView.ScreenDisplay.DisplayTransformation
  Set pEnvelope = pDisplayTransform.VisibleBounds
  ' IActiveView::Extent is a shortcut to the visible bounds
  Set pEnvelope = pActiveView.Extent

  Set pCenterPoint = New Point
  pCenterPoint.x = ((pEnvelope.XMax - pEnvelope.XMin) / 2) + _
   pEnvelope.XMin
  pCenterPoint.y = ((pEnvelope.YMax - pEnvelope.YMin) / 2) + _
   pEnvelope.YMin
  pEnvelope.Width = pEnvelope.Width / 2
  pEnvelope.Height = pEnvelope.Height / 2
  pEnvelope.CenterAt pCenterPoint
  pDisplayTransform.VisibleBounds = pEnvelope
  pActiveView.Refresh
End Sub
```

IActiveViewEvents : IUnknown	***Provides access to events that occur when the state of the active view changes.***
← AfterDraw (in Display: IDisplay, in phase: tagesriViewDrawPhase)	*Fired after the specified phase is drawn.*
← AfterItemDraw (in Index: Integer, in Display: IDisplay, phase: tagesriDrawPhase)	*Fired after an individual view item is drawn. Example: view items include layers in a map or elements in a page layout.*
← ContentsChanged	*Fired when the contents of the view changes.*
← ContentsCleared	*Fired when the contents of the view is cleared.*
← FocusMapChanged	*Fired when a new map is made active.*
← ItemAdded (in Item: Variant)	*Fired when an item is added to the view.*
← ItemDeleted (in Item: Variant)	*Fired when an item is deleted from the view.*
← ItemReordered (in Item: Variant, in toIndex: Long)	*Fired when a view item is reordered.*
← SelectionChanged	*Fired when the selection changes.*
← SpatialReferenceChanged	*Fired when the spatial reference is changed.*
← ViewRefreshed (in View: IActiveView, in phase: tagesriViewDrawPhase, in data: Variant, in Envelope: IEnvelope)	*Fired when view is refreshed before draw happens.*

The *IActiveViewEvents* interface is the default outbound interface on the *Map* object. It is exposed off the *Map* object so that clients may listen and respond to specific events related to the active view, such as

AfterDraw and *SelectionChanged*. Many coclasses implement this interface, and each of them fires events differently. For example, the *Map* object does not fire the *FocusMap* changed event, whereas the *PageLayout* object does. Similarly, the *Map* object fires the Item Deleted Event when a layer is removed from the *Map*, and the *PageLayout* object fires the same event when elements such as a map frame or graphic are deleted.

The *AfterViewDraw* event will not fire unless *IViewManager::VerboseEvents* is set to *True*. For more details, see the discussion on *IViewManager*.

The following VBA script is a simple example showing one possible way an event listener can be set up. Run the *SetUpEvents* routine to set up the listener. From that point on, whenever the focus *Map*'s selection changes, the *SelectionChanged* routine will be called.

```
Private WithEvents MapActiveViewEvents As Map

Public Sub SetUpEvents()
  Dim pMxDoc As IMxDocument
  Set pMxDoc = Application.Document
  Set MapActiveViewEvents = pMxDoc.FocusMap
End Sub

Private Sub MapActiveViewEvents_SelectionChanged()
  MsgBox "Selection Changed"
End Sub
```

Barriers are used by labeling engines to signal that a label should not be placed in a particular region. Barriers currently include annotation, graphical elements, and symbols generated from renderers. For example, a feature layer using a pie chart renderer doesn't want labels to appear directly above the pie chart's symbols. In this case, pie chart symbols act as barriers informing the label engine that no labels should be placed on top of them.

IMapBarriers : IUnknown	***Provides access to members that control map barriers.***
▪— Barriers2 (pExtent: IEnvelope, in pTrackCancel: ITrackCancel) : IBarrierCollection	*The list of barriers and their weight for labeling.*

The *IMapBarriers* interface returns a list of all the barriers and their weights from all the layers in the *Map*. Layers with barriers include those layers that implement *IBarrierProperties*—the *CompositeGraphicsLayer, CoverageAnnotationLayer,* and *FDOGraphicsLayer*. When creating a labeling engine, use this interface to conveniently access all the barriers from all the layers.

Bookmarks make it easy to jump to specific extents because they save map extents along with a name identifying them. There are two types of spatial bookmarks available in ArcMap: Area of Interest bookmarks and Feature bookmarks.

In ArcMap, bookmarks are accessible via the Bookmarks menu under the View menu. ArcMap also has a bookmark manager that allows users to delete undesired bookmarks.

IMapBookmarks : IUnknown	***Provides access to members that control the map bookmarks.***
▪— Bookmarks: IEnumSpatialBookmark	*The bookmarks.*
← AddBookmark (in bookmark: ISpatialBookmark)	*Adds a bookmark to the collection.*
← RemoveAllBookmarks	*Removes all bookmarks.*
← RemoveBookmark (in bookmark: ISpatialBookmark)	*Removes a bookmark from the collection.*

All spatial bookmarks are managed by a *Map* object and are persisted in the map document. A *Map*'s bookmarks are managed by the *IMapBookmarks* interface. Use *IMapBookmarks* to access existing bookmarks, add new ones, and delete old ones. Once you have a reference to a particular bookmark, you can make the *Map*'s extent equal to that stored in the bookmark.

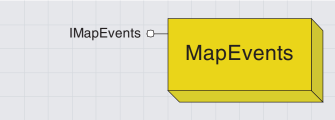
This sample shows one method for creating a new Area of Interest bookmark:

```
Public Sub AddSpatialBookMark()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pActiveView As IActiveView
  Dim pAreaOfInterest As IAOIBookmark
  Dim pMapBookmarks As IMapBookmarks

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pActiveView = pMap

  'Create a new bookmark and set its location to the focus map's
  'current extent
  Set pAreaOfInterest = New AOIBookmark
  Set pAreaOfInterest.Location = pActiveView.Extent
  'Give the bookmark a name
  pAreaOfInterest.Name = "My bookmark"
  'Add the bookmark to the map's bookmark collection.This will add
  'the bookmark to the Bookmarks menu accessible from the View menu
  Set pMapBookmarks = pMap
  pMapBookmarks.AddBookmark pAreaOfInterest
End Sub
```

This sample shows one way to find an existing spatial bookmark and zoom to its stored extent:

```
Public Sub ZoomToBookmark()
  Dim pMxDoc As IMxDocument
  Dim pMapBookmarks As IMapBookmarks
  Dim pEnumBookmarks As IEnumSpatialBookmark
  Dim pBookmark As ISpatialBookmark

  Set pMxDoc = Application.Document
  Set pMapBookmarks = pMxDoc.FocusMap
  Set pEnumBookmarks = pMapBookmarks.Bookmarks
  pEnumBookmarks.Reset
  Set pBookmark = pEnumBookmarks.Next
  Do While Not pBookmark Is Nothing
    If pBookmark.Name = "My bookmark" Then
      pBookmark.ZoomTo pMxDoc.FocusMap
      pMxDoc.ActiveView.Refresh
       Exit Sub
    End If
    Set pBookmark = pEnumBookmarks.Next
  Loop
End Sub
```

IMapEvents : IUnknown	Provides access to events that occur when the state of the map changes.
← FeatureClassChanged (in oldClass: IFeatureClass, in newClass: IFeatureClass)	Fired when the feature class changes.
← VersionChanged (in oldVersion: IVersion, in newVersion: IVersion)	Fired when the version changes.



The MapEvents *coclass provides access to the* IMapEvents *outbound interface.*

The *IMapEvents* interface is exposed off the *Map* object, enabling clients to listen and respond to two events occurring inside a map: *FeatureClassChanged* and *VersionChanged*. Both of these events are related to changing the version the map's layers are working with. For example, if someone changes the version an edit session is working with, the *Editor* has to know about all the new feature classes so that it can reset the snapping environment.

The *Map* object's default outbound interface is *IActiveViewEvents*. Because Visual Basic can only handle one outbound interface per object, the *MapEvents* object has been created to give Visual Basic users a method for responding to the events grouped under *IMapEvents*.

The example demonstrates listening to map events. The event is declared on the *MapEvents* object instead of the *Map* object.

```
Private WithEvents MapEvents As MapEvents

Public Sub InitBookMark()
  Dim pMxDoc As IMxDocument
  Set pMxDoc = Application.Document
  Set MapEvents = pMxDoc.FocusMap
End Sub

Private Sub MapEvents_FeatureClassChanged(ByVal oldClass As _
   IFeatureClass, ByVal newClass As IFeatureClass)
  MsgBox "Feature Class Changed"
End Sub

Private Sub MapEvents_VersionChanged(ByVal oldVersion As _
    IVersion, ByVal newVersion As IVersion)
  MsgBox "Version Changed"
End Sub
```

ITableCollection : IUnknown	Provides access to members that control a table collection.
■— Table (in Index: Long) : ITable	The table at the given index.
■— TableCount: Long	Number of tables.
← AddTable (in Table: ITable)	Adds a table to the collection.
← RemoveAllTables	Removes all tables from the collection.
← RemoveTable (in Table: ITable)	Removes a table from the collection.

The *ITableCollection* interface is used to manage tables associated with a *Map*. Use this interface to add new tables to a map, remove old tables, or access a table already loaded. The following VBA macro loads a table into the focus map.

```
Public Sub AddTable()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pTable As ITable
  Dim pTableCollection As ITableCollection

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pTableCollection = pMap 'QI
  Set pTable = OpenTable("d:\data\usa\tables", "stdemog.dbf")
  If pTable Is Nothing Then Exit Sub
  pTableCollection.AddTable pTable
  pMxDoc.UpdateContents
End Sub

Private Function OpenTable(strWorkspace As String, _
   strTableName As String) As ITable
  On Error GoTo ErrorHandler
  Dim pShpWorkspaceName As IWorkspaceName
  Dim pDatasetName As IDatasetName
  Dim pName As IName

  'Create the workspace name object
  Set pShpWorkspaceName = New WorkspaceName
  pShpWorkspaceName.PathName = strWorkspace
  pShpWorkspaceName.WorkspaceFactoryProgID = _
    "esriCore.shapefileworkspacefactory.1"

  'Create the table name object
  Set pDatasetName = New TableName
  pDatasetName.Name = strTableName
  Set pDatasetName.WorkspaceName = pShpWorkspaceName

  'Open the table
  Set pName = pDatasetName
  Set OpenTable = pName.Open

  Exit Function 'exit to avoid error handler
ErrorHandler:
  Set OpenTable = Nothing
End Function
```

IViewManager : IUnknown	Provides access to members used to describe or define view behavior.
ConserveMemory: Boolean	Indicates whether to be conservative when allocating resources.
DelayBackgroundDraw: Boolean	Indicates if the background should draw immediately. Set to true to eliminate flashing during animation.
ElementSelection: ISelection	Object to use for element selection.
ExternalDrawing (in phase: tagesriViewDrawPhase) : Boolean	Indicates if external clients are drawing in response to the specified phase.
OutputBandSize: Long	Size allocated for each band when banding output.
TopFilterIndex: Long	Phase index that supplements TopFilterPhase. Clients should set the item index here if they draw in response to AfterDrawItem and they use a display filter. TopFilterPhase must also be specified.
TopFilterPhase: tagesriViewDrawPhase	The highest phase in the drawing order that uses a display filter. Clients should set this when they draw in response to AfterDraw and they use a display filter.
UsesPageCoordinates: Boolean	Indicates whether view uses page coordinates.
VerboseEvents: Boolean	Expand or limit the number of events that are fired. The following events are not fired if VerboseEvents is false: AfterDrawItem.

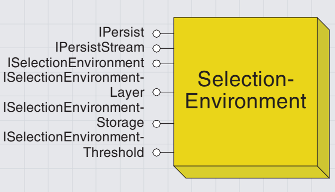
IViewManager is a low-level interface to the properties defining the behavior of the active view.

One commonly used property managed by the *IViewManager* interface is *VerboseEvents*. When *VerboseEvents* is set to *False*, the default, *IActiveViewEvents::AfterItemDraw*, is not fired. To listen for this event, you must set *VerboseEvents* equal to *True*.

The sample below buffers each selected feature and draws the result on the display. The buffer polygons have a black outline and a slanted red line fill.

```
Private WithEvents ActiveViewEvents As Map
Private m_pMxDoc As IMxDocument
Private m_pBufferPolygon As IPolygon
Private m_pLastBufferedExtent As IEnvelope
Private m_pFillSymbol As ISimpleFillSymbol
Public Sub InitEvents()
  Dim pViewManager As IViewManager
  Dim pRgbColor As IRgbColor

  Set m_pMxDoc = Application.Document
  Set pViewManager = m_pMxDoc.FocusMap
  pViewManager.VerboseEvents = True
  Set ActiveViewEvents = m_pMxDoc.FocusMap
  Set m_pActiveView = m_pMxDoc.FocusMap

  'Create a fill symbol
  Set m_pFillSymbol = New SimpleFillSymbol
  Set pRgbColor = New RgbColor
  pRgbColor.Red = 255
  m_pFillSymbol.Style = esriSFSForwardDiagonal
  m_pFillSymbol.Color = pRgbColor
End Sub
```

```
Private Sub ActiveViewEvents_AfterItemDraw(ByVal Index As Integer, _
    ByVal display As IDisplay, ByVal phase As esriDrawPhase)

  'Only draw in the geography phase
  If Not phase = esriDPGeography Then Exit Sub
  'Draw the buffered polygon
  If m_pBufferPolygon Is Nothing Then Exit Sub
  With display
    .SetSymbol m_pFillSymbol
    .DrawPolygon m_pBufferPolygon
  End With
End Sub

Private Sub ActiveViewEvents_SelectionChanged()
  Dim pActiveView As IActiveView
  Dim pEnumFeature As IEnumFeature
  Dim pFeature As IFeature
  Dim pPolygon As IPolygon
  Dim pTopoOperator As ITopologicalOperator
  Dim pGeometryBag As IGeometryCollection

  Set pActiveView = m_pMxDoc.FocusMap
  Set pGeometryBag = New GeometryBag

  'Flag last buffered region for invalidation
  If Not m_pLastBufferedExtent Is Nothing Then
    pActiveView.PartialRefresh esriViewGeography, Nothing, _
       m_pLastBufferedExtent
  End If

  If m_pMxDoc.FocusMap.SelectionCount = 0 Then
    'Nothing selected; don't draw anything; bail
    Set m_pBufferPolygon = Nothing
    Exit Sub
  End If

  'Buffer each selected feature
  Set pEnumFeature = m_pMxDoc.FocusMap.FeatureSelection
  pEnumFeature.Reset
  Set pFeature = pEnumFeature.Next

  Do While Not pFeature Is Nothing
    Set pTopoOperator = pFeature.Shape
    Set pPolygon = pTopoOperator.Buffer(0.1)
    pGeometryBag.AddGeometry pPolygon
    'Get next feature
    Set pFeature = pEnumFeature.Next
  Loop
  'Union all the buffers into one polygon
  Set m_pBufferPolygon = New Polygon
  Set pTopoOperator = m_pBufferPolygon 'QI
  pTopoOperator.ConstructUnion pGeometryBag

  Set m_pLastBufferedExtent = m_pBufferPolygon.Envelope

  'Flag new buffered region for invalidation
  pActiveView.PartialRefresh esriViewGeography, Nothing, _
      m_pBufferPolygon.Envelope

End Sub
```


IPersist
IPersistStream
ISelectionEnvironment
ISelectionEnvironment-Layer
ISelectionEnvironment-Storage
ISelectionEnvironment-Threshold
Selection-Environment

The selection environment controls the applications' selection behavior.

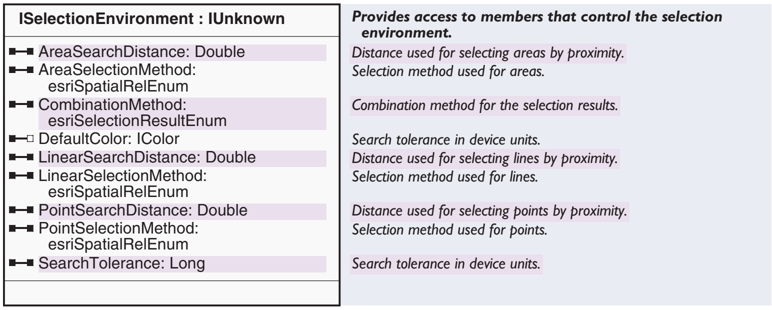
In the ArcMap application, most of the selection environment properties are available on the Selection/Options dialog box.

The *Application* object, which represents the running application, manages a *SelectEnvironment* object that controls several default properties related to creating and drawing selections. For example, when a selection is being performed, should previously selected objects be unselected, or should the newly selected object be appended to the original selection? The *SelectionEnvironment* object provides much more, including the default color all selections are drawn in. The one exception is the dominant element selection color.

A *SelectionEnvironment* object is automatically created by the *Application* object when the application starts. You may want to create your own *SelectionEnvironment* object if you want to perform a selection without changing the application's selection environment. Access to the *Application* object's *SelectionEnvironment* is through *IMxApplication::SelectionEnvironment*. This property is read-only; you cannot substitute the *Application* object's *SelectionEnvironment* object with another.

The code below changes the default selection color to red; the default is cyan.

```
Public Sub ChangeDefaultSelectionColor()
  Dim pMxDoc As IMxDocument
  Dim pMxApp As IMxApplication
  Dim pSelectionEnv As ISelectionEnvironment
  Dim pRgbColor As IRgbColor

  Set pMxApp = Application 'QI
  Set pMxDoc = Application.Document

  'Obtain a reference to the application's selection environment
  Set pSelectionEnv = pMxApp.SelectionEnvironment

  'Change the selection color to red
  Set pRgbColor = New RgbColor
  pRgbColor.Red = 255
  Set pSelectionEnv.DefaultColor = pRgbColor
End Sub
```



ISelectionEnvironment : IUnknown	Provides access to members that control the selection environment.
■—■ AreaSearchDistance: Double	Distance used for selecting areas by proximity.
■—■ AreaSelectionMethod: esriSpatialRelEnum	Selection method used for areas.
■—■ CombinationMethod: esriSelectionResultEnum	Combination method for the selection results.
■—□ DefaultColor: IColor	Search tolerance in device units.
■—■ LinearSearchDistance: Double	Distance used for selecting lines by proximity.
■—■ LinearSelectionMethod: esriSpatialRelEnum	Selection method used for lines.
■—■ PointSearchDistance: Double	Distance used for selecting points by proximity.
■—■ PointSelectionMethod: esriSpatialRelEnum	Selection method used for points.
■—■ SearchTolerance: Long	Search tolerance in device units.

The *ISelectionEnvironment* interface is the primary interface the *SelectionEnvironment* object implements; the *SelectionEnvironment* object also provides defaults for the various types of selections made, including the combination method, selection color, selection method, and search tolerance. The *MxDocument*'s *SearchTolerance* property is a shortcut to the *SearchTolerance* property on the *Application*'s *SelectionEnvironment* object.

This code sample selects features based on the mouse down point location.

To use this sample, add a new UIToolControl *onto a toolbar and paste this code into its mouse down event. Completely close VBA so that mouse events will fire. Select the tool and click the focus map to select features.*

```
Private Sub UIToolControl1_MouseDown(ByVal button As Long, _
   ByVal shift As Long, ByVal x As Long, ByVal y As Long)
  Dim pMxApp As IMxApplication
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pActiveView As IActiveView
  Dim pEnvelope As IEnvelope

  Set pMxApp = Application
  Set pMxDoc = Application.Document

  Set pMap = pMxDoc.FocusMap
  Set pActiveView = pMap

  Set pEnvelope = pMxDoc.CurrentLocation.Envelope
  pEnvelope.Expand pMxDoc.SearchTolerance, _
    pMxDoc.SearchTolerance, False

  'Refresh the old selection to erase it
  pActiveView.PartialRefresh esriViewGeoSelection, Nothing, Nothing

  'Perform the selection using a point created on mouse down
  pMap.SelectByShape pEnvelope, pMxApp.SelectionEnvironment, True

  'Refresh again to draw the new selection
  pActiveView.PartialRefresh esriViewGeoSelection, Nothing, Nothing
End Sub
```

Enumeration esriSelectionResultEnum	***Selection result options.***
0 - esriSelectionResultNew	*Creates a new selection.*
1 - esriSelectionResultAdd	*Adds to the current selection.*
2 - esriSelectionResultSubtract	*Subtracts from the current selection.*
3 - esriSelectionResultAnd	*Selects from the current selection.*
4 - esriSelectionResultXOR	*Performs an 'exclusive or' with the current selection.*

The *esriSelectionResultEnum* enumeration is used by *CombinationMethod* to specify the combination method when a new selection is being created. The default is to always create a new selection, but often you need to add new features to the current selection. To do this, change *ISelectionEnvironment::CombinationMethod* to *esriSelectionResultAdd* before performing the selection.

ISelectionEnvironmentStorage : IUnknown	Provides access to members that controls whether objects save their selections.
■—■ SaveSelections: Boolean	Indicates if objects save their selections.

The *ISelectionEnvironmentStorage* interface has one property, *SaveSelections*, that specifies whether each layer's current selection will be saved with the document or not. This property is set to *True* by default.

This interface is not automatically checked when creating a selection; instead, when creating a custom selection tool, you can optionally check the properties in the interface and determine, on your own, if a warning message should be displayed. For example, the ArcMap Select All *command uses this interface, but the* Select Features *tool does not.*

ISelectionEnvironmentThreshold : IUnknown	Provides access to members that control the selection environment warning threshold.
■—■ ShowSelectionWarning: Boolean	Indicates if warnings are displayed when the record count exceeds the selection warning threshold.
■—■ WarningThreshold: Long	Threshold (number of records), above which selection warnings may be shown.

The *ISelectionEnvironmentThreshold* interface holds properties that some selection tools use to determine if a warning should be displayed if the number of records reaches a certain threshold when performing large selections.

Each view has a ScreenDisplay *object that performs drawing operations. The* ScreenDisplay *object also makes it possible for clients to create any number of caches. A cache is an off-screen bitmap representing the application's window. Instead of drawing directly to the screen, graphics are drawn into caches, then the caches are drawn on the screen. When the application's window is obscured and requires redrawing, it is done so from the caches instead of the database. In this way, caches improve drawing performance—bitmap rendering is faster than reading and displaying data from a database.*

In general, the *Map* creates three caches: one for all the layers, another for any annotation or graphics, and a third for any feature selections. A layer can create its own private cache if it sets *ILayer::Cached* equal to *True*. In this case, the *Map* will create a separate cache for the layer and groups the layers above and below it into different caches.

IActiveView::PartialRefresh uses its knowledge of the cache layout to invalidate as little as possible. *IActiveView::Refresh*, on the other hand, invalidates all the caches (which is inefficient). Use *PartialRefresh* whenever possible.

Both *PartialRefresh* and *Refresh* call *IScreenDisplay::Invalidate*; this sets a flag clients watch for. Clients draw a cache from scratch (the database) if its flag is set to *True*, and from cache if its flag is set to *False*.

This table shows the phases each view supports and what they map to.

Phase	Map	Layout
esriViewBackground	unused	page/snap grid
esriViewGeography	layers	unused
esriViewGeoSelection	feature selection	unused
esriViewGraphics	labels/graphics	graphics
esriViewGraphicSelection	graphic selection	element selection
esriViewForeground	unused	snap guides

Multiple draw phases may be or'd together. For example, this code specifies a phase of 6 to invalidate the geography (2) and the geo selection (4).

```
pActiveView.PartialRefresh esriViewGeography + _
  esriViewGeoSelection, Nothing, Nothing
```

which is the same as:

```
pActiveView.PartialRefresh 6, Nothing, Nothing
```

Use the data parameter to invalidate just a specific piece of data. For example, if a layer is loaded and its cache property is set to *True*, this layer alone can be invalidated. A tracking layer is a good example of this.

The rectangle parameter specifies a region to invalidate. For example, if a graphic element is added, it is usually only necessary to invalidate the immediate area surrounding the new graphic. Both the data and rectangle parameters are optional.

Here are several Visual Basic examples in ArcMap:

refresh layer	`pActiveView.PartialRefresh esriViewGeography, pLayer, Nothing`
refresh all layers	`pActiveView.PartialRefresh esriViewGeography, Nothing, Nothing`
refresh selection	`pActiveView.PartialRefresh esriViewGeoSelection, Nothing, Nothing`
refresh labels	`pActiveView.PartialRefresh esriViewGraphics, Nothing, Nothing`

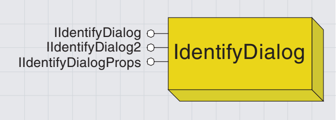
Below are several Visual Basic examples in *PageLayout*.

refresh element	`pActiveView.PartialRefresh esriViewGraphics, pElement, Nothing`
refresh all elements	`pActiveView.PartialRefresh esriViewGraphics, Nothing, Nothing`
refresh selection	`pActiveView.PartialRefresh esriViewGraphicSelection, Nothing, Nothing`

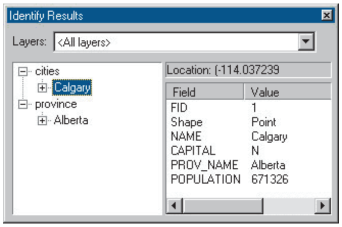
When using *PartialRefresh*, it is often necessary that you call it twice if more than one region on the display is being worked with. For example, when moving features, you must invalidate the original area the features were in as well as the new area to wihch the features have moved. A similar and more common case is working with selections. Whenever a new selection is created, you must call *PartialRefresh* twice, once to invalidate the old selection and again to invalidate the new selection. The following VBA code excerpt shows an example of this. This code has been taken from a *UIToolControl* that selects features.

```
Private Sub UIToolControl1_MouseDown(ByVal button As Long, _
    ByVal shift As Long, ByVal x As Long, ByVal y As Long)
  Dim pMxApp As IMxApplication
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pActiveView As IActiveView
  Dim pRubberEnv As IRubberBand
  Dim pEnvelope As IEnvelope

  Set pMxApp = Application 'QI
  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pActiveView = pMap 'QI
  Set pRubberEnv = New RubberEnvelope

  'Flag the area of the old selection to invalidate
  pActiveView.PartialRefresh esriViewGeoSelection, Nothing, Nothing

  'Use TrackNew to prompt user to drag out a square on the display
  Set pEnvelope = pRubberEnv.TrackNew(pActiveView.ScreenDisplay, _
    Nothing)

  'Perform the selection
  pMap.SelectByShape pEnvelope, pMxApp.SelectionEnvironment, False

  'Flag the area of the new selection to invalidate
  pActiveView.PartialRefresh esriViewGeoSelection, Nothing, Nothing
End Sub
```

PartialRefresh just flags an area on the display that needs invalidating. The invalidatation doesn’t immediately occur when *PartialRefresh* is called. Instead, a Windows flag is set, and only when Windows processes its message loop (after a routine like the one above is executed) does the actual invalidation occur. So, in the above example, calling *PartialRefresh* twice in a single routine simply tells Windows that there are two areas on the selection cache (bitmap) that require invalidating—the bounds of the old selection and the new selection.



IdentifyDialog is the dialog box for quickly querying data attributes.



Identify Results

Layers: <All layers>

- cities
  - Calgary
- province
  - Alberta

Location: (-114.037239

Field	Value
FID	1
Shape	Point
NAME	Calgary
CAPITAL	N
PROV_NAME	Alberta
POPULATION	671326

The Identify Results dialog box in ArcMap

Identifying features, raster cells, and so on, is simplified by the *IdentifyDialog* object. The *IdentifyDialog* object automatically performs a search on all the layers specified and populates a standard dialog box with the search results. This object makes identification easier because you don't have to manually call *IIdentify::Identify* on each desired layer—the *IdentifyDialog* does this automatically and populates the results in a standard dialog box.

To use the *IdentifyDialog* object, you must cocreate a new instance of it and set several of its properties—this hooks it up to the current application. The object is global, however, if an instance has already been created for the application. In this case, cocreating a new one really finds the one already available. It is important to remember that only one Identify dialog box may be opened per session in ArcMap.

IIdentifyDialog : IUnknown	Provides access to members that control Identifying layers by OID or a point.
Display: IDisplay	*The display.*
Map: IMap	*The map of identifying layers.*
AddLayerIdentifyOID (in pLayer: ILayer, in OID: Long)	*Add layer and show object of the given OID.*
AddLayerIdentifyPoint (in pLayer: ILayer, in X: Long, in Y: Long)	*Add layer and show objects that contain the given point.*
ClearLayers	*Clear shown layers.*
Show	*Show dialog.*

The primary interface on the *IdentifyDialog* object is the *IIdentifyDialog*. There are two properties, *Display* and *Map,* which must be set before the object can be used. These properties tie the object to the current application, enabling it to perform searches. Typically, the *Map* property is set to the document's focus map (*IMxDocument::FocusMap*), and the *Display* property is set to the focus map's *ScreenDisplay* object.

Features, rasters, and others are identified as they are added to the *IdentifyDialog* object. There are two methods for adding layers: *AddLayerIdentifyOID* and *AddLayerIdentifyPoint*. The first method searches for features based on a specific objectID (OID), and the latter searches for features based on an x,y location.

IIdentifyDialogProps : IUnknown	Provides access to members that control Identify dialog properties.
FlashEffect: Integer	*The flash effect.*
Layers: IEnumLayer	*The layers eligible for searching.*
TopmostOnly: Boolean	*Indicates if the search stops once a result has been found.*

The *IdentifyDialog* object additionally implements *IIdentifyDialogProps*.

The primary member of this interface is the *Layers* property, which provides a list of all the layers in the *Map* specified to *IIdentifyDialog::Map*.

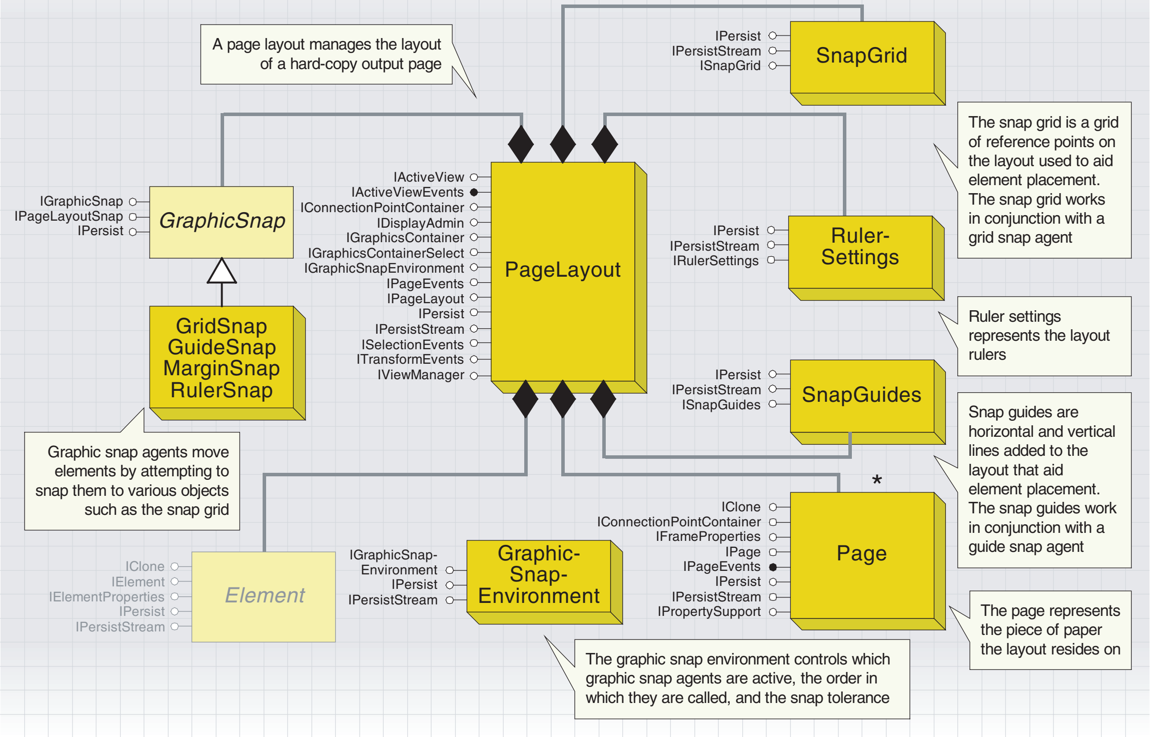
The *TopmostOnly* property is used internally by *IIdentifyDialog::AddLayerIdentifyPoint*. When set to *True*, the default, *AddLayerIdentifyPoint*, searches for features only in the top map layer. The only way to change this property is to change it in the Layers combo box on the Identify dialog box. You cannot programmatically set this beforehand. The dropdown combo box has choices for specific layers, all visible layers, topmost layer, and all selectable layers.

The *FlashEffect* property is currently not implemented.

The script below searches from features around an input x,y location coming from a *UIToolControl*'s mouse down event.

```
Private Sub UIToolControl1_MouseDown(ByVal button As Long, _
   ByVal shift As Long, ByVal x As Long, ByVal y As Long)
  Dim pMxDoc As IMxDocument
  Dim pActiveView As IActiveView
  Dim pIdentifyDialog As IIdentifyDialog
  Dim pIdentifyDialogProps As IIdentifyDialogProps
  Dim pEnumLayer As IEnumLayer
  Dim pLayer As ILayer

  Set pMxDoc = Application.Document
  Set pActiveView = pMxDoc.FocusMap

  'Create a new IdentifyDialog and associate it
  'with the focus map and the map's display
  Set pIdentifyDialog = New IdentifyDialog
  Set pIdentifyDialogProps = pIdentifyDialog 'QI
  Set pIdentifyDialog.Map = pMxDoc.FocusMap
  Set pIdentifyDialog.display = pActiveView.ScreenDisplay

  'Clear the dialog on each mouse click
  pIdentifyDialog.ClearLayers

  'Perform an identify on all of the layers the dialog
  'says are searchable
  Set pEnumLayer = pIdentifyDialogProps.Layers
  pEnumLayer.Reset
  Set pLayer = pEnumLayer.Next

  Do While Not pLayer Is Nothing
    pIdentifyDialog.AddLayerIdentifyPoint pLayer, x, y
    Set pLayer = pEnumLayer.Next
  Loop

  pIdentifyDialog.Show

End Sub
```

ArcMap page layout objects



A page layout manages the layout of a hard-copy output page

The snap grid is a grid of reference points on the layout used to aid element placement. The snap grid works in conjunction with a grid snap agent

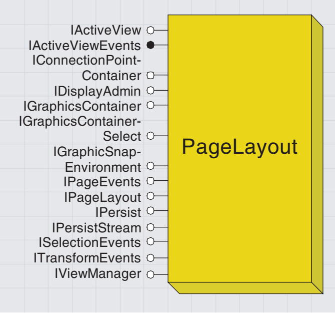
Ruler settings represents the layout rulers

Snap guides are horizontal and vertical lines added to the layout that aid element placement. The snap guides work in conjunction with a guide snap agent

Graphic snap agents move elements by attempting to snap them to various objects such as the snap grid

The page represents the piece of paper the layout resides on

The graphic snap environment controls which graphic snap agents are active, the order in which they are called, and the snap tolerance



The page layout manages the layout of a hardcopy output page. The view the page layout draws in the main application window depicts exactly what gets printed. A page layout typically consists of one or more maps, graphics, and a title. It facilitates the creation and management of these parts of a map.

The *PageLayout* object corresponds to the ArcMap layout view. A *PageLayout* object is automatically created by the document when you first start ArcMap. Access the ArcMap *PageLayout* object via *IMxDocument::PageLayout*. This property is read–write; you can instantiate your own *PageLayout* object and swap out the documents' existing *PageLayout*.

The *PageLayout* object is very similar to the *Map* object. Both are views, meaning they take control of the main application window; both are also graphics containers, meaning they can store graphical elements. If there is no map activated in layout view (*IMxDocument::ActivatedView*), all new graphic elements are added to the *PageLayout*. If a *Map* is activated, graphic elements are added to the focus map (*IMxDocument::FocusMap*). Although both the *PageLayout* and *Map* objects are graphics containers, the type of graphics they store is different. The *PageLayout* can additionally store frame elements such as a *MapFrame*, and both can store graphic elements, such as a *TextElement*.

Although the map document (*MxDocument*) can pass a reference to the focus map and the entire collection of maps in the document, the *PageLayout* object really manages all *Map* objects via *MapFrame* objects. In ArcMap, all *Maps* must be contained by a *MapFrame* element, which is directly managed by the *PageLayout*. It is only for convenience that map documents are able to pass a reference to *Maps*.

In order to present itself as a hardcopy output page, the *PageLayout* automatically creates these objects: *SnapGuides*, *SnapGrid*, *RulerSettings*, and *Page*.

The PageLayout *object also implements* IActiveView, *which, like the* Map *class, you interact with to control the extents that are being viewed. But unlike the* Map*'s active view, the reference system is in page units. Hence, all graphic elements are positioned in page units.*

IPageLayout : IUnknown	*Provides access to members that control the Page Layout.*
AlignToMargins: Boolean	*Indicates if graphics will be aligned to the margins or to each other.*
HorizontalSnapGuides: ISnapGuides	*The horizontal snapping guides.*
Page: IPage	*The page.*
RulerSettings: IRulerSettings	*The ruler settings.*
SnapGrid: ISnapGrid	*The snapping grid.*
VerticalSnapGuides: ISnapGuides	*The vertical snapping guides.*
ZoomPercent: Double	*The current zoom percent. 100 means 1:1. 200 means twice normal size, etc.*
FocusNextMapFrame	*Focus the next map.*
FocusPreviousMapFrame	*Focus the previous map.*
ReplaceMaps (in Maps: IMaps)	*Replace the maps in the data frames with the specified maps. If there are more maps than frames, new frames are created. If there are fewer frames than maps, extra frames are cleared.*
ZoomToPercent (in percent: Long)	*Magnify the page by a certain percentage. 100 means actual size. 200 means twice normal size, etc.*
ZoomToWhole	*Fit the whole page in the window.*
ZoomToWidth	*Fit the width of the page to the screen.*

The *IPageLayout* interface is the primary interface implemented by the *PageLayout* object. Use this interface to access the *RulerSettings*, the *SnapGrid*, the *SnapGuides*, and the *Page* objects. *IPageLayout* also has methods for zooming the view and changing the focus map. This code demonstrates zooming.

```
Public Sub ZoomToPercent()
  Dim pPageLayout As IPageLayout
  Dim pMxDoc As IMxDocument
  Set pMxDoc = Application.Document
  Set pPageLayout = pMxDoc.PageLayout
  'Ensure the application is in layout view
  If Not pMxDoc.ActiveView Is pMxDoc.PageLayout Then
    Set pMxDoc.ActiveView = pMxDoc.PageLayout
  End If
  pPageLayout.ZoomToPercent 50  'Zoom the view to 50%
End Sub
```

IGraphicsContainer : IUnknown	Provides access to members that control the Graphics Container.
← AddElement (in Element: IElement, in zorder: Long)	Add a new graphic element to the layer.
← AddElements (in Elements: IElementCollection, in zorder: Long)	Add new graphic elements to the layer.
← BringForward (in Elements: IEnumElement)	Move the specified elements one step closer to the top of the stack of elements.
← BringToFront (in Elements: IEnumElement)	Make the specified elements draw in front of all other elements.
← DeleteAllElements	Delete all the elements.
← DeleteElement (in Element: IElement)	Delete the given element.
← FindFrame (in frameObject: Variant) : IFrameElement	Find the frame that contains the specified object.
← GetElementOrder (in Elements: IEnumElement) : Variant	Private order object. Used to undo ordering operations.
← LocateElements (in Point: IPoint, in Tolerance: Double) : IEnumElement	Returns the elements at the given coordinate.
← LocateElementsByEnvelope (in Envelope: IEnvelope) : IEnumElement	Returns the elements that intersect with the given envelope.
← MoveElementFromGroup (in Group: IGroupElement, in Element: IElement, in zorder: Long)	Move the element from the group to the container.
← MoveElementToGroup (in Element: IElement, in Group: IGroupElement)	Move the element from the container to the group.
← Next: IElement	Returns the next graphic in the container.
← PutElementOrder (in order: Variant)	Private order object. Used to undo ordering operations.
← Reset	Reset internal cursor so that Next returns the first element.
← SendBackward (in Elements: IEnumElement)	Move the specified elements one step closer to the bottom of the stack of elements.
← SendToBack (in Elements: IEnumElement)	Make the specified elements draw behind all other elements.
← UpdateElement (in Element: IElement)	The graphic element's properties have changed.

IGraphicsContainer provides access to the *PageLayout* object's graphic elements. Use this interface to add new elements or access existing ones. For example, a title at the top of a layout is a *TextElement* stored in the layout's graphics container.

The script below shows one method for adding a new text element onto the page layout. In this example, a *UIToolControl* is used to get a mouse down event so users can place the text element anywhere they desire on the page layout. The script will only add a new element if ArcMap is in layout view.

```
Private Sub UIToolControl1_MouseDown(ByVal button As Long, _
    ByVal shift As Long, ByVal x As Long, ByVal y As Long)
  Dim pMxDoc As IMxDocument
  Dim pPageLayout As IPageLayout
  Dim pActiveView As IActiveView
  Dim pGraphicsContainer As IGraphicsContainer
  Dim pTextElement As ITextElement
  Dim pElement As IElement
  Dim pPoint As IPoint

  Set pMxDoc = Application.Document
  Set pPageLayout = pMxDoc.PageLayout
  Set pActiveView = pPageLayout 'QI
  Set pGraphicsContainer = pPageLayout 'QI

  'Check that ArcMap is in layout view
  If Not TypeOf pMxDoc.ActiveView Is IPageLayout Then
    MsgBox "Tool works only in layout view"
    Exit Sub
  End If

  Set pTextElement = New TextElement
  Set pElement = pTextElement 'QI
  'Create a point from the x,y coordinate parameters
  Set pPoint = _
   pActiveView.ScreenDisplay.DisplayTransformation.ToMapPoint(x,y)
  pTextElement.Text = "My Map"
  pElement.Geometry = pPoint
  pGraphicsContainer.AddElement pTextElement, 0

  'Refresh only the pagelayout's graphics
  pActiveView.PartialRefresh esriViewGraphics, Nothing, Nothing
End Sub
```

This script moves all the elements in the layout one inch to the right:

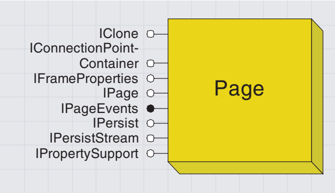
```
Public Sub MoveAllElements()
  Dim pMxDoc As IMxDocument
  Dim pPageLayout As IPageLayout
  Dim pActiveView As IActiveView
  Dim pGraphicsContainer As IGraphicsContainer
  Dim pElement As IElement
  Dim pTransform2D As ITransform2D

  Set pMxDoc = Application.Document
  Set pPageLayout = pMxDoc.PageLayout
  Set pActiveView = pPageLayout 'QI
  Set pGraphicsContainer = pPageLayout 'QI

  'Loop through all the elements and move each one 1 inch
  pGraphicsContainer.Reset
  Set pElement = pGraphicsContainer.Next
  Do While Not pElement Is Nothing
    Set pTransform2D = pElement
    pTransform2D.Move 1, 0
    Set pElement = pGraphicsContainer.Next
  Loop

  'Refresh only the pagelayout's graphics
  pActiveView.PartialRefresh esriViewGraphics, Nothing, Nothing
End Sub
```

IGraphicsContainerSelect : IUnknown	Provides access to members that control graphic container selection.
■–□ DominantElement: IElement	Dominant element.
■– ElementSelectionCount: Long	Returns the number of selected elements.
■– SelectedElements: IEnumElement	Returns the selected elements.
■– SelectionBounds (in Display: IDisplay) : IEnvelope	Returns the bounds of the selection.
← ElementSelected (in Element: IElement) : Boolean	Indicates if the element is selected.
← SelectAllElements	Selects all elements.
← SelectedElement (in Index: Long) : IElement	Returns the nth selected element. Use Selection count to get the number of selected elements.
← SelectElement (in Element: IElement)	Selects the specified element.
← SelectElements (in Elements: IEnumElement)	Selects the specified elements.
← SelectionTracker (in Index: Long) : ISelectionTracker	Returns the tracker for the nth selected element. Use Selection count to get the number of selected elements.
← UnselectAllElements	Unselects all elements.
← UnselectElement (in Element: IElement)	Unselects the specified element.
← UnselectElements (in Elements: IEnumElement)	Unselects the specified elements.

Most objects that are graphics containers, such as *PageLayout* and *Map*, implement the *IGraphicsContainerSelect* interface to expose additional members for managing their element selection. For example, *IGraphicsContainerSelect::UnselectAllElements* can be used to clear an object's graphic element selection.

The following simple VBA example returns the number of elements currently selected in the focus *Map* and the *PageLayout*:

```
Public Sub GraphicSelectionCount()
  Dim pMxDocument As IMxDocument
  Dim pMap As IMap
  Dim pPageLayout As IPageLayout
  Dim pMapGraphicsSelect As IGraphicsContainerSelect
  Dim pPageLayoutGraphicsSelect As IGraphicsContainerSelect

  Set pMxDocument = Application.Document
  Set pMap = pMxDocument.FocusMap
  Set pPageLayout = pMxDocument.PageLayout
  Set pMapGraphicsSelect = pMap
  Set pPageLayoutGraphicsSelect = pPageLayout
  MsgBox pMapGraphicsSelect.ElementSelectionCount
  MsgBox pPageLayoutGraphicsSelect.ElementSelectionCount
End Sub
```



The page represents the piece of paper on which the layout resides. The page has many properties, including color, size, and orientation.

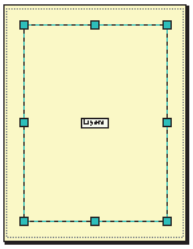
The *PageLayout* object automatically creates a *Page* object to manage the page of paper on which the layout resides. Aside from color, size, and orientation, the *Page* object manages additional layout properties, such as page units, border style, and printable bounds. Access the *PageLayout*'s *Page* object via *IPageLayout::Page*.

IPage : IUnknown	**Provides access to members that control the Page.**
Background: IBackground	*The page background.*
BackgroundColor: IColor	*The page color.*
Border: IBorder	*The page border.*
DelayEvents: Boolean	*Indicates if the page stops firing IPageEvents until the flag is set to false.*
FormID: esriPageFormID	*The Page form.*
IsPrintableAreaVisible: Boolean	*Indicates if the printable area is visible.*
Orientation: Integer	*The Page orientation. 1 = portrait. 2 = landscape.*
PageToPrinterMapping: esriPageToPrinterMapping	*The page to printer mapping.*
PrintableBounds: IEnvelope	*The printable bounds.*
StretchGraphicsWithPage: Boolean	*Indicates if graphics should stretch with the page when the page size changes.*
Units: esriUnits	*The units used for the page and all associated coordinates.*
DrawBackground (in Display: IDisplay)	*Draw the page background.*
DrawBorder (in Display: IDisplay)	*Draw the page border.*
DrawPaper (in Display: IDisplay, in eraseColor: IColor)	*Draw the paper. EraseColor is the color of the area surrounding the page. Only the area around the page is drawn in order to eliminate flashing. Use EraseColor = 0 to simply draw page.*
DrawPrintableArea (in Display: IDisplay)	*Draw the printable area.*
GetDeviceBounds (in Printer: IPrinter, in currentPage: Integer, in Overlap: Double, in Resolution: Integer, in deviceBounds: IEnvelope)	*The number of printer pages spanned by the page.*
GetPageBounds (in Printer: IPrinter, in currentPage: Integer, in Overlap: Double, in pageBounds: IEnvelope)	*The number of printer pages spanned by the page.*
PrinterChanged (in Printer: IPrinter)	*Called by PageLayout when printer changes.*
PrinterPageCount (in Printer: IPrinter, in Overlap: Double, out pageCount: Integer)	*The number of printer pages spanned by the page.*
PutCustomSize (in Width: Double, in Height: Double)	*The size of the page in page units.*
QuerySize (out Width: Double, out Height: Double)	*The size of the page in page units.*

IPage is the primary interface on the *Page* object. Use this interface to access all of the properties of an ArcMap page, including the page's border, background, background color, orientation, and size.

This code checks the current page size and, if it is 8.5" x 11", changes it to 5" x 5".

```
Public Sub CheckPageSize()
  Dim pMxDoc As IMxDocument
  Dim pPage As IPage
  Dim dHeight As Double
  Dim dWidth As Double

  Set pMxDoc = Application.Document
  Set pPage = pMxDoc.PageLayout.Page
  pPage.QuerySize dWidth, dHeight
  If dWidth = 8.5 And dHeight = 11 Then
    pPage.PutCustomSize 5, 5
  End If
End Sub

Public Sub ChangePageColor()
  Dim pMxDoc As IMxDocument
```



This code changes the page color to yellow.

```
  Dim pPage As IPage
  Dim pColor As IColor
  Dim pRgbColor As IRgbColor

  Set pMxDoc = Application.Document
  Set pPage = pMxDoc.PageLayout.Page
  Set pRgbColor = New RgbColor
  pRgbColor.Blue = 204
  pRgbColor.Red = 255
  pRgbColor.Green = 255
  pPage.BackgroundColor = pRgbColor
End Sub
```

Enumeration esriPageFormID	*Forms support in Page.*
0 - esriPageFormLetter	*Letter - 8.5in x 11in.*
1 - esriPageFormLegal	*Legal - 8.5in x 14in.*
2 - esriPageFormTabloid	*Tabloid - 11in x 17in.*
3 - esriPageFormC	*C - 17in x 22in.*
4 - esriPageFormD	*D - 22in x 34in.*
5 - esriPageFormE	*E - 34in x 44in.*
6 - esriPageFormA5	*Metric A5 - 148mm x 210mm.*
7 - esriPageFormA4	*Metric A4 - 210mm x 297mm.*
8 - esriPageFormA3	*Metric A3 - 297mm x 420mm.*
9 - esriPageFormA2	*Metric A2 - 420mm x 594mm.*
10 - esriPageFormA1	*Metric A1 - 594mm x 841mm.*
11 - esriPageFormA0	*Metric A0 - 841mm x 1189mm.*
12 - esriPageFormCUSTOM	*Custom Page Size.*
13 - esriPageFormSameAsPrinter	*Page Form same as Printer Form.*

The *esriPageFormID* enumeration provides a convenient list of preselected page sizes for use by the *Page* object. For example, to change the layout to standard legal page size, pass in *esriPageFormLegal* to *IPage::FormID*. This is much quicker than setting a custom size with *IPage::PutCustomSize*.

One important element in this enumeration is *esriPageFormSameAsPrinter*. When the *FormID* property has been set to this element, the layout's page size mimics the page size of the printer; whenever the printer page size changes, the layout's page size changes to match it. You can see this behavior in the ArcMap application on the Page Setup dialog box accessed from the File menu. Click the File menu and click Page Setup. If the Same as Printer check box is checked, the map setup will change to reflect any changes to the printer setup.

This sample uses the esriPageFormID enumeration to quickly change the page size.

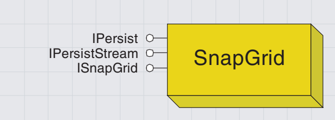
```
Public Sub SetLegalPageSize()
  Dim pMxDoc As IMxDocument
  Dim pPageLayout As IPageLayout
  Dim pPage As IPage
  Dim x As Double, y As Double

  Set pMxDoc = Application.Document
  Set pPageLayout = pMxDoc.PageLayout
  Set pPage = pPageLayout.Page
  pPage.FormID = esriPageFormLegal
  pPage.QuerySize x, y
  MsgBox x & "  " & y
End Sub
```

Enumeration esriPageToPrinterMapping	*Page to Printer Mapping.*
0 - esriPageMappingCrop	*Crop Page to Printer.*
1 - esriPageMappingScale	*Scale Page to Printer.*
2 - esriPageMappingTile	*Tile Page to Printer.*

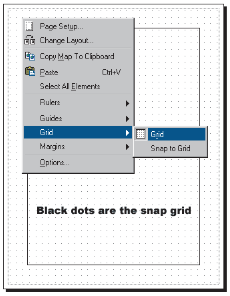
The *esriPageToPrinterMapping* enumeration tells the *Page* what to do when the layout's page size does not match the printer's page size. This is often the case when *IPage::FormID* is set to something other than *esriPageFormSameAsPrinter*. By default, ArcMap crops the page, but you can choose to either scale the page or tile it. In the ArcMap application, you can see these choices on the Print dialog box.

IPageEvents : IUnknown	*Provides access to events that occur when the Page changes.*
← PageColorChanged	*Fired when the page color changes.*
← PageMarginsChanged	*Fired when the page margins change.*
← PageSizeChanged	*Fired when the page size changes.*
← PageUnitsChanged	*Fired when the units used by the page changes.*

The *Page* object is the event source for page events. Page events are fired by the *Page* object to notify all clients that certain aspects of the page have changed. The page events are grouped under the *IPageEvents* interface and are *PageColorChanged, PageMarginsChanged, PageSizeChanged,* and *PageUnitsChanged*. Within ArcMap, there is only one client—the *PageLayout* object—listening for these events. The *PageLayout* object listens for these events so it can modify its layout according to changes made to its page. For example, when the page units are changed, the page layout needs to update its transformation, update the snap tolerance and snap grid, update its snap guides, and convert its graphics to the new units.



The layout view supports a snap grid, which is a grid of reference points on the layout used to help position elements. The grid may be used as a visual indicator of size and position, or it may be used to snap elements into position.



This image shows the snap grid.

In layout view, right-click the screen and click Grid. This lets you show or hide the snap grid, as well as enable or disable snapping to the grid. The *SnapGrid* object represents the snap grid. Although this object is cocreatable, there is generally no need to create one as the *PageLayout* object automatically creates one when it is created. Use *IPageLayout::SnapGrid* to get a reference to the snap grid currently associated with the layout view.

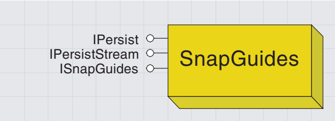
For information about enabling and disabling grid snapping, see the section on graphic snap agents.

The *SnapGrid* implements *IPersist* and *IPersistStream* to save the object's current settings in the current map document.

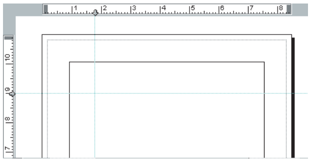
ISnapGrid : IUnknown	***Provides access to members that control the Snapping grid.***
HorizontalSpacing: Double	*The horizontal distance between grid points.*
IsVisible: Boolean	*Indicates if the snapping grid is visible.*
VerticalSpacing: Double	*The vertical distance between grid points.*
Draw (in Display: IDisplay, in Page: IPage)	*Draw the grid.*

The primary interface on the *SnapGrid* object is *ISnapGrid*. Use this interface to change the grid's horizontal and vertical spacing and control whether or not the grid is visible. The sample below changes the snap grid's vertical and horizontal spacing to 0.5 inches and ensures the grid is visible.

```
Public Sub SnapGrid()
  Dim pMxDoc As IMxDocument
  Dim pSnapGrid As ISnapGrid
  Dim pActiveView As IActiveView

  Set pMxDoc = Application.Document
  Set pSnapGrid = pMxDoc.PageLayout.SnapGrid
  pSnapGrid.HorizontalSpacing = 0.5
  pSnapGrid.VerticalSpacing = 0.5
  pSnapGrid.IsVisible = True
  Set pActiveView = pMxDoc.PageLayout
  pActiveView.Refresh
End Sub
```



You can use rulers, guides, and grids in layout view to align elements on the page.



This image shows a vertical and a horizontal snap guide added to the layout.

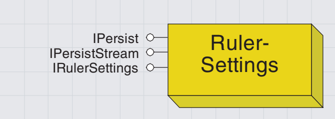
The *PageLayout* object has two *SnapGuides* objects, one for managing horizontal guides, and one for managing vertical guides. Use *IPageLayout::VerticalSnapGuides* or *IPageLayout::HorizontalSnapguides* to obtain a reference to the desired *SnapGuides* object.

Each *SnapGuides* object manages an internal collection of individual guides. For example, the *SnapGuides* object that represents the horizontal snap guides may contain 10 individual guides.

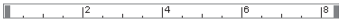
ISnapGuides : IUnknown	*Provides access to members that control the Snapping guides.*
AreVisible: Boolean	*Indicates if snapping guides are visible.*
DrawLevel: tagesriViewDrawPhase	*Level where guides are drawn.*
Guide (in idx: Long) : Double	*The nth guide. The position is specified in page units.*
GuideCount: Long	*The number of guides.*
AddGuide (in pos: Double)	*Adds a guide at the specified position. The position is specified in page units.*
Draw (in Display: IDisplay, in isHorizontal: Boolean)	*Draw a fine line showing exactly where objects will snap.*
DrawHighlight (in Display: IDisplay, in isHorizontal: Boolean)	*Draw a highlight around the snap line for a nice visual effect.*
RemoveAllGuides	*Removes all the guides.*
RemoveGuide (in idx: Long)	*Removes the nth guide.*

Use *ISnapGuides* to add a new guide, remove a guide, and turn the visibility of the guides on or off. The sample below adds a new horizontal guide 5 inches from the bottom of the page and then turns on the horizontal guides' visibility if they are turned off.

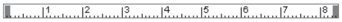
```
Public Sub AddHorizontalSnapGuide()
  'Add a horizontal snap guide 5 inches up the page
  Dim pMxDoc As IMxDocument
  Dim pHorizontalSnapGuides As ISnapGuides
  Dim pActiveView As IActiveView

  Set pMxDoc = Application.Document
  Set pHorizontalSnapGuides = pMxDoc.PageLayout.HorizontalSnapGuides
  pHorizontalSnapGuides.AddGuide 5
  If Not pHorizontalSnapGuides.AreVisible Then
    pHorizontalSnapGuides.AreVisible = True
    Set pActiveView = pMxDoc.PageLayout
    pActiveView.Refresh
  End If
End Sub
```



Rulers show the size of a page and elements on the final printed map.



This image shows the horizontal ruler with the SmallestDivision *property set to 2.*



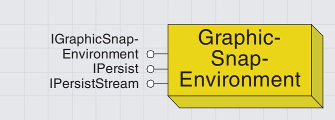
This image shows the same ruler again but with the SmallestDivision *property set to 0.1. Notice that there are now 10 markings between each inch.*

The *PageLayout* object has a *RulerSettings* object that manages the ruler settings. Although this object is cocreatable, there is generally no need to create one because the *PageLayout* object automatically instantiates one when it is created. Use *IPageLayout::RulerSettings* to get a reference to the *RulerSettings* object currently associated with the layout view.

IRulerSettings : IUnknown	***Provides access to members that control Ruler setup.***
▪—▪ SmallestDivision: Double	*The size of the smallest ruler division. The size is in page units.*

The *IRulerSettings* interface only has one property, *SmallestDivision*. This property controls the size of the smallest ruler division in page units. For example, if the page size is 8.5 by 11 inches and the *SmallestDivision* is set to 2, the rulers in layout view will read off every 2 inches. If the property is set to .1, the rulers will read off every 1/10 of an inch.

```
Public Sub ChangeRulerSettings()

  Dim pMxDoc As IMxDocument
  Dim pRulerSettings As IRulerSettings

  Set pMxDoc = Application.Document
  Set pRulerSettings = pMxDoc.PageLayout.RulerSettings
  pRulerSettings.SmallestDivision = 2
  pMxDoc.ActiveView.Refresh
End Sub
```



The graphic snap environment controls which graphic snap agents are active, the order in which they are called, and the snap tolerance.

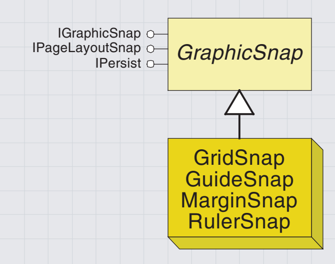
To aid in aligning and positioning elements on a page, the layout view supports element snapping. Elements may be snapped to the snap grid, rulers, guides, and margins. Snapping is performed by a combination of efforts between snapping target objects and snap agents. The snap agents attempt to move a graphic to a position on a snapping target object. The *PageLayout* object manages the snap agents, snapping target objects, and the snapping environment.

The *GraphicSnapEnvironment* object manages the graphic snap agents. This object is cocreatable, but typically this is not necessary because *PageLayout* object automatically creates the object when it itself is created. The *PageLayout* actually aggregates a *GraphicSnapEnvironment* object, making it part of the *PageLayout* object.

To get a reference to the *GraphicSnapEnvironment* associated with the page layout, simply perform a query interface from any of the other interfaces on *PageLayout,* such as *IPageLayout*.

IGraphicSnapEnvironment : IUnknown	***Provides access to members that control the Collection of snap agents used for snapping graphics.***
■— SnapAgent (in Index: Long) : IGraphicSnap	*Get a snap agent. The index argument is zero based.*
■— SnapAgentCount: Long	*The number of snap agents.*
■—■ SnapAgentOrder: IArray	*An array of IDs indicating how agents should be ordered.*
■—■ SnapTolerance: Double	*The snap tolerance in page units.*
← AddSnapAgent (in SnapAgent: IGraphicSnap)	*Add a new snap agent to the environment.*
← ClearSnapAgents	*Remove all snap agents.*
← DeleteSnapAgent (in SnapAgent: IGraphicSnap)	*Remove specified snap agent from the environment.*
← SnapShape (in Shape: IGeometry)	*Snap the shape using the agents in the environment.*

Use the *IGraphicSnapEnvironment* interface to add or delete snap agents and to snap a graphic into place with *SnapShape*. The *SnapShape* method calls each snap agent's snap method until one of them returns *True,* indicating that they have moved the graphic. When a snap agent returns *True*, no other snap agents are called. You can also use the *SnapAgentOrder* property on this interface to control in which order the snap agents are called. With this interface, you can establish a snap agent priority—for example, you may decide snapping to the snap grid is more important than snapping to the page margins.



The grid snap moves graphics to the snap grid. The guide snap moves graphics to the horizontal and vertical guides. The margin snap snaps graphics to the layouts printable bounds. The ruler snap snaps graphics to the rulers.

Rulers, guides, and grids are layout objects that aid in aligning elements on a page. However, these objects are only half the story—there are also snap agents that snap to them. Layout snap agents include *GridSnap, GuideSnap, MarginSnap,* and *RulerSnap*. There is a one-to-one correlation between the snap agents and the objects to which they snap. For example, the *GridSnap* snap agent attempts to snap graphic elements to the snap grid created by the *SnapGrid* object. The exception is the *MarginSnap* snap agent, which simply snaps to the layout's printable bounds (*IPage::PrintableBounds*).

Graphics are snapped into place by calling *IGraphicSnapEnvironment::SnapShape* on the *PageLayout* object. *SnapShape* in turn calls *IGraphicSnap::SnapX* and *IGraphicSnap::SnapY* on each active snap agent (in the order specified by *IGraphicSnapEnvironment::SnapOrder*) until one of the snap agents returns *True,* indicating that a new point has been found that meets the criteria of the snap agent. *SnapX* and *SnapY* are separate calls because some agents, such as guides, may only act in one direction.

GraphicSnap is an abstract class with the interface *IGraphicSnap*, which all graphic snap agents implement.

In ArcMap, a guide snap agent is automatically created and then snaps to vertical and horizontal snap guides. There is no need to create more than one type of snap agent. In ArcMap, you can access the snapping environment and snap agents by right-clicking in the layout view and clicking Options. On the Layout View tab, you can turn snap agents on or off, control the snap agent order, and set the snap tolerance.

IGraphicSnap : IUnknown	***Provides access to members that control snapping graphics.***
■— Name: String	*The name of the snap agent.*
← SnapX (in Shape: IGeometry, in Tolerance: Double) : Boolean	*Indicates if the point is snapped in the horizontal direction.*
← SnapY (in Shape: IGeometry, in Tolerance: Double) : Boolean	*Indicates if the point is snapped in the vertical direction.*

All graphic snap agents implement the *IGraphicSnap* interface. This interface only has three members: *Name, SnapX,* and *SnapY*. *SnapX* and *SnapY* are unique and are used to determine if a graphic can be snapped. For example, the *GridSnap* agent's implementation of *SnapX* for polygon graphics checks if either the *Xmin* or *Xmax* of the graphics bounding rectangle is within snap tolerance of the snap grid. If either is, the graphic is moved the calculated distance between the two. *SnapX* and *SnapY* always return a Boolean, indicating whether or not the graphic was snapped. If any snap agent returns *True*, no other snap agents are called.

IPageLayoutSnap : IGraphicSnap	***Provides access to members that control snap agents that are used with PageLayout.***
—■ PageLayout: IPageLayout	*Sets the PageLayout that this snap agent is associated with.*

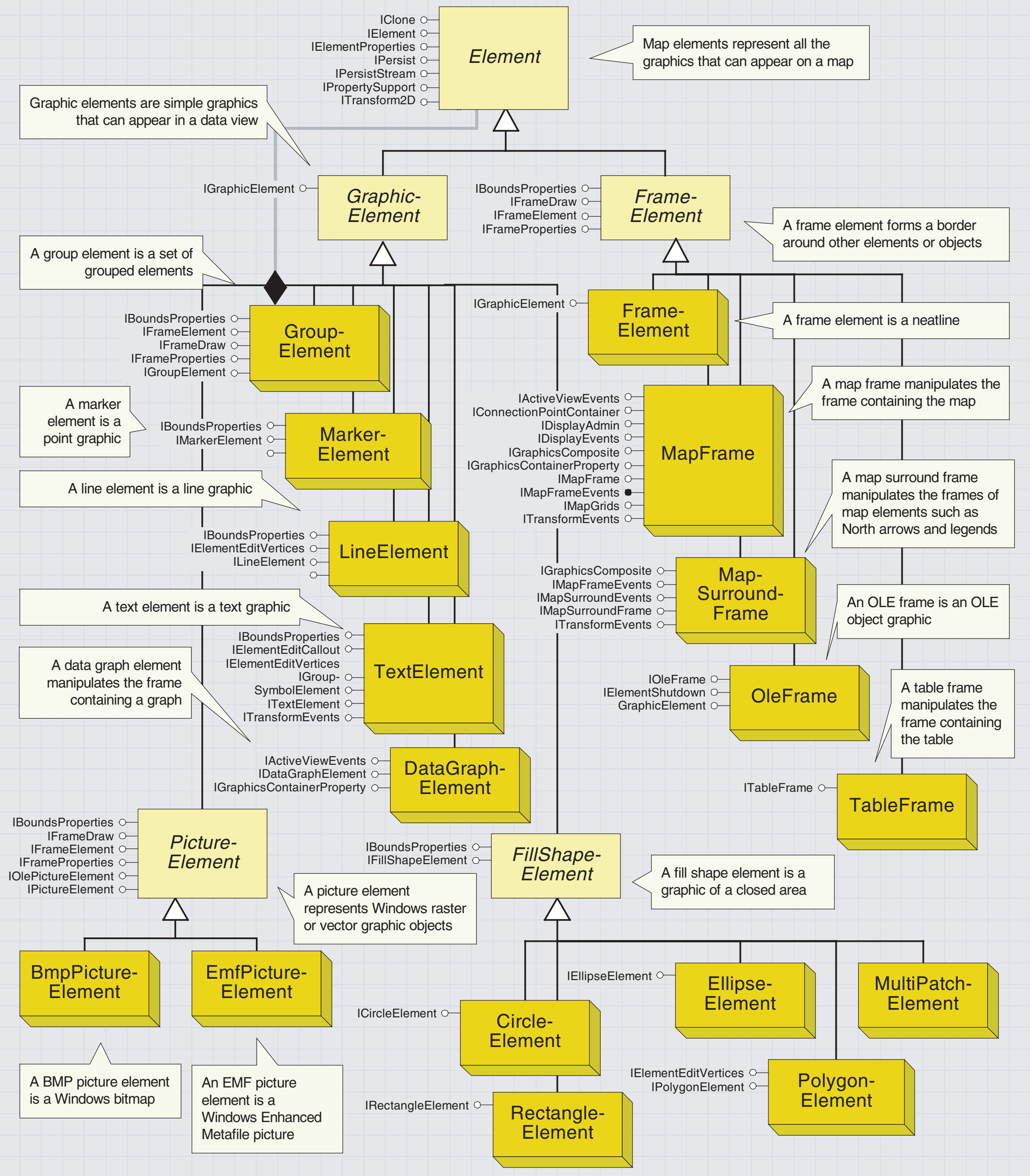
This interface is used to tie the snap agents to the *PageLayout* object. If this property is not set, the graphic snap agents will not work properly.

Because *IPageLayoutSnap* inherits from *IGraphicSnap*, all the methods on *IGraphicSnap* are directly available on *IPageLayoutSnap*.

The following sample demonstrates how a grid snap agent can be added to the layout:

```
Public Sub AddGridSnapAgent()
  Dim pMxDoc As IMxDocument
  Dim pPageLayout As IPageLayout
  Dim pSnapEnv As IGraphicSnapEnvironment
  Dim pPageLayoutSnap As IPageLayoutSnap

  Set pMxDoc = Application.Document
  Set pPageLayout = pMxDoc.PageLayout
  Set pSnapEnv = pPageLayout

  Set pPageLayoutSnap = New GridSnap
  pPageLayoutSnap.PageLayout = pPageLayout
  pSnapEnv.AddSnapAgent pPageLayoutSnap
End Sub
```

ArcMap map element objects



Map elements represent all the graphics that can appear on a map

Graphic elements are simple graphics that can appear in a data view

A frame element forms a border around other elements or objects

A group element is a set of grouped elements

A frame element is a neatline

A map frame manipulates the frame containing the map

A marker element is a point graphic

A line element is a line graphic

A map surround frame manipulates the frames of map elements such as North arrows and legends

A text element is a text graphic

An OLE frame is an OLE object graphic

A data graph element manipulates the frame containing a graph

A table frame manipulates the frame containing the table

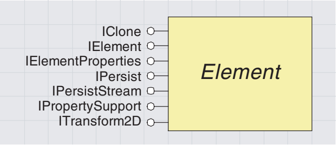
A picture element represents Windows raster or vector graphic objects

A fill shape element is a graphic of a closed area

A BMP picture element is a Windows bitmap

An EMF picture element is a Windows Enhanced Metafile picture

ELEMENT ABSTRACT CLASS



Element *is the abstract class on which all graphic elements and frames are based.*

A map layout and a data frame can both contain elements, but elements are most commonly manipulated as part of a map layout. Elements can basically be thought of as the nonfeature-based components of a map. The list of supported elements includes *FrameElements*, which hold maps; *MapSurroundFrames*, which hold North arrows, scale bar, and so on; and *GraphicElements*, which hold text, line, point, fillshape, and picture elements.

Elements are commonly accessed through the *IGraphicsContainer* interface implemented by the *Map* and *PageLayout* objects. Through this interface you can add, delete, update, and retrieve the individual elements within a *Map* or *PageLayout*. Use the *GroupElement* object to combine multiple elements into a single unit for manipulation by the user.

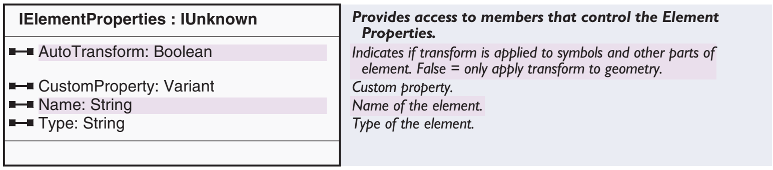
IElement : IUnknown	*Provides access to members that control the Element.*
Geometry: IGeometry	*Shape of the element as a geometry.*
Locked: Boolean	*Indicates if the element is in a read-only state.*
SelectionTracker: ISelectionTracker	*Selection tracker used by this element.*
Activate (in Display: IDisplay)	*Prepare to display graphic on screen.*
Deactivate	*ActiveView that graphics are displayed on is no longer visible.*
Draw (in Display: IDisplay, in trackCancel: ITrackCancel)	*Draws the element into the given display object.*
HitTest (in X: Double, in Y: Double, in Tolerance: Double) : Boolean	*Indicates if the given x and y coordinates are contained by the element.*
QueryBounds (in Display: IDisplay, in Bounds: IEnvelope)	*Bounds of the element taking symbology into consideration.*
QueryOutline (in Display: IDisplay, in Outline: IPolygon)	*Bounds of the element taking symbology into consideration.*

IElement is the generic interface implemented by all graphic elements and frames. Most methods that return graphics (various methods and properties of *IGraphicsContainer* and *IGraphicsContainerSelect*) return them as generic *IElement* objects. *IElement* gives the programmer access to the geometry of the object and employs methods for querying the object and drawing it. It is the programmer's responsibility to determine what type of object is hosting the *IElement* interface by performing a *QI*. In VB, check the elements in a page layout for a *PolygonElement* in the following manner:

```
Dim pDoc As IMxDocument, pPageLayout As IPageLayout
Dim pContainer As IGraphicsContainer, pElement As IElement
Set pDoc = ThisDocument
Set pPageLayout = pDoc.PageLayout
Set pContainer = pPageLayout
pContainer.Reset
Set pElement = pContainer.Next
Do While Not pElement Is Nothing
  If TypeOf pElement Is IPolygonElement Then
    MsgBox "This is a PolygonElement"
  End If
  Set pElement = pContainer.Next
Loop
```

The *SelectionTracker* property will return an *ISelectionTracker*, which can be used to reshape the element. Reshaping of elements is done via handles around the edges of the element. *QueryBounds* and

QueryOutline both require instantiated objects to be passed in. The results of each will be the same for line and point elements, but will vary for polygon elements (*QueryBounds* returns the bounding box, while *QueryOutline* will return an outline of the element).

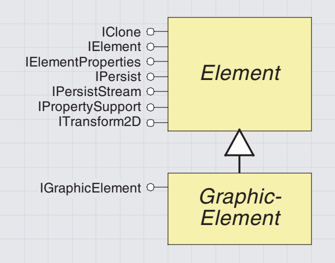


IElementProperties : IUnknown	Provides access to members that control the Element Properties.
AutoTransform: Boolean	Indicates if transform is applied to symbols and other parts of element. False = only apply transform to geometry.
CustomProperty: Variant	Custom property.
Name: String	Name of the element.
Type: String	Type of the element.

IElementProperties is a generic interface implemented by all graphic elements and frames. This interface allows the developer to attach custom properties to an element. The *Name* and *Type* properties allow the developer to categorize their custom properties.

AutoTransform is a Boolean value that indicates whether internal settings should be transformed along with the element's geometry when a transform is applied via *ITransform2D*. For instance, if you have a point element and you rotate it around a central location (the anchor point of the rotation being different from the point element itself), then the *AutoTransform* property is used to determine whether the orientation of the symbol associated to the element should also be rotated by the same amount.

GraphicElement abstract class



Descending from the Element *abstract class,* GraphicElement *objects are elements that work in both a data frame and a map layout. This category of elements includes text, lines, points, polygons, and pictures.*

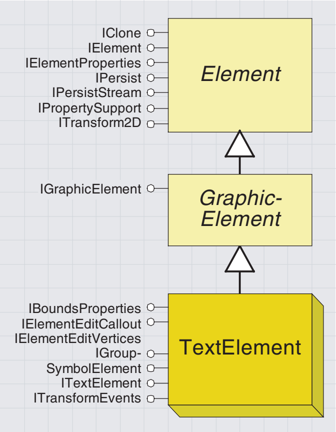
Graphic elements are added to a data frame or map to highlight areas or provide detail beyond that of the geographic features. The process of redlining (marking areas for correction or notification) can be done by adding graphic elements to the map. Annotation, which is used to label features, is unique in that it is both a geographic feature and a graphic element (specifically a *TextElement*). Annotation is added to the map based on attribute values or other text strings.

IGraphicElement : IUnknown	***Provides access to members that control the Graphic Element object.***
■—□ SpatialReference: ISpatialReference	*Spatial reference of the map.*

The *IGraphicElement* interface is a generic interface implemented by all graphic elements. This interface provides access to the spatial reference of the element. The spatial reference of the element reflects its location on the map.

ITransform2D : IUnknown	***Provides access to members that supply an object with Euclidean 2D transformation capabilities.***
← Move (dx: Double, dy: Double)	*Moves the object dx units horizontally and dy units vertically.*
← MoveVector (v: ILine)	*Moves the object defined by a 2D displacement vector.*
← Rotate (Origin: IPoint, RotationAngle: Double)	*Rotates the object about the specified origin point through rotationAngle radians.*
← Scale (Origin: IPoint, sx: Double, sy: Double)	*Scales the object about the specified origin point a factor of sx horizontally and sy vertically.*
← Transform (Direction: tagesriTransformDirection, Transformation: ITransformation)	*Applies an arbitrary transformation.*

The *ITransform2D* interface is implemented by elements and basic geometries (points, polylines, and so on) to aid in the repositioning of objects. This interface allows elements and geometries to be moved, rotated, scaled, and transformed to new locations. It is implemented for graphic elements so that they can move along with the geometries (features) by which they are placed. The *ITransform2D* interface is documented more fully in Volume 2, Chapter 9, 'Shaping features with geometry'.



The TextElement *coclass is a graphic element that supports text or annotation strings for labeling features and maps. Text elements range from the labeling on a street to the title of a map.*

Annotation is both a geographic feature (stored in the geodatabase as a feature with attributes) and a *TextElement*. It is actually a custom feature within the geodatabase, and the *TextElement* is one of the components of that feature.

The following VBA code will access the *TextElement* in a selected set of annotation features:

```
Dim pDoc As IMxDocument, pMap As IMap
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
Dim pFeatSel As IEnumFeature
Set pFeatSel = pMap.FeatureSelection
Dim pFeat As IFeature
Set pFeat = pFeatSel.Next
Do While Not pFeat Is Nothing
  If TypeOf pFeat Is IAnnotationFeature Then
    Dim pAnnoFeat As IAnnotationFeature, pElem As IElement
    Set pAnnoFeat = pFeat
    Set pElem = pAnnoFeat.Annotation
    Dim pTextEl As ITextElement
    Set pTextEl = pElem
  End If
  Set pFeat = pFeatSel.Next
Loop
```

The ITextElement *interface is the default interface for the* TextElement *coclass. This interface allows access to the text string and symbology for the element.*

ITextElement : IUnknown	Provides access to members that control the Text element.
ScaleText: Boolean	Indicates if the text scales with the map.
Symbol: ITextSymbol	Text symbol this element uses to draw itself.
Text: String	Text being displayed by this element.

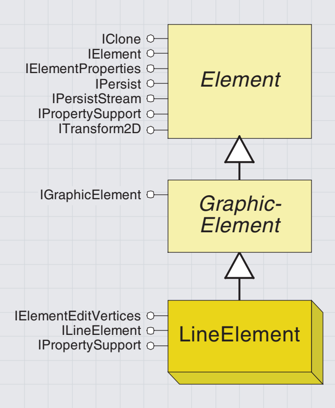
Annotation feature classes have a reference scale stored with them so that the annotation automatically scales based on a desired size. For instance, if you want your annotation to be 10 pt. at a scale of 400 map units, you will make your reference scale 400 and set your symbol size to 10 pt. When the scale of your map is set to 200, the annotation will appear twice as large. The *ScaleText* property of *ITextElement* indicates whether the automatic scaling should take place for that particular element.

The IElementEditVertices *interface is implemented by* TextElement, LineElement, *and* PolygonElement *to support the editing of vertices for these elements.*

IElementEditVertices : IUnknown	Provides access to members that control the Element edit vertices object.
MovingVertices: Boolean	Indicates if this element is moving its vertices.
GetMoveVerticesSelectionTracker: ISelectionTracker	Selection tracker to move points used by this element.

The *MovingVertices* property tells *SelectionTracker* to hand out the normal selection tracker (*False*) or forward the call to *GetMoveVerticesSelectionTracker* (*True*).

IElementEditCallout : IUnknown	Callout editing interfaces for text elements.
EditingCallout: Boolean	Returns or sets a flag indicating if this element is editing it's callout.
GetMoveTextSelectionTracker: ISelectionTracker	Returns the selection tracker to move the text used by this element.



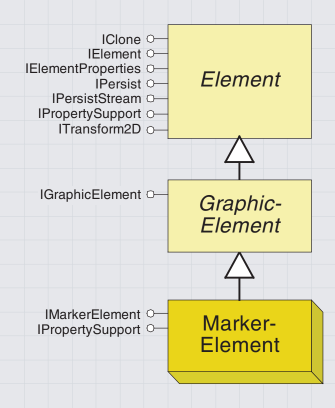
The LineElement *coclass is a type of graphic element used to support line graphics within a data frame or map layout.*

To determine whether a *GraphicElement* is a *LineElement*, check for the implementation of the *ILineElement* interface:

```
Dim pDoc As IMxDocument, pPageLayout As IPageLayout
Dim pContainer As IGraphicsContainer, pElement As IElement
Set pDoc = ThisDocument
Set pPageLayout = pDoc.PageLayout
Set pContainer = pPageLayout
pContainer.Reset
Set pElement = pContainer.Next
Do While Not pElement Is Nothing
  If TypeOf pElement Is ILineElement Then
    Dim pLineElem As ILineElement
    Set pLineElem = pElement
  End If
  Set pElement = pContainer.Next
Loop
```

ILineElement : IUnknown	Provides access to members that control the Line element.
▪━ Symbol: ILineSymbol	Line symbol this element uses to draw itself.

The *ILineElement* interface is the default interface for the *LineElement* coclass. This interface is only implemented for the *LineElement* coclass; it provides access to the symbology for the element.



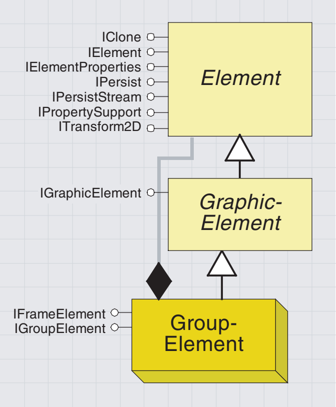
The MarkerElement *coclass is a type of graphic element used to support point (marker) graphics within a data frame or map layout.*

Check for the implementation of the *IMarkerElement* interface to determine if your element is a *MarkerElement*:

```
Dim pDoc As IMxDocument, pPageLayout As IPageLayout
Dim pContainer As IGraphicsContainer, pElement As IElement
Set pDoc = ThisDocument
Set pPageLayout = pDoc.PageLayout
Set pContainer = pPageLayout
pContainer.Reset
Set pElement = pContainer.Next
Do While Not pElement Is Nothing
  If TypeOf pElement Is IMarkerElement Then
    Dim pMarkerElem As IMarkerElement
    Set pMarkerElem = pElement
  End If
  Set pElement = pContainer.Next
Loop
```

IMarkerElement : IUnknown	Provides access to members that control the Marker element.
▪━ Symbol: IMarkerSymbol	Marker symbol this element uses to draw itself.

The *IMarkerElement* interface is the default interface for the *MarkerElement* coclass. This interface is only implemented for the *MarkerElement* coclass and provides access to the symbology for the element.



A group element is a creatable object that is composed of one or more element objects.

GroupElement objects are passed to the developer as *IElements* (by *IGraphicsContainer::Next* among other members). It is up to the developer to determine if the object supports *IGroupElement,* which would make it a *GroupElement* object. Use *GroupElement* objects when you want to move or rotate more than one element as a unit.

IGroupElement : IUnknown	Provides access to members that control the Group element.
Element (in Index: Long) : IElement	Element at the given index of the group.
ElementCount: Long	Number of elements in the group.
Elements: IEnumElement	Elements in the group.
AddElement (in Element: IElement)	Adds the given element to the group.
ClearElements	Removes all elements from the group.
DeleteElement (in Element: IElement)	Removes the given element from the group.

IGroupElement is the interface for creating a group of element objects. It is implemented by the *GroupElement* object. This interface will allow the programmer to manipulate (*Add*, *Clear*, or *Delete*) a group of elements.

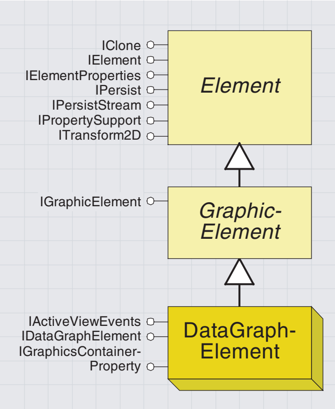
The following code uses *IGroupElement::DeleteElement* to remove the second element in a group:

```
Dim pDoc As IMxDocument, pPageLayout As IPageLayout
Dim pContainer As IGraphicsContainer, pElement As IElement
Set pDoc = ThisDocument
Set pPageLayout = pDoc.PageLayout
Set pContainer = pPageLayout
pContainer.Reset
Set pElement = pContainer.Next
Do While Not pElement Is Nothing
  If TypeOf pElement Is IGroupElement Then
    Dim pElem2 As IElement, pGroup As IGroupElement
    Set pGroup = pElement
    Set pElem2 = pGroup.Element(1)
    pGroup.DeleteElement pElem2
  End If
  Set pElement = pContainer.Next
Loop
```

DeleteElement removes the element from the group and deletes the element from the map. If you want to keep the element in the map but remove it from the group, you will need to readd the element to the map after deleting it from the group.

IFrameElement : IUnknown	Provides access to members that control the Frame element object.
Background: IBackground	Frame background used by this element.
Border: IBorder	Frame border used by this element.
DraftMode: Boolean	Indicates if this element is in draft mode, i.e., draws fast.
Object: Variant	Object framed by this element.
Thumbnail: Long	Small bitmap representation of this element.

The *IFrameElement* interface is a generic interface for manipulating the properties of the frame itself (not the object within the frame).



The DataGraphElement *object is a type of* Element *that supports graphs based on data in the map.*

Through the user interface, *DataGraphElement* objects are created by selecting the Show Graph on Layout option when creating a graph or the Show on Layout option after the graph has been created.

DataGraphElement objects can only appear on page layouts. The purpose of the class is to allow graphs to be displayed on the page layouts for outputting purposes.

IDataGraphElement : IUnknown

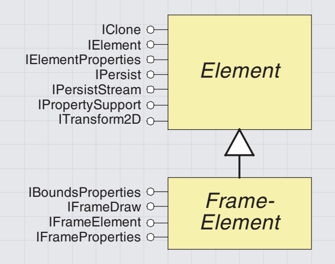
Provides access to members that control the datagraph element.

DataGraph: IDataGraph	*The graph.*
Map: IMap	*The parent map.*

The *IDataGraphElement* interface is implemented only by the *DataGraphElement* coclass and provides access to the graph and the parent map. Through the parent map, you can access the layer or table that was used to generate the graph.

The following VBA code demonstrates how to loop through the elements in a page layout, find the elements that support *IDataGraphElement*, and change the selection set property on the graph to *True* (use the selected set):

```
Dim pDoc As IMxDocument, pPageLayout As IPageLayout
Dim pContainer As IGraphicsContainer, pElement As IElement
Set pDoc = ThisDocument
Set pPageLayout = pDoc.PageLayout
Set pContainer = pPageLayout
pContainer.Reset
Set pElement = pContainer.Next
Do While Not pElement Is Nothing
  If TypeOf pElement Is IDataGraphElement Then
     Dim pDataGraphEl As IDataGraphElement, pDataGraph As IDataGraph
     Set pDataGraphEl = pElement
     Set pDataGraph = pDataGraphEl.DataGraph
     pDataGraph.UseSelectedSet = True
  End If
  Set pElement = pContainer.Next
Loop
```



FrameElement is the abstract class on which all frame element objects are based.

The FrameElement types include FrameElement (holds point, line, and polygon graphics), OleFrame (holds OLE objects such as Word documents), MapFrame (holds maps), and MapSurroundFrame (holds North arrows, scale bar, legends, and other map primitives).

FrameElements contain other map elements—they serve as the background and border to these elements. The *MapFrame* element holds a map and allows the programmer access to that map along with the background and border properties of the container holding that map within a layout session.

IFrameElement : IUnknown	***Provides access to members that control the Frame element object.***
Background: IBackground	*Frame background used by this element.*
Border: IBorder	*Frame border used by this element.*
DraftMode: Boolean	*Indicates if this element is in draft mode, i.e., draws fast.*
Object: Variant	*Object framed by this element.*
Thumbnail: Long	*Small bitmap representation of this element.*

The *IFrameElement* interface is a generic interface for manipulating the properties of the frame itself (not the object within the frame). This interface provides access to the background and border properties of the frame, as well as access to the object within the frame.

The *Object* property returns the object within the frame, but it returns it as a variant. The programmer is required to determine what type of object it is. To get an *IMap* object, first determine if the *FrameElement* supports *IMapFrame*, then use the *Map* property of that interface.

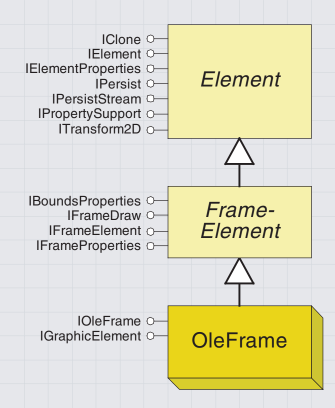
The *Thumbnail* property returns a picture of the contents within the frame. This is useful for showing previews in other windows.

The *FrameElement* object does not house any particular type of element, but can be grouped with other elements that are not normally associated with frames. For example, *PointElement* does not support *IFrameElement* interface, and so, by default, you do not have a frame for your point. However, there may be times when you want to make a point graphic stand out by placing it inside a border with a particular background. This can be accomplished by creating a *FrameElement* object and grouping it (*IGroupElement*) with your *PointElement*.

```
Dim pFrame as IFrameElement, pPointElement as IMarkerElement
Dim pGroup as IGroupElement
Set pFrame = New FrameElement
Set pGroup = New GroupElement
pGroup.AddElement pPointElement
pGroup.AddElement pFrame
```

IGraphicElement : IUnknown	***Provides access to members that control the Graphic Element object.***
SpatialReference: ISpatialReference	*Spatial reference of the map.*

The *IGraphicElement* interface is a generic interface implemented by all graphic elements and *OleFrame*. The purpose of the interface is to provide the spatial reference information for the element.



OleFrame *objects house OLE objects (Excel spreadsheets, Word documents, and so on) that have been added to a page layout.*

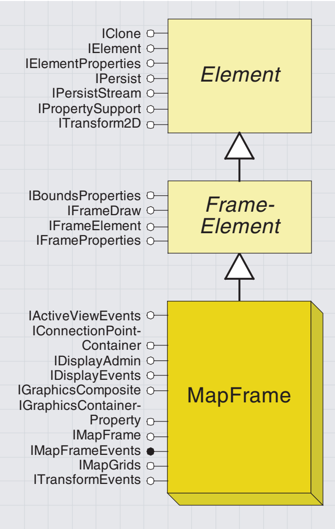
The *OleFrame* object allows for the embedding of standard OLE objects in a page layout. Check an element for the implementation of *IOleFrame* to determine if it is an *OleFrame* object.

IOleFrame : IUnknown	***Graphic Element that holds an OLE object***
■— OleClientItem	*Valid only in MFC environment. Returns pointer to the COleClientItem representing the OLE object.*
← CreateOleClientItem (oleDocument)	*Valid only in MFC environment. Initialize the internal COleClientItem. Pass in a pointer to the application's COleDocument.*
← Edit	*Edit the object in-place.*
← EditProperties: Boolean	*Show the properties dialog for the object.*
← Hide	*Stop editing the object.*
← Open	*Edit the object in a separate application window.*

The *IOleFrame* interface is implemented by the *OleFrame* coclass, which allows for the editing of embedded OLE objects. The interface allows for the standard manipulation of embedded OLE objects.

The *Edit* method allows for the editing of the object within the frame, while the *Open* method allows for editing of the object within its own domain.

C++ programmers can use the *CreateOleClientItem* method to initialize the internal *COleClientItem*. Pass in a pointer to the application's *COleDocument* when executing the method.



MapFrame *objects house* IMap *objects (data frames) within a page layout.*

MapFrame objects are unique among the other frames and elements because they support events (*MapSurroundFrames* also support events) and reference grids. The *MapFrameResized* event is supported through *IMapFrameEvents* to allow for the updating of map grids (graticules) when the frame is resized. Map grids are only supported through the *MapFrame*, not on the map itself.

Check an element for the implementation of *IMapFrame* to determine if it is a *MapFrame* object.

IMapFrame : IFrameElement	***Provides access to the members that control the map element object.***
■—□ Container: IGraphicsContainer	*The frame's container.*
■—■ ExtentType: esriExtentTypeEnum	*The way in which the map extent of the frame is specified.*
■— LocatorRectangleCount: Long	*The number of locator rectangles.*
■—□ Map: IMap	*The associated map.*
■—■ MapBounds: IEnvelope	*The bounds of the map displayed by the frame.*
■—■ MapScale: Double	*The scale at which the map should be displayed.*
← AddLocatorRectangle (in Locator: ILocatorRectangle)	*Add a new locator rectangle to the data frame.*
← CreateSurroundFrame (in CLSID: IUID, in optionalStyle: IMapSurround) : IMapSurroundFrame	*Returns the map surround frame element of the type given in clsid. An optional style object may be specified.*
← LocatorRectangle (in Index: Long) : ILocatorRectangle	*Returns the locator rectangle at the specified index.*
← RemoveAllLocatorRectangles	*Remove all the locator rectangles from the data frame.*
← RemoveLocatorRectangle (in Locator: ILocatorRectangle)	*Remove a locator rectangle from the data frame.*

IMapFrame is the interface implemented only by the *MapFrame* coclass. The interface provides access to the map within the frame and also has the ability to create locator rectangles outlining the areas covered by other data frames. Among other things, locator rectangles can be used to highlight inset areas.

The *MapBounds* and *MapScale* properties can be used to update the extent of the map within the frame, but make sure the *ExtentType* is set to the correct option for the property you update.

The *Container* property provides access to the *PageLayout* object within which the *MapFrame* object resides. The back pointer to the *PageLayout* is needed so that the container can be refreshed when the *MapFrame* is updated via a connection point (not through the *PageLayout* itself).

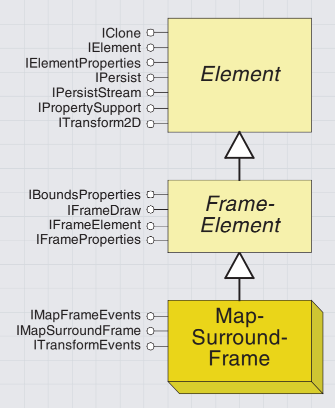
The *CreateSurroundFrame* method should be used for creating map surround elements (North arrows, scale bars, and so on) that you want to be linked to the map frame. Surrounds created in this method will be updated when the map is updated (scale changed, and so on).

IMapFrameEvents : IUnknown	***Provides access to the events that occur when the state of the map frame changes.***
← MapFrameResized	*Occurs when a map frame is resized.*

The *IMapFrameEvents* interface is implemented by the *MapFrame* and *MapSurroundFrame* coclasses. This interface is used to notify related objects of changes in the size of the frame.

IMapGrids : IUnknown	***Provides access to members that control the map grids in a data frame.***
■—■ MapGrid (in Index: Long) : IMapGrid	*The map grid at the specified index.*
■— MapGridCount: Long	*The number of map grids associated with the map frame.*
← AddMapGrid (in MapGrid: IMapGrid)	*Adds a map grid to the map frame.*
← ClearMapGrids	*Clears all map grids from the map frame.*
← DeleteMapGrid (in MapGrid: IMapGrid)	*Deletes a map grid from the map frame.*

The *IMapGrids* interface supports adding and deleting map grids (graticules) to a map frame. It is implemented by the *MapFrame* object and acts as a collection for map grids.



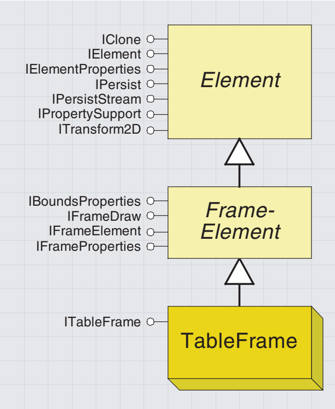
Surrounds are related to map frames so that changes in the map frame are reflected in the surround. For instance, if the map frame is rotated, then a North arrow linked to the frame should also be rotated.

The *MapSurroundFrame* object is a type of *FrameElement* that holds surround objects such as North arrows, legends, and scale bars. Like the *MapFrame* coclass, *MapSurroundFrame* objects support the *MapFrameResized* event. Listening for the event allows for the updating of objects, such as scale bars, that may need to change when the map is resized.

IMapSurroundFrame : IFrameElement	***Provides access to the members that control the map surround element interface.***
■—□ MapFrame: IMapFrame	*The frame element of the map associated with this object's map surround.*
■—□ MapSurround: IMapSurround	*The map surround displayed by this frame element.*

IMapSurroundFrame is the default interface for the *MapSurroundFrame* coclass. This interface permits access to the surround within the frame and the *IMapFrame* to which the surround is related.

The *MapFrame* property provides access to the frame to which the surround is linked.



The TableFrame *object is a type of* FrameElement *that holds tables.*

Through the user interface, *TableFrame* objects are created by opening an attribute table and selecting Add table to layout from the Options pulldown menu.

The purpose of the object class is to allow attributes tables to be displayed with a page layout. *TableFrame* objects can only exist within a page layout; they can't be added to a map.

ITableFrame: IUnknown	***Provides access to members that control table frames.***
StartCol: Long	*The first column to display.*
StartRow: Long	*The first row to display.*
Table: ITable	*The table (either standalone table or feature layer).*
TableProperty: ITableProperty	*The table property.*
TableView: ITableView	*The table view to show.*

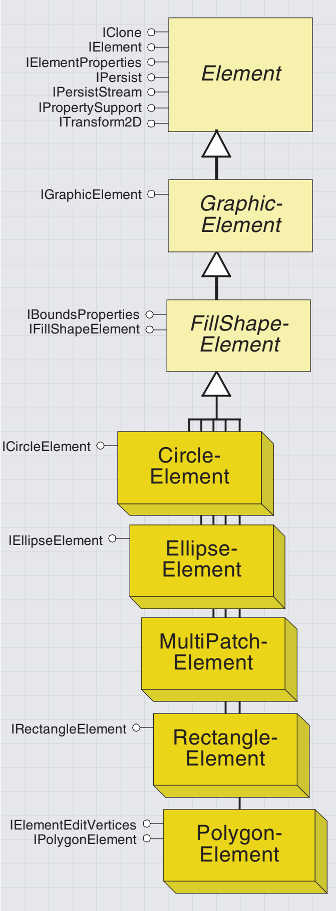
The *ITableFrame* interface is implemented only by the *TableFrame* coclass and provides access to the table held by the frame and the properties of that table. Through this interface, you can specify the starting column and row for the table being displayed and access the query filter and selection set for the table.

The following VBA code demonstrates how to loop through the elements in the page layout, find the ones that support *ITableFrame*, and set the starting row for each to 2:

```
Dim pDoc As IMxDocument, pPageLayout As IPageLayout
Dim pContainer As IGraphicsContainer, pElement As IElement
Set pDoc = ThisDocument
Set pPageLayout = pDoc.PageLayout
Set pContainer = pPageLayout
pContainer.Reset
Set pElement = pContainer.Next
Do While Not pElement Is Nothing
  If TypeOf pElement Is ITableFrame Then
    Dim pTab As ITableFrame
    Set pTab = pElement
    pTab.StartRow = 2
  End If
  Set pElement = pContainer.Next
Loop
```

Using the *TableView* property you can get an *ITableView* object and change properties of the table view such as *ShowSelected* (which determines whether all records or just the selected records are shown in the table).

The *Table* property will return to you the *ITable* object associated with the frame, but you can also get to this object by using the *Table* property on the *ITableProperty* object returned with the *TableProperty* property.



The *FillShapeElement* abstract class is a type of *Element*, but it is also an abstract class supporting *CircleElement*, *EllipseElement*, *PolygonElement*, and *RectangleElement*. Each of the supported elements represents a two-dimensional, closed-area graphic.

IFillShapeElement : IUnknown	***Provides access to members that control the Fill Shape element.***
Symbol: IFillSymbol	*Fill symbol this element uses to draw itself.*

IFillShapeElement is a generic interface supported by all *FillShapeElements*. This interface provides access to the symbology used in displaying the element.

IPropertySupport : IUnknown	***Provides access to members that set a default property on an object.***
Current (in pUnk: IUnknown Pointer) : IUnknown Pointer	*The object currently being used.*
Applies (in pUnk: IUnknown Pointer) : Boolean	*Indicates if the receiver can apply the given object at any given time.*
Apply (in NewObject: IUnknown Pointer) : IUnknown Pointer	*Applies the given property to the receiver and returns the old object.*
CanApply (in pUnk: IUnknown Pointer) : Boolean	*Indicates if the receiver can apply the given object at that particular moment.*

IPropertySupport is the interface implemented by *Elements* and various other components (*DimensionLayer*, *FeatureLayer*, *TinEdgeRenderer*, and others) to provide access to generic properties of the object. The interface determines whether a certain property can be applied to an object, then allows that property to be applied when appropriate.

Applies indicates whether an object can be applied at all, while *CanApply* indicates whether an object can be applied at that particular moment (whether or not the object is currently editable).

Current will return the current object of the specified type. For instance, you may ask a *CircleElement* for its current *IColor* property.

ICircleElement : IUnknown	***Provides access to members that control the Circle element.***

A CircleElement *is a type of* FillShapeElement *that supports circle graphics.*

The *ICircleElement* interface is implemented only by the *CircleElement* coclass. The interface does not have any properties or methods and primarily exists for determining if an element is a circle.

IEllipseElement : IUnknown	***Provides access to members that control the Ellipse element.***

An EllipseElement *is a type of* FillShapeElement *that supports ellipse graphics.*

The *IEllipseElement* interface is implemented only by the *EllipseElement* coclass. The interface does not have any properties or methods and primarily exists for determining if an element is an ellipse.

A PolygonElement *is a type of* FillShapeElement *that supports polygon graphics.*

IPolygonElement : IUnknown	Provides access to members that control the Polygon element.

The *IPolygonElement* interface is implemented only by the *PolygonElement* coclass. The interface does not have any properties or methods and primarily exists for determining if an element is a polygon.

A RectangleElement *is a type of* FillShapeElement *that supports rectangle graphics.*

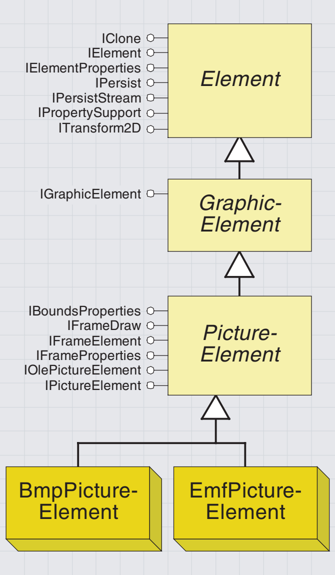
You can set a rectangle as the geometry for a RectangleElement, *but the geometry is actually stored and returned as a polygon.*

IRectangleElement : IUnknown	Provides access to members that control the Rectangle element.

The *IRectangleElement* interface is implemented only by the *RectangleElement* coclass. The interface does not have any properties or methods and primarily exists for determining if an element is a rectangle.

IElementEditVertices : IUnknown	Provides access to members that control the Element edit vertices object.
■—■ MovingVertices: Boolean	*Indicates if this element is moving its vertices.*
← GetMoveVerticesSelectionTracker: ISelectionTracker	*Selection tracker to move points used by this element.*

The *MovingVertices* property tells *SelectionTracker* to hand out the normal selection tracker (*False*) or forward the call to *GetMoveVerticesSelectionTracker* (*True*).



The PictureElement *abstract class is a type of graphic element that supports the* BmpPictureElement *and* EmfPictureElement *coclasses.*

The BmpPictureElement *coclass supports bitmap files. Query* IPictureElement::Filter *to determine if your element is a* BmpPictureElement*.*

The EmfPictureElement *coclass supports .emf (Windows Enhanced Metafile) files. Query* IPictureElement::Filter *to determine if your element is an* EmfPictureElement*.*

PictureElement objects are very similar to *OleFrame* objects. However, *PictureElements* are the elements themselves, while *OleFrames* are the frames around the object. More subtly, *OleFrame* objects can contain pictures (bmp files and others), but they can also contain other types of OLE objects (Word documents, Excel spreadsheets, and others). *PictureElement* objects can only contain pictures (.bmp or .emf files).

IPictureElement : IUnknown	***Provides access to members that control the Picture element.***
Filter: String	*Filter used in CFileDialog.*
MaintainAspectRatio: Boolean	*Indicates if the resize box will maintain the picture's aspect ratio.*
PictureAspectRatio: Double	*Filter used in CFileDialog.*
PictureDescription: String	*Description of the Picture Element.*
SavePictureInDocument: Boolean	*Indicates if the Picture will be stored in the Document.*
← ImportPictureFromFile (in Name: String)	*File to be imported.*

The *IPictureElement* interface is the generic interface implemented by *BmpPictureElement* and *EmfPictureElement* types.

Check for the implementation of the *IPictureElement* interface to determine if your element is a *PictureElement*. The following code demonstrates this.

```
Dim pMyElement As IPictureElement
Set pMyElement = New BmpPictureElement

If TypeOf pMyElement Is IPictureElement Then
  MsgBox ("pMyElement is IPictureElement")
Else
  MsgBox ("pMyElement is not IPictureElement")
End If
```

Use the *Filter* property to determine if the *PictureElement* is a *BmpPictureElement* or an *EmfPictureElement*. For instance, for the *EmfPictureElement*, the filter is "Windows Enhanced Metafile (*.emf)|*.emf|".

SavePictureInDocument specifies whether that actual picture will be saved with the document or just link to the picture on disk.

Make sure you have the correct filter set before using *ImportPictureFromFile*.

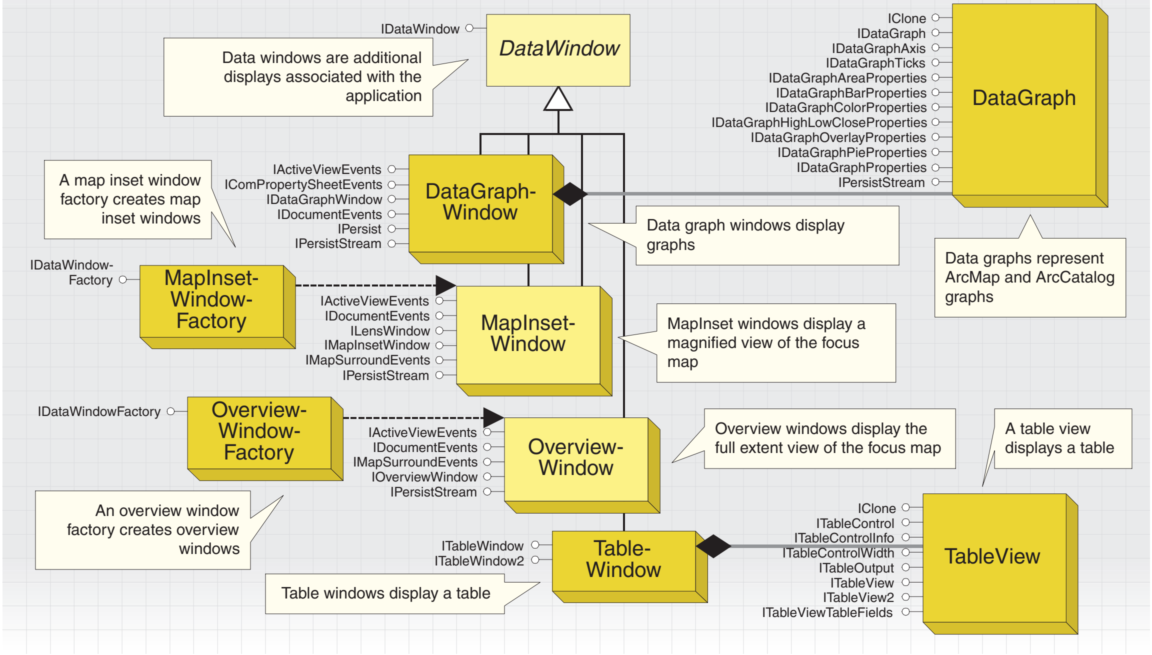
IOlePictureElement : IUnknown	***Provides access to members that control the Ole Style Picture element.***
← ImportPicture (in pictureDisp: Picture)	*Import Picture from an IPictureDisp interface.*

The *IOlePictureElement* interface is a generic interface implemented by *BmpPictureElement* and *EmfPictureElement*. The interface is used to load a picture into one of these coclasses through an OLE *IPictureDisp*. To load a picture from a file, use *IPictureElement*.

The following VBA code adds a picture element to the layout. The code uses the *PictureAspectRatio* property of *IPictureElement* to ensure that the proper ratio is maintained. The ratio is given as change in x/change in y, so if you want your image to be two inches tall on the y-axis, then it would need to be 2 * *PictureAspectRatio* long on the x-axis.

```
Private Sub AddPicture()
  Dim pDoc As IMxDocument, pPageLayout As IPageLayout
  Dim pContainer As IGraphicsContainer, pElement As IElement, _
    pPic As IPictureElement
  Set pDoc = ThisDocument
  Set pPageLayout = pDoc.PageLayout
  Set pContainer = pPageLayout
  pContainer.Reset
  Set pPic = New BmpPictureElement
  pPic.ImportPictureFromFile
"d:\arcgis\arcexe81\symbols\stipples\woodland.bmp"
  pPic.MaintainAspectRatio = True

  Dim pEnv As IEnvelope
  Dim dXmin As Double, dYmin As Double, dXmax As Double, _
    dYmax As Double
  dXmin = 2
  dYmin = 2
  dXmax = 2 + (2 * pPic.PictureAspectRatio)
  dYmax = 2 + 2
  Set pEnv = New Envelope
  pEnv.PutCoords dXmin, dYmin, dXmax, dYmax
  Set pElement = pPic
  pElement.Geometry = pEnv
  pPic.MaintainAspectRatio = True

  pContainer.AddElement pPic, 0
  Dim pActive As IActiveView
  Set pActive = pPageLayout
  pActive.Refresh
End Sub
```

ArcMap data window objects



Data windows are additional displays associated with the application

A map inset window factory creates map inset windows

Data graph windows display graphs

Data graphs represent ArcMap and ArcCatalog graphs

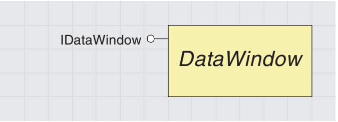
MapInset windows display a magnified view of the focus map

Overview windows display the full extent view of the focus map

A table view displays a table

An overview window factory creates overview windows

Table windows display a table



Data windows are additional displays associated with the application.

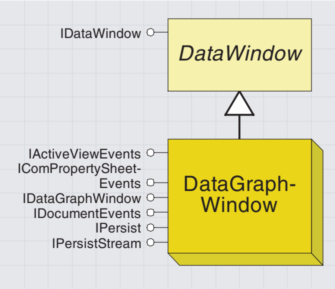
Data windows are additional windows associated with the ArcMap application; their purpose is to provide a separate window for displaying additional data. The data window framework provides an architecture for easily creating new data windows. ArcMap ships with a variety of data windows, including: *DataGraphWindow, TableWindow, TableView, MapInsetWindow,* and *OverviewWindow*.

The *Application* object manages all data windows; access to a particular window is available using the *IApplicationWindows* interface on the *Application* object.

All data windows implement the following interfaces: *IDataWindow, IActiveViewEvents,* and *IDocumentEvents*. However, custom data windows cannot be implemented in Visual Basic.

IDataWindow : IUnknown	***Provides access to members that control popup windows that show map data.***
Application: Object	*Provides the window with a reference to the application.*
hWnd: Long	*The window's handle.*
IsDockable: Boolean	*Indicates if the window is dockable.*
IsVisible: Boolean	*Indicates if the window is visible.*
PutPosition (in Left: Long, in Top: Long, in Right: Long, in bottom: Long)	*The window's position in screen pixels.*
QueryPosition (out Left: Long, out Top: Long, out Right: Long, out bottom: Long)	*The window's position in screen pixels.*
Refresh	*Cause the window to redraw.*
Show (in Show: Boolean)	*Indicates if the window is shown.*

Use the *IDataWindow* interface to access the generic properties and methods each data window has, such as the following: is it visible, is it dockable, refresh the window, and change its position.



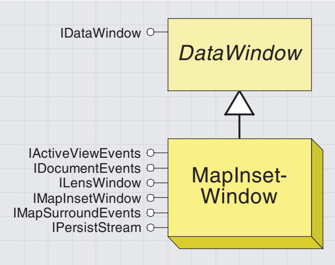
Data graph windows display graphs.

The *DataGraphWindow* wraps a *DataGraph* object that allows a data graph to appear in a separate data window. The *DataGraphElement* object also wraps the *DataGraph* object, but in this case it does so to enable a graph to be directly added to a layout. The example below shows one method for creating a new data graph window. This example creates a graph using the currently selected feature layer in the table of contents.

```
Public Sub CreateNewGraph()
   Dim pMxDoc As IMxDocument
   Dim pTable As ITable
   Dim pDataGraph As IDataGraph
   Dim pDataGraphProperties As IDataGraphProperties
   Dim pGraphWindow As IDataGraphWindow
   Dim pDataGraphs As IDataGraphs

   Set pMxDoc = Application.Document
   If pMxDoc.SelectedLayer Is Nothing Then Exit Sub
   If Not TypeOf pMxDoc.SelectedLayer Is IFeatureLayer Then Exit Sub
   Set pTable = pMxDoc.SelectedLayer

   'Create a new graph
   Set pDataGraph = New DataGraph

   'Set the default Table, DataGraph will select a default graph
   'type and some fields
   Set pDataGraph.Table = pTable

   'Specifically give the graph a name and title
   pDataGraph.Name = pMxDoc.SelectedLayer.Name & " Graph"
   Set pDataGraphProperties = pDataGraph 'QI
   pDataGraphProperties.Title = "Cool Graph"

   'Associate the data graph with a data graph window
   Set pGraphWindow = New DataGraphWindow
   Set pGraphWindow.DataGraph = pDataGraph
   Set pGraphWindow.Application = Application

   'Add the graph to the system
   Set pDataGraphs = pMxDoc 'QI
   pDataGraphs.Add pDataGraph
End Sub
```

IDataGraphWindow : IDataWindow	***Provides access to members that control the DataGraph Window.***
■—□ DataGraph: IDataGraph	*The DataGraph used by this window.*

Use the *IDataGraphWindow* interface to access or set the *DataGraph* object associated with the *DataGraphWindow*. For more information about the *DataGraph* object, see the section on elements.

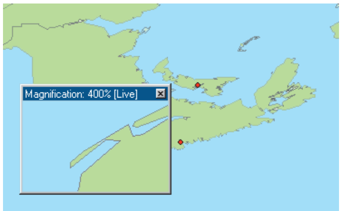


A map inset window displays a magnified view of the focus map.

The *MapInsetWindow* object is the component behind the ArcMap magnifier window. This data window provides a zoomed view of the current focus map. To create a new magnifier window in ArcMap, click the Windows menu and click Magnifier. The *MapInsetWindow* object contains a *MapInset* (a type of map surround), which has the job of controlling the zoom and setting the bounds of the map. The *MapInsetWindow* allows the *MapInset* to appear in its own private window rather than on the page layout.

The *MapInsetWindow* object is not a directly creatable object. To create a new map inset window, you must call *IDataWindowFactory::Create* on a new *MapInsetWindowFactory* object. The example below shows one method for creating a new magnifier window.

```
Public Sub CreateMagnifierWindow()
  Dim pMapInset As IMapInset
  Dim pMapInsetWindow As IMapInsetWindow
  Dim pDataWindowFactory As IDataWindowFactory

  Set pDataWindowFactory = New MapInsetWindowFactory
  If pDataWindowFactory.CanCreate(Application) Then
    Set pMapInsetWindow = pDataWindowFactory.Create(Application)
    Set pMapInset = pMapInsetWindow.MapInset
    'Set the zoom percent to 200%
    pMapInset.ZoomPercent = 200
    pMapInsetWindow.Show True
  End If
End Sub
```



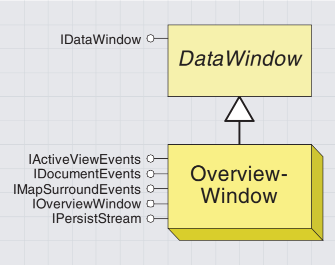
A magnification window with a zoom percent of 400

IMapInsetWindow : ILensWindow	***Provides access to members that control the Map Inset Window.***
■—□ MapInset: IMapInset	*The MapInset used by this window.*
← FlashLocation	*Draw leader lines from the inset to the location on the map shown by the inset.*

Use the *IMapInsetWindow* interface to access the *MapInset* object associated with the *MapInsetWindow*. *IMapInsetWindow* also contains a *FlashLocation* method, which pinpoints the bounds of the *MapInset* on the focus map.

ILensWindow : IDataWindow	***Provides access to members that control the Lens Window.***
■—■ IsLive: Boolean	*Indicates if the window shows a live view of what's under it or a snapshot.*
■— ScreenDisplay: IScreenDisplay	*The screen display used by this window.*
■—■ UpdateWhileDragging: Boolean	*Indicates if the window is redrawn as it's moved or not.*

Use the *ILensWindow* interface to access and set other import properties of a magnifier window. For example, *ILensWindow* controls whether or not the magnifier window updates while it is being dragged over the focus map; *ILensWindow* also controls whether or not the window should contain a snapshot of a specific location. Of course, when a snapshot is in place, the *UpdateWhileDragging* property has no effect.



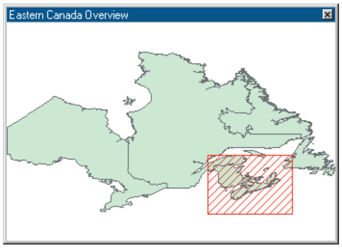
An overview window displays the full extent view of the focus map.

The *OverviewWindow* object is the component behind the ArcMap overview window. This data window provides an overview of the current focus map. To create a new overview window in ArcMap, click the Windows menu and click Overview.

The *OverviewWindow* object contains an *Overview* object—a type of map surround. This object controls the contents of the data window. The *OverviewWindow* allows the *Overview* to appear in its own private window rather than on the page layout.

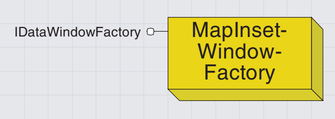
IOverviewWindow : IDataWindow	***Provides access to members that control the Overview Window.***
Overview: IOverview	*The Overview used by this window.*

The *OverviewWindow* object is not directly creatable. To make a new overview window, you must call *IDataWindowFactory::Create* on a new *OverviewWindowFactory* object. The code below shows one method for creating a new overview window.

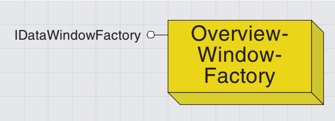


An overview window

```
Public Sub CreateOverviewWindow()
  Dim pOverview As IOverview
  Dim pOverviewWindow As IOverviewWindow
  Dim pDataWindowFactory As IDataWindowFactory
  Dim pFillSymbol As ISimpleFillSymbol
  Dim pLineSymbol As ISimpleLineSymbol
  Dim pRgbColor As IRgbColor

  Set pDataWindowFactory = New OverviewWindowFactory
  If Not pDataWindowFactory.CanCreate(Application) Then Exit Sub
  'Create a new overview window
  Set pOverviewWindow = pDataWindowFactory.Create(Application)
  'Change the area of interterest fill symbol
  'to a hollow fill with a blue border
  Set pOverview = pOverviewWindow.Overview
  Set pFillSymbol = New SimpleFillSymbol
  Set pLineSymbol = New SimpleLineSymbol
  Set pRgbColor = New RgbColor
  pRgbColor.Blue = 255
  pLineSymbol.Color = pRgbColor
  pFillSymbol.Style = esriSFSNull
  pFillSymbol.Outline = pLineSymbol
  pOverview.AoiFillSymbol = pFillSymbol
End Sub
```

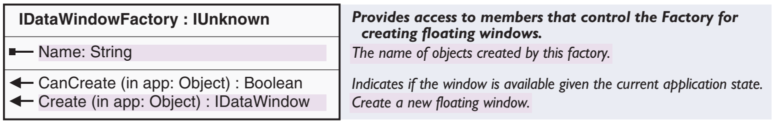


Use a map inset window factory to create a map inset window (magnification window).



Use an overview window factory to create an overview window.

As discussed earlier, the *MapInsetWindow* and *OverviewWindow* objects are not directly creatable. You must use the related factory objects to create them.



IDataWindowFactory : IUnknown	***Provides access to members that control the Factory for creating floating windows.***
■— Name: String	*The name of objects created by this factory.*
← CanCreate (in app: Object) : Boolean	*Indicates if the window is available given the current application state.*
← Create (in app: Object) : IDataWindow	*Create a new floating window.*

The data window factory objects implement the *IDataWindowFactory* interface. Use this interface to check if the window object is creatable and, if it is, to create it. For example, map inset windows and overview windows cannot be created when ArcMap is in layout mode. For more information, see the *CreateMagnifierWindow* code sample documented with the *MapInsetWindow* class.

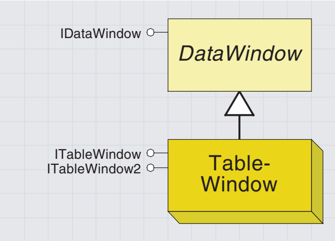


Table windows display tables.

The *TableWindow* object is a data window that presents a feature class attribute table or standalone table. Each *TableWindow* houses a *TableView*; for more information on *TableViews*, see Chapter 7, 'Working with the Catalog'. The *TableWindow* allows users to sort, summarize, edit, and get statistics on records in a table.

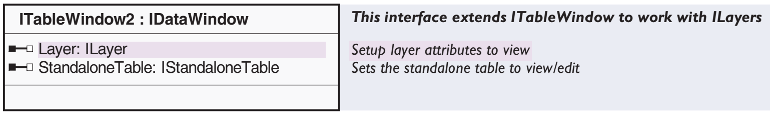
ITableWindow : IDataWindow	Displays table window in ArcMap. This interface intergrates ITableView with ArcMap's events and selections.
FeatureLayer: IFeatureLayer	Setup feature class to view/edit
SelectionSet: ISelectionSet	Current selection set of the table. Only valid for tables showing all rows.
ShowAliasNamesInColumnHeadings: Boolean	Show alias names or the real field name in column headings. Default False.
ShowSelected: Boolean	Show only features that are selected
Table: ITable	Setup table to view/edit
TableControl: ITableControl	Get table control. Table needs to be showing before you can get a valid pointer.
TableSelectionAction: tagesriTableSelectionActions	Action to perform when table selections are made
FindViaFeatureLayer (in pFeatureLayer: IFeatureLayer, in ShowSelected: Boolean) : ITableWindow	Is table (of a featurelayer) already being displayed
FindViaTable (in pTable: ITable, in ShowSelected: Boolean) : ITableWindow	Is table already being displayed
UpdateSelection (in pSelection: ISelectionSet)	Updates current table selection. Does not update Mx feature layer selection.

ITableWindow is the primary interface on the *TableWindow* object. Use this interface to set or access the properties of a *TableWindow*, such as the feature layer or standalone table that is to be presented, in the data window. One interesting property on *ITableWindow* is *ShowSelected*; use this property to control whether all records or just the selected ones are displayed.

The example below opens the table associated with the currently selected feature layer or standalone table in the ArcMap table of contents. The code only creates a new table if it determines one has not already been created. To use this code, select a feature layer or standalone table in the table of contents and run this VBA macro.

```
Public Sub OpenTableWindow()
  Dim pMxDoc As IMxDocument
  Dim pUnknown As IUnknown
  Dim pFeatureLayer As IFeatureLayer
  Dim pStandaloneTable As IStandaloneTable
  Dim pTable As ITable
  Dim pTableWindow As ITableWindow
  Dim pExistingTableWindow As ITableWindow
  Dim bSetProperties As Boolean

  'Get the selected item from the current contents view
  Set pMxDoc = ThisDocument
  Set pTableWindow = New TableWindow
  Set pUnknown = pMxDoc.SelectedItem

  'Determine the selected item's type
  'Exit sub if item is not a feature layer or standalone table
  If pUnknown Is Nothing Then
```

```
    Exit Sub
  ElseIf TypeOf pUnknown Is IFeatureLayer Then 'A featurelayer
    Set pFeatureLayer = pUnknown
    Set pExistingTableWindow = _
         pTableWindow.FindViaFeatureLayer(pFeatureLayer, False)
    'Check if a table already exists; if not create one
    If pExistingTableWindow Is Nothing Then
      Set pTableWindow.FeatureLayer = pFeatureLayer
      bSetProperties = True
    End If
  ElseIf TypeOf pUnknown Is IStandaloneTable Then
    'A standalone table
    Set pStandaloneTable = pUnknown
    Set pTable = pStandaloneTable.Table
    Set pExistingTableWindow = _
       pTableWindow.FindViaTable(pTable, False)
    'Check if a table already exists; if not, create one
    If pExistingTableWindow Is Nothing Then
      Set pTableWindow.Table = pTable
      bSetProperties = True
    End If
  Else 'Cannot determine selected item type, exit sub
    Exit Sub
  End If

  If bSetProperties Then
    pTableWindow.TableSelectionAction = esriSelectFeatures
    pTableWindow.ShowSelected = False
    pTableWindow.ShowAliasNamesInColumnHeadings = True
    Set pTableWindow.Application = Application
  Else
    Set pTableWindow = pExistingTableWindow
  End If
  'Ensure table is visible
  If Not pTableWindow.IsVisible Then pTableWindow.Show True

End Sub
```



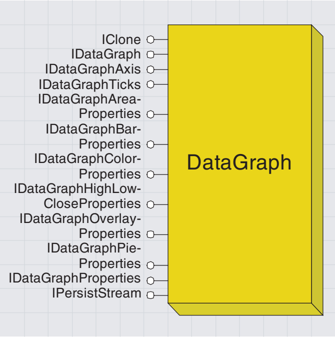
ITableWindow2 : IDataWindow

This interface extends ITableWindow to work with ILayers

Layer: ILayer	*Setup layer attributes to view*
StandaloneTable: IStandaloneTable	*Sets the standalone table to view/edit*

ITableWindow2 extends table windows, making other layer types (such as raster layers) addable. With *ITableWindow*, only feature layers can be added to a table window.

DataGraph coclass



Data graphs present information about map features in an easy-to-understand manner. The information on a graph comes directly from the attribute information stored with the geographic data.

The *DataGraph* object is the main attribute graphing or charting generation object.

IDataGraph : IUnknown	*Provides access to members that control the data graph.*
CGraphHandle: Long	*The CGraph handle. CGraph handle can only be used with C++ clients.*
FieldSet1: String	*First field set as a comma delimited list.*
FieldSet2: String	*Second field set as a comma delimited list.*
FieldSet3: String	*Third field set as a comma delimited list.*
FieldSet4: String	*Fourth field set as a comma delimited list.*
MaxDataPoints: Long	*Maximum number of data points.*
Name: String	*Name of the graph.*
PreviewMode: Boolean	*Indicates if the graph is in preview mode.*
ReloadAlways: Boolean	*Indicates if the graph should always be reloaded.*
SeriesByRecord: Boolean	*Indicates if the records or fields for the data series should be used.*
Table: ITable	*The graph's table.*
UseSelectedSet: Boolean	*Indicates if the selected set should be used.*
Valid: Boolean	*Indicates if the graph is currently valid.*
Attach (in hWnd: Long)	*Attaches the DataGraph to the input hWnd.*
CopyToClipboard	*Copys the graph to the clipboard.*
Detach	*Detaches the DataGraph from its current hWnd.*
Draw	*Updates the display of the graph based upon the associated map's current settings.*
DrawToDC (in hDC: Long, in pRect: tagRECT)	*Draws the graph to the input device context.*
ExportToFile (in FileName: String)	*Exports the graph to a file.*
LoadFromFile (in FileName: String)	*Load the graph from a file.*
Print	*Prints the graph.*
Reload	*Loads data values from a table.*
Resize (in nType: Long, in Width: Long, in Height: Long)	*Resizes the graph display.*
SaveToFile (in FileName: String)	*Saves the graph to a file.*

The *IDataGraph* interface contains the most basic methods and properties common to all *DataGraph* objects.

Important properties of the *IDataGraph* interface include the *Table* property and the *FieldSet* properties (*FieldSet1, FieldSet2, FieldSet3,* and *FieldSet4*). The *FieldSet* properties strings contain comma-delimited lists of field names. Note that the different *FieldSets* are used differently depending on the graph type of the *DataGraph*. Other properties control how the graph is displayed in a *DataGraphWindow* or on the *PageLayout* coclass.

IDataGraph methods perform operations such as reloading the *DataGraph* (*Reload* method), redrawing the graph (*Draw* method), drawing the graph to a particular Windows device context (*DrawToDC*), and loading a graph from a file or exporting the graph to a different file format (*SaveToFile, LoadFromFile,* and *ExportToFile*).

The *Attach* and *Detach* methods allow the graph to draw directly to a Window hWnd. This method can be used both by C++ and VB, as long as you have access to the control's *hWnd* property.

IDataGraphProperties : IUnknown	Provides access to members that control the datagraph properties.
■-■ GraphSubtype: esriDataGraphSubtypeEnum	Subtype of the graph.
■-■ GraphType: esriDataGraphTypeEnum	Type of graph.
■-■ LegendPosition: esriDataGraphLegendPositionEnum	The graph's legend position.
■-■ ShowDataLabels: Boolean	Indicates if the graph shows data labels.
■-■ ShowLegend: Boolean	Indicates if the graph shows a legend.
■-■ ShowXAxisLabels: Boolean	Indicates if the graph shows X axis labels.
■-■ SubTitle: String	Sub-title of the graph.
■-■ Title: String	Title of the graph.
■-■ XAxisLabelField: String	X axis label field.
← EditAdvancedProperties	Edits the advanced properties for the graph.

The *IDataGraphProperties* interface contains additional general properties common to all graph types. The *GraphType* and *GraphSubType* properties allow you to set the graph type and graph subtype using enum values. Other properties control whether to show different types of labels, the values used for the title and subtitle, and the position and display status of the legend. The *EditAdvancedProperties* method invokes an additional set of property pages on the *DataGraph* object.

IDataGraphAreaProperties : IUnknown	Provides access to members that control the datagraph area properties.
■-■ UseLogXAxis: Boolean	Indicates if a logrithmic X Axis should be used.
■-■ UseLogYAxis: Boolean	Indicates if a logrithmic Y Axis should be used.

The *IDataGraphAreaProperties* interface contains properties specific to area type graphs. The two properties control if the area graph uses logarithms on the x- or y-axes when generating the graph display.

IDataGraphBarProperties : IUnknown	Provides access to members that control the datagraph bar properties.
■-■ BarGap: Long	Gap between bars in a Bar or Column graph. Gap value is expressed as a value between 0 and 100.

The *IDataGraphBarProperties* interface contains properties specific to bar type graphs. The *BarGap* property controls the gap between bars on the graph display.

IDataGraphColorTable : IUnknown	Provides access to the datagraph color table.
■-■ ColorEnum (in Index: Long) : esriDataGraphColorEnum	The color enum of a position in the color table.
■-■ ColorRGB (in Index: Long) : Long	The RGB value of a position in the color table.
■-■ PaletteIndex: esriDataGraphPaletteEnum	The palette index of the color table.
■-■ Size: Long	Size of the color table.
← Reset	Resets the color table to the default settings.

The *IDataGraphColorTable* interface contains properties and methods for controlling the graph's color table.

Note that *DataGraphs* have a very limited set of palettes. The *ColorRGB* property performs a color match to match the input color with the closest color from the current graph color palette. Other methods on the *IDataGraphColorTable* interface allow you to set the color palette, set a color table entry by an *esriDataGraphColorEnum*, or reset the color table to the default settings.

IDataGraphHighLowCloseProperties : IUnknown	Provided access to memebrs that control the datagraph high low close properties.
ShowHighLowTicks: Boolean	Indicates if tick marks at high and low locations should be shown.
ShowOpenCloseTicks: Boolean	Indicates if tick marks at open and close locations should be shown.

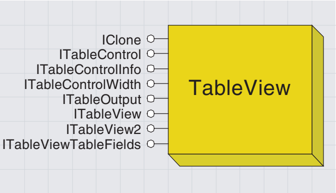
The *IDataGraphHighLowCloseProperties* interface contains properties specific to *HighLowClose* type graphs. The properties control whether the tick marks show at high and low locations and at open and close locations.

IDataGraphOverlayProperties : IUnknown	Provides access to members that control the datagraph overlay properties.
OverlayColor: esriDataGraphColorEnum	Overlay color.
OverlayLinePattern: esriDataGraphOverlayLinePatternEnum	Overlay line pattern.
OverlayLineThickness: esriDataGraphOverlayLineThicknessEnum	Overlay line thickness.
OverlayMarker: esriDataGraphMarkerEnum	Overlay marker.
OverlayType: esriDataGraphOverlayTypeEnum	Overlay graph type.
ShareYAxisRange: Boolean	Indicates if the overlay field shares the Y axis data range.
ShowBestFit: Boolean	Indicates if the best fit should be shown.
ShowCurveFit: Boolean	Indicates if the curve should be fitted.
ShowMean: Boolean	Indicates if the mean should be shown.
ShowMinMax: Boolean	Indicates if the min/max should be shown.
ShowStdDev: Boolean	Indicates if the standard deviation should be shown.
UseOverlay: Boolean	Indicates if an overlay graph should be used.
UseOverlayLineThickness: Boolean	Indicates if line thickness flag should be used.
XAxisField: String	X axis field.
YAxisField: String	Y axis field.

The *IDataGraphOverlayProperties* interface contains properties specific to graph overlays. A graph overlay is a separate set of graph features drawn on top of the primary graph features. The overlay graph properties control elements such as the type of overlay graph, the color of the overlay graph, line thickness or line pattern, and overlay marker symbol. They also control whether different types of statistical lines show along with the overlay graph.

IDataGraphPieProperties : IUnknown	Provides access to members that control the datagraph pie properties.
LabelSlicesUsing: esriDataGraphPieLabelSliceUsingEnum	The pie slice labels using enumeration.
LabelUsingColors: Boolean	Indicates if label pie slices should be using colors.
PreventLabelOverlap: Boolean	Indicates if pie label overlap should be prevented.
ShowConnectingLines: Boolean	Indicates if pie label connecting lines should be shown.

The *IDataGraphPieProperties* interface contains properties specific to pie type graphs. The properties control different labeling options as well as whether or not to display lines connecting labels with their pie slices.



A table view (table control) holds a table.

In ArcMap, all tables are presented in a table data window. Table windows house a table view, also known as a table control. In ArcCatalog, there are no table windows; instead, a table view is directly displayed as a GX view. The table view object is cocreatable. For example, you can instantiate a new table view object, link it to a table, and display it in a custom form.

ITableView : IUnknown	***Provides access to members that set up the table and initially show it.***
Callback: ITableViewCallback	*Sets up the call back routine.*
QueryFilter: IQueryFilter	*QueryFilter of records to show.*
SelectionSet: ISelectionSet	*Selection set of records to show/select.*
ShowAliasNamesInColumnHeadings: Boolean	*Show alias names or the real field name in column headings. Default False.*
ShowSelected: Boolean	*Show only features that are selected.*
Table: ITable	*Table to view/edit.*
TableSelectionAction: tagesriTableSelectionActions	*Action to perform when table selections are made.*
Show (in parentHWnd: Long, in initialExtent: tagRECT, in initiallyVisible: Boolean)	*Show table*

The primary interface on the table view objects is *ITableView*. Use this interface to link a table to the table view and display it.

ITableView2 : IUnknown	***Provides access to members that interact with table.***
AllowEditing: Boolean	*Allow editing. Default: True*
ShowAliasNamesInColumnHeadings: Boolean	*Indicates if column headings are using alias names.*
ShowSelected: Boolean	*Indicates if selected records are being displayed.*
GetLeftCol: Long	*Gets the left visible column of the view window.*
GetTopRow: Long	*Gets the top visible row of the view window.*
Output (in hDC: Long, in dpi: Long, in Left: Long, in Top: Long, in Width: Long, in Height: Long, in StartRow: Long, in StartCol: Long)	*Draw the table to the specified device context.*
SetPosition (in Left: Long, in Top: Long, in Width: Long, in Height: Long)	*Sets the position of the view window.*

ITableView2 manages some additional table view properties such as whether the table can be edited or not. It also controls whether the table only shows selected records or all of the records.

ITableControl : IUnknown	***Provides access to members that control the table once it has been shown.***
DrawSelectedShapes (in pDisplay: IDisplay)	*Draws selected features on display.*
EditChanged	*Call after start or stop editing, to update table grid.*
GetCurrentRow (in isOid: Boolean) : Long	*The current row the user is on. If isOid = TRUE, then rowNumber is an OID, else it is an offset.*
Redraw	*Redraws the grid.*
RemoveAndReloadCache	*Lose cache, so the table window is current with the underlying database.*
RereadFIDs (pSelection: ISelectionSet)	*ReReads rows. Called when viewing selected records and the selection changes.*
SetCurrentRow (in isOid: Boolean, in rowNumber: Long)	*The current row the user is on. If isOid = TRUE, then rowNumber is an OID, else it is an offset.*
UpdateSelection (pSelection: ISelectionSet)	*Updates the current selection, that the current selection is currently pointing to.*

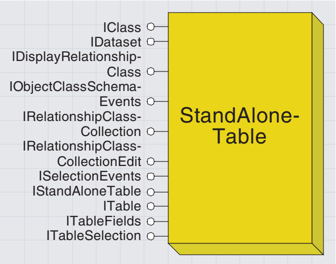
The *ITableControl* interface manages methods that apply to an existing displayed table. For example, use the methods managed by this interface to draw the features currently selected in the table, redraw the table after edits have been made, and set the current row in the table.

ITableControlWidth : IUnknown	***Provides access to members that control the table once it has been shown.***
■— FullTableWidth: Long	*Table width of all columns, and scroll bars.*
■— RecommendMinimumTableWidth: Long	*Recommend minimum table width, that will ensure all controls can be seen.*

The *ITableControlWidth* interface has two properties that aid in sizing the table when first displaying it. The *RecommendMinimumTableWidth* property returns the minimum width the table needs to be to see all columns. The *FullTableWidth* property returns the current table width.

ITableViewTableFields : IUnknown	***Provides access to members that associate additional field properties with the table being displayed.***
■—□ TableFields: ITableFields	*The collection of field information for the table being viewed/edited.*

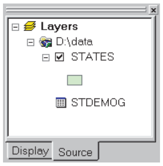
The *ITableViewTableFields* interface has one property that provides access to the fields in the table.


IClass
IDataset
IDisplayRelationship-Class
IObjectClassSchema-Events
IRelationshipClass-Collection
IRelationshipClass-CollectionEdit
ISelectionEvents
IStandAloneTable
ITable
ITableFields
ITableSelection
StandAlone-Table

A StandaloneTable *is not associated with a feature class, raster, or other dataset.*

Not all the tabular data associated with a layer has to be stored in its attribute table. You may choose to store some data in separate tables. You can add this tabular data directly to your map as a table and use it in conjunction with the layers on your map. These tables don't display on your map, but they are listed in the table of contents on the Source tab. Work with these tables as you would any table based on geographic features. For example, you can view the table, add new fields, create graphs, and join it to other tables.

Use the *IStandaloneTableCollection* interface on the *Map* to get a reference to a *StandaloneTable*. Alternatively, if you have a *TableWindow*, you can use the *ITableWindow2::StandaloneTable* property to get the *StandaloneTable* that is displayed by that *TableWindow*.



This map contains a standalone table called STDEMOG. Standalone tables are listed on the Source tab.

IStandaloneTable : IUnknown	***Provides access to members that control a standalone table.***
DisplayField: String	*Primary display field.*
Name: String	*Name of the standalone table.*
Table: ITable	*The table associated with the standalone table.*
Valid: Boolean	*Indicates if the standalone table is currently valid.*

The *IStandaloneTable* interface has properties to manage the table on which the standalone table is based.

Use *Table* property to set or get the underlying table object. There are also properties to specify the name and the display field.

ITableFields : IUnknown	***Table Fields interface.***
Field (in Index: Long) : IField	*The field at the given index.*
FieldCount: Long	*The field count.*
FieldInfo (in Index: Long) : IFieldInfo	*The extended field information for the field at the given index.*
FindField (in FieldName: String) : Long	*The index of the field with the given name.*

You can use the *ITableFields* interface to return the field count and to get a particular field.

The *FieldInfo* property provides extended information on the field; it returns a *FieldInfo* object. For more information, refer to the discussion on the *FieldInfo* coclass later in this chapter.

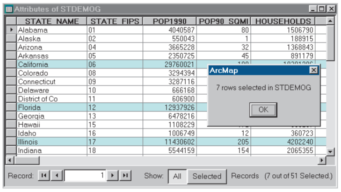
ITableSelection : IUnknown	***Provides access to members that control table selection.***
SelectionSet: ISelectionSet	*The selected set of rows.*
AddRow (in Row: IRow)	*Adds a row to the selection set (honoring the current combination method).*
Clear	*Clears the selection.*
SelectionChanged	*Fires the layer update event. Required when SelectionSet changes.*
SelectRows (in Filter: IQueryFilter, in Method: esriSelectionResultEnum, in justOne: Boolean)	*Selects rows based upon the specified criteria and combination method.*

The *ITableSelection* interface lets you perform a selection on the table, add a row to the current selection, and clear the selection; it then notifies you that the selection changed. You can also specify the selection set using the *SelectionSet* property.

For information on the other interfaces on *StandaloneTable*, refer to the *FeatureLayer* coclass later in this chapter.

The following VBA code gets the first standalone table in the map, selects the rows that have a population greater that 10,000,000, and reports the number of selected rows:

```
Public Sub TableSel()
  Dim pMxDoc As IMxDocument
  Dim pMap As IStandaloneTableCollection
  Dim pStdAloneTbl As IStandaloneTable
  Dim pTableSel As ITableSelection
  Dim pQueryFilt As IQueryFilter
  Dim pSelSet As ISelectionSet

  ' Get the standalone table from the map
  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pStdAloneTbl = pMap.StandaloneTable(0)
  Set pTableSel = pStdAloneTbl

  ' Make the query filter
  Set pQueryFilt = New QueryFilter
  pQueryFilt.WhereClause = "POP1990 > 10000000"

  ' Perform the selection
  pTableSel.SelectRows pQueryFilt, esriSelectionResultNew, False

  ' Report how many rows were selected
  Set pSelSet = pTableSel.SelectionSet
  MsgBox pSelSet.Count & " rows selected in " & pStdAloneTbl.Name
End Sub
```



Attributes of STDEMOG

STATE NAME	STATE FIPS	POP1990	POP90 SQMI	HOUSEHOLDS
Alabama	01	4040587	80	1506790
Alaska	02	550043	1	188915
Arizona	04	3665228	32	1368843
Arkansas	05	2350725	45	891179
California	06	29760021		
Colorado	08	3294394		
Connecticut	09	3287116		
Delaware	10	666168		
District of Co	11	606900		
Florida	12	12937926		
Georgia	13	6478216		
Hawaii	15	1108229		
Idaho	16	1006749	12	360723
Illinois	17	11430602	205	4202240
Indiana	18	5544159	154	2065355

ArcMap

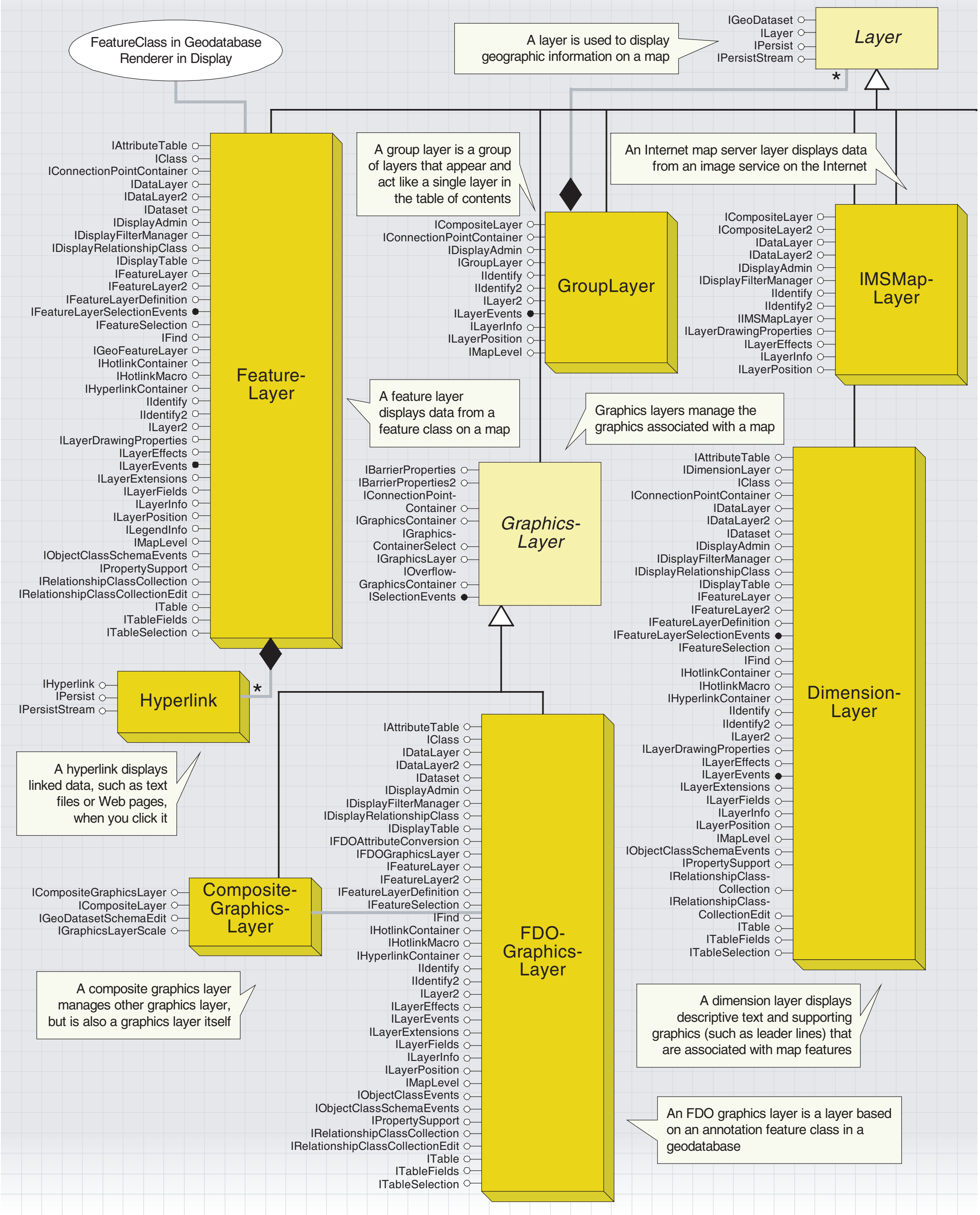
7 rows selected in STDEMOG

OK

Record: 1 Show: All Selected Records (7 out of 51 Selected.)

After running this macro, the selection is shown in the table window. The message box reports how many rows were selected.

ArcMap map



A layer is used to display geographic information on a map

A group layer is a group of layers that appear and act like a single layer in the table of contents

An Internet map server layer displays data from an image service on the Internet

A feature layer displays data from a feature class on a map

Graphics layers manage the graphics associated with a map

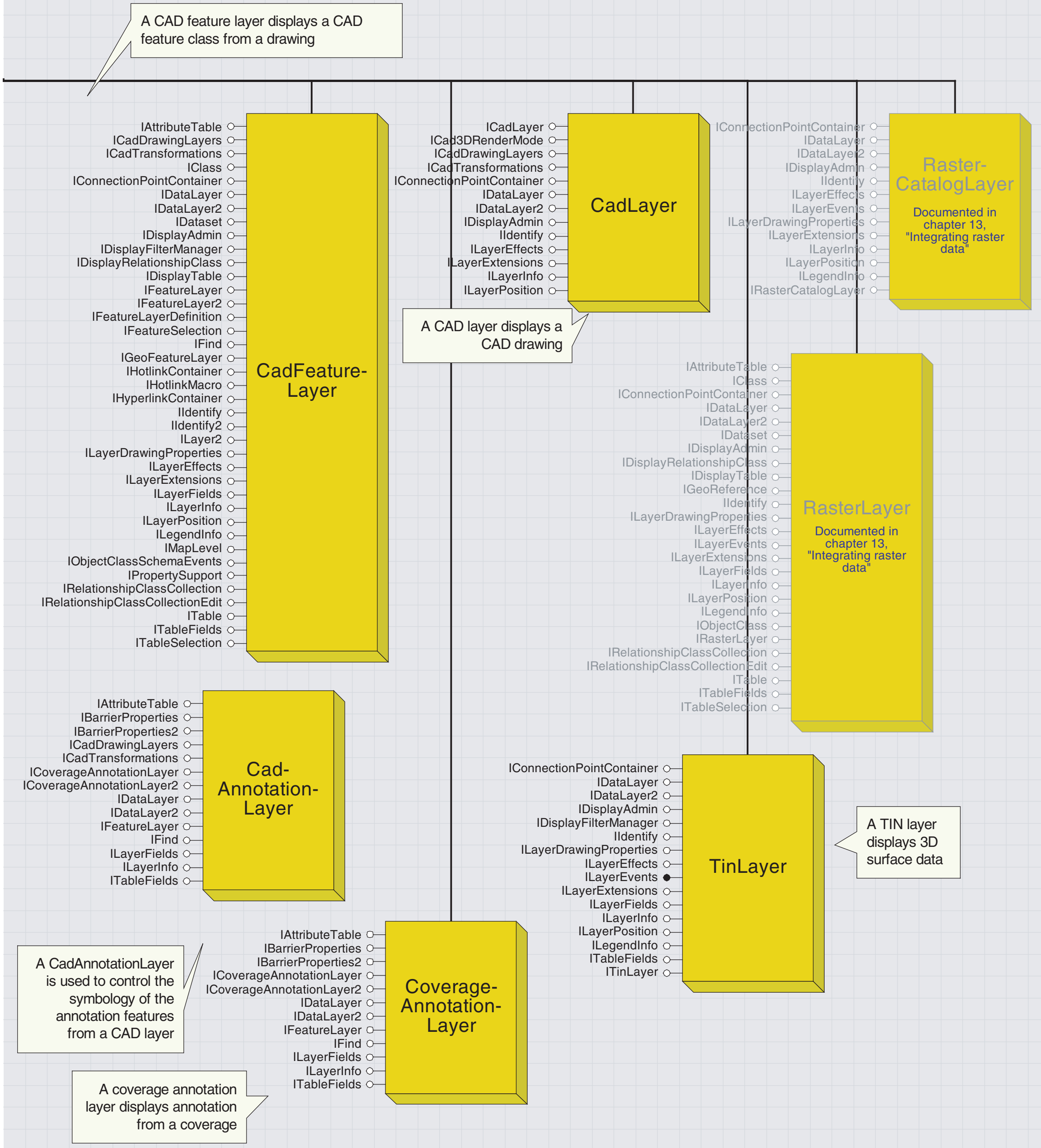
A hyperlink displays linked data, such as text files or Web pages, when you click it

A composite graphics layer manages other graphics layer, but is also a graphics layer itself

A dimension layer displays descriptive text and supporting graphics (such as leader lines) that are associated with map features

An FDO graphics layer is a layer based on an annotation feature class in a geodatabase

layer objects



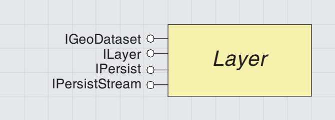
A CAD feature layer displays a CAD feature class from a drawing

A CAD layer displays a CAD drawing

A TIN layer displays 3D surface data

A CadAnnotationLayer is used to control the symbology of the annotation features from a CAD layer

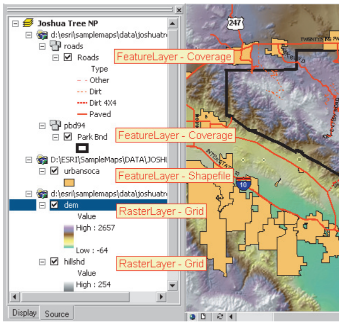
A coverage annotation layer displays annotation from a coverage



Geographic data is represented on a map as a layer. A layer might represent a particular type of feature, such as highways, lakes, or wildlife habitats, or it might represent a particular type of data, such as a satellite image, a computer-aided design (CAD) drawing, or a terrain elevation surface in a TIN.

Layers display geographic information on a map. A layer doesn't store the actual geographic data; it references the data contained in coverages, shapefiles, geodatabases, images, grids, and so on, then defines how to display this geographic data.

Each different type of layer object represents different types of data. Examples of layer objects include *FeatureLayer, GraphicsLayer, RasterLayer, TinLayer, CoverageAnnotationLayer,* and *GroupLayer*.



This map contains different types of layers.

The *Map* object manages the collection of layers. You can use the *Layer* or the *Layers* property on the *IMap* interface to get a reference to a layer. To determine the type of layer to which you have a reference, query for specific interfaces. For example, if the layer object supports the *IGeoFeatureLayer* interface, then you know it is a *FeatureLayer* object. In Visual Basic, this might be coded as follows:

```
Dim pLayer as ILayer
Set player = pMap.Layer(0)
If TypeOf pLayer is IGeoFeatureLayer Then
  'pLayer is a FeatureLayer object
End If
```

ILayer : IUnknown	Provides access to members that work with all layers.
AreaOfInterest: IEnvelope	The default area of interest for the layer.
Cached: Boolean	Indicates if the layer needs its own display cache.
MaximumScale: Double	Maximum scale (representative fraction) at which the layer will display.
MinimumScale: Double	Minimum scale (representative fraction) at which the layer will display.
Name: String	Layer name.
ShowTips: Boolean	Indicates if the layer shows map tips.
SpatialReference: ISpatialReference	Spatial reference for the layer.
SupportedDrawPhases: Long	Supported draw phases.
TipText (in X: Double, in Y: Double, in Tolerance: Double) : String	Map tip text at the specified location.
Valid: Boolean	Indicates if the layer is currently valid.
Visible: Boolean	Indicates if the layer is currently visible.
Draw (in drawPhase: tagesriDrawPhase, in Display: IDisplay, in trackCancel: ITrackCancel)	Draws the layer to the specified display for the given draw phase.

All layer objects implement the *ILayer* and *IGeoDataset* interfaces. The *ILayer* interface has a method to draw the layer and properties to define the extent of the layer, the minimum and maximum display scale, the spatial reference, the name, the supported draw phases, and the map tip text. There are also properties that indicate whether the layer is visible, valid, or cached, and whether or not the layer shows map tips.

For more information on caching, see the topic 'Refreshing the map versus partial refresh' earlier in this chapter.

The *Cached* property indicates whether the layer requires its own display cache or not. If *Cached* is set to *True*, the *Map* will give a separate display cache to the layer so it can be refreshed independently of all other layers. A tracking layer is a good example of a custom layer that would set the *Cached* property to *True*.

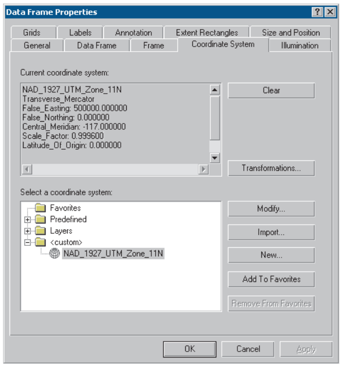
Note that the *SpatialReference* property is used only for the map display; it does not change the spatial reference of the underlying data. It carries the map object's knowledge of the current on-the-fly projection back to the feature layer.

The following VB function finds and returns the layer with the specified name.

```
Function FindLayerByName(pMap As IMap, sName As String) As ILayer
  Dim i As Integer
  For i = 0 To pMap.LayerCount - 1
    If pMap.Layer(i).Name = sName Then
      Set FindLayerByName = pMap.Layer(i)
    End If
  Next
End Function
```

IGeoDataset : IUnknown	*GeoDataset Interface.*
Extent: IEnvelope	*The extent of the GeoDataset.*
SpatialReference: ISpatialReference	*The spatial reference of the GeoDataset.*

The *IGeoDataset* interface specifies the extent and spatial reference of the underlying data. The *SpatialReference* property on *IGeoDataset* is read-only. The property is used to set the spatial reference of the *Map*; the *Map*'s spatial reference is automatically set to the spatial reference of the first layer loaded. For more information on this interface, refer to Volume 2, Chapter 8, 'Accessing the geodatabase'.



Current coordinate system:

```
NAD_1927_UTM_Zone_11N
Transverse_Mercator
False_Easting: 500000.000000
False_Northing: 0.000000
Central_Meridian: -117.000000
Scale_Factor: 0.999600
Latitude_Of_Origin: 0.000000
```

Select a coordinate system:

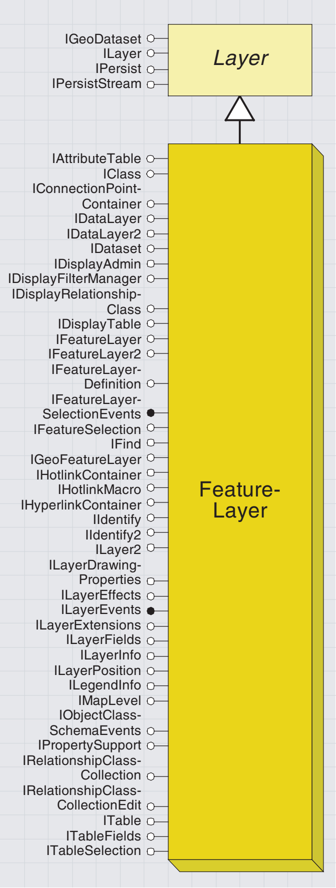
- Favorites
- Predefined
- Layers
- <custom>
  - NAD_1927_UTM_Zone_11N

The Coordinate System panel of Data Frame Properties is automatically set based on the spatial reference of the first layer added to the map.

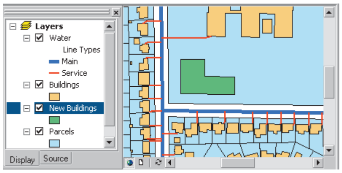
The following code reports the name of the spatial reference of the layer.

```
Sub ReportSpatRef()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pLayer As IGeoDataset
  Dim pSpatRef As ISpatialReference

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pLayer = pMap.Layer(0)
  Set pSpatRef = pLayer.SpatialReference
  MsgBox pSpatRef.Name
End Sub
```

A *FeatureLayer* is a layer based on a feature class in a vector geographic dataset—a geodatabase, coverage, or shapefile.



A feature layer displays point, line, or polygon geographic data.



This map contains feature layers.

IFeatureLayer : ILayer

Provides access to members that control common aspects of a feature layer.

DataSourceType: String	*Data source type.*
DisplayField: String	*Primary display field.*
FeatureClass: IFeatureClass	*The layer's feature class.*
ScaleSymbols: Boolean	*Indicates if symbols are scaled for the layer.*
Selectable: Boolean	*Indicates if layer is selectable.*
Search (in QueryFilter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor	*Creates a cursor based upon the search criteria.*

The *IFeatureLayer* interface has properties that determine the feature class of the layer, the data source type, the display field, whether the symbols are scaled, and whether the layer is selectable. There is also a method for performing a search on the layer. If there is a definition query set on the layer, the *Search* method will work on the subset of the features in the layer that meet the definition criteria. However, the *Search* method will not work on joined fields. If the feature layer has any joins, use the *IGeoFeatureLayer::SearchDisplayFeatures* method instead.

The following code creates a feature layer from a shapefile and adds it to the map:

```
Sub AddLayer()
  Dim pShpWksFact As IWorkspaceFactory
  Dim pFeatWks As IFeatureWorkspace
  Dim pFeatClass As IFeatureClass
  Dim pFeatLayer As IFeatureLayer
  Dim pDataSet As IDataset
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap

  Set pShpWksFact = New ShapefileWorkspaceFactory
  Set pFeatWks = pShpWksFact.OpenFromFile("D:\Data\Canada", 0)
  Set pFeatClass = pFeatWks.OpenFeatureClass("province")
  Set pFeatLayer = New FeatureLayer
  Set pFeatLayer.FeatureClass = pFeatClass
  Set pDataSet = pFeatClass
  pFeatLayer.Name = pDataSet.Name

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  pMap.AddLayer pFeatLayer
End Sub
```

IGeoFeatureLayer : IFeatureLayer	Provides access to members that control geographic aspects of a feature layer.
AnnotationProperties: IAnnotateLayerPropertiesCollection	Annotation properties.
AnnotationPropertiesID: IUID	The UID used for annotation properties.
CurrentMapLevel: Long	Current map level for drawing symbols.
DisplayAnnotation: Boolean	Indicates if the layer displays annotation.
DisplayFeatureClass: IFeatureClass	Feature class used for display operations (may include joined fields).
ExclusionSet: IFeatureIDSet	Set of features that are excluded from drawing.
Renderer: IFeatureRenderer	Renderer used to draw the layer.
RendererPropertyPageClassID: IUID	Class id of the property page for the renderer.
SearchDisplayFeatures (in QueryFilter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor	Creates a cursor from the display feature class based upon the search criteria.

Only the *FeatureLayer* object uses the *IGeoFeatureLayer*. This interface has properties to set the annotation and renderer for the layer.

The *SearchDisplayFeatures* method allows you to search the feature layer to find features that meet the specified criteria. If there is a definition query set on the layer, the *SearchDisplayFeatures* method will work on the subset of the features in the layer that meet the definition criteria. This search method will also work on joined fields if you qualify the field names. For example, if you want to search on a joined field called "Pop1990" from a table called "Demog", you should use "Demog.Pop1990" as the field name in query filter used in the search method. The *IDisplayTable::SearchDisplayTable* method is a similar search method that will work on feature layers as well as other types of layers. If you want your code to be generic enough to work on different types of layers and standalone tables, you should perform searches using *IDisplayTable::SearchDisplayTable*.

The *IGeoFeatureLayer* interface inherits from the *IFeatureLayer* interface, and the *IFeatureLayer* interface inherits from the *ILayer* interface. This means that when you are working with the *IGeoFeatureLayer* interface, all the properties and methods in *IFeatureLayer* and *ILayer* are exposed. Therefore, when you are working with a feature layer object, you don't need to *QI* for *IFeatureLayer* or *ILayer*; if you *QI* for *IGeoFeatureLayer*, you will get everything from all of these three interfaces.

The following code performs a search on the first layer in the map. This layer is joined to a table named "Demog", and a joined field is used in the query filter for the search method. The name of each feature in the results is reported.

```
Sub GeoFeatLyrSearch()
  Dim pDoc As IMxDocument, pMap As IMap
  Dim pLayer As IGeoFeatureLayer
  Dim pQueryFilt As IQueryFilter
  Dim pFeatCursor As IFeatureCursor
  Dim pFeature As IFeature
  Set pDoc = Application.Document
  Set pMap = pDoc.FocusMap
  Set pLayer = pMap.Layer(0)
  ' Create the query filter and set the where clause. Note that
  ' this is a joined layer so you must qualify the field names.
  Set pQueryFilt = New QueryFilter
  pQueryFilt.WhereClause = "DEMOG.Pop1991 > 1000000"

  'Perform the search and report name of each feature in results
  Set pFeatCursor = pLayer.SearchDisplayFeatures(pQueryFilt, True)
  Set pFeature = pFeatCursor.NextFeature
  MsgBox pFeature.Value(pFeatCursor.FindField("Province.Name"))
  Do Until pFeature Is Nothing
    Set pFeature = pFeatCursor.NextFeature
    If Not pFeature Is Nothing Then
      MsgBox pFeature.Value(pFeatCursor.FindField("Province.Name"))
    End If
  Loop
End Sub
```

IDataLayer : IUnknown	***Provides access to members that control the data source properties of a layer.***
DataSourceName: IName	*Name of the data object for the layer.*
DataSourceSupported (in Name: IName) : Boolean	*Indicates if the specified data object name is supported by the layer.*
RelativeBase: String	*Base path used when storing relative path names.*
Connect (in pOptRepairName: IName) : Boolean	*Connects the layer to its data source. An optional name object can be specified to aid in repairing a lost connection.*

The *IDataLayer* interface provides information about the data source of the layer, such as the data source name, the base path used in relative pathnames, and whether the layer supports the data source. There is also a method to connect to the data source if the connection has been lost. The following code reports the base path used in relative pathnames:

```
Public Sub GetRelativeBase()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pLayer As IDataLayer
  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pLayer = pMap.Layer(0)
  MsgBox pLayer.RelativeBase
End Sub
```

IDisplayTable : IUnknown	***Provides access to members that work with the display table associated with a standalone table.***
DisplayTable: ITable	*The display table.*
SearchDisplayTable (in pQueryFilter: IQueryFilter, in Recycling: Boolean) : ICursor	*Creates a cursor from the display table based upon the search criteria.*
SelectDisplayTable (in pQueryFilter: IQueryFilter, in selType: esriSelectionType, in selOption: esriSelectionOption, in pSelWorkspace: IWorkspace) : ISelectionSet	*Creates a selection set from the display table based upon the search criteria.*

The display table is the table used for display purposes. This table differs from the table of the base feature class of the layer (*IFeatureLayer::FeatureClass*) in that it may contain joined fields. The display table is the *RelQueryTable* object of the layer. The *IDisplayTable* interface has a property to get a reference to the display table and methods to perform searches and selections on the display table. If you want your code to be generic enough to work on different types of layers and standalone tables, you should perform selections and searches using the methods on *IDisplayTable* rather than similar methods on other interfaces.

The following code creates a selection set using the *SelectDisplayTable* method, then reports the number of selected features. It is necessary to create a scratch workspace to use for the selection. This code only creates a selection set; it doesn't show the selection on the display. To see how to show the selection on the display, refer to the *IFeatureSelection* interface.

```
Public Sub DpyTableSelect()
  Dim pDoc As IMxDocument
  Dim pMap As IMap
  Dim pDpyTable As IDisplayTable
  Dim pScratchWorkspace As IWorkspace
  Dim pScratchWorkspaceFactory As IScratchWorkspaceFactory
  Dim pQFilt As IQueryFilter
  Dim pSelSet As ISelectionSet

  Set pDoc = Application.Document
  Set pMap = pDoc.FocusMap
  Set pDpyTable = pMap.Layer(0)

  ' Create a scratch workspace to use for the selection
  Set pScratchWorkspaceFactory = New ScratchWorkspaceFactory
  Set pScratchWorkspace = _
   pScratchWorkspaceFactory.DefaultScratchWorkspace

  ' Create the query filter
  Set pQFilt = New QueryFilter
  pQFilt.WhereClause = "TYPE = 'Gravel'"

  ' Create the selection set
  Set pSelSet = pDpyTable.SelectDisplayTable(pQFilt, _
    esriSelectionTypeIDSet, esriSelectionOptionNormal, _
    pScratchWorkspace)

  ' Report number of selected features
  MsgBox pSelSet.Count
End Sub
```

A display filter allows a rasterized version of the layer to be processed for drawing purposes. You can create your own display filter to display a layer using more raster-like effects, such as contrast and brightness adjustments.

IDisplayAdmin : IUnknown	***Provides access to members that control display administration.***
■— UsesFilter: Boolean	*Indicates if the current object draws using a filter.*

The *IDisplayAdmin* interface indicates whether the layer uses a display filter.

IDisplayFilterManager : IDisplayAdmin	***Provides access to members that control display filter management.***
■—■ DisplayFilter: IDisplayFilter	*The display filter.*

The *IDisplayFilterManager* interface specifies what display filter object is currently being used.

IPropertySupport : IUnknown	***Provides access to members that set a default property on an object.***
■— Current (in pUnk: IUnknown Pointer) : IUnknown Pointer	*The object currently being used.*
← Applies (in pUnk: IUnknown Pointer) : Boolean	*Indicates if the receiver can apply the given object at any given time.*
← Apply (in NewObject: IUnknown Pointer) : IUnknown Pointer	*Applies the given property to the receiver and returns the old object.*
← CanApply (in pUnk: IUnknown Pointer) : Boolean	*Indicates if the receiver can apply the given object at that particular moment.*

Many objects implement the *IPropertySupport* interface to provide access to properties of the object. The interface has methods for determining whether a certain property can be applied to an object; it allows the property to be applied when appropriate. *FeatureLayer*'s implementation of *IPropertySupport* is used to check to see if the specified display filter object can be applied to the layer. The *Applies* method indicates whether the specified display filter object can be applied at all, while the *CanApply* method indicates whether the specified display filter object can be applied at that particular moment. The *Current* method will return the current display filter. *FeatureLayer* also uses *IPropertySupport* for some renderer objects.

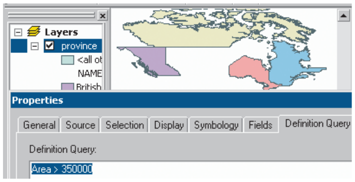
IFeatureLayer2 : IUnknown	***Additional interface to provides access to members that control common aspects of a feature layer.***
■— ShapeType: tagesriGeometryType	*The layer's shape type.*

The *IFeatureLayer2* interface has a *ShapeType* property that uses the *esriGeometryType* enumeration to indicate the shape type of the features in the layer.

IFeatureLayerDefinition : IUnknown	***Provides access to members that are used to create a selection layer from an existing FeatureLayer's selected features.***
■—■ DefinitionExpression: String	*Definition query expression for the existing layer.*
■— DefinitionSelectionSet: ISelectionSet	*Set of features defined by the existing layer's definition query expression.*
■—□ RelationshipClass: IRelationshipClass	*The current relationship class used to display related fields.*
← CreateSelectionLayer (in LayerName: String, in useCurrentSelection: Boolean, in joinTableNames: String, in Expression: String) : IFeatureLayer	*Creates a new feature layer from the existing layer based on the current selection and the specified query expression.*

The *IFeatureLayerDefinition* interface can be used to set a definition query on the feature layer so that only the features that meet the specified criteria are displayed. The *CreateSelectionLayer* method allows you to create a new layer based on the current selection on the layer, the current definition query on the layer, or the combination of the two.

The *RelationshipClass* property returns a reference to the relationship class that defines the relationship between the layer and the table to which it is joined, if there is one. However, it's better to use the *RelationshipClass* property on the *IDisplayRelationshipClass* interface for this since you'll also have access to the other properties and methods that deal with joins.



Definition Query:
Area > 350000

After running this macro, only the features that meet the specified criteria are shown in the display. The Definition Query panel of the layer's Properties dialog box shows the expression that was assigned by this macro.

The following code uses the *DefinitionExpression* property to assign a definition query to the feature layer. Only the features in the layer that have an area greater than 350,000 are displayed.

```
Sub DefineLayer()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pFeatLayerDef As IFeatureLayerDefinition
  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pFeatLayerDef = pMap.Layer(0)
  pFeatLayerDef.DefinitionExpression = "Area > 350000"
  pMxDoc.ActiveView.PartialRefresh esriViewGeography, _
        Nothing, Nothing
End Sub
```

IFeatureLayerSelectionEvents : IUnknown	*Provides access to events that occur when the selection changes.*
← FeatureLayerSelectionChanged	*Occurs when the selection changes.*

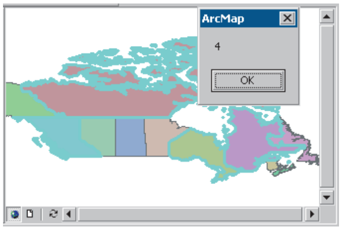
The *IFeatureLayerSelectionEvents* interface has an event that occurs when the selection on the layer changes.

IFeatureSelection : IUnknown	*Provides access to members that control feature selection.*
■—■ BufferDistance: Double	*Buffer distance used for the selection.*
■—■ CombinationMethod: esriSelectionResultEnum	*Combination method for the selection.*
■—□ SelectionColor: IColor	*Selection color. (used when SetSelectionSymbol = FALSE).*
■—□ SelectionSet: ISelectionSet	*The selected set of features.*
■—□ SelectionSymbol: ISymbol	*Selection symbol.*
■—■ SetSelectionSymbol: Boolean	*Indicates if the selected set of features is drawn using the SelectionSymbol.*
← Add (in Feature: IFeature)	*Adds a feature to the selection set (honoring the current combination method).*
← Clear	*Clears the selection.*
← SelectFeatures (in Filter: IQueryFilter, in Method: esriSelectionResultEnum, in justOne: Boolean)	*Selects features based upon the specifed criteria and combination method.*
← SelectionChanged	*Fires the features layer update event. Required when SelectionSet changes.*

The *IFeatureSelection* interface has properties to set the selection color and symbol, buffer distance, and selection combination method. There are methods to perform a selection on the layer, add a feature to the current selection, clear the selection, and notify you that the selection changed. The *SelectFeatures* method performs the selection and automatically shows the selection in the display. Use the *SelectionSet* property to get the set of the selected features after the selection is performed. If you have created a selection set some other way, you can use the *SelectionSet* property to assign that selection set to the feature layer so that the selection shows up on the display.

This code selects all the features that have an area greater than 350,000 data units and reports the number of selected features.

```
Public Sub SelFeatures()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pFeatSel As IFeatureSelection
  Dim pQueryFilt As IQueryFilter
  Dim pSelSet As ISelectionSet

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pFeatSel = pMap.Layer(0)

  ' Make the query filter
  Set pQueryFilt = New QueryFilter
  pQueryFilt.WhereClause = "AREA > 350000"

  'Perform the selection and refresh the view
  pFeatSel.SelectFeatures pQueryFilt, esriSelectionResultNew, False
  pFeatSel.SelectionChanged
  pMxDoc.ActiveView.PartialRefresh esriViewGeography, _
         Nothing, Nothing

  'Report how many features were selected
  Set pSelSet = pFeatSel.SelectionSet
  MsgBox pSelSet.Count
End Sub
```



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After running this macro, the selection is shown in the display, and the message box reports how many features were selected.

IIdentify : IUnknown	Provides access to members that identify features.
Identify (in pGeom: IGeometry) : IArray	Identifies objects at the specified location.

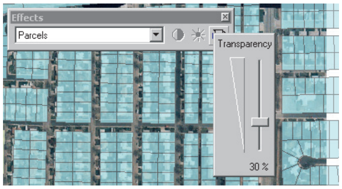
The *IIdentify* interface has a method that identifies features at the specified location. The *Identify* method returns an array of *FeatureIdentifyObj* objects.

ILayer2 : IUnknown	Provides access to additional members that work with all layers.
AreaOfInterest: IEnvelope	Area of interest for the layer.
ScaleRangeReadOnly: Boolean	Indicates if the minimum and maximum scale range values are read-only.

The *ILayer2* interface contains additional *ILayer* properties that set the extent of the layer and lock the scale range.

ILayerDrawingProperties : IUnknown	Provides access to members that control layer drawing properties.
DrawingPropsDirty: Boolean	Indicates if the layer drawing properties are dirty.

The *ILayerDrawingProperties* interface is used internally by the Layer Properties dialog box to indicate whether any of the properties



Setting a layer's transparency in ArcMap

that determine how a layer is drawn have been changed. For example, if you set the minimum or maximum draw scale, set the renderer, turn on labeling, or change similar properties, then the *DrawingPropsDirty* property is automatically set to *True*. The map display is refreshed only if the layer's drawing properties are dirty after the Layer Properties dialog box is dismissed.

ILayerEffects : IUnknown	*Provides access to members that control layer effects.*
Brightness: Integer	*Layer brightness in percent (0-100).*
Contrast: Integer	*Layer contrast in percent (0-100).*
SupportsBrightnessChange: Boolean	*Indicates if the layer supports brightness changes.*
SupportsContrastChange: Boolean	*Indicates if the layer supports contrast changes.*
SupportsInteractive: Boolean	*Indicates if the layer supports interactive effects changes.*
SupportsTransparency: Boolean	*Indicates if the layer supports transparency.*
Transparency: Integer	*Layer transparency in percent (0-100).*

The *ILayerEffects* interface changes the brightness, contrast, and transparency of the layer. The controls on the *Effects* toolbar use the *ILayerEffects* interface. Feature layers only support transparency changes. Raster layers support all three types of layer effects. Before you attempt to change a layer effect, you should check to see if the layer supports that type of change. To determine this, use the *SupportsBrightnessChange, SupportsContrastChange,* and *SupportsTransparency* properties. The display settings on your computer must be set to True Color in order for layer effects to work correctly.

The following VBA code changes the transparency of the first map layer:

```
Sub ChangeTransparency()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pLayerEffects As ILayerEffects
  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pLayerEffects = pMap.Layer(0)
  If pLayerEffects.SupportsTransparency Then
    pLayerEffects.Transparency = 30
    pMxDoc.ActiveView.PartialRefresh esriViewGeography, _
         Nothing, Nothing
  End If
End Sub
```

When you set the *ILayerEffects::Transparency* property on a feature layer, a display filter is created and applied to the layer. You can accomplish the same effect by implementing *IDisplayFilter* and using *IDisplayFilterManager* to assign it to the layer.

ILayerEvents : IUnknown	Provides access to events that occur when layer visibility changes.
← VisibilityChanged (in currentState: Boolean)	Occurs when layer visibility changes.

The *ILayerEvents* interface has an event that occurs when the visibility of the layer changes—either the layer is turned on (checked) or off (unchecked) in the table of contents. The *LayerEvents::-VisibilityChanged* event occurs when the value of the *ILayer::Visible* property is changed. Note, *VisibilityChanged* does not occur when the visibility of the layer changes due to minimum or maximum scale properties.

The following code listens for the *VisibilityChanged* event. When the first feature layer in the map is turned on or off, a message box is displayed.

```
Dim WithEvents pLyrEvents As FeatureLayer
Sub StartListening()
  Dim pMxDoc As IMxDocument, pMap As IMap
  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pLyrEvents = pMap.Layer(0)
End Sub

Private Sub pLyrEvents_VisibilityChanged(ByVal currentState As Boolean)
  Dim pLayer As ILayer
  Set pLayer = pLyrEvents
  MsgBox pLayer.name & " is visible: " & currentState
End Sub
```

ILayerExtensions : IUnknown	Provides access to members that manage layers used by the extensions.
■— Extension (in Index: Long) : IUnknown Pointer	The extension at the specified index.
■— ExtensionCount: Long	Number of extensions.
← AddExtension (in ext: IUnknown Pointer)	Adds a new extension.
← RemoveExtension (in Index: Long)	Removes the specified extension.

You can extend the existing layer implementation by implementing and registering layer extensions. For example, feature layers currently use extensions that implement *IFeatureLayerSourcePageExtension* to set a feature layer's data source.

ILayerFields : IUnknown	Provides access to members that work with a layer's fields.
■— Field (in Index: Long) : IField	The field at the specified index.
■— FieldCount: Long	The number of fields.
■— FieldInfo (in Index: Long) : IFieldInfo	Extended field information for the field at the specified index.
← FindField (in FieldName: String) : Long	Returns the index of the field with the specified name.

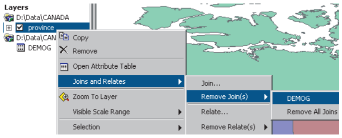
The *ILayerFields* interface has properties and methods for finding fields, returning the field count, and getting extended information on the field. The *FieldInfo* coclass provides this extended information.

ILegendInfo : IUnknown	Provides access to members that control legend information provided by a renderer.
■— LegendGroup (Index: Long) : ILegendGroup	Number of legend groups contained by the object.
■— LegendGroupCount: Long	Number of legend groups contained by the object.
■— LegendItem: ILegendItem	Optional. Defines legend formatting for layer rendered with this object.
■—■ SymbolsAreGraduated: Boolean	Indicates if symbols are graduated.

The *ILegendInfo* interface has properties that report legend information provided by a renderer. Each layer must implement *ILegendInfo*; normally, the implementation is delegated to the renderer.

ArcMap provides two ways to associate data stored in tables with the features in the layer: joins and relates. When you join a table to the layer's attribute table, you append the fields from the table to the layer's table. Joins can be used for one-to-one or many-to-one relationships between a layer and a table.

Relating the layer's table with another table defines a relationship between the two tables, but it doesn't append the fields of the table to the layer's table. Relates can be used for one-to-many or many-to-many relationships between a layer and a table. Relates defined in ArcMap are essentially the same as simple relationship classes defined in a geodatabase, except that they are saved with the map instead of in a geodatabase. If the feature class of the layer already has predefined relationship classes in the geodatabase, these relationships are automatically available for use in ArcMap (you do not have to relate the tables in ArcMap).



The join called DEMOG is associated with the layer.

The *IDisplayRelationshipClass* interface is used to manage joins on the layer, and the *IRelationshipClassCollection* and *IRelationshipClassCollectionEdit* interfaces are used to manage relates on the layer.

IDisplayRelationshipClass : IUnknown	***Provides access to members that are used to set up joins.***
JoinType: esriJoinType	*Join type for the most recent join performed.*
RelationshipClass: IRelationshipClass	*Relationship class that defines how the tables are joined.*
DisplayRelationshipClass (in relClass: IRelationshipClass, in JoinType: esriJoinType)	*Sets a join based on the specified relationship class and join type.*

The *IDisplayRelationshipClass* interface is used to set up joins between the layer and other tables. The *DisplayRelationshipClass* method internally calls *RelQueryTable::Init* to perform a join. The relationship class that is used as input to the *DisplayRelationshipClass* method can be either a predefined relationship class in a geodatabase or a memory relationship class (*MemoryRelationshipClass* coclass). For more information on both types of relationship classes, refer to Volume 2, Chapter 8, 'Accessing the geodatabase'.

The *IDisplayRelationshipClass* interface also has a property that indicates the type of the most recent join and a property that returns the relationship class that defines the tables that are joined. The *RelationshipClass* property on the *IFeatureLayerDefinition* interface can also be used to get a reference to the relationship class. However, it's better to use the *IDisplayRelationshipClass* interface for this since you'll have access to the other properties and methods dealing with joins.

Enumeration esriJoinType	***Different types of joins.***
0 - esriLeftOuterJoin	*Left outer join. All source rows are included.*
1 - esriLeftInnerJoin	*Left inner join. Only match source rows are included.*

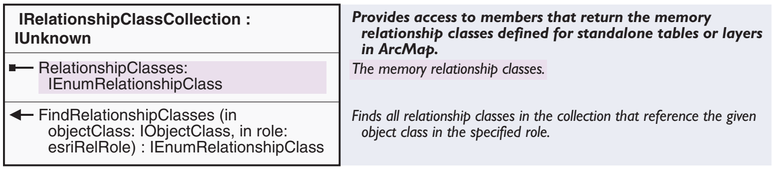
The *esriJoinType* enumeration indicates the join type. The join can either be a left-outer join, where all source rows are included, or a left-inner join, where only match source rows are included.

The following code performs a one-to-one, left-outer join on the first layer in the map and the first table in the map using a memory relationship class. The join field is "Code" in both the layer and the table. In the *IMemoryRelationshipClassFactory::Open* method, it is important to use the layer's feature class as the *pOriginForeignClass* rather than the *pOriginPrimaryClass*.

```
Public Sub JoinTable()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pLayer As IGeoFeatureLayer
  Dim pDpyRC As IDisplayRelationshipClass
  Dim pTableCollection As ITableCollection
  Dim pTable As ITable
  Dim pMemRCFact As IMemoryRelationshipClassFactory
  Dim pRelClass As IRelationshipClass
  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  ' Get a reference to the layer
  Set pLayer = pMap.Layer(0)
  Set pDpyRC = pLayer

  ' Get a reference to the table
  Set pTableCollection = pMap
  Set pTable = pTableCollection.Table(0)

  ' Create a relationship class in memory
  Set pMemRCFact = New MemoryRelationshipClassFactory
  Set pRelClass = pMemRCFact.Open("ProvDemog", pTable, "CODE",
pLayer.FeatureClass, _
        "CODE", "Province", "Demog", esriRelCardinalityOneToOne)

  ' Perform the join
  pDpyRC.DisplayRelationshipClass pRelClass, esriLeftOuterJoin
End Sub
```

The following code performs a join using a predefined relationship in a geodatabase:

```
Public Sub JoinWithGDBRelate()
  Dim pMxDoc As IMxDocument, pMap As IMap
  Dim pLayer As IGeoFeatureLayer
  Dim pDpyRC As IDisplayRelationshipClass
  Dim pFeatClass As IFeatureClass
  Dim pEnumRC As IEnumRelationshipClass
  Dim pRelClass As IRelationshipClass

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap

  ' Get a reference to the layer
  Set pLayer = pMap.Layer(0)
  Set pDpyRC = pLayer

  ' Get the relationshipclass from the layer's featureclass
  Set pFeatClass = pLayer.FeatureClass
  Set pEnumRC = pFeatClass.RelationshipClasses(esriRelRoleAny)
  Set pRelClass = pEnumRC.Next

  ' Perform the join
  pDpyRC.DisplayRelationshipClass pRelClass, esriLeftOuterJoin
End Sub
```



IRelationshipClassCollection : IUnknown

Provides access to members that return the memory relationship classes defined for standalone tables or layers in ArcMap.

RelationshipClasses: IEnumRelationshipClass

The memory relationship classes.

FindRelationshipClasses (in objectClass: IObjectClass, in role: esriRelRole) : IEnumRelationshipClass

Finds all relationship classes in the collection that reference the given object class in the specified role.

The *IRelationshipClassCollection* interface provides a method to get all the relationship classes associated with the layer and a method to find all the relationship classes that reference the given object class in the specified role.

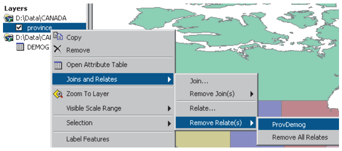
Enumeration esriRelRole	*Relationship Role.*
1 - esriRelRoleAny	*Any.*
2 - esriRelRoleOrigin	*Origin.*
3 - esriRelRoleDestination	*Destination.*

The *esriRelRole* enumeration indicates the relationship role. The layer can be the origin or the destination in the relationship.

IRelationshipClassCollectionEdit : IUnknown	***Provides access to members that add and remove memory relationship classes from a standalone table or layer.***
← AddRelationshipClass (in RelationshipClass: IRelationshipClass)	*Adds the specified memory relationship class to a standalone table or layer.*
← RemoveAllRelationshipClasses	*Removes all memory relationship classes from a standalone table or layer.*
← RemoveRelationshipClass (in RelationshipClass: IRelationshipClass)	*Removes the specified memory relationship class from a standalone table or layer.*

The *IRelationshipClassCollectionEdit* interface provides members that manage the memory relationships (relates) associated with the layer. You can add relationship classes, remove a particular relationship class, or remove all relationship classes using the methods on this interface. The following code uses the *AddRelationshipClass* method to set up a relate between the first layer in the map and the first table in the map:

```
Public Sub RelateTable()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pLayer As IGeoFeatureLayer
  Dim pTableCollection As ITableCollection
  Dim pTable As ITable
  Dim pMemRC As IMemoryRelationshipClass
  Dim pRCCollectionEdit As IRelationshipClassCollectionEdit

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap

  'Get a reference to the layer
  Set pLayer = pMap.Layer(0)
  Set pRCCollectionEdit = pLayer

  ' Get a reference to the table
  Set pTableCollection = pMap
  Set pTable = pTableCollection.Table(0)

  ' Create a relationship class in memory
  Set pMemRC = New MemoryRelationshipClass
  pMemRC.Init "ProvDemog", pTable, "CODE", pLayer.FeatureClass, _
          "CODE", "Province", "DEMOG", esriRelCardinalityOneToOne

  ' Perform the relate
  pRCCollectionEdit.AddRelationshipClass pMemRC
End Sub
```



The relate called ProvDemog *is associated with the layer.*

A hyperlink displays linked data, such as text files or Web pages, when you click it.

There are two types of hyperlinks that can be associated with a layer—dynamic hyperlinks, which can be created as you browse your data, and hotlinks, which are hyperlinks stored in a field in the feature layer. Both hyperlinks and hotlinks can be assigned to features in a layer to display a document or Web page when a feature is clicked using the Hyperlink tool.

Hotlinks use a field in the database to store the hyperlink address for a Web page, document, or some information used by a macro.

When hotlinks are assigned to a feature layer, every feature in the layer is linked to the item listed in its hotlink field. If the hotlink field is empty for a feature, that feature is not linked to anything. To set up hotlinks using the user interface in ArcMap, click the Display panel of the Layer Properties dialog box and check Support Hyperlinks using field. Click the field that contains the hyperlink information, then use the *IHotlinkContainer* interface on the *FeatureLayer* coclass to programmatically assign hotlinks.

IHotlinkContainer : IUnknown	***Provides access to members that manage all the hotlinks of a layer (e.g. field based hyperlinks or those that that call macros).***
▪━▪ HotlinkField: String	*Field used for hotlinks.*
▪━▪ HotlinkType: esriHyperlinkType	*Hotlink type.*

The *IHotLinkContainer* interface is used to assign hotlinks to a layer. Using this interface, you can specify what field in the layer's attribute table contains the hotlink information; you can also specify the hotlink type.

Enumeration esriHyperlinkType	***Hyperlink type.***
0 - esriHyperlinkTypeDocument	*Document hyperlink type.*
1 - esriHyperlinkTypeURL	*URL hyperlink type.*
2 - esriHyperlinkTypeMacro	*Macro hyperlink type.*

The *esriHyperlinkType* enumeration specifies the type of hotlinks and hyperlinks—either document, URL, or macro—that are assigned to the layer.

The following code sets the hotlink field and type for the first layer in the map:

```
Sub AssignHotlinks()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pHotlinkContainer As IHotlinkContainer

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pHotlinkContainer = pMap.Layer(0)

  pHotlinkContainer.HotlinkField = "Canada-ID"
  pHotlinkContainer.HotlinkType = esriHyperlinkTypeDocument
End Sub
```

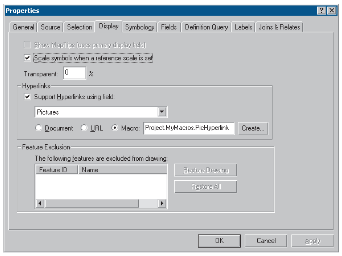
IHotlinkMacro : IUnknown	***Provides access to members that control a hyperlink that calls a macro.***
▪━▪ MacroName: String	*Name of macro used for the hotlink.*

The *IHotlinkMacro* interface specifies the macro to be used by the hotlinks if the hyperlink type is *esriHyperlinkTypeMacro*. A hotlink macro has the following structure by default. The *pLink* argument is a hyperlink object that is automatically created and has its *Link* property set to a value from the hotlink field.

```
Sub Hyperlink(pLink, pLayer)
  Dim pHyperlink As IHyperlink
  Set pHyperlink = pLink
  Dim pFLayer As IFeatureLayer
  Set pFLayer = pLayer
  ' Then do something with the hyperlink
End Sub
```

The following code sets up hotlinks for the first layer in the map using the Picture field. A macro called *PicHyperlink* is used for the hotlinks. When you click a feature with the Hotlink tool, the macro displays a form showing the picture specified in the hotlink field for that feature.

```
Sub AssignHotlinks()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pHotlinkContainer As IHotlinkContainer
  Dim pHotlinkMacro As IHotlinkMacro

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pHotlinkContainer = pMap.Layer(0)
  Set pHotlinkMacro = pHotlinkContainer

  pHotlinkContainer.HotlinkField = "Pictures"
  pHotlinkContainer.HotlinkType = esriHyperlinkTypeMacro
  pHotlinkMacro.MacroName = "Project.MyMacros.PicHyperlink"
End Sub

Sub PicHyperlink(pLink, pLayer)
  Dim pHyperlink As IHyperlink
  Set pHyperlink = pLink
  Dim pFLayer As IFeatureLayer
  Set pFLayer = pLayer
  If Not UserForm1.Visible Then
    UserForm1.Show vbModeless
  End If
  UserForm1.Picture = LoadPicture(pHyperlink.link)
End Sub
```



□ Show MapTips (uses primary display field)

☑ Scale symbols when a reference scale is set

Transparent: 0 %

Hyperlinks

☑ Support Hyperlinks using field: Pictures

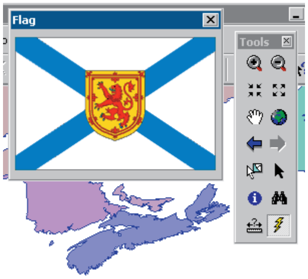
○ Document ○ URL ● Macro: Project.MyMacros.PicHyperlink

Feature Exclusion

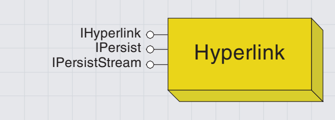
The following features are excluded from drawing:

Feature ID	Name

After running this code, the Display panel of the Layer Properties dialog box shows that the layer now supports hyperlinks using the Pictures field—the hyperlink type is macro.



When you click a feature with the Hyperlink tool, a window showing the picture specified in the hotlink field appears.



Hyperlinks are not dependent on a field and do not call macros. They are dynamic and more flexible than a hotlink in that they do not need to exist in a container.

Hyperlinks are generally assigned one feature at a time; unlike hotlinks, they are set up for an individual feature rather than an entire feature layer. The Identify dialog box in the user interface in ArcMap interactively sets up hyperlinks.

IHyperlinkContainer : IUnknown	***Provides access to members that manage all the hyperlinks of a layer.***
Hyperlink (in Index: Long) : IHyperlink	*The hyperlink at the specified index.*
HyperlinkCount: Long	*Number of hyperlinks.*
AddHyperlink (in link: IHyperlink)	*Adds a hyperlink.*
RemoveHyperlink (in Index: Long)	*Removes the hyperlink at the specified index.*

Use the *IHyperlinkContainer* interface on the *FeatureLayer* coclass with the *IHyperlink* interface on the *Hyperlink* coclass to programmatically assign hyperlinks.

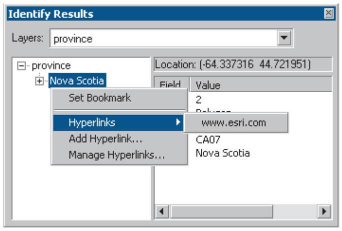
The hyperlink container manages the hyperlinks for a feature layer. The *IHyperlinkContainer* interface has methods for adding hyperlinks to and removing hyperlinks from the layer. There is a property to get a count of all the hyperlinks on the layer and a property to get a reference to a specific hyperlink. To assign hyperlinks to a feature in the layer, you must first create a new *Hyperlink* object, then set the properties on the *IHyperlink* interface.

IHyperlink : IUnknown	***Provides access to members that control a dynamic hyperlink (i.e. one that can exist with or without a container).***
FeatureId: Long	*Id for the feature that contains the hyperlink.*
link: String	*Hyperlink target.*
LinkType: esriHyperlinkType	*Hyperlink type.*
Jump	*Jumps to the hyperlink target.*

The *IHyperlink* interface defines a hyperlink. Use this interface to set the ID of the feature with which the hyperlink is associated, the name of the file or URL to which it is to be linked, and the type of hyperlink it is.

The following code creates a hyperlink for the selected feature in the layer. The link type is URL, and the link is set to ESRI's Web page. The *IHyperlinkContainer::AddHyperlink* method assigns the hyperlink to the layer.

```
Sub AddHyperlink()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pLayer As IGeoFeatureLayer
  Dim pFeatureSel As IFeatureSelection
  Dim pSelSet As ISelectionSet
  Dim pEnumIDs As IEnumIDs
  Dim pFID As Long
  Dim pHyperlink As IHyperlink
  Dim pHyperlinkContainer As IHyperlinkContainer

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
```


Identify Results

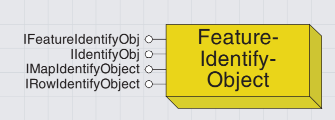
Layers: province

Location: (-64.337316 44.721951)

Field	Value
	2
	CA07
	Nova Scotia

After running this code, the Identify dialog box shows that the hyperlink was assigned to the selected feature.

```
  Set pLayer = pMap.Layer(0)
  'Get the feature id of first selected feature
  Set pFeatureSel = pLayer
  Set pSelSet = pFeatureSel.SelectionSet
  If pSelSet.Count = 0 Then
    MsgBox "Please select a feature."
    Exit Sub
  End If
  Set pEnumIDs = pSelSet.IDs
  pFID = pEnumIDs.Next

  'Create a new hyperlink and set its properties
  Set pHyperlink = New Hyperlink
  pHyperlink.link = "www.esri.com"
  pHyperlink.LinkType = esriHyperlinkTypeURL
  pHyperlink.FeatureId = pFID

  'Assign the hyperlink to the layer
  Set pHyperlinkContainer = pLayer
  pHyperlinkContainer.AddHyperlink pHyperlink
End Sub
```



A FeatureIdentifyObject *provides shortcuts to some of the properties of the identified feature.*

A *FeatureIdentifyObject* object provides access to the identified feature and has methods that can operate on that feature.

IFeatureIdentifyObj : IUnknown	**Provides access to a member that sets the feature used by the identify object.**
Feature: IFeature	*The feature to be identified.*

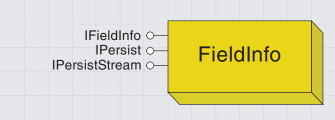
The *IFeatureIdentifyObj* interface sets the feature to be identified.

IIdentifyObj : IUnknown	**Provides access to members that control feature identification for a layer.**
hWnd: Long	*The window handle.*
Layer: ILayer	*Target layer for identification.*
Name: String	*Name of the identify object.*
CanIdentify (in pLayer: ILayer) : Boolean	*Indicates if the object can identify the specified layer.*
Flash (in pDisplay: IScreenDisplay)	*Flashes the identified object on the screen.*
PopUpMenu (in X: Long, in Y: Long)	*Displays a context sensitive popup menu at the specified location.*

The *IIdentifyObj* interface returns the window handle, layer, and name of the feature; it has methods to flash the feature in the display and to display a context menu at the Identify location.

The following *UIToolControl* code uses the *IIdentify::Identify* method to get the *FeatureIdentifyObject* objects at the mouse-click location. Then, some of the properties of the feature first identified are reported.

```
Private Sub UIToolControl1_MouseDown(ByVal button As Long, _
    ByVal shift As Long, ByVal x As Long, ByVal y As Long)
  Dim pMxApp As IMxApplication, pDoc As IMxDocument
  Dim pMap As IMap, pIdentify As IIdentify
  Dim pPoint As IPoint, pIDArray As IArray
  Dim pFeatIdObj As IFeatureIdentifyObj, pIdObj As IIdentifyObj

  Set pMxApp = Application
  Set pDoc = Application.Document
  Set pMap = pDoc.FocusMap
  Set pIdentify = pMap.Layer(0)

  ' Convert x and y to map units
  Set pPoint = pMxApp.Display.DisplayTransformation.ToMapPoint(x, y)
  Set pIDArray = pIdentify.Identify(pPoint)

  'Get the FeatureIdentifyObject
  If Not pIDArray Is Nothing Then
    Set pFeatIdObj = pIDArray.Element(0)
    Set pIdObj = pFeatIdObj
    pIdObj.Flash pMxApp.Display

    ' Report info from FeatureIdentifyObject
    MsgBox "Layer: " & pIdObj.Layer.Name & vbNewLine & _
          "Feature: " & pIdObj.Name
  Else
    MsgBox "No feature identified."
  End If
End Sub
```



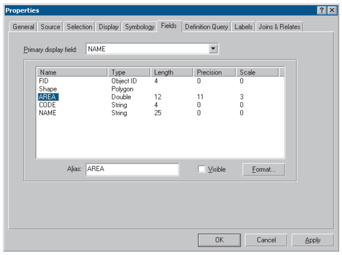
FieldInfo *provides extend information on a field.*

The *FieldInfo* coclass has an interface called *IFieldInfo* that allows you to set an alias for the field, set the number format if the field is numeric, set the visibility flag for the field, and return a string representation of a value in the field.

IFieldInfo : IUnknown	*Provides access to properties that give extended information on the field.*
Alias: String	*The alias for the field.*
AsString (in Value: Variant) : String	*The string representation of a given value based on the current field information.*
NumberFormat: INumberFormat	*The number format for the field (invalid if non-numeric field).*
Visible: Boolean	*Indicates if the field is visible.*

This code uses the *ILayerFields::FindField* method to get the index of the specified field and then uses the *FieldInfo* property to access the *FieldInfo* object for that field. The field's visible property is set to *False* so that the field is no longer visible in the attribute table of the layer.

```
Public Sub HideField()
  Dim pDoc As IMxDocument
  Dim pMap As IMap
  Dim pLayerFlds As ILayerFields
  Dim pFldInfo As IFieldInfo
  Set pDoc = Application.Document
  Set pMap = pDoc.FocusMap
  Set pLayerFlds = pMap.Layer(0)
  Set pFldInfo = pLayerFlds.FieldInfo(pLayerFlds.FindField("Area"))
  pFldInfo.Visible = False
End Sub
```

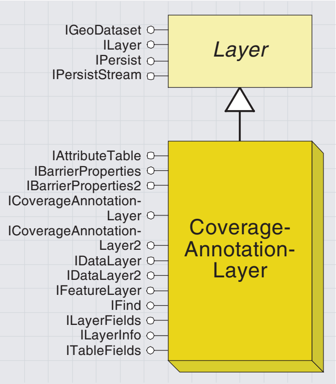


Primary display field: NAME

Name	Type	Length	Precision	Scale
FID	Object ID	4	0	0
Shape	Polygon			
AREA	Double	12	11	3
CODE	String	4	0	0
NAME	String	25	0	0

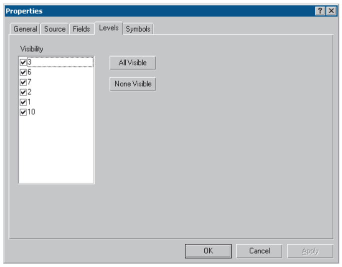
Alias: AREA ☐ Visible

After running this code, the Fields panel of the Layer Properties dialog box shows that the Area field has been made invisible.



Annotation is a unique coverage feature class that stores labels used to describe other geographic features.

Annotation is only used for display purposes; it is not used in analysis.The labels are stored as text strings along with the text symbol numbers used to draw them and their location and positioning specifications.A coverage annotation feature class can use more than one symbol to define how the annotation is to be displayed.

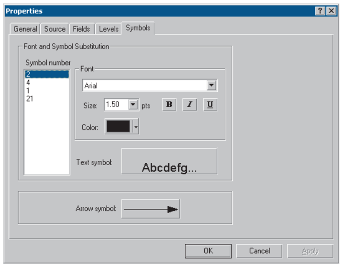

Properties

General | Source | Fields | Levels | Symbols

Visibility

- ☑ 3
- ☑ 6
- ☑ 7
- ☑ 2
- ☑ 1
- ☑ 10

The Levels panel of the coverage annotation's Layer Properties dialog box shows that this layer has six levels and shows which levels are visible.


Properties

General | Source | Fields | Levels | Symbols

Font and Symbol Substitution

Symbol number: 2, 4, 1, 21

Font: Arial

Size: 1.50 pts

Color:

Text symbol: Abcdefg...

Arrow symbol:

The Symbols panel of the coverage annotation's Layer Properties dialog box shows that this layer has four symbols and shows their properties.

Annotation can be organized into annotation levels and subclasses. For example, a coverage storing roads may have street names in one annotation level, highway names in another level, and place names in a third level. Alternatively, the roads coverage might have two subclasses, one for street names, Anno.Street, and one for highway names, Anno.Hwy. Each subclass may contain several levels for specific annotation text sizes.

A *CoverageAnnotationLayer* is a layer that is based on a coverage annotation feature class. If an annotation coverage has no subclasses, then there is only one layer for this coverage. However, if the annotation coverage has subclasses, each subclass is treated as a separate layer. A *CoverageAnnotationLayer* may have more than one level.

ICoverageAnnotationLayer : IUnknown	*Provides access to members that control a coverage annotation layer.*
ArrowSymbol: ILineSymbol	*The line symbol for the arrow.*
Font (in SymbolNumber: Long) : Font	*The font for the specified symbol number.*
FontColor (in SymbolNumber: Long) : IColor	*The font color for the specified symbol number.*
LevelCount: Long	*The number of levels in the layer.*
LevelNumber (in Index: Long) : Long	*The level number at the specified index.*
LevelVisibility (in LevelNumber: Long) : Boolean	*Indicates if the level at the specified level number is visible.*
NextGraphic: IElement	*Generates the next graphic element in the graphics generation loop. Returns a NULL element after the last annotation feature has been read. Call only after StartGeneratingGraphics.*
SymbolCount: Long	*The number of symbols used by the layer.*
SymbolNumber (in Index: Long) : Long	*The symbol number at the specified index.*
TextSymbol (in SymbolNumber: Long) : ITextSymbol	*The text symbol for the specified symbol number.*
GenerateGraphics (in box: IEnvelope, in Display: IDisplay) : IEnumElement	*Generates graphic elements from the annotation features. The optional envelope specifies a bounding box. The display is used for converting from map units.*
NextFeatureAndGraphic (out Feature: IFeature, out Element: IElement)	*Generates the next feature and graphic element in the graphics generation loop. Returns a NULL feature and element after the last annotation feature has been read. Call only after StartGeneratingGraphics.*
StartGeneratingGraphics (in box: IEnvelope, in Display: IDisplay, in withAttributes: Boolean)	*Starts a graphics generation process from the annotation features. The optional envelope specifies a bounding box. The display is used for converting from map units.*

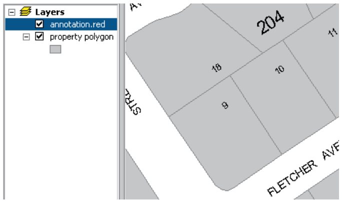
The *ICoverageAnnotationLayer* interface controls the display of coverage annotation. Use the *LevelCount* property to get the number of levels in the layer and the *LevelVisibility* property to specify whether a specific level is visible in the layer.

Use the *SymbolCount* property to get the number of symbols defined for the layer. The *ArrowSymbol, Font, FontColor,* and *TextSymbol* properties allow you to change the properties of a specific symbol in the layer.

The *ICoverageAnnotationLayer* interface also has methods for converting the annotation to graphics.

The following VBA code reports how many levels and symbols there are in the coverage annotation layer. It loops through all the levels and reports whether the level is visible. It also loops through all the symbols and reports the font size of that symbol.

```
Public Sub AnnoReport()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pCovAnnoLyr As ICoverageAnnotationLayer
  Dim i As Integer
  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pCovAnnoLyr = pMap.Layer(0)

  ' Report the count of levels and symbols
  MsgBox "This layer has " & pCovAnnoLyr.LevelCount & _
     " levels and " & pCovAnnoLyr.SymbolCount & " symbols."

  ' Loop through the levels and report whether level is visible
  For i = 0 To pCovAnnoLyr.LevelCount - 1
   MsgBox "Level " & pCovAnnoLyr.LevelNumber(i) & _
     " is visible: " & pCovAnnoLyr.LevelVisibility(i)
  Next

  ' Loop through the symbols and report the font size
  For i = 0 To pCovAnnoLyr.SymbolCount - 1
   MsgBox "Symbol " & pCovAnnoLyr.SymbolNumber(i) & ": " & _
   pCovAnnoLyr.Font(i).Size
  Next
End Sub
```



This map contains a coverage annotation layer called annotation.red.

IBarrierProperties2 : IUnknown	***Provides access to members that control how objects (text, features, graphics) act as barriers for labelling with the cancel tracker***
Barriers2 (in Display: IDisplay, in pBarriers: IGeometryCollection, in Extent: IEnvelope, in trackCancel: ITrackCancel)	*List of barriers within the specified extent, or all barriers if no extent given.*
Weight: Long	*Weight of the barriers for this layer.*

Barriers are used by labeling engines to signal that a label should not be placed in a particular location. Barriers currently include annotation, graphical elements, and symbols generated from renderers. A layer uses barriers to let other layers know where its elements are so that nothing gets displayed on top of those elements.

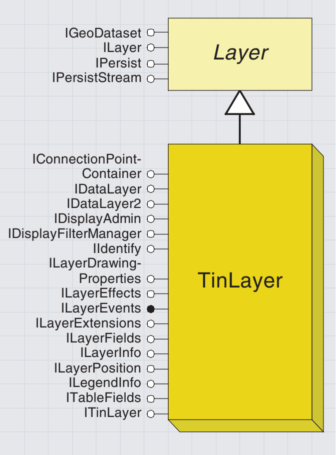
The *IBarrierProperties2* interface has a *QueryBarriers* method for getting the collection of geometries (the *pBarriers* parameter) that represent the barriers for the layer. The *trackCancel* parameter is used to get the *CancelTracker* object; this allows the drawing of labels to be stopped during the barriers loading phase. The *IBarriersProperties2* interface also has a *Weight* property that specifies the weight of the barriers in the layer.

The *IBarriersProperties* interface is the original version of this interface. You should always use *IBarriersProperties2*.

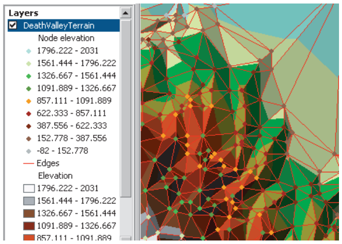
You can use the *IMapBarriers* interface on *Map* to conveniently access all the barriers from all the layers in the map; this interface returns a collection of barriers.

The following VBA macro reports the number of barriers in the current extent of the data view. You have to create a valid geometry collection object and pass this object into the *QueryBarriers* method, which will populate the collection. The resulting collection will consist of the geometries that represent the barriers in the current extent.

```
Public Sub Barriers()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pActiveView As IActiveView
  Dim pCovAnnoLyr As ICoverageAnnotationLayer
  Dim i As Integer

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pActiveView = pMap
  Set pCovAnnoLyr = pMap.Layer(0)

  Dim pBarrierProp As IBarrierProperties2
  Set pBarrierProp = pCovAnnoLyr

  ' Create a geometry collection to pass into the method
  Dim pGeomCol As IGeometryCollection
  Set pGeomCol = New GeometryBag

  ' Use the QueryBarriers method to populate the geometry collection
  pBarrierProp.QueryBarriers pActiveView.ScreenDisplay, pGeomCol, _
      pActiveView.Extent, Nothing
  MsgBox pGeomCol.GeometryCount
End Sub
```



TIN layers are used to display three-dimensional surface data.



Layers

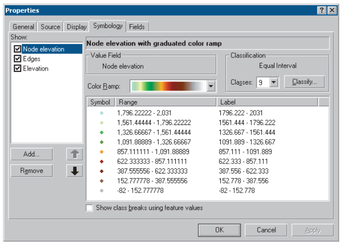
☑ DeathValleyTerrain

Node elevation
- ◆ 1796.222 - 2031
- ◆ 1561.444 - 1796.222
- ◆ 1326.667 - 1561.444
- ◆ 1091.889 - 1326.667
- ◆ 857.111 - 1091.889
- ◆ 622.333 - 857.111
- ◆ 387.556 - 622.333
- ◆ 152.778 - 387.556
- ◆ -82 - 152.778

— Edges

Elevation
- ▨ 1796.222 - 2031
- ▨ 1561.444 - 1796.222
- ▨ 1326.667 - 1561.444
- ▨ 1091.889 - 1326.667
- ▨ 857.111 - 1091.889

This map has a TIN layer called DeathValleyTerrain. *Three different renderers are used to display this layer.*



Show:

☑ Node elevation
☑ Edges
☑ Elevation

Node elevation with graduated color ramp

Value Field: Node elevation

Classification: Equal Interval

Classes: 9

Color Ramp:

Symbol	Range	Label
◆	1,796.22222 - 2,031	1796.222 - 2031
◆	1,561.44444 - 1,796.22222	1561.444 - 1796.222
◆	1,326.66667 - 1,561.44444	1326.667 - 1561.444
◆	1,091.88889 - 1,326.66667	1091.889 - 1326.667
◆	857.111111 - 1,091.88889	857.111 - 1091.889
◆	622.333333 - 857.111111	622.333 - 857.111
◆	387.555556 - 622.333333	387.556 - 622.333
◆	152.777778 - 387.555556	152.778 - 387.556
◆	-82 - 152.777778	-82 - 152.778

☐ Show class breaks using feature values

The Symbology panel of the TIN layer Properties dialog box shows which renderers are used by the layer, and allows you to add and remove renderers and set the properties of the renderers.

TINs represent continuous surfaces, such as terrain elevation or temperature gradient. Typically, you display a TIN using color-shaded relief. This lets you easily see the ridges, valleys, and hillsides, along with their respective heights. You can display any one of three surface characteristics—slope, aspect, and elevation—on your map and even simulate shaded relief. You can also display the internal structure of a TIN—for example, nodes and breaklines—independently or on top of the shaded relief display.

A *TinLayer* is a layer that is based on TIN. A *TinLayer* can use more than one renderer for its display.

ITinLayer : ILayer	***Provides access to members that control a TIN layer.***
Dataset: ITin	*The TIN used to define the layer.*
DisplayField: String	*The primary display field.*
RendererCount: Long	*The number of renderers.*
ScaleSymbols: Boolean	*Indicates if symbols are scaled for this layer.*
AddRenderer (in Renderer: ITinRenderer)	*Add a renderer to the end of the group.*
ClearRenderers	*Remove all the renderers from the group.*
DeleteRenderer (in Renderer: ITinRenderer)	*Remove a renderer from the group.*
GetRenderer (in Index: Long) : ITinRenderer	*Gets the nth renderer.*
InsertRenderer (in Renderer: ITinRenderer, in Index: Long)	*Insert a renderer at given index.*

The *ITinLayer* interface defines how the TIN is displayed in the layer.

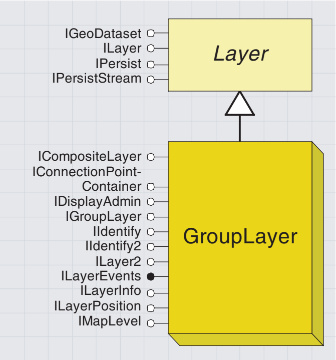
The *Dataset* property returns the TIN dataset on which the layer is based.

The *RendererCount* property returns the number of renderers currently used by the TinLayer.

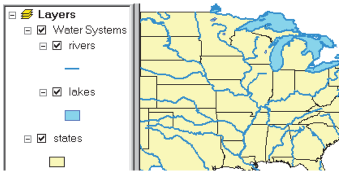
Use the *AddRenderer, InsertRenderer, GetRenderer, ClearRenderers,* and *DeleteRenderers* methods to define the set of renderers associated with the layer.

The following VBA code reports the name of each renderer used by the *TinLayer*:

```
Public Sub RendererReport()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pTinLayer As ITinLayer
  Dim pTinRend As ITinRenderer
  Dim i As Integer

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pTinLayer = pMap.Layer(0)

  For i = 0 To pTinLayer.RendererCount - 1
    Set pTinRend = pTinLayer.GetRenderer(i)
    MsgBox pTinRend.Name
  Next
End Sub
```



A group layer is a group of several layers that appear and act like a single layer in the table of contents in ArcMap.



This map contains a group layer called Water Systems, which consists of two layers—rivers and lakes.

When you want to work with several layers as one layer, gather them together into a group layer. Suppose you have two layers on a map, with one representing rivers and the other lakes. You might choose to group these layers together and name the resulting layer "water systems". Turning off a group layer turns off all its component layers. The properties of the group layer override any conflicting properties of its constituent layers. However, you can still work with the individual layers in the group.

IGroupLayer : ILayer	***Provides access to members that control a collection of layers that behaves like a single layer.***
▪— Expanded: Boolean	*Indicates if the group's entry is expanded in the TOC.*
← Add (in Layer: ILayer)	*Adds a layer to the end of the group.*
← Clear	*Removes all layers from the group.*
← Delete (in Layer: ILayer)	*Removes the specified layer from the group.*

The *IGroupLayer* interface provides methods for managing the contents of group layers.

The *Add* method adds the specified layer to the group, the *Remove* method removes the specified layer from the group, and the *Clear* method removes all the layers from the group.

The *Expanded* property indicates whether or not the group layer is expanded in the map's table of contents.

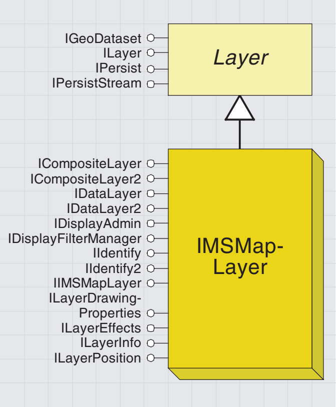
ICompositeLayer : IUnknown	***Provides access to members that work with a collection of layers that behaves like a single layer.***
▪— Count: Long	*Number of layers in the collection.*
▪— Layer (in Index: Long) : ILayer	*Layer in the collection at the specified index.*

The *ICompositeLayer* is a generic interface for working with a layer that contains other layers.

The *Count* property returns the number of layers in the group, and the *Layer* property returns the layer at the specified index.

The following VBA code creates a new group layer, moves two layers from the map into this group layer, adds the group layer to the map, then reports the number of layers in the new group layer.

```
Sub CreateGroupLayer()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pRiverLayer As IGeoFeatureLayer
  Dim pLakeLayer As IGeoFeatureLayer
  Dim i As Integer
  Dim pGroupLayer As IGroupLayer
  Dim pCompLayer As ICompositeLayer

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap

  ' Get references to the rivers and lakes layers.
  For i = 0 To pMap.LayerCount - 1
    If pMap.Layer(i).Name = "rivers" Then
      Set pRiverLayer = pMap.Layer(i)
    End If
    If pMap.Layer(i).Name = "lakes" Then
      Set pLakeLayer = pMap.Layer(i)
    End If
  Next

  ' Create the group layer and add the layers to it.
  Set pGroupLayer = New GroupLayer
  pGroupLayer.Name = "Water Systems"
  pGroupLayer.Add pRiverLayer
  pGroupLayer.Add pLakeLayer

  ' Remove the rivers and lakes layers from the map,
  ' add the group layer to the map, and refesh the TOC.
  pGroupLayer.Expanded = True
  pMap.DeleteLayer pRiverLayer
  pMap.DeleteLayer pLakeLayer
  pMap.AddLayer pGroupLayer
  pMxDoc.UpdateContents

  ' Report the number of layers in the group layer
  Set pCompLayer = pGroupLayer
  MsgBox "Number of layers in the new group layer: " & _
        pCompLayer.Count
End Sub
```



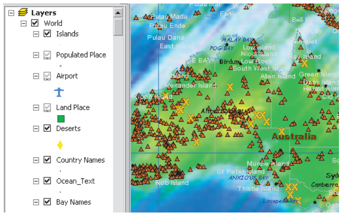
An Internet Map Server layer displays data from an image service on the Internet.

The Internet is a vast resource for geographic data. Organizations can publish their data using ArcIMS® and serve it over the Internet. The Geography Network℠, which also uses ArcIMS, provides easy access to data on the Internet. You can view this data as layers in ArcMap.

ArcIMS provides two types of map services: an ArcIMS Feature Service and an ArcIMS Image Service.

An ArcIMS feature service is similar to a feature dataset that contains many feature classes. Each ArcIMS feature class represents a unique entity; the actual features are streamed to the client. When you add a feature service to the map, a group layer consisting of one or more feature layers is also added to the map. You can work with feature layers based on ArcIMS feature services in ArcMap the same way you work with feature layers based on local feature classes.

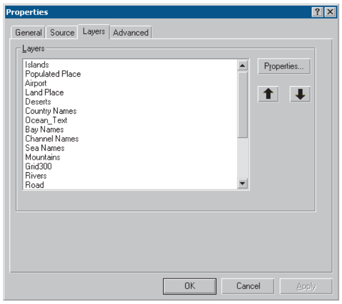
An ArcIMS image service is a raster representation of a complete map. When you add an image service to ArcMap, you'll see a new layer on your map. This layer is an Internet Map Server map layer (*IMSMap-Layer*). You can turn off specific sublayers in the IMS map layer so you see only those that are of interest to you.



This map contains an IMSMapLayer called "World", which contains many IMS sublayers. The symbology for each layer is defined by the Internet service.

An *IMSMapLayer* is a composite layer consisting of IMS sublayers. You can use the *ICompositeLayer::Layer* property to get a reference to an IMS sublayer; the sublayer is of type *IIMSSubLayer*. From that, you can get a reference to the *ACLayer* (Arc Connection layer) on which the sublayer is based. An *ACLayer* does not implement *ILayer*; rather, it is an XML representation of the layer from the Internet service. *ACLayers* use the symbology defined on the Internet service for display in ArcMap.

IIMSMapLayer : ILayer	*IMS Map Layer interface.*
AreaOfInterest: IEnvelope	The area of interest.
Connection: IIMSServiceDescription	The service.
IMSMap: IACMap	The IMS map.
ConnectToService (in Service: IIMSServiceDescription)	Connects to the map service with the given server url.
MoveSubLayerTo (in subLayer: IIMSSubLayer, in Index: Long)	Change the sublayer order.



Layers

Islands
Populated Place
Airport
Land Place
Deserts
Country Names
Ocean_Text
Bay Names
Channel Names
Sea Names
Mountains
Grid300
Rivers
Road

The Layers panel of the IMSMapLayer *Properties dialog box lists all of the sublayers in the* IMSMapLayer, *and provides access to the properties of each sublayer.*

The *IIMSMapLayer* interface indicates that the layer is an IMS map layer.

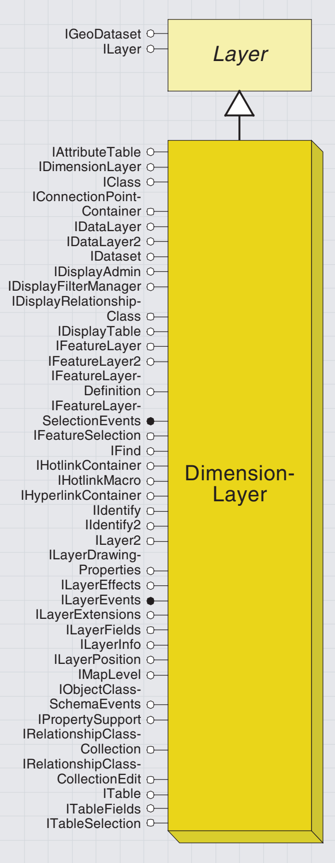
The *Connection* property and *Connect* method manage the connection to the Internet service.

The *MoveSubLayerTo* method allows you to rearrange the order of the sublayers in the *IMSMapLayer*.

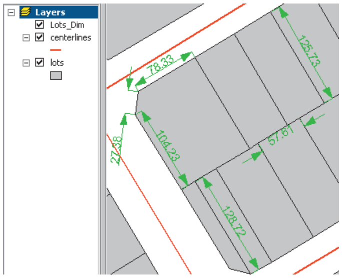
The *IMSMap* property returns a reference to the *ACMap* (Arc Connection map), which is an XML representation of the map that was served over the Internet.

The following code loops through all the sublayers in the *IMSMapLayer* and reports the name of the sublayer.

```
Public Sub IMSLyrInfo()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pIMSMapLyr As IIMSMapLayer
  Dim pCompLyr As ICompositeLayer
  Dim pIMSSubLyr As IIMSSubLayer
  Dim pACLayer As IACLayer
  Dim i As Integer

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap

  If TypeOf pMap.Layer(0) Is IIMSMapLayer Then
    Set pIMSMapLyr = pMap.Layer(0)
    Set pCompLyr = pIMSMapLyr
    For i = 0 To pCompLyr.Count - 1
      If TypeOf pCompLyr.Layer(i) Is IIMSSubLayer Then
        Set pIMSSubLyr = pCompLyr.Layer(i)
        Set pACLayer = pIMSSubLyr.IMSLayer
        MsgBox pACLayer.Name
      End If
    Next
  End If
End Sub
```



DimensionLayer *displays descriptive text and supporting graphics, such as leader lines, that are associated with map features.*



This map contains a dimension layer called "Lots_Dim". The green arrows and text are the dimension features.

Dimensions are a special kind of map annotation that show specific lengths or distances on a map. A dimension may indicate the length of a side of a building or land parcel or the distance between two features such as a fire hydrant and the corner of a building. Dimensions can be as simple as a piece of text with a leader line or more elaborate.

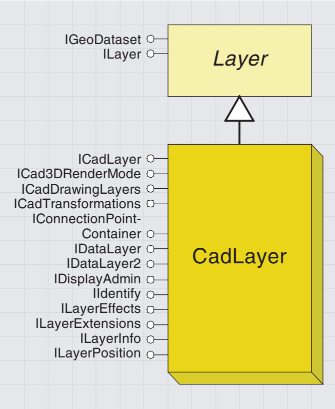
In the geodatabase, dimensions are stored in dimension feature classes. Like other feature classes in the geodatabase, all features in a dimension feature class have a geographic location and attributes and can either be inside or outside of a feature dataset. Like annotation features, each dimension feature knows what its symbology is and how it should be drawn.

A *DimensionLayer* object is a layer that is based on a dimension feature class. Feature classes of feature type *esriFTDimension* are dimension feature classes.

IDimensionLayer : IUnknown	***Provides identity for dimension layers.***

The *IDimensionLayer* interface indicates to the map that this layer is a dimension layer. There are no methods or properties on this interface. Most of the interfaces that are implemented by *FeatureLayer* are available for use with the *DimensionLayer*.

The symbology used to display the dimension layer is defined in the geodatabase.



You can display a CAD drawing as a layer in ArcMap; you don't have to convert the data.

An ArcMap layer based on CAD drawing is either a CadLayer *or a* CadFeatureLayer*.*

In ArcMap, a CAD drawing is represented as either a CAD drawing or a CAD dataset. The CAD drawing represents all the layers in the drawing. The CAD dataset represents the drawing's features with individual feature classes (point, line, polygon, and annotation feature classes).

A CadLayer *is based on the CAD drawing representation, and a* CadFeatureLayer *is based on CAD dataset representation.*

The CadLayer *in this map represents all the CAD drawing layers. The symbology defined in the CAD drawing displays the layer in the map.*

Use a *CadLayer* if you want to add the CAD drawing as a layer for display only. In the map, this layer contains all of the layers in the drawing and uses the symbology defined in the drawing. You can choose which of the drawing's layers the layer in ArcMap displays.

ICadLayer : ILayer	*Provides access to properties that give information on the CAD drawing.*
CadDrawingDataset: ICadDrawingDataset	*The dataset of the CAD drawing.*
FilePath: String	*Full pathname of the CAD drawing.*
Is2d: Boolean	*Indicates if the CAD drawing is 2D.*
Is3d: Boolean	*Indicates if the CAD drawing is 3D.*
IsAutoCad: Boolean	*Indicates if the CAD drawing is an AutoCAD file.*
IsDgn: Boolean	*Indicates if the CAD drawing is a MicroStation file.*

The *ICadLayer* interface has properties to determine if the CAD drawing is an AutoCAD® drawing (.dwg) file, a MicroStation® design (.dgn) file, a 2D drawing, or a 3D drawing. It also gives you the full pathname of the CAD drawing file used by the layer and the CAD drawing dataset.

This code reports some of the properties of the first CAD layers in the map:

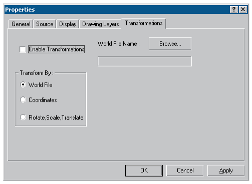
```
Sub LayerProps()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pCadLayer As ICadLayer

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pCadLayer = pMap.Layer(0)

  MsgBox "File: " & pCadLayer.FilePath & vbNewLine & _
      "Is AutoCAD: " & pCadLayer.IsAutoCad & vbNewLine & _
      "Is Dgn: " & pCadLayer.IsDgn & vbNewLine & _
      "Is 3D: " & pCadLayer.Is3d & vbNewLine
End Sub
```

ICadDrawingLayers : IUnknown	*Provides access to properties that give information on the layers in the CAD drawing.*
DrawingLayerCount: Long	*The number of layers in the CAD drawing.*
DrawingLayerName (in Index: Long) : String	*The name of the CAD drawing layer at the specified index.*
DrawingLayerVisible (in Index: Long) : Boolean	*Indicates if the specified CAD drawing layer visible in the CAD layer in ArcMap.*
OriginalDrawingLayerVisible (in Index: Long) : Boolean	*Indicates if the specified CAD drawing layer visible in the CAD drawing itself.*

The *ICadDrawingLayers* interface manages the layers in the CAD drawing. These are the CAD drawing layers, not the layers in the map in ArcMap. You can get the count of the layers in the drawing and the name of the layer at the specified index in the drawing.

The *DrawingLayerVisible* property indicates if the specified drawing layer is visible in the *CadLayer* or *CadFeatureLayer* in ArcMap.

The *OriginalDrawingLayerVisible* property indicates if the drawing layer is visible in the CAD drawing itself.



□ Enable Transformations

World File Name :

Transform By :

● World File

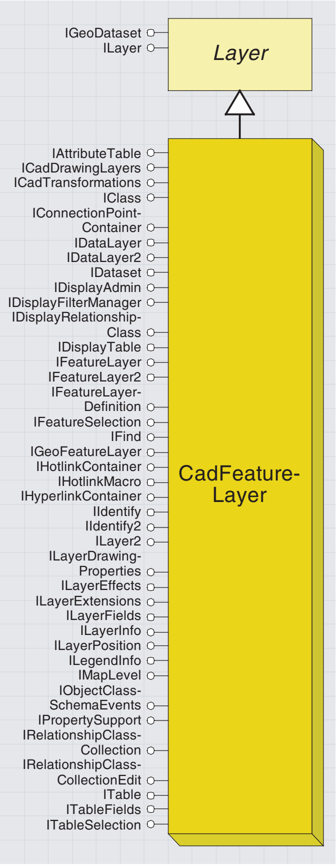
○ Coordinates

○ Rotate,Scale,Translate

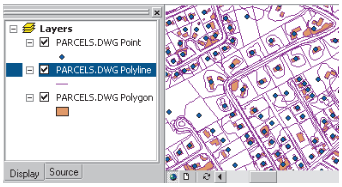
The ICadTransformations *interface controls the settings in the Transformation panel of the layer's Properties dialog box for* CadLayer *and* CadFeatureLayer.

ICadTransformations : IUnknown	***ICadTransformations Interface***
EnableTransformations: Boolean	*Indicates if global transformations are enabled.*
TransformMode: tagesriCadTransform	*The transformation type.*
WorldFileName: String	*The pathname of the world file.*
GetFromToTransform (out fromPoint1: _WKSPoint, out fromPoint2: _WKSPoint, out toPoint1: _WKSPoint, out toPoint2: _WKSPoint)	*Returns the points of a two point transformation.*
GetTransformation (out from: _WKSPoint, out to: _WKSPoint, out Angle: Double, out Scale: Double)	*Returns the rotation, scale, and translation of a transformation.*
SetFromToTransform (in fromPoint1: _WKSPoint, in fromPoint2: _WKSPoint, in toPoint1: _WKSPoint, in toPoint2: _WKSPoint)	*Sets the points of a two point transformation.*
SetTransformation (in from: _WKSPoint, in to: _WKSPoint, in Angle: Double, in Scale: Double)	*Sets the rotation, scale, and translation of a transformation.*

The *ICadTransformations* interface allows you to transform the CAD data so that it matches other data in your map. You can perform the transformation using a two-point method, a rotation, a scale and translation method, or a World file. If a World file is used, there is a property to get and set the filename of the World file.



Use a CadFeatureLayer *if you want to change symbology or analyze CAD data.*



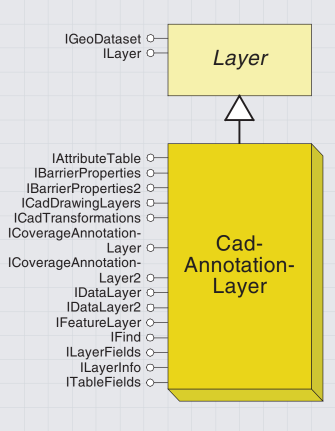
This map has three CadFeatureLayers. *The* PARCELS.DWG *point layer contains all the point features in the CAD drawing, the* PARCELS.DWG *polyline layer contains all the polyline features in the CAD drawing, and the* PARCELS.DWG *polygon layer contains all the polygon features in the CAD drawing.*

CAD data is treated as features in a *CadFeatureLayer*. CAD drawing files typically store different types of entities on different layers in a drawing file. There might be one layer in the CAD drawing for building footprints, another for streets, a third for well locations, and a fourth for textual annotation. However, CAD drawing files do not restrict the type of entities you can have on a drawing layer. Thus, building footprints might be on the same drawing layer as streets. When working with a CAD drawing as feature classes in ArcMap, all points are represented in one layer, all lines are represented in another layer, and all polygons are represented in a third layer. Therefore, you'll likely add several ArcMap layers from the same CAD drawing file and adjust what features display in those layers.

The *CadFeatureLayer* implements *ICadDrawingLayers* and *ICADTransformations*. Also, with *CadFeatureLayer* you can *QI* to most of the interfaces on *FeatureLayer*. Thus, you can perform the same operations on CAD feature layers as you can on feature layers.

The following code loops through all the drawing layers. If the drawing layer's name is BLDGS, then the layer is made visible in the *CadFeatureLayer*; otherwise, the drawing layer is made invisible. You can do this if, for example, you only want buildings in the polygon *CadFeatureLayer* for that CAD drawing.

```
Sub SetVisibleLayers()
  Dim pMxDoc As IMxDocument, pMap As IMap
  Dim pCadDrawLyrs As ICadDrawingLayers, i As Integer
  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pCadDrawLyrs = pMap.Layer(0)
  For i = 0 To pCadDrawLyrs.DrawingLayerCount - 1
    If pCadDrawLyrs.DrawingLayerName(i) = "BLDGS" Then
      pCadDrawLyrs.DrawingLayerVisible(i) = True
     Else
      pCadDrawLyrs.DrawingLayerVisible(i) = False
     End If
  Next
  pMxDoc.ActiveView.PartialRefresh esriViewGeography, Nothing, _
   Nothing
End Sub
```

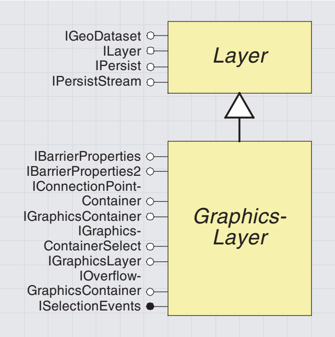


You would use a CadAnnotationLayer *if you want to change the symbology of the annotation or have more control over which annotation entities get displayed in the ArcMap layer.*

In a *CadAnnotationLayer*, CAD data is treated as annotation features. All the annotation entities in the CAD drawing file will be included in one *CadAnnotationLayer*.

Since the *CadAnnotationLayer* coclass implements *ICadDrawings*, you are able to specify what layers from the CAD drawing file are visible in the *CadAnnotationLayer*. Therefore, you are able to control which annotation entities from the drawing are actually displayed in the layer in ArcMap.

The *CadAnnotationLayer* coclass also implements all of the interfaces that are found on the *CoverageAnnotationLayer* coclass. Thus you can perform the same operations on CAD annotation layers as you can on coverage annotation layers.



Graphics layers manage the graphics associated with a map.

Graphics layer objects manage the graphics associated with a map—graphic elements that were added in data view.

If you want more control over when graphics in a data frame draw in relation to other layers, or you want to draw graphics only when a particular layer is visible, you can create annotation. Annotation can be graphic elements but not frame elements.

When you add graphics to a data frame, you can choose which annotation target they're added to. By default, the annotation target is your map, so your graphics will be stored in the map and will always be drawn. Alternatively, you can create an annotation group and make that the target to which graphics will be added.

Each annotation group is a graphics layer. Annotation groups are useful for organizing a large number of graphics because they can be turned on and off individually.

If you want to use annotation on different maps, store it in a geodatabase as an annotation feature class and make that the target for graphics you add. Annotation feature classes that you create appear in your map as annotation layers (*FDOGraphicLayer* objects) in the table of contents.

All graphics layers implement *IGraphicsLayer, IGraphicsContainer,* and *ISelectionEvents.*

IGraphicsLayer : IUnknown	***Provides access to members that control the Graphics Layer.***
AssociatedLayer: ILayer	*Layer that is associated with this graphics layer.*
UseAssociatedLayerVisibility: Boolean	*Indicates if the layer that is associated with this graphics layer controls the visibility*
Activate (in containerScreen: IScreenDisplay)	*Prepare to display graphic on screen.*
Deactivate	*ActiveView that graphics are displayed on is no longer visible.*

A graphics layer can be associated with another layer in the map; when that other layer changes visibility, the graphics layer can change visibility also. The *IGraphicsLayer* interface manages this.

The *AssociatedLayer* property specifies which layer the graphics layer is associated with—for example, this can be *Nothing*.

The *UseAssociatedLayerVisibility* property indicates if the graphics layer should use the same visibility setting as the associated layer.

The *IGraphicsLayer* interface also has methods to activate and deactivate the graphics layer. When a graphics layer is active, it is the current annotation target.

Note that the methods that add elements to the graphics container do not clone the elements. If the element that you are adding to a graphics container was retrieved from another graphics container, you should make sure that your code clones the element before you add it to the destination graphics container.

IGraphicsContainer : IUnknown	***Provides access to members that control the Graphics Container.***
← AddElement (in Element: IElement, in zorder: Long)	*Add a new graphic element to the layer.*
← AddElements (in Elements: IElementCollection, in zorder: Long)	*Add new graphic elements to the layer.*
← BringForward (in Elements: IEnumElement)	*Move the specified elements one step closer to the top of the stack of elements.*
← BringToFront (in Elements: IEnumElement)	*Make the specified elements draw in front of all other elements.*
← DeleteAllElements	*Delete all the elements.*
← DeleteElement (in Element: IElement)	*Delete the given element.*
← FindFrame (in frameObject: Variant) : IFrameElement	*Find the frame that contains the specified object.*
← GetElementOrder (in Elements: IEnumElement) : Variant	*Private order object. Used to undo ordering operations.*
← LocateElements (in Point: IPoint, in Tolerance: Double) : IEnumElement	*Returns the elements at the given coordinate.*
← LocateElementsByEnvelope (in Envelope: IEnvelope) : IEnumElement	*Returns the elements that intersect with the given envelope.*
← MoveElementFromGroup (in Group: IGroupElement, in Element: IElement, in zorder: Long)	*Move the element from the group to the container.*
← MoveElementToGroup (in Element: IElement, in Group: IGroupElement)	*Move the element from the container to the group.*
← Next: IElement	*Returns the next graphic in the container.*
← PutElementOrder (in order: Variant)	*Private order object. Used to undo ordering operations.*
← Reset	*Reset internal cursor so that Next returns the first element.*
← SendBackward (in Elements: IEnumElement)	*Move the specified elements one step closer to the bottom of the stack of elements.*
← SendToBack (in Elements: IEnumElement)	*Make the specified elements draw behind all other elements.*
← UpdateElement (in Element: IElement)	*The graphic element's properties have changed.*

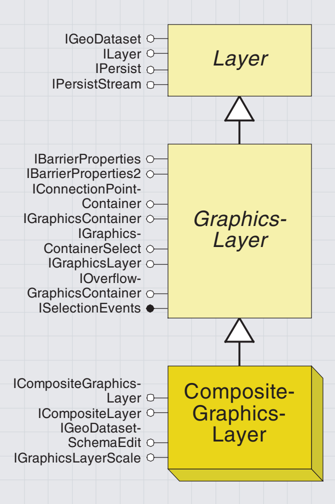
A graphics layer is essentially a graphics container. The *IGraphicsContainer* interface manages the elements in the graphics container. Use this interface to access and manipulate existing graphic elements or to add new ones.

ISelectionEvents : IUnknown	***Provides access to events that occur when the selection changes.***
← SelectionChanged	*Fired when the selection changes.*

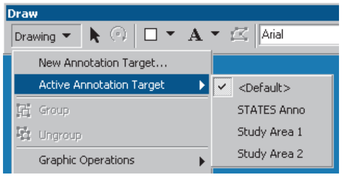
The *ISelectionEvents* interface has one event, *SelectionChanged*, which occurs when the selection in the graphics layer changes.

The following code reports when the selection in the graphics layer of the map changes. The *StartListening* macro is used to initialize the events variable, *pSelEvents*.

```
Dim WithEvents pSelEvents As CompositeGraphicsLayer

Sub StartListening()
  Dim pMxDoc As IMxDocument, pMap As IMap
  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pSelEvents = pMap.BasicGraphicsLayer
End Sub

Private Sub pSelEvents_SelectionChanged()
  MsgBox "Selection has changed."
End Sub
```



A CompositeGraphicsLayer *object is a graphics layer that can manage other graphics layers. The basic graphics container of a map is a composite graphics layer.*



The Active Annotation Target menu shows which graphics layer is currently active.

The graphic elements in a *Map* are organized and stored in graphics layers.

By default, graphics are stored in the basic graphics layer (*IMap::BasicGraphicsLayer* property). For example, when you label features or use the graphics tools, these elements are added to the basic graphics layer by default. The basic graphics layer has a graphics container to manage the graphic elements in that layer. If you *QI* from the *Map* coclass to *IGraphicsContainer*, you get the same graphics container as the one on the basic graphics layer.

The basic graphics layer is also a composite graphics layer, so it can manage other graphics layers. The graphics layers that the *CompositeGraphicsLayer* manages are referred to as annotation groups or annotation target layers. The *IMap::ActiveGraphicsLayer* property specifies which graphics layer is currently active. By default, the basic graphics layer is the active layer, but any annotation group, or an *FDOGraphicsLayer*, can be set as the active graphics layer.

ICompositeGraphicsLayer : IGraphicsLayer	***Provides access to members that control a collection of graphics layers that behave like single layer.***
← AddLayer (in LayerName: String, in FeatureLayer: IFeatureLayer) : IGraphicsLayer	*Adds a layer to the composite graphics layer.*
← DeleteLayer (in LayerName: String)	*Removes a layer from the composite graphics layer.*
← FindLayer (in LayerName: String) : IGraphicsLayer	*Finds a layer in the composite graphics layer.*

The *ICompositeGraphicsLayer* interface provides methods for creating, finding, and deleting graphics layers. When you add a new graphics layer to the *CompositeGraphicsLayer*, you can specify what feature layer this new graphics layer is associated with.

From the ArcMap user interface, click the option to Convert Labels to Annotation from the feature layer context menu. Choose the Map as the annotation storage option. A new graphics layer is added to the *CompositeGraphicsLayer* and is associated with that feature layer. If you choose the New Annotation Target option from the Drawing menu on the Draw toolbar and choose to save annotation in the map, a new graphics layer is added to the *CompositeGraphicsLayer*, but it is not associated with any layer in the map.

ICompositeLayer : IUnknown	***Provides access to members that work with a collection of layers that behaves like a single layer.***
■— Count: Long	*Number of layers in the collection.*
■— Layer (in Index: Long) : ILayer	*Layer in the collection at the specified index.*

The *CompositeGraphicsLayer* and its graphics layers (annotation groups) are not treated as other types of layers in that none of these layers can be accessed with the *IMap::Layer* or *IMap::Layers* properties. In addition, they are not included in the *IMap::LayerCount*, and they are not shown in the table of contents.

Use the *IMap::BasicGraphicsLayer* property to get access to the *CompositeGraphicsLayer*. Then, you can *QI* to the *ICompositeLayer* interface to get access to the individual layers and get a count of the graphics layers.

The basic graphics layer itself is not included in the count and cannot be accessed by the *Layer* property on *ICompositeLayer*; the reference you have to the *CompositeGraphicsLayer* is really the basic graphics layer itself.

The following code loops through all the layers in the basic graphics layer and reports whether the graphics layers are associated with a feature layer:

```
Sub CheckAssociation()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pBasicGraLyr As ICompositeLayer
  Dim pGraLyr As IGraphicsLayer
  Dim pAssocLayer As ILayer
  Dim i As Integer

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pBasicGraLyr = pMap.BasicGraphicsLayer

  For i = 0 To pBasicGraLyr.Count - 1
    Set pGraLyr = pBasicGraLyr.Layer(i)
    Set pAssocLayer = pGraLyr.AssociatedLayer
    If Not pAssocLayer Is Nothing Then
      MsgBox "Associated feature layer: " & pAssocLayer.Name
    Else
      MsgBox "Not associated with a feature layer."
    End If
  Next
End Sub
```

The *IGeoDatasetSchemaEdit* interface allows you to change the spatial reference associated with the graphics layer. For more information on this interface, refer to Volume 2, Chapter 8, 'Accessing the geodatabase'.

The *CompositeGraphicsLayer* coclass also implements *IGraphicsContainerSelect*. If you *QI* from the *CompositeGraphicsLayer* coclass to *IGraphicsContainerSelect*, you get the same object as you would with a *QI* from the *Map* coclass to *IGraphicsContainerSelect*.

IGraphicsLayerScale : IUnknown	***Provides access to members that control the Graphics Layer Scale.***
ReferenceScale: Double	*the reference scale of the layer as a representative fraction*
Units: esriUnits	*the units the reference scale is in.*

The *IGraphicsLayerScale* has a *ReferenceScale* property that specifies the map scale to be used as a reference for the annotation size. The annotation will scale as you zoom the map. For example, if the reference scale is set to 1000 (1:1000), the same text will display twice as large at the mapscale 1:500 and, similarly, twice as small at 1:2000.

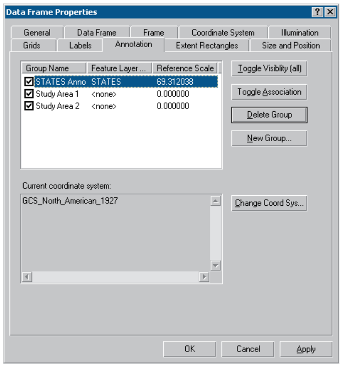
The *Units* property on this interface is not implemented.

IOverflowGraphicsContainer : IUnknown	*Provides access to members that control the Overflow Graphics Container.*
■–□ OverflowElements: IElementCollection	*the element collection.*
← AddOverflowElement (pElement: IElement)	*Add an element to the collection.*
← DeleteAllOverflowElements	*Delete all the element in the collection.*
← DeleteOverflowElement (pElement: IElement)	*Delete an element in the collection.*

When you convert labels to annotation, the labels that overlap other labels can be placed in the overflow labels window. This enables you to decide whether you want them to appear on the map and, if so, place them manually on the map at the desired location. An overflow graphics container manages the collection of elements displayed in the overflow labels window.

The *IOverFlowGraphicsContainer* interface has properties and methods that control the overflow graphics container. There are methods to add an overflow label to the element collection, delete an overflow label from the element collection, or delete all the elements.

The Annotation panel of the Data Frame Properties dialog box lists all of the graphics layers available to the map. The following table shows what properties and methods are used by the controls on this property sheet.



Group Name	Feature Layer ...	Reference Scale
☑ STATES Anno	STATES	69.312038
☑ Study Area 1	<none>	0.000000
☑ Study Area 2	<none>	0.000000

Current coordinate system:

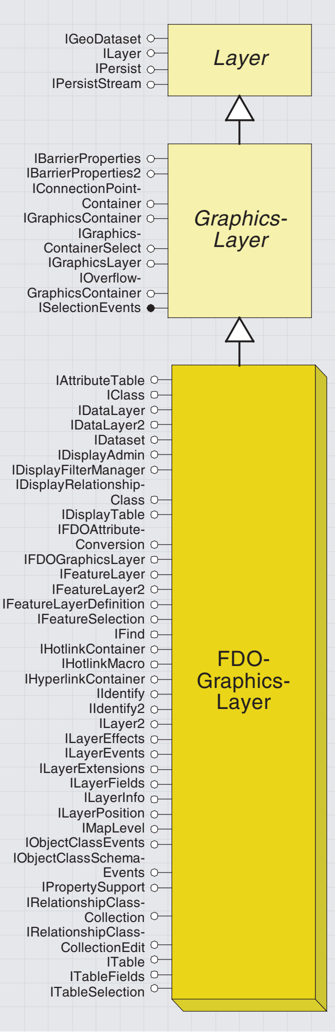
GCS_North_American_1927

The Annotation panel of the Data Frame Properties dialog box

Control	Property or Method
Group Name column	ICompositeLayer::Layer(i)::Name
Feature Layer Name column	IGraphicsLayer::AssociatedLayer
Reference Scale column	IGraphicsLayerScale::ReferenceScale
ToggleVisibilty button	ICompositeLayer::Layer(i)::Visible
Toggle Association button	IGraphicsLayer::UseAssociatedLayer
Delete Group button	ICompositeGraphicsLayer::DeleteLayer
Add Group button	ICompositeGraphicsLayer::AddLayer
Change Coord Sys button	IGeoDatasetSchemeEdit::AlterSpatialReference

The following code creates a new annotation group in the map and moves the selected graphics from the default graphics layer to the new annotation group. To accomplish this, a new graphics layer is added to the *CompositeGrapicsLayer* of the map.

```
Public Sub CreateAnnoGroup()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pBasicGraLyr As ICompositeGraphicsLayer
  Dim pBasicGraCont As IGraphicsContainer
  Dim pBasicGraContSel As IGraphicsContainerSelect
  Dim pEnumElement As IEnumElement
  Dim pNewAnnoGroup As IGraphicsLayer
  Dim pNewGraCont As IGraphicsContainer
  Dim pElement As IElement
  Dim pClone As IClone
  Dim pElemClone As IClone

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pBasicGraLyr = pMap.BasicGraphicsLayer
  Set pBasicGraCont = pBasicGraLyr
  Set pBasicGraContSel = pBasicGraLyr

  ' Create the new graphics layer group and associate it
  ' with the first feature layer in the map
  Set pNewAnnoGroup = pBasicGraLyr.AddLayer("New Anno",  pMap.Layer(0))
  Set pNewGraCont = pNewAnnoGroup

  ' Get the selected elements from the default graphics layer
  Set pEnumElement = pBasicGraContSel.SelectedElements
  Set pElement = pEnumElement.Next

  ' Clone each selected graphic from the default graphics layer,
  ' add the clone to the new graphics layer, and delete original
  ' from the default graphcis layer
  While Not pElement Is Nothing
    Set pClone = pElement
    Set pElemClone = pClone.Clone
    pNewGraCont.AddElement pElemClone, 0
    pBasicGraCont.DeleteElement pElement
    Set pElement = pEnumElement.Next
  Wend
  pMxDoc.ActivatedView.PartialRefresh esriViewGraphics, Nothing, Nothing
End Sub
```



Annotation in a geodatabase is stored in special feature classes called annotation classes. An FDOGraphicsLayer *(Feature Data Object graphics layer) is based on an annotation feature class stored in a geodatabase. Use an* FDOGraphicsLayer *if you want to use this annotation on different maps.*

FDOGraphicsLayer objects are different from other graphics layers in that they are listed in the table of contents. However, they are also listed in the Active Annotation Target menu. To add elements to an *FDOGraphicsLayer*, you must start editing the layer and set it as the active annotation target.

IFDOGraphicsLayer : IUnknown

Provides access to members that control the FDO graphics layer.

Member	Description
BeginAddElements	*Begins a batch process for adding elements to a graphics layer.*
DoAddElements (in pElements: IElementCollection, in zorder: Long)	*Adds a batch of elements to a graphics layer.*
DoAddFeature (in pFeature: IFeature, in pElement: IElement, in zorder: Long)	*Adds a feature and its corresponding element to a graphics layer.*
EndAddElements	*Ends the batch process for adding elements to a graphics layer.*
SetupAttributeConversion (in numAttributes: Long, in inputCols: Long, in outputCols: Long)	*Sets up attribute conversion parameters for batch conversion.*

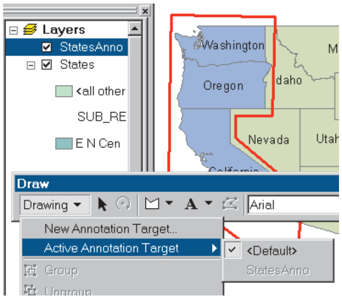
The *IFDOGraphicsLayer* interface indicates that the graphics layer is an *FDOGraphicsLayer*. If you have a reference to a graphics layer, you can try to *QI* for *IFDOGraphicsLayer* to check if you have an *FDOGraphicsLayer* object. This interface also has methods for batch loading annotation. These methods provide an optimized way to convert labels to annotation.

IFDOAttributeConversion : IUnknown

Provides access to members that control the attribute conversion to a FDO graphics layer.

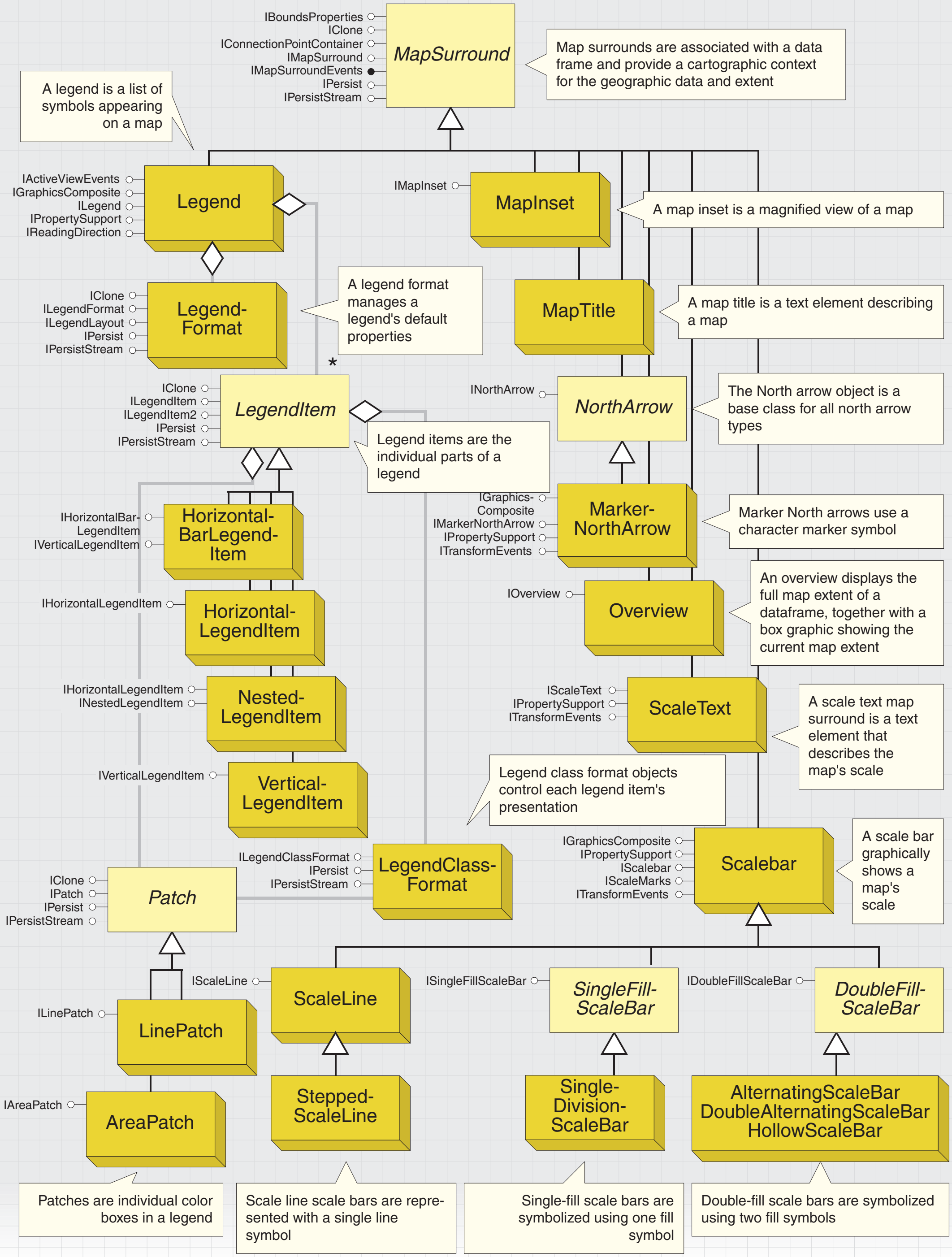
Member	Description
SetupAttributeConversion2 (in numAttributes: Long, in inputCols: Variant, in outputCols: Variant)	*Sets up attribute conversion parameters for batch conversion*

The *SetupAttributeConversion* method on *IFDOGraphicsLayer* will not work in Visual Basic; use the *SetupAttributeConversion2* method on *IFDOAttributeConversion* instead.



The *StatesAnno* layer is an *FDOGraphicsLayer*. This layer consists of the state labels and the red polygon, and shows up in both the table of contents and the active annotation target list.

ArcMap map surround objects



Map surrounds are associated with a data frame and provide a cartographic context for the geographic data and extent

A legend is a list of symbols appearing on a map

A map inset is a magnified view of a map

A legend format manages a legend's default properties

A map title is a text element describing a map

The North arrow object is a base class for all north arrow types

Legend items are the individual parts of a legend

Marker North arrows use a character marker symbol

An overview displays the full map extent of a dataframe, together with a box graphic showing the current map extent

A scale text map surround is a text element that describes the map's scale

Legend class format objects control each legend item's presentation

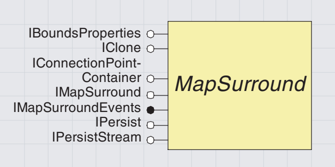
A scale bar graphically shows a map's scale

Patches are individual color boxes in a legend

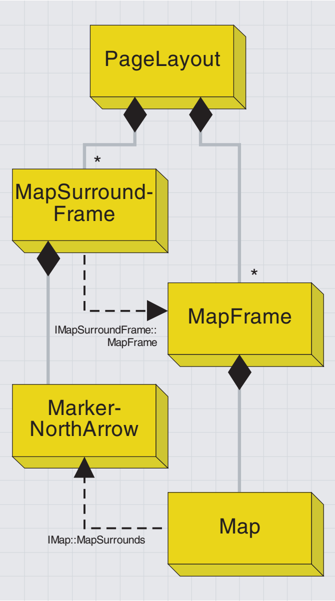
Scale line scale bars are represented with a single line symbol

Single-fill scale bars are symbolized using one fill symbol

Double-fill scale bars are symbolized using two fill symbols



Map surrounds are a special class of elements that are contained by a map surround frame and associated with a Map.



This diagram shows the relationship between a North arrow map surround, its map surround frame, and its related Map. *The* PageLayout *ultimately manages the frame objects but, when a* Map *is deleted, its related map surrounds and their frames are deleted as well.*

Map surrounds are specific types of elements that are associated with a *Map* object. A good example of a map surround and its capabilities is the North arrow. North arrows are built as map surrounds so that they can respond to map rotation—when a map is rotated, its North arrow is rotated the same amount.

In ArcMap, map surrounds are always contained by a *MapSurroundFrame* object—a type of element. *MapSurroundFrames* are similar to *MapFrames*, which house a *Map* object, in that the *PageLayout* object manages both of them. In fact, the *PageLayout* manages all frame objects. Each *MapSurroundFrame* is also related to a *MapFrame*; if a *MapFrame* is deleted, all of its *MapSurroundFrames* are deleted as well. Map surrounds are placed on the layout, not in a *Map*'s graphics layer.

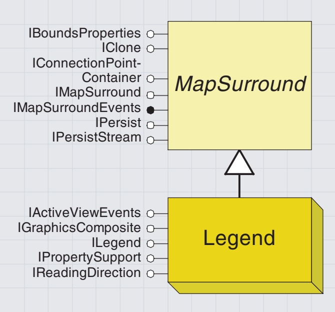
Map surrounds can be moved anywhere on the layout, not just within the confines of a map frame. Because map surrounds are directly associated with a *Map*, the *Map* has a shortcut to all the map surrounds associated with it, *IMap::MapSurrounds*. This member, along with *IMap::MapSurroundCount*, allows you to loop through all of the available map surrounds for a given *Map* object.

IMapSurround : IUnknown	Provides access to members that control the map surround.
Icon: Long	Icon used to represent the map surround.
Map: IMap	The parent map.
Name: String	Name of the map surround.
DelayEvents (in delay: Boolean)	Used to batch operations together to minimize notifications.
Draw (in Display: IDisplay, in trackCancel: ITrackCancel, in Bounds: IEnvelope)	Draws the map surround into the specified display bounds.
FitToBounds (in Display: IDisplay, in Bounds: IEnvelope, out Changed: Boolean)	Adjusts the map surround to fit the bounds. The changed argument indicates whether the size of the map surround was changed.
QueryBounds (in Display: IDisplay, in oldBounds: IEnvelope, newBounds: IEnvelope)	Returns the bounds of the map surround.
Refresh	Makes sure the latest updates are refected the next time the Map Surround is drawn.

All map surrounds implement the *IMapSurround* interface. This interface provides all the common functionality between all map surrounds. Use this interface to access the name of a particular map surround and the associated map. This interface also has methods for determining a surround's size and changing it.

IMapSurroundEvents : IUnknown	Provides access to events that occur when the state of the map surrounds changes.
AfterDraw (in Display: IDisplay)	Fired after drawing completes.
BeforeDraw (in Display: IDisplay)	Fired before drawing starts.
ContentsChanged	Fired when the contents of the map surround changes.

IMapSurroundsEvents is the outbound interface for all map surround objects. This interface allows you to draw a map surround in a window. The events let the window know when to redraw.

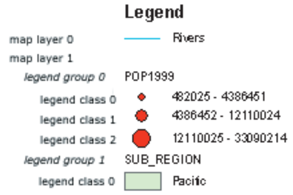


A legend is a list of symbols appearing on the map; legends include a sample of each symbol and text describing what feature each symbol represents.

The *Legend* coclass is one of the most complicated map surround objects because it relies on several other objects to create a good-looking legend.

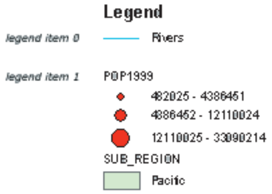
Legends are associated with the renderers that belong to each layer in a map. Each layer in a map has a separate renderer. Each renderer has one or more *LegendGroup* objects; the number of legend groups depends on the renderer's implementation. Each *LegendGroup*, in turn, has one or more *LegendClass* objects. A *LegendClass* object represents an individual classification and has its own symbol and label—a description and format are optional.

The diagram to the left illustrates this hierarchy. This legend has two map layers in it: USA Rivers and USA States. The symbology for the States layer is based on multiple attributes: SUB_REGION and POP1999. For simplicity, only the Pacific region has been added to the legend. Because the USA States layer is symbolizing on multiple items, there are two legend groups. The first legend group has three legend classes, and the second legend group has one legend class. The USA Rivers layer has one legend group and one legend class. For more details on legend groups and classes, see Chapter 5, 'Displaying graphics'.



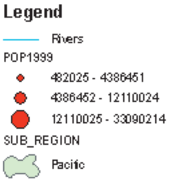
This image maps ArcMap layer renderers' legend groups and classes to a typical legend.

Legends have a similar hierarchy. Each *Legend* object has one or more *LegendItem* objects. There is one legend item per map layer involved in the legend. Legend items control the presentation of the layers in a legend. There are several types of legend items, including *HorizontalLegendItem, HorizontalBarLegendItem, VerticalLegendItem,* and *NestedLegendItem*.



This image labels a legend's items. There is one legend item per map layer, just as there is one legend group per map layer (renderer).

The symbology and classification scheme in a legend is almost entirely based on the map's renderers. For example, to change the color of an element in a legend, you must change the element's corresponding legend class. Legends automatically update in response to changes made in their related renderers. You can also customize the style of a legend patch. For example, you change regular rectangle area patches to natural area patches.

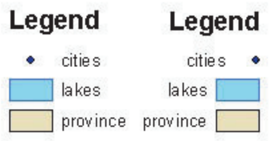


The bottom area patch's style has been changed from a rectangular area patch to a natural area patch.

Legends have many more properties, including the gap size between the various parts of the legend, the title position, and default patches. Each *Legend* object automatically instantiates a *LegendFormat* object that manages all of these additional properties. Most legend properties have a default, making it very easy to create a new legend that looks good. When you change the properties of a legend after you have added it to the layout, you must call *ILegend::Refresh* to have changes reflected.

ILegend : IMapSurround	***Provides access to members that control a legend.***
AutoAdd: Boolean	*Indicates if a new item should be added when a new layer is added to the map.*
AutoReorder: Boolean	*Indicates if the legend items should be kept in the same order as the layers.*
AutoVisibility: Boolean	*Indictes if items should be shown only when associated layers are visible.*
FlowRight: Boolean	*Reserved for future use.*
Format: ILegendFormat	*The formatting options for the legend (can be stored in the style gallery).*
Item (in Index: Long) : ILegendItem	*The specified item from the legend.*
ItemCount: Long	*Number of items in the legend.*
Title: String	*Title.*
AddItem (in Item: ILegendItem)	*Adds a new item to the legend (to the end of the list).*
ClearItems	*Removes all items from the legend.*
InsertItem (in Index: Long, in Item: ILegendItem)	*Inserts a new item into the legend (at the location specified by index).*
RemoveItem (in Index: Long)	*Removes the specified item from the legend.*

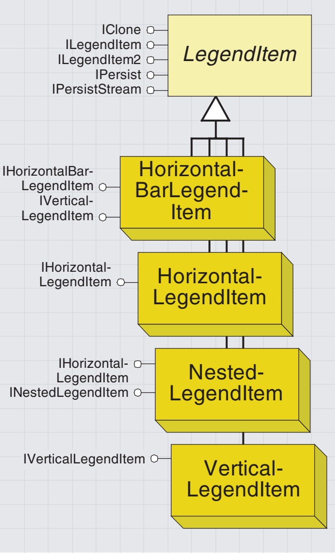
The *Legend*'s primary interface is *ILegend*. Use this interface to modify a legend and access its subparts. For example, this interface provides access to the legend's items and its legend format object. *ILegend* also manages a few of the legend properties such as the title. Again, when changing the properties of an existing legend, you must call *ILegend::Refresh* to have the changes reflected in the layout.



The legend on the left has RightToLeft *set to* False, *and the legend on the right has* RightToLeft *set to* True.

IReadingDirection : IUnknown	***Provides access to members that control the reading direction.***
RightToLeft: Boolean	*Reading direction.*

The *IReadingDirection* interface has one property that controls whether the legend items are aligned along the left or right side. By default, this property is set to *False*.



Legend items are the individual items in a legend. For example, a simple map with three layers typically has three legend items in its legend.

Legend map surrounds maintain a collection of associated layers. Each layer is represented by a *LegendItem*. *LegendItems* are responsible for formatting the legend information for a single layer. The *Legend* relies heavily on its associated *LegendItems* to lay out the legend. When the legend is refreshed, it creates a set of graphic elements to use for rendering itself.

The legend items do most of the work—each one pulls the legend information from its associated layer and formats it into a positioned set of graphic elements. The *Legend* simply positions the title and legend item graphics relative to one another.

All legend items have a *LegendClassFormat* object that optionally contains additional formatting information. For example, this object can control the text formatting, patch style, and patch size. In most cases, however, these properties are not set, and the *Legend* uses its *LegendFormat* object instead.

The *Legend*'s *LegendFormat* object manages defaults for these properties. For example, legend patches are usually managed by the *LegendFormat* object and not by a *LegendClassFormat* object.

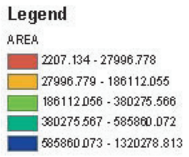
There are currently four types of legend items: *HorizontalLegendItem, VerticalLegendItem, HorizontalBarLegendItem,* and *NestedLegendItem*.

ILegendItem : IUnknown	***Provides access to members that control how a layer appears in a legend. Can be stored in a style.***
■— CanDisplay (in Layer: ILayer) : Boolean	*Indicates if the style is compatible with the specified layer.*
■—■ Columns: Integer	*Number of columns in the legend item.*
■— Graphics: IEnumElement	*List of graphics that represent the legend item. Must call CreateGraphics first.*
■—■ GroupIndex: Long	*Zero-based index of the legend group shown by this item. Use -1 to show all legend groups using this item.*
■—■ HeadingSymbol: ITextSymbol	*Text symbol used to draw the heading.*
■— Height: Double	*Height of the item in points. Must call CreateGraphics first.*
■—■ KeepTogether: Boolean	*Indicates if classes must appear in a single column or whether they can be split across multiple columns.*
■—□ Layer: ILayer	*Associated layer.*
■—■ LayerNameSymbol: ITextSymbol	*Text symbol used to draw the layer name.*
■—■ LegendClassFormat: ILegendClassFormat	*Default formatting information for the legend classes. Renderer may override.*
■— Name: String	*Name of the style.*
■—■ NewColumn: Boolean	*Indicates if the item starts a new column in the legend.*
■—■ ShowDescriptions: Boolean	*Indicates if descriptions are visible.*
■—■ ShowHeading: Boolean	*Indicates if heading is visibile.*
■—■ ShowLabels: Boolean	*Indicates if labels are visible.*
■—■ ShowLayerName: Boolean	*Indicates if layer name is visibile.*
■— Width: Double	*Width of the item in points. Must call CreateGraphics first.*
← CreateGraphics (in Display: IDisplay, in LegendFormat: ILegendFormat)	*Rebuilds the list of graphics. Call whenever the associated layer changes.*

All legend items implement the *ILegendItem* interface. The interface controls all of the properties a legend item has—the layer it is associated with; the number of columns it should span; whether it should be displayed in a new column; and whether the label, description, heading, and layer name should be displayed. This interface also provides access to the legend items *LegendClassFormat* object.

Enumeration esriLegendItemArrangement	***Legend item arrangement options for the order of patches, labels, and descriptions.***
0 - esriPatchLabelDescription	*Patch followed by label followed by description.*
1 - esriPatchDescriptionLabel	*Patch followed by description followed by label.*
2 - esriLabelPatchDescription	*Label followed by patch followed by description.*
3 - esriLabelDescriptionPatch	*Label followed by description followed by patch.*
4 - esriDescriptionPatchLabel	*Description followed by patch followed by label.*
5 - esriDescriptionLabelPatch	*Description followed by label followed by patch.*

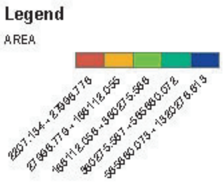
All legend items use the *esriLegendItemArrangement* enumeration to specify the position of the label, patch, and description. The default is *esriPatchLabelDescription,* which translates to the patch on the far left, label to the right of the patch, then the description, if available, on the far right.



Horizontal legend items in a legend

IHorizontalLegendItem : IUnknown	***Provides access to members that work with legend item arrangement.***
⊶ Arrangement: esriLegendItemArrangement	*Legend item arrangement.*

Horizontal legend items are the default and most commonly used class of legend items. The image to the left shows an example.

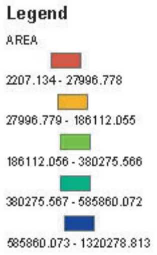


Horizontal bar legend items in a legend

IHorizontalBarLegendItem : IUnknown	***Provides access to members that work with horizontal bar legend items.***
⊶ AngleAbove: Double	*Angle of text that appears above the bar.*
⊶ AngleBelow: Double	*Angle of text that appears below the bar.*

The *IHorizontalBarLegendItem* interface supports additional properties for controlling the angle of the labels above and below the patch. The default is to display the labels at a 45-degree angle. The image to the left shows such an example.

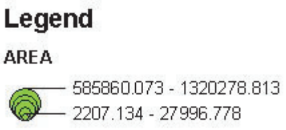
IVerticalLegendItem : IUnknown	***Provides access to members that work with legend item arrangement.***
⊶ Arrangement: esriLegendItemArrangement	*Legend item arrangement.*



Vertical legend items in a legend

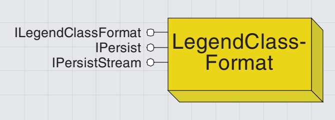
Vertical legend items have the patches on top of the legend item text.

INestedLegendItem : IUnknown	***Provides access to members that work with nested legend items.***
⊶ AutoLayout: Boolean	*Indicates if text automatically sizes to fit the markers.*
⊶ HorizontalAlignment: tagesriTextHorizontalAlignment	*Horizontal alignment of markers.*
⊶ LabelEnds: Boolean	*Indicates if only the first and last markers are labeled.*
⊶ LeaderOverhang: Double	*Distance that the leaders extend past the circles (points).*
⊶ LeaderSymbol: ILineSymbol	*Symbol used to draw the leader lines.*
⊶ OutlineSymbol: IFillSymbol	*Symbol used to draw outlines.*
⊶ ShowOutlines: Boolean	*Indicates if only the marker outlines are drawn.*



Nested legend items in a legend

Nested legend items only work with graduated symbols. The image to the left shows a legend with a default nested legend item. The *INestedLegendItem* interface controls the many properties a nested legend item has, including whether or not to label the ends, the leader symbol, and the outline symbol.

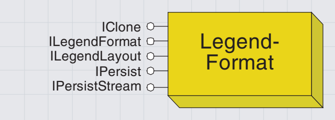


Legend class format objects control each legend item's presentation.

As mentioned earlier, each legend item has a *LegendClass* format object that controls the format of the individual legend item, including the symbols used for the label and description.

ILegendClassFormat : IUnknown	***Provides access to members that control formatting information for a legend class.***
■—■ AreaPatch: IAreaPatch	*The area patch. (Optional. If non-null, this overrides default area patch specified by ILegend.LegendFormat.)*
■—■ DescriptionSymbol: ITextSymbol	*Text symbol used to draw legend group descriptions.*
■—■ LabelSymbol: ITextSymbol	*Text symbol used to draw the legend group labels.*
■—■ LinePatch: ILinePatch	*The line patch. (Optional. If non-null, this overrides default line patch specified by ILegend.LegendFormat.)*
■—■ PatchHeight: Double	*Height of the patch in points.*
■—■ PatchWidth: Double	*Width of the patch in points.*

The renderer used to display the layer may also supply a default *LegendClassFormat* so that the legend formatting information gets stored with the layer (in a metadata-like fashion). By default, a layer's *LegendClassFormat* is set to *Nothing*. When a layer does not supply a *LegendClassFormat*, the legend's *LegendFormat* is used. The *LegendClassFormat* properties are optional. If they are not set, the default value from the *LegendFormat* object is used instead. This applies to *PatchWidth, PatchHeight, LinePatch,* and *AreaPatch*. This makes it easy to get all the patches in the legend to look the same even though they are controlled by different legend items. It also makes it possible to have different patch shapes for each layer if desired.



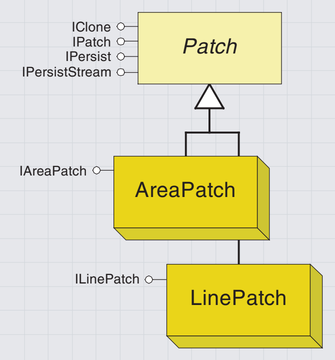
The legend format controls the spacing between the different parts in a legend.

Although LegendFormat *is creatable, creating a new* Legend *object automatically creates a new* LegendFormat*. Access to the* Legend*'s* LegendFormat *object is through* ILegend::Format*.*

Each *Legend* has a *LegendFormat* object with which it works. The *LegendFormat* object controls many of the properties of a legend, particularly the spacing between the different parts in a legend.

ILegendFormat : IUnknown	***Provides access to members that control formatting information for a legend.***
■—■ DefaultAreaPatch: IAreaPatch	*Area patch. Can be overridden by the LegendItem.*
■—■ DefaultLinePatch: ILinePatch	*Line patch. Can be overridden by the LegendItem.*
■—■ DefaultPatchHeight: Double	*Patch height in points. Can be overridden by the LegendItem.*
■—■ DefaultPatchWidth: Double	*Patch width in points. Can be overridden by the LegendItem.*
■—■ GroupGap: Double	*Vertical distance in points between legend groups.*
■—■ HeadingGap: Double	*Vertical distance in points between a heading and the legend graphics that follow.*
■—■ HorizontalItemGap: Double	*Horizontal distance in points between legend item columns. Used for legends that have more than one column.*
■—■ HorizontalPatchGap: Double	*Horizontal distance in points between a patch and the legend graphics before and after.*
■—■ LayerNameGap: Double	*Vertical distance in points between layer names and the legend graphics that follow.*
■—■ ShowTitle: Boolean	*Indicates if title is visibile.*
■—■ TextGap: Double	*Horizontal distance in points between labels and descriptions.*
■—■ TitleGap: Double	*Vertical distance in points between title and first legend item.*
■—■ TitlePosition: esriRectanglePosition	*Legend title position.*
■—■ TitleSymbol: ITextSymbol	*Text symbol used to draw the legend title.*
■—■ VerticalItemGap: Double	*Vertical distance in points between legend items.*
■—■ VerticalPatchGap: Double	*Vertical distance in points between patches.*
← Scale (in XScale: Double, in YScale: Double)	*Multiply all distances, gaps, and size property values on this interface by the specified scale factors.*

The *ILegendFormat* interface manages many legend properties, most notably the spacing between the different legend parts. There are also properties for default line and area patches, including their height and width, that are used when a legend item does not provide its own formatting information.



The patches help describe the features in each legend class.

Patches are the individual color boxes or lines associated with each legend class. Both the *LegendFormat* and *LegendFormatClass* objects manage area and line patches.

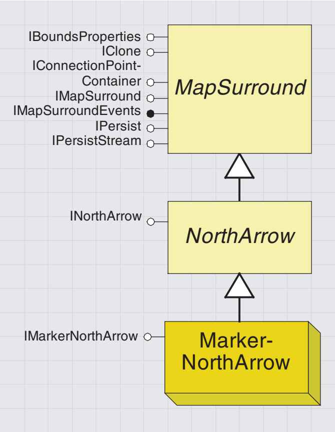
IPatch : IUnknown	***Provides access to members that work with a legend patch.***
Geometry: IGeometry	*Patch geometry.*
Name: String	*Name of the patch.*
PreserveAspectRatio: Boolean	*Indicates if aspect ratio of patch is preserved.*
get_Geometry (in Bounds: IEnvelope) : IGeometry	*Patch geometry sized to fit the specified bounds.*

Geometry and *PreserveAspectRatio* are two primary properties in a patch area. The *Geometry* property specifies the shape of the patch. The sample below shows one way to programmatically change a legend's area patches. The *PreserveAspectRatio* property controls how the geometry scales when the legend expands.

The sample below changes the *LegendFormat*'s default area patch to a shape similar to the selected element. To use, add a new polygon element (it doesn't matter what size) to the layout. Select the new element and then select a legend. Make sure the legend has area patches in it. Run the macro, and all the area patches in the specified legend item should adopt the new style. The code works with the last legend item; modify the code as necessary. Also, the color of the element has no bearing on the legend since the color comes from the renderer. You can modify the sample to also do line patches.

```
Public Sub CustomAreaPatch()
  Dim pMxDoc As IMxDocument
  Dim pGraphicsContainer As IGraphicsContainerSelect
  Dim pLegendSurround As IMapSurroundFrame
  Dim pLegend As ILegend
  Dim pLegendItem As ILegendItem
  Dim pPatch As IPatch
  Dim pElement As IElement
  Dim pLegendFormat As ILegendFormat

  Set pMxDoc = Application.Document
  Set pGraphicsContainer = pMxDoc.PageLayout
  Set pLegendSurround = pGraphicsContainer.SelectedElement(1)
  Set pLegend = pLegendSurround.MapSurround
  Set pLegendItem = pLegend.Item(pLegend.ItemCount - 1)
  Set pElement = pGraphicsContainer.SelectedElement(0)
  Set pPatch = New AreaPatch
  pPatch.Geometry = pElement.Geometry
  Set pLegendFormat = pLegend.Format
  pLegendFormat.DefaultAreaPatch = pPatch
  pLegend.Refresh
  pMxDoc.ActiveView.PartialRefresh esriViewGraphics, Nothing, Nothing
End Sub
```

Patches also implement indicator interfaces so that the patch type for a given object can easily be determined. Area patches implement *IAreaPatch*, and line patches implement *ILinePatch*. These interfaces have no members.



Marker North arrows are typical North arrows added to a layout.

MarkerNorthArrows are character marker symbols typically coming from the ESRI North font. However, any character from any font can be used as a North arrow.

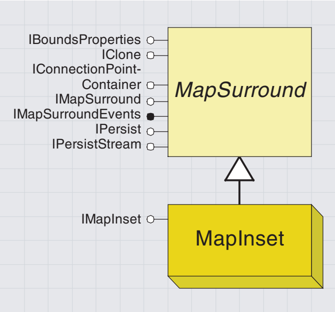
MarkerNorthArrows implement two additional interfaces: *INorthArrow* and *IMarkerNorthArrow*.

INorthArrow : IMapSurround	Provides access to members that control the north arrow.
Angle: Double	The counter-clockwise rotation of the north arrow in degrees. This value is calculated from the map.
CalibrationAngle: Double	Calibration angle. Rotation is modified by this angle.
Color: IColor	Color used to draw the north arrow.
ReferenceLocation: IPoint	The point on the map where north is calculated.
Size: Double	Size of the north arrow in points (1/72 inch).

The *INorthArrow* interface provides a common interface for North arrow properties, such as size, color, and reference location.

IMarkerNorthArrow : IUnknown	Provides access to members that control the Marker north arrow.
MarkerSymbol: IMarkerSymbol	Symbol used to draw the north arrow. Use set to specify a marker for custom north arrows.

IMarkerNorthArrow has one property, *MarkerSymbol*, that controls which marker symbol the North arrow uses. By default, the marker symbol belongs to the ESRI North font.



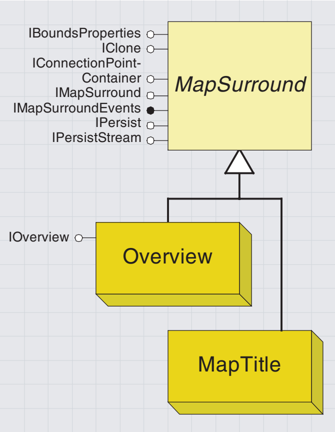
A map inset is a miniature map that typically shows a magnified view of an actual map.

A *MapInset* map surround is another view of the current map extent. If you pan or zoom in on the map the *MapInset* is related to, the *MapInset* will mimic the change.

A map inset map surround is the surround found inside map inset data windows.

IMapInset : IMapSurround	Provides access to members that control the inset map surrounds.
Description: String	Description reflecting the current settings of the MapInset.
IsLive: Boolean	Indicates if the inset shows a live view of the underlying map. False means a snapshot of the underlying map is taken at the time the flag is changed.
MapBounds: IEnvelope	The relative position of the inset to the associated map (used when the inset is live). The zoom amount is applied to this rectangle to determine the visible bounds that is actually drawn.
UsingZoomScale: Boolean	Indicates if ZoomScale or ZoomPercent is being used. The one specified last is being used.
VisibleBounds: IEnvelope	The map extent shown by the inset (used when the inset is not live).
ZoomPercent: Double	Zoom amount as a percentage. 100 means show the underlying map at normal size.
ZoomScale: Double	The zoom amount as an absolute Scale (i.e., 1:20000).
CalculateVisibleBounds	Calculates the visible bounds by applying the zoom or scale parameter to MapBounds (used when snapshot is false).

For more information on map inset windows (magnification windows), see ‘ArcMap data window objects’ earlier in this chapter.



An Overview *map surround is a map showing the full extent of the map to which it is related.*

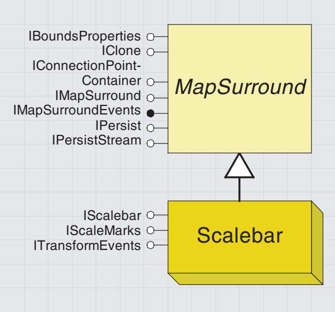
A map title holds text to label a map.

An overview map surround is the surround found in overview data windows.

IOverview : IMapSurround	***Provides access to members that control the overview.***
■–■ AoiFillSymbol: IFillSymbol	*Fill symbol used to display the area of interest.*
■–■ OverlayGridLabelSymbol: ITextSymbol	*Text symbol used to label overlay grid cells with the layer's display field.*
■–■ OverlayGridLayer: ILayer	*Overlay grid layer for the overview.*
← SetOverlayGridCell (in gridLayerFid: Long)	*Sets the extent of the associated map to the specified overlay grid cell.*
← UpdateDisplay (in windowWidth: Long, in windowHeight: Long)	*Updates the display of the overview based upon the associated map's current settings.*

For more information on overview windows, see 'ArcMap data window objects' earlier in this chapter.

The map title object is a map surround that holds a piece of text you can use to label a map. This may not be the title of the whole layout, but rather a subtitle for a specific map in the layout.



A scale bar shows a map's scale graphically.

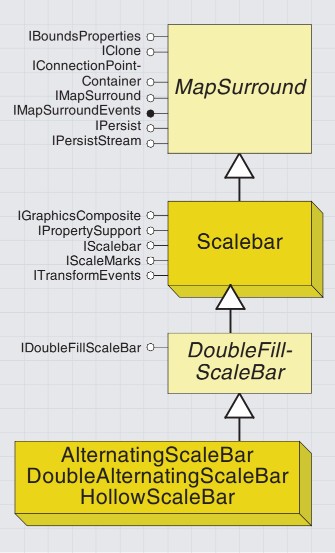
There are many types of scale bar map surrounds, including several types of scale lines, single-fill scale bars, and double-fill scale bars. All scale bars implement *IScaleBar* and *IScaleMarks*.

IScaleBar : IMapSurround	***Provides access to members that control the scalebar map surrounds.***
BarColor: IColor	*Color used to draw the bar.*
BarHeight: Double	*Height of the bar in points (1/72 inch).*
Division: Double	*Number of units in one major division.*
Divisions: Integer	*Total number of divisions (including those before zero).*
DivisionsBeforeZero: Integer	*Number of divisions to the left of zero.*
LabelFrequency: tagesriScaleBarFrequency	*The label style indicating which marks are labeled.*
LabelGap: Double	*Vertical gap between the bar and the labels in points (1/72 inch).*
LabelPosition: tagesriVertPosEnum	*Vertical positioning of the mark labels.*
LabelSymbol: ITextSymbol	*Symbol used to draw the labels.*
NumberFormat: INumberFormat	*Number format.*
ResizeHint: tagesriScaleBarResizeHint	*Indicates what happens when scale bar is resized.*
Subdivisions: Integer	*Number of subdivisions per major division.*
UnitLabel: String	*The unit label.*
UnitLabelGap: Double	*Gap between the scale bar and the unit label in points (1/72 inch).*
UnitLabelPosition: tagesriScaleBarPos	*Vertical positioning of the unit label.*
UnitLabelSymbol: ITextSymbol	*Unit label symbol.*
Units: esriUnits	*The units reported.*
← UseMapSettings	*Sets division and units based on map.*

The *IScaleBar* interface manages most of the properties a scale bar has, including bar color, bar height, division, and label frequency.

IScaleMarks : IUnknown	***Provides access to members that control the scale bar mark properties.***
DivisionMarkHeight: Double	*Height of division marks in points (1/72 inch). Use esriAutoScaleBar to automatically calculate.*
DivisionMarkSymbol: ILineSymbol	*Symbol used to draw the division marks.*
MarkFrequency: tagesriScaleBarFrequency	*Mark frequency.*
MarkPosition: tagesriVertPosEnum	*Vertical positioning of the marks relative to the bar.*
SubdivisionMarkHeight: Double	*Height of subdivision marks in points (1/72 inch). Use esriAutoScaleBar to automatically calculate.*
SubdivisionMarkSymbol: ILineSymbol	*Symbol used to draw the subdivision marks.*

The *IScaleMarks* interface manages all of the properties of a scale bar that relate to the individual marks, including the division mark height, division marker symbol, marker frequency, and marker position.



Double-fill scale bars are one style of scale bar that uses two fill symbols.

Double-fill scale bars are the most advanced scale bars. These use two symbols to create an attractive scale bar. There are currently three types of double-fill scale bars: alternating, double-alternating, and hollow. The graphic to the lower-left corner shows an example of each.

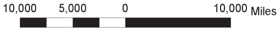
IDoubleFillScaleBar : IUnknown

- FillSymbol1: IFillSymbol
- FillSymbol2: IFillSymbol

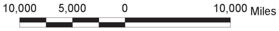
Provides access to members that control a scale bar that uses two fill symbols to draw bar.

Symbol used to draw the bar.
Symbol used to draw the bar.

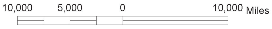
All double-fill scale bars implement the *IDoubleFillScaleBar* interface. This interface manages the two fill symbols used when rendering the scale bar.



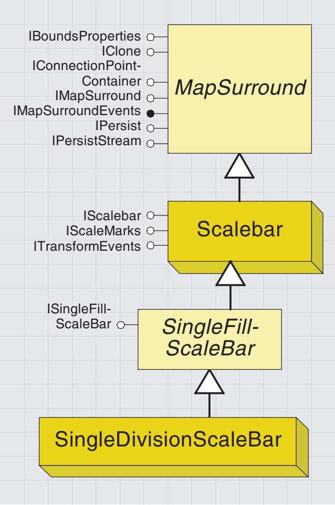
Alternating scale bar



Double alternating scale bar



Hollow scale bar



Single-fill scale bars are those scale bars symbolized with a single fill symbol.

Single-fill scale bars are similar to double-fill scale bars except they use one fill symbol. ArcMap currently has one single-fill scale bar, the *SingleDivisionScaleBar*. The graphic to the left shows an example of a single-division scale bar.

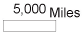
ISingleFillScaleBar : IUnknown

- FillSymbol: IFillSymbol

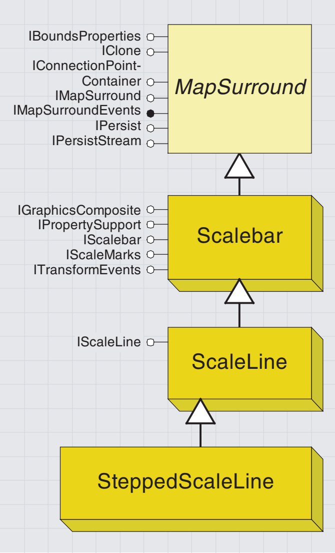
Provides access to members that control a scale bar that uses a single fill symbol to draw bar.

Symbol used to draw the bar.

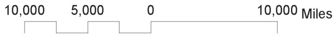
The *ISingleFillScaleBar* interface manages the single-fill symbol used by scale bars of this type.



Single division scale bar



Scale lines are another class of scale bars that are based on line work instead of polygons. The graphic below shows an example of a stepped-line scale bar.

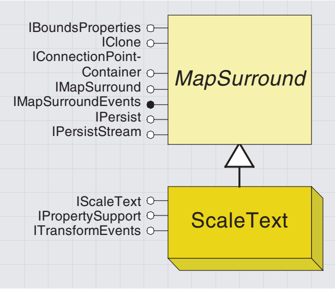


Stepped-line scale bar

Scale line scale bars are the only class of scale bars that represent a scale bar as a line. ArcMap currently has one type of scale line scale bar—the stepped-line scale bar.

IScaleLine : IUnknown	***Provides access to members that control a line scale bar.***
▪━▪ LineSymbol: ILineSymbol	*Symbol used to draw the line.*

The *IScaleLine* interface manages the one line symbol used by scale lines.



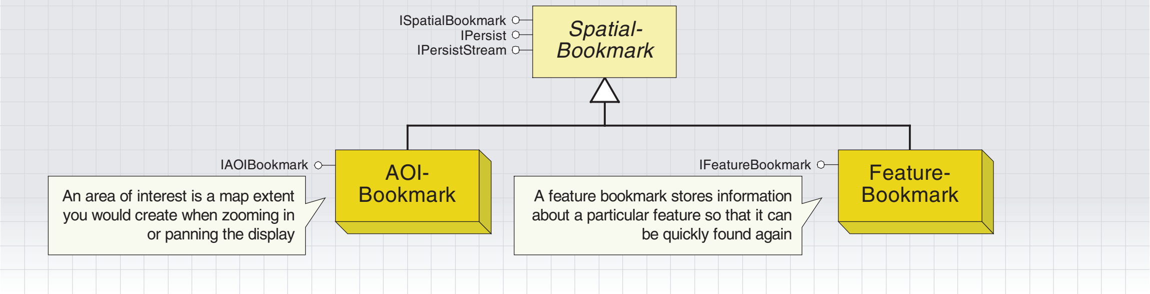
Scale text is a text element indicating a map's scale.

Scale text is essentially a text element that describes the map's scale. One example of scale text is “1 inch equals 2,400 miles”.

IScaleText : IMapSurround	***Provides access to members that control the scale text.***
▪━▪ Format: String	*Format of the scale text. Style must be set to custom.*
▪━▪ MapUnitLabel: String	*Map unit label of the scale text. Style must be set to relative.*
▪━▪ MapUnits: esriUnits	*Map units of the scale text. Style must be set to custom.*
▪━▪ NumberFormat: INumberFormat	*Number formatting.*
▪━▪ PageUnitLabel: String	*Page unit label of the scale text. Style must be set to relative.*
▪━▪ PageUnits: esriUnits	*Page units of the scale text. Style must be set to custom.*
▪━▪ Style: tagesriScaleTextStyleEnum	*Style of the scale text.*
▪━▪ Symbol: ITextSymbol	*Symbol of the scale text.*
▪━ Text: String	*The scale text.*

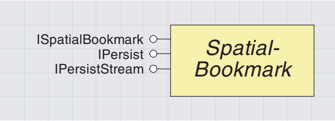
The *IScaleText* interface controls the format of the string that is added as a map surround element. This interface has properties such as *MapUnit* and *MapUnitLabel*—“miles”, *PageUnit* and *PageUnitLabel*—“inches”, and *Text,* which combines the label properties into a sentence.

ArcMap spatial bookmark objects



An area of interest is a map extent you would create when zooming in or panning the display

A feature bookmark stores information about a particular feature so that it can be quickly found again



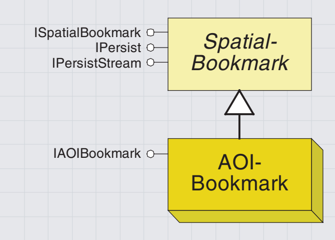
Spatial bookmarks are user-defined extents saved, along with a name identifying them, in an ArcMap document.

There are two types of spatial bookmarks in ArcMap: Area of Interest and Feature bookmarks. Both types of spatial bookmarks are managed by the *Map* object for which they store extents. Bookmarks are persisted in the map document saved to disk. You can access a *Map*'s spatial books using its *IMapBookmarks* interface. This interface has methods for accessing bookmarks, adding new ones, and deleting old ones.

ISpatialBookmark : IUnknown	***Provides access to members that control a spatial bookmark.***
■— BookmarkType: String	*Type of the bookmark.*
■—■ Name: String	*Name of the bookmark.*
← ZoomTo (in Map: IMap)	*Zooms to the bookmark.*

All spatial bookmarks implement the *ISpatialBookmark* interface. This interface defines all the common functionality between all bookmarks, particularly the name of the bookmark and a zoom function. Use this interface to check the name of a spatial bookmark and zoom to the extent stored in a bookmark. The *ZoomTo* function changes the map's extent via *IActiveView::Extent*. *ZoomTo* does not automatically invalidate the display.

Implement the *ISpatialBook* interface to create new custom spatial bookmarks.



This is the Area of Interest bookmark. An area of interest is a map extent that one would create when zooming in or panning the display.

Create a new *AOIBookmark* whenever you want to create an Area of Interest bookmark. This object persists an envelope holding an extent somewhere within the confines of the map's spatial extent. Like all spatial bookmarks, after creating an Area of Interest bookmark, you can later find it by name and set the map's current extent equal to the extent stored in the bookmark. In ArcMap, new Area of Interest bookmarks are created using the various commands found by clicking View and clicking Bookmarks.

IAOIBookmark : ISpatialBookmark	***Provides access to members that control an AOI bookmark.***
■—□ Location: IEnvelope	*Location of the bookmark.*

The only other interface that *AOIBookmark* implements is *IAOIBookmark*, which has one property for accessing the extent the object holds. All of the different spatial bookmark objects have a unique interface that actually inherits from *ISpatialBookmark*. This makes it easy to access the *ISpatialBookmark* members without performing a query interface. By inheriting the interface, the members appear as though they belong directly on the unique interface. For example, if you have a variable declared as an *IAOIBookmark*, you can directly call *ZoomTo* without querying the interface for *ISpatialBookmark*.

The script below creates a new Area of Interest bookmark and adds it to the focus map's bookmark collection:

```
Public Sub AddAreaOfInterestBookMark()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pActiveView As IActiveView
  Dim pAreaOfInterest As IAOIBookmark
  Dim pMapBookmarks As IMapBookmarks

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pActiveView = pMap 'QI

  'Create a new bookmark and set it's location to focus map's current extent
  Set pAreaOfInterest = New AOIBookmark
  Set pAreaOfInterest.Location = pActiveView.Extent
  'Give the bookmark a name
  pAreaOfInterest.Name = "My Bookmark"
  'Add the bookmark to the map's bookmark collection
  'This will add the bookmark to Bookmarks menu accessible from View menu
  Set pMapBookmarks = pMap
  pMapBookmarks.AddBookmark pAreaOfInterest
End Sub
```

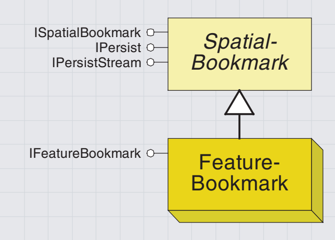
This script searches for a specific bookmark and then zooms to its stored extent.

```
Public Sub FindSpatialBookMark()
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pActiveView As IActiveView
  Dim pAreaOfInterest As IAOIBookmark
  Dim pMapBookmarks As IMapBookmarks
  Dim pEnumBookmarks As IEnumSpatialBookmark
  Dim pSpatialBookmark As ISpatialBookmark

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap
  Set pMapBookmarks = pMap 'QI
  Set pActiveView = pMap 'QI

  Set pEnumBookmarks = pMapBookmarks.Bookmarks
  pEnumBookmarks.Reset
  Set pSpatialBookmark = pEnumBookmarks.Next
  'Loop through all the available bookmarks
  'to find the one we want to zoom to
```

```
 Do While Not pSpatialBookmark Is Nothing
  If pSpatialBookmark.Name = "My Bookmark" Then
   'Zoom to the bookmark's extent
   pSpatialBookmark.ZoomTo pMxDoc.FocusMap
   'Refresh the display
   pActiveView.Refresh
    Exit Do
  End If
  Set pSpatialBookmark = pEnumBookmarks.Next
 Loop
End Sub
```

Create a new *FeatureBookmark* whenever you want to quickly find a particular feature more than one time. This object stores the ID of a feature and the feature class it belongs to so that it can quickly discover and display the feature at any time.

In ArcMap, new Feature bookmarks are created using the Identify tool. Identify a feature and right-click the feature node in the Identify dialog box, then click Set Bookmark. Like all bookmarks, this new bookmark will be added to the map's collection of bookmarks and listed on the Bookmarks menu.

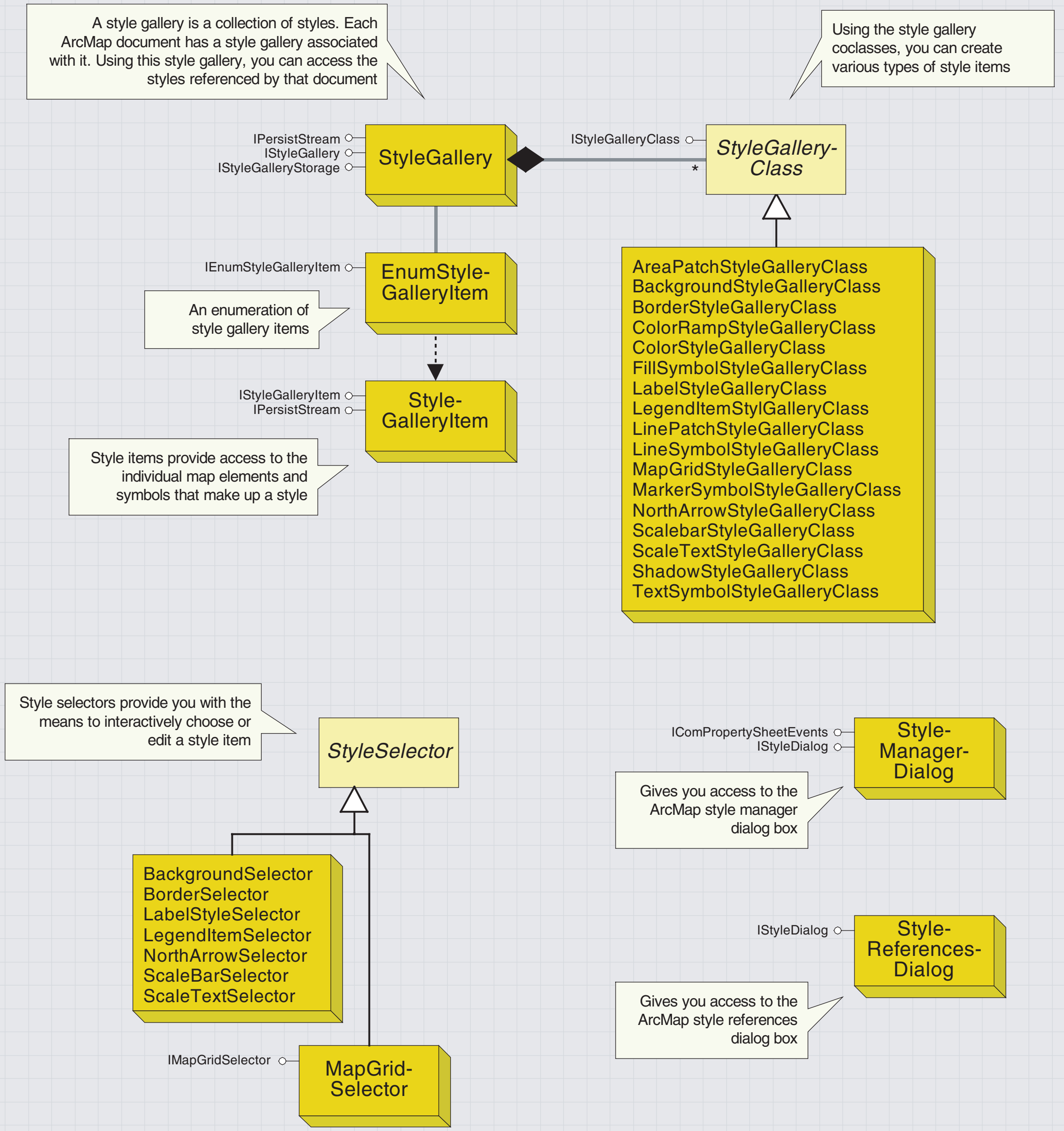


Where Area of Interest bookmarks store a user-specified extent, Feature bookmarks store information about a particular feature so that it may quickly be found and displayed over and over again.

IFeatureBookmark : ISpatialBookmark	***Provides access to members that control a feature bookmark.***
FeatureClass: IFeatureClass	*Feature class.*
FeatureId: Long	*Feature id.*
Draw (in Display: IDisplay)	*Draws the feature on the map display.*
Flash (in Display: IDisplay)	*Flashes the feature on the map display.*
PanTo (in Display: IDisplay)	*Pans to the feature on the map display.*

The *FeatureBookmark* object also implements the *IFeatureBookmark* interface, which provides the necessary properties for setting the feature class and feature ID. This interface also has methods for flashing the feature, panning to it, and drawing. These methods are not implemented at ArcGIS 8.1.

ArcMap style gallery objects



A style gallery is a collection of styles. Each ArcMap document has a style gallery associated with it. Using this style gallery, you can access the styles referenced by that document

Using the style gallery coclasses, you can create various types of style items

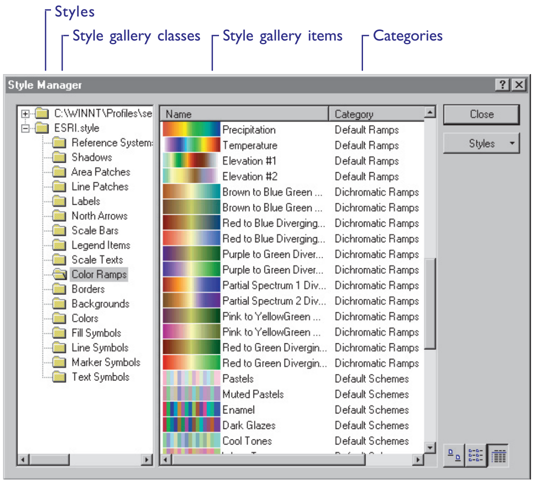
An enumeration of style gallery items

Style items provide access to the individual map elements and symbols that make up a style

Style selectors provide you with the means to interactively choose or edit a style item

Gives you access to the ArcMap style manager dialog box

Gives you access to the ArcMap style references dialog box

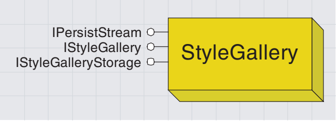


Name	Category
Precipitation	Default Ramps
Temperature	Default Ramps
Elevation #1	Default Ramps
Elevation #2	Default Ramps
Brown to Blue Green ...	Dichromatic Ramps
Brown to Blue Green ...	Dichromatic Ramps
Red to Blue Diverging...	Dichromatic Ramps
Red to Blue Diverging...	Dichromatic Ramps
Purple to Green Diver...	Dichromatic Ramps
Purple to Green Diver...	Dichromatic Ramps
Partial Spectrum 1 Div...	Dichromatic Ramps
Partial Spectrum 2 Div...	Dichromatic Ramps
Pink to YellowGreen ...	Dichromatic Ramps
Pink to YellowGreen ...	Dichromatic Ramps
Red to Green Divergin...	Dichromatic Ramps
Red to Green Divergin...	Dichromatic Ramps
Pastels	Default Schemes
Muted Pastels	Default Schemes
Enamel	Default Schemes
Dark Glazes	Default Schemes
Cool Tones	Default Schemes

Styles are collections of symbols and map elements that are often grouped by functionality. For example, symbols and map elements used by the transportation industry may be grouped into a Transportation Style.

Styles are stored in files that usually have a .style extension. ESRI provides several styles for you to use out of the box. These styles are found under <install_directory>\Bin\Styles. You will find commonly used symbols and map elements in ESRI.style, and more domain-specific style items in relevantly named .style files. The personal style file for each user is maintained in that user's Profiles directory—for example, C:\WINNT\Profiles\user_name\Application Data\ESRI\ArcMap\user_name.style.

A style is composed of several style items. These style items provide access to individual map elements and symbols. Style items are organized into classes, which are types of style items. A class may have several groups of items organized into categories. In the style manager figure, Precipitation is a style item that belongs to the Color Ramps class and the Default Ramps category.



A style gallery is a collection of styles. Each ArcMap document has a style gallery associated with it. Using this style gallery, you can access the styles referenced by that document.

The *StyleGallery* coclass is a collection of the styles referenced by a map document. *StyleGallery* is a singleton class, which means that there is only one instance of this class per ArcMap session.

IStyleGallery : IUnknown	*Provides access to members modify the Style Gallery.*
Categories (in ClassName: String) : IEnumBSTR	*The categories within the given class.*
Class (in Index: Long) : IStyleGalleryClass	*The class at the given index.*
ClassCount: Long	*Number of classes in the Style Gallery.*
Items (in ClassName: String, in styleSet: String, in Category: String) : IEnumStyleGalleryItem	*The style items from the specified style file, in the specified class and category. The style set and category may be blank to return all items.*
AddItem (in Item: IStyleGalleryItem)	*Adds an item to the target style file.*
Clear	*Removes all styles from the Style Gallery.*
ImportStyle (in FileName: String)	*Imports a style from a file other than a .style file.*
LoadStyle (in FileName: String, in ClassName: String)	*Loads a style from a file. If class is specified, only items in that class will be loaded.*
RemoveItem (in Item: IStyleGalleryItem)	*Removes an item from the target style file.*
SaveStyle (in FileName: String, in styleSet: String, in ClassName: String)	*Saves the specified style to a file. If class is specified, only items in that class will be saved.*
UpdateItem (in Item: IStyleGalleryItem)	*Updates an existing item in target style file.*

The *IStyleGallery* interface provides access to the categories, classes, and items in a style. Using this interface, you can add, remove, and update style items. You can also load style files, save a style into another file, or import a style from a custom style file.

You can get to the style gallery used by a map document using the *IMxDocument::StyleGallery* property.

```
Dim pMxDoc As IMxDocument
Dim pStyleGallery As IStyleGallery
```

```
Set pMxDoc = ThisDocument
Set pStyleGallery = pMxDoc.StyleGallery
```

Using the *IStyleGallery::Categories* interface, you can get a listing of the categories in a particular style class. This property takes in the name of the class as an argument. This is the string after which style class folders are named in the style manager. This is also the string returned by *IStyleGalleryClass::Name* for the style gallery class of your interest.

```
Dim pEnumBstr As IEnumBSTR
Dim sCatList As String
Dim sCat As String

Set pEnumBstr = pStyleGallery.Categories("Fill Symbols")
sCatList = "Fill Symbol Categories: "
sCat = pEnumBstr.Next

Do
  sCatList = sCatList & " " & sCat
  sCat = pEnumBstr.Next
Loop While sCat <> ""
MsgBox sCatList
```

You can access the various classes available to the style gallery using *IStyleGallery::Class*.

```
Dim lClasses as Long
lClasses = pStyleGallery.ClassCount
Dim pClass As IStyleGalleryClass
Dim I As Long

For I = 0 To (lClasses - 1)
  Set pClass = pStyleGallery.Class(I)
  MsgBox pClass.Name
Next I
```

Using *IStyleGallery::Items*, you can access the style items in a style file. Using the *ClassName* and *Category* arguments, you can get the style items from a specific style gallery class and a specific category in that class. If you use blank strings for these arguments, you get all the style items in the style.

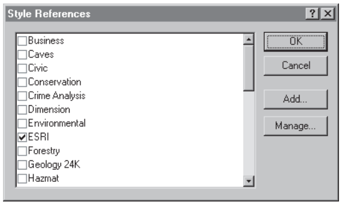
```
Dim pEnumStyleGall As IEnumStyleGalleryItem
Dim pStyleItem As IStyleGalleryItem
Dim pStyleStorage As IStyleGalleryStorage

'Add style file to style gallery
Set pStyleStorage = pStyleGallery
pStyleStorage.AddFile “D:\test.style”

'Access style items
Set pEnumStyleGall = pStyleGallery.Items("Shadows", "D:\test.style", _
  "Default")
Set pStyleItem = pEnumStyleGall.Next
```

After accessing an item, you can make changes to it and update the item in the style file it comes from using *IStyleGallery::UpdateItem*.

```
'Make changes to the item
pStyleItem.Category = "My Category"

Dim pStyleStorage As IStyleGalleryStorage
Set pStyleStorage = pStyleGallery

Dim sOldFile As String
sOldFile = pStyleStorage.TargetFile

'Set the target style file for the changes
pStyleStorage.TargetFile = "D:\test.style"

'Update the item in the style
pStyleGallery.UpdateItem pStyleItem
pStyleStorage.TargetFile = sOldFile
```

Similarly, you can remove an item from a style file by first accessing it, then using *IStyleGallery::RemoveItem* to remove it.

```
Dim sOldFile As String
sOldFile = pStyleStorage.TargetFile

'Set the target style file for the changes
pStyleStorage.TargetFile = "D:\test.style"

'Remove the item from the style
pStyleGallery.RemoveItem pStyleItem
pStyleStorage.TargetFile = sOldFile
```



□ Business
□ Caves
□ Civic
□ Conservation
□ Crime Analysis
□ Dimension
□ Environmental
☑ ESRI
□ Forestry
□ Geology 24K
□ Hazmat

The Style References dialog box shows referenced style files with checked check boxes and unreferenced style files with unchecked check boxes.

To add a style item, you would first have to create it. After creating the style item, you can add it using *IStyleGallery::AddItem*.

```
Dim sOldFile As String
sOldFile = pStyleStorage.TargetFile

'Set the target style file for the changes
pStyleStorage.TargetFile = "D:\test.style"

'Add the new item
pStyleGallery.AddItem pNewItem
pStyleStorage.TargetFile = sOldFile
```

Using *IStyleGallery::ImportStyle*, you can load a style from a custom style file. This method looks for a custom style importer under the Style Importers category in the Category Manager. If the custom style importer's *IStyleImporter::CanImport* property returns *True*, this importer's *IStyleImporter::Import* method is used to import the file.

IStyleGalleryStorage : IUnknown	Provides access to members that manage the files used in the Style Gallery.
■— CanUpdate (in Path: String) : Boolean	Indicates if the specified file can be updated.
■— DefaultStylePath: String	The default file path for searching for standard styles.
■— File (in Index: Long) : String	The file at the given index.
■— FileCount: Long	The number of files in the Style Gallery.
■—■ TargetFile: String	The target output file for adding, updating and removing items.
← AddFile (in Path: String)	Adds a file to the Style Gallery.
← RemoveFile (in Path: String)	Removes a file from the Style Gallery.

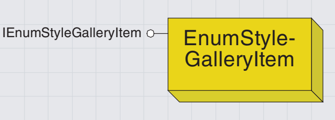
The *IStyleGalleryStorage* interface provides access to the style files referenced in the style gallery. It also has methods that let you add and remove style files.

IStyleGalleryStorage::DefaultStylePath gives the location from which style files are read and listed for referencing in the Style References dialog box. This is currently <install_directory>\Bin\Styles. If you do not specify a path for a style file, this is the directory that ArcMap looks into for the file you specified.

The *IStyleGalleryStorage::TargetFile* property allows you to set a style file as the target for adding, removing, or updating items using the *IStyleGallery* interface. You can see this functionality illustrated in the *IStyleGallery* code samples. If the file you specify as *IStyleGalleryStorage::TargetFile* is not referenced by the style gallery, it gets referenced automatically. If this file does not exist, it gets created.

You can use *IStyleGalleryStorage::CanUpdate* to check if you have permissions to make changes to a style file before doing so.

```
pStyleStorage.AddFile pStyleStorage.DefaultStylePath & "Civic.style"
pStyleStorage.TargetFile = pStyleStorage.DefaultStylePath & "ESRI.style"
MsgBox "The target file now is " & pStyleStorage.TargetFile
```

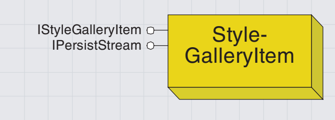


EnumStyleGalleryItem *is an enumeration of style gallery items.*

EnumStyleGalleryItem is an enumeration of style gallery items. It is created by the style gallery in response to *IStyleGallery::Items*.

IEnumStyleGalleryItem : IUnknown	*Provides access to members that enumerate over a set of Style Gallery items.*
← Next: IStyleGalleryItem	*Gets the next Style Gallery item.*
← Reset	*Resets the enumerator.*

Using *IEnumStyleGalleryItem*, you can access the style gallery items in the enumeration. *IEnumStyleGalleryItem::Reset* resets the enumeration so that the item accessed by *IEnumStyleGalleryItem::Next* will be the first item on the enumeration.



A StyleGalleryItem *object contains a symbol or map element and the style item information associated with it.*

The *StyleGalleryItem* coclass encapsulates a symbol or map element and the style information associated with it, such as its name, ID, and category.

IStyleGalleryItem : IUnknown	*Provides access to members that defien items in the Style Gallery.*
↔ Category: String	*The category of the item.*
← ID: Long	*Id for the item in the Style Gallery.*
↔ Item: IUnknown Pointer	*The symbol or map element to be stored in the Style Gallery item.*
↔ Name: String	*The name of the item in the Style Gallery.*

Using *IStyleGalleryItem*, you can access the category a style item belongs to and the name it is with. You can also find the ID of that item in the style file. But, most importantly, the *IStyleGalleryItem::Item* property allows you to access the symbol or map element of which the item is composed. *IStyleGalleryItem::Item* returns an *IUnknown* interface that you can *QI* for an interface supported by that symbol or map element.

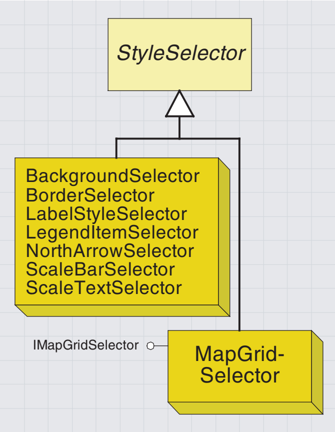
The following example shows how you can access the marker symbols stored in a style:

```
Dim pStyleStorage As IStyleGalleryStorage
Dim pStyleGallery As IStyleGallery
Dim pStyleClass As IStyleGalleryClass
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Set pStyleGallery = pMxDoc.StyleGallery
Set pStyleStorage = pStyleGallery

Dim pEnumStyleGall As IEnumStyleGalleryItem
Dim pStyleItem As IStyleGalleryItem
Dim pMarkerSym As IMarkerSymbol

'Initialize the style gallery
Set pEnumStyleGall = pStyleGallery.Items("Marker Symbols", "ESRI.style", _
  "Default")
pEnumStyleGall.Reset
Set pStyleItem = pEnumStyleGall.Next

Do While Not pStyleItem Is Nothing   'Loop through and access each marker
  Set pMarkerSym = pStyleItem.Item
```

```
    Debug.Print pStyleItem.Name & " " & pMarkerSym.Size
    Set pStyleItem = pEnumStyleGall.Next
  Loop
```

You can create new style gallery items by first creating a symbol or map element relevant to this style gallery class. You can make this the Item for a newly created style gallery item. You can then add this item to a style gallery. Alternatively, you can use *IStyleGalleryClass::NewObject* to create the symbol or map element. The latter method is illustrated under *IStyleGalleryClass*.

```
  'Create the new object
  Dim pNewObject As IUnknown
  Set pNewObject = New SimpleFillSymbol

  'Assign properties specific to the style class
  Dim pSimpleFillSymbol As ISimpleFillSymbol
  Set pSimpleFillSymbol = pNewObject
  pSimpleFillSymbol.Color = BuildRGB(55, 55, 200)

  'Create new style item using object, and add it to the target style
  Dim pNewItem As IStyleGalleryItem
  Set pNewItem = New StyleGalleryItem
  pNewItem.Item = pNewObject
  pNewItem.Name = "My Fill Symbol"
  pStyleGallery.AddItem pNewItem
```



The Style Selector dialog box lets you choose a style item of a specific style class. For example, the BackgroundSelector *allows you to choose a background style item.*

Style Gallery Class	Style Selector
AreaPatchStyleGalleryClass	None
BackgroundStyleGalleryClass	BackgroundSelector
BorderStyleGalleryClass	BorderSelector
ColorRampStyleGalleryClass	None
ColorStyleGalleryClass	ColorSelector
FillSymbolStyleGalleryClass	SymbolSelector
LabelStyleGalleryClass	LabelStyleSelector
LegendItemStyleGalleryClass	LegendItemSelector
LinePatchStyleGalleryClass	None
LineSymbolStyleGalleryClass	SymbolSelector
MapGridStyleGalleryClass	MapGridSelector
MarkerSymbolStyleGalleryClass	SymbolSelector
NorthArrowStyleGalleryClass	NorthArrowSelector
ScaleBarStyleGalleryClass	ScaleBarSelector
ScaleTextStyleGalleryClass	ScaleTextSelector
ShadowStyleGalleryClass	ShadowSelector
TextSymbolStyleGalleryClass	SymbolSelector

This table shows you the selectors you can use to interactively choose items of each style gallery class.

The *StyleSelector* abstract class is inherited by several coclasses, all of which are dialog boxes you can use in your application to select a style item of the respective type.

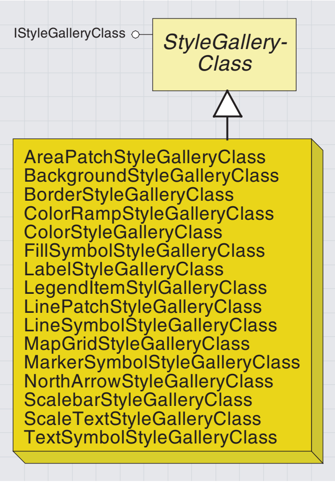
IStyleSelector : IUnknown	*Style Selector Dialog interface*
← AddStyle (in Style: IUnknown Pointer) : Boolean	*Specify the original style. May specify more than one.*
← DoModal (in parentHWnd: Long) : Boolean	*Show the selector.*
← GetStyle (in Index: Long) : IUnknown Pointer	*Returns the updated style. Index is required when more than one style was originally added.*

The methods in the *IStyleSelector* interface allow you to bring up a Style Selector dialog box. You can use *IStyleSelector::DoModal* to bring up the dialog. Optionally, you can specify the style item that the Style Selector dialog box comes up with using *IStyleSelector::AddStyle*. This will allow you to control the default style item. You can get the user's choice with *IStyleSelector::GetStyle*.

```
Dim pSelector As IStyleSelector
Set pSelector = New BackgroundSelector

Dim bOK As Boolean
Dim pFill As IFillSymbol
Dim pBackground As ISymbolBackground

bOK = pSelector.DoModal(Application.hWnd)
If (bOK) Then
  Set pBackground = pSelector.GetStyle(0)
  Set pFill = pBackground.FillSymbol
  MsgBox pFill.Color.CMYK
End If

Set pBackground = New SymbolBackground
Set pFill = New SimpleFillSymbol
pFill.Color = BuildRGB(200, 90, 90)
pBackground.FillSymbol = pFill

pSelector.AddStyle pBackground
bOK = pSelector.DoModal(Application.hWnd)
If (bOK) Then
  Set pBackground = pSelector.GetStyle(0)
  Set pFill = pBackground.FillSymbol
  MsgBox pFill.Color.CMYK
End If
```

IMapGridSelector : IUnknown	***Provides access to the map grid selector.***
—□ MapFrame: IMapFrame	*The map frame whose map grids are edited.*

Map grid selectors need information on the data frame to which the map grid belongs. You can specify this using *IMapGridSelector*.


IStyleGalleryClass
StyleGallery-Class
AreaPatchStyleGalleryClass
BackgroundStyleGalleryClass
BorderStyleGalleryClass
ColorRampStyleGalleryClass
ColorStyleGalleryClass
FillSymbolStyleGalleryClass
LabelStyleGalleryClass
LegendItemStylGalleryClass
LinePatchStyleGalleryClass
LineSymbolStyleGalleryClass
MapGridStyleGalleryClass
MarkerSymbolStyleGalleryClass
NorthArrowStyleGalleryClass
ScalebarStyleGalleryClass
ScaleTextStyleGalleryClass
TextSymbolStyleGalleryClass

You can instantiate new style items of a specific class with a style gallery class. The list of available style gallery classes is read from the ESRI Style Gallery Classes category in the Component Category Manager.

The various coclasses that inherit from the *StyleGallery* abstract class encapsulate functionality, creating style items of the respective type.

IStyleGalleryClass : IUnknown	*Style Gallery Class interface*
Description: String	*Description for the Style Gallery Class*
ItemClass: GUID	*Interface ID for the items in the class*
Name: String	*Name of the Style Gallery Class*
NewObject (in newType: String) : IUnknown Pointer	*Creates a new object of the specified type*
NewObjectTypes: IEnumBSTR	*Returns the available types of new items in this class*
PreviewRatio: Double	*The width ratio to 1 height.*
EditProperties (in galleryItem: IUnknown Pointer, in listener: IComPropertySheetEvents, in hWnd: Long, out ok: Boolean)	*Edits the properties of a Style Gallery Item of the supported class*
Preview (in galleryItem: IUnknown Pointer, in hDC: Long, in rectangle: tagRECT)	*Draws a preview of a Style Gallery Item of the supported class*

The *IStyleGalleryClass* interface gives you access to the class name, description, and type of new objects that can be created with the class. Using this interface, you can create new style items using edit properties of an item, then draw a preview of the item to a window.

The table below lists some of the properties exposed by *IStyleGalleryClass* for the coclasses that support it.

Style gallery class	Name	New object types	Preview ratio	Description
AreaPatchStyleGalleryClass	Area Patches	Area patches	2	Area patch—geometry used to draw symbol patches
BackgroundStyleGalleryClass	Backgrounds	Normal Background	2	Background
BorderStyleGalleryClass	Borders	Normal Border	4	Border
ColorRampStyleGalleryClass	Color Ramps	Random Color Ramp, Multipart Color Ramp, Preset Color Ramp, Algorithmic Color Ramp	4	Color Ramps
ColorStyleGalleryClass	Colors	RGB, CMYK, HSV, Gray, Name	1	Colors
FillSymbolStyleGalleryClass	Fill Symbols	Fill Symbol	1	Fill Symbols
LabelStyleGalleryClass	Labels	Label	4	Labels—text symbol and placement option for labeling
LegendItemStyleGalleryClass	Legend Items	Horizontal Bar, Nested, Horizontal, Vertical	2	Legend Items—the part of the legend that corresponds to one layer
LinePatchStyleGalleryClass	Line Patches	Line Patches	2	Line Patch—geometry used to draw symbol patches
LineSymbolStyleGalleryClass	Line Symbols	Line Symbol	1	Line Symbols
MapGridStyleGalleryClass	Reference Systems	Graticule, Measured Grid, Index Grid	3	Reference Systems
MarkerSymbolStyleGalleryClass	Marker Symbols	Marker Symbol	1	Marker Symbols
NorthArrowStyleGalleryClass	North Arrows	North Arrow	1	North Arrows
ScaleBarStyleGalleryClass	Scale Bars	Scale Line, Stepped Scale Line, Hollow Scale Bar, Single Division Scale Bar, Alternating Scale Bar, Double Alternating Scale Bar	6	Scale Bars
ScaleTextStyleGalleryClass	Scale Texts	Scale Text	10	Scale Texts—display scale as formatted text
ShadowStyleGalleryClass	Shadows	Normal Shadow	2	Drop Shadow
TextSymbolStyleGalleryClass	Text Symbols	*Text Symbol*	3	Text Symbols

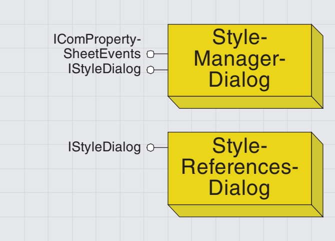
The code below illustrates how you can access the style gallery classes in a style:

```
Dim lClasses As Long
Dim sObjTypeList As String
Dim sObjType As String
lClasses = pStyleGallery.ClassCount
Dim pClass As IStyleGalleryClass
Dim i As Long
For i = 0 To (lClasses - 1)
  Set pClass = pStyleGallery.Class(i)
  sObjTypeList = pClass.Name & ":"
  Set pEnumBstr = pClass.NewObjectTypes
  sObjType = pEnumBstr.Next
 Do While Not sObjType = ""
    sObjTypeList = sObjTypeList & "," & sObjType
    sObjType = pEnumBstr.Next
   Loop
  Debug.Print sObjTypeList
Next i
```

When you create a new symbol item using *IStyleGalleryClass::NewObject*, the argument has to be one of the strings reported by *IStyleGalleryClass::NewObjectTypes* for that class. You can *QI* the returned object for an interface supported by the new style gallery item, then add this as an item to the style gallery using *IStyleGalleryItem*.

This method of creating a new style gallery item is especially useful when you wish to create a new object based on your user's choice of object type from a list of object types that you create using *IStyleGalleryClass::NewObjectTypes*.

```
'Create the new object
Dim pClass As IStyleGalleryClass
Dim pNewObject As IUnknown
Set pClass = New FillSymbolStyleGalleryClass
Set pNewObject = pClass.NewObject("Fill Symbol")

'Assign properties specific to the style class
If TypeOf pNewObject Is ISimpleFillSymbol Then
  Dim pSimpleFillSymbol As ISimpleFillSymbol
  Set pSimpleFillSymbol = pNewObject
  pSimpleFillSymbol.Color = BuildRGB(55, 55, 200)
End If

'Create new style item using object, and add it to the target style
Dim pNewItem As IStyleGalleryItem
Set pNewItem = New StyleGalleryItem
pNewItem.Item = pNewObject
pNewItem.Name = "My Fill Symbol"
pStyleGallery.AddItem pNewItem
```



The StyleManagerDialog *and the* StyleReferencesDialog *allow you to bring up the Style Manager and the Style References dialog boxes, respectively.*

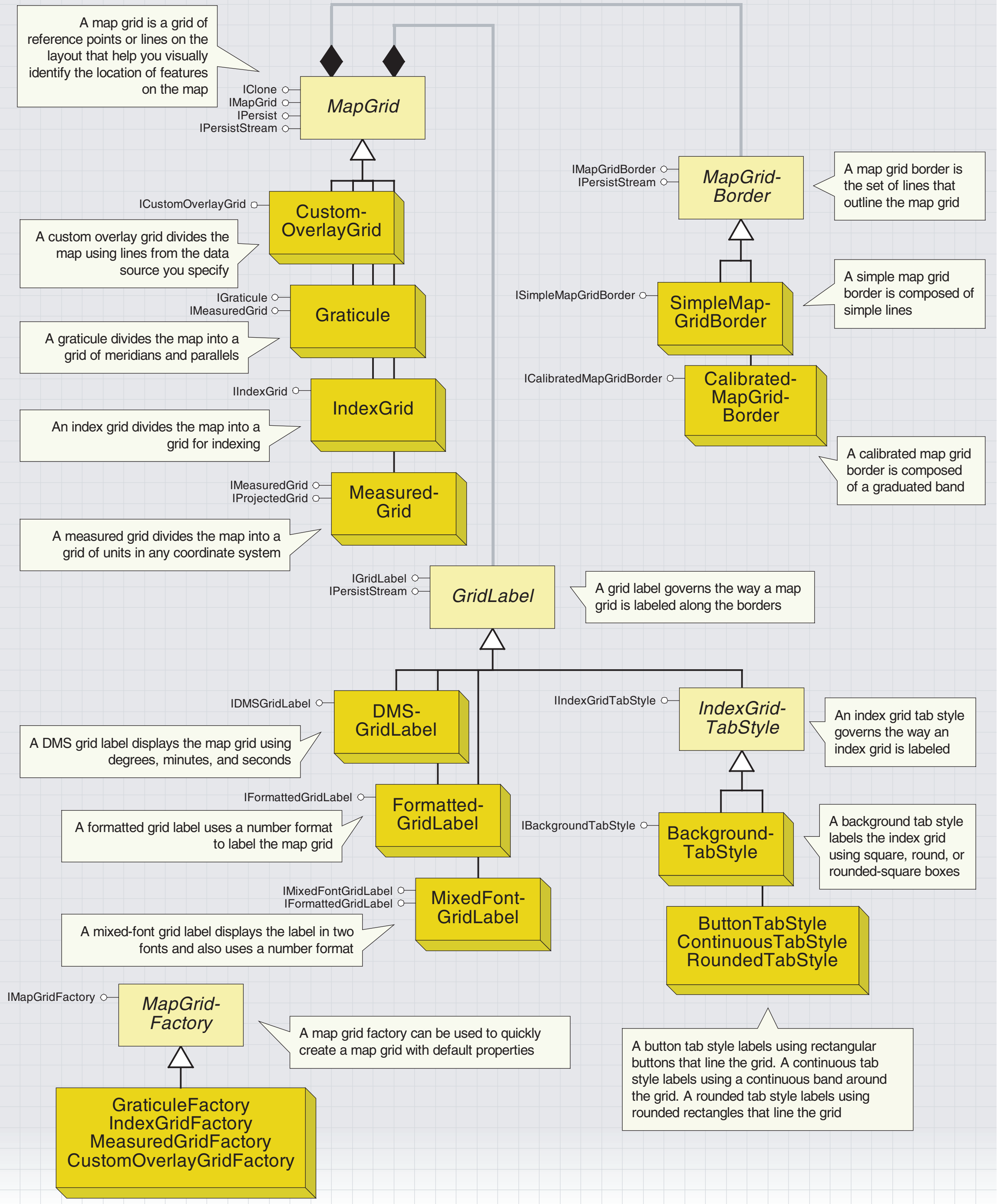
The *StyleManagerDialog* coclass is a dialog box that lets you manage the styles referenced by a map document and the style items in them. The *StyleReferencesDialog* coclass is a dialog box that lets you manage which style files ArcMap references.

IStyleDialog : IUnknown	*Style Dialog interface*
■━■ Title: String	*The title of the style dialog.*
← DoModal (in StyleGallery: IStyleGallery, Parent: Long) : Boolean	*Displays a style dialog for the given style gallery.*

Before calling *IStyleDialog::DoModal*, use *IStyleManager::Title* to change the title of the Style Manager dialog box.

```
Dim pMxDoc As IMxDocument
Dim pStyleGallery As IStyleGallery
Set pMxDoc = ThisDocument
Set pStyleGallery = pMxDoc.StyleGallery

Dim pStyleDialog As IStyleDialog
Set pStyleDialog = New StyleManagerDialog
pStyleDialog.DoModal pStyleGallery, Application.hWnd
```

ArcMap map grid objects



A map grid is a grid of reference points or lines on the layout that help you visually identify the location of features on the map

A custom overlay grid divides the map using lines from the data source you specify

A graticule divides the map into a grid of meridians and parallels

An index grid divides the map into a grid for indexing

A measured grid divides the map into a grid of units in any coordinate system

A map grid border is the set of lines that outline the map grid

A simple map grid border is composed of simple lines

A calibrated map grid border is composed of a graduated band

A grid label governs the way a map grid is labeled along the borders

A DMS grid label displays the map grid using degrees, minutes, and seconds

A formatted grid label uses a number format to label the map grid

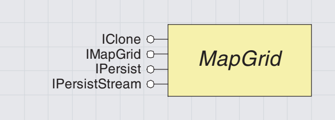
A mixed-font grid label displays the label in two fonts and also uses a number format

An index grid tab style governs the way an index grid is labeled

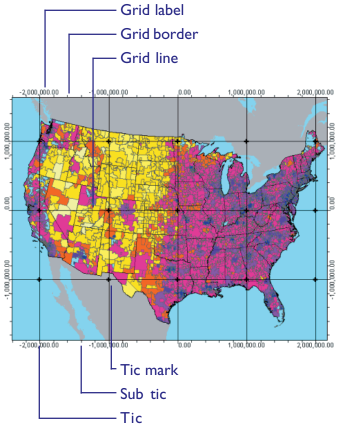
A background tab style labels the index grid using square, round, or rounded-square boxes

A button tab style labels using rectangular buttons that line the grid. A continuous tab style labels using a continuous band around the grid. A rounded tab style labels using rounded rectangles that line the grid

A map grid factory can be used to quickly create a map grid with default properties



A map grid is a grid of reference points or lines on the layout.



Parts of a map grid

A map grid can be a grid of geographic or projected coordinates, or a reference grid like those found in street maps. Map grids are part of the layout of a map and can only be seen in layout view.

You can use map grids to look at a map and figure out the approximate location of a feature. You can also use them to find features on the map when you know the location of the feature.

Map grids are essentially made up of three coclasses derived from the MapGrid, MapGridBorder, *and* GridLabel *abstract classes. To create a* MapGrid *object, create instances of all of these. Associate the* MapGridBorder *and the* GridLabel *objects with the* MapGrid *object. Then, add the new* MapGrid *to the layout. We will see each of these steps in detail as we progress through this section.*

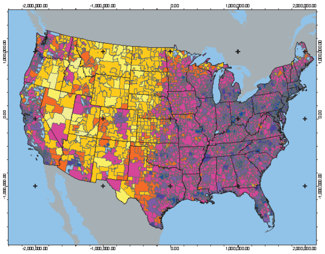
To get to a map grid programmatically, navigate to the *PageLayout* coclass, then use its *IGraphicsContainer* interface's *FindFrame* method to get to the *Map*'s *MapFrame*. The *MapFrame* coclass has an *IMapGrids* interface from which you can get to all the map grids for that dataframe.

```
Dim pMap As IMap, pMxDoc As IMxDocument
Dim pMapFrame As IMapFrame
Dim pGraphicsContainer As IGraphicsContainer
Dim pMapGrid As IMapGrid
Set pMxDoc = ThisDocument
Set pMap = pMxDoc.FocusMap
Set pGraphicsContainer = pMxDoc.PageLayout
Set pMapFrame = pGraphicsContainer.FindFrame(pMap)

Dim pMapGrids As IMapGrids
Set pMapGrids = pMapFrame
Set pMapGrid = pMapGrids.MapGrid(0)
```

IMapGrid : IUnknown	Provides access to members that control a map grid.
Border: IMapGridBorder	The map grid border.
ExteriorWidth (in pDisplay: IDisplay, in pMapFrame: IMapFrame) : Double	The width (in display units) of the portion of the grid that is outside of the frame.
LabelFormat: IGridLabel	The label format for map grid labels.
LineSymbol: ILineSymbol	The symbol used to draw grid lines - null will draw no lines.
Name: String	The name of the map grid.
SubTickCount: Integer	The number of subticks to draw between the major ticks.
SubTickLength: Double	The length of the subticks in points.
SubTickLineSymbol: ILineSymbol	The symbol used to draw the subtick lines.
TickLength: Double	The length of the major ticks in points.
TickLineSymbol: ILineSymbol	The line symbol used to draw the major ticks.
TickMarkSymbol: IMarkerSymbol	The symbol used to draw tick marks at the grid interval intersections - null will draw no tick marks.
Visible: Boolean	Indicates if the map grid is visible.
Draw (in Display: IDisplay, in pMapFrame: IMapFrame)	Draws the map grid for a map frame to the given display.
GenerateGraphics (in pMapFrame: IMapFrame, in GraphicsContainer: IGraphicsContainer)	Generates graphic elements corresponding to the grid lines and stores them in the specified graphics container.
PrepareForOutput (in hDC: Long, in dpi: Long, in PixelBounds: tagRECT, in pMapFrame: IMapFrame)	Prepares the map grid for output to a device.
QueryLabelVisibility (out leftVis: Boolean, out topVis: Boolean, out rightVis: Boolean, out bottomVis: Boolean)	Returns the visibility of the labels along all four sides of the map grid.
QuerySubTickVisibility (out leftVis: Boolean, out topVis: Boolean, out rightVis: Boolean, out bottomVis: Boolean)	Returns the visibility of the subticks along all four sides of the map grid.
QueryTickVisibility (out leftVis: Boolean, out topVis: Boolean, out rightVis: Boolean, out bottomVis: Boolean)	Returns the visibility of the ticks along all four sides of the map grid.
SetDefaults (in pMapFrame: IMapFrame)	Sets the properties of the map grid to default values.
SetLabelVisibility (in leftVis: Boolean, in topVis: Boolean, in rightVis: Boolean, in bottomVis: Boolean)	Sets the visibility of the labels along all four sides of the map grid.
SetSubTickVisibility (in leftVis: Boolean, in topVis: Boolean, in rightVis: Boolean, in bottomVis: Boolean)	Sets the visibility of the subticks along all four sides of the map grid.
SetTickVisibility (in leftVis: Boolean, in topVis: Boolean, in rightVis: Boolean, in bottomVis: Boolean)	Sets the visibility of the ticks along all four sides of the map grid.

IMapGrid holds the methods and properties common to all types of map grids. The *Draw* method can be used to draw a map grid to, for example, a *PictureBox* control that has a map and display associated with it. The *PrepareForOutput* method takes a device's *HDC* and should be called before the *Draw* method.

When you create a new map grid, you have to populate the properties of the grid that *IMapGrid* exposes. The following code illustrates how you can do this. After doing this, you can populate the properties exposed by interfaces specific to the grid type, then add the grid to a data frame.

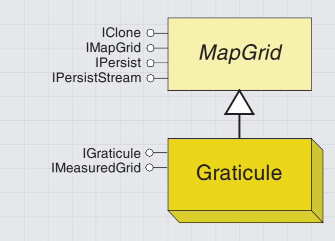


If you want tick marks in your grid, you can create a marker symbol and assign it to the IMapGrid::TickMarkSymbol *property. If you do not want either a* TickMarkSymbol *or a* TickLineSymbol*, set these properties to 'Nothing'.*

```
Dim pMapGrid As IMapGrid 'Create the map grid
Set pMapGrid = New Graticule
pMapGrid.Name = "Map Grid" 'Set the map grid's name

'Set the line symbol used to draw the grid
Dim pLineSymbol As ISimpleLineSymbol
Set pLineSymbol = New SimpleLineSymbol
pLineSymbol.Style = esriSLSSolid
pLineSymbol.Width = 2
pLineSymbol.Color = BuildRGB(52, 52, 52)  'Soft Black
pMapGrid.LineSymbol = pLineSymbol

pMapGrid.TickLength = 15 'Set the Tick Properties
Set pLineSymbol = New SimpleLineSymbol
pLineSymbol.Style = esriSLSSolid
pLineSymbol.Width = 1.5
pLineSymbol.Color = BuildRGb(0, 0, 0)
pMapGrid.TickLineSymbol = pLineSymbol
pMapGrid.TickMarkSymbol = Nothing

pMapGrid.SubTickCount = 5 'Set the Sub Tick Properties
pMapGrid.SubTickLength = 10
Set pLineSymbol = New SimpleLineSymbol
pLineSymbol.Style = esriSLSSolid
pLineSymbol.Width = 0.2
pLineSymbol.Color = BuildRGb(0, 0, 0)
pMapGrid.SubTickLineSymbol = pLineSymbol

'Set the Tick, SubTick, Label Visibility along the 4 sides of the grid
pMapGrid.SetTickVisibility True, True, True, True
pMapGrid.SetSubTickVisibility True, True, True, True
pMapGrid.SetLabelVisibility True, True, True, True

'Make map grid visible, so it gets drawn when Active View is updated
pMapGrid.Visible = True
```

To avoid code repetition, the *BuildRGB* function is used in this section to create *Color* objects using red, blue, and green values and to get their *IColor* interface.

```
Public Function BuildRGB(lRed As Long, lGreen As Long, lBlue As Long) _
  As IRgbColor

  Dim pRGBColor As IRgbColor
  Set pRGBColor = New RgbColor
  With pRGBColor
    .Red = lRed
    .Green = lGreen
    .Blue = lBlue
    .UseWindowsDithering = True
  End With
  Set BuildRGb = pRGBColor
End Function
```



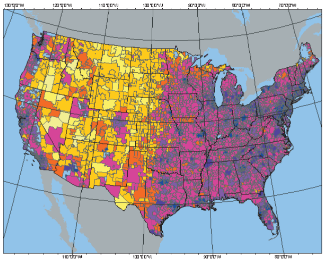
A graticule divides the map by meridians and parallels.

A graticule is a map grid with lines along longitudes and latitudes.

IGraticule : IMapGrid	Provides access to the members that control the graticule.
▪━ AutoInterval: Boolean	Indicates if the graticule automatically and interactively computes the interval size.
← AddElement (in Label: String, in Location: Double, in IsLatitude: Boolean, in LabelSymbol: ITextSymbol)	Adds a grid line at custom location to the graticule.
← RemoveElement (in Label: String)	Removes a grid line in a custom location.

The *IGraticule* interface is not implemented yet. The *AddElement* method is intended to be used for adding extra lines to the graticule. The *RemoveElement* method is intended to remove these lines. *AutoInterval* is intended to enable the computation of a suitable interval between grid lines based on the scale of display.

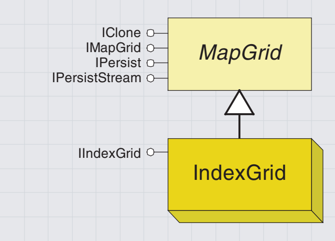
IMeasuredGrid : IUnknown	Provides access to the members that control the lines that make up the map grid.
▪━ FixedOrigin: Boolean	Indicates if the origin is read from the XOrigin and YOrigin properties (true) or if it is computed dynamically from the data frame (false).
▪━ Units: esriUnits	The units for the intervals and origin.
▪━ XIntervalSize: Double	The interval between grid lines along the X axis.
▪━ XOrigin: Double	The origin of the grid on the X axis.
▪━ YIntervalSize: Double	The interval between grid lines along the Y axis.
▪━ YOrigin: Double	The origin of the grid on the Y axis.



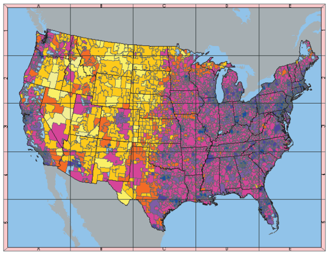
A graticule

The *IMeasureGrid* interface is implemented by the *MeasuredGrid* and *Graticule* coclasses. It exposes information on the origins, intervals, and units of the grid. If you set *IMeasuredGrid::FixedOrigin* to *False*, the origin is computed from the data frame instead of from the x- and y-origin properties. *IMeasuredGrid::Units* need not be populated for a graticule.

```
'Create graticule
Dim pMapGrid As IMapGrid
Dim pMeasuredGrid As IMeasuredGrid
Set pMeasuredGrid = New Graticule
Set pMapGrid = pMeasuredGrid

'Set the IMeasuredGrid properties
pMeasuredGrid.FixedOrigin = True
pMeasuredGrid.XIntervalSize = 10  'meridian interval
pMeasuredGrid.XOrigin = -180
pMeasuredGrid.YIntervalSize = 10 'parallel interval
pMeasuredGrid.YOrigin = -90
```



An index grid divides the map into a grid for indexing. A popular use for this is in street maps, where you locate a street in an alphabetic listing on the map, find the grid cell it is in, and use this information to locate the street on the map.



An index grid

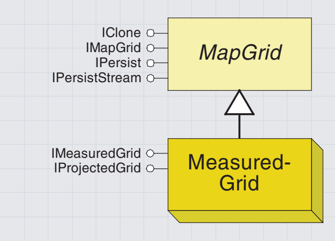
An index grid is a map grid that divides the map into the specified number of columns and rows. It is mainly used to index a map.

IIndexGrid : IMapGrid	Provides access to members that control the index grid.
ColumnCount: Long	The number of columns in the index grid.
RowCount: Long	The number of rows in the index grid.
XLabel (in column: Long) : String	The label for the given column in the index grid.
YLabel (in Row: Long) : String	The label for the given row in the index grid.
QueryCellExtent (in Row: Long, in column: Long, in pMapFrame: IMapFrame, Extent: IEnvelope)	Provides access to the cell extent in page space for the given row and column.

IIndexGrid gives you access to the functionality common to all index grids. Using the *XLabel* and the *YLabel* properties, you can set or retrieve the label for each column and index in the grid. You can create an index grid as illustrated in the sample below:

```
'Create indexgrid
Dim pMapGrid As IMapGrid
Dim pIndexGrid As IIndexGrid
Set pIndexGrid = New IndexGrid
Set pMapGrid = pIndexGrid

'Set the IIndexGrid properties
pIndexGrid.ColumnCount = 5
pIndexGrid.RowCount = 5
'Set grid label strings for the x and y axes
Dim i As Integer
For i = 0 To (pIndexGrid.ColumnCount - 1)
  pIndexGrid.XLabel(i) = VBA.Chr(i + Asc("A"))
Next i
For i = 0 To (pIndexGrid.RowCount - 1)
  pIndexGrid.YLabel(i) = VBA.Str(i + 1)
Next i
```

IIndexGrid::QueryCellExtent is useful for finding the features that cross a cell in the grid. You can use the envelope returned by this method in a spatial filter after transforming it into map coordinates. Using *IDisplayTransformation::TransformRect*, you can use this filter to search for the features that cross this cell in the grid and to create an index listing of features and their location on the grid.



A measured grid divides the map into a grid of units in a coordinate system of your choice.

The grid can be in a projected coordinate system or in a geographic coordinate system. A measured grid in a geographic coordinate system is equivalent to a graticule.A measured grid can be in the same spatial reference system as the data frame or in a different one.

A measured grid is a map grid with grid lines on a coordinate system specified using the *IProjectedGrid* interface.

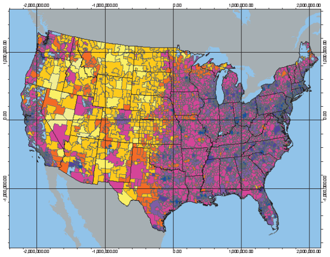
IProjectedGrid : IUnknown	Provides access to members that control the projection information for map grids.
SpatialReference: ISpatialReference	The spatial reference system of the grid.

The *IProjectedGrid* interface holds the spatial reference information associated with a measured grid. If you want to create a measured grid in the same projection as the data frame it is in, you can set the *IProjectedGrid::SpatialReference* property using the data frame's *IMap::SpatialReference* property.

To create a measured grid with a different projection, you should first create an instance of a coclass that inherits from *SpatialReference*. You can then set the *IProjectedGrid::SpatialReference* property of the grid with the *ISpatialReference* interface of this object.

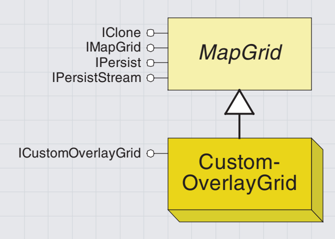
The following example shows how to create a measured grid and set the properties exposed through its specific interfaces.

```
'create measuredgrid
Dim pMapGrid As IMapGrid, pMeasuredGrid As IMeasuredGrid
Set pMeasuredGrid = New MeasuredGrid
Set pMapGrid = pMeasuredGrid

'Set the IMeasuredGrid properties
' Origin coordinates and interval sizes are in map units
pMeasuredGrid.FixedOrigin = True
pMeasuredGrid.Units = m_pMap.MapUnits
pMeasuredGrid.XIntervalSize = 1000000  'meridian interval
pMeasuredGrid.XOrigin = -3000000
pMeasuredGrid.YIntervalSize = 1000000 'parallel interval
pMeasuredGrid.YOrigin = -3000000

'Set the IProjectedGrid properties
Dim pProjectedGrid As IProjectedGrid
Set pProjectedGrid = pMeasuredGrid
Set pProjectedGrid.SpatialReference = m_pMap.SpatialReference
```



A measured grid

A custom overlay grid is a map grid with grid lines read from a feature class.



The custom overlay grid divides the map using lines from the data source you specify.

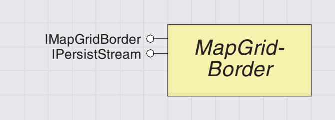
ICustomOverlayGrid : IMapGrid	Custom Overlay Grid interface
DataSource: IFeatureClass	Sets or returns the data source containing the grid cells
LabelField: String	Sets or returns the name of the field used to label the grid

The *ICustomOverlayGrid* interface gives you access to the feature class that the grid lines are read from through the *ICustomOverlayGrid::DataSource* property. It also lets you specify which field in this feature class will label the grid using the *ICustomOverlayGrid::LabelField* property.

MapGridBorder and SimpleMapGridBorder

ArcMap

The map grid border coclasses determine how the outline of a map grid is drawn.



A map grid border is the set of lines that outline the map grid.

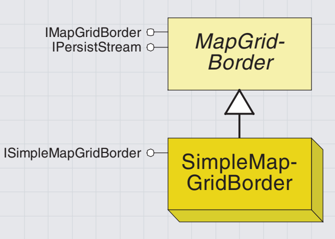
IMapGridBorder : IUnknown	Provides access to members that control the map grid border.
DisplayName: String	The display name for the map grid border.
Width: Double	The width of the map grid border in points.
Draw (in Display: IDisplay, in frameGeometry: IGeometry, in mapGeometry: IGeometry)	Draws the border to the specified display, using the frame bounds and the map bounds in page space.

Type of MapGridBorder	Display Name
SimpleMapGridBorder	"Simple Border"
CalibratedMapGridBorder	"Calibrated Border"

Using the *IMapGridBorder* interface, you can find the width of the map grid border. Using the *DisplayName* property, you can report the type of the border object to which the *IMapGridBorder* interface is pointing. The table on the left lists the strings reported by this property for the two border types.

When you create a new map grid border, you don't need to use the *IMapGridBorder* interface. As you can see, all the properties exposed by this interface are read-only.

A simple map grid border is drawn using a line symbol specified with the *ISimpleMapGridBorder* interface.

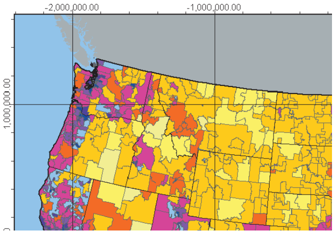


A simple map grid border is composed of the lines that frame the map grid.

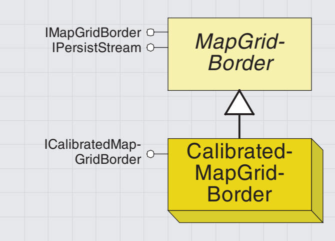
ISimpleMapGridBorder : IUnknown	Provides access to the members that control the simple map grid border.
LineSymbol: ILineSymbol	The line symbol used to draw the border.

The *ISimpleMapGridBorder* interface provides access to the line symbol used to draw the grid border through the *LineSymbol* property. The code below illustrates how you can create a simple map grid border.

```
'Create a simple map grid border
Dim pSimpleMapGridBorder As ISimpleMapGridBorder
Set pSimpleMapGridBorder = New SimpleMapGridBorder

'Set the ISimpleMapGridBorder properties
Dim pLineSymbol As ISimpleLineSymbol
Set pLineSymbol = New SimpleLineSymbol
pLineSymbol.Style = esriSLSSolid
pLineSymbol.Color = BuildRGb(0, 0, 0)
pLineSymbol.Width = 2
pSimpleMapGridBorder.LineSymbol = pLineSymbol

'Assign this border to the map grid
pMapGrid.Border = pSimpleMapGridBorder
```



A simple map grid border



A calibrated map grid border is composed of a graduated band defining the edge of the map grid.

The *CalibratedMapGridBorder* coclass encapsulates the functionality required to draw a map grid outline composed of a graduated band.

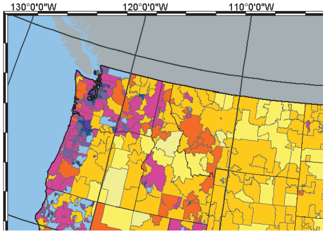
ICalibratedMapGridBorder : IUnknown	Provides access to members that control the calibrated map grid border.
Alternating: Boolean	Indicates if the border pattern alternates across the width of the border.
BackgroundColor: IColor	The background color of the border pattern.
BorderWidth: Double	The width of the border in points.
ForegroundColor: IColor	The foreground color of the border pattern.
Interval: Double	The interval between border patterns in points.

You can use the *ICalibratedMapGridBorder* interface to set or retrieve the properties of a calibrated map grid border, such as the foreground and background color of the pattern, the interval of the pattern, the background color of the band, and the width of the border.

If you want the pattern to alternate in two bands across the width of the border, set the *Alternating* property to *True*. Setting this property to *False* will produce a border with a single band of the pattern.

The code below illustrates how you can create a calibrated map grid border.

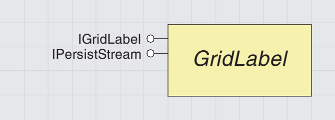
```
'Create a calibrated map grid border
Dim pCalibratedBorder As ICalibratedMapGridBorder
Set pCalibratedBorder = New CalibratedMapGridBorder

'Set ICalibratedMapGridBorder properties
pCalibratedBorder.BackgroundColor = BuildRGb(255, 255, 255)
pCalibratedBorder.ForegroundColor = BuildRGb(0, 0, 0)
pCalibratedBorder.BorderWidth = 10
pCalibratedBorder.Interval = 72
pCalibratedBorder.Alternating = True  'Double alternating border

'Assign this border to the map grid
pMapGrid.Border = pCalibratedBorder
```



A calibrated map grid border

The interval of the pattern on the band is in points and page units. If you want to compute your border intervals in map units, you can use a *DisplayTransformation* to convert your interval from map units to page units. You can convert these to points, considering that there are 72 points to an inch.

For more information on using *DisplayTransformation*, see Chapter 5, 'Displaying graphics'.



A grid label governs the way a map grid is labeled along the borders.

A grid label object is associated with every map grid object and provides the functionality required to draw labels around the map grid.

IGridLabel : IUnknown	***Provides access to members that control the way a map grid is labeled.***
Applies (in grid: IMapGrid) : Boolean	*Indicates if this grid label can be used with the specified map grid.*
Color: IColor	*The color of the grid label.*
DisplayName: String	*The display name for the type of grid label.*
EditObject: IUnknown Pointer	*The interface to an object that can be edited with a property sheet. The object is either the grid label itself or a single editable property.*
Font: Font	*The font used by the grid label.*
LabelAlignment (in axis: esriGridAxisEnum) : Boolean	*Indicates if the grid label is horizontal (true) or vertical (false) on the specified axis.*
LabelOffset: Double	*The offset of the grid label from the border in points.*
Draw (in labelValue: Double, in Location: IPoint, in axis: esriGridAxisEnum, in Display: IDisplay)	*Draws a label on the specified grid axis.*
Preview (in hDC: Long, in rectangle: tagRECT)	*Draws a preview of the grid label into the specified hdc.*
QueryTextExtent (in labelValue: Double, in Location: IPoint, in axis: esriGridAxisEnum, in Display: IDisplay, Extent: IEnvelope)	*Determines the extent of a label's text on the specified grid axis.*

Grid	Label	DisplayName
Graticule	DMSLabel	Degrees Minutes Seconds
Measured-Grid	FormattedLabel	Formatted
	MixedFontLabel	Mixed Font
Index-Grid	ButtonTabStyle	Button Tabs
	RoundedTabStyle	Rounded Tabs
	ContinuousTabStyle	Continuous Tabs
	BackgroundTabStyle	Filled Background

The *IGridLabel* interface holds properties common to all types of grid labels. Not all grid labels can be used with all types of grids. The *Applies* property of *IGridLabel* returns *True* if the grid label can be used with the grid that you pass in as argument. The table to the left lists the types of labels that can be used with each grid type.

Using the *IGridLabel::DisplayName* property, you can list the type of label that the *IGridLabel* interface is pointing to. The strings returned for the various label types are also listed in the table to the left.

You can control the vertical or horizontal orientation of the labels along each of the four sides of the grid using the *IGridLabel::LabelAlignment* property. You specify which axis you are setting the property for using an *esriGridAxisEnum* enumeration.

Enumeration esriGridAxisEnum	***Map grid axes.***
0 - esriGridAxisNone	*No axis.*
1 - esriGridAxisTop	*Top axis.*
2 - esriGridAxisBottom	*Bottom axis.*
3 - esriGridAxisLeft	*Left axis.*
4 - esriGridAxisRight	*Right axis.*

Here's how you would populate the properties exposed by *IGridLabel* for a newly created *GridLabel*:

```
 ' Create grid label
Dim pGridLabel as IGridLabel
Set pGridLabel = New DMSGridLabel

 ' Set font and color
Dim pFont As IFontDisp
Set pFont = New StdFont
pFont.Name = "Arial"
pFont.Size = 24
pGridLabel.Font = pFont
pGridLabel.Color = BuildRGB(0, 0, 0)
```

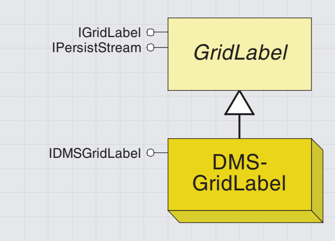
```
'Specify Vertical Labels
pGridLabel.LabelAlignment(esriGridAxisLeft) = False
pGridLabel.LabelAlignment(esriGridAxisRight) = False
pGridLabel.LabelOffset = 6
```

You would then set the properties specific to the type of grid label you are creating. You would associate the newly created grid label to the grid using the grid's *IMapGrid::LabelFormat* property:

```
pMapGrid.LabelFormat = pGridLabel
```

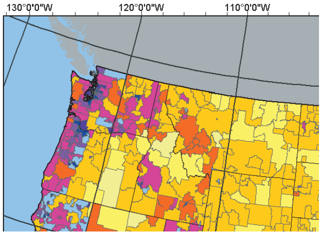
Grid label	Edit object returned
DMSGridLabel	IDMSGridLabel
FormattedGridLabel	INumberFormat
MixedFontGridLabel	IMixedFontGridLabel
IndexFontGridLabel	IIndexGridTabStyle

IGridLabel::QueryTextExtent is used to check for labeling conflicts by ArcMap. The *IGridLabel::EditObject* method is used in the *MapGrid* property pages. It returns an interface that determines which dialog box is brought up when a user clicks Additional Properties under the Labels tab. The interfaces returned for each of the label types are listed in the table on the left.

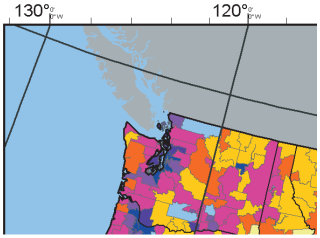


A DMS grid label labels the map grid using degrees, minutes, and seconds. You can use this coclass to label graticules.

You can use a standard label to create a DMS label with the degrees, minutes, and seconds on the same line. A stacked label has the minutes stacked over the seconds, with both in smaller font size.



DMS grid label set to esriDMSGridLabelStandard



DMS grid label set to esriDMSGridLabelStacked

The *DMSGridLabel* coclass is used to label a map grid using degrees, minutes, and seconds.

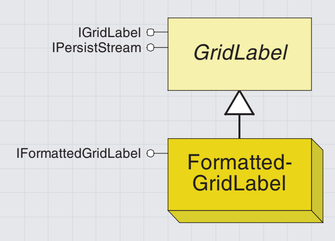
IDMSGridLabel : IUnknown	*Provides access to members that control the DMS Grid Label.*
LabelType: esriDMSGridLabelType	*The type of the DMS grid label.*
LatLonFormat: ILatLonFormat	*The format with which the latitudes and longitudes are displayed.*
MinutesColor: IColor	*The color used to display the minutes.*
MinutesFont: Font	*The font used to display the minutes.*
SecondsColor: IColor	*The color used to display the seconds.*
SecondsFont: Font	*The font used to display the seconds.*
ShowZeroMinutes: Boolean	*Indicates if zero minutes are shown.*
ShowZeroSeconds: Boolean	*Indicates if zero seconds are shown.*

IDMSGridLabel provides access to the font, color, and format information required to create a DMS grid label. The *LabelType* property can be set using the *esriDMSGridLabelType* enumeration, which is listed below. At ArcGIS 8.1, only the *esriDMSGridLabelStandard* and *esriDMSGridLabelStacked* values have been implemented.

Enumeration esriDMSGridLabelType	*DMS grid label type options.*
0 - esriDMSGridLabelStandard	*Standard.*
1 - esriDMSGridLabelStacked	*Minutes stacked over seconds.*
2 - esriDMSGridLabelDD	*Decimal degrees.*
3 - esriDMSGridLabelDM	*Decimal minutes.*
4 - esriDMSGridLabelDS	*Decimal seconds.*

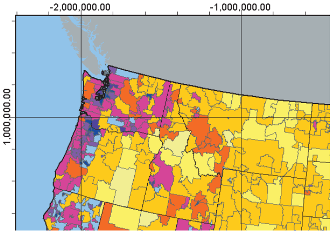
The following code demonstrates how to create a DMS grid label:

```
'Create a DMS grid label
Dim pDMSLabel As IDMSGridLabel
Set pDMSLabel = New DMSGridLabel

'Set IDMSGridLabel properties
pDMSLabel.LabelType = esriDMSGridLabelStandard
pDMSLabel.ShowZeroMinutes = True
pDMSLabel.ShowZeroSeconds = True

Dim pLatLonFormat As ILatLonFormat
Set pLatLonFormat = New LatLonFormat
pLatLonFormat.ShowDirections = True
pDMSLabel.LatLonFormat = pLatLonFormat

Dim pFont As IFontDisp
Set pFont = New StdFont
pFont.Bold = False
pFont.Name = "Arial"
pFont.Italic = False
pFont.Underline = False
pFont.Size = 8
pDMSLabel.MinutesFont = pFont
pDMSLabel.MinutesColor = BuildRGB(0, 0, 0)
pDMSLabel.SecondsFont = pFont
pDMSLabel.SecondsColor = BuildRGB(0, 0, 0)
```



A formatted grid label uses any of the number format coclasses that support INumberFormat *to label the map grid.*

For more information on these classes, refer to the ArcMap number format objects topic in this chapter.



A measured grid with formatted grid labels

The *FormattedGridLabel* coclass makes use of one of the coclasses that inherits from the *NumberFormat* abstract class to create the grid labels.

IFormattedGridLabel : IUnknown

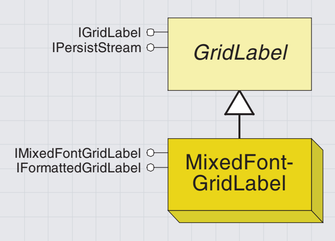
Provides access to members controlling the number format of a grid label.

- Format: INumberFormat — *The format used to display the numbers in the grid label.*

This interface has a *Format* property that takes an *INumberFormat* interface. The following code illustrates the creation of a formatted grid label:

```
'Create the label
Dim pFormattedGridLabel As IFormattedGridLabel
Set pFormattedGridLabel = New FormattedGridLabel

'Set IFormattedGridLabel properties
Dim pNumericFormat As INumericFormat
Set pNumericFormat = New NumericFormat
pNumericFormat.AlignmentOption = esriAlignRight
pNumericFormat.RoundingOption = esriRoundNumberOfDecimals
pNumericFormat.RoundingValue = 2
pNumericFormat.ShowPlusSign = False
pNumericFormat.UseSeparator = True
pNumericFormat.ZeroPad = True
pFormattedGridLabel.Format = pNumericFormat
```

MixedFontGridLabel coclass



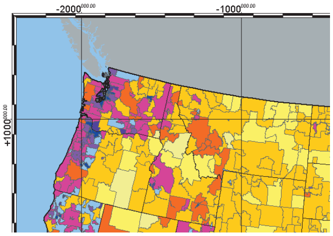
A mixed font grid label uses two fonts to display the label. It also uses a number format to format the label string.

Use the *MixedFontGridLabel* coclass to label map grids in two fonts and in the format specified using the *IFormattedGridLabel* interface.

IMixedFontGridLabel : IUnknown	***Provides access to members that define the appearance of the secondary group of digits in the grid label.***
NumGroupedDigits: Integer	*The number of digits that are displayed in the secondary font and color.*
SecondaryColor: IColor	*The color of the second group of digits.*
SecondaryFont: Font	*The font used for the second group of digits.*

The *IMixedFontGridLabel::NumberOfDigits* property determines how the two fonts are applied to the label string. The last n digits of the label—where n is the number assigned as the *NumberOfDigits*—are displayed in the secondary font and color. The remaining digits are displayed in the primary font and color.

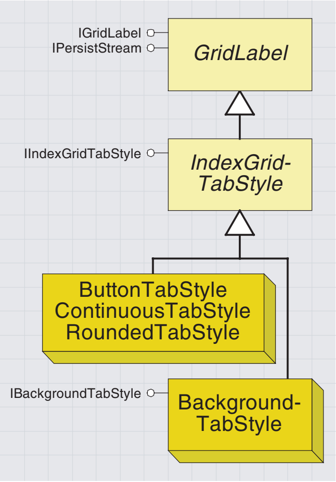
The primary font and color are set using *IGridLabel::Font* and *IGridLabel::Color*. The secondary font and color are set using *IMixedFontGridLabel::SecondaryFont* and *IMixedFontGridLabel::SecondaryColor*.



A measured grid with mixed font labels

The following code illustrates how you can create a mixed font grid label:

```
'Create the label
Dim pMixedFontLabel As IMixedFontGridLabel
Set pMixedFontLabel = New MixedFontGridLabel

'Set IMixedFontGridLabel properties
Dim pFont As IFontDisp
Set pFont = New StdFont
pFont.Name = "Arial"
pFont.Size = 12
pMixedFontLabel.SecondaryFont = pFont
pMixedFontLabel.SecondaryColor = BuildRGB(0, 0, 0)
pMixedFontLabel.NumGroupedDigits = 6 '-1 if not being used

'Set IFormattedGridLabel properties
Dim pFormattedGridLabel As IFormattedGridLabel
Set pFormattedGridLabel = pMixedFontLabel
Dim pNumericFormat As INumericFormat
Set pNumericFormat = New NumericFormat
pNumericFormat.AlignmentOption = esriAlignRight
pNumericFormat.RoundingOption = esriRoundNumberOfDecimals
pNumericFormat.RoundingValue = 2
pNumericFormat.ShowPlusSign = True
pNumericFormat.UseSeparator = False
pNumericFormat.ZeroPad = True
```



An index grid tab style governs the way an index grid is labeled.

The index grid tab style coclasses provide the means to label an index grid. These coclasses are described below.

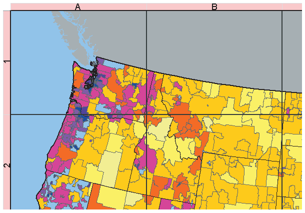
IIndexGridTabStyle : IUnknown — ***Provides access to members that control the way an index grid's labels are drawn.***

ForegroundColor: IColor	*The foreground color of the tab.*
OutlineColor: IColor	*The outline color of the tab.*
Thickness: Double	*The thickness of the tab in points.*
PrepareDraw (in labelValue: String, in tabWidthPage: Double, in axis: esriGridAxisEnum)	*Sets up the tab for drawing.*

The *IIndexGridTabStyle* interface provides access to the color and thickness of the index grid's labels. The *PrepareDraw* method should be called before *IGridLabel::Draw* is called on index grid tab style labels.

You can create an index grid tab style label using a coclass that inherits from *IndexGridTabStyle*, as outlined in the following examples. The code illustrates how to populate the properties exposed by the *IIndexGridTabStyle* interface after you create the label:

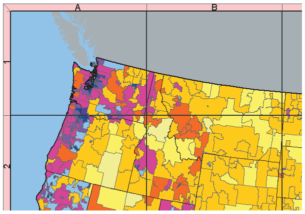
```
'Set IIndexGridTabStyle properties
pIndexGridTabStyle.ForegroundColor = BuildRGB(255, 190, 190)
pIndexGridTabStyle.OutlineColor = BuildRGB(110, 110, 110)
pIndexGridTabStyle.Thickness = 20
```



Button tab style

Button tab style labels are rectangular buttons, each the width of the grid cell that it borders. The following code shows you how to create a button tab style grid label.

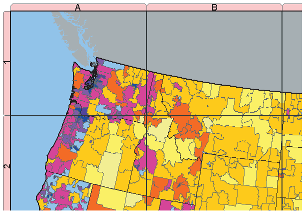
```
'Create the label
Dim pIndexGridTabStyle As IIndexGridTabStyle
Set pIndexGridTabStyle = New ButtonTabStyle
```



Continuous tab style

Continuous tab style labels form a continuous band around the map grid. The example below shows how you can create a label of this kind:

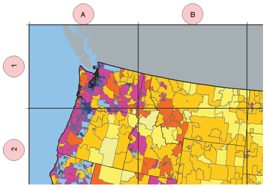
```
Dim pIndexGridTabStyle As IIndexGridTabStyle
Set pIndexGridTabStyle = New ContinuousTabStyle
```



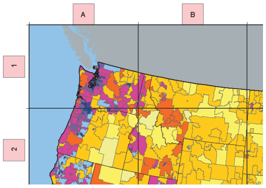
Rounded tab style

Rounded tab style labels are rounded rectangles; each one is the width of the grid cell it borders. Using the example below, you can create your rounded tab style grid label.

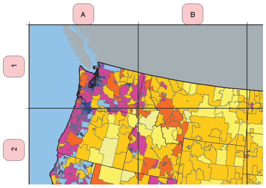
```
Dim pIndexGridTabStyle As IIndexGridTabStyle
Set pIndexGridTabStyle = New RoundedTabStyle
```



esriBackgroundTabRound



esriBackgroundTabRectangle



esriBackgroundTabRoundedRectangle

A background tab style labels the index grid using square, round, or rounded-square boxes. These boxes are centered outside the grid cells they border.

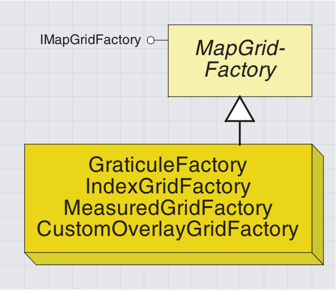
IBackgroundTabStyle : IUnknown	*Provides access to members that control background tab style grid labels.*
BackgroundType: esriBackgroundTabType	*The type of the background tab style.*

IBackgroundTabStyle has a *BackgroundType* property you can use to determine the shape of the boxes that the *BackGroundTabStyle* label uses.

Enumeration esriBackgroundTabType	*Types of background tabs for index grids.*
0 - esriBackgroundTabRound	*Round.*
1 - esriBackgroundTabRectangle	*Rectangle.*
2 - esriBackgroundTabRoundedRectangle	*Rounded rectangle.*

The example below illustrates how you can create a background tab style label that uses round boxes to label a map grid.

```
Dim pIndexGridTabStyle As IIndexGridTabStyle
Set pIndexGridTabStyle = New BackgroundTabStyle

'Set IBackgroundTabStyle properties
Dim pBackgroundTabStyle As IBackgroundTabStyle
Set pBackgroundTabStyle = pIndexGridTabStyle
pBackgroundTabStyle.BackgroundType = esriBackgroundTabRound
```



A map grid factory lets you quickly create a map grid with default properties.

You can use the *MapGridFactory* coclasses to quickly create map grids. The map grids created will have default properties applied.

Use one of the inheriting coclasses—*GraticuleFactory, IndexGridFactory, MeasuredGridFactory,* or *CustomOverlayGridFactory*—to create the respective map grid.

IMapGridFactory : IUnknown	***Provides access to members of the map grid factory.***
■— Name: String	*The name of the map grid class.*
◄— Create (in MapFrame: IMapFrame) : IMapGrid	*Creates a map grid.*

IMapGridFactory::Create takes a map frame as the argument and returns an *IMapGrid* interface to a newly created map grid. The map grid has default properties. This is similar to creating a map grid and using *IMapGrid::SetDefault* to assign properties to it. *IMapGridFactory::Name* returns the name of the map grid class to which the map grid factory object belongs. The following code shows you how to create a graticule using a map grid factory:

```
'Get the map frame for selected data frame
Dim pMap As IMap
Dim pMxDoc As IMxDocument
Dim pGraphicsContainer As IGraphicsContainer
Dim pMapFrame As IMapFrame
Set pMxDoc = ThisDocument
Set pMap = pMxDoc.FocusMap
Set pGraphicsContainer = pMxDoc.PageLayout
Set pMapFrame = pGraphicsContainer.FindFrame(pMap)
'Create a graticule
Dim pMapGrid As IMapGrid
Dim pMapGridFactory As IMapGridFactory
Set pMapGridFactory = New GraticuleFactory
Set pMapGrid = pMapGridFactory.Create(pMapFrame)
```

ADDING A MAP GRID TO A DATA FRAME

After creating your map grid, you can use the *IMapGrids::AddMapGrid* method to add it to the data frame. You can get the map frame as outlined in the previous example and *QI* it for the *IMapGrids* interface. If you want the change to be immediately apparent, refresh the active view. The following code illustrates this.

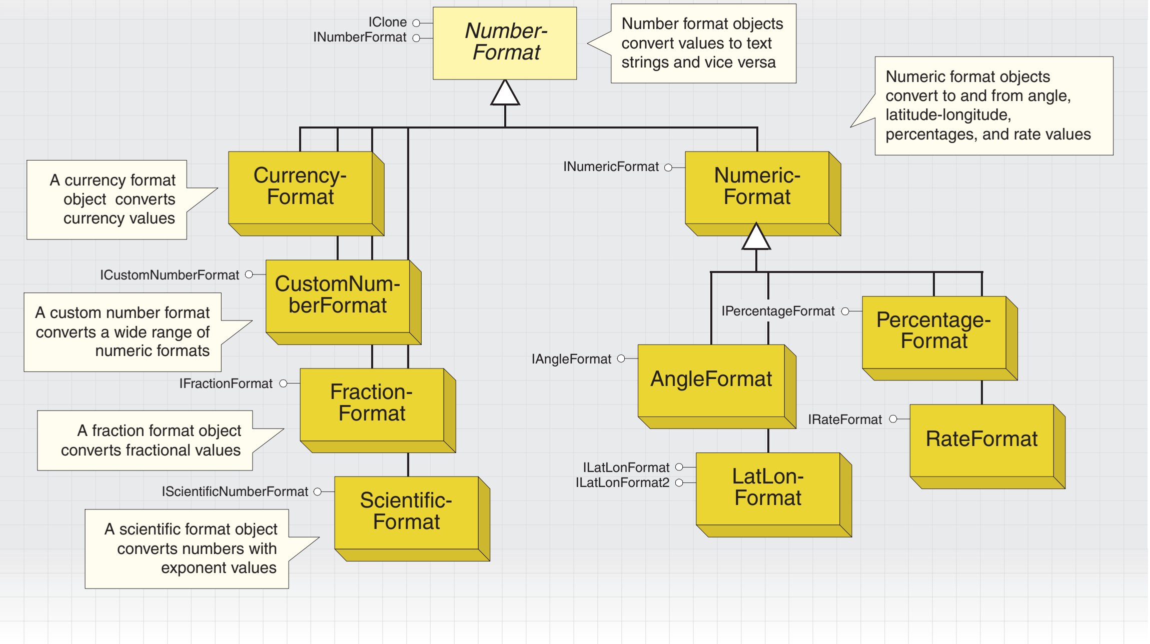
```
'Get the IMapGrids and IActiveView interfaces
Dim pMapGrids As IMapGrids
Set pMapGrids = pMapFrame
Set pMapGrid = pMapGrids.MapGrid(0)

Dim pActiveView As IActiveView
Set pActiveView = pMxDoc.PageLayout

pMapGrids.AddMapGrid pMapGrid  'Add map grid, and refresh active view
pActiveView.PartialRefresh esriViewBackground, Nothing, Nothing
```

REMOVING MAP GRIDS FROM A DATA FRAME

To remove map grids from a data frame, use *IMapGrids::DeleteMapGrid* as shown below.

```
Dim i As Long
Dim lCount As Long

lCount = m_pMapGrids.MapGridCount

For i = 0 To lCount - 1  'Delete all map grids
  'When you delete grid(0), then next grid becomes the new grid(0).
  Set pMapGrid = m_pMapGrids.MapGrid(0)
  m_pMapGrids.DeleteMapGrid pMapGrid
Next i

Set m_pActiveView = pMxDoc.ActiveView
m_pActiveView.PartialRefresh esriViewBackground, Nothing, Nothing
```

ArcMap number format objects



Number format objects convert values to text strings and vice versa

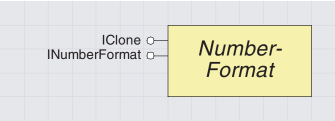
Numeric format objects convert to and from angle, latitude-longitude, percentages, and rate values

A currency format object converts currency values

A custom number format converts a wide range of numeric formats

A fraction format object converts fractional values

A scientific format object converts numbers with exponent values



The number-format objects convert numerical values into strings and strings into numerical values using ValueToString *and* StringToValue *methods. How this conversion takes place is normally dependent on the property settings of one or two other interfaces.*

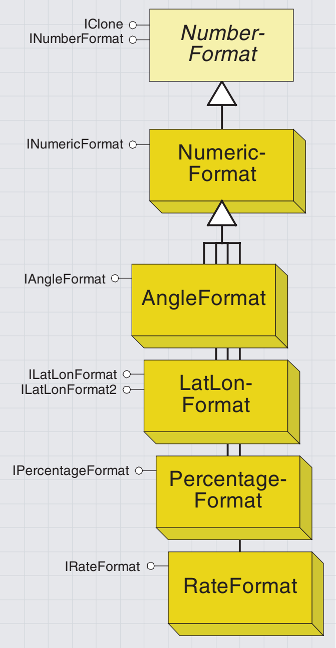
The *INumberFormat* interface exposes the two number-formatting methods (*ValueToString* and *StringToValue*) used by all the number format interfaces and coclasses.

INumberFormat : IUnknown	*Provides access to members that format numbers.*
← StringToValue (in str: String) : Double	*Converts a formatted string to a numeric value.*
← ValueToString (in Value: Double) : String	*Converts a numeric value to a formatted string.*

The *ValueToString* method transforms numerical values into a string. The *StringToValue* method returns numerical values from formatted strings, reversing the *ValueToString* operation.

The *ValueToString* method converts a numerical value into a formatted string. The string is formatted based on the property settings of the particular number-formatting interfaces used. For more information about property settings of number-formatting interfaces, refer to the number-formatting interface you're interested in later in this section. In some cases, the format produced by the *ValueToString* method depends on two interfaces' property settings. For example, *AngleFormat* uses *IAngleFormat* and *INumericFormat* to determine the formatting.

The *StringToValue* method converts a formatted string into a numerical value in the form of a *Double*. The string doesn't necessarily need to be formatted with the *ValueToString* method, but it does need to appear as if it were formatted with the associated interface's implementation of the *ValueToString* method. For more information, refer to the relevant number-formatting interface in which you're interested in the sections that follow.



The following coclasses all support the INumericFormat *interface:*

AngleFormat

LatLonFormat

NumericFormat

PercentageFormat

RateFormat

The AngleFormat, LatLonFormat, PercentageFormat, *and* RateFormat *coclasses all support the* INumericFormat *interface as well as their own default interfaces (*IAngleFormat, ILatLonFormat, IPercentageFormat, *and* IRateFormat, *respectively).*

For each of the coclasses, the combination of properties on both interfaces is used to determine how numbers are formatted when using the ValueToString *and* StringToValue *methods from the associated* INumberFormat *interface.*

The format produced with the *NumericFormat* coclass object is determined solely by the *INumericFormat* interface property settings.

Formats produced with other coclasses that support *INumericFormat* depend on two interfaces' property settings: the *INumericFormat* interface as well as the implemented interface within the numeric format coclasses. This means that the *NumericFormat* coclass can be used to do general formatting of numbers (such as number of decimal places and plus sign), while the other coclasses that support *INumericFormat* can perform special formatting (such as rates, latitude–longitude, and percentages) by using a combination of *INumericFormat* and their own interface.

INumericFormat : IUnknown	***Numeric format interface.***
AlignmentOption: esriNumericAlignmentEnum	*The alignment option applied to the ValueToString method.*
AlignmentWidth: Long	*The alignment width applied to the ValueToString method.*
RoundingOption: esriRoundingOptionEnum	*The rounding option applied to the ValueToString method.*
RoundingValue: Long	*The rounding value, whose meaning depends on the rounding option.*
ShowPlusSign: Boolean	*Indicates if formatted numbers contain a plus sign for positive numbers.*
UseSeparator: Boolean	*Indicates if formatted numbers contain digit grouping symbols.*
ZeroPad: Boolean	*Indicates if formatted numbers contain padded zeros to the right of the decimal.*

The *AlignmentOption* property sets or returns an option that tells the *ValueToString* method in the associated *INumberFormat* interface how to align formatted numbers. For example, the value "0.34", formatted as a string with an *AlignmentWidth* of 5, is returned as "0.34" with an *AlignmentOption* of *esriAlignRight* and "0.34" with an *AlignmentOption* of *esriAlignLeft*.

The settings for *AlignmentOption* are as follows:

- With *esriAlignRight*, which is the default, numbers are aligned to the right. If the *AlignmentWidth* property is wider than the resulting formatted number, spaces are padded at the left to make the output *AlignmentWidth* characters wider.
- With *esriAlignLeft*, numbers are aligned to the left. No spaces are padded at the left or the right. If *AlignmentOption* is set to *esriAlignLeft*, the *AlignmentWidth* property is ignored. For both options, even if the *AlignmentWidth* is not sufficient to hold the formatted number, the number will not be truncated.

The *AlignmentWidth* property is used to set or return the width (the default is 12) of the resulting string produced by *ValueToString* from the associated *INumberFormat* interface.

If the *AlignmentOption* property is set to *esriAlignRight*, the formatted number will be *AlignmentWidth* characters wide; spaces will be padded to the left of the number as needed. If *AlignmentOption* is equal to *esriAlignLeft*, the *AlignmentWidth* property is ignored. The width includes plus signs and any decimal points. For example, +1,234.56 has a width of 9.

The *RoundingOption* property specifies how the *RoundingValue* property should be used to format a number using *ValueToString*. The two options are *esriRoundNumberOfDecimals,* which is the default, and *esriRoundNumberOfSignificantDigits*.

The *esriRoundNumberOfDecimals* option rounds values to the number of decimal places defined in the *RoundingValue* property. If *ZeroPad* is also set to *True*, decimal zeros are appended up to the number of places indicated in the *RoundingValue* property.

If *esriRoundNumberOfSignificantDigits* is used, then values are rounded to the number of significant digits indicated in the *RoundingValue* property.

To format numbers and express significant zeros at the right of the decimal, set *ZeroPad* to *True*. For example, the number 12.0345, formatted with a *RoundingValue*, is equal to 8, and *ZeroPad* = *True* becomes 12.034500, or simply 12.0345 if *ZeroPad* = *False*.

The *RoundingValue* property sets or returns the number of decimal places or significant digits to round a number to when the *ValueToString* method in the associated *INumberFormat* interface formats numbers. The default value is 6 for both rounding options.

The table below shows how the value of 123.456 is formatted as a string with various rounding settings.

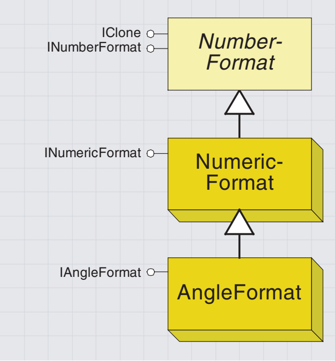
Rounding option	Rounding value	ZeroPad	ValueToString result
esriRoundNumberOfDecimals	2	*True*	"123.46"
		False	"123.46"
	4	*True*	"123.4560"
		False	"123.456"
esriRoundNumberOfSignificantDigits	2	*True*	"120"
		False	"120"
	8	*True*	"123.45600"
		False	"123.456"

The *ShowPlusSign* property sets or returns a Boolean indicator that indicates whether or not a plus sign symbol (+) is to be prefixed to positive numbers when the *ValueToString* method in the associated *INumberFormat* interface is used.

The default value is *False*—positive numbers are formatted without a plus sign, and negative values are formatted with a minus sign (-). If this property is set to *True*, then positive numbers are formatted with a plus sign, and negatives behave as before. Zero values are never prefixed.

The *UseSeparator* property is used to specify whether to include a digit-grouping symbol when formatting numbers with the *ValueToString* method. *False* is the default, meaning that numbers are formatted without a digit-grouping symbol—for example, “1234567.89”. However, if it is set to *True,* then a digit-grouping symbol is used as follows: “1,234,567.89”. The formatting itself is determined using the current regional settings defined for the system at runtime. To change the separator symbol or where the separator appears in the formatted number, change the settings on the Number tab of the Control Panel’s Regional Settings applet.

ZeroPad is a Boolean property that states whether or not to pad zeros to the right of the decimal. If this property is left as the default value of *False*, then numbers will be formatted without padding decimal zeros. The last decimal digit (to the right of the decimal point) will be a nonzero digit. If set to *True*, however, zeros are appended to the right of the decimal point in accordance with the *RoundingValue* property.



The angle format object is used for formatting numeric values that represent angles, such as 69°. It also allows the conversion between radians and degrees.

AngleFormat is the *IAngleFormat* interface coclass whose members determine how the *ValueToString* method in the associated *INumberFormat* interface formats numbers in an angular format.

IAngleFormat : IUnknown	*Angle format interface.*
AngleInDegrees: Boolean	*Indicates if the ValueToString argument is in degrees.*
DisplayDegrees: Boolean	*Indicates if the formatted number is an angle in degrees.*

The members in the *IAngleFormat* interface define how the *ValueToString* method in the associated *INumberFormat* interface formats numbers.

Use the *IAngleFormat* interface to format numbers that represent angles.

The *AngleInDegrees* property sets or returns whether the input angle represents degrees (*True*) or radians (*False*), which is the default value.

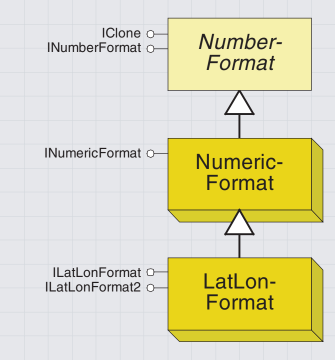
DisplayDegrees sets or returns whether the angle is displayed as degrees (*True*) or radians (*False*).

If the *AngleInDegrees* property is not set the same as the *DisplayDegrees* property (both of these are Boolean properties), a radian-to-degree or degree-to-radian conversion will take place when the *ValueToString* method formats the number. *AngleInDegrees* affects the *ValueToString* argument value. If the value is in degrees, then *AngleInDegrees* is set to *True*. If *AngleInDegrees* is *False*, the argument is assumed to be a radian value.

DisplayDegrees deals with the *ValueToString* result. If you want the resulting formatted number to be a degree value, set *DisplayDegrees* to *True*. A degree symbol (°) is also appended to the resulting formatted number. If *DisplayDegrees* is *False*, the formatted number is a radian value, and no degree symbol is appended.

The corresponding *StringToValue* method also uses these two properties. To obtain the numerical value that was used as a parameter to the *ValueToString* method, make sure the *AngleInDegrees* and *DisplayDegrees* properties are the same as they were when the *ValueToString* method was used. These settings may seem like they work in reverse when using the *StringToValue* method, but if you consider that *StringToValue* is intended to obtain numerical values from formatted strings, this makes more sense.

The *DisplayDegrees* property sets or returns an option that tells the *ValueToString* method in the associated *INumberFormat* interface whether or not the resulting formatted expression is in degrees or radians. If this property is set to *False,* the default, then the resulting format is a radian value, and a degree symbol is not appended. If the property is set to *True*, however, the resulting format is displayed as a degree value with a degree symbol appended to it.



This LatLonFormat *object formats numbers from decimal values to degrees, minutes, and seconds.*

This *LatLonFormat* coclass formats numbers that represent latitude and longitude values. For example, the value 55.87 would be converted to the string ‘55°52’12"N’.

ILatLonFormat : IUnknown	*Latitude/Longitude format interface.*
IsLatitude: Boolean	*Indicates if a formatted number is a latitude or not.*
ShowDirections: Boolean	*Indicates if a directional letter (N-S-E-W) is appended to the formatted number.*
ShowZeroMinutes: Boolean	*Indicates if zero minutes are included in formatted output.*
ShowZeroSeconds: Boolean	*Indicates if zero seconds are included in formatted output.*
GetDMS (in Value: Double, out degrees: Long, out minutes: Long, out seconds: Double)	*Returns the degrees, minutes, and seconds for a lat/lon number.*

Use the *ILatLonFormat* interface to format numbers that represent latitude or longitude. The members in the *ILatLonFormat* interface define how the *ValueToString* method in the associated *INumberFormat* interface formats numbers.

The *LatLonFormat* coclass also inherits the *INumericFormat* interface, which means both of these interfaces’ properties determine how numbers are formatted. *GetDMS* is a utility method that returns the degrees, minutes, and seconds for a given latitude or longitude value. To use it you should pass in the input decimal degree value and also pass in three double values representing the output degrees, minutes, and seconds that will be populated by the method. The following code demonstrates this.

```
Sub LatLonTest()
  Dim pLatLonFormat As ILatLonFormat
  Set pLatLonFormat = New LatLonFormat

  Dim dValue as Double
  dValue = 45.253

  Dim lDegrees As Long, lMinutes As Long, dSeconds As Double

  ' The GetDMS method calculates degrees, minutes and seconds
  pLatLonFormat.GetDMS dValue, lDegrees, lMinutes, dSeconds

  MsgBox lDegrees & " degrees" & vbNewLine & lMinutes & _
   "minutes" & vbNewLine & dSeconds & " seconds", , "DMS(" & dValue & ")"
End Sub
```

The *IsLatitude* property specifies whether subsequent values represent latitude (*True*) or longitude (*False*). If the value of the property is set to *False* and the *ShowDirections* property is set to *True*, then when the *ValueToString* method from the associated *INumberFormat* interface is used, a directional letter designation of either E (for positive values) or W (for negative values) is appended to the format. An example is “23°E”. Also, when used with the *IDMSGridLabel* interface, it sets an indicator to specify that latitude labels will be placed on top of the data frame border, and longitude labels will be placed to the left of the data frame border.

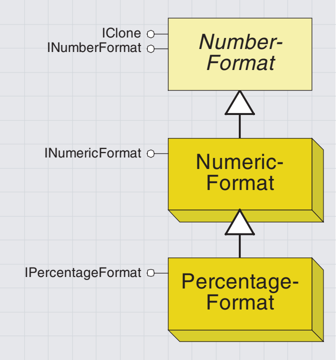
If *True,* the directional letter will be either N or S; with *IDMSGridLabel*, latitude labels are placed below the data frame border, and longitude labels are placed to the right.

ShowDirections sets or returns a Boolean value specifying whether or not direction is shown with a letter (N, S, E, or W). It is useful only with the *ValueToString* method in the associated *INumberFormat* interface. The default value is *False*.

As an alternative, the *ShowPlusSign* property from *INumericFormat* can be used to show similar information since the *LatLonFormat* coclass also supports this interface.

The *ShowZeroMinutes* and *ShowZeroSeconds* properties simply set or return a Boolean value to specify whether or not a zero value in the minutes or seconds location is expressed when the *ValueToString* method in the associated *INumberFormat* interface formats numbers. For both properties, nonzero values are always expressed in the format. If *ShowZeroSeconds* is *True*, then zero values in the minutes location are also shown, regardless of the *ShowZeroMinutes* setting.

As an example, if *ShowZeroSeconds* is *True*, then *ValueToString* will return 17°0'0 from an input value of 17.0.



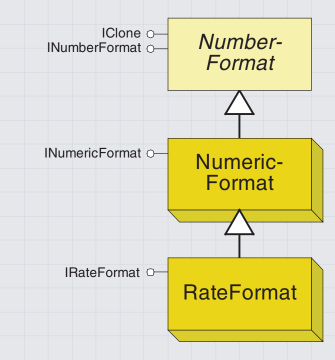
The percentage-format object formats values that represent percentages. For example, 56 is formatted to "56%", with an optional conversion from a fraction to a percentage, for example, 0.5 to "56%".

The *PercentageFormat* coclass allows the conversion between values and strings that represent percentages. The *PercentageFormat* coclass also supports the *INumericFormat* interface, so a combination of these interfaces' properties determines how numbers are formatted.

IPercentageFormat : IUnknown	***Percentage format interface.***
AdjustPercentage: Boolean	*Indicates if ValueToString agument is treated as a fraction or a percentage.*

The *AdjustPercentage* property allows the conversion to and from fractions. If it is set to *False,* the default, then the arguments to both the *ValueToString* and *StringToValue* methods are assumed to be in percentage format already. For *ValueToString* a percentage symbol is simply appended to the value, and for *StringToValue* this is removed. If this property is set to *True*, however, the argument to the *ValueToString* method is treated as a fraction. The value is multiplied by 100, and a percent symbol is appended. For *StringToValue,* the output is converted to a fraction (from a percentage)—it is divided by 100, and any percentage symbol is removed. This is demonstrated in the following code:

```
Sub PercentageFormatExample()
  Dim pPercentageFormat As IPercentageFormat
  Dim dValue As Double, sV2S As String, dS2V As Double
  Dim pNumberFormat As INumberFormat

  Set pPercentageFormat = New PercentageFormat
  Set pNumberFormat = pPercentageFormat

  dValue = 0.5 ' Set the input value

  'First try with a conversion between fractions and percentages
  pPercentageFormat.AdjustPercentage = True

  sV2S = pNumberFormat.ValueToString(dValue)
  dS2V = pNumberFormat.StringToValue(sV2S)

  MsgBox "ValueToString(" & dValue & ") = '" & sV2S & "'" & _
    vbNewLine & "StringToValue('" & sV2S & "') = " & dS2V, , _
    "PercentageFormat - AdjustPercentage = " & _
    pPercentageFormat.AdjustPercentage

  'Now try without converting between fractions and percentages
  pPercentageFormat.AdjustPercentage = False

  sV2S = pNumberFormat.ValueToString(dValue)
  dS2V = pNumberFormat.StringToValue(sV2S)

  MsgBox "ValueToString(" & dValue & ") = '" & sV2S & "'" & _
    vbNewLine & "StringToValue('" & sV2S & "') = " & dS2V, , _
    "PercentageFormat - AdjustPercentage = " & _
    pPercentageFormat.AdjustPercentage
End Sub
```



The rate-format object allows the formatting of values that represent rates. Using the associated ValueToString *method on* INumericFormat, *it can be used to multiply the value by the* RateFactor *and append the* RateString.

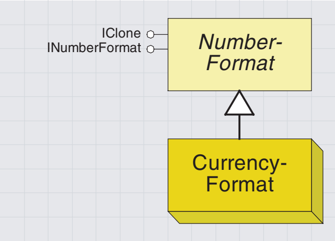
The *RateFormat* coclass and the *IRateFormat* interface format numeric values according to a given rate factor and string suffix.

IRateFormat : IUnknown	Rate format interface.
RateFactor: Double	The rate factor applied to the ValueToSring and StringToValue methods.
RateString: String	The label appended to the formatted rate number.

The interface's two properties (*RateString* and *RateFactor*) determine how the formatting takes place when using the *ValueToString* and *StringToValue* methods of the associated *INumberFormat* interface. This coclass supports *INumericFormat* so its members are also used in the formatting process.

When using the *ValueToString* method, any string defined in the *RateString* property (the default value is *Null*) is appended to the method's input value. Also, the value in the *RateFactor* property (the default value is 1000) is divided into the *ValueToString* argument value. For example, *ValueToString (300)* with a *RateFactor* of 3 and a *RateString* of "loaves" would return a formatted string of "100 loaves".

The corresponding *StringToValue* method also uses both these properties. The value from the input string is multiplied by the value in the *RateFactor* property when *StringToValue* converts the number back. Also, if set, the *RateString* is stripped from the result.



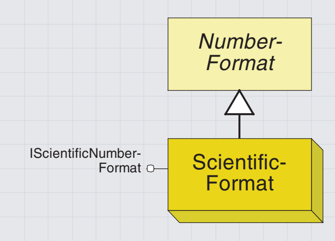
The CurrencyFormat *coclass has no interface of its own—it simply uses the* ValueToString *and* StringToValue *methods from* INumberFormat *to convert between values representing currency and formatted strings. The formatting is taken from your system settings.*

CurrencyFormat is a coclass that formats numbers to look like a currency. For example, the number 123456.789, when formatted with *CurrencyFormat* (default U.S. English regional settings), looks like $123,456.79. Note that the formatted number is rounded to the nearest cent. Negative numbers are typically depicted inside parentheses—for example, a negative number of the same value would be formatted as ($123,456.79).

To format numbers as currency, create a *CurrencyFormat* object and use the *ValueToString* method.

CurrencyFormat does not have an *ICurrencyFormat* interface because there are no member properties to set. To use it, define an object as an *INumberFormat* and set it to a new *CurrencyFormat*. Numbers are formatted according to the current regional settings defined for the system at runtime. To change the way currency numbers are formatted, change the settings on the Currency tab of the Control panel's Regional Settings applet.

ScientificFormat coclass

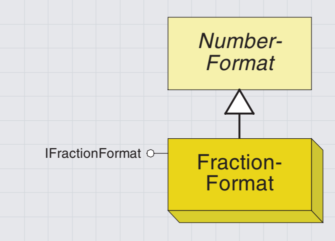


The scientific-format object allows the conversion of values to and from scientific (exponential) notation, for example, 19730 to "1.97e+006".

Use the *ScientificFormat* coclass when you want to express numbers in a scientific format, for example, to create a table of empirical values. *ScientificFormat* expresses numbers as a power of 10. For example, the value 1500 in scientific format to 3 significant digits is the expression 1.50e+003, where the number before "e" is the mantissa, and the number after "e" is the power of 10, or exponent. The meaning of this expression is 1.50 x 10^3. The number of digits in the exponent (+003) cannot be changed—it is always a plus or minus sign and 3 digits.

The *DecimalPlaces* property sets or returns a long representing the number of decimals to show in the mantissa. Since all digits in a scientific format expression are significant, set the *DecimalPlaces* property to the number of desired significant digits minus 1. For example, to express the value 1 to 3 significant digits (1.00e+000), set *DecimalPlaces* to 2. The default value is 6.

The power behind the scientific format expresses significant zeros. For example, a 1000-yard distance measured with a bicycle odometer may only be accurate to the nearest 10th mile (176 yards). In this case, 1000 is only significant to one place and should be expressed as 1 x 10^3. On the other hand, you may know the measurement is precise to the last zero (perhaps you carefully measured this distance with a yardstick)—in this case, you should express the measurement as 1.000 x 10^3.



The fraction-format object converts from decimal values to fractions (using ValueToString*) and vice versa (using* StringToValue*).*

Use the *IFractionFormat* interface to either convert from a decimal fraction to a formatted fraction (using the *ValueToString* method) or to evaluate a formatted fraction as a decimal (using the *StringToValue* method). Basically, this means that *ValueToString* could convert an input of 0.75 to a string such as “3/4”, and 2.5 could become “2 1/2”, while *StringToValue* would do the reverse.

The properties *FractionOption* and *FractionFactor* give you more control over how the *ValueToString* conversion takes place because they allow you to use the *FractionFactor* to specify what denominator should be used for the output. The way in which this *FractionFactor* is used depends on which of the two settings (*esriFractionOptionEnum*) is used for the *FractionOption* property.

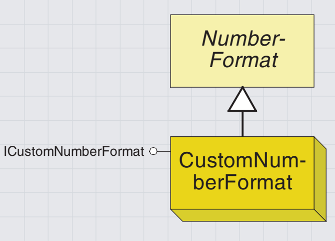
The default option for *FractionOption* is *esriSpecifyFractionDigits*, which means that the *FractionFactor* property specifies the maximum number of digits to which the numerator or denominator is calculated. If the value passed to *ValueToString* evaluates a fraction whose numerator or denominator has more digits than specified in the *FractionFactor* property, the formatted string will be rounded to represent the closest fraction to the number of digits specified. As an example, the fraction 893/1234 returns a decimal value of 0.723662884927066. *ValueToString* can format this decimal number back to “893/1234”; however, the maximum number of decimal places to be used in the output fraction is three (by default). Therefore, by default this returns a formatted result of 474/655 because this is the closest three-digit fraction to the decimal value. To calculate all four digits in the denominator and return to the original fraction, *FractionFactor* needs to be set to a value of 4. The caveat here is that the higher the *FractionFactor* setting, the more processing time it will take to figure out the fraction.

Alternatively, if *FractionOption* is set to *esriSpecifyFractionDenominator*, then the *FractionFactor* property value is used to explicitly specify the denominator. Since the *ValueToString* method doesn’t have to calculate the denominator, the result is returned very quickly. For example, when using *esriSpecifyFractionDenominator*, if the *FractionFactor* is set to 8, then the resulting fraction would be given in eighths.

```
Public Sub FractionDemo()
  Dim pFraForm As IFractionFormat
  Dim pNumForm As INumberFormat

  Set pFraForm = New FractionFormat
  Set pNumForm = pFraForm

  'Specify denominator explicitly
  pFraForm.FractionOption = esriSpecifyFractionDenominator

  pFraForm.FractionFactor = 8 'Use eighths
  MsgBox pNumForm.ValueToString(0.75) 'Shows "6/8"
  pFraForm.FractionFactor = 4 'Use fourths
  MsgBox pNumForm.ValueToString(0.75) 'Shows "3/4"

  pFraForm.FractionFactor = 4  'Use fourths
  'Still shows "3/4" because result is rounded
  MsgBox pNumForm.ValueToString(0.85)

End Sub
```

The result will be rounded to fit the denominator specified, as both 0.75 and 0.85 become “3/4” in the above example.

When using *StringToValue,* neither the *FractionOption* nor the *FractionFactor* properties are used; instead, a straightforward evaluation of the fraction is carried out. For example, “5/8” returns a value of 0.625, and “6 3/4” returns 6.75.



The custom-number-format object and its default interface allow numeric values to be formatted as strings. It works by pattern matching and allows conversions, such as changing ValueToString*(12345678.9) to "$12,345,678.90 big ones".*

Use the *ICustomNumberFormat* interface to format numbers in a customized way using the *FormatString* member property. The associated *INumberFormat*'s *ValueToString* method is used to return a string formatted to fit whatever the *FormatString* property is set to. The *StringToValue* method reverses this formatting. The formatting is done based on the following sets of characters in the *FormatString*:

0 Digit placeholder. Displays a digit or a zero. If the expression has a digit in the position where the 0 appears in the format string, display it; otherwise, display a zero in that position. If the number has fewer digits than there are zeros (on either side of the decimal) in the format expression, display leading or trailing zeros. If the number has more digits to the right of the decimal separator than there are zeros to the right of the decimal separator in the format expression, round the number to as many decimal places as there are zeros. If the number has more digits to the left of the decimal separator than there are zeros to the left of the decimal separator in the format expression, display the extra digits without modification.

The actual characters used as decimal placeholders and thousand's separators in the formatted output depend on the number format recognized by the system at runtime; thus, it is dependent on your regional settings.To change the way numbers are formatted, change the settings on the Numbers tab of the Control panel's Regional Settings applet.

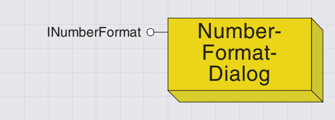
Digit placeholder. Displays a digit or nothing. If the expression has a digit in the position where the # appears in the format string, display it; otherwise, display nothing in that position. This symbol works like the 0-digit placeholder, except that leading and trailing zeros aren't displayed if the number has the same or fewer digits than there are # characters on either side of the decimal separator in the format expression.

. Decimal placeholder. In some locales, a comma is used as the decimal separator. The decimal placeholder determines how many digits are displayed to the left and right of the decimal separator. If the format expression contains only number signs to the left of this symbol, numbers smaller than 1 begin with a decimal separator. To display a leading zero displayed with fractional numbers, use 0 as the first-digit placeholder to the left of the decimal separator. The actual character used as a decimal placeholder in the formatted output depends on the number format recognized by your system.

, Thousand separator. In some locales, a period is used as a thousand separator. The thousand separator separates thousands from hundreds within a number that has four or more places to the left of the decimal separator. Standard use of the thousand separator is specified if the format contains a thousand separator surrounded by digit placeholders (0 or #). The actual character used as the thousand separator in the formatted output depends on the number format recognized by your system.

‘ABC’ Literal string. You can place literal strings on either side of numeric placeholders. For example, you can define a format expression as, “The formatted number is: ###,###.#0”.

All of the above can be combined to produce complex results. For example, using *ValueToString* with a value of 12345678.9 and a *FormatString* of ‘$#,###,###.#0 bucks’, the output should be “$12,345,678.90 bucks”.

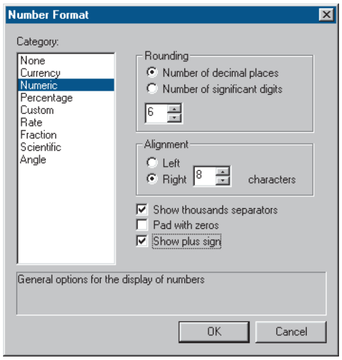


The Number Format dialog box gives a graphical user interface for setting up the number format objects in the above sections.

A *NumberFormatDialog* represents a graphical interface on the properties of the above interfaces. It allows you to set up one of the number format objects, which you may then use to format numeric values. The dialog box can be seen as a helper object since you are not required to use it, and you may wish to create your own VBA form to present the options to users in a different way.

The dialog box itself is split into two parts. On the left side is a list of all the categories available, each of which equates to roughly one of the *NumberFormat* coclasses. The right side shows the user interface particular to the category selected on the left-hand side.

For example, when *RateFormat* is selected from the left-hand side, the right side displays a dropdown box that allows the user to select and type in the factor (*IRateFactor::RateFactor*), and a text box where they can optionally type in a suffix (*IRateFactor::RateString*). Additionally, because the *RateFactor* coclass also supports *INumericFormat,* the Numeric Options button is also shown. If this button is pressed, then a second modal dialog box is displayed that allows access to the properties from *INumericFormat*, such as *ShowPlusSign, RoundingValue,* and *RoundingOption*.


Number Format

Category:
None
Currency
Numeric
Percentage
Custom
Rate
Fraction
Scientific
Angle

Rounding
● Number of decimal places
○ Number of significant digits
6

Alignment
○ Left
● Right 8 characters

☑ Show thousands separators
□ Pad with zeros
☑ Show plus sign

General options for the display of numbers

The Number Format dialog box is used within ArcMap in several places, including:

Symbol property page: FormatLabels *option in the* ClassBreaksRenderer *section*

Scale bar property page: Number Format button in the Numbers & Marks tab

Layer property page: Format button in the Fields tab

It can also be used by developers to present number-formatting options to users.

INumberFormatDialog : IUnknown	*Number Format Dialog*
■— NumberFormat: INumberFormat	*Sets or returns the current number format object*
← DoModal (in hWnd: Long) : Boolean	*Displays the number format dialog*

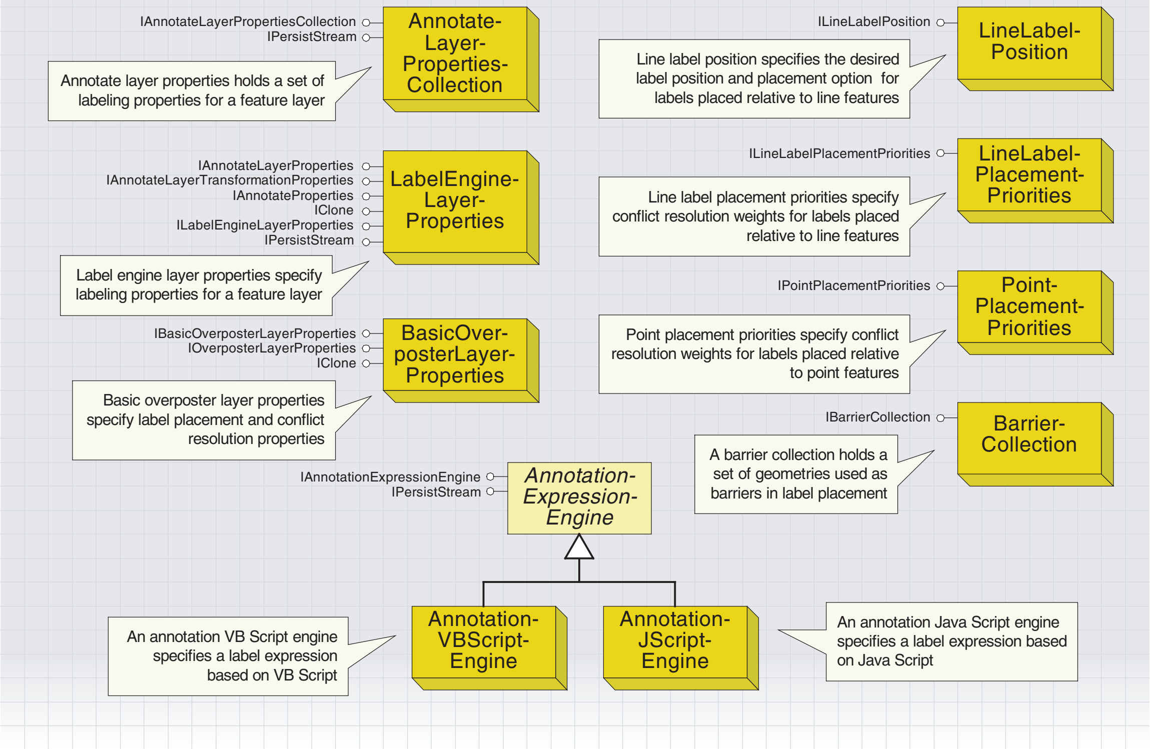
The only interface supported by the *NumberFormatDialog* is *INumberFormatDialog*, which has one method, *DoModal*, and one read–write property, *NumberFormat*.

DoModal displays the dialog box on top of the window specified by the *hWnd* parameter. The method returns a Boolean to indicate which button was clicked when the dialog box was closed. *True* is returned if OK was clicked, and *False* is returned if either Cancel or the Close button was clicked. Because the dialog box is displayed modally, code execution does not continue until the dialog box has been closed.

The *NumberFormat* property allows you to set or get the *NumberFormat* object used by the dialog box. This has two uses: setting the *NumberFormat* object prior to calling *DoModal* (telling the dialog box which type of format object should be shown in the display initializing any settings) and getting the number-format object returned from the dialog box.

```
Private Sub UIButtonControl1_Click()
  Dim pApp As IApplication
  Dim pNumFrmDialog As INumberFormatDialog
  Dim pNumerForm As INumericFormat
  Dim pNumForm As INumberFormat
  Dim hWnd As OLE_HANDLE
  ' Get the application's window handle
  hWnd = Application.hWnd
  ' Create a new NumberFormatDialog
  Set pNumFrmDialog = New NumberFormatDialog
  ' Create a new NumericFormat
  Set pNumerForm = New NumericFormat

  ' Setup the NumericFormat
  With pNumerForm
    .RoundingOption = esriRoundNumberOfDecimals
    .RoundingValue = 3
    .ShowPlusSign = True
    .UseSeparator = True
  End With

  ' Set the NumberFormatDialog's NumberFormat property
  pNumFrmDialog.NumberFormat = pNumerForm

  ' Open the dialog on the application's window
  If pNumFrmDialog.DoModal(hWnd) Then
    ' Get the returned INumberFormat and use to format a number
    Set pNumForm = pNumFrmDialog.NumberFormat
    MsgBox pNumForm.ValueToString(12345.6789)
  End If
End Sub
```

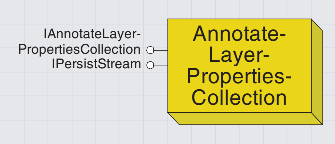
Labeling objects


IAnnotateLayerPropertiesCollection
IPersistStream
Annotate-Layer-Properties-Collection
Annotate layer properties holds a set of labeling properties for a feature layer
IAnnotateLayerProperties
IAnnotateLayerTransformationProperties
IAnnotateProperties
IClone
ILabelEngineLayerProperties
IPersistStream
LabelEngine-Layer-Properties
Label engine layer properties specify labeling properties for a feature layer
IBasicOverposterLayerProperties
IOverposterLayerProperties
IClone
BasicOver-posterLayer-Properties
Basic overposter layer properties specify label placement and conflict resolution properties
IAnnotationExpressionEngine
IPersistStream
Annotation-Expression-Engine
Annotation-VBScript-Engine
Annotation-JScript-Engine
An annotation VB Script engine specifies a label expression based on VB Script
An annotation Java Script engine specifies a label expression based on Java Script
ILineLabelPosition
LineLabel-Position
Line label position specifies the desired label position and placement option for labels placed relative to line features
ILineLabelPlacementPriorities
LineLabel-Placement-Priorities
Line label placement priorities specify conflict resolution weights for labels placed relative to line features
IPointPlacementPriorities
Point-Placement-Priorities
Point placement priorities specify conflict resolution weights for labels placed relative to point features
IBarrierCollection
Barrier-Collection
A barrier collection holds a set of geometries used as barriers in label placement

One of the key factors in creating a usable map is labeling (or annotating) features on the map. Labeling is the placing of text near a feature to purvey information about that feature. Normally the label is based on attribute values of the feature itself, but it doesn't have to be.

The ArcMap labeling environment offers a wide variety of methods for labeling features and for resolving conflicts when labels overlap each other. The labeling environment includes the ability to specify which features are to be labeled (all features, features identified by an SQL query, and so on); the expression that is used to label them (expressions can be simple or complex based on VB and Java scripting); placement options and weights for those placements; and priority specifications of one layer versus another. Depending on the requirements of the user, it is also possible to label one layer with multiple expressions.

The objects in this model provide the ability to access all of the parameters associated with the labeling of features. Advanced developers can also create their own expression-parsing engines to be used in the labeling process.



The AnnotateLayerPropertiesCollection *object holds one or more labeling property objects for a feature layer. These objects in turn specify how the labels are to be rendered and placed relative to the features. Each object in the set can apply to a subset (query) of the features.*

The *AnnotateLayerPropertiesCollection* holds a collection of the different labeling sets (*LabelEngineLayerProperties* objects) assigned to a particular feature layer. The collection can be created, or it can be retrieved from the *IGeoLayer::AnnotationProperties* property on a feature layer. It is possible to label a layer with more than one expression. The purpose of the *AnnotateLayerPropertiesCollection* object is to keep track of the set of expressions that have been assigned.

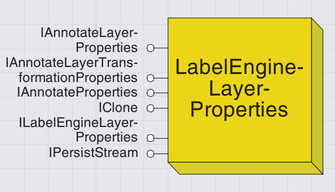
IAnnotateLayerPropertiesCollection : IUnknown	***Provides access to members that work with a collection of annotation settings for a feature layer.***
■— Count: Long	*Returns the number of items in the collection.*
← Add (in Item: IAnnotateLayerProperties)	*Adds an item to the collection.*
← Clear	*Removes all the items in the collection.*
← QueryItem (in Index: Long, out Item: IAnnotateLayerProperties, placedElements: IElementCollection, unplacedElements: IElementCollection)	*Returns the item in the collection at the specified index.*
← Remove (in Layerprops: IAnnotateLayerProperties)	*Removes the item in the collection at the specified index.*
← Sort	*Sorts the items in the collection.*

The *IAnnotateLayerPropertiesCollection* interface allows for the manipulation of the *IAnnotateLayerProperties* (*LabelEngineLayerProperties* coclass) objects held within the collection. Through the interface, the developer can add, remove, sort, and query the objects in the collection.

QueryItem provides access to the items in the collection as well as the placed and unplaced elements that go with each *LabelEngineLayerProperties* object.

The following VBA code gets the collection object from a layer and displays the expression defined for each property set within the collection.

```
Sub AnnoClasses()
  Dim pDoc As IMxDocument, pMap As IMap, lLoop As Long
  Dim pGeoLayer As IGeoFeatureLayer
  Set pDoc = ThisDocument
  Set pMap = pDoc.FocusMap
  For lLoop = 0 To pMap.LayerCount - 1
    If UCase(pMap.Layer(lLoop).Name) = "PIPES" Then
      Set pGeoLayer = pMap.Layer(lLoop)
       Exit For
    End If
  Next lLoop

  Dim pAnnoProps As IAnnotateLayerPropertiesCollection
  Dim pLabelEngine As ILabelEngineLayerProperties
  Set pAnnoProps = pGeoLayer.AnnotationProperties
  For lLoop = 0 To pAnnoProps.count - 1
    pAnnoProps.QueryItem lLoop, pLabelEngine
    Debug.Print pLabelEngine.Expression
  Next lLoop
End Sub
```



The LabelEngineLayerProperties *object maintains one instance of labeling properties for a feature layer. These properties specify how the labels are to be rendered and placed relative to the features. These properties include on which attribute or expression you should base the labels, with which symbol to render the label text, the position relative to the features, and conflict resolution weights.*

A *LabelEngineLayerProperties* object maintains the set of properties associated with the labeling of a feature layer. Multiple *LabelEngineLayerProperties* can be created for a single feature layer; they are stored within an *AnnotateLayerPropertiesCollection*. The object keeps track of which features to label, how to label them, what symbology to use, how to transform the labels based on the current scale, and what to do with unplaced labels.

The following VBA code demonstrates how to create a new *LabelEngineLayerProperties* object and add it to the *AnnotateLayerPropertiesCollection* object retrieved from a line feature layer (for example, “PIPES”). The code also creates and employs *BasicOverposterLayerProperties, LineLabelPlacementPriorities,* and *LineLabelPosition* objects.

```
Sub AddAnnoProps()
  Dim pDoc As IMxDocument, pMap As IMap, lLoop As Long
  Dim pGeoLayer As IGeoFeatureLayer
  Set pDoc = ThisDocument
  Set pMap = pDoc.FocusMap
  For lLoop = 0 To pMap.LayerCount - 1
    If UCase(pMap.Layer(lLoop).Name) = "PIPES" Then
      Set pGeoLayer = pMap.Layer(lLoop)
       Exit For
    End If
  Next lLoop

  Dim pAnnoProps As IAnnotateLayerPropertiesCollection
  Set pAnnoProps = pGeoLayer.AnnotationProperties
  Dim pAnnoLayerProps As IAnnotateLayerProperties
  Dim pPosition As IlineLabelPosition
  Dim pPlacement As ILineLabelPlacementPriorities
  Dim pBasic As IBasicOverposterLayerProperties
  Dim pLabelEngine As ILabelEngineLayerProperties
  Set pPosition = New LineLabelPosition
  pPosition.Parallel = False
  pPosition.Perpendicular = True

  Set pPlacement = New LineLabelPlacementPriorities
  Set pBasic = New BasicOverposterLayerProperties
  pBasic.FeatureType = esriOverposterPolyline
  pBasic.LineLabelPlacementPriorities = pPlacement
  pBasic.LineLabelPosition = pPosition

  Set pLabelEngine = New LabelEngineLayerProperties
  Set pLabelEngine.BasicOverposterLayerProperties = pBasic
  pLabelEngine.Expression = "[TONODE_]"
  Set pAnnoLayerProps = pLabelEngine
  pAnnoProps.Add pAnnoLayerProps
End Sub
```

IAnnotateLayerProperties : IUnknown	*Provides access to members that work with the display of dynamic labels (text) for a feature layer.*
■—■ AddUnplacedToGraphicsContainer: Boolean	*Indicates if overflow labels are put into a graphics container.*
■—■ AnnotationMaximumScale: Double	*The maximum scale at which to display annotation.*
■—■ AnnotationMinimumScale: Double	*The minimum scale at which to display annotation.*
■—■ Class: String	*The class name.*
■—■ CreateUnplacedElements: Boolean	*Indicates if unplaced elements are created.*
■—■ DisplayAnnotation: Boolean	*Indicates if the layer displays annotation.*
■—■ Extent: IEnvelope	*The extent to perform labeling in.*
■—□ FeatureLayer: IFeatureLayer	*The annotated feature class.*
■—■ FeatureLinked: Boolean	*Indicates if the text is feature linked.*
■—□ GraphicsContainer: IGraphicsContainer	*The graphics container used to hold overflow labels.*
■—■ LabelWhichFeatures: esriLabelWhichFeatures	*The type of features labeled.*
■—■ Priority: Long	*Priority for labels of this feature class (0 is highest).*
■—■ UseOutput: Boolean	*Indicates if the output will be used.*
■—■ WhereClause: String	*SQL where clause that determines which features are labeled.*

The *IAnnotateLayerProperties* interface is implemented only by the *LabelEngineLayerProperties* object and provides the answer to the question of which features to label and at what scales. Through this interface, the developer can specify the priority of the labels, a where clause to be applied to the feature layer, and a specification of what to do with unplaced elements.

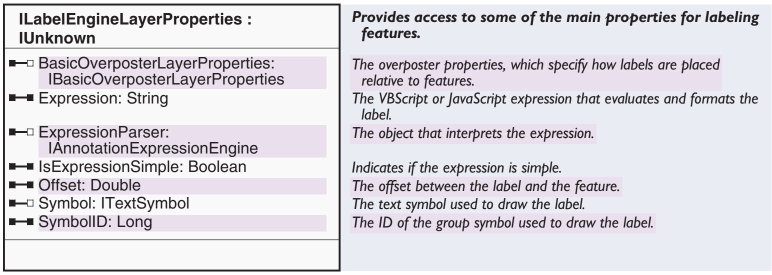
The *FeatureLinked*, *LabelWhichFeatures*, and *GraphicsContainer* properties apply only when the set of labels is being converted to annotation. The developer can use the *GraphicsContainer* property to specify where the converted labels will go.

The *FeatureLayer* property is used internally during the labeling process. If you find it necessary to set this property, be sure to set it back to *Null* after labeling has completed.

IAnnotateLayerTransformationProperties : IUnknown	*Provides access to members that control transformation properties for the display of dynamic labels (text) for a feature layer..*
■—■ Bounds: IEnvelope	*The full extent in world coordinates.*
■—■ ReferenceScale: Double	*Reference scale for computing scaled symbol sizes*
■—■ ScaleRatio: Double	*Scale ratio of the transformation. Based on IAnnotationLayerProperties.Extent and Bounds.*
■—■ Units: esriUnits	*The units of the world coordinates.*

The *IAnnotateLayerTransformationProperties* interface is implemented only by the *LabelEngineLayerProperties* object; it holds the settings that determine what size to draw the labels at different scales. Use this interface when you want to specify the reference scale and other transformation properties to use with a *LabelEngineLayerProperties* object.

The *ScaleRatio* is a ratio between the *IAnnotateLayerProperties::Extent* property and the *IAnnotateLayerTransformationProperties* property.



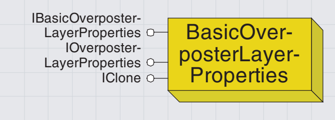
ILabelEngineLayerProperties : IUnknown	Provides access to some of the main properties for labeling features.
■—□ BasicOverposterLayerProperties: IBasicOverposterLayerProperties	The overposter properties, which specify how labels are placed relative to features.
■—■ Expression: String	The VBScript or JavaScript expression that evaluates and formats the label.
■—□ ExpressionParser: IAnnotationExpressionEngine	The object that interprets the expression.
■—■ IsExpressionSimple: Boolean	Indicates if the expression is simple.
■—■ Offset: Double	The offset between the label and the feature.
■—□ Symbol: ITextSymbol	The text symbol used to draw the label.
■—■ SymbolID: Long	The ID of the group symbol used to draw the label.

The *ILabelEngineLayerProperties* interface is implemented only by the *LabelEngineLayerProperties* object and provides access to the expression, symbol, and overposting properties of the label engine object. Use this interface when you want to access the *AnnotationExpressionEngine* and *BasicOverposterLayerProperties* objects associated with the label engine object.

By default, the *ExpressionParser* property will return the *AnnotationVBScriptEngine* object. In general, the developer would not use this property unless they wanted to use Java scripting for labeling. In this case, an *AnnotationJScriptEngine* object would be created, and the *ExpressionParser* property would be set to this. The expression to use is always set through the *Expression* property.

The *IsExpressionSimple* property identifies whether a complex expression is being used in the *Expression* property. Complex expressions involve a parser object (ExpressionParser *property*) to parse the string.

The *SymbolID* property is used during the conversion of labels to annotation when a group symbol is being applied. A group symbol is applied when a feature-linked annotation class is being created and when converting coverage annotation to the geodatabase.


IBasicOverposter-LayerProperties
IOverposter-LayerProperties
IClone
BasicOver-posterLayer-Properties

The BasicOverposterLayerProperties *object maintains properties that specify the desired label position relative to the features and weights for resolving conflict among labels and features from other layers.*

You can either create the *BasicOverposterLayerProperties* object, or you can retrieve it from the *ILabelEngineLayerProperties::BasicOverposterLayerProperties* property.

IBasicOverposterLayerProperties : IUnknown	***Provides access to members that control the placement of labels relative to features using conflict detection.***
BufferRatio: Double	*Label buffer ratio. A value of 1 means a buffer the size of the label height.*
FeatureType: esriBasicOverposterFeatureType	*Feature type.*
FeatureWeight: esriBasicOverposterWeight	*Barrier weighting for features in the layer.*
GenerateUnplacedLabels: Boolean	*Indicates if unplaced labels are generated.*
LabelWeight: esriBasicOverposterWeight	*Barrier weighting for labels in the layer.*
LineLabelPlacementPriorities: ILineLabelPlacementPriorities	*Line label placement position priority options.*
LineLabelPosition: ILineLabelPosition	*Line label placement position options.*
LineOffset: Double	*Offset in map units at which labels will be placed away from line features.*
NumLabelsOption: esriBasicNumLabelsOption	*Feature labeling option for the layer.*
PointPlacementAngles: Variant	*Point label placement angle(s).*
PointPlacementMethod: esriOverposterPointPlacementMethod	*Point label placement method.*
PointPlacementOnTop: Boolean	*Indicates if point labels are placed on top of features.*
PointPlacementPriorities: IPointPlacementPriorities	*Point label placement position priority options.*

The *IBasicOverposterLayerProperties* interface is implemented only by the *BasicOverposterLayerProperties* object—it provides access to the overposting resolution methods employed by the label engine object. Each set of labeling properties defines how conflict resolution (overposting) issues will be resolved for those labels. The *IBasicOverposterLayerProperties* interface provides access to most of these properties.

FeatureType specifies whether labeling is being performed on point, line, or polygon features. Be sure to check this property before accessing any feature-type-specified property, such as *LineLabelPosition* or *PointPlacementAngles*.

FeatureWeight specifies whether labels can be placed on top of the features in a layer, while *LabelWeight* specifies whether the labels can conflict with other labels.

NumLabelsOption indicates how many labels to place per feature.

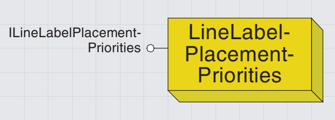
IBasicOverposterLayerProperties2 : IUnknown	***Provides access to members that control the maximum distance labels/symbols are placed away from their respective features.***
MaxDistanceFromTarget: Double	*The feature type.*

The *IBasicOverposterLayerProperties2* interface is implemented only by the *BasicOverposterLayerProperties* object and was added to allow you to set the maximum distance a label could be placed from its target (*MaxDistanceFromTarget* property).

IOverposterLayerProperties : IUnknown	***Provides access to members that control the placement of labels or symbols on top of features (barriers).***
IsBarrier: Boolean	*Indicates if features are treated as barriers to label/symbol placement.*
PlaceLabels: Boolean	*Indicates if labels are placed for the layer.*
PlaceSymbols: Boolean	*Indicates if symbols are placed for the layer.*

The *IOverposterLayerProperties* interface is implemented only by the *BasicOverposterLayerProperties* object and provides access to whether labels or symbols are placed.

The *IsBarrier* property indicates whether the features in the layer should serve as barriers for label placement (do not put labels on top of the features).


ILineLabelPlacement-Priorities
LineLabel-Placement-Priorities

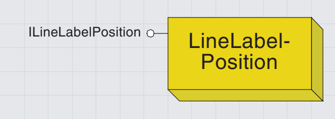
The LineLabelPlacementPriorities *object maintains the weights associated with label placement positions relative to the line start points and endpoints.*

The *LineLabelPlacementPriorities* object keeps track of the weight values assigned to the label engine object during the placement of labels along line features. The object is creatable, but it can also be retrieved from the *IBasicOverposterLayerProperties::LineLabelPlacementPriorities* property.

ILineLabelPlacementPriorities : IUnknown	***Provides access to members that control placement position priorities for line labels.***
AboveAfter: Long	*Label position priority for above and after the line.*
AboveAlong: Long	*Label position priority for above and along the line.*
AboveBefore: Long	*Label position priority for above and before the line.*
AboveEnd: Long	*Label position priority for above and at the end of the line.*
AboveStart: Long	*Label position priority for above and at the start of the line.*
BelowAfter: Long	*Label position priority for below and after the line.*
BelowAlong: Long	*Label position priority for below and along the line.*
BelowBefore: Long	*Label position priority for below and before the line.*
BelowEnd: Long	*Label position priority for below and at the end of the line.*
BelowStart: Long	*Label position priority for below and at the start of the line.*
CenterAfter: Long	*Label position priority for in the center and after the line.*
CenterAlong: Long	*Label position priority for in the center and along the line.*
CenterBefore: Long	*Label position priority for in the center and before the line.*
CenterEnd: Long	*Label position priority for in the center and at the end of the line.*
CenterStart: Long	*Label position priority for in the center and at the start of the line.*

The *ILineLabelPlacementPriorities* interface is the only interface implemented by the *LineLabelPlacementPriorities* coclass. Use this interface when you want to change the weighting values for conflict resolution when labeling line features.

The *Start* weight (*AboveStart, BelowStart,* and *CenterStart*) values only come into play when the Label only at start option is selected. The same principle applies for the *End* weight values.

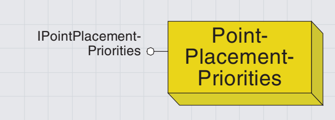


The LineLabelPosition *object maintains the flags associated with the possible label placement options. These include whether the labels should be placed horizontally, parallel (straight or curved), or perpendicular relative to the line, and whether the orientation should be determined by the line direction.*

The *LineLabelPosition* object is used in conjunction with the *LineLabelPlacementPriorities* object to specify how labels are to be placed along line features. The *LineLabelPosition* object dictates the default position for labels along lines, while the *LineLabelPlacementPriorities* object dictates how the labels will be placed when there are conflicts. The *LineLabelPosition* coclass is creatable, but it can also be retrieved from the *IBasicOverposterLayerProperties::LineLabelPosition* property.

ILineLabelPosition : IUnknown	***Provides access to members that control the relative position of line labels.***
Above: Boolean	*Indicates if labels are placed above lines.*
AtEnd: Boolean	*Indicates if labels are placed at the start of lines.*
AtStart: Boolean	*Indicates if labels are placed at the start of lines.*
Below: Boolean	*Indicates if labels are placed below lines.*
Horizontal: Boolean	*Indicates if labels are placed horizontally.*
InLine: Boolean	*Indicates if labels are placed inside lines.*
Left: Boolean	*Indicates if labels are placed to the left of lines.*
Offset: Double	*Offset from the start/end of line.*
OnTop: Boolean	*Indicates if labels are placed on top of lines.*
Parallel: Boolean	*Indicates if labels are placed parallel to lines.*
Perpendicular: Boolean	*Indicates if labels are placed perpendicular to lines.*
ProduceCurvedLabels: Boolean	*Indicates if labels follow lines.*
Right: Boolean	*Indicates if labels are placed to the right of lines.*

Use the *ILineLabelPosition* interface when you want to specify the default location of labels along line features. *AtEnd* and *AtStart* properties specify default locations that have weights attached to them in case there is a conflict, while *Parallel* and *Perpendicular* properties indicate options that are not changed by conflicts.



The PointPlacementPriorities *object maintains the weights associated with label placement positions relative to point features.*

The *PointPlacementPriorities* object keeps track of the weight values assigned to the label engine object during the placement of labels around point features.

The *PointPlacementPriorities* object is creatable, but it can also be retrieved from *IBasicOverposterLayerProperties::PointPlacementPriorities*.

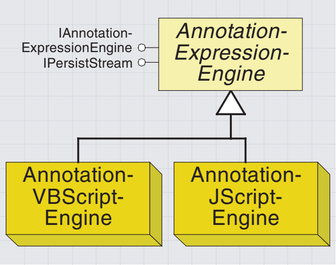
IPointPlacementPriorities : IUnknown	*Provides access to members that control placement position priorities for point labels.*
AboveCenter: Long	*Label position priority for above and center (0-9).*
AboveLeft: Long	*Label position priority for above and to the left (0-9).*
AboveRight: Long	*Label position priority for above and to the right (0-9).*
BelowCenter: Long	*Label position priority for below and center (0-9).*
BelowLeft: Long	*Label position priority for below and to the left (0-9).*
BelowRight: Long	*Label position priority for below and to the right (0-9).*
CenterLeft: Long	*Label position priority for center and to the left (0-9).*
CenterRight: Long	*Label position priority for center and to the right (0-9).*

The *IPointPlacementPriorities* interface is the only interface implemented by the *PointPlacementPriorities* coclass. Use this interface when you want to change the weighting values for conflict resolution when you are labeling point features. The interface provides weight settings for the eight positions around the point when the *IBasicOverposterLayerProperties::PointPlacementMethod* is set to *esriAroundPoint*. A value of one sets the highest priority (preferred position), a value of 2 sets the second priority, and so on. A value of 0 means that the position should not be used.

AboveCenter identifies the weight to use when attempting to place labeling for a point at the "12:00" position.

The following VBA code shows how to change the placement options for the labeling of the feature layer "VALVES" to ensure labels are only placed in the *AboveCenter* position.

```
Sub PointLabelProps()
  Dim pDoc As IMxDocument, pMap As IMap, lLoop As Long
  Dim pGeoLayer As IGeoFeatureLayer
  Set pDoc = ThisDocument
  Set pMap = pDoc.FocusMap
  For lLoop = 0 To pMap.LayerCount - 1
    If UCase(pMap.Layer(lLoop).Name) = "VALVES" Then
      Set pGeoLayer = pMap.Layer(lLoop)
      Exit For
    End If
  Next lLoop

  Dim pAnnoProps As IAnnotateLayerPropertiesCollection
  Dim pLabelEngine As ILabelEngineLayerProperties
  Dim pBasic As IBasicOverposterLayerProperties
  Dim pProps As IPointPlacementPriorities
  Set pAnnoProps = pGeoLayer.AnnotationProperties
  pAnnoProps.QueryItem 0, pLabelEngine
  Set pBasic = pLabelEngine.BasicOverposterLayerProperties
  Set pProps = pBasic.PointPlacementPriorities
  pProps.AboveCenter = 1
  pProps.AboveLeft = 0
  pProps.AboveRight = 0
  pProps.BelowCenter = 0
  pProps.BelowLeft = 0
  pProps.BelowRight = 0
  pProps.CenterLeft = 0
  pProps.CenterRight = 0
  pBasic.PointPlacementPriorities = pProps
End Sub
```



The AnnotationExpressionEngine object parses an expression on which to base the label text. This can be a function based on either VB or Java script code.

The *AnnotationExpressionEngine* supports two types of objects for parsing the expressions used in labeling: the *AnnotationVBScriptEngine* (for VB scripting) and the *AnnotationJScriptEngine* (for Java scripting). On very rare occasions, a developer may want to write their own parser based on this abstract class.

IAnnotationExpressionEngine : IUnknown	Provides access to members that work with low level information about a script based labeling expression.
AppendCode: String	The code to append.
Name: String	The name of the expression engine.
CreateFunction (in Name: String, in parameters: String, in Expression: String) : String	Creates the specified function.
SetCode (in fullCode: String, in runFunction: String) : IAnnotationExpressionParser	The function to base labels on.
SetExpression (in preCode: String, in Expression: String) : IAnnotationExpressionParser	The expression to base labels on.

The *IAnnotationExpressionEngine* interface is implemented by all label parsing engines.

This interface is used internally to initially define and later validate labeling expressions entered by the user through the user dialog boxes. In general, developers will not need to use the properties and methods of this interface. However, if a developer chooses to write their own parser engine, then this interface must be implemented for defining the expression to use in generating labels.

AppendCode indicates the string to use when appending multiple strings together to form the expression. For VB scripting, the *AppendCode* is set to"&", while for Java scripting it is "+".

Name identifies the type of engine being used as the parser ("VB Script" or "Java Script").

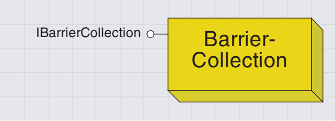
The *AnnotationVBScriptEngine* coclass is used for parsing VB scripting code during the labeling process. By default, VB scripting is used through this object to parse advanced labeling expressions. In general, a developer would only use an object of this type generating strings based on the defined expression for use outside the core labeling environment.

The methods on this interface only need to be called when the developer wants to generate strings to use outside the core labeling environment.

The *AnnotationJScriptEngine* coclass is used for parsing Java scripting code during the labeling process. A developer will create an object of this type when they want to perform labeling of features based on Java scripting code. Once the object is created, it can be applied through *ILabelEngineLayerProperties::ExpressionParser*.

Assuming an *IGeoLayer* object is present, the following code can be used to change the parser to Java Script (just make sure you also update the *Expression* as necessary):

```
Dim pAnnoProps As IAnnotateLayerPropertiesCollection
Set pAnnoProps = pGeoLayer.AnnotationProperties
Dim pAnnoLayerProps As IAnnotateLayerProperties
pAnnoProps.QueryItem 0, pAnnoLayerProps
Dim pLabelEngine As ILabelEngineLayerProperties
Set pLabelEngine = pAnnoLayerProps
Dim pAnnoEngine As IAnnotationExpressionEngine
Set pAnnoEngine = New AnnotationJScriptEngine
Set pLabelEngine.ExpressionParser = pAnnoEngine
```



The BarrierCollection *object holds one or more geometry collection objects, each with an associated label conflict resolution weight.*

The *BarrierCollection* object keeps track of the set of barrier geometries being used during the placement of labels. As new labels are placed, their geometries are also added to the collection. When a new label to be placed conflicts with an existing barrier in the collection, the overposting engine will look for a new location for the label (depending on the settings defined in the *BasicOverposterLayerProperties* object). The object can either be created, or it can be retrieved from the *IMap::Barriers* or *IMapBarriers::Barriers2* properties.

IBarrierCollection : IUnknown	***Provides access to members that control a collection of objects that act as barriers to label placement.***
Count: Long	*Returns the number of items in the collection.*
Add (in Barriers: IGeometryCollection, in Weight: esriBasicOverposterWeight)	*Adds the specified item to the collection.*
Clear	*Removes all the items in the collection.*
QueryItem (in Index: Long, out Barrier: IGeometryCollection, Weight: esriBasicOverposterWeight)	*Returns the item in the collection at the specified index.*

The *IBarrierCollection* interface allows for the manipulation of the geometries that make up the current set of barriers to label placement. Through this interface the developer can add, clear, and query the defined geometries and weights.

The *Add* and *QueryItem* properties add and return collections of geometries (*IGeometryCollection*) as a single barrier. Each *IGeometryCollection* represents a single graphics layer in the map.

The following VBA code shows how to access the *BarrierCollection* and the number of geometries for one entry in the collection based on the current extent of the map:

```
Sub LabelBarriers()
  Dim pDoc As IMxDocument, pMap As IMap, pBarriers As IBarrierCollection
  Dim pGeometry As IGeometryCollection, pActive As IActiveView
  Set pDoc = ThisDocument
  Set pMap = pDoc.FocusMap
  Set pActive = pMap
  Set pBarriers = pMap.Barriers(pActive.Extent)
  pBarriers.QueryItem 0, pGeometry
  Debug.Print pBarriers.count & " - " & pGeometry.GeometryCount
End Sub
```

In general, the model for extending ArcGIS applications is through in-process COM delivered as DLLs, such as extensions, commands, property pages, and so on. In some cases, however, it may be necessary to "drive" ArcGIS applications from a separate application, a practice commonly referred to as Automation.

In modern operating systems, such as UNIX® and Windows NT, all applications run in their own protected address space. Since memory is not directly accessible between these separate processes, calls made between them are necessarily slower due to the translations and remote invocations that must occur.

Normally, ArcGIS applications are extended by user customizations made available to the application through such mechanisms as component categories. For example, when ArcMap is launched, this application loads all properly registered extension objects into its process space. Since these objects then exist in ArcMap process space, access between them is direct and fast. The same is true for custom extensions, commands, and even VBA code running within ArcMap since they do not need to communicate between each other across process boundaries. COM communication in this case is generally referred to as "in-process" or simply "in-proc".

Conversely, it is possible to create a Visual Basic executable—a standalone application—that obtains a reference to and works with ArcMap "remotely" from its separate process space. In this case, there are two separate applications running and, therefore, two separate process spaces. COM communication in this case is referred to as "out-of-process" or simply "out-of-proc". This kind of access is also commonly called "automation". Although, as far as the client is concerned, things appear to be the same in automation as they are in the in-proc case, there are important differences of which programmers need to be aware.

PROBLEMS WITH AUTOMATION

Performance

Interapplication communication (whether through COM or some other mechanism) must cross process boundaries since all applications (in UNIX, Windows NT, and other operating systems) live in their own protected-address space. When a COM object is created in one process and accessed in another, interprocess marshaling (communication) must occur, and this is very expensive. In an application such as ArcMap, where large numbers of components are accessed over short periods of time (such as in drawing or query), this overhead can become extreme.

Process-confined types

Certain types, such as GDI handles and others, cannot be used within the context of a different process from which they were created in, or are restricted in what can be done with them in that foreign process. For instance, a bitmap created in one process and handed to another through COM (for example, as an OLE_HANDLE) cannot be rendered on a DC in the foreign-process space.

Deadlocks and other threading issues

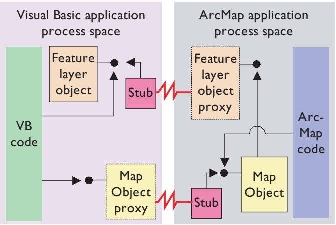
Some areas of ArcGIS do not currently support access from a foreign-process space. For instance, map layers from one instance of ArcMap cannot be successfully rendered in a separate instance of ArcMap. Many of these limitations are due to limitations of what sorts of system objects can be shared between separate process spaces, and some are due to performance issues.

SOLUTION

In general, when "driving" ArcMap through automation, it is often the case that what you really want is for things to be as they are in the in-proc case. It would be desirable if there were some way that a request to create an object in one process space could be controlled so that the actual object instance could come into existence within the application being "driven" (ArcMap), instead of from where the request is actually made (the driving application). In reality, using VB's *New* statement simply creates the object in the driving application's process space, not in the ArcMap process.

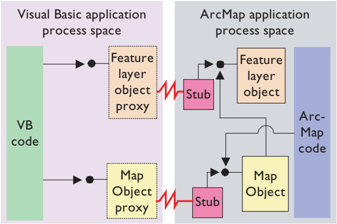
This sort of control is made possible by the *IObjectFactory* interface, obtainable from the ArcMap *Application* object (which your process obtains through automation). This interface can be used to create an arbitrary object within the ArcMap process (in the main STA) by calling the *Create* method—passing in the ProgID/ClsID of the component you want to create. The caller receives a proxy to that object that now resides within ArcMap. Calls from within ArcMap to objects created in this way are local to the ArcMap process.

A useful example would be where an attempt is made to load a new feature layer into a map within ArcMap by a separate application written in Visual Basic, which uses automation to control the instance of ArcMap. Prior to ArcGIS 8.1, a new *FeatureLayer* object could only be created in the VB application's process space. In this case, the *FeatureLayer* would have to be remotely accessed by the ArcMap *Map* object, while the *Map* object itself would have to be remotely accessed by both the VB code in the separate executable as well as the *FeatureLayer* object.


Visual Basic application process space
ArcMap application process space
Feature layer object
Stub
Feature layer object proxy
VB code
Arc-Map code
Map Object proxy
Stub
Map Object

This case is actually even more complex due to numerous other support objects that are involved in the interactions between *Map* and *FeatureLayer* objects. For example, for ArcMap to draw all the features represented in the feature layer, each feature would have to be remotely accessed through automation, creating an enormous bottleneck and a corresponding performance disaster. Note in the diagram to the left how the *FeatureLayer* object and the *Map* object exist in separate process spaces, and so must communicate through proxies.

With the release of ArcGIS 8.1, it is possible to create the *FeatureLayer* object within ArcMap process space so that the interaction between these two objects is direct instead of through intra-application communication. Automation in still occurring in the sense that the VB code in


Visual Basic application process space
ArcMap application process space
VB code
Feature layer object proxy
Map Object proxy
Stub
Stub
Feature layer object
Map Object
Arc-Map code

the separate process is still calling remotely to these objects, which now exist in ArcMap's process, but these remote calls are minimal in number (setting a property or two, and so on). The numerous calls that normally occur as a result of drawing now occur solely within ArcMap. Note in the new diagram how both the *FeatureLayer* object and the *Map* object exist in ArcMap process space.

The following example demonstrates how a feature layer can be loaded into ArcMap from a standalone Visual Basic application using the *IObjectFactory* interface.

```
Private m_pMxApp As IApplication

Private Sub Form_Load()
  frmIObjectFactory.MousePointer = vbHourglass

  ' Create an out-of-process instance of ArcMap
  Dim pDoc As IDocument
  Set pDoc = New MxDocument

  ' Hold on to this instance of ArcMap in a global in case
  ' we need it later.
  Set m_pMxApp = pDoc.Parent

  frmIObjectFactory.MousePointer = vbNormal
End Sub

Private Sub Form_Unload(Cancel As Integer)
  m_pMxApp.Shutdown
End Sub

Private Sub Command1_Click()
  Dim pObjFactory As IObjectFactory
  Dim pWorkspaceFactory As IWorkspaceFactory
  Dim pFeatureWorkspace As IFeatureWorkspace
  Dim pFeatureLayer As IFeatureLayer
  Dim pMxDocument As IMxDocument
  Dim pMap As IMap

  ' Show ArcMap
  m_pMxApp.Visible = True

  ' Obtain the object factory interface from the app
  Set pObjFactory = m_pMxApp

  ' Create a shapefile feature layer and add it to ArcMap.
  ' Note that we will use ArcMap's generic object factory to ensure that
  ' these objects exist in ArcMap's process space.
  ' Equivalent of Set pWorkspaceFactory = New ShapefileWorkspaceFactory
  Set pWorkspaceFactory = _
     pObjFactory.Create("esriCore.ShapefileWorkspaceFactory")

  Set pFeatureWorkspace = _
    pWorkspaceFactory.OpenFromFile("D:\Samples\Data\Usa", 0)

  ' Equivalent of Set pFeatureLayer = New FeatureLayer
  Set pFeatureLayer = pObjFactory.Create("esriCore.FeatureLayer")

  Set pFeatureLayer.FeatureClass = _
    pFeatureWorkspace.OpenFeatureClass("States")
  pFeatureLayer.Name = pFeatureLayer.FeatureClass.AliasName

  'Add the FeatureLayer to the focus map
  Set pMxDocument = m_pMxApp.Document
  Set pMap = pMxDocument.FocusMap

  pMap.AddLayer pFeatureLayer
  pMxDocument.ActiveView.PartialRefresh esriViewGeography, Nothing, Nothing
End Sub
```

5

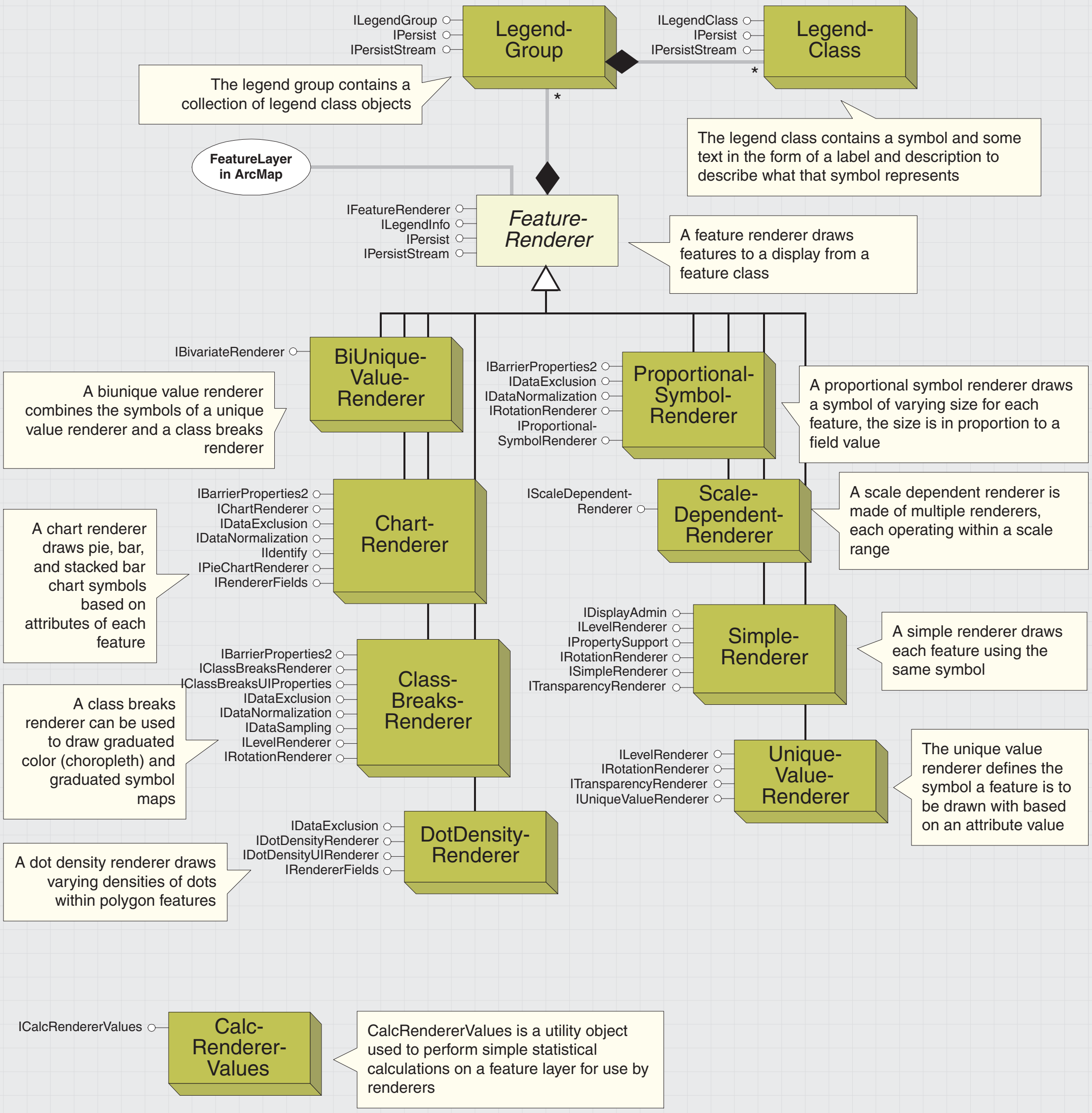
Displaying graphics

Shelly Gill, Scott Campbell, Chris Davies, Steve Van Esch, Jim Clarke, Cory Eicher

ArcMap employs a rich palette of display objects to realize strong user interaction and sophisticated cartographic presentation. These are the components in ArcObjects for customizing ArcMap, making superior maps, and building custom map-centric applications.

The topics covered in this chapter include: drawing layers with feature renderers • defining colors for display and printing • drawing point features with marker symbols • drawing linear features with line symbols • drawing areas with fill symbols • labeling features with text symbols • displaying numeric data with chart symbols • adorning frame elements with frame decorations • controlling the display output • grouping numeric values into classes • customizing user interaction with rubber band objects, selection trackers, and display feedbacks

Feature renderer objects



The legend group contains a collection of legend class objects

The legend class contains a symbol and some text in the form of a label and description to describe what that symbol represents

A feature renderer draws features to a display from a feature class

A biunique value renderer combines the symbols of a unique value renderer and a class breaks renderer

A proportional symbol renderer draws a symbol of varying size for each feature, the size is in proportion to a field value

A chart renderer draws pie, bar, and stacked bar chart symbols based on attributes of each feature

A scale dependent renderer is made of multiple renderers, each operating within a scale range

A simple renderer draws each feature using the same symbol

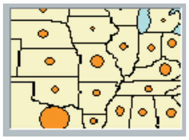
A class breaks renderer can be used to draw graduated color (choropleth) and graduated symbol maps

The unique value renderer defines the symbol a feature is to be drawn with based on an attribute value

A dot density renderer draws varying densities of dots within polygon features

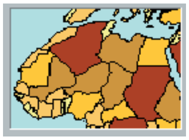
CalcRendererValues is a utility object used to perform simple statistical calculations on a feature layer for use by renderers

Drawing a map with a single symbol

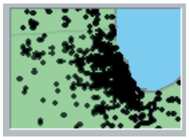


Drawing a map with proportional symbols

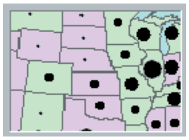
Drawing categories in a map with symbols



Drawing quantities in a map with symbols



Drawing value densities in a map with dots

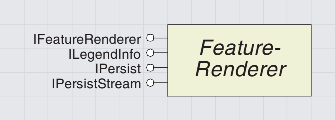


Drawing multiple categories in a map

Drawing a map with pie charts

A feature renderer is a method for drawing feature layers. The feature renderers use symbols and colors to visually display features, possibly based on one or more attributes. There is one feature renderer associated with each feature layer. The scale breaks and biunique value renderers also contain other renderers. You can choose a renderer to display features differently depending on attribute values in the fields of a feature class. The following are types of feature renderers:

- *SimpleRenderer* uses the same symbol for each feature.
- *ClassBreaksRenderer* allows classes of numeric attribute values to be defined. A different symbol is specified for each class. The symbols typically vary in either color or size. This renderer can be used for ordinal, interval, or ratio data.
- *UniqueValueRenderer* uses a different symbol for each unique attribute value. A value can come from a single field or a combination of more than one field. This is used for nominal data.
- *ProportionalSymbolRenderer* modifies the size of the symbol in proportion to an attribute from a field.
- *DotDensityRenderer* displays a scattering of marker symbols in polygon features, the density of which reflects the value of an attribute.
- *ChartRenderer* displays pie, bar, or stacked bar charts that are comprised from one or more attribute fields.
- *ScaleBreaksRenderer* switches renderers depending on the map viewing scale.
- *BiUniqueValueRenderer* combines a unique-value renderer with a class-breaks renderer (either graduated colors or graduated symbol type symbology). This allows multiple attributes to be reflected in one symbol.



The feature renderer determines how a feature class is drawn. A renderer object describes the process of matching features and attributes to symbols.

To get to a feature renderer object in ArcMap from a layer, *QI* to *IGeoFeatureLayer* and get the *Renderer* property. A simple renderer is the default renderer object when a new feature class is loaded.

```
' Check if the layer is a feature layer
If Not TypeOf pLayer Is IGeoFeatureLayer Then Exit Sub
Set pGeoFeatureLayer = pLayer

' Check if there is a simple renderer and get a reference to it
If Not TypeOf pGeoFeatureLayer.Renderer Is ISimpleRenderer Then Exit Sub
Set pSimpleRenderer = pGeoFeatureLayer.Renderer
```

All feature renderers implement the IFeatureRenderer *interface; it is used by the framework to draw features from a feature class.*

IFeatureRenderer : IUnknown	***Provides access to members that control functionality common to all feature renderers.***
ExclusionSet: IFeatureIDSet	*Sets an object reference to a temporary drawing exclusion set.*
RenderPhase (in drawPhase: tagesriDrawPhase) : Boolean	*Indicates if renderer uses the specified draw phase.*
SymbolByFeature (in Feature: IFeature) : ISymbol	*Symbol used to draw the specified feature.*
CanRender (in featClass: IFeatureClass, in Display: IDisplay) : Boolean	*Indicates if the specified feature class can be rendered on the given display.*
Draw (in Cursor: IFeatureCursor, in drawPhase: tagesriDrawPhase, in Display: IDisplay, in trackCancel: ITrackCancel)	*Draws features from the specified cursor on the given display.*
PrepareFilter (in fc: IFeatureClass, in QueryFilter: IQueryFilter)	*Prepares the query filter for the rendering process.*

The *ExclusionSet* is a list of feature IDs to be excluded from a drawing.

The *PrepareFilter* is called prior to the *Draw* method and gives the renderer a chance to adjust the query filter to incorporate extra constraints. For example, if a particular field is required for the renderer, it would add this field to the filter to ensure it is accessible during a draw.

The default implementation of a feature takes the symbol supplied by the renderer and uses this to draw the feature. However, if this feature is a custom feature, the developer may have chosen to ignore the supplied symbol and used the custom feature's own symbology.

The *Draw* method is typically called by the framework to renderer features to a display. This could be in response to a *Refresh* on the *Map*. The *Draw* method will iterate through all the features and render each feature with an appropriate symbol. The actual draw of the feature is normally performed by calling the *Draw* method on the feature's *IFeatureDraw* interface; it simply uses the symbol created by the renderer.

To allow complex rendering to be canceled halfway through a draw, the renderer will typically check the *TrackCancel* object after each feature. If a cancel action has occurred, the renderer will exit.

SymbolByFeature is called to return the symbol corresponding to a feature. This is used to turn features into graphics.

If the renderer is not applicable to a feature layer, then it can return *False* in response to a *CanRender* method. For example, the dot-density renderer is only applicable to polygon feature layers and returns *False* in response to other feature layers. Similarly, if the renderer is not applicable to a particular draw phase, this can be indicated by returning *False* to the *RenderPhase* property. Typically, all renderers draw in the geography phase.

There are two drawing phases: annotation and geography. For example, consider a proportional renderer for drawing a polygon layer. The proportional renderer draws the polygons with a fill symbol in the geography drawing phase and the proportional symbol in the annotation drawing phase. The renderer indicates in the RenderPhase *method that it wants to draw both phases. Subsequently, the* Draw *method gets called twice.*

For more discussion on drawing phases, refer to the topic 'Refreshing a map versus partial refresh' in Chapter 4.

Remember that after changing symbology for a layer to update the display for that layer with code like this:

```
Dim pDoc As IMxDocument
pDoc.ActiveView.PartialRefresh esriDPGeography, pLayer, Nothing
```

Additionally, the table of contents needs to be updated, too.

```
pDoc.UpdateContents
```

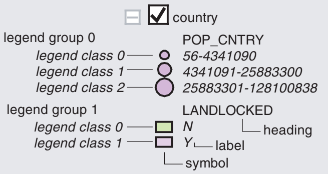
After you have set up a new renderer object and assigned it to a feature layer, you will need to associate the correct property page (Layer properties/ Symbology in ArcMap) with the renderer. The *IGeoFeatureLayer::-RendererPropertyPageClassID* property needs to be initialized to the GUID of the appropriate property page.

One way to do this is to use the *UID* object and give it the GUID of the property page. The ProgID is not used because it is not guaranteed to be unique.

```
Dim pUID As New UID ' Create a new UID object
'ProgID is "esricore.BarChartPropertyPage"
pUID.Value = "{98DD7040-FEB4-11D3-9F7C-00C04F6BC709}"
pGeofeaturelayer.RendererPropertyPageClassID = pUID
```

ILegendInfo : IUnknown	*Provides access to members that control legend information provided by a renderer.*
LegendGroup (Index: Long) : ILegendGroup	*Number of legend groups contained by the object.*
LegendGroupCount: Long	*Number of legend groups contained by the object.*
LegendItem: ILegendItem	*Optional. Defines legend formatting for layer rendered with this object.*
SymbolsAreGraduated: Boolean	*Indicates if symbols are graduated.*

Example of legend groups and classes for a bi-unique value renderer



The ILegendInfo *interface is used by the ArcMap framework to generate the symbols and labels for each layer shown in the table of contents and the* Legend *object.*

The *ILegendInfo* interface is implemented by several layer types: feature, raster, and TIN. Although the feature layer object implements this interface, it just defers all methods and properties to the feature renderer's *ILegendInfo* interface.

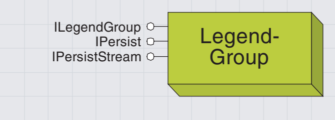
Legend and other related objects such as *LegendItem* and *LegendFormat* are discussed in Chapter 4, 'Composing maps'.

The *ILegendInfo* interface has a property array of *LegendGroup* objects. The number of groups is determined by the implementation of the renderer. Consequently, these properties are read-only. For example, the simple renderer always has one group, but the biunique renderer can have any number of groups.

The simple, class breaks, and unique value renderers will update the legend class objects for you when you set the renderer's symbols. In fact, these renderers store their symbols there. However, with the proportional-symbol, chart, dot-density, and biunique renderers, you must call *CreateLegend* for the legend class objects to be set up and placed into appropriate groups.

The property *SymbolsAreGraduated* indicates whether the symbols used for the legend of this particular renderer vary by size. For example, the proportional-symbol renderer will return *True* for this property.

A renderer can override the legend appearance of a layer's legend by returning an *ILegendItem*.



A legend group represents a collection of related symbols stored in legend classes.

Typically, all the symbols used in a group are of the same type. For example, a chart renderer that is being used to create pie charts has two groups—the first contains a single pie chart symbol, the second group contains fill symbols for each slice of the pie chart.

The *LegendGroup* object contains a collection of *LegendClass* objects.

ILegendGroup : IUnknown	Provides access to members that control the collection of legend classes provided by a renderer.
Class (in Index: Long) : ILegendClass	Legend class at the specified index.
ClassCount: Long	Number of legend classes in the group.
Editable: Boolean	Indicates if the group can be edited. Default is editable.
Heading: String	String heading.
Visible: Boolean	Indicates if the group is displayed.
AddClass (in LegendClass: ILegendClass)	Adds a new legend class to the group at the end of list.
ClearClasses	Removes all classes from the group.
InsertClass (in Index: Long, in LegendClass: ILegendClass)	Inserts a new legend class into the group at the specified index.
RemoveClass (in Index: Long)	Removes the legend class from the group at the specified index.

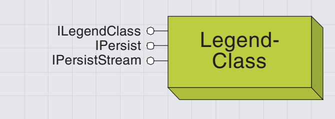
The *ILegendGroup* interface manages a property array of *LegendClass* objects. Inside a *LegendClass* object is one *Symbol* object. Classes can be looked up, but modifying the number of classes through addition, insertion, and deletion is the job of the renderer object. Some properties of the legend group can be retrieved.

The *Editable* property returns whether the symbols and text strings in the *LegendClass* objects of the group can be edited individually. You can see this in ArcMap by double-clicking the symbol in the table of contents. If the Symbol Properties dialog box appears, then the group has *Editable* set to *True*.

For example, a pie chart symbol in a group by itself returns *False*, and its symbol can't be edited. However, the fill symbols for each pie slice (this is in a second group) has *Editable* set to *True*, the fill symbol can be changed, and this is picked up by the renderer for all pie charts.

The *Visible* property controls if the group can be seen. Typically, this is in the table of contents. For example, setting *Visible* to *False* for all the legend groups of a layer will collapse and hide the symbols for a layer in the table of contents.

The *Heading* property of a group is a piece of text to describe what the group represents. For example, the field name is used when using the unique-value renderer.



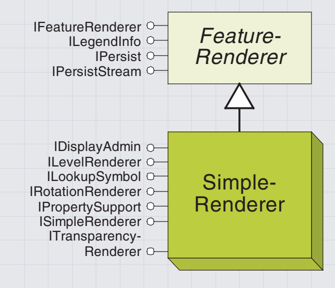
A legend class stores a symbol and text pair that is used in making legends.

There are many *LegendClass* objects in a *LegendGroup*. The legend class contains a symbol and some text in the form of a *Label* and *Description* to describe what that symbol represents. If the legend group is editable, then the symbol can be modified and the renderer will pick this up at the next draw phase.

However, the typical route for modifying renderer appearance is to go to the renderer objects themselves. For example, to change the simple renderer symbol, label and description fields, use the methods and properties of *ISimpleRenderer* in preference to the legend class object.

ILegendClass : IUnknown	Provides access to members that control the legend/TOC entry for a renderer class.
■—■ Description: String	Legend class description.
■—■ Format: ILegendClassFormat	Optional. If non-null, then layer specifies class formatting information.
■—■ Label: String	Legend class label.
■—□ Symbol: ISymbol	Legend class symbol.

Setting the *Format* property allows the appearance of the symbol to override the settings of the legend object.



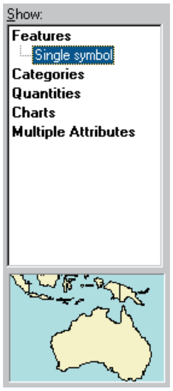
SimpleRenderer *draws each feature using a single symbol.*

The *SimpleRenderer* coclass draws each feature using a single symbol.

The symbol typically matches the geometry of the layer so that fill symbols are used for drawing polygons, line symbols for drawing lines, and marker symbols for drawing points. One exception is that a marker symbol can also be used with a polygon layer—this will draw a marker at the center of the polygon.

A symbol can also be rotated if it is a marker symbol (*IRotationRenderer*) or made transparent (*ITransparencyRenderer*) if it is a fill symbol. The amount of transparency or rotation is specified by attribute values associated with each feature.

ISimpleRenderer : IUnknown	*Provides access to members that control a renderer which draws the same symbol for each feature.*
Description: String	*Renderer description.*
Label: String	*Renderer label.*
Symbol: ISymbol	*Symbol used to draw each feature.*



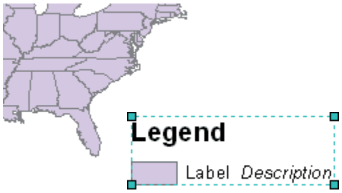
In the Layer Properties/Symbology/Show list in ArcMap, the simple renderer corresponds to SingleSymbol under the type of Features.

By getting or setting the symbol property of *ISimpleRenderer*, the symbology of the whole layer can be changed. The label property states what that symbol means. For example, a black circular marker symbol represents “Cities”. The description property provides further explanatory text. The symbol, label, and description can all appear and be arranged in a legend.

The simple renderer symbol is also accessible in the legend. It is the only symbol in the first legend class.

Here is an example VBA script to change the fill symbol of a simple renderer. (For code samples to get and refresh a simple renderer, see the documentation for the *FeatureRenderer* abstract class.)

```
'Set the color of Lilac
Set pColor = New RgbColor
pColor.Red = 235
pColor.Green = 202
pColor.Blue = 250

Set pFillSymbol = New SimpleFillSymbol
pFillSymbol.Color = pColor

Set pSimpleRenderer.Symbol = pFillSymbol
pSimpleRenderer.Label = "Label"
pSimpleRenderer.Description = "Description"
```



A map drawn with the simple renderer and its legend.

IDisplayAdmin : IUnknown	*Provides access to members that control display administration.*
UsesFilter: Boolean	*Indicates if the current object draws using a filter.*

The *IDisplayAdmin* interface is called by the framework to determine if the renderer is using a display filter. For the simple renderer, this will return *True* if a transparency field has been specified.

ILevelRenderer : IUnknown	Provides access to members that control the drawing of symbols for features, where symbols are separated into levels, and each level drawn separately.
CurrentDrawLevel: Long	The current draw level, (set to -1 to draw all levels).
LevelArray (out levels: Variant)	Array that contains all levels used by the symbols, (symbols without a level get a level of 0).

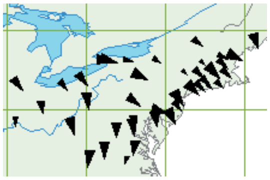
The *ILevelRenderer* interface draws symbols on different levels. The renderers that support *ILevelRenderer* are *ClassBreaksRenderer*, *SimpleRenderer* coclass, and *UniqueValueRenderer*.

For more information on multilevel symbols, refer to the discussion on the IMapLevel *interface under the* Symbol *abstract class documented later in this chapter.*

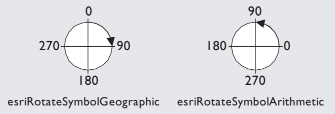
This interface is used by the framework to draw multilevel symbols. This only happens if the property *IMap::UseSymbolLevels* is true. Multilevel symbols are enabled through the Advance Drawing Options dialog box on the data frame in ArcMap. This dialog box is also accessible through the *SymbolLevelDialog* object.

The *LevelArray* property returns an array of long integers listing all the levels of the symbols used by the render. The framework will iterate through all the available levels across all feature layers, thus ensuring that symbols of the same level will appear to join or merge.

The *CurrentDrawLevel* is set by the framework at draw time to specify which level of symbols the renderer is to draw.



The rotation renderer is very effective for displaying maps of wind direction. If combined with a proportional symbol renderer and arrow markers, locations of wind direction and magnitude can be clearly mapped.



IRotationRenderer: IUnknown	Provides access to members that control the drawing of rotated marker symbols based on field values.
RotationField: String	Rotation field.
RotationType: esriSymbolRotationType	Rotation type.

The *IRotationRenderer* interface can be used in a renderer when applying marker symbols. The amount of rotation can be specified using an attribute field in the feature class specified with the *RotationField* property. The value in the attribute field should be in degrees and in the direction set by the *RotationType* property.

For an example of applying *IRotationRenderer* to making maps of wind direction, look in the ArcObjects Developer Help under ArcMap/Symbology/Renderers.

Enumeration esriSymbolRotationType	Marker symbol rotation options.
0 - esriRotateSymbolGeographic	Clockwise rotation with 0 at the positive y-axis.
1 - esriRotateSymbolArithmetic	Counter clockwise rotation with 0 at the positive x-axis.

The *esriSymbolRotationType* enumeration defines which one of two conventions for rotation angles is used.

The renderers that support *IRotationRenderer* are *ProportionalSymbolRenderer*, *ClassBreaksRenderer*, *UniqueValueRenderer*, and *SimpleRenderer* coclass.

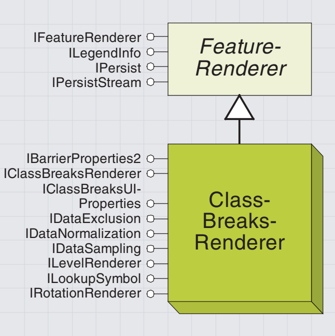
IPropertySupport : IUnknown	Provides access to members that set a default property on an object.
■— Current (in pUnk: IUnknown Pointer) : IUnknown Pointer	*The object currently being used.*
← Applies (in pUnk: IUnknown Pointer) : Boolean	*Indicates if the receiver can apply the given object at any given time.*
← Apply (in NewObject: IUnknown Pointer) : IUnknown Pointer	*Applies the given property to the receiver and returns the old object.*
← CanApply (in pUnk: IUnknown Pointer) : Boolean	*Indicates if the receiver can apply the given object at that particular moment.*

IPropertySupport is a generic interface implemented by most graphic elements and a few other objects. *IPropertySupport* is used for updating generic properties of an object. Through *IPropertySupport,* you can ask an object if another object, such as a color object, applies to it. If the object does apply, you can apply a new object of that type or ask for the current object.

ITransparencyRenderer : IUnknown	Provides access to members that control the drawing of features with varying transparency, where transparency is determined by feature values.
■—■ TransparencyField: String	*Transparency field.*

The *ITransparencyRenderer* interface is only used on layers that are based on polygon feature classes. The values in the *TransparencyField* modify the fill symbols (if they are of type *ISimpleFillSymbol*) such that the transparency of each symbol used to render each feature corresponds with the value in the field. The field values should range from 0 to 100. An attribute value of 100 is opaque, and a value of 0 is invisible.

If a transparency field is specified, the simple renderer will use the aggregated *TransparencyDisplayFilter* object to perform the changes to the display to achieve the transparency effect.

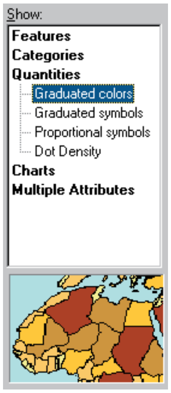


Use the class-breaks renderer to display data based on an attribute with values that represent ordinal, interval, or ratio data.

The *ClassBreaksRenderer* object can be set to break up one field of numeric data into arbitrary classes—for example, to separate population values into three classes of low, medium, and high. Classes are defined by specifying the break values between the classes; you can set these to be any values you like. However, you can use the *Classify* and *TableHistogram* objects to help calculate some useful breaks, such as “equal intervals”.

A symbol is associated with each class, and this is used to draw features. For example, with a polygon feature class, a yellow fill symbol can represent low population, orange fill can represent medium, and red fill can represent high. The *ClassBreaksRenderer* works well with other feature types, too. For example, a line feature class representing roads with associated numeric values for traffic density can be rendered using different colors for high, medium, and low traffic. Cities, represented as points, could be classified with a range of circular marker symbols with different sizes and colors reflecting population.

IClassBreaksRenderer : IUnknown	***Provides access to members that control a renderer which is used to draw graduated color (choropleth) and graduated symbol maps.***
BackgroundSymbol: IFillSymbol	*Background fill symbol used when graduated marker symbols are draw on polygon features.*
Break (in Index: Long) : Double	*Break value at the specified index. Break(0) is the lowest break and represents the upper bound of the lowest class.*
BreakCount: Long	*Number of class breaks (equal to the number of classes).*
Description (in Index: Long) : String	*Description at the specified index.*
Field: String	*Classification field.*
Label (in Index: Long) : String	*Label at the specified index.*
MinimumBreak: Double	*Minimum break, i.e. the lower bound of the first class.*
NormField: String	*Normalization field.*
SortClassesAscending: Boolean	*Indicates if classes are displayed in increasing order in legends/TOC.*
Symbol (in Index: Long) : ISymbol	*Symbol at the specified index (used to draw features in the specified class).*



The class-breaks renderer corresponds to GraduatedValues under the type of Quantities.

The *Field* property specifies to which field in the feature class the class breaks apply. This field must be numeric.

To initialize some breaks, you just need to know how many breaks to set. This is set in *BreakCount* and corresponds to the number of classes. Once the *BreakCount* is set, the breaks, description, label, and symbol properties are initialized with the first index of 0 and the last index of *BreakCount* -1. Increasing *BreakCount* preserves existing breaks, but decreasing *BreakCount* removes excess break values.

```
Dim pClassBreaksRenderer As IClassBreaksRenderer
Set pClassBreaksRenderer = New ClassBreaksRenderer
pClassBreaksRenderer.Field = "POP1997"
pClassBreaksRenderer.BreakCount = 3
```

Before setting break values it is important to determine some characteristics of the data. If the field values have predefined intervals and related symbols, then these can be set without inspecting the data. For example, a temperature classification from freezing to boiling could be set up with breaks every 10 degrees Celsius.

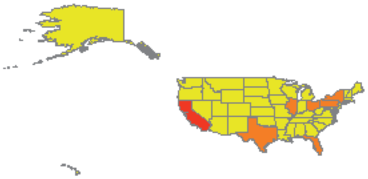
If the classes are relative to the data (for example, classifying the data into equal intervals), then the data must be inspected to determine the classes. This could be done by iterating through the dataset and keeping a tally of the values found so far. Alternatively, the *TableHistogram* object can be used to extract data values and frequencies. These can then be passed to a *Classify* object to determine the breaks. These breaks may then be retrieved and set into the *ClassBreaksRenderer* object.

The lowest value in the dataset is specified via the *MinimumBreak* property. Values less than this will be considered outside the lowest class. Typically, this is set to the minimum data value. The value in *Break(0)* represents the upper value in the lowest class, and the break value is included. The highest value class is bounded by, and includes, the last break (*breakCount*-1). This is typically set to the maximum value.

Symbols are initialized and placed in indices corresponding to the breaks using the symbol property array. Consequently, the lowest class bounded by *Break(0)* will be depicted using *Symbol(0)*. Data values that are left out of the class breaks are drawn using the *BackgroundFill* symbol. The *BackgroundFill* symbol is also used to fill the polygon if the polygons are drawn with marker symbols.

The code below illustrates the setting up of three class breaks. The *maximumPopulation* variable has been previously calculated, and the function *GetRGBColor* is not shown, but it is used to return a color object with the supplied red, green, and blue values.

```
pClassBreaksRenderer.MinimumBreak = 0

' Low population class in yellow
Set pFillSymbol = New SimpleFillSymbol
pFillSymbol.Color = GetRGBColor(245, 245, 0)
pClassBreaksRenderer.Symbol(0) = pFillSymbol
pClassBreaksRenderer.Break(0) = maximumPopulation / 3
pClassBreaksRenderer.Label(0) = "Low"

' Medium population class in orange
Set pFillSymbol = New SimpleFillSymbol
pFillSymbol.Color = GetRGBColor(245, 122, 0)
pClassBreaksRenderer.Symbol(1) = pFillSymbol
pClassBreaksRenderer.Break(1) = maximumPopulation * (2 / 3)
pClassBreaksRenderer.Label(1) = "Medium"

' High population in red
Set pFillSymbol = New SimpleFillSymbol
pFillSymbol.Color = GetRGBColor(245, 0, 0)
pClassBreaksRenderer.Symbol(2) = pFillSymbol
pClassBreaksRenderer.Break(2) = maximumPopulation
pClassBreaksRenderer.Label(2) = "High"
```



Break index	Break value	Corresponding Class	Fill symbol color
Break(2)	32,197,302		
		High (California)	🟥
Break(1)	21,026,670		
		Medium (Texas and five others)	🟧
Break(0)	11,066,153		
		Low (all other states, Wyoming at minimum)	🟨
Minimum break	484,520		

The *Label* and *Description* fields are used to associate text with each class. These are used by the table of contents and map legends.

If *SortClassesAscending* is set to *False* (its default is *True*) the symbols used to draw the features are reversed in order. In the previous example, low population would be drawn in red.

The *NormField* allows a field to be specified to divide into the field specified for classification. Setting this property is the same as setting *IDataNormalization::NormalizationType* = *esriNormalizeByField* and setting *IDataNormalization::NormalizationField* equal to the field name.

IDataNormalization : IUnknown	Provides access to members that control the data normalization properties of a renderer.
NormalizationField: String	Normalization field.
NormalizationFieldAlias: String	Normalization field alias.
NormalizationTotal: Double	Total of all values (used when normalizing by percent of total).
NormalizationType: esriDataNormalization	Normalization type.

The *IDataNormalization* interface is used to map ratio data. This is used if you want to minimize differences based on the size of areas or numbers of features in each area. Ratios are created by dividing two data values; this is referred to as *normalizing* the data. For example, dividing the 18- to 30-year-old population by the total population yields the ratio of people aged 18 to 30. Similarly, dividing a value by the area of the feature yields a value-per-unit area, or density.

You can normalize your data in several ways by applying one of the following *esriDataNormalization* constants to the *NormalizationType* property.

Enumeration esriDataNormalization	Data normalization type.
0 - esriNormalizeByField	Normalize by field.
1 - esriNormalizeByLog	Normalize by Log.
2 - esriNormalizeByPercentOfTotal	Normalize by percent of total.
3 - esriNormalizeByArea	Normalize by area.
4 - esriNormalizeByNothing	Do not Normalize.

esriNormalizeByField requires the *NormalizationField* property to be set to a valid field name. This field is then divided into the data value.

esriNormalizeByLog will take a base 10 logarithm of the data values.

esriNormalizeByPercentageOfTotal requires the *NormalizationTotal* field to be set to the total data value. This is used to calculate percentage values by dividing the total into each data value and multiplying by 100.

esriNormalizeByArea is not implemented.

IDataExclusion: IUnknown	Provides access to members that control the exclusion of data values from a renderer.
■—■ ExclusionClause: String	Data exclusion where clause.
■—■ ExclusionDescription: String	Description for the excluded data.
■—■ ExclusionLabel: String	Label for the excluded data.
■—■ ExclusionSymbol: ISymbol	Symbol used to draw excluded values.
■—■ ShowExclusionClass: Boolean	Indicates if the exclusion symbol is used.

The *IDataExclusion* interface is implemented by *ChartRenderer, ClassBreaksRenderer, DotDensityRenderer,* and *ProportionalSymbolRenderer.*

This interface can be used to eliminate features from the renderer. These features may have erroneous attributes associated with them. An SQL expression set to the property *ExclusionClause* identifies these values—be careful to ensure the SQL syntax is valid, otherwise no features will be drawn.

Values that are excluded can optionally be symbolized with the symbol in *exclusionSymbol.* If this is not set, the feature will not be drawn.

If *ShowExclusionClass* is set to *False,* then excluded features will not be drawn with the *ExclusionSymbol.* This property controls the display of the map and the legend.

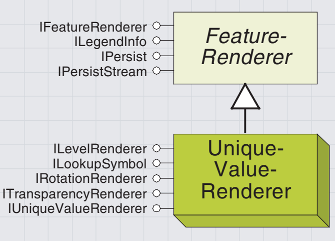
IClassBreaksUIProperties: IUnknown	Provides access to members that control some user interface properties of a ClassBreaksRenderer. The properties set through this interface do NOT affect what is drawn on the map.
■—■ ColorRamp: String	File and path name of the color ramp.
■—■ DeviationInterval: Double	Deviation interval (0-1), where 0 means that no deviation is used.
■—■ LowBreak (in Index: Long) : Double	Lower bound of the class at the specified index.
■—□ Method: IUID	Classification method.
■—□ NumberFormat: INumberFormat	Number format for class labels.
■—■ ShowClassGaps: Boolean	Indicates if each lower bound is adjusted up to the nearest existing data value.

The *IClassBreaksUIProperties* interface is used by the Layer/Properties/Symbology dialog box to store additional values reflecting what the user has chosen in the dialog box. The properties of this interface are not parameters to rendering features. Keeping these values up-to-date helps keep the standard ArcMap dialog boxes consistent with the current settings. For example, when you set values into the LowBreak property, they will appear in the Range column of the classes.

IDataSampling: IUnknown	Provides access to members that control the data sampling properties of a renderer.
■—■ MaxSampleSize: Long	Maximum sample size.
■—■ SamplingMethod: esriDataSampling	Data sampling method.

The *IDataSampling* interface is similarly used by the Layer/Properties/Symbology dialog box to reflect values the user has chosen. If you programmatically update corresponding values in ArcObjects, update the values in this interface to keep the dialog box in synch with your application.

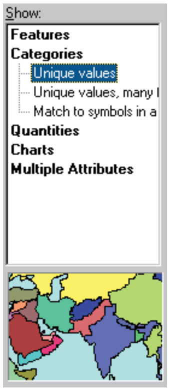
For documentation on the *IRotationRenderer* interface, see the previous topic on *SimpleRenderer.*



UniqueValueRenderer is a way to symbolize the features of a layer based on the unique values of one or more attributes.

Use the *UniqueValueRenderer* to display data that falls into distinct categories based on attribute values. If you have parcel data with land use types of residential, agriculture, and retail, you can use a different symbol to represent each unique land use type.

More than one category can be combined to give unique values. This is useful for differentiating features that are ambiguous in the individual categories but unique in their combination. When more than one attribute is specified, the combinations of unique values are used. Combinations of fields can be depicted, such as A|X, A|Y, A|Z, B|X, B|Y, B|Z, where | is a field delimiter.


Show:
Features
Categories
Unique values
Unique values, many f
Match to symbols in a
Quantities
Charts
Multiple Attributes

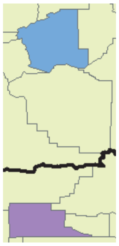
In the Layer Properties/Symbology/Show list in ArcMap, the unique-value renderer corresponds to Unique Values under the type of Categories.

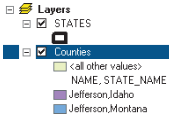
IUniqueValueRenderer : IUnknown	*Provides access to members that control a renderer where symbols are assigned to features based on unique attribute values.*
ColorScheme: String	*Color scheme (user interface property only).*
DefaultLabel: String	*Label used for unspecified values.*
DefaultSymbol: ISymbol	*Symbol used to draw any unspecified values (may be NULL).*
Description (in Value: String) : String	*Desription for the specified label.*
Field (in Index: Long) : String	*Field at the specified index that is used to categorize features.*
FieldCount: Long	*Number of fields used by the renderer (0-3).*
FieldDelimiter: String	*Delimiter used to separate field values.*
FieldType (in Index: Long) : Boolean	*Indicates if the field at the specified index is a string.*
Heading (in Value: String) : String	*Heading that contains the specified value.*
Label (in Value: String) : String	*Label for the specified value.*
LookupStyleset: String	*Style used for matching (user interface property only).*
ReferenceValue (in Value: String) : String	*Reference value for the specified value.*
Symbol (in Value: String) : ISymbol	*Symbol associated with the specified value.*
UseDefaultSymbol: Boolean	*Indicates if DefaultSymbol is used for drawing unspecified values.*
Value (in Index: Long) : String	*Value at the specified index.*
ValueCount: Long	*Number of unique values used to categorize the data.*
AddReferenceValue (in Value: String, in refValue: String)	*Adds a value to the renderer to be grouped with refValue, which has already been added to the renderer.*
AddValue (in Value: String, Heading: String, in Symbol: ISymbol)	*Adds a value and corresponding symbol to the list. For multivariate cases, the specified value is a delimitted list of individual values.*
RemoveAllValues	*Removes all values from the renderer.*
RemoveValue (in Value: String)	*Removes a value from the renderer.*

Use the *IUniqueValueRenderer* interface to specify the fields and then your unique values and corresponding symbols. Typically, you would specify one field as shown in this VBA code.

```
pUniqueValueRenderer.FieldCount = 1
pUniqueValueRenderer.Field(0) = "NAME"
```

You may also specify additional fields, which is valuable when a feature is ambiguous in the categories of the first field. For example, in the United States there are many counties in each state, and the county names are ambiguous to the United States as a whole. There are 26 counties called "Jefferson", and these would all get the same symbol unless they were distinguished by state name.

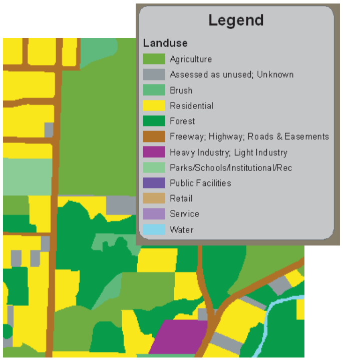



Layers
☑ STATES
☑ Counties
<all other values>
NAME, STATE_NAME
Jefferson,Idaho
Jefferson,Montana

These two bitmaps show a map of two of the "Jefferson" counties distinguished by state name and the table of contents.

```
pUniqueValueRenderer.FieldCount = 2
pUniqueValueRenderer.Field(0) = "NAME"
pUniqueValueRenderer.Field(1) = "STATE_NAME"
pUniqueValueRenderer.FieldDelimiter = ","
```

Having set up the fields, the next step is to populate the unique values. The *AddValue* method creates a new value with a corresponding symbol and heading in the renderer object. You can retrieve and change the symbol at a later date by using the value as a lookup parameter to the *Symbol* property array.


Legend
Landuse
Agriculture
Assessed as unused; Unknown
Brush
Residential
Forest
Freeway; Highway; Roads & Easements
Heavy Industry; Light Industry
Parks/Schools/Institutional/Rec
Public Facilities
Retail
Service
Water

Sample ArcMap display of the UniqueValueRenderer

This also applies to the legend texts specified through the lookup parameter of *Label, Heading,* and *Description* property arrays. If a *Label* is not supplied, then it defaults to the same text as the value parameter. *Heading* defaults to the field name. The *Description* property is empty by default.

If a value and a new symbol are passed into *AddValue* and the value already exists in the renderer, then the symbol is replaced with the new symbol. The *ValueCount* property returns the number of unique values set up so far. The *Value* property array can be used to iterate through the existing values; the maximum index is *ValueCount* -1.

If multiple fields are involved, then the unique value must contain the two attribute values separated by the string specified in the *FieldDelimiter* property. This is typically set to a character that does not occur in the attribute string, for example, a comma.

```
pUniqueValueRenderer.AddValue "Jefferson,Montana", "", pSym1
pUniqueValueRenderer.AddValue "Jefferson,Idaho", "", pSym2
```

Values that have not been added to the renderer object can be drawn according to the symbol set in the *DefaultSymbol* property; remember to set the *UseDefaultSymbol* property to *True* first. The label for the default symbol is set in the *DefaultLabel* property.

If you would like two or more values to be in the same category and drawn with the same symbol, you can call the *AddReferenceValue* method, passing in the new value as the first parameter and an existing *refValue* as the second parameter. This will create a new unique value, but this value will not directly have an associated symbol—the symbol of the *refValue* is used to render the feature.

For example, the code below "Freeway" will be drawn using the symbol *pSymbol*. "Highway" is added as a reference to "Freeway" and will be drawn using the same symbol. Note that you cannot retrieve a symbol using *Symbol("Highway")* property—this will result in a VBA error exception. You can retrieve the reference value using the *ReferenceValue("Highway")* property. In this case, "Freeway" will be returned.

```
pUniqueValueRenderer.FieldCount = 1
pUniqueValueRenderer.Field(0) = "DESC"
pUniqueValueRenderer.AddValue "Freeway", "", pSymbol
pUniqueValueRenderer.AddReferenceValue "Highway", "Freeway"
```

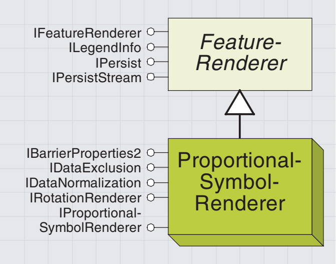
The code snippets shown above put the values directly into *UniqueValueRenderer*. However, it is more likely you will scan the feature class for values and put them into the renderer object. Symbol colors to match the values can also be generated by iterating through a color ramp object. The VBA code below illustrates this loop.

pNextRow *is a cursor to the current row.* fieldNumber *is the index of the field you are collecting values from.* pEnumRamp *enumerates colors from a color ramp object.* codeValue *is a string to hold the value read from the feature class.*

It is also possible to use the IDataStatistics::UniqueValues *method on the* DataStatistics *object to gather all the unique values in memory and then iterate through them.*

```
Do While Not pNextRow Is Nothing
  Set pNextRowBuffer = pNextRow  'Get a value
  codeValue = pNextRowBuffer.Value(fieldNumber)
  Set pNextUniqueColor = pEnumRamp.Next 'Get a color
  If pNextUniqueColor Is Nothing Then 'Reset the ramp if  out of colors
```

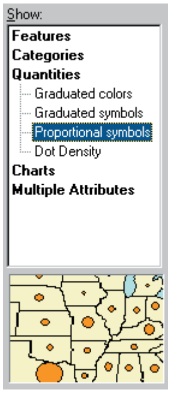
```
   pEnumRamp.Reset
   Set pNextUniqueColor = pEnumRamp.Next
  End If
 Set pSym = New SimpleFillSymbol 'Set the symbol to the new Color
 pSym.Color = pNextUniqueColor
 pUniqueValueRenderer.AddValue codeValue, "", pSym ' Add value and symbol
 Set pNextRow = pCursor.NextRow ' Advance to the next row
Loop
```



The proportional-symbol renderer draws symbols of varying size for each feature. The size is in proportion to a field value.

You can use the *ProportionalSymbolRenderer* to represent data values more precisely; the size of a proportional symbol reflects the actual data value.

IProportionalSymbolRenderer : IUnknown	*Provides access to members that control the drawing of varying size symbols for each feature, each sized in proportion to a field value.*
BackgroundSymbol: IFillSymbol	*Background fill symbol used when proportional marker symbols are draw on polygon features.*
Field: String	*Value field.*
FlanneryCompensation: Boolean	*Indicates if Flannery Compensation is applied.*
LegendSymbolCount: Long	*Number of symbols displayed in the TOC and legend.*
MaxDataValue: Double	*Normalized maximum data value.*
MinDataValue: Double	*Normalized minimum data value.*
MinSymbol: ISymbol	*Symbol used to draw feature with the normalized minimum data value.*
NormField: String	*Normalization field.*
ValueRepresentation: esriValueRepresentations	*Representation type of the value field.*
ValueUnit: esriUnits	*Units of the value field.*
CreateLegendSymbols	*Creates the legend. Call after all properties have been set.*


Show:
Features
Categories
Quantities
Graduated colors
Graduated symbols
Proportional symbols
Dot Density
Charts
Multiple Attributes

In the Layer Properties/Symbology/Show list in ArcMap, the proportional-symbol renderer corresponds to Proportional symbol under the type of Categories.

The symbol used to display the data is set with the property *MinSymbol*. This can be a marker or line symbol. Marker symbols can be used with polygon features. In this case, they are placed at the center of the polygon. An additional *BackgroundSymbol* property can also be specified to fill the polygons.

The *Field* property specifies the name of a numeric field; this is used to calculate each symbol's size on the map.

The *ValueUnit* specifies what distance units the data in the field represents (feet, meters, or other), or, for units that are not a distance (population counts, velocity, or other), this should be set to *esriUnknownUnits*.

If the *ValueUnit* is a distance, then the proportional-symbol renderer can take these values and change the size of the symbol supplied in *MinSymbol* to reflect this. There is no need to set the *MinDataValue* in this case. However, you should set the *ValueRepresentation* to specify how the symbol relates to the measurement. Marker symbols can be proportional by radius or area, whereas lines can be proportional by width or distance from the center line (half the width). Additionally, marker symbols should be circular or square for the radius and area settings to apply. If the *ValueRepresentation* is *esriValueRepUnknown*, then the symbol is proportional by width in both marker and lines.

An example of using the proportional-value renderer is where you have map tree locations as points and an attribute reflecting the radius of the tree canopy. By using proportional circles, the trees can be depicted by circles reflecting the actual ground covered by the tree.

Another application is a population map; the area of a circular marker can directly relate to the population value. Proportional symbols also apply well to line symbology; a river could be symbolized with a network of lines with different widths reflecting the river flow.

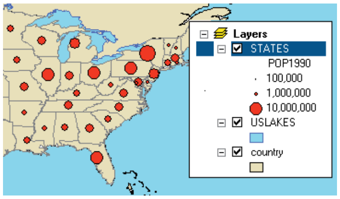
Enumeration esriValueRepresentations	*Value representation type.*
0 - esriValueRepUnknown	*Value represents Unknown.*
1 - esriValueRepRadius	*Value represents Radius.*
2 - esriValueRepArea	*Value represents Area.*
3 - esriValueRepDistance	*Value represents Distance from Center.*
4 - esriValueRepWidth	*Value represents Width.*

These are the values that can be set in the *ValueRepresentation* property.

If the *ValueUnit* is not known, then the proportional-symbol renderer must calculate an accurate scale for the symbols. In this case, the *MinDataValue* property must be set to the data value that relates to the size of the symbol set in *MinSymbol*. The symbols increase in proportion to the data values, with marker symbols increasing by the area and lines by width. So a value that is twice as big as the *MinDataValue* will have a marker twice the area of the smallest marker. In this case, the area is computed as if the marker was a square. With line symbols, a value that is twice the smallest value will have a line symbol twice as wide.

For marker symbols with unknown units, an appearance compensation can be specified. This will increase the marker size and is enabled by setting the *FlanneryCompensation* to *True*; this increase is an empirically derived result.

Similar to the class breaks renderer, you can specify a normalization field through the *NormField* property. This is exactly the same as setting the field in the *IDataNormalization::NormalizationField* property. Data is normalized before any calculations to set the symbol sizes are carried out. Normalization types for the proportional-symbol renderer can be by field value or by a base 10 logarithm.



This is a 1990 population map of the United States. The size area of the marker is in proportion to the population.

As the proportional-symbol renderer does not use a fixed set of symbols, the symbols used in the legend must be created. Call *CreateLegendSymbols* to do this. If *ValueUnit* is set to a distance, then one symbol is used in the legend, and this is taken from *MinSymbol*.

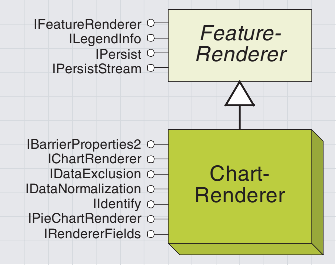
If the units are unknown, then a range of symbols are generated. The *MaxDataValue* should be set to represent the largest possible data value; this will correspond to the biggest symbol. *LegendSymbolCount* should be set to the number of required symbols in the legend. Be sure to set these two properties before calling *CreateLegendSymbols*. The symbols will be generated at powers of ten between the minimum and maximum values and then half- and quarter-values.

The VBA sample below illustrates setting up a proportional symbol renderer object for a population field for polygons of the United States. The units of population are not distance units; therefore, the *valueUnit* is set to be unknown. The *MinSymbol* is set to be a circular marker symbol and the *BackgroundSymbol* is a fill symbol. The minimum and maximum data values are calculated using a *DataStatistics* object that iterates a field and puts the results into the *IStatisticsResult* object.

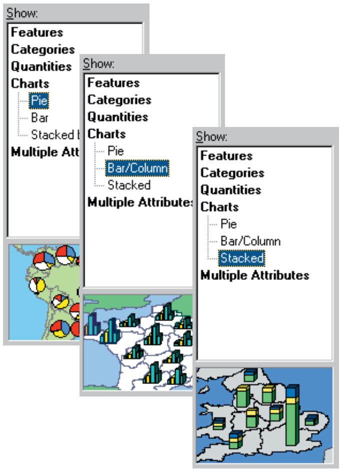
```
Set pProportionalSymbolRenderer = New ProportionalSymbolRenderer
With pProportionalSymbolRenderer
  .ValueUnit = esriUnknownUnits
  .ValueRepresentation = esriValueRepUnknown
  .Field = "POP1990"
  .FlanneryCompensation = False
  .MinDataValue = pStatisticsResult.Minimum
  .MaxDataValue = pStatisticsResult.Maximum
  .BackgroundSymbol = pFillSymbol
  .MinSymbol = pSimpleMarkerSymbol
  .LegendSymbolCount = 3
  .CreateLegendSymbols
End With
```

The proportional symbol renderer also supports the *IDataExclusion* interface—using this to exclude spurious data values can be an essential step for attributes that have unknown units.

For example, the population of the world has a large variation, from over a billion for China and India to some population values that are zero or unknown (-99999). In this case, even if the minimum symbol is one point in size, the maximum symbol can be huge. One way to avoid this problem is to exclude all countries with a population of less than a million persons.



Charts are marker symbols and are placed at the center of polygons.



In the Layer Properties/Symbology/Show list in ArcMap, the chart renderer produces pie, bar, and stacked charts under the type of Charts.

The *ChartRenderer* object provides the ability to compare multiple attributes of a feature by depicting the attributes as elements of either a pie chart or bar chart.

Bar charts are available in two styles: a conventional bar chart, with a series of bars on a horizontal axis, and a stacked bar chart, where each bar is placed one above another. With pie charts, you can compare one feature to another by the relative size of the pie chart.

All the charts require a list of fields that are to be used in the chart; this is specified in the *IRendererFields* interface.

The chart renderers require specific marker symbols; these symbols implement *IChartSymbol*. A chart symbol contains further symbols that describe how each component of the chart is to be drawn.

For example, if a *BarChartSymbol* consists of two bars, then the object contains two fill symbols for each bar, and these correspond to two fields specified in *IRendererFields* in the *ChartRenderer*.

The available chart symbols are *BarChartSymbol, PieChartSymbol,* and *StackedBarChartSymbol*. By default, the chart symbols have a 3D appearance. For more information, see the section on chart symbols in this chapter.

Setting up a chart requires some properties to be set in *IChartRenderer*; additionally, there are some options for pie charts in *IPieChartRenderer* that can be set to size the pie chart.

The *IDataExclusion* and *IDataNormalization* interfaces are available in a similar way to the *ProportionalSymbolRenderer* object.

The VBA code below illustrates setting up a typical chart renderer object.

```
'Set up the chart marker symbol to use with the renderer
Dim pBarChartSymbol As IBarChartSymbol, pFillSymbol As IFillSymbol
Dim pMarkerSymbol As IMarkerSymbol, pSymbolArray As ISymbolArray
Dim pChartSymbol As IChartSymbol, pChartRenderer As IChartRenderer
Dim pRendererFields As IRendererFields

' Create a new bar chart symbol
Set pBarChartSymbol = New BarChartSymbol
' Set the width of each bar - units are points
pBarChartSymbol.Width = 6
Set pMarkerSymbol = pBarChartSymbol ' QI to marker symbol interface
Set pChartSymbol = pBarChartSymbol ' QI to chart symbol interface
pChartSymbol.maxValue = maxValue ' This is the biggest value of all bars
pMarkerSymbol.Size = 30 ' This is the maximum height of the biggest bar

Set pSymbolArray = pBarChartSymbol
Set pFillSymbol = New SimpleFillSymbol
pFillSymbol.Color = GetRGBColor(213, 212, 252) ' pastel green
pSymbolArray.AddSymbol pFillSymbol
Set pFillSymbol = New SimpleFillSymbol
```

```
pFillSymbol.Color = GetRGBColor(193, 252, 179) ' pastel purple
pSymbolArray.AddSymbol pFillSymbol
Set pChartRenderer = New ChartRenderer ' Create a new chart renderer
' Set up the fields that comprise the components of a chart; a bar in
' a bar chart or a slice of a pie chart
Set pRendererFields = pChartRenderer
pRendererFields.AddField "MALES"
pRendererFields.AddField "FEMALES"

' Set the chart symbol into the renderer. This could also be a stacked
' bar or pie chart
Set pChartRenderer.ChartSymbol = pBarChartSymbol
Set pFillSymbol = New SimpleFillSymbol
pFillSymbol.Color = GetRGBColor(239, 228, 190)
Set pChartRenderer.BackgroundSymbol = pFillSymbol

' Disable so that charts appear in polygon centers
pChartRenderer.UseOverposter = False

pChartRenderer.CreateLegend ' Create the legend symbols

pChartRenderer.Label = "Population by Gender"
```

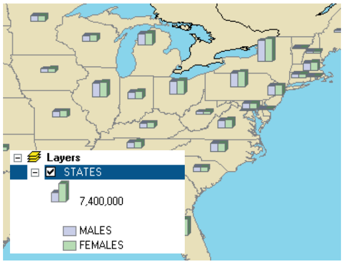
IRendererFields : IUnknown	***Provides access to members that work with the list of fields for renderers that use multiple value fields.***
Field (in Index: Long) : String	*Field at the specified index.*
FieldAlias (in Index: Long) : String	*Field alias at the specified index.*
FieldCount: Long	*Number of fields.*
AddField (in Name: String, Alias: String)	*Adds a field to the renderer.*
ClearFields	*Removes all fields from the renderer.*
DeleteField (in Name: String)	*Removes the specified field from the renderer.*

The *IRendererFields* interface allows you to specify the fields from the feature class that make up the chart. You can add in additional fields with *AddField* and then access and change individual fields using the *Field* property array. If you would like the text for the legend to be different from the field name, then set the *FieldAlias* array to the desired text.

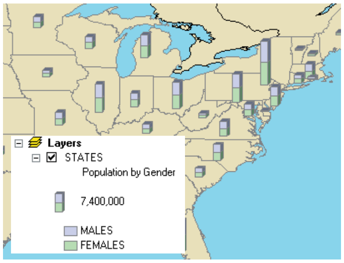
IChartRenderer : IUnknown	***Provides access to members that control the drawing of chart symbols (pie, bar, stacked bar) on a map to represent features.***
BaseSymbol: ISymbol	*Background fill symbol, (used when chart symbols are drawn for polygon features).*
ChartSymbol: IChartSymbol	*Chart symbol object.*
ColorScheme: String	*Color scheme (user interface property only).*
FieldTotal (in Index: Long) : Double	*Field total for the field at the specified index.*
Label: String	*Chart label.*
UseOverposter: Boolean	*Indicates if the overposter is used for positioning the chart symbols.*
CreateLegend	*Creates the legend. Call after all properties are set.*

The *IChartRenderer* interface specifies properties for pie, bar, and stacked bar charts. Pie charts require some additional properties to be set—see the *IPieChartRenderer* interface.

Charts are marker symbols and are placed at the center of polygons, so setting the *BackgroundSymbol* is a good idea so you can see the polygon shapes. The *ChartSymbol* property can be set to one of *BarChart-*

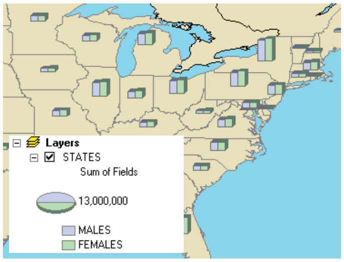


U.S. population by gender rendered with bar chart symbols



U.S. population by gender rendered with stacked bar chart symbols

Symbol, PieChartSymbol, or *StackedBarChartSymbol*. The chart symbol's *ISymbolArray::SymbolCount* must match the number of fields specified in the renderer's *IRendererFields::FieldCount*.



U.S. population by gender rendered with pie symbols

Setting *UseOverposter* to *False* will place the charts in the center of polygons; if this is set to *True*, the charts will be moved so that they do not overlap each other.

The symbols for the legend need to be explicitly created with the *CreateLegend* method. The *Legend* is composed of the chart symbol sized and labeled for half the maximum data value, followed by each fill symbol making up the chart with the text from *ISymbolArray::FieldAlias* (if this is empty, the field name is used). The *Label* property specifies what text appears above the chart in the legend; this must be set after calling *CreateLegend*.

If the normalization type is *esriNormalizeByPercentOfTotal*, the sum of the attribute values in a field has to be supplied in the *FieldTotal* property array.

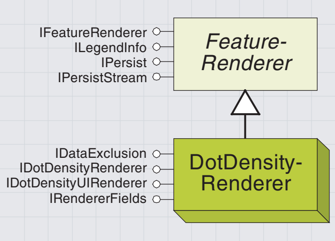
IPieChartRenderer : IUnknown	***Provides access to members that work with additional chart renderer properties specific to pie charts.***
FlanneryCompensation: Boolean	*Indicates if Flannery Compensation is applied.*
MinSize: Double	*Symbol size (points) corresponding to the minimum value.*
MinValue: Double	*Minimum value (used for proportional sizing).*
ProportionalBySum: Boolean	*Indicates if the size of pie chart symbols is determined by the sum of the values.*
ProportionalField: String	*Field used to determine size of the pie chart symbols.*
ProportionalFieldAlias: String	*Field alias for the proportional field.*

The overall size of a pie chart can be adjusted in a similar way to marker symbols with the proportional symbol renderer. If you want all the pies to appear as the same size, then leave all the properties in this interface set to their default values.

The pies can be sized by the sum of the values making up the pie. Set the *ProportionalBySum* property to *True* for this option to apply. Alternatively, the pie can be sized by a data value from another field. To do this, set the field name to *ProportionalField*. As with other data values, this field is normalized before the pie is sized. The legend text against the pie chart is taken from *ProportionalFieldAlias*, or, if this is empty, the proportional field name is used.

For both these options, you must set the *MinSize* property, which is the size in points of the width of the smallest pie chart. Additionally, you must set the minimum data value into *MinValue* property. Appearance compensation can also be specified to increase the size of the markers by setting *FlanneryCompensation* to *True*. For example, if the individual slices in a pie reflect population of males and population of females in a state, then the radius of the pie can represent the sum of the fields or population of the states as a whole.

```
Dim pPieChartRenderer As IPieChartRenderer
Set pPieChartRenderer = pChartRenderer
pPieChartRenderer.ProportionalBySum = True
pPieChartRenderer.MinSize = 6
pPieChartRenderer.MinValue = minFieldValue
```



A dot-density renderer places varying densities of dots within polygon features.

The *DotDensityRenderer* object requires a *DotDensityFillSymbol*. It fills a polygon layer with a scattering of marker symbols. The markers are randomly placed. The density of the marker symbols is determined by specifying the *DotValue*, or how much each dot represents.

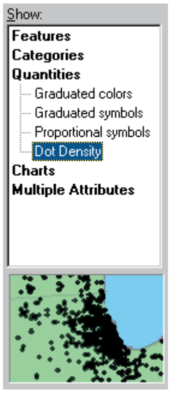
Multiple attributes may be specified in one dot density fill symbol, where each attribute has a different marker symbol. However, this can lead to some confusing maps, so typically only one attribute is used.

Additionally, a mask layer of polygons can be specified, which can limit the areas where dots are placed.

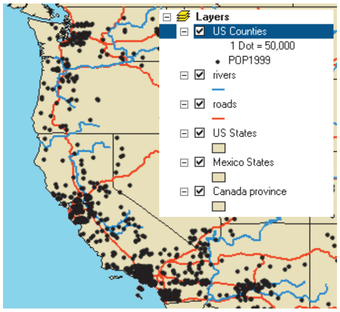
The following sample code exercises a *DotDensityRenderer*:

```
Dim pDotDensityRenderer As IDotDensityRenderer
Dim pDotDensityFillSymbol As IDotDensityFillSymbol
Dim pRendererFields As IRendererFields, pSymbolArray As ISymbolArray
Dim pColor As IColor, pMarkerSymbol As ISimpleMarkerSymbol

Set pDotDensityRenderer = New DotDensityRenderer
Set pRendererFields = pDotDensityRenderer 'QI to the fields
pRendererFields.AddField "POP1999" 'Add in the one population field

' Set up a new dot density fill symbol
Set pDotDensityFillSymbol = New DotDensityFillSymbol

' this is the size of each dot in points
pDotDensityFillSymbol.DotSize = 3

' The fill only has dots, the outline and background fill are removed
Set pColor = New RgbColor
pColor.NullColor = True
pDotDensityFillSymbol.BackgroundColor = pColor
pDotDensityFillSymbol.Outline = Nothing

' Put one circular marker into the dot density symbol
' use default color (black)
Set pSymbolArray = pDotDensityFillSymbol
Set pMarkerSymbol = New SimpleMarkerSymbol
pMarkerSymbol.Style = esriSMSCircle
pSymbolArray.AddSymbol pMarkerSymbol

' Put the dot density fill symbol into the renderer
Set pDotDensityRenderer.DotDensitySymbol = pDotDensityFillSymbol

pDotDensityRenderer.DotValue = 50000 'Each dot represents 50,000 people
pDotDensityRenderer.CreateLegend 'Create the symbols for the legend
```

In the Layer Properties/Symbology/Show list in ArcMap, the dot-density renderer corresponds to Dot Density under the type of Quantities.



The features of a polygon feature class are displayed with a number of dots corresponding to a value. This renderer is suitable for distribution throughout an area. For instance, a dot map depicting population will most likely have the strongest concentrations of dots along rivers and roads and near coastlines.



Map of the west coast of the U.S. Population density is drawn by county.

IDotDensityRenderer : IUnknown	*Provides access to members that control the drawing of varying densities of dots within polygon features to represent different quantities.*
■—■ ColorScheme: String	*Color scheme, (user interface property only).*
■—□ ControlLayer: IFeatureLayer	*Control layer used for masking.*
■—□ DotDensitySymbol: IDotDensityFillSymbol	*The dot density symbol.*
■—■ DotValue: Double	*Value of each dot.*
■—■ MaintainSize: Boolean	*Indicates if dot size is preserved when zooming (the alternative is that density is preserved).*
← CreateLegend	*Creates the legend. Call after all properties are set.*

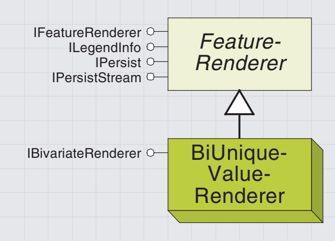
The dot-density fill symbol is set into *DotDensitySymbol*. Additionally, you must set the *DotValue*, which represents the quantity of each dot. In combination with the area of the polygon, this value relates to the density of the dots. To increase the density of the dots, decrease the *DotValue*.

The symbols used in the legend must be explicitly created with a call to the *CreateLegend* method; the legend will contain a single marker symbol for each field, added using *IRendererFields::AddField*.

IDotDensityUIRenderer : IUnknown	*Provides access to members that work with additional renderer properties which appear on the user interface.*
■—■ maxArea: Double	*Area in map units of the polygon with maximum density.*
■—■ maxValueArea: Double	*Maximum density.*
■—■ meanArea: Double	*Mean area in map units.*
■—■ meanValueArea: Double	*Mean density.*
■—■ minArea: Double	*Area in map units of the polygon with minimum density.*
■—■ minValueArea: Double	*Minimum density.*

Set values in the *IDotDensityUIRenderer* interface if you wish to keep the settings in the renderer object consistent with the property page.

The *IRendererFields* interface stores a list of attribute field names used to draw dot densities, for example, population. The number of marker symbols in the *DotDensityFillSymbol* must match the number of renderer fields. See the description of this interface under the *ChartRenderer* coclass.



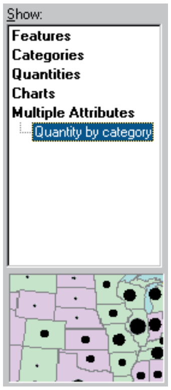
The biunique value renderer creates maps of multiple attributes.

The biunique value renderer is used to produce multivariate maps. Unlike maps that display one attribute, or characteristic, of the data—for example, a name or an amount—multivariate maps display two or more attributes at the same time. A multivariate map could use color to show the unique habitats of Africa and also display biodiversity of each region using a graduated symbol, where a larger symbol represents a greater diversity.

IBivariateRenderer : IUnknown	*Provides access to members that control the rendering of bivariate symbology based on two constiuent renderers.*
MainRenderer: IFeatureRenderer	*Main renderer of a bivariate renderer.*
VariationRenderer: IFeatureRenderer	*Variation renderer of a bivariate renderer.*
CreateLegend	*Creates the legend. Call after all properties are set.*

The *MainRenderer* property must be set to a *UniqueValueRenderer*, and the *VariationRenderer* must be a *ClassBreaksRenderer*. The *BiUniqueValueRenderer* takes the symbols of the unique value renderer and alters it by the size or color of the class-breaks renderer.

In the Layer Properties/Symbology/Show list in ArcMap, the biunique value renderer corresponds to Quantity by Category under the type of Multiple Attributes.


Show:

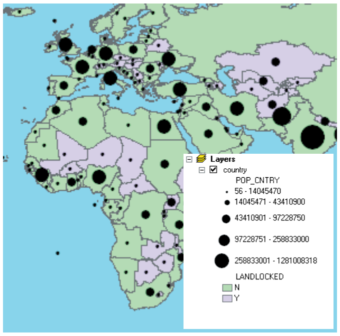
Features
Categories
Quantities
Charts
Multiple Attributes
Quantity by category

The *VariationRenderer* would typically be set up with a symbol type that matches the *MainRenderer*, for example, marker symbols in the main renderer and marker symbols in the variation renderer. The only exception to this is where the main renderer uses a fill symbol of varying colors for polygons, and the variation renderer uses markers varying in size. In this case, markers are placed at the polygon centers with varying background fills.

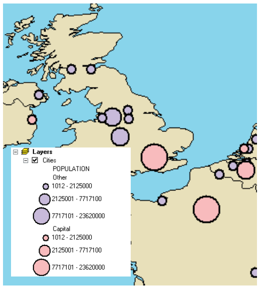
If variation renderer symbols vary in size, then the color of the main renderer is used and this is subdivided by size for the second attribute.

If the variation renderer symbols vary in color, then the colors of the main render are modified by the hue and saturation of the symbols of the variation renderer. In this case, it is wise to have your main renderer symbols colors, which have different hue values but the value and saturation do not really matter. The opposite applies to the variation renderer.

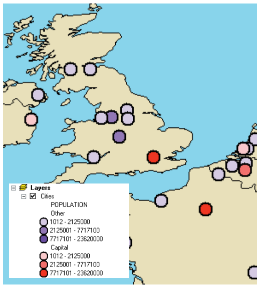
The *CreateLegend* method will generate legend symbols from both renderers that are related to the one layer. The legend typically consists of combinations of all possible values from the two renderers, unless different-sized maker symbols are used with polygon fills, in which case the marker sizes and fills are shown separately.



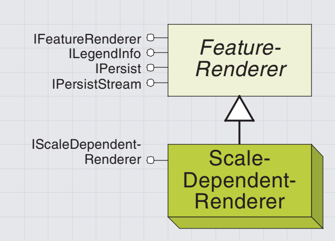
This map shows landlocked countries illustrated as two colors and population as a circular marker.



This map shows cities of the world sized by population—capital cities are in a different color than other cities.



This map shows cities of the world with a uniform circular marker, capital cities distinguished by color, and population distinguished by lightness.

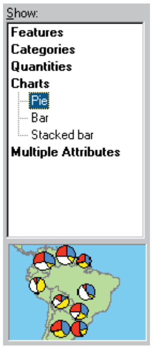


The scale-dependent renderer is made of multiple renderers, each operating within a scale range.

The *ScaleDependentRenderer* is a renderer that contains other renderers. Its purpose is to allow you to specify different renderers for scale ranges. For example, when a user views a layer at its full extent, it will draw with one set of basic symbols, and when the user zooms in far enough, the symbols will change to become more detailed.

You can specify as many renderers and scale ranges as you need. One example would be showing road networks—when zoomed out to view a country, then roads would be drawn as simple lines with a *SimpleRenderer* coclass. But when zoomed in, the roads may be drawn using detailed line symbols reflecting the road type using a *UniqueValueRender*.

IScaleDependentRenderer : IUnknown	***Provides access to members that control a renderer which is composed of mulitple renderers, of which only one is enabled within a particular scale range.***
Break (in Index: Long) : Double	*Scale value at which to break for the specified index.*
Renderer (in Index: Long) : IUnknown Pointer	*The renderer at the specified index.*
RendererCount: Long	*Number of renderers.*
AddRenderer (in Renderer: IFeatureRenderer)	*Adds a renderer to the end of the list.*
MoveRenderer (in Renderer: IFeatureRenderer, in toIndex: Long)	*Moves renderer to the specified location in the list.*
RemoveRenderer (in Renderer: IFeatureRenderer)	*Removes the specified renderer from the list.*

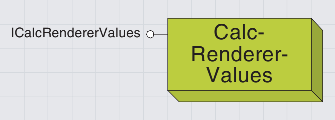


In the Layer Properties/ Symbology/Show list in ArcMap, the dot-density renderer corresponds to Dot Density under the type of Quantities.

The *AddRenderer* method adds a feature renderer to the scale renderer. You must then set a corresponding *Break* array property to indicate map scale below which the renderer is used. For example, a renderer that displays at less than 1:10,000 would have a break value set to 10,000.

The following VBA sample combines the renderers from the second and third map layers into a scale-dependent renderer and sets this into the first map layer. Typically, you would add the same layer three times to ArcMap first, set some symbology on the second and third layers, then run this macro to set up the first layer.

```
Dim pDoc As IMxDocument, pLayer0 As IGeoFeatureLayer
Dim pLayer1 As IGeoFeatureLayer, pLayer2 As IGeoFeatureLayer
Dim pScaleDependentRenderer As IScaleDependentRenderer
Set pDoc = Document
Set pLayer0 = pDoc.FocusMap.Layer(0) ' Get a handle on each layer
Set pLayer1 = pDoc.FocusMap.Layer(1)
Set pLayer2 = pDoc.FocusMap.Layer(2)

Set pScaleDependentRenderer = New ScaleDependentRenderer
With pScaleDependentRenderer
  .AddRenderer pLayer1.Renderer ' Add in the detail renderer
  .Break(0) = 12000000
  .AddRenderer pLayer2.Renderer ' Add in the less detailed renderer
  .Break(1) = 1000000000
End With

' Set the scale break renderer into the first layer.
Set pLayer0.Renderer = pScaleDependentRenderer
```



CalcRendererValues is a utility object used to perform simple statistical calculations on a feature layer for use by renderers.

The *CalcRendererValues* object is a utility object that can be used in combination with a chart renderer and a feature layer. It is used to calculate minimum and maximum data values and field totals.

First, set up your chart renderer object. You can set data exclusion and normalization properties, but do not set the *MinValue* or *FieldTotals* yet. Next, call the *ICalcRendererValues::SetData* method. This points the *CalcRendererValues* object at the chart renderer and feature layer objects. To simply calculate the maximum and minimum values, use the *CalcMinMax* method. This will do the job of iterating the feature layer, taking into account normalization and data exclusion to determine the minimum and maximum values.

ICalcRendererValues: IUnknown	*Provides access to members that are used to calculate the renderer statistics required for some uses of a ChartRenderer.*
← CalcMinMax (out MinValue: Double, out MaxValue: Double)	*Calculates minimum and maximum values.*
← GetFieldTotals: Variant	*Gets totals for all fields.*
← SetData (in Layer: IFeatureLayer, in Renderer: IFeatureRenderer)	*Sets data for calculation.*
← SetDirty	*Sets object to state where values will be recalculated.*
← SetMinMax (MinValue: Double, MaxValue: Double)	*Manually sets minimum and maximum values.*

CalcMinMax also takes into account what minimum and maximum values the chart renderer requires. There are three possibilities.

1. When you are sizing pie charts in proportion to a single field, then the minimum and maximum value of the attribute values of this field are returned. This is the case when IChartRenderer::ProportionalField has been set.

2. When you are sizing a pie chart by the sum of all fields, then the minimum and maximum sums of all fields are returned. This is the case when IChartRenderer::ProportionalBySum is set to True.

3. When you are using a bar (or stacked bar) chart and you want to get the maximum and minimum attribute values, not caring which field these come from, then these values will be used to set into IChartSymbol::MaxValue to size the biggest bar in all the charts.

You can set your own minimum and maximum values with *SetMinMax*. If you call *CalcMinMax* a second time, the same minimum and maximum values will then be returned without rescanning the feature layer. To force a recalculation, call *SetDirty* before calling *CalcMinMax*.

If your chart renderer requires field totals (the normalization type is *esriNormalizeByPercentOfTotal)* and your chart renderer is for bar or stacked bar charts, you can call *GetFieldTotals* to work these out and return a safe array of the double values. You can then set the *IChartRenderer::FieldTotal* property array based on this array of doubles. Again, the *SetDirty* method is required to force a rescan of the feature layer.

The following VBA code illustrates how to calculate minimum and maximum values for a pie chart renderer where the pies are sized in proportion to the sum attribute values of the pie slices. In this code, *pFeatureLayer* is a feature layer, *pPieChartRenderer* is set to be a *IPieChartRenderer* and has *ProportionalBySum = True*. Because of this, using the *CalcRendererValues* object works out the minimum to be the sum of the data values of the smallest pie.

```
Dim pCalcRendererValues As ICalcRendererValues
Set pCalcRendererValues = New CalcRendererValues

' Point the CalcRendererValues at the feature layer
pCalcRendererValues.SetData pFeatureLayer, pPieChartRenderer
Dim minVal As Double, maxVal As Double

' This will scan all the features and return minimum and maximum values
pCalcRendererValues.CalcMinMax minVal, maxVal
' Now set the smallest pie value, other pies will be drawn in proportion
pPieChartRenderer.minValue = minVal
```

You can create your own renderer COM object. This is useful if you want complete control over drawing all the features for a feature layer.

There are several examples of custom renderers in the ArcObjects Developer Help under ArcMap/Symbology/Renderers.

The IFeatureRenderer *interface is more fully documented with the* FeatureRenderer *abstract class at the beginning of this chapter section.*

Custom feature drawing can be used to achieve a similar effect to custom renderers. However, custom features are more powerful. They can encapsulate behavior that is not related to symbology. Additionally, unlike custom renderers, the link between the custom feature and the behavior is stored in the geodatabase, not in map documents.

Another way to integrate a custom renderer and property page within the ArcGIS framework is by writing a FeatureClassExtension*. Your class extension must implement* IFeatureClassExtension *and* IFeatureClassDraw*.*

In brief, the GUID of the FeatureClassExtension *object is stored as an entry in the geodatabase. Then, when the* FeatureClass *draws, it looks to the* FeatureClassExtension *and uses the renderer defined there (*IFeatureClassDraw::CustomRenderer*), which can be either a custom renderer or one of the standard ESRI renderers. You can also associate a custom renderer property page through* IFeatureClassDraw:: CustomRendererPropertyPageCLSID*.*

For more information about writing feature class extensions, see Volume 2, Chapter 8, 'Accessing the geodatabase', as well as the sample code under Geodatabase/Class Extensions.

The minimum interface you are required to implement for a functioning custom renderer is the *IFeatureRenderer* interface. However, it is usually recommended to implement additional interfaces. This topic is a summary of the typical interfaces that are implemented.

IFeatureRenderer : IUnknown	***Provides access to members that control functionality common to all feature renderers.***
—□ ExclusionSet: IFeatureIDSet	*Sets an object reference to a temporary drawing exclusion set.*
■— RenderPhase (in drawPhase: tagesriDrawPhase) : Boolean	*Indicates if renderer uses the specified draw phase.*
■— SymbolByFeature (in Feature: IFeature) : ISymbol	*Symbol used to draw the specified feature.*
← CanRender (in featClass: IFeatureClass, in Display: IDisplay) : Boolean	*Indicates if the specified feature class can be rendered on the given display.*
← Draw (in Cursor: IFeatureCursor, in drawPhase: tagesriDrawPhase, in Display: IDisplay, in trackCancel: ITrackCancel)	*Draws features from the specified cursor on the given display.*
← PrepareFilter (in fc: IFeatureClass, in QueryFilter: IQueryFilter)	*Prepares the query filter for the rendering process.*

The *IFeatureRenderer* interface is the core of the renderer. The main method that will be called by the framework is *Draw*. It is the job of your renderer to draw the feature layer anyway you specify. Your renderer is passed a feature cursor as well as a display on which to draw.

Before a *Draw* occurs, you are given an opportunity with *PrepareFilter* to modify the filter used to produce the feature cursor. At a minimum, you must add into the filter any fields you need for your renderer.

In response to a *IFeatureRenderer::Draw* method, a renderer will typically iterate through the feature cursor, taking each feature in turn. For each feature, the renderer works out a symbol to represent the feature and passes this off to *IFeatureDraw::Draw* for display. Calling the feature's *IFeatureDraw::Draw* allows custom features to use their own drawing methods.

If you want to restrict which layers your custom renderer can be applied to, such as being applicable only to line layers, then in your implementation of *IFeatureRenderer::CanRender,* you can test properties of the feature layer and return *True* if your renderer supports it and *False* if it does not.

IPersistStream : IUnknown
← GetSizeMax (out pcbSize: _ULARGE_INTEGER)
← IsDirty
← Load (in pstm: IStream)
← Save (in pstm: IStream, in fClearDirty: Long)

Implement *IPersistStream* to preserve the symbology of your renderer in map documents (.mxd), layer files (.lyr), or anything else that persists object state. This gives you the opportunity to load and save any objects (typically symbols) you are using in your renderer. If the objects you are using also implement the *IPersistStream* mechanism (as do symbols), you can call on those objects to persist themselves.

IPersistVariant : IUnknown	Provides access to members used for storage of an object through VARIANTs.
■— ID: IUID	The ID of the object.
◀— Load (in Stream: IVariantStream)	Loads the object properties from the stream.
◀— Save (in Stream: IVariantStream)	Saves the object properties to the stream.

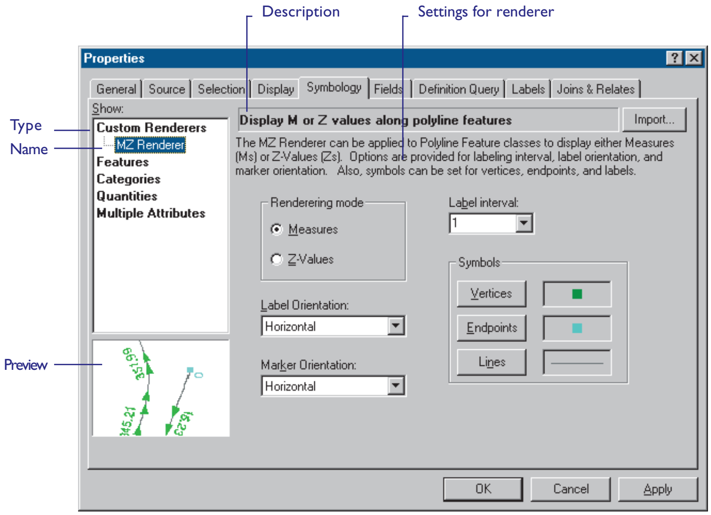
When programming in Visual Basic, use *IPersistVariant* instead of *IPersistStream* because *IPersistStream* contains types not supported in VB.

ILegendInfo : IUnknown	Provides access to members that control legend information provided by a renderer.
■— LegendGroup (Index: Long) : ILegendGroup	Number of legend groups contained by the object.
■— LegendGroupCount: Long	Number of legend groups contained by the object.
■— LegendItem: ILegendItem	Optional. Defines legend formatting for layer rendered with this object.
■—■ SymbolsAreGraduated: Boolean	Indicates if symbols are graduated.

Implement *ILegendInfo* to ensure the table of contents and legends show a list of what symbols, labels, and headings your renderer is using. Typically, you reuse the existing *LegendGroup* and *LegendClass* objects and use these to hold the symbols for your renderer. Implement your own interface to allow your renderer settings to be modified by a caller of your renderer. This could well be by a custom renderer property page.

To make your custom renderer object active on a layer, you could run a VBA script that creates your renderer object (you will need to add a reference in the VBA environment to your custom renderer's DLL), then replace an existing renderer in a particular layer.

```
' pGeoFeatureLayer is an interface pointer to the IGeoFeatureLayer
' interface on a Feature Layer object.

' Create a your custom renderer
 Set pMyRenderer = New CustomRenderer.clsMyRenderer
' You could set some properties here

' Now set the custom renderer into the feature layer
 Set pGeoFeatureLayer.Renderer = pMyRenderer

' Now refresh the active view and update the contents of the doc to _
' reflect the new symbology
```



Properties

General | Source | Selection | Display | Symbology | Fields | Definition Query | Labels | Joins & Relates

Show:

- Custom Renderers
  - MZ Renderer
- Features
- Categories
- Quantities
- Multiple Attributes

Display M or Z values along polyline features Import...

The MZ Renderer can be applied to Polyline Feature classes to display either Measures (Ms) or Z-Values (Zs). Options are provided for labeling interval, label orientation, and marker orientation. Also, symbols can be set for vertices, endpoints, and labels.

Rendering mode: ● Measures ○ Z-Values

Label interval: 1

Label Orientation: Horizontal

Marker Orientation: Horizontal

Symbols: Vertices 🟩 Endpoints 🟦 Lines

OK Cancel Apply

Creating a custom property page provides a user interface for working with the settings of a custom object that is fully integrated within the ArcMap framework. This section provides an overview of how to implement a custom renderer property page that allows users to interact with the settings of a custom renderer. By registering the property page in the “ESRI Renderer Property Pages” component category, your custom user interface will appear in the Layer/Properties/Symbology page along with all of the standard symbology options. While this section provides a good overview, you should also look at the developer sample code before embarking on a custom property page implementation.

Define your custom renderer property page as a class that implements three interfaces: *IRendererPropertyPage*, *IComPropertyPage* (essentially a Visual Basic compatible version of the Microsoft interface *IPropertyPage*), and *IComEmbeddedPropertyPage*. Design your GUI on a form, placing all controls and descriptive text either directly on the form or on another object that supports a window handle, such as a Picture box control. Also, it is good practice to always reference this form through a private data member in your class module.

IRendererPropertyPage : IUnknown	***Provides access to members that control renderer property pages.***
ClassID: IUID	*Property page class id (unique identifier object).*
Description: String	*Renderer description.*
Name: String	*Name of the renderer.*
PreviewImage: Long	*Preview bitmap for the renderer that appears on the page.*
RendererClassID: IUID	*Renderer class id (unique identifier object).*
Type: String	*Renderer type. Used to group renderers into categories.*
CanEdit (in obj: IFeatureRenderer) : Boolean	*Indicates if the property page can modify the properties of the specified renderer.*

Some properties in *IRendererPropertyPage* will appear on the ArcMap symbology property page (your page’s parent) to help guide users when accessing your custom page. These include the *Description*, which will appear at the top of the page, and the *PreviewImage*, which will appear in the bottom left.

Name appears in the tree view on the left side of the symbology property page.

If you use an already existing *Type*, then your renderer will appear under that category. Or, you can use a new *Type*, in which case a new category will be created for your renderer.

Use *IComPropertyPage::Priority* to control where your renderer appears in the tree. Use a lower number to have your renderer and category

Type	Name	Priority
Features	Single symbol	100
Categories	Unique values	200
	Unique values, many fields	210
	Match to symbols in a style	300
	Graduated symbols	310
	Proportional symbols	320
	Dot density	330
Charts	Pies	400
	Bars	410
	Stacked	420
Multiple Attributes	Quantity by category	500

This table lists standard renderer property pages and their priorities.

appear toward the top of the list. Note that the priority of the first page in a category controls where that category fits in the list.

In *CanEdit* you should check the in parameter to make sure your custom page can edit the specified renderer. Typically, your custom property page will only edit your custom renderer. Follow similar logic in *IComPropertyPage::Applies*.

IComPropertyPage : IUnknown	***COM Property Page***
■— Height: Long	*Returns the height of the page in pixels.*
■— HelpContextID (in controlID: Long) : Long	*Returns the help context ID for the specified control on the page.*
■— HelpFile: String	*Returns the help file name for the page.*
■— IsPageDirty: Boolean	*Check if the page made any changes to the object(s).*
—□ PageSite: IComPropertyPageSite	*Sets the sheet that contains the page.*
■—■ Priority: Long	*Sets or returns the page priority. The higher the priority, the sooner the page appears in the containing property sheet.*
■—■ Title: String	*Sets or returns the title of the property page.*
■— Width: Long	*Returns the width of the page in pixels.*
◄— Activate: Long	*Called on page creation. Return the hWnd of the page here.*
◄— Applies (in Objects: ISet) : Boolean	*Check if the page applies to the specified objects.*
◄— Apply	*Apply any changes to the object(s).*
◄— Cancel	*Cancel changes to the object(s).*
◄— Deactivate	*Destroy the page.*
◄— Hide	*Hide the page.*
◄— SetObjects (in Objects: ISet)	*Supply the page with the object(s) to be edited.*
◄— Show	*Show the page.*

IComPropertyPage works with general property page settings. The typical behavior for a property page is to allow changes to a temporary object (that is, a renderer). Then if the Apply or Ok button is pressed, the temporary renderer replaces the “live” renderer object on the feature layer. If the Cancel button is pressed, then the temporary renderer is discarded. (In an alternate implementation, there is no temporary renderer object. Instead, the property page stores temporary changes to the renderer’s settings. Then, if OK or Apply is clicked, the settings are applied to the renderer, and if Cancel is clicked, these settings are discarded.)

SetObjects is called by the framework as a renderer property page is opened. In this method you are passed a set of objects (map, feature layer, feature class, and feature renderer). You should find the renderer in this list, check for the proper type, and pass it to your page (that is, your form) for editing. The framework automatically handles cloning of the renderer object, so it is not necessary to make a copy before passing it to your page. (In the alternate implementation, instead of passing the renderer to your page for editing, simply initialize your page’s controls using the renderer properties.)

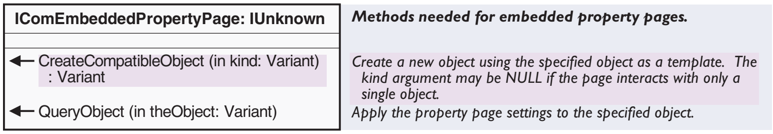
For renderer property pages, the framework handles the cloning of the renderer as the page is opened and also the apply and cancel operations as the page is dismissed. This behavior holds true for renderers, but it can vary for other types of objects.

Conversely, the *Apply* method is triggered when the user presses Apply or Ok on the layer properties property sheet. In this method, call *IComEmbeddedPropertyPage::QueryObject*, passing your renderer. If your page is directly editing the renderer, then do nothing in *QueryObject*, as the framework will automatically make all changes to the renderer permanent. (In the alternate implementation, you must instead manually update the renderer properties based on the settings from your page.)

Activate is called as your page gains focus. Load the form here, and return your page's window handle (that is, either the handle of your form or your Picture box). Unload your form in *Deactivate*, which is called when the page loses focus. In ArcMap, this occurs when the user switches to another symbology option or to another tab on the Layer Properties dialog box or when this dialog box is closed. *Cancel* is triggered when the user presses Cancel on the layer properties property sheet.

PageSite allows your page to call back to its parent, telling it that a change has been made. In ArcMap, this gives a renderer property page control over the enabling of the Apply button on the layer properties property sheet. For a custom page, one implementation is to have a data member of type *IComPropertyPageSite* on your form, and set this in *PageSite*. In your form code, call *IComPropertyPageSite::PageChanged* on this member anytime a control changes. This will enable the Apply button.

Similarly, the framework also checks *IsPageDirty* to determine if your page needs to be redrawn. Avoid unnecessary redrawing by only conditionally returning *True*.



ICOMEMBEDDEDPROPERTYPAGE: IUNKNOWN

Methods needed for embedded property pages.

← CreateCompatibleObject (in kind: Variant) : Variant — *Create a new object using the specified object as a template. The kind argument may be NULL if the page interacts with only a single object.*

← QueryObject (in theObject: Variant) — *Apply the property page settings to the specified object.*

Custom renderer property pages fall into the class of embedded property pages and thus must implement *IComEmbeddedPropertyPage*. Embedded property pages (as opposed to simple property pages) reside in the framework in a configuration that, as the property page is loaded, allows for the retention of properties from a previously edited object. *IComEmbeddedPropertyPage::CreateCompatibleObject* is used to manage the preservation of properties from the old object to the new object, which may or may not be of the same type.

For example, in ArcMap, users pick from different symbology options from the tree view on the Layer properties symbology tab. Because the internal representation of each option is a different renderer object, as the user picks a new option, a new renderer is being edited. In some cases, properties are preserved during this transition. For example, when a user switches between the Bar chart and Pie chart options, the renderer fields and symbols are preserved from the old to the new renderer. Other examples of embedded property pages in ArcMap include the *ColorBrowser* and *NumberFormatDialog*.

In addition to managing the retention of properties from an old renderer, you should also use *CreateCompatibleObject* to avoid unnecessary, excessive cloning of renderers. In this method check to see if the in parameter is an object of the type your page should edit. If so, return that same object. If not, create and return a new renderer object of the proper type, setting properties on the new object if you wish.

Designing a custom symbol property page provides an integrated user interface for working with the custom symbol settings. The implementation strategy for this page will be similar to that followed when designing a custom renderer property page.

Define your custom symbol property page as a class that implements four interfaces: *ISymbolPropertyPage, IComPropertyPage, IComPropertyPage2,* and *IPropertyPageContext*. Register your custom symbol object in the proper custom symbol category, for example, “Marker Symbols”.

Register your custom property page object in the category “Symbol Property Pages”. Your custom property page will then become available in the “Type” pulldown menu on the ArcMap symbol property editor property sheet.

ISymbolPropertyPage : IUnknown	***Provides a dialog for managing properties associated with Symbol property methods***
■—■ Units: esriUnits	*Units to display symbol properties in.*

The *ISymbolPropertyPage* interface controls the measurement units that will appear on the page.

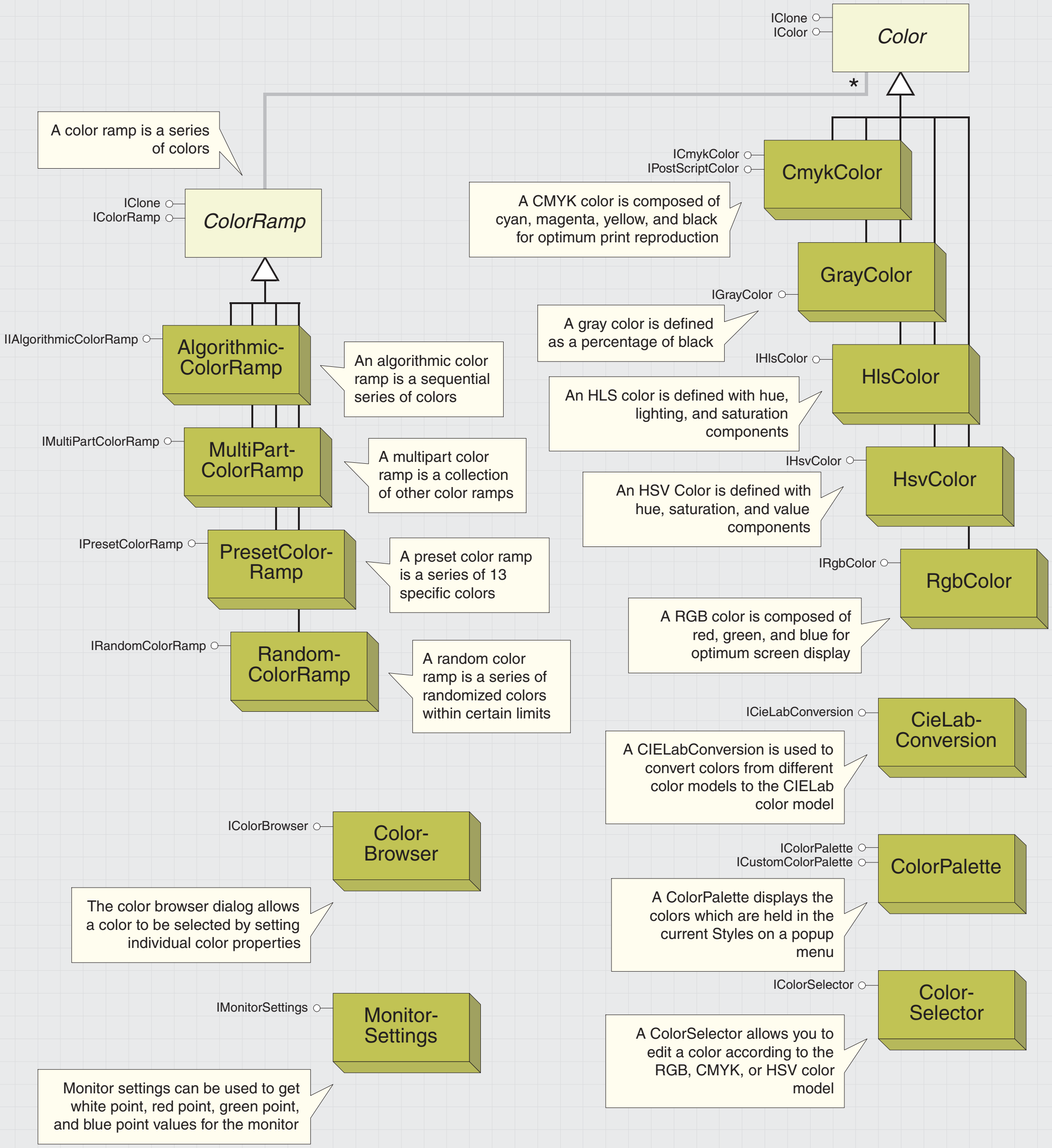
IComPropertyPage : IUnknown	***COM Property Page***
■— Height: Long	*Returns the height of the page in pixels.*
■— HelpContextID (in controlID: Long) : Long	*Returns the help context ID for the specified control on the page.*
■— HelpFile: String	*Returns the help file name for the page.*
■— IsPageDirty: Boolean	*Check if the page made any changes to the object(s).*
—□ PageSite: IComPropertyPageSite	*Sets the sheet that contains the page.*
■—■ Priority: Long	*Sets or returns the page priority. The higher the priority, the sooner the page appears in the containing property sheet.*
■—■ Title: String	*Sets or returns the title of the property page.*
■— Width: Long	*Returns the width of the page in pixels.*
◄— Activate: Long	*Called on page creation. Return the hWnd of the page here.*
◄— Applies (in Objects: ISet) : Boolean	*Check if the page applies to the specified objects.*
◄— Apply	*Apply any changes to the object(s).*
◄— Cancel	*Cancel changes to the object(s).*
◄— Deactivate	*Destroy the page.*
◄— Hide	*Hide the page.*
◄— SetObjects (in Objects: ISet)	*Supply the page with the object(s) to be edited.*
◄— Show	*Show the page.*

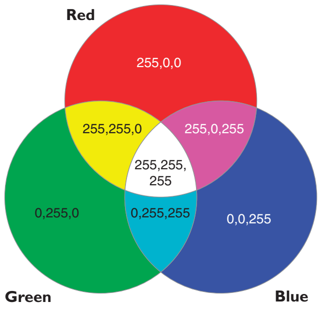
For more information about implementing *IComPropertyPage* and *IPropertyPageContext*, see the section on implementing a custom renderer property page.

IComPropertyPage2 : IUnknown	***Provides access to members that control a COM property page.***
◄— QueryCancel: Boolean	*Returns VARIANT_FALSE to prevent the cancel operation or VARIANT_TRUE to allow it.*

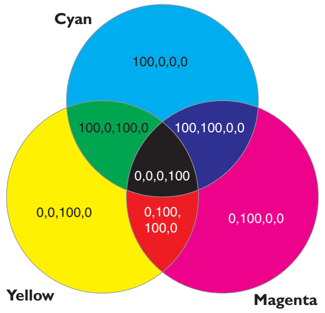
The *IComPropertyPage2* interface controls the Cancel operation on your page.

Color objects

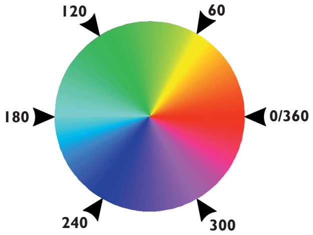

IClone
IColor
Color
*
A color ramp is a series of colors
IClone
IColorRamp
ColorRamp
ICmykColor
IPostScriptColor
CmykColor
A CMYK color is composed of cyan, magenta, yellow, and black for optimum print reproduction
GrayColor
IGrayColor
A gray color is defined as a percentage of black
IIAlgorithmicColorRamp
Algorithmic-ColorRamp
An algorithmic color ramp is a sequential series of colors
IHlsColor
HlsColor
An HLS color is defined with hue, lighting, and saturation components
IMultiPartColorRamp
MultiPart-ColorRamp
A multipart color ramp is a collection of other color ramps
IHsvColor
HsvColor
An HSV Color is defined with hue, saturation, and value components
IPresetColorRamp
PresetColor-Ramp
A preset color ramp is a series of 13 specific colors
IRgbColor
RgbColor
A RGB color is composed of red, green, and blue for optimum screen display
IRandomColorRamp
Random-ColorRamp
A random color ramp is a series of randomized colors within certain limits
ICieLabConversion
CieLab-Conversion
A CIELabConversion is used to convert colors from different color models to the CIELab color model
IColorBrowser
Color-Browser
The color browser dialog allows a color to be selected by setting individual color properties
IColorPalette
ICustomColorPalette
ColorPalette
A ColorPalette displays the colors which are held in the current Styles on a popup menu
IColorSelector
Color-Selector
IMonitorSettings
Monitor-Settings
A ColorSelector allows you to edit a color according to the RGB, CMYK, or HSV color model
Monitor settings can be used to get white point, red point, green point, and blue point values for the monitor



Red, green, blue (RGB) color model



Cyan, magenta, yellow (CMY) color model



Color wheel for hue, saturation, and value (HSV) color model

Color can be represented using a number of different models, which often reflect the ways in which colors can be created in the real world.

You may be familiar with the RGB color model, which is based on the primary colors of light—red, green, and blue. When red, green, and blue rays of light coincide, white light is created. The RGB color model is therefore termed *additive*, as adding the components together creates light.

By displaying pixels of red, green, and blue light, your computer monitor is able to portray hundreds, thousands, and even millions of different colors. To define a color as an RGB value, you give a separate value to the red, green, and blue components of the light. A value of 0 indicates no light, and 255 indicates the maximum light intensity.

Here are a few rules for RGB values:

- If all RGB values are equal, then the color is a gray tone.
- If all RGB values are 0, the color is black (an absence of light).
- If all RGB values are 255, the color is white.

Another common way to represent color, the CMYK model, is modeled on the creation of colors by spot printing. Cyan, magenta, yellow, and black inks are mingled on paper to create new colors. The CMYK model, unlike RGB, is termed *subtractive*, as adding all the components together creates an absence of light (black).

Cyan, magenta, and yellow are the primary colors of pigments—in theory you can create any color by mixing different amounts of cyan, magenta, and yellow. In practice, you also need black, which adds definition to darker colors and is better for creating precise black lines.

HSV, or the hue, saturation, and value color model, describes colors based around a color wheel that arranges colors in a spectrum.

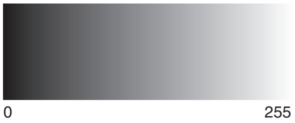
The hue value indicates where the color lies on this color wheel and is given in degrees. For example, a color with a hue of 0 will be a shade of red, whereas a hue of 180 will indicate a shade of cyan.

Saturation describes the purity of a color. Saturation ranges from 0 to 100; therefore, a saturation of 20 would indicate a neutral shade, whereas a saturation of 100 would indicate the strongest, brightest color possible.

The value of a color determines its brightness, with a range of 0 to 100. A value of 0 always indicates black; however, a value of 100 does not indicate white, it just indicates the brightest color possible.

Hue is simple to understand, but saturation and value can be confusing. It may help to remember these rules:

- If value = 0, the color is black.
- If saturation = 0, the color is a shade of gray.
- If value = 255 and saturation = 0, the color is white.



Grayscale color model

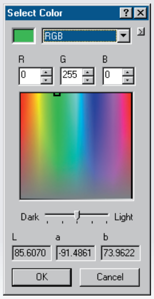
The HLS, or hue, lightness, and saturation model, has similarities with the HSV model. Hue again is based on the spectrum color wheel, with a value of 0 to 360. Saturation again indicates the purity of a color, from 0 to 100. However, instead of value, a lightness indicator is used, again with a range of 0 to 100. If lightness is 100, white is produced, and if lightness is 0, black is produced.

The last color model is grayscale. 256 shades of pure gray are indicated by a single value. A grayscale value of 0 indicates black, and a value of 255 indicates white.

The CIELAB color model is used internally by ArcObjects, as it is device independent. The model, based on a theory known as opponent process theory, describes color in terms of three "opponent channels". The first channel, known as the *1* channel, traverses from black to white. The second, or *2* channel, traverses red to green hues. The last channel, or *3* channel, traverses hues from blue to yellow.

Sample color values

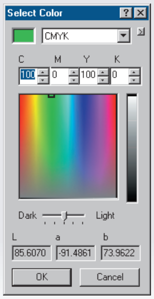
	RGB			CMYK				HLS			HSV			Gray
	Red	Green	Blue	Cyan	Magenta	Yellow	Black	Hue, lightness, saturation			Hue, saturation, value			Value
Red	255	0	0	0	100	100	0	0	50	100	0	100	100	-
Orange	255	128	0	0	50	100	0	30	50	100	30	100	100	-
Yellow	255	255	0	0	0	100	0	60	50	100	60	100	100	-
Bright green	0	255	0	100	0	100	0	120	50	100	120	100	100	-
Cyan	0	255	255	100	0	0	0	180	50	100	180	100	100	-
Blue	0	0	255	100	100	0	0	240	50	100	240	100	100	-
Violet	128	0	255	50	100	0	0	270	50	100	270	100	100	-
Magenta	255	0	255	0	100	0	0	300	50	100	300	100	100	-
White	255	255	255	0	0	0	0	NA	100	NA	NA	0	100	0
Mid-gray	128	128	128	0	0	0	50	NA	50	NA	NA	0	50	50
Black	0	0	0	0	0	0	100	NA	0	NA	NA	NA	0	100


Select Color

RGB

R 0 G 255 B 0

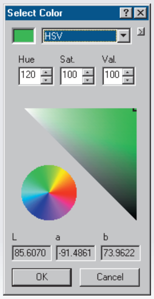
L 85.6070 a -91.4861 b 73.9622


Select Color

CMYK

C 100 M 0 Y 100 K 0

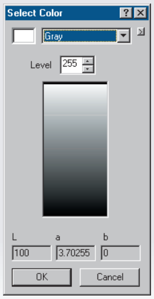
L 85.6070 a -91.4861 b 73.9622


Select Color

HSV

Hue 120 Sat. 100 Val. 100

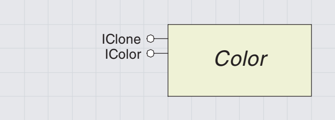
L 85.6070 a -91.4861 b 73.9622


Select Color

Gray

Level 255

L 100 a 3.70255 b 0



The color objects allow you to define colors simply and precisely. They also control color-related effects such as transparency.

Objects that support the *IColor* interface allow precise control over any color used within the ArcObjects model. You can get and set colors using a variety of standard color models—RGB, CMYK, HSV, HLS, and Grayscale.

Color is used in many places in ArcGIS applications—in feature and graphics symbols, as properties set in renderers, as the background for ArcMap or ArcCatalog windows, and as properties of a raster image.

The type of color model used in each of these circumstances will vary. For example, a window background would be defined in terms of an RGB color because display monitors are based on the RGB model. A map made ready for offset-press publication could have CMYK colors to match printer's inks.

*"CMYK" stands for **c**yan, **m**agenta, **y**ellow, and blac**k**, the colors of the four inks used by offset presses. "RGB" stands for **r**ed, **g**reen, and **b**lue, the three colors emitted in a monitor display.*

You can convert any color object to its representative value in the CIELAB color model, which is used internally by ArcObjects.

IColor : IUnknown	***Provides access to members that control the basic color interface.***
↔ CMYK: Long	*The CMYK value of color.*
↔ NullColor: Boolean	*The Null Color Flag*
↔ RGB: Long	*The RGB value of color.*
↔ Transparency: Unsigned Char	*The Alpha Blending value. (0 for transparent, 255 for opaque)*
↔ UseWindowsDithering: Boolean	*Indicates if colors should be dithered to simulate colors that aren't supported by the display. This only applies on displays that have 256 or fewer colors.*
← GetCIELAB (out l: Double, out a: Double, out b: Double)	*The CIELAB value of color.*
← SetCIELAB (in l: Double, in a: Double, in b: Double)	*The CIELAB value of color.*

The properties available on the *IColor* interface define the common functionality of all color objects. Representations of colors are held internally as CIELAB colors, described in the color theory topic. The CIELAB color model is device independent, providing a frame of reference to allow faithful translation of colors between one color model and another. You can use the *GetCIELAB* and *SetCIELAB* methods of the *IColor* interface to interact directly with a color object using the CIELAB model.

One important point to note when reading the RGB *property: the* UseWindowsDithering *property should generally be set to* True*. If* UseWindowsDithering *is* False*, the* RGB *property returns a number with a high byte of 2, indicating the use of a system color, and the* RGB *property will return a value outside of the range you would expect. If you write to the* RGB *property, the* UseWindowsDithering *property will be set to* True *for you.*

Although colors are held internally as CIELAB colors, you don't need to deal directly with the CIELAB color model—you can use the *IColor* interface to simply read and define colors. For example, the *RGB* property can be used to read or write a *Long* integer representing the red, green, and blue values for any color object. You can use the Visual Basic *RGB* function to set the *RGB* property of a color object as follows.

```
  colMyColor.RGB = RGB(intMyRedValue, intMyGreenValue, intMyBlueValue)
```

Or, you could use the following function, which essentially performs the same action but lets you see how the conversion is performed.

```
Public Function RGBToLong(lngRed As Long, lngGreen As Long, _
   lngBlue As Long) As Long
  RGBToLong = lngRed + (&H100 * lngGreen) + (&H10000 * lngBlue)
End Function
```

For more information on converting individual byte values to long integer representation, look for topics on color models and hexadecimal numbering in your development environment's online Help system.

If you are reading the *RGB* property, you can break down the RGB value into its component red, green, and blue values with an inverse function of the previously defined *RGBToLong* function, as follows:

```
Public Function ReturnRGBBytes(ByVal lngRGB As Long) As Byte()
  Dim bytArray(2) As Byte
  bytArray(0) = lngRGB Mod &H100
  bytArray(1) = (lngRGB \ &H100) Mod &H100
  bytArray(2) = (lngRGB \ &H10000) Mod &H100
  ReturnRGBBytes = bytArray
End Function
```

The *IColor* interface also provides access to colors through another color model—CMYK. The *CMYK* property can be used in a similar way as RGB to read or write a *Long* integer representing the cyan, magenta, yellow, and black components of a particular color—the difference being that the CMYK color model requires four values to define a color. Visual Basic does not have a function for creating a *CMYK Long* integer value, but the *RGBToLong* function can be adapted as shown.

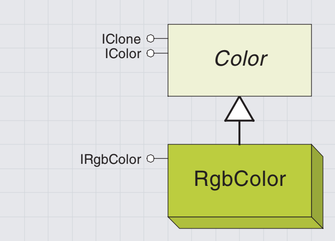
```
Public Function CMYKToLong(lngBlack As Long, lngYellow As Long, _
                lngMagenta As Long, lngCyan As Long) As Long
  CMYKToLong = lngBlack + (&H100 * lngYellow) + _
                (&H10000 * lngMagenta) + (&H1000000 * lngCyan)
End Function
```

Setting the *NullColor* property to *True* will result in the set color being nullified. All items with color set to *Null* will not appear on the display. This only applies to the specific color objects—not all items with the same apparent color; therefore, you can have different null colors in one *Map* or *PageLayout*.

IColor also has two methods to convert colors to and from specific CIELAB colors, using the parameters of the CIELAB color model. You can set a color object to a specific CIELAB color by using *SetCIELab*, or read CIELAB parameters from an existing color by using *GetCIELab*. See also the *CieLabConversion* coclass.

Color transparency does not get used by the feature renderers; instead, a display filter is used. Setting the transparency on a color has no effect, unless the objects using the color honor this setting.

The *Color* class is only an abstract class—when dealing with a color object, you always interact with one of the color coclasses, which are described below. *RGBColor*, *CMYKColor*, *GrayColor* coclass, *HSVColor*, and *HLSColor* are all creatable classes, allowing new colors to be created programmatically according to the most appropriate color model.



RGB colors are defined in terms of the amount of red, green, and blue.

The *RGBColor* coclass defines a simpler way to get and set the red, green, and blue components of a color, compared to using the *RGB* property of the *IColor* interface.

IRgbColor : IColor	***Provides access to members that control the RGB color values.***
Blue: Long	*The blue component of an IRgbColor (0-255)*
Green: Long	*The green component of an IRgbColor (0-255)*
Red: Long	*The red component of an IRgbColor (0-255)*

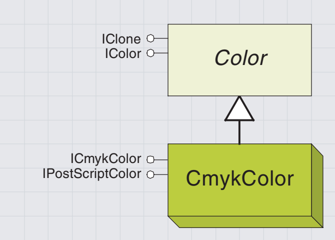
The *IRGBColor* interface defines colors by using 3 properties, *Red, Green,* and *Blue*, which may all be set to values between 0 and 255.

The *IRGBColor* interface defines a simpler way to get and set the red, green, and blue components of a color, compared to using the *RGB* property of the *IColor* interface as discussed earlier. The *Red, Green,* and *Blue* properties may all be set to values between 0 and 255.

For example, from the color theory discussed previously, you can see that if you mix red and green, you get yellow. Therefore, to create a new color that is bright yellow, you might do the following.

```
Dim pRGB As IRgbColor
Set pRGB = New RgbColor
pRGB.Red = 255   'Use the maximum amount of Red
pRGB.Green = 255 'Use the maximum amount of Green
```

There's no need to set the *Blue* property in this example, as the *Red*, *Green*, and *Blue* properties all default to zero. A darker yellow would be created by using equal, but smaller, values for *Red* and *Green*.



CMYK colors are defined in terms of the amount of cyan, magenta, yellow, and black.

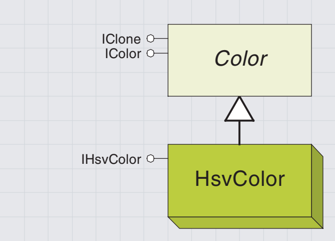
The *CMYKColor* coclass represents colors by using the CMYK color model, described on the color theory page. Colors can be specified for output in terms of *Cyan, Magenta, Yellow,* and *Black*.

ICmykColor : IColor	***Provides access to members that control the CMYK color values.***
Black: Long	*The black component of an ICmykColor (0-255)*
Cyan: Long	*The cyan component of an ICmykColor (0-255)*
Magenta: Long	*The magenta component of an ICmykColor (0-255)*
Yellow: Long	*The yellow component of an ICmykColor (0-255)*

The *ICMYKColor* interface allows you to define colors in terms of the CMYK color model by setting its four properties—*Cyan*, *Magenta*, *Yellow*, and *Black*—to values between 0 and 100. A value of 0 indicates the lack of a color, and a value of 100 indicates a maximum of a color. From the color theory, mixing magenta and yellow creates red; therefore, to create a red *CMYKColor,* you could write code like this:

```
Dim pCMYKCol As ICmykColor
Set pCMYKCol = New CmykColor
pCMYKCol.Yellow = 100
pCMYKCol.Magenta = 100
```

The *CMYKColor* coclass also includes the *IPostScriptColor* interface, but this interface is not supported at ArcGIS 8.1.



HSVColors *are defined based on the HSV color model, which defines colors in terms of hue (color), saturation (purity), and value (brightness).*

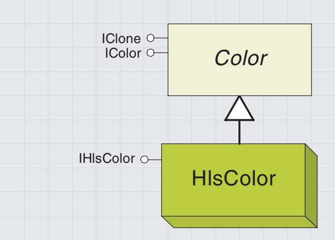
The *HSVColor* coclass represents colors by using the hue, saturation, and value color model described on the color theory page. *HSVColors* may be returned, for example, by a *RandomColorRamp* class.

IHsvColor : IColor	***Provides access to members that control the HSV color values***
Hue: Long	*The hue component of an IhsvColor (0-360)*
Saturation: Long	*The saturation component of an IhsvColor (0-100)*
Value: Long	*The value component of an IhsvColor (0-100)*

The *HSVColor* coclass supports the *IHSVColor* interface. Colors are defined by three read–write properties: *Hue*, *Saturation,* and *Value*. The *Hue* property may be set to a number between 0 and 360, indicating in degrees where the hue lies on the color wheel. The *Saturation* property is a number between 0 and 100 indicating the saturation, or purity, of the color, and the *Value* property is a number between 0 and 100 indicating the value, or brightness, of a color. All of the properties have a default value of 0; therefore, the default *HSVColor* is black.

Using these properties, you can create a bright yellow *HSVColor* like this:

```
Dim pHSV As IHSVColor
Set pHSV = New HSVColor
pHSV.Hue = 60            'Yellow lies at 60 degrees on the color wheel
pHSV.Saturation = 100    'Use the maximum saturation for a bright color
```

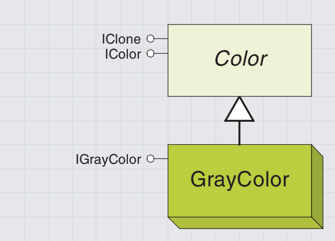


HLSColors *are defined based on the HLS color model, similar to the HSV model, which defines colors in terms of hue (color), lightness, and saturation (purity).*

The *HLSColor* coclass represents colors by using the hue, saturation, and lightness—a similar color model to HSV. However, HLS colors use *Lightness* instead of *Value*.

IHlsColor : IColor	***Provides access to members that control the HLS color model***
Hue: Long	*The hue component of an IHlsColor (0-360)*
Lightness: Long	*The lightness component of an IHlsColor (0-100)*
Saturation: Long	*The saturation component of an HlslColor (0-100)*

The *IHLSColor* interface defines colors by three read–write properties, *Hue, Saturation,* and *Lightness*. The *Hue* property may be set to a number between 0 and 360, indicating in degrees where the hue lies on the color wheel. The *Saturation* property is a number between 0 and 100 indicating the saturation, or purity, of the color, and the *Lightness* property is a number between 0 and 100 indicating the lightness, or paleness, of a color. Regardless of the other properties, a lightness of 0 is always black, and a lightness of 100 is always white. All of the properties have a default value of 0; therefore, the default *HSVColor* is black.

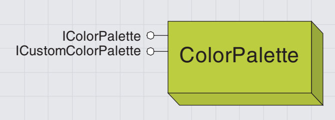


Gray colors are expressed as simple values from 0 to 255.

The *GrayColor* class represents the simplest of all the color models. Gray colors may be encountered, for example, in a grayscale bitmap.

IGrayColor : IColor	***Provides access to members that control the gray color.***
Level: Long	*The level of grayness of an IGrayColor (0 = White - 255 = Black)*

The *Level* property can be set to a value representing a pure shade of gray, from 0, which is black, to 255, which is white.



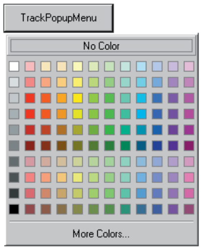
The ColorPalette *is a popup menu displaying a choice of the colors defined by your currently selected* Styles *or, alternatively, a set of colors you specify.*

The *ColorPalette* coclass defines a popup menu that can be used to allow interactive selection of colors. The colors included in the menu include all the colors in the *Styles* currently referenced by the *StyleGallery*. By selecting the More Colors option on the menu, the *ColorSelector* will be displayed.

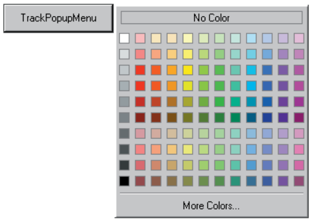
IColorPalette : IUnknown

Color Palette interface.

Color: IColor	Get Selected Color
TrackPopupMenu (in rect: tagRECT, in currentColor: IColor, in Orientation: Boolean, in hParentWnd: Long) : Boolean	Show Color Palette



TrackPopupMenu, *Orientation* = *False*



TrackPopupMenu, *Orientation* = *True*

The *IColorPalette* interface allows you to display the *ColorPalette* to users, allowing them to select the colors they wish. The *TrackPopupMenu* method controls the display of the palette with four parameters. The first parameter defines a rectangle, a *tagRect* structure, in screen coordinates (pixels) that the menu will align itself with—for example, the coordinates of the button that displays the popup menu. For more information about getting the onscreen coordinates of controls, see your development environment's documentation.

The third parameter is a Boolean, which affects the orientation and location of the menu. If *False*, the menu will align beneath the rectangle specified; if *True,* the menu will appear to the right of the rectangle.

The second parameter is a color object, which allows you to specify the current color. If the color exactly matches a color on the menu, that color will be displayed as selected initially. If the user cancels the palette rather than selecting a color, the read-only *Color* property will reflect the color passed in this parameter.

If the user selects a specific color, the *Color* property will return that selected color. If the user selects the More Colors option and selects a color from the *ColorSelector* that is then displayed, the *IColorPalette Color* property will return that color.

ICustomColorPalette : IUnknown

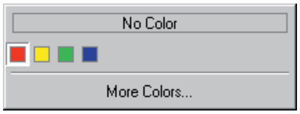
Interface for Setting or Creating a Custom Color Palette

ColorSet: ISet	Set the Color Objects

The *ColorPalette* coclass also supports the *ICustomColorPalette* interface. This interface allows you to determine exactly which colors will be shown on the *ColorPalette* menu, instead of displaying the colors defined in the current Styles. To use the *ICustomColorPalette* interface, set the write-only property *ColorSet* to a *Set* coclass. The *Set* coclass, which supports the *ISet* interface required by the *ColorSet* property, should contain the *Color* objects you wish to display. For example, you could display a *ColorPalette* with four simple colors like this:

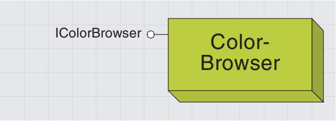
```
Dim pColorSet As ISet, pColor As IColor
Set pColorSet = New esriCore.Set
Set pColor = New RgbColor
```

```
pColor.RGB = 255     ' Red
pColorSet.Add pColor
Set pColor = New RgbColor
pColor.RGB = 65535    ' Yellow
pColorSet.Add pColor
Set pColor = New RgbColor
pColor.RGB = 65280    ' Green
pColorSet.Add pColor
Set pColor = New RgbColor
pColor.RGB = 16711680 ' Blue
pColorSet.Add pColor

Dim pCustomPalette As ICustomColorPalette, pPalette As IColorPalette, _
   pRect As tagRECT

Set pCustomPalette = New ColorPalette
Set pCustomPalette.ColorSet = pColorSet

Set pPalette = pCustomPalette
pPalette.TrackPopupMenu pRect, pColor, False, Me.hWnd
```



The code produces this dialog box display.

Note that since the *ISet Add* method passes the item by reference, you must create a new color object to pass into the method each time.



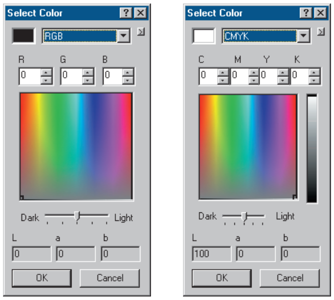
The ColorBrowser *allows the user to select a color by specifying individual RGB, CMYK, HSV, HLS, or gray color properties.*

Use the *ColorBrowser* coclass to display the ArcMap color browser dialog box. Note that this coclass should only be used from within the ArcMap framework.

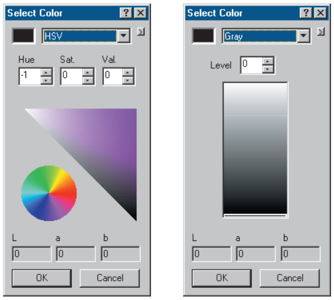
IColorBrowser : IUnknown	*Custom Color Dialog interface.*
■━■ Color: IColor	*Color edited by the browser.*
◀━ DoModal (in hWnd: Long) : Boolean	*Show the browser.*

First, set the *Color* property to an existing *IColor* object—the type of coclass you use will determine what options the dialog displays for editing the color (see the pictures to the left).

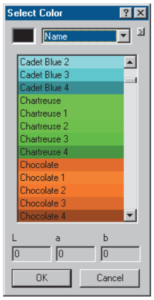
Use the *DoModal* method as shown with the *ColorSelector* coclass, passing in the *hWnd* of the *Application* object of the ArcMap framework as this method's parameter.



Edit a color by specifying red, green, and blue proportions or by specifying cyan, magenta, yellow, and black proportions.

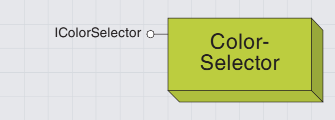


Edit a color by specifying hue, saturation, and value proportions or by specifying the degree of grayness.

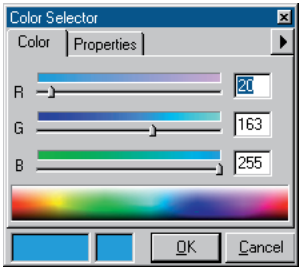


Edit a color by specifying a name selected from all the available colors in your selected Styles.

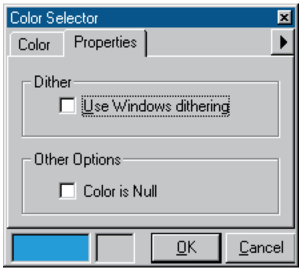
ColorSelector coclass



The ColorSelector is a dialog box that can be used to create new color objects. The dialog presents slider bars and check boxes that can be used to precisely set the properties of the new color.



R 20
G 163
B 255



Dither
☐ Use Windows dithering

Other Options
☐ Color is Null

The *ColorSelector* coclass contains a popup menu that can be used to allow interactive selection of a range of colors.

IColorSelector : IColorBrowser	*Custom Color Dialog interface.*
← InitPopupPosition (in parentLeft: Long, parentTop: Long, parentRight: Long, parentBottom: Long, aboveParent: Boolean)	*Initialize Popup Position*

IColorBrowser : IUnknown	*Custom Color Dialog interface.*
■–■ Color: IColor	*Color edited by the browser.*
← DoModal (in hWnd: Long) : Boolean	*Show the browser.*

Using the *IColorSelector* interface and the inherited *IColorBrowser* interface, you can present users with the Color Selector dialog box.

First, you may want to specify the color that is already displayed by the dialog box when the user first sees it—you can do this by setting the read–write *Color* property to any color object, as shown in the following code.

```
Dim pColor As IColor
Set pColor = New RgbColor
pColor.RGB = 255 'Red

Dim pSelector As IColorSelector
Set pSelector = New ColorSelector
pSelector.Color = pColor
```

The *InitPopupPosition* method can be used to set the initial display location of the dialog box in screen coordinates.

To display the dialog box, you should call the *DoModal* method. The method takes one parameter, a handle to the parent Form, which is used to ensure the dialog box displays modally. The *DoModal* method returns a Boolean—you should check the result to determine if the user intended to cancel the action (the result is *False*) or click OK (the result is *True*). For example:

```
If Not pSelector.DoModal(Me.hWnd) Then
  Dim pOutColor As IColor
  Set pOutColor = pSelector.Color
  Me.BackColor = pOutColor.RGB
End If
```

To determine which color was selected, simply read the *Color* property.

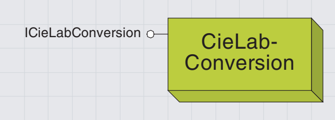
IMonitorSettings
Monitor-
Settings

The monitor settings object can be used in conjunction with a device called a colorimeter to adjust the display of colors on a monitor.

The *MonitorSettings* coclass is not commonly used. It can be set to get and set *WhitePoint, RedPoint, GreenPoint,* and *BluePoint* values for the *Monitor*.

IMonitorSettings : IUnknown	***Provides access to members that control the monitor settings.***
Gamma: Double	*The gamma value of the monitor. (1 <= gamma value <= 3).*
MonitorName: String	*The name of the monitor.*
PhosphorName: String	*The phosphor name of the monitor.*
WhitePointName: String	*The white point name of the monitor.*
GetBluePoint (out X: Double, out Y: Double)	*The blue point of the monitor (0 <= x <= 1, 0 <= y <= 1.*
GetGreenPoint (out X: Double, out Y: Double)	*The green point of the monitor (0 <= x <= 1, 0 <= y <= 1.*
GetRedPoint (out X: Double, out Y: Double)	*The red point of the monitor (0 <= x <= 1, 0 <= y <= 1.*
GetWhitePoint (out X: Double, out Y: Double)	*The white point of the monitor (0 <= x <= 1, 0 <= y <= 1.*
SetBluePoint (in X: Double, in Y: Double)	*The blue point of the monitor (0 <= x <= 1, 0 <= y <= 1.*
SetGreenPoint (in X: Double, in Y: Double)	*The green point of the monitor (0 <= x <= 1, 0 <= y <= 1.*
SetRedPoint (in X: Double, in Y: Double)	*The red point of the monitor (0 <= x <= 1, 0 <= y <= 1.*
SetWhitePoint (in X: Double, in Y: Double)	*The white point of the monitor (0 <= x <= 1, 0 <= y <= 1.*

After using the *SetBluePoint, SetGreenPoint, SetRedPoint,* or *SetWhitePoint* methods to change monitor settings, the monitor settings should be reloaded.



CieLabConversion *provides information about colors within the CIELAB color space and can also be used to compare colors.*

The *CieLabConversion* coclass provides information about the location of colors within the CIELAB color space, the device independent color model used internally by ArcObjects. Colors can be converted from RGB and HSV models to the CIELAB model. It can also be used to compare the visual difference between two colors.

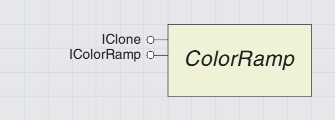
ICieLabConversion : IUnknown	***Provides access to members that control the CIE Lab conversion.***
■— SettingsVersion: Long	*Gets monitor settings version*
← GetDistance (in l1: Double, a1: Double, b1: Double, l2: Double, a2: Double, b2: Double) : Double	*Gets visual difference between two CIELAB colors*
← HsvToLab (in h: Integer, in s: Unsigned Char, in v: Unsigned Char, out l: Double, a: Double, b: Double)	*Converts an RGB color to a CIELAB color*
← LabToHsv (out h: Integer, in s: Unsigned Char, in v: Unsigned Char, in l: Double, a: Double, b: Double)	*Converts a CIELAB color to an RGB color*
← LabToRgb (out RGB: Long, in l: Double, a: Double, b: Double)	*Converts a CIELAB color to an RGB color*
← ReloadSettings	*Reloads the monitor settings from the registry*
← RgbToLab (in RGB: Long, out l: Double, a: Double, b: Double)	*Converts an RGB color to a CIELAB color*

The *ICieLabConversion* interface provides four methods for converting colors to and from the CIELAB color model (these methods are the ones used by the *IColor* interface's *SetCIELab* and *GetCIELab* methods). The methods *RGBtoLab, LabToRGB, HSVToLab,* and *LabToHSV* all take in parameters with which to populate the new converted values, as well as the value to convert. For example, to convert an HSV color representing yellow to CIELAB values, you might do the following:

```
Dim l As Double, a As Double, b As Double
Dim h As Integer, s As Byte, v As Byte

h = 60
s = 100
v = 100

Dim gConversion As ICieLabConversion
Set gConversion = New CieLabConversion
Call gConversion.HsvToLab(h, s, v, l, a, b)
MsgBox "L=" & l & " a=" & a & "  b=" & b, 64, "CIELAB conversion from HSV"
```

The *GetDistance* function provides a useful indication of the visual difference of two colors by passing in two colors via their l, a, and b values. A distance of 4–10 may be indicative of two very similar but distinguishable colors—lighter colors tend to be more distinguishable. A distance of 20–30 may produce distinct but similar colors, whereas distances of > 30 indicate quite different colors.

Bear in mind that the difference between two colors will be affected by your monitor settings—if you have less than 24-bit color, two internally similar colors may be displayed exactly the same. If you have changed your monitor settings, call the *ReloadSettings* method to update your *CieLabConversion* object.



The color ramp objects offer a simple way to create a coherent or random range of colors. You may wish to use a color ramp as the fill when drawing polygons or to define the colors used by a renderer.

The objects supporting the *IColorRamp* interface offer a simple way to define a series of colors for use elsewhere in ArcObjects. For example, you can set a color ramp directly onto the *ColorRamp* property of the *IGradientFillSymbol* interface of a *FillSymbol*, or you might wish to create a color ramp to define the colors used in a *ClassBreaksRenderer*.

The individual *ColorRamp* objects offer different ways of defining the criteria that determine which colors will comprise the *ColorRamp*. Random colors can be created using the *RandomColorRamp*, and sequential colors can be created using the *AlgorithmicColorRamp*. The *PresetColorRamp* coclass contains 13 colors, allowing the creation of ramps mimicking ArcView GIS 3.x color ramps. In addition, the *MultiPartColorRamp* allows you to create a single color ramp that concatenates other color ramps, providing unlimited color ramp capabilities.

IColorRamp : IUnknown	***Provides access to the methods and properties common to all color ramp objects.***
■— Color (in Index: Long) : IColor	*The color at the given index position. Call CreateRamp before calling this method.*
■— Colors: IEnumColors	*The list of colors. Call CreateRamp before calling this method.*
■—■ Name: String	*The name of the color ramp.*
■—■ Size: Long	*The number of colors that will be generated by the CreateRamp method.*
← CreateRamp (out ok: Boolean)	*Generates a color ramp with length determined by Size value.*

ColorRamps are used in two different ways in ArcObjects: by accessing the individual colors in a ramp or by using the ramp object directly as a property or, in a method, of another object.

First, a color ramp can be set up and its individual colors accessed. For example, when a *UniqueValueRenderer* is created, each symbol in its symbol array should be set individually, perhaps using colors from a color ramp.

To retrieve individual colors from a color ramp, first set the *Size* property according to the number of *Color* objects you wish to retrieve from the ramp. The *CreateRamp* method should then be called, which populates both the *Color* and the *Colors* properties. The *Color* property holds a read-only, zero-based array of *Color* objects, returned by index. The code fragment below shows the creation of a *RandomColorRamp* and the generation of 10 color objects from that ramp. Note that the Boolean parameter used in the *CreateRamp* method is checked after the method is called to ensure the colors were generated correctly.

Note that if you set the Size *property, then read it back before calling* CreateRamp*, you will find that* Size *= 0. This indicates that no* Colors *have been created. After calling* CreateRamp*, the* Size *property will equal 5.*

```
Dim pColorRamp As esriCore.IRandomColorRamp
Set pColorRamp = New esriCore.RandomColorRamp
pColorRamp.Size = 10
Dim bOK As Boolean
pColorRamp.CreateRamp bOK
If bOK = True Then
  Dim i As Integer
  For i = 0 To pColorRamp.Size - 1
    ' Access the Color array here, for example, set the colors
    ' for an array of symbols, or map layers etc...
  Next i
End If
```

The *Colors* property returns an enumeration of colors and is useful as a lightweight object to pass around between procedures.

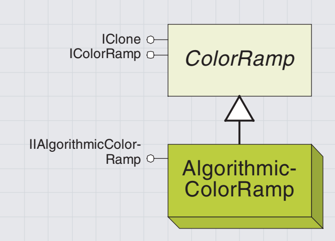
Second, a color ramp object may be used directly—for example, the *ColorRamp* property of the *IGradientFillSymbol* can be set to a specific color ramp object. The *MultiPartColorRamp* also uses color ramp objects directly by passing the object as a parameter in the *AddRamp* method. Below you can see a *GradientFillSymbol* object being created with an *AlgorithmicColorRamp* as its fill. The *IntervalCount* is set, which decides the amount of colors in the gradient fill.

```
Dim pAlgoRamp As IAlgorithmicColorRamp
Set pAlgoRamp = New AlgorithmicColorRamp

pAlgoRamp.FromColor = myFromColorObject
pAlgoRamp.ToColor = myToColorObject

Dim pGFill As esriCore.IGradientFillSymbol
Set pGFill = New esriCore.GradientFillSymbol
pGFill.ColorRamp = pAlgoRamp
pGFill.IntervalCount = 5
```

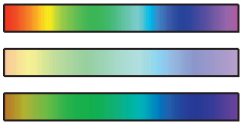
If the ramp will be used directly, as above, it is not necessary to set the *Size* property or to call the *CreateRamp* method yourself. In these cases, the parent object uses the information contained in the color ramp object to generate the number of colors it requires. The *Size* property will be ignored.

The name property simply stores a string, which you may want to use to keep track of your color ramps—it is not used internally by ArcObjects.

Each of the color ramp coclasses has one interface that inherits from the *IColorRamp* interface, allowing access to all of the *IColorRamp* properties and methods from the interface specific to the coclass you are using. The following pages detail each of these coclasses, with example code demonstrating their use.

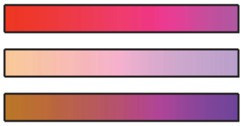


The algorithmic color ramp provides a series of sequential colors. After start and end colors are specified, intervening colors are interpolated by a choice of three different algorithms, providing an intuitive series of colors.

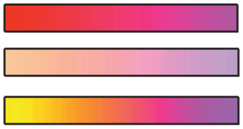


Using the esriHSVAlgorithm *can often give the most vibrant or distinct results. The algorithm used to interpolate intervening colors traverses hues based on the HSV color model; therefore, if the* FromColor *and* ToColor *have very different hue values, the ramp will contain a large variety of hues. If the* FromColor *is red and the* ToColor *is the reddest* PurpleRed, *the result will look like the full spectrum of colors.*

The other algorithms interpolate the FromColor *and* ToColor *using other color models, producing results similar to those you might expect if you were mixing two colors of paint.*



The CIELAB algorithm uses a shortest path between the FromColor *and* ToColor, *based on the CIELAB color space. The result is an apparent blending of the start and end colors with no intervening colors.*



LabLCh *is also a shortest path type of algorithm but does not mute the intervening colors, often resulting in a brighter color ramp.*

The *AlgorithmicColorRamp* class offers a way to produce a series of sequential colors and therefore is ideal for creating colors to represent sequential data in a layer—for example, when data is displayed using a *ClassBreaksRenderer*.

IAlgorithmicColorRamp : IColorRamp	***Provides access to members that control the AlgorithmicColorRamp. A color ramp defined by two colors and the algorithm used to traverse the intervening color space between them.***
▬■ Algorithm: esriColorRampAlgorithm	*The algorithm used to ramp between the first and last colors.*
▬■ FromColor: IColor	*The first color in the color ramp.*
▬■ ToColor: IColor	*The last color in the color ramp.*

The *IAlgorithmicColorRamp* interface allows you to specify how the series of colors is created using three properties. Colors created are *HSVColor* objects.

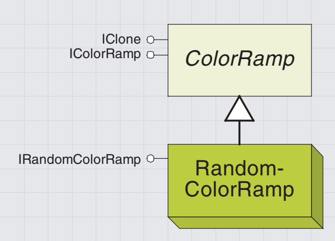
The read–write *FromColor* and *ToColor* properties specify the starting and ending color of the ramp using an object that supports the *IColor* interface. You can use any object that supports the *IColor* interface to set the *FromColor* or *ToColor* properties, although returning the *FromColor* or *ToColor* always gives an *HSVColor* object. For example, a simple color ramp starting at red and fading to white could be created as shown below. Note that the *FromColor* and *ToColor* properties are set by value; therefore, you cannot change the *RGB* values directly from the *IColor* interface returned by the *IAlgorithmicColorRamp* interface.

```
Dim pCol As IRgbColor
Set pCol = New RgbColor

Dim pAlgoRamp As esriCore.IAlgorithmicColorRamp
Set pAlgoRamp = New esriCore.AlgorithmicColorRamp

pCol.RGB = 255  'Red
pAlgoRamp.FromColor = pCol
pCol.RGB = 0    'White
pAlgoRamp.ToColor = pCol
```

The *Algorithm* property can be set to one of the three *esriColorRampAlgorithm* constants. There is little to choose between the algorithms if the *FromColor* and *ToColor* are similar—the different algorithms may produce a color ramp slightly weighted to one end or the other. If the hues are significantly different, the algorithms produce very different results, as you can see in the diagrams to the left.

Enumeration esriColorRampAlgorithm	***ESRI ColorRamp Algorithm.***
0 - esriHSVAlgorithm	*Use the HSV colorramp algorithm.*
1 - esriCIELabAlgorithm	*Use the CIE Lab colorramp algorithm.*
2 - esriLabLChAlgorithm	*Use the LabLCh colorramp algorithm.*

The advantage of the CIELAB algorithm is that the colors of the ramp are visually equidistant, which produces a better ramp.



The random color ramp provides a series of randomly created colors. You can specify limits on the range of hues, values, and saturations possible to create "themed" random colors.

The *RandomColorRamp* class offers a way to produce a series of pseudo-random colors and therefore is ideal for creating a series of colors to represent nominal data based on unique values, for example, when a layer is displayed using a *UniqueValueRenderer*.

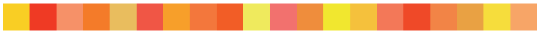
IRandomColorRamp : IColorRamp	*Provides access to members that control the properties of a RandomColorRamp. A color ramp that is a list of randomly picked colors.*
EndHue: Long	*The end hue (0-360).*
MaxSaturation: Long	*The maximum saturation (0-100).*
MaxValue: Long	*The maximum value (0-100).*
MinSaturation: Long	*The minimum saturation (0-100).*
MinValue: Long	*The minimum value (0-100).*
Seed: Long	*The seed of the random number generator.*
StartHue: Long	*The start hue (0-360).*
UseSeed: Boolean	*Indicates if a seed is used when the ramp is generated. Set this property to True without changing the Seed to generate identical color ramps in succession.*

The *IRandomColorRamp* interface allows you to control, to some degree, the randomness of the colors within a random color ramp. The *RandomColorRamp* is designed around the HSV color model and therefore the colors in a random color ramp may be restricted in terms of hue, saturation, and value. Setting the *StartHue* and *EndHue* properties to values between 0 and 360 will restrict the colors that may appear in the ramp. Setting *MinValue* and *MaxValue* to between 0 and 100 will restrict the brightness, and setting *MinSaturation* and *MaxSaturation* to between zero and 100 will restrict the purity of the colors in the ramp. Colors created are *HSVColor* objects.

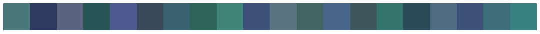
You may wish to restrict the colors in the ramp to bright, light red, and yellow tones, creating a randomized color scheme of vibrant, warm colors. To achieve this effect, you could create a new *RandomColorRamp* and set the *StartHue* property to red (on the color wheel, red is zero), and the *EndHue* property to yellow (yellow has a *Hue* of 60, based on the color wheel). Then, you could restrict the *Saturation* and *Value* ranges. Here is some code to create a random color ramp:

```
Dim pRandomRamp As esriCore.IRandomColorRamp
Set pRandomRamp = New esriCore.RandomColorRamp
With pRandomRamp
  .StartHue = 0
  .EndHue = 60
  .MinSaturation = 60
  .MaxSaturation = 100
  .MinValue = 90
  .MaxValue = 100
End With
```

The code above produces a color ramp with warm colors like this:



If you wish to create a color scheme of dark, muted colors, try restricting the hue range to 160–240, the saturation range to 20–40, and the value range to 30–50, which produces a color ramp like this:

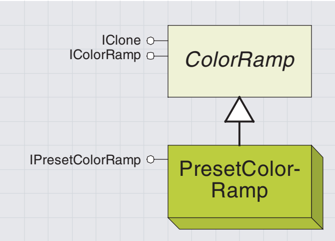


Perhaps a range of pastel colors would be more appropriate. Try using the full hue range of 0–360, a saturation range of 10–20, and a value range of 80–95. These values will produce a color ramp like this:

The *RandomColorRamp* creates colors based on a seed value, which is used to set the state of the pseudorandom number generator. For a specific seed value, the colors created are always the same.

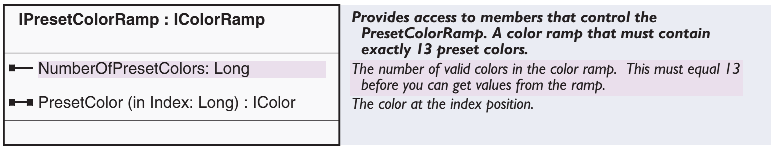
Remember when you are setting your ranges that *StartHue* must always be less than the *EndHue*, *MinSaturation* less than *MaxSaturation*, and *MinValue* less than *MaxValue*. If the values are set incorrectly, the *RandomColorRamp* will use the full range of hue, saturation, or value.

By default, the *UseSeed* property of the *IRandomColorRamp* is *False*. In this case, the *RandomColorRamp* creates a new random number to use as the seed value for each call to *CreateRamp*, ensuring that the *Colors* created are random and different each time *CreateRamp* is called. If the *UseSeed* property is set to *True*, the seed used for the *RandomColorRamp* is taken from the *Seed* property, and therefore each time you call *CreateRamp* with a specific *Seed* value, the sequence of colors created is unchanged.



The algorithmic color ramp holds a series of 13 specific colors, which can be used to mimic ArcView GIS 3.x color ramps.

The *PresetColorRamp* class offers a way to store a series of 13 specific colors, which allows you to mimic ArcView GIS 3.x color ramps in order to preserve your symbology from older systems.



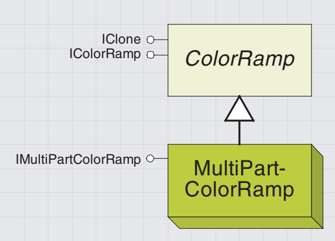
IPresetColorRamp : IColorRamp	Provides access to members that control the PresetColorRamp. A color ramp that must contain exactly 13 preset colors.
NumberOfPresetColors: Long	The number of valid colors in the color ramp. This must equal 13 before you can get values from the ramp.
PresetColor (in Index: Long) : IColor	The color at the index position.

The *IPresetColorRamp* interface provides simple access to the 13 colors in the ramp—the *NumberOfPresetColors* property always returns 13. By default, a *PresetColorRamp* contains 13 *RGBColor* objects ranging from red to green. The *PresetColor* property provides read–write access to the 13 colors in the ramp. For example, you might wish to use 13 random colors as your *PresetColorRamp*, which you could achieve like this:

```
Dim pRandomRamp As esriCore.IRandomColorRamp
Set pRandomRamp = New esriCore.RandomColorRamp
pRandomRamp.Size = 13
pRandomRamp.CreateRamp True

Dim pPresetRamp As esriCore.IPresetColorRamp
Set pPresetRamp = New esriCore.PresetColorRamp
Dim i As Integer
For i = 0 To 12
  'Here you set each PresetColor
  pPresetRamp.PresetColor(i) = pRandomRamp.Color(i)
Next i
```

To re-create ArcView predefined color ramps, you can use the Import ArcView ColorRamps *sample from the ArcObjects Developer Help system.*

MultiPartColorRamp coclass



The multipart color ramp offers a simple way to create more complex color ramps by adding together algorithmic, random, preset, or other multipart color ramps.

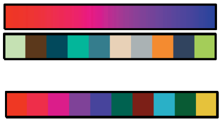
Although the algorithmic, preset, and random color ramp coclasses offer a wide range of options for defining color ramps, you may need to create specific ramps that cannot be created using these coclasses. By concatenating existing color ramps, the *MultiPartColorRamp* coclass offers a way to create highly complex color ramp schemes.

IMultiPartColorRamp : IColorRamp	***Provides access to members that control the MultiPartColorRamp. A color ramp defined by a list of constituent color ramps.***
NumberOfRamps: Long	*The number of constituent color ramps.*
Ramp (in Index: Long) : IColorRamp	*The color ramp at the index position.*
AddRamp (in ColorRamp: IColorRamp)	*Adds a color ramp to the list.*
RemoveRamp (in Index: Long)	*Removes the color ramp located at the index position.*

The *IMultiPartColorRamp* interface provides the framework for concatenating color ramps. After creating a *MultiPartColorRamp* object, you can add color ramps to it with the *AddRamp* method. You can add existing algorithmic, preset, random, or even other multipart color ramps.

As discussed in the *IColorRamp* section, member ramps are used here as properties of another object, and therefore you do not need to set a *Size* and call *CreateRamp* for any ramp set as a member of a *MultiPartColorRamp*—it is the *MultiPartColorRamp* itself that will create the colors when its *Size* property is set. A *MultiPartColorRamp* will try to use an equal number of colors from each member ramp to create its colors. In the illustrated code below, two different color ramps are added to a new *MultiPartColorRamp*, which is used to create 10 colors.

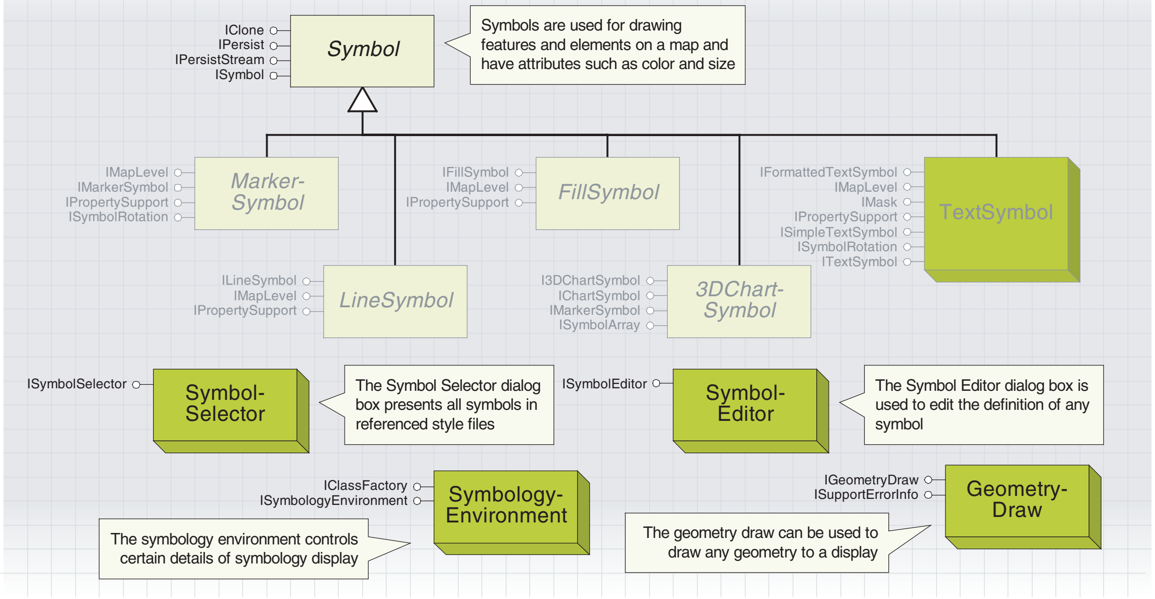
```
Dim pMPRamp As esriCore.IMultiPartColorRamp
Set pMPRamp = New esriCore.MultiPartColorRamp
With pMPRamp
  .AddRamp pAlgoRamp        ' added:
  .AddRamp pRandomRamp      ' added:
  .Size = 10
  .CreateRamp True      'results in:
End With
```



You can check the number of ramps in a *MultiPartColorRamp* by reading the *NumberOfRamps* property. You can access individual ramps by using the *Ramp* property array, which returns an individual ramp. You can also remove specfic ramps using the *RemoveRamp* method, which removes a ramp at a specific index, for example, to remove the last ramp in a *MultiPartColorRamp*:

```
pMPRamp.RemoveRamp pMPRamp.NumberOfRamps - 1
```

Symbol objects



Symbols are used for drawing features and elements on a map and have attributes such as color and size

The Symbol Selector dialog box presents all symbols in referenced style files

The Symbol Editor dialog box is used to edit the definition of any symbol

The symbology environment controls certain details of symbology display

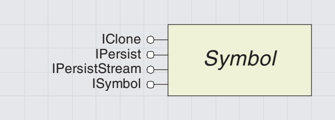
The geometry draw can be used to draw any geometry to a display

ArcObjects uses three categories of symbols to draw geographic features: marker symbols, line symbols, and fill symbols. These same basic symbols are also used to draw graphic elements, such as neatlines and North arrows, on a *Map* or *PageLayout*. A fourth symbol, the *TextSymbol*, is used to draw labels and other textual items. A fifth symbol, the *3DChartSymbol*, is used for drawing charts.

In the case of a graphic element, a symbol is set as a property of each element. Layers, however, are drawn with a renderer, which has one or more symbols associated with it.

The size of a symbol is always specified in points (such as the width of a line), but the size of their geometry (such as the path of a line) is determined by the item they are used to draw. Most items, when created, have a default symbol, so instead of creating a new symbol for every item, you can modify the existing one.

Another way to get a symbol is to use a style file. ArcObjects uses style files, which are distributable databases, to store and access symbols and colors. Many standard styles, offering thousands of predefined symbols, are available during the installation process. Using the *StyleGallery* and *StyleGalleryItem* classes, you can retrieve and edit existing symbols, which may be more efficient than creating symbols from scratch.



A symbol determines how any item is drawn on a map or page layout. Every item on a page layout or map has to have a symbol in order to be drawn.

You might also wish to use the standard symbol editors found in ArcMap, which can be opened programmatically using the *SymbolEditor* coclass. The following pages describe how to create all the different symbols from first principles.

The *Symbol* abstract class provides high-level functionality for all symbols. It allows you to draw any symbol directly to a device context (DC). A device context is an internal Windows structure—each window has a device context handle, or hDC.

ISymbol : IUnknown	***Provides access to members that control symbols.***
ROP2: tagesriRasterOpCode	*Raster operation code for pixel drawing.*
Draw (in Geometry: IGeometry)	*Draws the specified shape.*
QueryBoundary (in hDC: Long, in displayTransform: ITransformation, in Geometry: IGeometry, in Boundary: IPolygon)	*Fills an existing polygon with the boundary of the specified symbol.*
ResetDC	*Restores DC to original state.*
SetupDC (in hDC: Long, in Transformation: ITransformation)	*Prepares the DC for drawing the symbol.*

The *SetupDC, Draw,* and *ResetDC* methods can be used in conjunction with the *ROP2* property to draw a symbol to a device context, providing a familiar procedure for those who have worked with device context drawing before. Calling the *SetupDC* method selects the *Symbol* into the specified DC, and setting the *ROP2* property to one of the *esriRasterOpCodes* specifies how the *Symbol* is drawn (see below). Subsequently calling the *Draw* method will draw the *Symbol*, using the *Geometry* parameter from the *Draw* method, to the DC.

The following code demonstrates drawing to a device context, where *pDisplay* is a valid *Display* object, *pPoint* is a valid *Point* in display coordinates, and *pSymbol* is any valid *Symbol*. There are two important points to note:

- Call *StartDrawing* on the *Display* before using the *Draw* method, as this sets up the *Display*'s device context. Always ensure you call *FinishDrawing* on the *Display* after you have finished.
- Always make sure you call *ResetDC* after you finish drawing with a particular symbol, which restores the DC to its original state.

```
Sub DrawSymbol
  pDisplay.StartDrawing pDisplay.hDC, esriNoScreenCache
  pSymbol.SetupDC pDisplay.hDC, pDisplay.DisplayTransformation
  pSymbol.Draw pPoint
  pSymbol.ResetDC
  pDisplay.FinishDrawing
End Sub
```

The esriROPXOrPen *or* esriROPNotXOrPen *are ideal for use in events where an item with a* Symbol *is being dragged around, as a repeat* Draw *at the same location will in effect erase the previous* Draw.

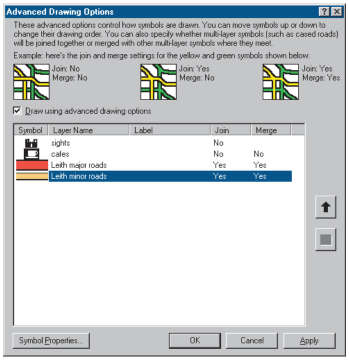
Try setting the *ROP2* property to a different raster operation than the default, *esriROPCopyPen*, in which the color of each pixel is the color determined by the *Symbol*. A careful choice of pen can give many different results, for example, flashing symbols, drawing and erasing, silhouettes, and negative effects.

The example below demonstrates the use of this raster operation, where the *Symbol* is drawn twice in the *MouseMove* event, the first *Draw* erasing the existing symbol and the second *Draw* drawing the symbol in a new location. The *MouseUp* event erases the final symbol. The *m_Symbol* variable indicates any existing symbol.

```
Private m_Display As IDisplay
Private m_Symbol As ISymbol
Private m_newPoint As IPoint
Private m_DrawPhase As Boolean
Private Sub UIToolControl1_MouseDown(ByVal button As Long, ByVal shift As
Long, ByVal x As Long, ByVal y As Long)
  Dim pMxDoc As IMxDocument
  Set pMxDoc = ThisDocument
  Set m_Display = pMxDoc.ActiveView.ScreenDisplay
  Set m_newPoint = m_Display.DisplayTransformation.ToMapPoint(x, y)
  m_DrawPhase = True
  DrawSymbol
End Sub

Private Sub UIToolControl1_MouseMove(ByVal button As Long, ByVal shift As
Long, ByVal x As Long, ByVal y As Long)
  If m_DrawPhase Then
    DrawSymbol
    Set m_newPoint = m_Display.DisplayTransformation.ToMapPoint(x, y)
    DrawSymbol
  End If
End Sub

Private Sub UIToolControl1_MouseUp(ByVal button As Long, ByVal shift As
Long, ByVal x As Long, ByVal y As Long)
  If m_DrawPhase Then
    Set m_newPoint = m_Display.DisplayTransformation.ToMapPoint(x, y)
    DrawSymbol
    m_DrawPhase = False
  End If
End Sub
```

Enumeration tagesriRasterOpCode	***Binary Raster op-codes for symbol drawing.***
1 - esriROPBlack	*Pixel is always 0.*
2 - esriROPNotMergePen	*Pixel is the inverse of the esriROPMergePen color.*
3 - esriROPMaskNotPen	*Pixel is a combination of the colors common to both the screen and the inverse of the pen.*
4 - esriROPNotCopyPen	*Pixel is the inverse of the pen color.*
5 - esriROPMaskPenNot	*Pixel is a combination of the colors common to both the pen and the inverse of the screen.*
6 - esriROPNot	*Pixel is the inverse of the screen color.*
7 - esriROPXOrPen	*Pixel is a combination of the colors in the pen and in the screen, but not in both.*
8 - esriROPNotMaskPen	*Pixel is the inverse of the esriROPMaskPen color.*
9 - esriROPMaskPen	*Pixel is a combination of the colors common to both the pen and the screen.*
10 - esriROPNotXOrPen	*Pixel is the inverse of the esriROPXOrPen color.*
11 - esriROPNOP	*Pixel remains unchanged.*
12 - esriROPMergeNotPen	*Pixel is a combination of the screen color and the inverse of the pen color.*
13 - esriROPCopyPen	*Pixel is the pen color.*
14 - esriROPMergePenNot	*Pixel is a combination of the pen color and the inverse of the screen color.*
15 - esriROPMergePen	*Pixel is a combination of the pen color and the screen color.*
16 - esriROPWhite	*Pixel is always 1.*

You can select a value for the *ROP2* property from the *esriRasterOpCode* enumeration.



Advanced Drawing Options

These advanced options control how symbols are drawn. You can move symbols up or down to change their drawing order. You can also specify whether multi-layer symbols (such as cased roads) will be joined together or merged with other multi-layer symbols where they meet.

Example: here's the join and merge settings for the yellow and green symbols shown below:

Join: No
Merge: No

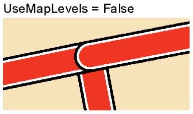
Join: Yes
Merge: No

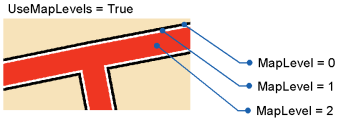
Join: Yes
Merge: Yes

☑ Draw using advanced drawing options

Symbol	Layer Name	Label	Join	Merge
	sights		No	
	cafes		No	No
🟥	Leith major roads		Yes	Yes
	Leith minor roads		Yes	Yes

The IMapLevel *interface was designed for use by the Advanced Drawing Options dialog box in ArcMap, which allows you to join and merge multilayer symbols.*





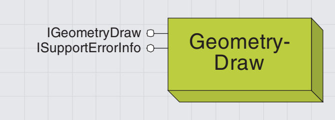
IMapLevel : IUnknown	*Provides access to memebers that control the map level.*
MapLevel: Long	*Current map level for drawing multi-level symbols.*

Using the *IMapLevel* interface allows you to alter the draw order of the symbols used to draw feature layers. This functionality was originally designed for drawing cased roads and similar symbols but has been designed to offer flexibility and can be used on any symbol used by a renderer except 3D chart symbols. Graphic elements ignore *MapLevels*, as do *ISymbol::Draw* calls.

To draw layers in a map using map levels, first set the *IMap::UseSymbolLevels* property to *True*. Then, set up each individual symbol to have a *MapLevel*. Any symbols with *MapLevel* equal to 0 draw first (at the bottom), then any symbols with *MapLevel* equal to 1, until the highest *MapLevel* is reached. If more than one symbol has the same *MapLevel*, then when that *MapLevel* is reached those symbols are drawn in the normal layer order. A *MapLevel* of -1 on a multilayer symbol indicates that each of its symbol layers are drawn with their individual *MapLevel*.

The following code example demonstrates how you could “merge” a *MultiLayerLineSymbol* that belongs to a *SimpleRenderer* on the top map layer by setting the *MapLevel* symbols in the *MultiLayerLineSymbol*. The *SetMapLevel* function is called on each *Symbol* in the *MultiLayerLineSymbol*.

```
pMap.UseSymbolLevels = True

If TypeOf pMap.Layer(0) Is IGeoFeatureLayer Then
  Dim pFeatLyr As IGeoFeatureLayer
  Set pFeatLyr = pMap.Layer(0)

  If TypeOf pFeatLyr.Renderer Is ISimpleRenderer Then
    Dim pSimpleRend As ISimpleRenderer
    Set pSimpleRend = pFeatLyr.Renderer

    If TypeOf pSimpleRend.Symbol Is IMultiLayerLineSymbol Then
      Dim pMulti As IMultiLayerLineSymbol
      Set pMulti = pSimpleRend.Symbol
      SetMapLevel pMulti, -1
      Dim i As Long
      For i = 0 To pMulti.LayerCount - 1
        SetMapLevel pMulti.Layer(i), pMulti.LayerCount - (i + 1)
      Next i
    End If
  End If
End If

Sub SetMapLevel(pMapLevel As IMapLevel, lngLevel As Long)
  If Not pMapLevel Is Nothing Then
    pMapLevel.MapLevel = lngLevel
  End If
End Sub
```



The geometry draw can be used to draw any geometry to a display.

The GeometryDraw *object provides an alternative to using the* ISymbol::Draw *method, which draws a* Symbol *to a device context using a particular* Geometry *to provide the location.*

The *GeometryDraw* coclass is used to draw an *IGeometry* object to an *IDisplay* object.

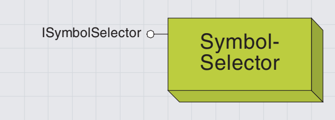
IGeometryDraw : IUnknown	***Converts a geometry into a sequence of Win32 drawing instructions.***
← Draw (hDC: Long, pGeometry: IGeometry, pTransformation: ITransformation, pVisibleBounds: IEnvelope)	*Draws the geometry.*
← QueryGeometryFromWin32Path (in hDC: Long, in Transform: ITransformation, in Geometry: IPolygon)	*Queries the geometry.*

Use the *Draw* method to draw a *Geometry* to a *Display*, as shown below.

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument

Dim pDisplay As IDisplay
Set pDisplay = pMxDoc.ActiveView.ScreenDisplay
pDisplay.StartDrawing 0, esriNoScreenCache

Dim pGeomDraw As IGeometryDraw
Set pGeomDraw = New GeometryDraw
'pGeom is an existing Geometry object
pGeomDraw.Draw pDisplay.hDC, pGeom, pDisplay.DisplayTransformation, _
 pGeom.Envelope
pDisplay.FinishDrawing
```

The *Geometry* is drawn using the current symbol set on the *Display*, which you can set by calling *IDisplay::SetSymbol*. Note the call to *StartDrawing*, which is necessary to set up the *Display* with a valid *hDC*.

SymbolSelector coclass



The Symbol Selector dialog box presents all the symbols in the currently referenced style files.

The *SymbolSelector* coclass is ideal for presenting the user with a choice of symbols, either marker, line, fill, or text symbols. The symbols in the selector are taken from all the currently referenced style files.

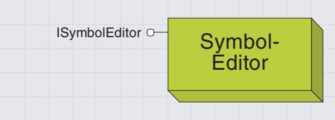
ISymbolSelector : IUnknown	*Provides a dialog for Symbol Selection*
← AddSymbol (in Symbol: ISymbol) : Boolean	*Provides a dialog for Adding a symbol*
← GetSymbolAt (in Index: Long) : ISymbol	*Gets the symbol at the given index*
← SelectSymbol (hWnd: Long) : Boolean	*Displays a dialog that lets the user select a symbol*

The *AddSymbol* method is used to define which type of symbols should be displayed in the *SymbolSelector*. For example, passing a *MarkerSymbol* will display all available *MarkerSymbols*. The *AddSymbol* method also determines which symbol is shown in the initial Preview frame when the dialog box opens.

The *SelectSymbol* method is used to display the dialog box; check the return value to determine if the user clicked OK (*True*) or Cancel (*False*).

Finally, the *GetSymbolAt* method is used to retrieve the selected symbol using an index of zero.

```
Dim pSymbolSelector As ISymbolSelector
Set pSymbolSelector = New SymbolSelector
Dim pMarker As ISimpleMarkerSymbol
Set pMarker = New SimpleMarkerSymbol
If Not pSymbolSelector.AddSymbol(pMarker) Then
  MsgBox "Could not add symbol"
Else
  If  pSymbolSelector.SelectSymbol(0) Then
    Dim pSymbol As ISymbol
    Set pSymbol = pSymbolSelector.GetSymbolAt(0)
  End If
```



The SymbolEditor *is the dialog box shown by ArcMap to edit the details of any given* Symbol*.*

The pages shown on the dialog box will depend on the type of symbol used. For example, a cartographic line symbol has a slightly different dialog box than a marker line symbol.

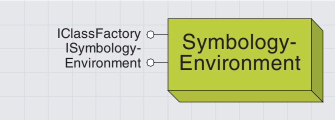
The *SymbolEditor* provides an ideal way to allow a user to edit all the properties of a specific, preexisting symbol.

ISymbolEditor : IUnknown	*Symbol Editor*
■-■ ShowUnits: Boolean	*Indicates whether to display the Units combo box.*
■-■ Title: String	*The title of the Symbol Editor dialog.*
← EditSymbol (Symbol: ISymbol, hWnd: Long) : Boolean	*Displays the Symbol Editor dialog for the given symbol and returns a flag indicating if the symbol changed.*

The *EditSymbol* method takes an *ISymbol* parameter, which must be an existing object that supports *ISymbol*. This object is passed by reference and will be directly changed depending on the selections made in the dialog box. Its coclass may even change.

The *EditSymbol* method call will open the *SymbolEditor* dialog box. To determine if the user clicked Cancel or OK, check the return value.

```
Dim pSymbol As IMarkerSymbol
Set pSymbol = New SimpleMarkerSymbol
Dim pSymbolEditor As ISymbolEditor
Set pSymbolEditor = New SymbolEditor
pSymbolEditor.Title = "Edit My Marker"
If Not pSymbolEditor.EditSymbol(pSymbol, 0) Then
  MsgBox "Use pressed Cancel"
Else
  'Do something with the edited Symbol
End If
```

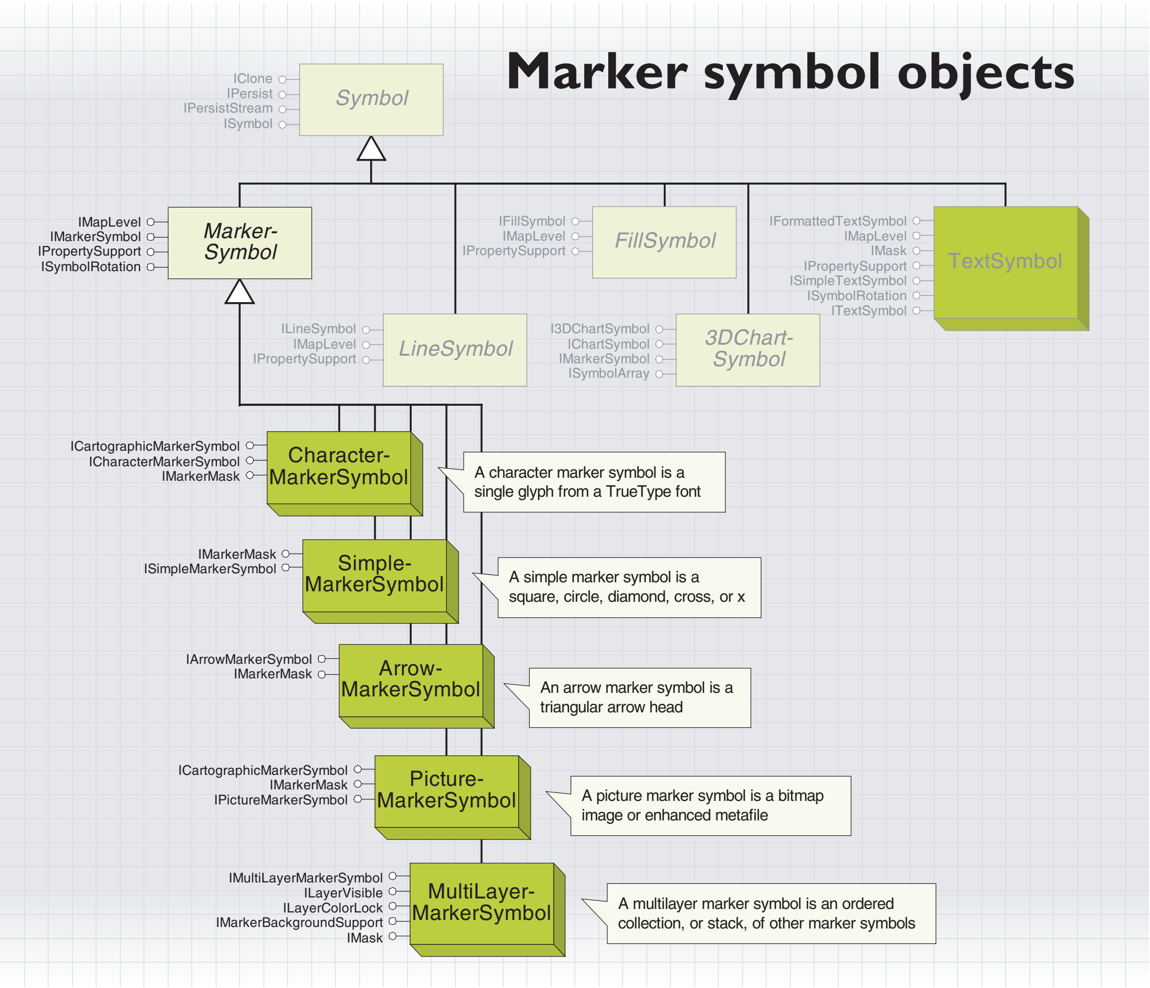


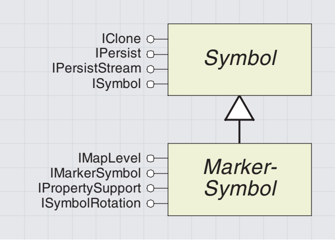
The symbology environment object is used internally by ArcMap when outputting maps.

The *SymbologyEnvironment* coclass is a Singleton and controls certain details of how symbols are drawn as Graphical Device Interface (GDI) objects. Most developers will find it unnecessary to change the default *SymbologyEnvironment* properties, as the coclass is used primarily by ArcMap to set symbology options for exporting and printing.

ISymbologyEnvironment : IUnknown	***Controls the environment for certain Symbol operations***
■-■ GeometryClipping: Boolean	*Indicates if all geometry is clipped on output.*
■-■ OutputGDICommentForCMYKColor: Boolean	*Indicates if a GDI comment is output for CMYK colors.*
■-■ OutputGDICommentForGroupings: Boolean	*Indicates if a GDI comment is output for groupings.*
■-■ OutputGDICommentForLayers: Boolean	*Indicates if a GDI comment is output for layers.*
■-■ OutputGDICommentForText: Boolean	*Indicates if a GDI comment is output for text.*
■-■ StrokeTrueTypeMarkers: Boolean	*Indicates if TrueType markers are stroked.*

Marker symbol objects





A MarkerSymbol *represents how a point or multipoint feature or graphic is drawn.*

The *MarkerSymbol* abstract class represents the properties all types of *MarkerSymbol* have in common. These are *Angle, Color, Size XOffset,* and *YOffset*.

IMarkerSymbol : IUnknown	***Provides access to members that control marker symbols.***
Angle: Double	*Marker symbol angle.*
Color: IColor	*Marker symbol color.*
Size: Double	*Marker symbol size.*
XOffset: Double	*Symbol X-axis offset from point location.*
YOffset: Double	*Symbol Y-axis offset from point location.*

IMarkerSymbol is the primary interface for all marker symbols in ArcMap. All other marker symbol interfaces inherit the properties and methods of *IMarkerSymbol*. The interface has five read–write properties that allow you to get and set the basic properties of any *MarkerSymbol*.

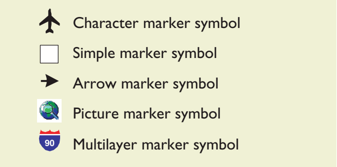
The *Color* property can be set to any *IColor* object, and its effects will be dependent on the type of coclass you are using.

coclass	default color	color property sets
SimpleMarkerSymbol	black	the fill color of the marker
ArrowMarkerSymbol	black	the fill color of the arrow head
CharacterMarkerSymbol	black	the fill color of the text symbol
PictureMarkerSymbol 1 bit	black	parts of the boolean image which contain a color
PictureMarkerSymbol n bits	not set	no effect
MultiLayerMarkerSymbol	none	dependent on ILayerColorLock

The *Size* property sets the overall height of the symbol if the symbol is a *SimpleMarkerSymbol, CharacterMarkerSymbol, PictureMarkerSymbol,* or *MultiLayerMarkerSymbol*. For an *ArrowMarkerSymbol*, *Size* sets the length. The units are points. The default size is eight for all marker symbols except the *PictureMarkerSymbol*—its default size is 12.

The Size, XOffset, *and* YOffset *of a marker symbol is in printer's points—1/72 of an inch.*

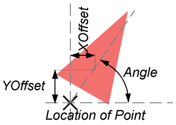
The *Angle* property sets the angle in degrees to which the symbol is rotated counterclockwise from the horizontal axis; and its default is 0. The *XOffset* and *YOffset* properties determine the distance to which the symbol is drawn offset from the actual location of the feature. The properties are both in printer's points, both have a default of zero, and both can be negative or positive; positive numbers indicate an offset above and to the right of the feature, and negative numbers indicate an offset below and to the left.



The types of marker symbols.

Below, you create an *ArrowMarkerSymbol* and set only the properties inherited from *IMarkerSymbol*. This results in the symbol shown.

```
Dim pArrow As IMarkerSymbol
Set pArrow = New ArrowMarkerSymbol
With pArrow
  .Angle = 60
  .Size = 50
  .XOffset = 20
  .YOffset = 30
  .Color = pColor
End With
```



To the left are some examples of each of the marker symbol types.

Simple marker symbols

Arrow marker symbols

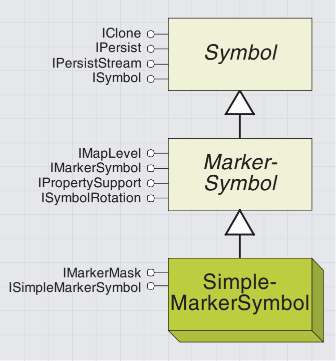
Character marker symbols

Picture marker symbols

Multilayer marker symbols

SimpleMarkerSymbol coclass

The *SimpleMarkerSymbol* coclass can be used to display a point with simple characteristics. The *SimpleMarkerSymbol* determines the shape of the simple symbol and also its outline characteristics.



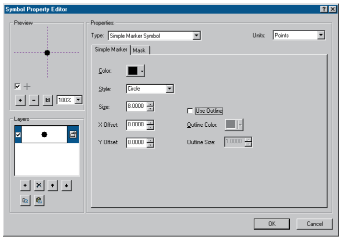
The simple marker symbol draws a circle, square, cross, x, or diamond.

ISimpleMarkerSymbol : IMarkerSymbol	***Provides access to members that control the simple marker symbol.***
Outline: Boolean	*Indicates if the symbol outline will draw.*
OutlineColor: IColor	*Outline color.*
OutlineSize: Double	*Outline diameter.*
Style: tagesriSimpleMarkerStyle	*Marker style.*

The *ISimpleMarkerSymbol* interface inherits from the *IMarkerSymbol* interface and has four read–write properties.

The *Style* property determines the basic shape of the symbol and can be set to one of five basic shapes using the *esriSimpleMarkerStyle* constants.

Enumeration tagesriSimpleMarkerStyle		***Simple marker styles.***
0 - esriSMSCircle	●	*The marker is a circle.*
1 - esriSMSSquare	■	*The marker is a square.*
2 - esriSMSCross	+	*The marker is a cross.*
3 - esriSMSX	✕	*The marker is an X.*
4 - esriSMSDiamond	◆	*The marker is a diamond.*


Symbol Property Editor

Preview

☑ 100%

Layers

Properties:

Type: Simple Marker Symbol

Units: Points

Simple Marker | Mask

Color:

Style: Circle

Size: 8.0000

X Offset: 0.0000

Y Offset: 0.0000

☐ Use Outline

Outline Color:

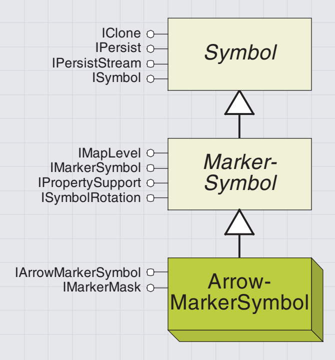
Outline Size: 1.0000

This is the ArcMap dialog box for editing simple marker symbols.

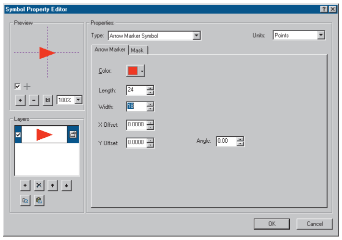
These simple shapes can be enhanced with outlines. Try setting the *Outline* property to *True* and setting an *IColor* onto the *OutlineColor* property.

The *OutlineSize* property determines the thickness of the outline in printer's points. Bear in mind that the outline is drawn on top of the symbol and will overlap the symbol by half its thickness. By default, a simple marker symbol will be a circle with no outline.

The default *OutlineColor* is black, and the default *OutlineSize* is 0.



The ArrowMarkerSymbol *displays a feature as an arrowhead.*


Symbol Property Editor

Type: Arrow Marker Symbol

Units: Points

Color:

Length: 24

Width: 18

X Offset: 0.0000

Y Offset: 0.0000

Angle: 0.00

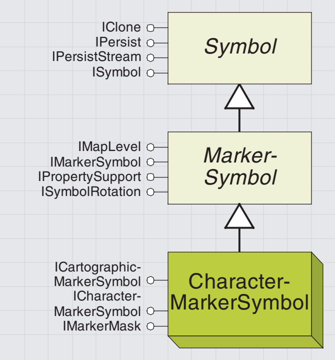
The ArcMap dialog box for editing arrow marker symbols.

The *ArrowMarkerSymbol* coclass can be used to display a point as the head of an arrow.

IArrowMarkerSymbol : IMarkerSymbol	*Provides access to members that control the arrow marker symbol.*
Length: Double	*Arrow marker length.*
Style: tagesriArrowMarkerStyle	*Arrow marker style.*
Width: Double	*Arrow marker width.*

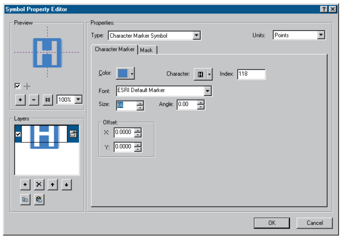
The *IArrowMarkerSymbol* interface inherits from the *IMarkerSymbol* interface and allows you to set characteristics of the arrow marker. There is currently one style, a simple triangular arrowhead—the *Style* property therefore is always equal to the *esriArrowMarkerStyle* constant *esriAMSPlain*.

The *Length* and *Width* properties set the dimensions of the arrow. Note that the *Length* property equals the inherited *Size* property, so you can set the relative length and width of the arrow using the *Length* and *Width* properties and then scale the arrow marker using the *Size* property.



The CharacterMarkerSymbol *displays a feature as a character from a font. You can use any font on your system and specify which glyph from the font should be used as the symbol.*

A glyph is a single character from a font.



Type: Character Marker Symbol

Units: Points

Index: 118

Font: ESRI Default Marker

Size: 66

Angle: 0.00

X: 0.0000

Y: 0.0000

The ArcMap dialog box for editing character marker symbols.

To display a point as a glyph from a font, use the *CharacterMarkerSymbol* coclass.

ICharacterMarkerSymbol : IMarkerSymbol	Provides access to members that control the character marker symbol.
CharacterIndex: Long	Character index within font.
Font: Font	Font used for character symbol.

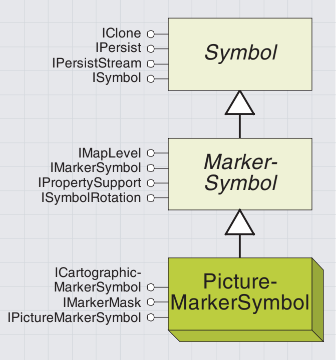
The *ICharacterMarkerSymbol* interface inherits from the *IMarkerSymbol* interface and allows you to specify the characteristics of your chosen glyph. To choose a font from which to pick your glyph, create a standard OLE font object and set this onto the *Font* property. This is shown in the following code:

```
Dim pFont As New stdole.StdFont
With pFont
  .Name = "Arial"
  .Bold = True
  .Italic = True
End With
Dim pMarker As esriCore.ICharacterMarkerSymbol
Set pMarker = New esriCore.CharacterMarkerSymbol
pMarker.Font = pFont
pMarker.Size = 12.0
```

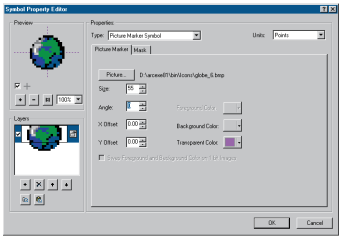
Now that you have set up the font to use, you should pick which glyph you require. Set the *CharacterIndex* property to the required glyph number. Each font has up to 256 glyphs. To work out which glyph you require, you may wish to use the Windows NT *CharacterMap* accessory. You can also use the *CharacterIndex* sample to work out all the character indices for a selected font. Use the *IMarkerSymbol* interface's *Size* property to set the size of the symbol, not the *Size* property of the font itself.

ICartographicMarkerSymbol: IUnknown	Provides access to members that control the cartographic marker symbol.
XScale: Double	Symbol scale along X-axis.
YScale: Double	Symbol scale along Y-axis.

To stretch a *PictureMarkerSymbol* or *CharacterMarkerSymbol*, use the *ICartographicMarkerSymbol* interface. The *ICartographicMarkerSymbol* interface inherits from the *IMarkerSymbol* interface and allows you to scale a marker symbol in the x and y directions independently by setting the *XScale* and *YScale* properties. For example, setting *XScale* and *YScale* to 1 (the default) indicates the symbol should remain at its original proportions; an *XScale* of 2 indicates the symbol is stretched to twice its original width.

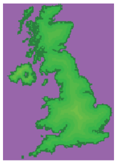


The PictureMarkerSymbol *displays a feature as a bitmap. Use a* PictureMarkerSymbol *when you require a specific kind of symbol that cannot be created using the other marker types.*



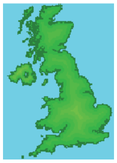
Type: Picture Marker Symbol
Units: Points
D:\arcexe81\bin\Icons\globe_6.bmp
Size: 55
Angle: 0
X Offset: 0.00
Y Offset: 0.00
Foreground Color:
Background Color:
Transparent Color: 🟪
☐ Swap Foreground and Background Color on 1 bit Images
100%

The ArcMap dialog box for editing picture marker symbols



Bitmap plus purple mask color (matching the sea color in the original)

The original bitmap



Bitmap plus purple mask plus cyan background, which effectively replaces the purple

The *PictureMarkerSymbol* coclass draws a point as a bitmap or Windows metafile. Pictures can be 1-bit up to 24-bit (true color) images.

IPictureMarkerSymbol : IMarkerSymbol	*Provides access to members that control the raster (bitmap) marker symbol.*
BackgroundColor: IColor	*Background color of the picture for 1 bit images.*
BitmapTransparencyColor: IColor	*Color within bitmap indicating transparency.*
Picture: Picture	*Picture used for marker symbol.*
SwapForeGroundBackGroundColor: Boolean	*Indicates if foreground and background colors are swapped on 1 Bit Images Only.*
CreateMarkerSymbolFromFile (in Type: tagesriIPictureType, in FileName: String)	*Create symbol from picture file.*

There are two ways to set the *Picture* of a *PictureMarkerSymbol*—calling *CreateMarkerSymbolFromFile* or setting the *Picture* property directly.

The *CreateMarkerSymbolFromFile* method has two parameters that specify a picture type and file path. Set the *FileName* parameter to the full path name of the picture you wish to use—an error is generated if the file path is incorrect. Set the *Type* parameter to one of the *esriPictureType* constants.

Enumeration tagesriIPictureType	*IPicture Data Types.*
0 - esriIPictureEMF	*EMF.*
1 - esriIPictureBitmap	*BITMAP.*

```
Dim pPicMarker As IPictureMarkerSymbol
Set pPicMarker = New PictureMarkerSymbol
pPicMarker.CreateMarkerSymbolFromFile esriIPictureBitmap, _
   "C:\Data\MyImage.bmp"
```

If you already have a reference to an OLE picture, you can directly set the *Picture* property—note the *Picture* property is by reference. Below, the VB *LoadPicture* function returns an *IPictureDisp* interface.

```
Set pPicMarker.Picture = LoadPicture("C:\Data\MyImage.bmp")
```

The *Picture* property of a standard VBA Image control also returns an *IPictureDisp* interface.

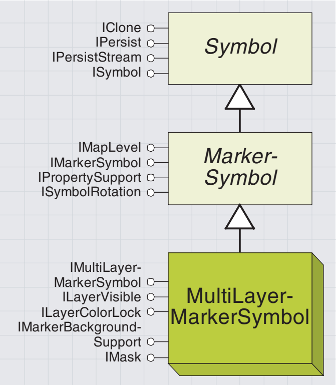
```
Set pPicMarker.Picture = UserForm1.ImageControl1.Picture
```

Your picture may have a solid filled background. You can display your marker without this background by setting the *BitmapTransparencyColor* property to the color of the background fill (or any other color in the image you wish to be transparent). You can decide to fill in any unfilled areas of your picture with a different color by setting the *BackgroundColor* property. If you have set the *BitmapTransparencyColor*, the background will be drawn in the transparent areas.

To remove these color effects from your marker, set the *BitmapTransparencyColor* and *BackgroundColor* properties to *Nothing*.

The *SwapForeGroundBackGroundColor* property only affects the drawing of 1-bit images, where each pixel will either have a value of 0 or 1. When a 1-bit image is used as a *PictureMarkerSymbol*, the foreground equates to the “0” pixels, and the background equates to the “1” pixels.

By default, the *Color* property is black, the *BackgroundColor* is also black but is a *NullColor*, and *SwapForeGroundBackGroundColor* is *True*.



A MultiLayerMarkerSymbol *is a collection of* MarkerSymbols*, all of which are used to display a single point feature.*

The *MultiLayerMarkerSymbol* coclass can be used to display a point by drawing a number of different marker symbols together, so complex marker symbols can be built up from simple marker symbols.

IMultiLayerMarkerSymbol : IMarkerSymbol	Provides access to members that control the multiLayer marker symbol.
Layer (in Index: Long) : IMarkerSymbol	Marker symbol per index position.
LayerCount: Long	Symbol layer count.
AddLayer (in markerLayer: IMarkerSymbol)	Add marker symbol layer.
ClearLayers	Remove all symbol layers.
DeleteLayer (in markerLayer: IMarkerSymbol)	Delete marker symbol layer.
DrawLayer (in Index: Long, in Geometry: IGeometry)	Draw a symbol layer.
MoveLayer (in markerLayer: IMarkerSymbol, in toIndex: Long)	Change layer index position.

The *IMultiLayerMarkerSymbol* interface refers to each symbol in the collection as a layer and provides a read-only *LayerCount* property summing the number of layers currently present.

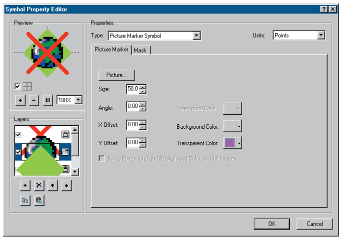
The *Layer* property provides read-only access to each symbol within the *MultiLayerMarkerSymbol*.

Simple marker symbols are added to form a multilayer marker symbol.

Marker symbols can be added to the collection by passing the required symbol to the *AddLayer* method, which adds the symbols by value, for example:

```
Dim pMultiMarker As esriCore.IMultiLayerMarkerSymbol
Set pMultiMarker = New MultiLayerMarkerSymbol
pMultiMarker.AddLayer pSimpleMarker  'passing a valid SimpleMarkerSymbol
pMultiMarker.AddLayer pArrowMarker   'passing a valid ArrowMarkerSymbol
```

Now you have a *MultiLayerMarkerSymbol* with a *SimpleMarkerSymbol* and an *ArrowMarkerSymbol*—the *ArrowMarkerSymbol* was the last to be added, and therefore has an index of zero, and will be drawn last on top of the *SimpleMarkerSymbol*.



Type: Picture Marker Symbol

Units: Points

Size: 50.0

Angle: 0.00

X Offset: 0.00

Y Offset: 0.00

Background Color:

Transparent Color:

100%

□ Swap Foreground and Background Color on 1 bit Images

The ArcMap dialog box for editing multilayer marker symbols.

Each symbol can be moved to a different index by calling the *MoveLayer* method. For example, you may wish to move the largest symbols to the bottom of the *MultiLayerMarkerSymbol*. You can remove a symbol entirely from the *MultiLayerMarkerSymbol* by calling *DeleteLayer*, as shown in the following code:

Note the use of the Do…While loop. This is especially useful when removing an item from the collection that is being looped through—you could not use a For…Each here.

```
Dim pRemove As IMarkerSymbol
Dim lngLayer As Long
Do While lngLayer < pMultiMarker.LayerCount
  If TypeOf pMultiMarker.Layer(lngLayer ) Is IArrowMarkerSymbol Then
    Set pRemove = pMultiMarker.Layer(lngLayer )
    pMultiMarker.DeleteLayer pRemove
     lngLayer = 0
  End If
  lngLayer = lngLayer + 1
Loop
```

To remove all the symbols from a *MultiLayerMarkerSymbol*, simply call the *ClearLayers* method. It's also possible to draw an individual layer from the *MultiLayerMarkerSymbol* straight to a specific device context by using the *DrawLayer* method. The use of this method is similar to the *ISymbol::Draw* method; you must call *SetupDC* before and *ResetDC* after your draw method. You may wish to use this capability, for example, if you are implementing your own multilayer symbol editor.

ILayerColorLock : IUnknown	Provides access to members that control the layer color locking.
■—■ LayerColorLock (in LayerIndex: Long) : Boolean	Color lock state per layer index.
◀— SetAllColorLocked (allLocked: Boolean)	Indicates if the color is locked for all layers.

The *ILayerColorLock* interface determines which layers will be affected by setting the *IMultiLayerMarkerSymbol::Color* property. Layers with *LayerColorLock* equal to *True* will not be affected. Layers with *LayerColorLock* equal to *False* will have their *Color* property set to the color assigned in *IMultiLayerMarkerSymbol::Color*.

If you wish to set only the topmost layer of a *MultiLayerMarkerSymbol* (*pMultiLayerMarker*) to a new color (*pColor*), you could write code like this:

```
Dim pColorLock As ILayerColorLock
Set pColorLock = pMultiLayerMarker
pColorLock.SetAllColorLocked True
pColorLock.LayerColorLock(0) = False
pMultiLayerMarker.Color = pColor
```

Each symbol in the *MultiLayerMarkerSymbol* has a visibility property that determines whether or not each individual layer is drawn. This visibility property can be accessed by using the *ILayerVisible* interface.

ILayerVisible : IUnknown	Provides access to members that control the layer visibility.
■—■ LayerVisible (in LayerIndex: Long) : Boolean	Visibility of layer per layer index.
◀— SetAllVisible (allVisible: Boolean)	Indicates if all the layers are visible or invisible.

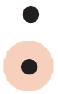
You can alter a given *MultiLayerMarkerSymbol* by "turning off" every alternate symbol. You can set all the layers visible or invisible in one command by calling the *SetAllVisible* method.

```
Dim pLayerVisible As ILayerVisible, pLyr As Long
Set pLayerVisible = pMultiLayerMarker   'Existing Marker
For pLyr = 0 To pMultiLayerMarker.LayerCount - 1 Step 2
  pLayerVisible.LayerVisible(pLyr) = False
Next pLyr
```

IMask : IUnknown	Provides access to members that control the symbol mask.
■—■ MaskSize: Double	The mask size.
■—■ MaskStyle: tagesriMaskStyle	The mask style.
■—□ MaskSymbol: IFillSymbol	The mask symbol.

Use a contrasting color mask to highlight items that are a similar color to the features or their outlines underneath it.

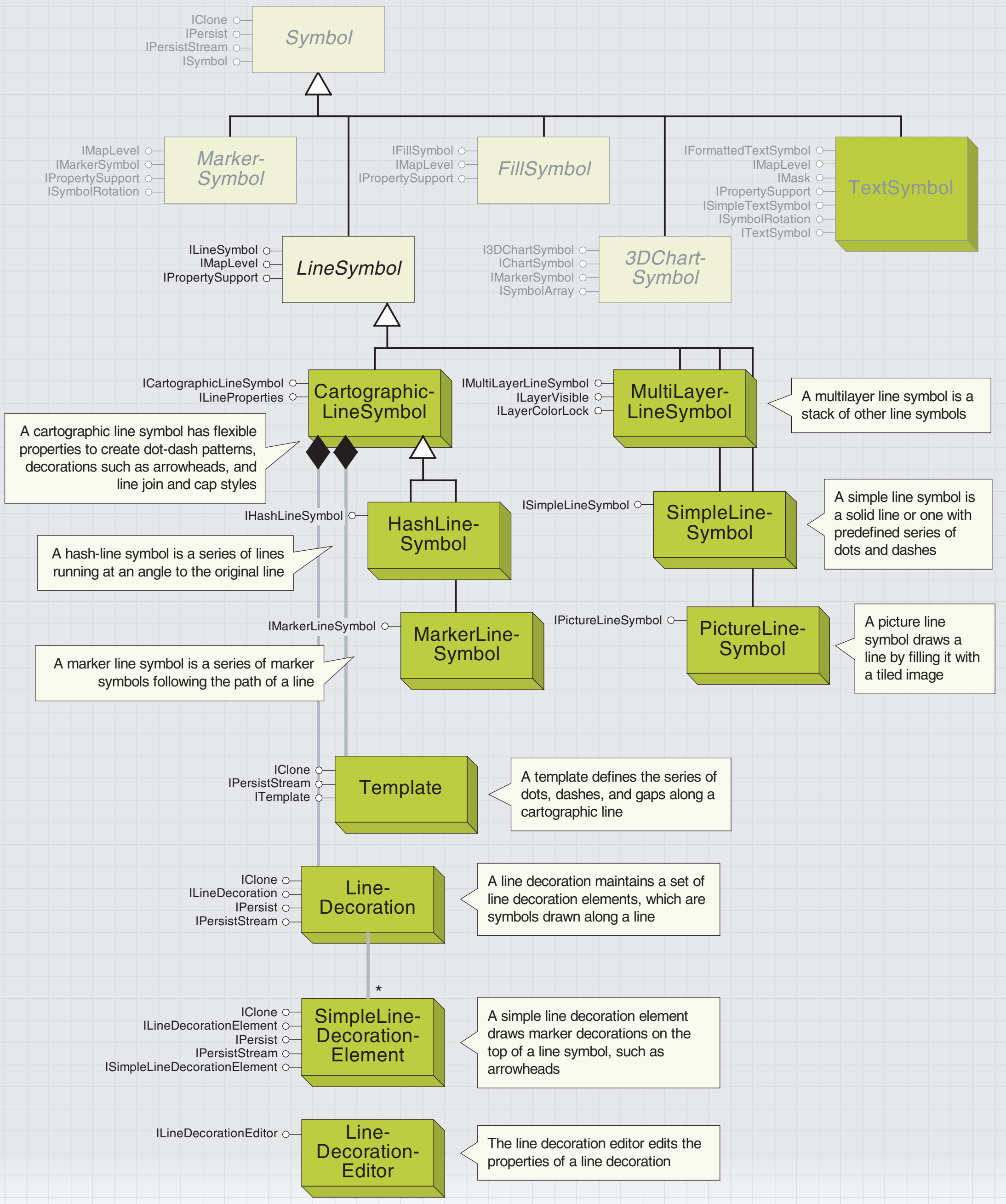
The *IMask* interface provides a simple and efficient way to draw a symbol around the edge of your *Marker*. Set the *MaskStyle* property to an *esriMaskStyle* constant.



Enumeration tagesriMaskStyle	*Text mask styles.*
0 - esriMSNone	*No mask.*
1 - esriMSHalo	*The text mask style is halo.*

You can either fill the mask with a solid color by setting the *Color* property or with any other kind of *FillSymbol* by setting the *MaskSymbol* property. The *MaskSize* property indicates the width of the mask in points, measured from the marker edge.

Line symbol objects



A multilayer line symbol is a stack of other line symbols

A cartographic line symbol has flexible properties to create dot-dash patterns, decorations such as arrowheads, and line join and cap styles

A simple line symbol is a solid line or one with predefined series of dots and dashes

A hash-line symbol is a series of lines running at an angle to the original line

A picture line symbol draws a line by filling it with a tiled image

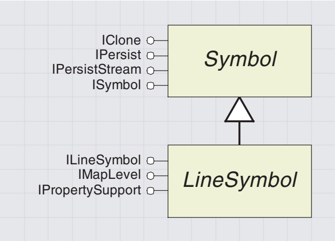
A marker line symbol is a series of marker symbols following the path of a line

A template defines the series of dots, dashes, and gaps along a cartographic line

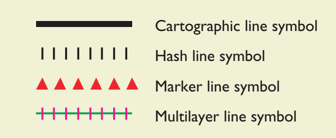
A line decoration maintains a set of line decoration elements, which are symbols drawn along a line

A simple line decoration element draws marker decorations on the top of a line symbol, such as arrowheads

The line decoration editor edits the properties of a line decoration



A line symbol represents how a one-dimensional feature or graphic is drawn. Straight lines, polylines, curves, and outlines can all be drawn with a line symbol. There are five different types of line symbols you can use.



The width of a line symbol is in printer's points—about 1/72 of an inch.

The *LineSymbol* abstract class represents the two properties—*Color* and *Width*—all types of line symbols have in common.

ILineSymbol : IUnknown

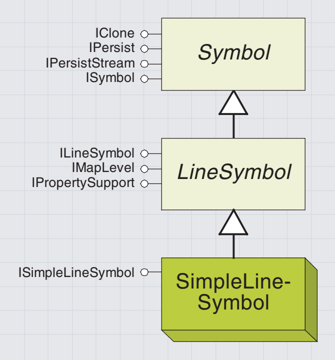
Provides access to members that control line symbols.

Color: IColor	*Line symbol color.*
Width: Double	*Line symbol width.*

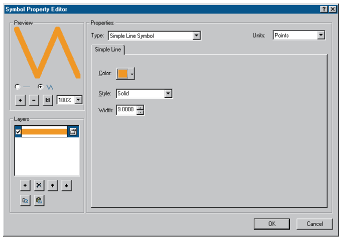
ILineSymbol is the primary interface for all line symbols, which all inherit the properties and methods of *ILineSymbol*. The interface has two read–write properties that allow you to get and set the basic properties of any line symbol. The *Color* property controls the color of the basic line (it does not affect any line decoration that may be present—see the *ILineProperties* interface) and can be set to any *IColor* object. The *Color* property is set to black by default except for the *SimpleLineSymbol*, which has a default of mid-gray.

The *Width* property sets the overall width of a line, and its units are points. Note that for a *HashLineSymbol*, the *Width* property sets the length of each hash—see *HashLineSymbol* for more information. The default width is 1 for all line symbols except *MarkerLineSymbol*, which has a default width of 8.

To create a new symbol for a line, use one of the line symbol coclasses detailed in the following pages.



The simple line symbol displays a line with a simple symbol such as a solid line or a series of dots and/or dashes.



Properties:

Type: Simple Line Symbol

Units: Points

Simple Line

Color:

Style: Solid

Width: 9.0000

The ArcMap dialog box for editing simple line symbols.

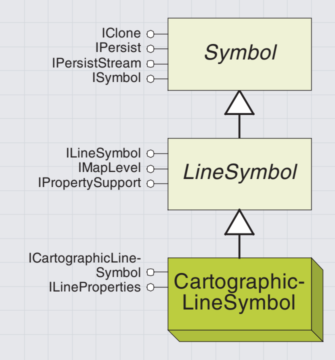
The *SimpleLineSymbol* coclass can be used to display a line as a basic series of dots and dashes or as a solid line.

ISimpleLineSymbol : ILineSymbol	***Provides access to members that control the simple line symbol.***
Style: tagesriSimpleLineStyle	*The style of the line symbol.*

The *ISimpleLineSymbol* interface inherits from the *ILineSymbol* interface, and its read–write *Style* property determines which style of line is used. It can be set to one of seven basic line patterns by using the *esriSimpleLineStyle* constants.

Enumeration tagesriSimpleLineStyle	***Simple line styles.***
0 - esriSLSSolid	*The line is solid.*
1 - esriSLSDash	*The line is dashed ——*
2 - esriSLSDot	*The line is dotted ....*
3 - esriSLSDashDot	*The line has alternating dashes and dots _._._._*
4 - esriSLSDashDotDot	*The line has alternating dashes and double dots _.._.._*
5 - esriSLSNull	*The line is invisible.*
6 - esriSLSInsideFrame	*The line will fit into it's bounding rectangle, if any.*

The default *Style* is *esriSLSSolid*. You should use only the *esriSLSSolid* style to draw lines with a *Width* greater than 1. Due to limitations of the Windows GDI routines used, dashed or dotted lines with a *Width* greater than 1 will be drawn as solid lines. In these cases, cartographic line symbols can be used instead to achieve the same effect.



The cartographic line symbol is a general-purpose symbol used to display line features. More complex than the simple line symbol, it allows custom line patterns, offsets, and other characteristics to be set according to your requirements.

The *CartographicLineSymbol* coclass can be used to display one-dimensional features with a more complex symbology than *SimpleLineSymbol*. The *ICartographicLineSymbol* and *ILineProperties* interfaces offer precise control over the characteristics of the line.

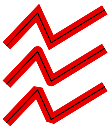
ICartographicLineSymbol: ILineSymbol	*Provides access to members that control the cartographic line symbol.*
Cap: tagesriLineCapStyle	*Line end cap style.*
Join: tagesriLineJoinStyle	*Line join style.*
MiterLimit: Double	*Size threshold for showing mitered line joins.*

The *ICartographicLineSymbol* interface controls the attributes of line symbol vertices.

The *MiterLimit* property determines the shape of a mitered join but does not affect lines with round or beveled joins. A miter length is defined as the distance from the intersection of the line walls on the inside of the join to the intersection of the line walls on the outside of the join. The *MiterLimit* property returns or sets the maximum allowed ratio of miter length to the line width. If a miter join exceeds the limit, the corner is not pointed but is cut off at the limit point. The default miter limit is 10.0.

The *Cap* property controls the appearance of line ends: butt, round, or square.

Enumeration tagesriLineCapStyle	*Line cap styles.*
0 - esriLCSButt	*Line ends do not extend passed the end points.*
1 - esriLCSRound	*Line ends are rounded at the end points.*
2 - esriLCSSquare	*Line ends are squared off at the end points.*



The *esriLineCapStyle* constants are used to set the line ends in the *Cap* property.

The *Join* property controls the appearance of any vertices of a line.

Enumeration tagesriLineJoinStyle	*Line join styles.*
0 - esriLJSMitre	*Line joins are mitred.*
1 - esriLJSRound	*Line joins are round.*
2 - esriLJSBevel	*Line joins are beveled.*

The *esriJoinCapStyle* constants are used to set the line join styles in the *Join* property.

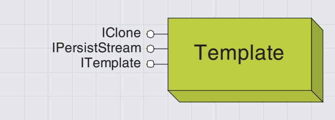
ILineProperties: IUnknown	*Provides access to members that control the properties common to several line types.*
DecorationOnTop: Boolean	*Indicates if the decoration is drawn on top.*
Flip: Boolean	*Indicates if the line symbol is flipped.*
LineDecoration: ILineDecoration	*Line decoration element collection.*
LineStartOffset: Double	*The line start offset.*
Offset: Double	*The line offset value.*
Template: ITemplate	*The line template.*

The *ILineProperties* interface precisely controls the dash–dot pattern of any line, where a dash may be a *MarkerSymbol* in the case of a *MarkerLineSymbol* coclass, a *LineSymbol* in the case of a

HashLineSymbol coclass, or a simple dash in the case of a *CartographicLineSymbol* coclass. This interface also controls line pattern properties, such as offsets and line decoration elements.

The *Template* property sets or returns, by reference, a *Template* object that stores the pattern of dashes and dots along a cartographic line symbol.

TEMPLATE COCLASS

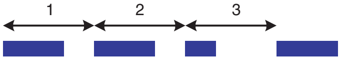


A template defines the series of dots, dashes, and gaps along a cartographic line. It also determines where lines and markers appear on a hash line symbol and a marker line symbol.

The *Template* framework lets you design a common template for multiple *LineSymbol* objects in a *MultiLayerLineSymbol*, allowing you to synchronize multiple line patterns. You can use the same template to stack and center line dashes with markers or reverse the template to center a marker in each gap of a dashed line.

ITemplate : IUnknown	*Provides access to members that control the template.*
Geometry: IGeometry	*The pattern geometry.*
Interval: Double	*The interval.*
PatternElementCount: Long	*Returns the number of pattern elements.*
AddPatternElement (in mark: Double, in Gap: Double)	*Adds a pattern element.*
ClearPatternElements	*Clears all pattern elements.*
DeletePatternElement (in Index: Long)	*Removes the pattern element at the given index.*
GetPatternElement (in Index: Long, out mark: Double, out Gap: Double)	*Gets pattern element properties for a given index.*
MovePatternElement (in fromIndex: Long, in toIndex: Long)	*Moves a pattern element.*
QueryNextLine (in pGeometry: IGeometry)	*Queries for the next line in the pattern.*
QueryNextPoint (in pPoint: IPoint, in pAngle: Double)	*Queries for the next point in the pattern.*
Reset	*Resets the enumerator.*
Setup (in hDC: Long, in Transformation: ITransformation, in lineSym: ILineSymbol)	*Set up items needed by template.*

A *Template* is built up by calling the *AddPatternElement* method. This method determines the size of an individual line dash and the following gap, measured in points. Together, each mark and following gap are known as a pattern element. Pattern elements can be any length, and setting the first mark to zero indicates the line starts with a gap.



```
Dim pTemplate as ITemplate
Set pTemplate = New Template
pTemplate.AddPatternElement 5,2
pTemplate.AddPatternElement 5,5
pTemplate.AddPatternElement 2,5
```

There is no specific limit to the number of elements you add, but you don’t need to repeat the same one over and over again—the entire template is repeated over and over again, as required.

The *Interval* property affects the length that each element is drawn. The mark value times the interval equals the length of the mark. The gap value times the interval equals the length of the gap.

The *Interval* property defaults to zero, so always make sure to set this property greater than zero if you have a *MarkerLineSymbol* or *HashLineSymbol* (a *CartographicLineSymbol* will draw a solid line if *Interval* is zero). You can use *Interval* to produce similar patterns with one template or to scale up a template when the *LineSymbol*’s *Width* is altered to maintain the proportions of the line pattern.

```
Dim pLineSymbol As ILineSymbol
' Set the LineSymbol here as required
Dim pLineProperties As ILineProperties
Set pLineProperties = pLineSymbol
pLineProperties.Template.Interval = pLineSymbol.Width * 0.7
```

Use *ClearPatternElement, DeletePatternElement, GetPatternElement, PatternElementCount,* and *MovePatternElement* to maintain your template.

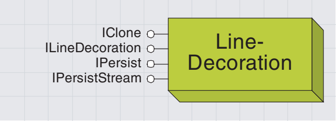
The code below takes one *Template* and produces a complementary *Template* containing the opposite gaps and marks, allowing you to create a *MultiLayerLineSymbol* with alternating colors or a dashed line with markers in the gaps.

```
Dim pTemplateNew As ITemplate
Set pTemplateNew = New Template
pTemplateNew.Interval = pTemplateOld.Interval
Dim i As Integer, dblMark As Double
Dim dblGap As Double, dblSaveGap As Double
pTemplateOld.GetPatternElement i, dblMark, dblGap
If dblMark > 0 Then
  pTemplateNew.AddPatternElement 0, dblMark
  For i = 1 To pTemplateOld.PatternElementCount - 1
    dblSaveGap = dblGap
    pTemplateOld.GetPatternElement i, dblMark, dblGap
    pTemplateNew.AddPatternElement dblSaveGap, dblMark
  Next i
  pTemplateNew.AddPatternElement dblGap, 0
End If
```

Note that this code only works where the template does not begin with a gap (that is, the first mark is zero), but this algorthim could be adapted to cover this.

The *Geometry, QueryNextPoint, QueryNextLine, Setup,* and *Reset* methods and properties can be used together to find out the actual location of each individual marker, hash, or line.

These methods are used internally by the *CartographicLineSymbol* coclasses but can also be called directly. The mechanism is similar to the *TextPath::Next* method, which is discussed later in this chapter.



Line decorations are used for placing decorations such as arrowheads at particular places along a line symbol. A line decoration belongs to a cartographic line symbol and is not used as a line symbol itself.

The *LineDecoration* property of the *ILineProperties* interface, set by reference, stores symbols that are drawn on top of a marker line, hash line, or cartographic line. By default, no decoration is present on a line, so the first step to adding line decorations is to create a new line decoration coclass in this property:

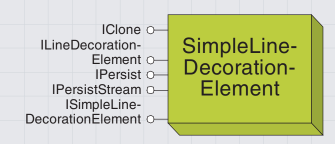
```
Set pLineProperties.LineDecoration = New LineDecoration
```

ILineDecoration : IUnknown	***Provides access to members that control the line decoration.***
■— Element (in Index: Long) : ILineDecorationElement	*Returns the element at the given position.*
■— ElementCount: Long	*Returns the number of line decoration elements.*
← AddElement (in lineDecorationElement: ILineDecorationElement)	*Adds an element.*
← ClearElements	*Clears all line decoration elements.*
← DeleteElement (in Index: Long)	*Deletes the element at the given index.*
← Draw (in hDC: Long, in Transform: ITransformation, in LineGeometry: IGeometry)	*Draws the given line geometry.*
← MoveElement (in Element: ILineDecorationElement, in toIndex: Long)	*Moves a line decoration element to the given index.*
← QueryBoundary (in hDC: Long, in Transform: ITransformation, in LineGeometry: IGeometry, in Boundary: IPolygon)	*Queries for the boundary of the given line geometry.*

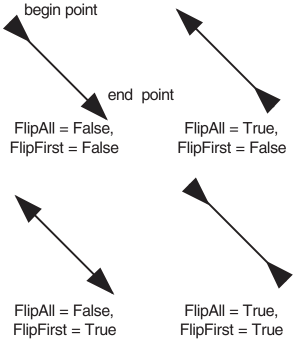
A LineSymbol *with* LineDecorations *has advantages over a* MultiLayerLineSymbol *for producing arrows or similar symbols, as you can specify decorations to appear only at the ends, in the center of a line, or at any other proportion along a line. Therefore, if your line geometry changes, you do not need to update the location of any decoration element, as they are calculated internally.*

The *ILineDecoration* interface maintains a collection of line decoration elements for a *LineSymbol*. Line decorations are symbols that display at certain locations along a line. Many decorations can be added to the collection by passing an *ILineDecorationElement* to the *AddElement* method—the most recently added elements display on top.

Use the *ClearElements, DeleteElement, Element, ElementCount,* and *MoveElement* methods to maintain the list of decorations like any other collection. To find out the boundary of the collection of line decorations, call the *QueryBoundary* method. You may wish to use this method to refresh specific areas of your display.



A simple line decoration element draws marker decorations on the top of a line symbol. It's ideal for pleacing arrowheads at the start or end of a line.


begin point
end point
FlipAll = False, FlipFirst = False
FlipAll = True, FlipFirst = False
FlipAll = False, FlipFirst = True
FlipAll = True, FlipFirst = True

These lines with simple line decorations have Rotate *to* True, Positions *equal to 0 and 1, and* PositionsAsRatio *equal to* True.

The *SimpleLineDecorationElement* stores the decorations that are drawn on the top of a line symbol and defines how they appear. The *SimpleLineDecorationElement* is the only type of line decoration available currently in ArcObjects.

ISimpleLineDecorationElement : ILineDecorationElement	***Provides access to members that control the simple line decoration.***
FlipAll: Boolean	*Indicates if all symbols are flipped 180 degrees.*
FlipFirst: Boolean	*Indicates if marker symbol in '0' position is flipped 180 degrees.*
MarkerSymbol: IMarkerSymbol	*The marker symbol.*
Rotate: Boolean	*Indicates if marker symbols are rotated to follow the line.*

The *ISimpleLineDecorationElement* allows you to specify any *MarkerSymbol* as a line decoration. For each *SimpleLineDecorationElement*, this *MarkerSymbol* can be repeated at different positions along the line.

If *Rotate* is *False*, the decorations are drawn at a constant angle to the container. If it is *True*, they are rotated to follow the axis of the line. The default value is *True*.

The *FlipAll* and *FlipFirst* properties are particularly useful when generating arrow line symbols. Consider a *LineDecoration* with arrowheads as decorations. If *Rotate* is *True*, the arrows are rotated along the axis of the line and will point toward the *ToPoint* of the line. If *FlipAll* is *True*, the arrows will point toward the *FromPoint*. Setting *FlipFirst* to *True* will make the first arrow point to the *FromPoint* and the rest point toward the *ToPoint*. Combining both would create arrows pointing toward the center of the line.

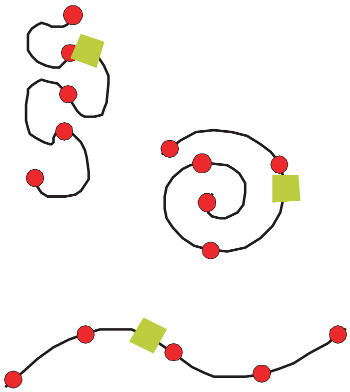
ILineDecorationElement : IUnknown	***Provides access to members that control the line decoration element.***
Position (in Index: Long) : Double	*Returns the element position at the given index.*
PositionAsRatio: Boolean	*Indicates if positions represent percentage or absolute distance along the line.*
PositionCount: Long	*Returns the number of positions.*
AddPosition (in elementPosition: Double)	*Adds a position.*
ClearPositions	*Clears all positions.*
DeletePosition (in Index: Long)	*Deletes a position.*
Draw (in hDC: Long, in Transform: ITransformation, in LineGeometry: IGeometry)	*Draws the given line geometry.*
QueryBoundary (in hDC: Long, in Transform: ITransformation, in LineGeometry: IGeometry, in Boundary: IPolygon)	*Queries for the boundary of a given line geometry.*

Because of interface inheritance, all members of the *ILineDecorationElement* interface are available when working with the *ISimpleLineDecorationElement* interface.

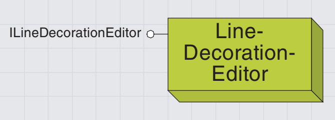
If the *PositionAsRatio* property is *True*, then a *Position* of 1 indicates a decoration at the end of the line, and a *Position* of 0.5 indicates a decoration halfway along the line. If *PositionAsRatio* is *False*, positions are set as specific lengths along the line. Any decorations that have a position greater than the line length will not be displayed; if the line is subsequently edited to an even greater length, the decorations will then appear.

The code that follows creates a basic *CartographicLineSymbol* with small red circles repeated every quarter of the way along the line and larger green squares at the first whole unit along the line.

```
Dim pLineProperties As ILineProperties
Set pLineProperties = New CartographicLineSymbol
Set pLineProperties.LineDecoration = New LineDecoration

Dim pColor As IColor
Set pColor = New RgbColor
pColor.RGB = 255

Dim pMarker As ISimpleMarkerSymbol
Set pMarker = New SimpleMarkerSymbol
pMarker.Style = esriSMSCircle
pMarker.Size = 8
pMarker.Color = pColor
Dim pSimpleLineDec As ISimpleLineDecorationElement
Set pSimpleLineDec = New SimpleLineDecorationElement
With pSimpleLineDec
  .MarkerSymbol = pMarker
  .PositionAsRatio = True
  .AddPosition 0
  .AddPosition 0.25
  .AddPosition 0.5
  .AddPosition 0.75
  .AddPosition 1
End With
pLineProperties.LineDecoration.AddElement pSimpleLineDec

pColor.RGB = 655280
Set pMarker = New SimpleMarkerSymbol
pMarker.Style = esriSMSSquare
pMarker.Size = 12
pMarker.Color = pColor

Set pSimpleLineDec = New SimpleLineDecorationElement
With pSimpleLineDec
  .MarkerSymbol = pMarker
  .PositionAsRatio = False
  .AddPosition 1
End With
pLineProperties.LineDecoration.AddElement pSimpleLineDec
```



The cartographic line symbol created using the neighboring script



The LineDecorationEditor *is the dialog box used by ArcMap to allow the user to edit the properties of line decorations.*

The *LineDecorationEditor* shows the dialog box used by ArcMap to allow a user to edit the properties of a *LineDecoration* of a *CartographicLineSymbol, HashLineSymbol,* or *MarkerLineSymbol.*

ILineDecorationEditor : IUnknown — ***Provides a dialog for managing properties associated with Line Decoration.***

ShowUnits: Boolean — *Indicates whether to display the Units combo box.*

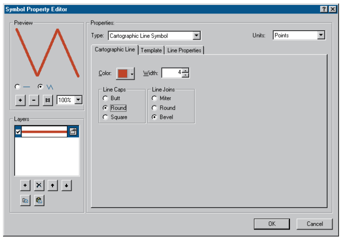
Title: String — *The title of the Line Decoration Editor dialog.*

EditLineDecoration (LineDecoration: ILineDecoration, in previewLine: ILineSymbol, hWnd: Long) : Boolean — *Displays the Line Decoration Editor dialog for the given symbol and returns a flag indicating if the symbol changed.*

The *EditLineDecoration* method takes an *ILineDecoration* and an *ILineSymbol* parameter. The *LineDecoration* parameter, passed by reference, has its properties edited by the user. The *LineSymbol* is required to correctly display the line in the Preview frame of the dialog box.

If a user clicks the LineProperties *button in the* LineSymbolEditor, *they can access the* LineDecorationEditor *and add decorations to the* LineSymbol. *However, using the* LineDecorationEditor *directly restricts the user to setting the properties of the decorations only for a specific* LineSymbol *object.*

```
Dim pLineDec As ILineDecoration
Set pLineDec = pLineSymbol.LineDecoration
' pLineSymbol is a preexisting line symbol

Dim pLineDecEditor As ILineDecorationEditor
Set pLineDecEditor = New LineDecorationEditor
pLineDecEditor.Title = "Edit My Text Background"
pLineDecEditor.ShowUnits = False
If Not pLineDecEditor.EditLineDecoration(pLineDec, pLineSymbol, 0) Then
  MsgBox "User pressed Cancel"
Else
  'Do something with the edited Line Decoration
End If
```


Symbol Property Editor

Type: Cartographic Line Symbol

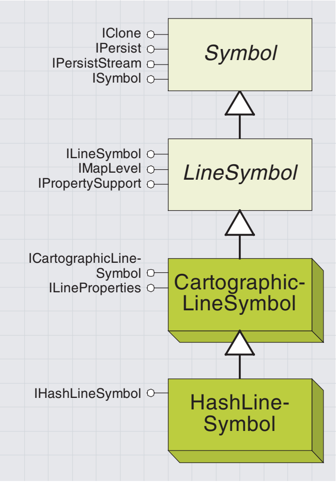
Units: Points

Width: 4

Line Caps: ○ Butt ● Round ○ Square

Line Joins: ○ Miter ○ Round ● Bevel

The ArcMap dialog box for editing simple line decoration elements



A HashLineSymbol *is a line symbol made up of many short lines crossing the path of the line feature, such as part of a railroad symbol.*

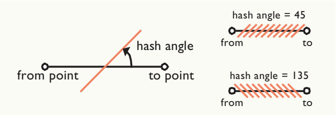
Using the *HashLineSymbol*, a line feature can be symbolized by a repeated line symbol, or hash, drawn across the path of the line feature.

IHashLineSymbol: ILineSymbol	***Provides access to members that control the hash line symbol.***
■—■ Angle: Double	*Hash line angle.*
■—□ HashSymbol: ILineSymbol	*Line symbol used for hash pattern.*

The *IHashLineSymbol* interface has two simple properties.

The *HashSymbol* property is used to return or set a *LineSymbol* that draws the hashes across the line path. The property is set by reference, so be careful with your object references.

The *Angle* property sets or returns the angle at which the hashes are drawn, relative to the path of the line feature. An angle of 90 degrees will draw all the hashes perpendicular to the path, angles of 0 to 89 degrees will tilt the hash toward the end vertex of the path, and angles of 91 to 180 degrees will tilt the hash toward the start vertex of the path.



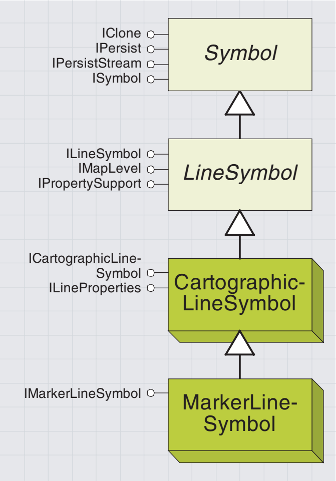
The *Width* property, inherited from *ILineSymbol*, refers to the length of each hash line, and therefore the actual width of the symbol will be a function of both the *Width* and *Angle* properties.

Below, you set a *HashLineSymbol*'s *Width* by calculating the *LineSymbol Width* required to produce a symbol with an actual width of 20 points. The *SymbolWidth* function converts a value from a required perpendicular width to the required *LineSymbol Width*.

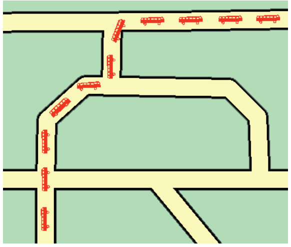
```
Dim pHashLineSym As IHashLineSymbol
Set pHashLineSym = New HashLineSymbol
pHashLineSym.Angle = 45
pHashLineSym.Width = SymbolWidth(20, 45)

Function SymbolWidth(dblPerpendicularWidth As Double, _
    pAngle As Double) As Double
  Const dblPi = 3.14159265
  SymbolWidth = dblPerpendicularWidth / Sin(pAngle * (dblPi / 180))
End Function
```

The default *HashSymbol* is a *SimpleLineSymbol* with a width of 1 and an angle of 90, but you could use any *LineSymbol*, even another *HashLineSymbol*.

Use the *ILineProperties* interface to set the pattern of the hashes, discussed in the *CartographicLineSymbol* abstract class. Note that for a *HashLineSymbol*, the *Template* marks how many dashes will occur in the pattern segment.



A line can be drawn as a repeated marker symbol by using a MarkerLineSymbol. *For example, the path of a bus through a town may be shown as a repeated bus symbol.*



Using the *MarkerLineSymbol*, a line feature can be drawn as a repeated *MarkerSymbol*.

IMarkerLineSymbol : ILineSymbol

■—□ MarkerSymbol: IMarkerSymbol

Provides access to members that control the marker line symbol.

Symbol used for marker line.

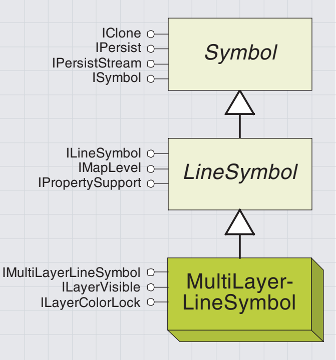
The *IMarkerLineSymbol* interface has one property, which sets the *MarkerSymbol* used to symbolize the line. Set this property to any *MarkerSymbol*, but be careful with your object references, as this property is set by reference.

```
Dim pMarkerLine As IMarkerLineSymbol
Set pMarkerLine = New MarkerLineSymbol

Dim pMarker As ISimpleMarkerSymbol
Set pMarker = New SimpleMarkerSymbol
Set pMarkerLine.MarkerSymbol = pMarker
pMarker.Size = 20
```

Note that the *MarkerSymbol*'s *Size* property equals the *MarkerLineSymbol*'s *Width* property.

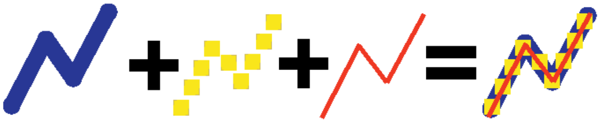
You can set the pattern of the markers on your line by using the *ILineProperties* interface, discussed in the *CartographicLineSymbol* abstract class.

MultiLayerLineSymbol coclass



A multilayer line symbol allows a collection of different line symbols to be used to draw a single line feature.

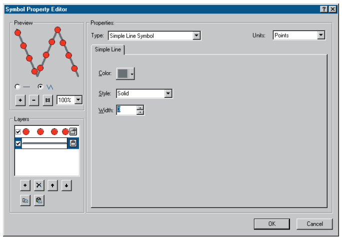
The *MultiLayerLineSymbol* coclass can be used to display a line by stacking a number of different line symbols together, allowing more complex line symbols to be created from the basic building blocks provided. This is shown below.



IMultiLayerLineSymbol: ILineSymbol	***Provides access to members that control the multilayer line symbol.***
Layer (in Index: Long) : ILineSymbol	*Line symbol per index value.*
LayerCount: Long	*The number of layers in the symbol.*
AddLayer (in lineLayer: ILineSymbol)	*Adds a layer to the line symbol.*
ClearLayers	*Removes all line symbol layers.*
DeleteLayer (in lineLayer: ILineSymbol)	*Deletes a layer from the line symbol.*
DrawLayer (in Index: Long, in Geometry: IGeometry)	*Draws a line symbol layer.*
MoveLayer (in lineLayer: ILineSymbol, in toIndex: Long)	*Move line symbol layer to different layer position.*

The *IMultiLayerLineSymbol* interface performs similar functions to the *IMultiLayerMarkerSymbol* interface. For more information, refer to the *MultiLayerMarkerSymbol* section earlier in this chapter.

The *MultiLayerLineSymbol* also supports the *ILayerColorLock* and *ILayerVisible* interfaces, also discussed earlier in this chapter.



Properties:

Type: Simple Line Symbol

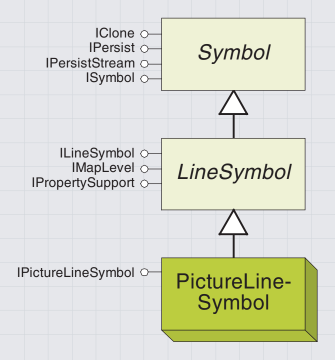
Units: Points

Color:

Style: Solid

Width: 3

The ArcMap dialog box for editing multilayer line symbols.



The PictureLineSymbol *draws a line by filling it with a tiled image.*

The *PictureLineSymbol* coclass provides a way to fill a *LineSymbol* with a tiled image, as if the boundary of the *LineSymbol* was a filled *Polygon*. This coclass can be used in preference to a *MarkerLineSymbol* using a *PictureMarkerSymbol*.

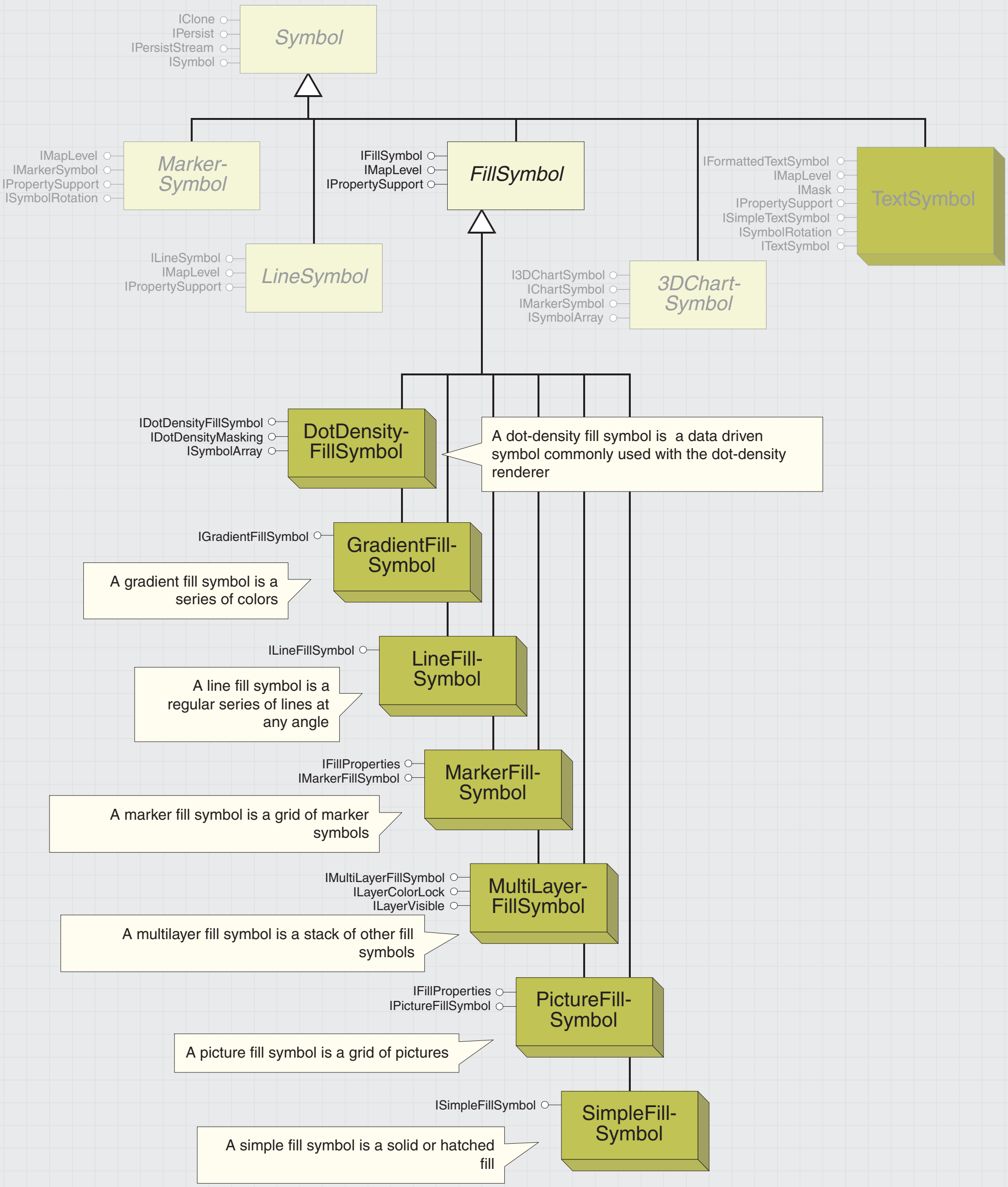
IPictureLineSymbol: ILineSymbol	***Provides access to members that control the picture line symbol.***
BackgroundColor: IColor	*Line background color.*
BitmapTransparencyColor: IColor	*Color within bitmap indicating transparency.*
Offset: Double	*Picture offset from center of line.*
Picture: Picture	*Picture used for line.*
Rotate: Boolean	*Indicates if the picture is rotated to follow the line.*
SwapForeGroundBackGroundColor: Boolean	*Indicates if the foreground and background colors are swapped on 1 Bit Images Only.*
XScale: Double	*Scale of picture along X-axis.*
YScale: Double	*Scale of picture along Y-axis.*
CreateLineSymbolFromFile (in Type: tagesriIPictureType, in FileName: String)	*Create line symbol from picture file.*

Use the *CreateLineSymbolFromFile* method to set the picture that is to be used for the fill. This method sets the *Picture* property (note that this property is set by reference).

```
Dim pPictureLine As IPictureLineSymbol
Set pPictureLine = New PictureLineSymbol
pPictureLine.CreateLineSymbolFromFile esriIPictureBitmap,_
 "C:\MyIcons\Pattern.bmp"
```

Set the *Width* property to control the thickness of the line. The *Picture* is tiled to entirely fill the thickness of the line, but the size of each tile can be scaled using the *XScale* and *YScale* properties. For more information on the use of the *BackgroundColor, BitmapTransparencyColor,* and *SwapForeGroundBackGroundColor* properties, see the *PictureMarkerSymbol* coclass.

Fill symbol objects



A dot-density fill symbol is a data driven symbol commonly used with the dot-density renderer

A gradient fill symbol is a series of colors

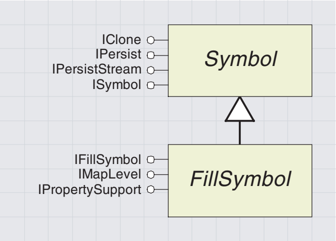
A line fill symbol is a regular series of lines at any angle

A marker fill symbol is a grid of marker symbols

A multilayer fill symbol is a stack of other fill symbols

A picture fill symbol is a grid of pictures

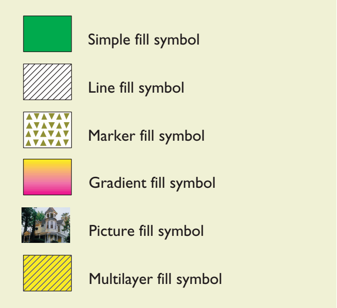
A simple fill symbol is a solid or hatched fill



A fill symbol specifies how the area and outline of any polygon is to be drawn.

The *FillSymbol* abstract class represents the two properties—*Color* and *Outline*—all types of fill symbols have in common.

IFillSymbol : IUnknown	***Provides access to members that control fill symbols.***
Color: IColor	*Fill color.*
Outline: ILineSymbol	*Line symbol of fill outline.*



The *IFillSymbol* interface, inherited by all the specialist fill symbols in ArcObjects, has two read–write properties.

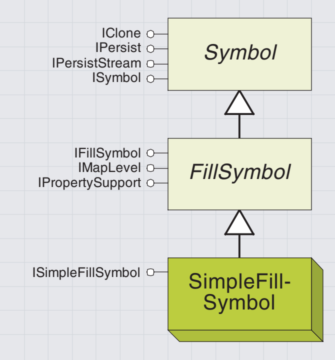
The *Color* property controls the color of the basic fill as described below and can be set to any *IColor* object.

Coclass	Default color	Color property
SimpleFillSymbol	black	color of the solid fill or pattern
MarkerFillSymbol	black	Color property of MarkerSymbol, see IMarkerSymbol for more details
GradientFillSymbol	blue	not used, set ColorRamp property instead
LineFillSymbol	mid-gray	Color property of the LineSymbol - See ILineSymbol for more details
PictureFillSymbol, 1 bit image	black	the parts of the boolean image which contain a color
PictureMarkerSymbol, >1 bit image	not set	no effect
MultiLayerFillSymbol	black	dependent on ILayerColorLock

outline width = 1 pt
outline width = 5 pt

The *Outline* property sets an *ILineSymbol* object, which is drawn as the outline of the fill symbol. By default, the outline is a solid *SimpleLineSymbol*, but you can use any type of line symbol as your outline.

Note that the outline is centered on the boundary of the feature; therefore, an outline with a width of 5 will overlap the fill symbol by a visible amount.



An areal feature can be filled with a solid flood fill or a simple pattern, such as cross-hatching or vertical lines.

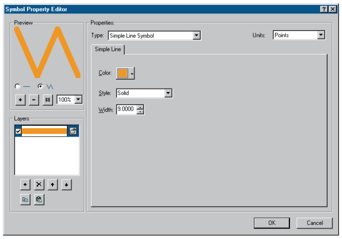
The *SimpleFillSymbol* coclass is used to fill an areal shape with either a solid flood fill, a hollow fill (only the outline is drawn), or one of six simple line patterns.

ISimpleFillSymbol : IFillSymbol	*Provides access to members that control the simple fill symbol.*
Style: tagesriSimpleFillStyle	*Fill style.*

The *ISimpleFillSymbol* interface allows you to specify the type of fill by setting the *Style* property to one of the *esriSimpleFillStyle* constants listed below.

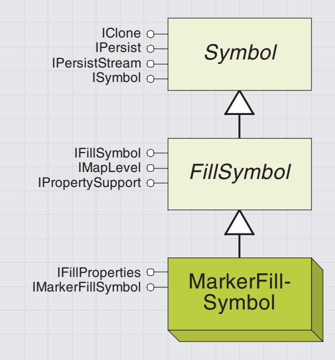
Enumeration tagesriSimpleFillStyle	*Simple fill styles.*
0 - esriSFSSolid	*Solid fill.*
1 - esriSFSHollow	*Hollow fill (same as esriSFSNull).*
1 - esriSFSNull	*Empty fill.*
2 - esriSFSHorizontal	*Horizontal hatch fill ——*
3 - esriSFSVertical	*Vertical hatch fill ||||||*
4 - esriSFSForwardDiagonal	*45-degree downward, left-to-right hatch fill \\\*
5 - esriSFSBackwardDiagonal	*45-degree upward, left-to-right hatch fill //////*
6 - esriSFSCross	*Horizontal and vertical crosshatch ++++++*
7 - esriSFSDiagonalCross	*45-degree crosshatch xxxxxx*

The *esriSimpleFillStyle* constants are used to set a simple fill style.



Properties:
Type: Simple Line Symbol
Units: Points
Simple Line
Color:
Style: Solid
Width: 9.0000
100%

The ArcMap dialog box for editing simple fill symbols



An areal feature can be filled by drawing MarkerSymbols *in a regular grid or in random locations throughout the area.*

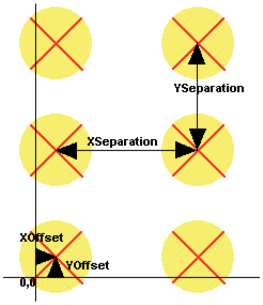
The *MarkerFillSymbol* coclass can be used to fill a polygon, rectangle, ellipse, or other two-dimensional shape with a repeated pattern of marker symbols.

IMarkerFillSymbol: IFillSymbol	***Provides access to members that control the marker fill symbol.***
GridAngle: Double	*Angle of marker position grid.*
MarkerSymbol: IMarkerSymbol	*Marker symbol used for fill.*
Style: tagesriMarkerFillStyle	*Fill style.*

The *MarkerSymbol* property returns or sets the marker symbol that will be repeated throughout the fill—note that this property is set by reference, so watch your object references. You can use any *MarkerSymbol* for your fill, but note that the *PictureFillSymbol* may be more appropriate for your needs than using a *PictureMarkerSymbol* as the *MarkerSymbol*.

The *GridAngle* property is not yet functional.

The *Style* property offers options for the distribution of markers throughout the fill and can be set to one of the *esriMarkerFillStyle* constants.

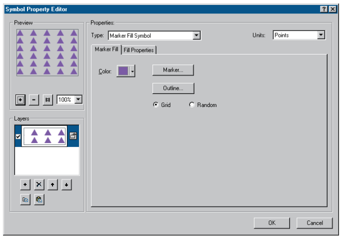


Enumeration tagesriMarkerFillStyle	***Marker fill styles.***
0 - esriMFSGrid	*Fill symbol markers are placed in a grid.*
1 - esriMFSRandom	*Fill symbol markers are placed randomly.*

If the grid style is chosen, then the *Marker* objects will be aligned on a grid starting at the origin of the containers coordinate system, with the center of a marker at (0,0); therefore, if the same fill is applied to many shapes in one container, the markers within every shape will align together.

IFillProperties : IUnknown	***Provides access to members that control the general fill properties.***
XOffset: Double	*Fill offset along X-axis.*
XSeparation: Double	*Fill element separation along X-axis.*
YOffset: Double	*Fill offset along Y-axis.*
YSeparation: Double	*Fill element separation along Y-axis.*

The *IFillProperties* interface provides control over the distribution of *MarkerSymbol* objects within the fill shape. The *XOffset* and *YOffset* properties alter the alignment of grid-distributed symbols as defined above by shifting the start of the grid. The *XSeparation* and *YSeparation* properties determine the spacing of the markers on the grid. Remember that *Marker* objects represent zero-dimensional shapes, so a separation less than the marker size would result in overlapping markers. All four properties use points for units, and the default separation is 12 points. Setting separation values also determines the average spacing of *Marker* objects if the *Style* is *esriMFSRandom*.


Symbol Property Editor

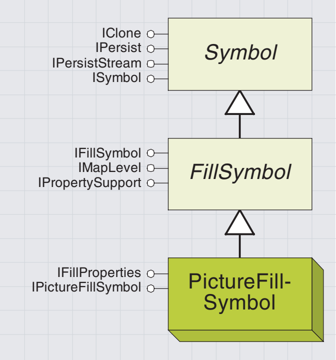
Type: Marker Fill Symbol

Units: Points

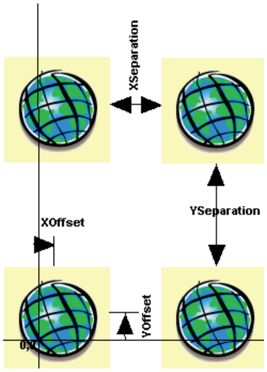
100%

● Grid ○ Random

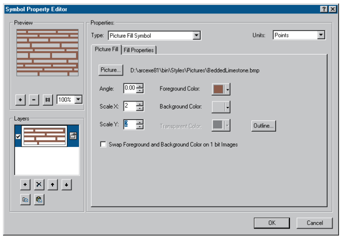
The ArcMap dialog box for editing marker fill symbols



An areal feature can be filled with a repeated bitmap, which is ideal for adding a textural or pictorial fill to your map.



For information on the BackgroundColor, BitmapTransparencyColor, *and* SwapForeGroundBackGroundColor *properties, refer to these properties on the* IPictureMarkerSymbol *interface.*


Symbol Property Editor

Preview

100%

Layers

Properties:

Type: Picture Fill Symbol

Units: Points

Picture Fill | Fill Properties

Picture... D:\arcexe81\bin\Styles\Pictures\BeddedLimestone.bmp

Angle: 0.00

Foreground Color:

Scale X: 2

Background Color:

Scale Y: 2

Transparent Color:

Outline...

□ Swap Foreground and Background Color on 1 bit Images

OK Cancel

The ArcMap dialog box for editing picture fill symbols

The *PictureFillSymbol* coclass allows you to specify the properties of a picture that is used to fill an areal feature.

IPictureFillSymbol : IFillSymbol	*Provides access to members that control the picture fill symbol.*
Angle: Double	*Angle of picture fill.*
BackgroundColor: IColor	*Fill background color.*
BitmapTransparencyColor: IColor	*Color within bitmap indicating transparency.*
Picture: Picture	*Picture used for fill.*
SwapForeGroundBackGroundColor: Boolean	*Indicates if the foreground and background colors are swapped on 1 Bit Images Only.*
XScale: Double	*Scale of picture fill along X-axis.*
YScale: Double	*Scale of picture fill along Y-axis.*
CreateFillSymbolFromFile (in Type: tagesriIPictureType, in FileName: String)	*Create fill symbol from picture file.*

The first property you should set when creating a *PictureFillSymbol* is *Picture*, which you can set directly to an existing OLE picture. Note that the *Picture* property is set by reference. You may prefer to call the *CreateFillSymbolFromFile* method, which sets the *Picture* property for you. Using this method, you can set either an EMF or a BMP file as the *Picture* by using the correct *esriIPictureType* constant.

Enumeration tagesriIPictureType	*IPicture Data Types.*
0 - esriIPictureEMF	*EMF.*
1 - esriIPictureBitmap	*BITMAP.*

You could use code like this:

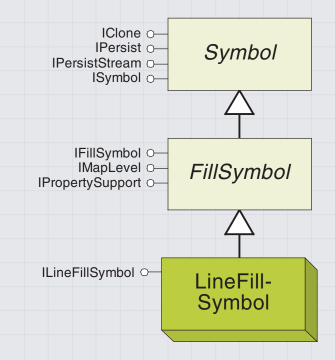
```
Dim pPictureFill As IPictureFillSymbol
Set pPictureFill = New PictureFillSymbol
If UCase(Right(filename, 3)) = "EMF" Then
  pPictureFill.CreateFillSymbolFromFile esriIPictureEMF, filename
ElseIf UCase(Right(filename, 3)) = "BMP" Then
  pPictureFill.CreateFillSymbolFromFile esriIPictureBitmap, filename
End If
```

If the filename referenced is not a valid file and path, an error is raised by the *CreateFillSymbolFromFile* method.

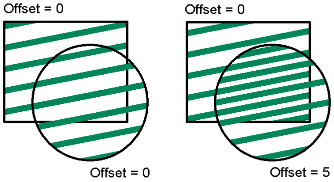
After the *Picture* is set, the other properties can be set to adjust the appearance and pattern of the picture within the fill. The *Picture* is repeated on a grid, starting at the top left of the *Geometry* to which the fill is applied. The angle of the grid can be adjusted by setting the *Angle* property. A value of 45 will rotate the grid 45 degrees clockwise.

You can stretch the *Picture* in size by setting the *XScale* and *YScale* properties. For example, to make each picture in the fill twice as big as the original, set both properties to 2. *XScale* and *YScale* may also be set to values less than 1 to shrink the original image.

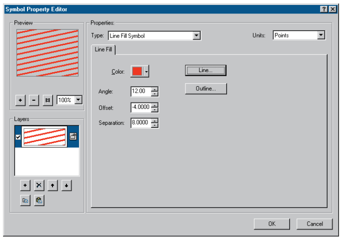
The *PictureFillSymbol* coclass also implements the *IFillProperties* interface, discussed previously with the *MarkerFillSymbol* coclass. Remember that a picture is two-dimensional; therefore, the *XSeparation* and *YSeparation* properties refer to the separation from the edge of one picture to the start of another. A separation of 0 (the default separation for a *PictureFillSymbol*) will result in a contiguous picture fill.



An areal feature can be filled with a repeated line.



Setting the Offset *property affects how overlapping line fill symbols are drawn.*



Symbol Property Editor

Preview

100%

Layers

Properties:

Type: Line Fill Symbol

Units: Points

Line Fill

Color: 🟥

Angle: 12.00

Offset: -4.0000

Separation: 8.0000

The ArcMap dialog box for editing line fill symbols

The *LineFillSymbol* coclass can be used to fill an areal shape with a repeated line, symbolized by any *LineSymbol* in ArcObjects.

ILineFillSymbol : IFillSymbol

Provides access to members that control the line fill symbol.

Angle: Double	*Line symbol angle within fill.*
LineSymbol: ILineSymbol	*Line symbol used for fill.*
Offset: Double	*Line fill offset.*
Separation: Double	*Line symbol separation within fill.*

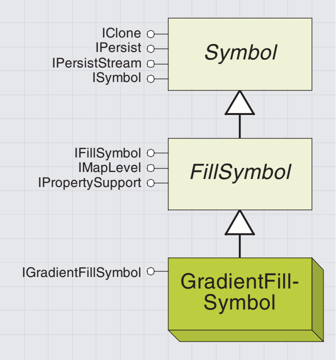
The *ILineFillSymbol* interface is used to specify the type of *LineSymbol* used for a fill, its *Angle, Offset,* and *Separation*.

The *LineSymbol* property should be set to any *LineSymbol* object (see the section in this chapter on line symbols). Be careful with your object references, as this property is set by reference.

The *Angle* property indicates the number of degrees between the *LineSymbol* and a horizontal line and defaults to 0.

The first line will always be drawn through the origin (0, 0) of the container's coordinate system, unless the *Offset* property is set to a value other than zero. This means that line fill symbols can be aligned or offset as required between multiple shapes.

The *Separation* property, which is in points, determines the frequency of the line symbols within the areal feature. If the *Separation* is less than the *LineSymbol*'s *Width,* the lines will overlap, but a *Separation* greater than the *Width* will leave a transparent area between the *LineSymbols*, through which underlying symbols' elements can be seen.



An areal feature can be filled with a series of colors, creating many different effects.

The *GradientFillSymbol* coclass can be used to fill an areal shape with colors from a *ColorRamp*.

IGradientFillSymbol : IFillSymbol	*Provides access to members that control the gradient fill symbol.*
ColorRamp: IColorRamp	*Color ramp property.*
GradientAngle: Double	*Direction of fill gradient.*
GradientPercentage: Double	*Gradient percentage - controls the bleeding effect of the fill.*
IntervalCount: Long	*Interval count - controls number of colors in the color ramp.*
Style: tagesriGradientFillStyle	*Gradient fill style.*

Set any *IColorRamp* onto the *ColorRamp* property and it will be used to fill the areal feature. A graded effect can best be achieved by using an *AlgorithmicColorRamp* (see the topics in this chapter on *ColorRamps*).

You should note that you don't need to set a *Size* or call *CreateRamp* on your *ColorRamp*. Instead, the *IntervalCount* property defines the number of color steps required. Set the *IntervalCount* property depending on what kind of effect you wish to achieve.

You may wish to use the *GradientFillSymbol* to produce a smooth gradation of color in an area and therefore need an appropriate *IntervalCount*. The average computer screen has a resolution at least three times as coarse as the average printer at 300 dpi, as a rough guide. Although your printer may have a resolution of 600 or more dpi, an average person may not be able to distinguish between output at 300 dpi and 600 dpi when viewing regions of shifting color.

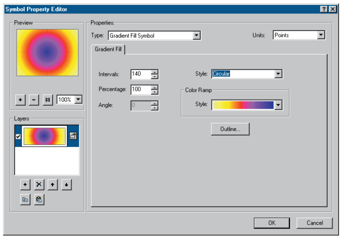
Therefore, a smooth fill on the screen may appear banded in the printed output. To produce a smooth progression of color in your fill for output to a printer, first set the 1:1 scale on the PageLayout view to account for differences in printed scale and onscreen scale. Next, experiment to find the *IntervalCount* at which the fill appears smooth on the screen—this will be dependent on the characteristics of your *ColorRamp*, the size of the area to be filled, and the *GradientPercentage* (see below). Then, multiply the *IntervalCount* by at least 3 times and try your output.

Decide how you want the gradient to fill your shape by setting the *Style* to one of the *esriGradientFillStyle* constants.

Enumeration tagesriGradientFillStyle	*Gradient fill styles.*
0 - esriGFSLinear	*Linear Gradient Fill Style.*
1 - esriGFSRectangular	*Rectangular Gradient Fill Style.*
2 - esriGFSCircular	*Circular Gradient Fill Style.*
3 - esriGFSBuffered	*Buffered Gradient Fill Style.*

For the *esriGFSLinear* or *esriGFSRectangular* styles, you can alter the fill by setting a *GradientAngle*. This is an angle, in degrees, between the vertical and the lines of fill.

You can also determine the percentage of the fill that has a gradient fill by setting *GradientPercentage* to a value between 0 and 1. A value of one indicates that the entire shape should be filled with the color ramp, but a value of 0.5 indicates only half the shape should be filled with the color ramp; the first half of the area is filled by the first color in the color ramp, and the remaining area is filled with the color ramp.



Type: Gradient Fill Symbol
Units: Points
Intervals: 140
Percentage: 100
Angle: 0
Style: Circular

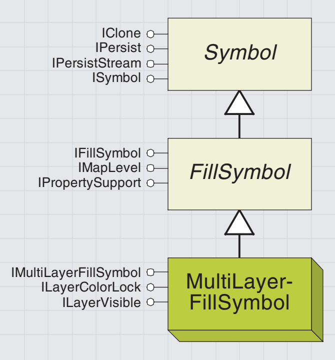
The ArcMap dialog box for editing gradient fill symbols

The *MultiLayerFillSymbol* coclass can be used to create a complex fill pattern by stacking a number of different fill symbols together.

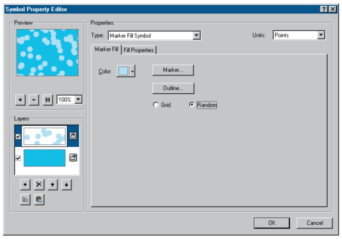
IMultiLayerFillSymbol : IFillSymbol	Provides access to members that control the multilayer fill symbol.
▪— Layer (in Index: Long) : IFillSymbol	Fill symbol per layer position.
▪— LayerCount: Long	Symbol layer count.
← AddLayer (in fillLayer: IFillSymbol)	Add fill symbol layer.
← ClearLayers	Remove all symbol layers.
← DeleteLayer (in fillLayer: IFillSymbol)	Delete fill symbol layer.
← DrawLayer (in Index: Long, Geometry: IGeometry)	Draw a symbol layer.
← MoveLayer (in fillLayer: IFillSymbol, in toIndex: Long)	Change symbol layer position index.

The *IMultiLayerFillSymbol* interface performs similar functions to the *IMultiLayerMarkerSymbol* interface discussed earlier in this chapter.

The *MultiLayerFillSymbol* also supports the *ILayerColorLock* and *ILayerVisible* interfaces, also discussed previously.



A MultiLayerFillSymbol *allows a collection of different fill symbols to be used to fill a single area feature, with lower fill patterns showing through the gaps in higher fill symbols.*



Type: Marker Fill Symbol

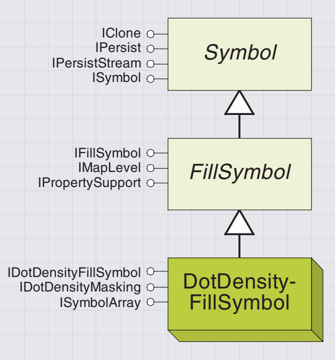
Units: Points

Color:

○ Grid ● Random

100%

The ArcMap dialog box for editing multilayer fill symbols



Dot-density fill symbols fill an areal shape with dots. When used in conjunction with a dot-density renderer, the density of dots is calculated from an attribute field.

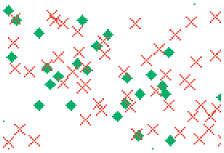
The *DotDensityFillSymbol* is a data-driven symbol typically used in conjunction with the *DotDensityRenderer* coclass. A *DotDensityFillSymbol* fills a shape with *MarkerSymbols* placed in random locations. The number of marker symbols drawn per unit area is calculated by the *DotDensityRenderer*, giving a representation of the density of an attribute value.

In addition to the interfaces detailed below, *DotDensitySymbol* implements the *ISymbolArray* interface, discussed further with the 3D chart symbols. *DotDensitySymbols* can be filled with more than one type of dot, and the symbol array is used to store a *MarkerSymbol* for each type of dot.

The Symbol *at index 0 is the first symbol to be added—it will be drawn first in the fill, below any other dots that may be specified.*

If you intend to use the *DotDensitySymbol* in a *DotDensityRenderer* to draw dots of two types, indicating two different attributes, you might use code like this:

```
Dim pMarker As ISimpleMarkerSymbol, pSymArray As ISymbolArray
Set pSymArray = New DotDensityFillSymbol

Set pMarker = New SimpleMarkerSymbol
pMarker.Style = esriSMSDiamond
pSymArray.AddSymbol pMarker

Set pMarker = New SimpleMarkerSymbol
pMarker.Style = esriSMSCross
pSymArray.AddSymbol pMarker
```



Many different dots can be used in a DotDensityFillSymbol.

You can also set other properties of each individual *MarkerSymbol* here, but you don't need to set the *Size* property, as the size of each marker is controlled by the *IDotDensityFillSymbol::DotSize property.*

IDotDensityFillSymbol: IFillSymbol	*Provides access to the main properties of a data driven symbol commonly used with a dot density renderer.*
BackgroundColor: IColor	*The background color.*
DotCount (in Index: Long) : Long	*The number of dots used to fill.*
DotSize: Double	*The size of dots used to fill.*
DotSpacing: Double	*The distance between dot centers, expressed as a percentage of dot size.*
FixedPlacement: Boolean	*Indicates if the dots are always placed at the same location (the alternative is random placement).*

IDotDensityFillSymbol controls the appearance of the marker symbols within the dot-density fill.

BackgroundColor reflects the color used to fill areas that are not covered by dots—use a *NullColor* if you wish the underlying layers to be visible through the dots.

Color indicates the color of the dots, and *Outline* can be used to alter the appearance of the boundary of the shape.

Set *FixedPlacement* to *True* if you wish the dots to be always placed in the same location. The *DotSize* property indicates the size of each dot in points—using a small size, such as 1 to 3 points, is usually most suitable.

The *DotCount* property contains a zero-based array of values that determine the number of dots drawn in a filled shape. The *DotCount* at array index 0 indicates the number of dots drawn by *ISymbolArray::Symbol(0)*, and the size of the array is determined by the number of symbols that have been added to the *DotDensitySymbol*. If you are using a *DotDensityRenderer*, you do not need to set this property, as it will be set by the *DotDensityRenderer* to an appropriate value for each *Feature*, based on the specified attribute and the *IDotDensityRenderer::DotValue* property.

If you are using the *DotDensitySymbol* independently of a *DotDensityRenderer*, then the array should be set as required. You may wish to set the *DotCount* proportionally to the shape's area, and remember to scale up the *DotCount* if the item that uses the fill changes area.

DotSpacing is not implemented at ArcGIS 8.1.

IDotDensityMasking: IUnknown	***Provides access to the masking properties of a dot density fill symbol.***
■—■ ExcludeMask: Boolean	*Indicates if the dots are to be excluded from the mask area.*
■—□ MaskGeometry: IGeometry	*The geometry used for masking (can be a geometry collection).*
■—■ UseMasking: Boolean	*Indicates if masking is used.*

DotDensityFillSymbols can be slower to display than other fill symbols—a *DotDensityRenderer* must recalculate a new *DotCount* for each *Feature* whenever the *Map* is changed. Therefore, masking may be appropriate.

DotDensityMasking allows you to exclude certain areas of a fill when drawing—for example, you may wish to exclude all areas that are covered by another *MapLayer*.

If *UseMasking* is *True* then the *ExcludeMask* property should be set as required. *ExludeMask* equal to *False* indicates that only areas inside the specified *MaskGeometry* will be drawn with dots, while *True* indicates that only areas outside of the *MaskGeometry* will be drawn with dots.

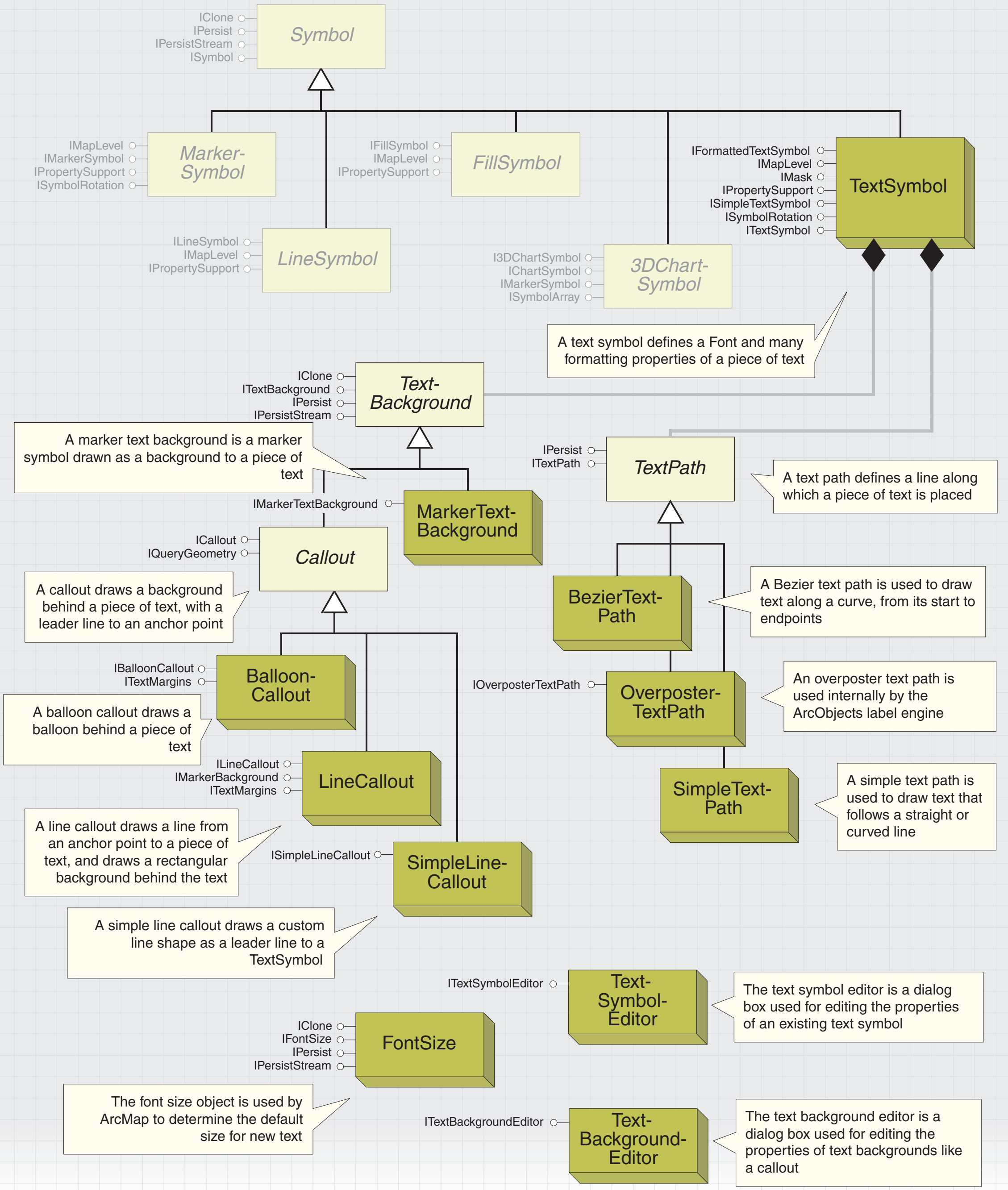
The *MaskGeometry* property is set from the *IDotDensityRenderer::ControlLayer* property. If using the *DotDensityFillSymbol* independently, you should set the *MaskGeometry* property yourself.

The code below specifies that only areas inside features in the *pControlLayer* are drawn with dots in a *DotDensityRenderer*.

```
Dim pDotDenSymbol As IDotDensitySymbol, pMasking As IDotDensityMasking
Set pDotDenSymbol = New DotDensityFillSymbol
' Set the properties of the symbol here
Set pMasking = pDotDensitySymbol
With pMasking
  .UseMasking = True
  .ExcludeMask = False
End With

Dim pDotDenRenderer As IDotDensityRenderer,
Set pDotDenRenderer = New DotDensityRenderer
Set pDotDenRenderer.DotDensitySymbol = pDotDenSymbol
pDotDenRenderer.ControlLayer = pControlLayer
```

Note that masking is only supported for *DotDensityFillSymbols* that are used in *DotDensityRenderers*.

Text symbol objects



A text symbol defines a Font and many formatting properties of a piece of text

A marker text background is a marker symbol drawn as a background to a piece of text

A text path defines a line along which a piece of text is placed

A callout draws a background behind a piece of text, with a leader line to an anchor point

A Bezier text path is used to draw text along a curve, from its start to endpoints

A balloon callout draws a balloon behind a piece of text

An overposter text path is used internally by the ArcObjects label engine

A line callout draws a line from an anchor point to a piece of text, and draws a rectangular background behind the text

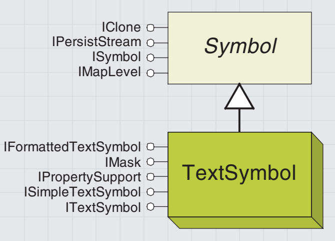
A simple text path is used to draw text that follows a straight or curved line

A simple line callout draws a custom line shape as a leader line to a TextSymbol

The text symbol editor is a dialog box used for editing the properties of an existing text symbol

The font size object is used by ArcMap to determine the default size for new text

The text background editor is a dialog box used for editing the properties of text backgrounds like a callout



A text symbol is used for rendering cartographic and marginal text, such as annotation, labels, titles, text blocks, key legends, scale bars, graphs, graticule labels, and reports.

The *TextSymbol* coclass provides the object that is used to symbolize text in graphic elements, annotation, labels, and other places.

A *TextSymbol* defines much more than just a font. Its three main interfaces, *ITextSymbol, ISimpleTextSymbol,* and *IFormattedTextSymbol*, control exactly how the text appears and how the individual characters are displayed. Extended ASCII characters are supported by the *TextSymbol*.

ITextSymbol : IUnknown	***Provides access to members that control text symbols.***
Angle: Double	*Text baseline angle.*
Color: IColor	*Text color.*
Font: Font	*Text font.*
HorizontalAlignment: tagesriTextHorizontalAlignment	*Horizontal alignment style.*
RightToLeft: Boolean	*Indicates if the text is drawn from right to left.*
Size: Double	*Text size.*
Text: String	*Text to draw.*
VerticalAlignment: tagesriTextVerticalAlignment	*Vertical alignment style.*
← GetTextSize (in hDC: Long, in Transformation: ITransformation, in Text: String, out xSize: Double, out ySize: Double)	*Gets the x and y dimensions of 'text' in points (1/72 inch).*

The *ITextSymbol* interface is the primary interface for defining the characteristics of a text and is inherited by the *ISimpleTextSymbol* and *IFormattedTextSymbol* interfaces and therefore may not need to be declared specifically. It contains the *Font* property, which is the first logical step to defining a new *TextSymbol*. To set a *Font*, you should first create a COM font object. Using the *IFontDisp* interface of your font, you should set the *Name* of the font. You should also set whether or not your *IFontDisp* is italic, bold, strike-through, or underlined and set its *CharacterSet* and weight. In Visual Basic, you can use the *StdFont* object, which provides VB's standard implementation of the COM font object.

Each font may include different character sets to allow for different alphabets and symbology. For most applications, you won't need to swap character sets from the default.

```
Dim pFnt As stdole.IFontDisp
Set pFnt = New stdole.StdFont
pFnt.Name = "ESRI Cartography"
pFnt.Bold = True
```

The StdFont *object is defined in the stdole2.tlb type library, a reference to which is included, by default, in all standard VB projects. Other development environments should provide a similar implementation.*

Now you can set the *Font* and also set the *Color* (as any coclass supporting *IColor*) and a *Size* (in points). The *Text* property is used for a standalone *TextSymbol* object only (such as a *TextSymbol* in a style file); a *TextElement* will draw text according to the *Text* property of the *TextElement* coclass. Set the *HorizontalAlignment* and *VerticalAlignment* relative to the text anchor as shown below.

Enumeration tagesriTextHorizontalAlignment	***Horizontal text alignment options.***
0 - esriTHALeft	*The text is left justified.*
1 - esriTHACenter	*The text is center justified.*
2 - esriTHARight	*The text is right justified.*
3 - esriTHAFull	*The text is fully justified.*

Enumeration tagesriTextVerticalAlignment	*Vertical text alignment options.*
0 - esriTVATop	*The text is aligned at the top.*
1 - esriTVACenter	*The text is aligned at the center.*
2 - esriTVABaseline	*The text is aligned at the baseline.*
3 - esriTVABottom	*The text is aligned at the bottom.*

If the *TextSymbol* is used to draw text to a point, not along a line (see *TextPath*), you can use the *Angle* property to rotate the text string. The *Angle* property specifies the angle of the text baseline, in degrees from the horizontal, and defaults to zero. For Hebrew and Arabic fonts, set the *RightToLeft* property to *True* to lay the text string out in a right-to-left reading order.

GetTextSize *is useful for calculating text placements on a* PageLayout *or whether a text string should be truncated to fit within a certain space.*

For any existing *TextSymbol*, the actual size in x and y directions can be calculated using the *GetTextSize* method. Having set a *Size* that defines the font height, the *GetTextSize* method will calculate the actual height and length of the symbol in points. Note that the *GetTextSize* method ignores the *TextPath* property if it is set through the *ISimpleTextSymbol* interface.

The use of this method is shown below, where *pDisplay* is the *IDisplay* of the *PageLayout* or *Map* that the *TextSymbol* belongs to, and *pTextSymbol* is a valid *TextSymbol*. Note that the *StartDrawing* and *FinishDrawing* calls are necessary to make sure the *hDC* of the display is valid. The *dblX* and *dblY* variables are populated respectively with the height and length of the text parameter when drawn with the *pTextSymbol* symbol.

```
Dim dblX As Double, dblY As Double
pDisplay.StartDrawing 0, esriNoScreenCache
pTextSymbol.GetTextSize pDisplay.hDC, pDisplay.DisplayTransformation,_
  "My Text", dblX, dblY
pDisplay.FinishDrawing
```

Remember that many properties, such as XOffset *and* YOffset*, are set in* Points*—if the size is changed, you may want to change these properties to a percentage of the new size.*

ISimpleTextSymbol : ITextSymbol	***Provides access to members that control the simple text symbol.***
▪—▪ BreakCharacter: Long	*Character to be interpreted as text line end.*
▪—▪ Clip: Boolean	*Indicates if the text will be clipped per geometry.*
▪—□ TextPath: ITextPath	*Path of text baseline.*
▪—▪ XOffset: Double	*Text offset along X-axis.*
▪—▪ YOffset: Double	*Text offset along Y-axis.*

The *ISimpleTextSymbol* interface defines a further set of properties to graphically alter the appearance of a *TextSymbol*. The *BreakCharacter* property can be used to set the character code, which is interpreted as a line break character and is particularly useful if you are working with text from a different operating system. For example, the ASCII character code for “A” is 65; therefore, if you set *BreakCharacter* to 65, the text “My ArcMap and my ArcInfo” would appear as:

My
rcMap and my
rcInfo

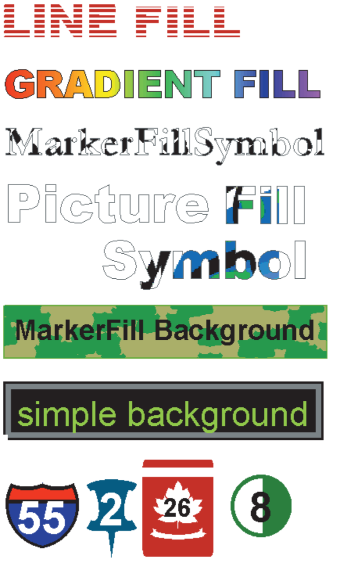
Note that *BreakCharacter* objects are not used for splined text (for example, if a *TextElement*’s *Geometry* is of type *Line*).

The *XOffset* property sets a horizontal offset in points for the placement of the text from the text anchor, and the *YOffset* performs a similar function in the vertical direction.

The Boolean *Clip* property, if *True*, will clip the text string to fit inside an *Envelope* geometry. Note that at ArcGIS 8.1, there are no *TextElements* that support the *Envelope* geometry; however, this functionality will work with the *ISymbol::Draw* method.

The *TextPath* property is set by reference. For more information about this property, see the *TextPath* abstract class.

IFormattedTextSymbol: ITextSymbol	*Provides access to members that control the formatted text symbol.*
Background: ITextBackground	*The text background object.*
Case: tagesriTextCase	*The text case.*
CharacterSpacing: Double	*The character spacing.*
CharacterWidth: Double	*The character width.*
Direction: tagesriTextDirection	*The text direction.*
FillSymbol: IFillSymbol	*The fill symbol.*
FlipAngle: Double	*The flip angle.*
Kerning: Boolean	*Indicates if kerning is on.*
Leading: Double	*The character leading.*
Position: tagesriTextPosition	*The text position.*
ShadowColor: IColor	*The shadow color.*
ShadowXOffset: Double	*The shadow X offset.*
ShadowYOffset: Double	*The shadow Y offset.*
TypeSetting: Boolean	*Indicates if typesetting is used.*
WordSpacing: Double	*The word spacing.*



Examples of text symbols with various backgrounds and fill symbols

The *IFormattedTextSymbol* interface defines a further set of properties, relating mainly to details of exact character placement and the background properties of a *TextSymbol*. Many of the properties on *IFormattedTextSymbol* will be familiar to those with a background in printing or those who have used the Windows API for working with fonts.

Change the spread of characters in the text string by setting the *CharacterSpacing* property, which indicates the spacing between each character as a percentage. The default is 0, which indicates the standard character spacing, but values of -200 to 200 are valid. Lines of text can be spaced by setting the *Leading* property, whose units are *Points*.

You can change the case of every alphabetic character in the text string by setting the *Case* property to one of the *esriTextCase* constants.

Enumeration tagesriTextCase	*Text case options.*
0 - esriTCNormal	*The text draws normally.*
1 - esriTCLowercase	*The text draws as all lowercase.*
2 - esriTCAllCaps	*The text draws as all capitals.*
3 - esriTCSmallCaps	*The text draws as small capitals.*

You can also create subscript and superscript text by setting the *Position* property.

Enumeration tagesriTextDirection	*Text direction options.*
0 - esriTDHorizontal	*The text draws horizontally.*
1 - esriTDAngle	*The text draws along an angle.*
2 - esriTDVertical	*The text draws vertically.*

A *TextSymbol*'s appearance can be changed dramatically by using a background or drawing with a *FillSymbol* instead of a simple *Color*. The *BackGround* and *FillSymbol* properties are both set by reference and are null by default (if the *FillSymbol* property is null, the *ITextSymbol*'s *Color* property is used to draw the symbol). For more information, see the *TextBackground* and *FillSymbol* abstract classes, respectively.

ArcObjects

In addition to the background properties, you can add a shadow by using the *ShadowColor, ShadowXOffset,* and *ShadowYOffset* properties. For example, to create a gray shadow like in the graphic to the left, you could set the properties like this:

```
Dim pC0l As IColor
Set pC0l = New RgbColor
pC0l.RGB = 8421504
pFTS.ShadowColor = pC0l
pFTS.ShadowXOffset = pFTS.Size / 10
pFTS.ShadowYOffset = -pFTS.ShadowXOffset
```

To remove a shadow, simply set the *ShadowColor* to null.

The *CharacterWidth, WordSpacing, Kerning, FlipAngle, TypeSetting,* and *Direction* properties are not implemented at ArcGIS 8.1.

IMask : IUnknown	***Provides access to members that control the symbol mask.***
■—■ MaskSize: Double	*The mask size.*
■—■ MaskStyle: tagesriMaskStyle	*The mask style.*
■—□ MaskSymbol: IFillSymbol	*The mask symbol.*

Use a contrasting color Mask *to highlight text that is a similar color to the features or their outlines underneath it.*

The *IMask* interface provides a simple and efficient way to draw a symbol around the edge of your *Text*. For more information about masks, see the *IMask* interface remarks under the *MarkerSymbol* coclass.

To create a rectangular block around your text, try a LineCallout *with no leader line or accent bar.*

A *Mask* differs from a *TextBackground* in that it immediately surrounds the characters in the text string in a limited and predefined way, whereas the *TextBackground* draws behind the entire text string in an extensible manner.

Set the *MaskStyle* property to an *esriMaskStyle* constant.

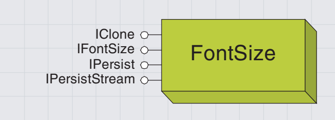
Enumeration tagesriMaskStyle	*Text mask styles.*
0 - esriMSNone	*No mask.*
1 - esriMSHalo	*The text mask style is halo.*

You can either fill the mask with a solid color by setting the *Color* property, or you can fill it with any other kind of *FillSymbol* by setting the *MaskSymbol* property.

IPropertySupport : IUnknown	***Provides access to members that set a default property on an object.***
■— Current (in pUnk: IUnknown Pointer) : IUnknown Pointer	*The object currently being used.*
◀— Applies (in pUnk: IUnknown Pointer) : Boolean	*Indicates if the receiver can apply the given object at any given time.*
◀— Apply (in NewObject: IUnknown Pointer) : IUnknown Pointer	*Applies the given property to the receiver and returns the old object.*
◀— CanApply (in pUnk: IUnknown Pointer) : Boolean	*Indicates if the receiver can apply the given object at that particular moment.*

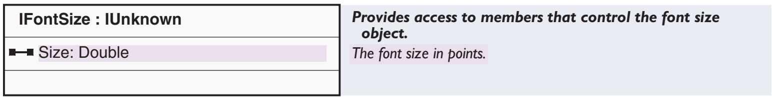
The *IPropertySupport* interface can be used to determine which interfaces are supported as properties of the *TextSymbol* interfaces. This interface was designed for use by the ArcMap Drawing toolbar. ArcObjects developers should use this interface with caution, as certain interfaces may not be supported by the *Applies* and *CanApply* methods.

FontSize coclass



The font size object is used by ArcMap to determine the default size for new text.

The *FontSize* coclass is used by the *IMxDocument::DefaultTextFontSize* property to determine a default font size for ArcMap tools, such as the New Text tool on the Draw toolbar.

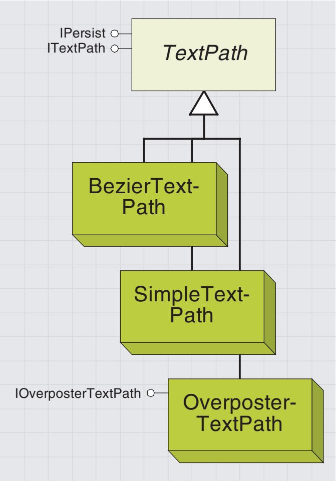


IFontSize : IUnknown — ***Provides access to members that control the font size object.***

Size: Double — *The font size in points.*

For example, if you wish text added with the New Text tool to have a size of 30 points, use the following VBA code:

```
Dim pFontSize As IFontSize
Set pFontSize = New FontSize
pFontSize.Size = 30

Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
pMxDoc.DefaultTextFontSize = pFontSize
```



A piece of text can follow along a path (a series of connected lines) and is often known as splined text. A TextPath *is the object used to calculate the position of each glyph along the path.*

The ITextPath::Setup *method sets the* TextPath *and its* TextSymbol *into the display device context, which allows it to calculate the coordinates based on the* DisplayTransformation.

The *TextPath* abstract class defines the common functionality of the text path coclasses and provides the primary interface for creating splined text. Once a valid text path object is set as the *TextPath* property of the *ISimpleTextSymbol* interface, the text will be drawn splined along the path.

ITextPath : IUnknown	***Provides access to members that control the text path.***
Geometry: IGeometry	*The geometry used for the path.*
XOffset: Double	*The X offset value.*
YOffset: Double	*The Y offset value.*
Next (out X: Double, out Y: Double, out Angle: Double)	*Returns the next coordinate.*
Reset	*Resets the coordinate enumerator.*
Setup (in hDC: Long, in Transformation: ITransformation, in textSym: ITextSymbol)	*Set up items needed by text path.*

The *ITextPath* interface provides methods to calculate the exact location of each character along a text path, allowing you to investigate the exact placement of text and find out at which point the text string turns a corner or reaches a certain location. First, set the *Geometry* property to an object supporting the *ICurve* interface. Set the *XOffset* and *YOffset* properties if you want to offset your text from this curve (the units are points). Call the *Setup* method, passing parameters based on the *Display* to which the *Symbol* belongs. Then, call the *Next* method repeatedly to calculate the angle and x,y coordinates of each successive character in the text string.

The code below demonstrates the drawing of a symbol at the coordinates of each character in the *TextSymbol*, where *pPath* is its *TextPath*, *pDisplay* is a valid *ScreenDisplay*, and *pMark* is the *MarkerSymbol* used to draw the coordinates.

```
Dim i As Integer
Dim dblX As Double, dblY As Double, dblAngle As Double
Dim pPoint As IPoint
Set pPoint = New esriCore.Point

pDisplay.StartDrawing pDisplay.hDC, esriNoScreenCache
pDisplay.SetSymbol pMark

pPath.Setup pDisplay.hDC, pDisplay.DisplayTransformation, pSimpleTxtSym
pPath.Reset

For i = 1 To Len(strTheTextString)
  pPath.Next dblX, dblY, pAngle
  pPoint.PutCoords dblX, dblY
  pMark.angle = dblAngle
  pDisplay.DrawPoint pPoint
Next i
pDisplay.FinishDrawing
```

The *SimpleTextPath* coclass can be used to spline text along the path of any *ICurve*. Simply set a *SimpleTextPath* as the *TextPath* of a *TextSymbol* and ensure that the *Geometry* used to draw the *Symbol* is a type of *Geometry* that supports *ICurve*. For example, if you wish to use splined text as a graphics element on a *PageLayout*, the *Geometry* property of the *IElement* interface of the *TextElement* must support *ICurve*. The code below demonstrates how to create splined text, from an existing *TextSymbol* (*pTextSymbol*) and *BezierCurve* (*pCurve*). Note that you set the required *Geometry* onto the *TextElement*.

If you're creating a splined TextElement *or* AnnotationElement, *make sure you set the* IElement's Geometry *property to the required curve, as the* Geometry *of the* Element *is used to place the text.*

```
Dim pTextPath As ITextPath
Set pTextPath = New SimpleTextPath
Set pTextSymbol.TextPath = pTextPath

pTextElement.Symbol = pTextSymbol

Dim pElement As IElement
Set pElement = pTextElement

pElement.Geometry = pCurve
```

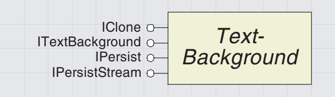
Experimenting with *ITextSymbol::VerticalAlignment* will result in text above, below, or on the line.

The *BezierTextPath* coclass has been superseded by the *SimpleTextPath*, which should generally be used in preference. It provided an early implementation of splined text along a Bézier curve before the *BezierCurve* class in geometry was introduced to ArcObjects. For a *BezierCurve*, a *BezierTextPath* takes the first, last, and midpoint of the given geometry and splines text along a Bézier curve calculated from those three points.

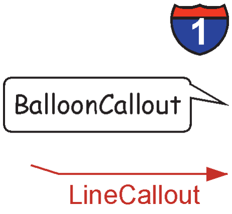
The *OverPosterTextPath* is used internally by the ArcObjects label engine. It is impractical for developers to use as it requires a specialized *Geometry* that is used within the label engine itself.

IOverposterTextPath : IUnknown	***Provides access to members that control the overposter text path.***

The *IOverPosterTextPath* is present only as a type-check mechanism; the coclass is used in a similar way to the *SimpleTextPath*. The specialized geometry required is a *PointCollection*, which contains two points for every character to be drawn. The first point of the two-point pair is the location at which the given character draws; the second point is used along with the first to determine the angle each character should be drawn at.



A background can be used to emphasize text or to aid clarity where text is obscured by features or other symbols. A background can also be part of the text symbology—for example, a highway feature can be labeled by a number drawn within a highway shield. Callouts can be applied to label features in cluttered areas of a map or layout by using a leader line. All of these examples are types of TextBackground.



Examples of the three types of text background: marker text background, balloon callout, and line callout.

A leader line is a line from a piece of text that draws the viewer's eye from the label toward a specific place on the layout or map.

A text background will automatically grow to account for text size and shadows and move to account for offsets.

The *TextBackground* abstract class defines the common properties of the different types of background—*MarkerTextBackground, BalloonCallout,* and *LineCallout*. Use a *MarkerTextBackground* to draw text over a single glyph from a font (for example, a highway shield and number). A *BalloonCallout* draws a rectangular- or balloon-shaped background for a text string with a predefined leader line. A *LineCallout* is similar to a *BalloonCallout* but has a different leader line with a user-defined style and an accent bar.

Callout text backgrounds can be used for *TextSymbol* objects with a *TextPath* set, but note that the callout will produce a background to the envelope of the text, not one following the path.

ITextBackground : IUnknown	***Provides access to members that control the text background.***
TextBox: IEnvelope	*Sets the text box.*
TextSymbol: ITextSymbol	*The text symbol.*
Draw (in hDC: Long, in Transform: ITransformation)	*Draws the text background.*
QueryBoundary (in hDC: Long, in Transform: ITransformation, in Boundary: IPolygon)	*Queries for the boundary of the text background.*

The *Draw* method is used in a similar way to the *ISymbol::Draw* method. Note that *ISymbol::Draw* called on a *TextSymbol* coclass will also call *ITextBackground::Draw*, if a *Background* is set, thus drawing both the background and the text. Note that there is no *Geometry* required in this method; the location and size of the *TextBackground* is determined by the *TextSymbol*.

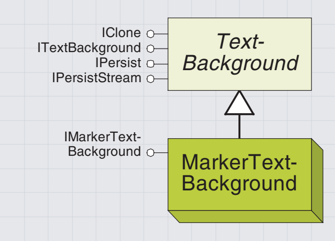
Use the *QueryBoundary* method to find the shape of a callout. This method populates a *Polygon* with the boundary of the callout. For a *LineCallout*, this is the minimum bounding rectangle of the leader line and text background box. For a *BalloonCallout*, this is the shape of the balloon. For a *MarkerTextBackground*, this is the union of the bounding box of the *Marker* and the *Text*.

The *TextBox* property is write-only. It is set by a *TextSymbol* before a call to *ITextBackground::Draw* or *ITextBackground::QueryBoundary*. For this reason, the *ITextBackground* also has a *TextSymbol* property, which is the *TextSymbol* of which the *Background* is a property.

IQueryGeometry : IUnknown	***Provides access to members that control geometry query.***
GetGeometry (in hDC: Long, in displayTransform: ITransformation, in drawGeometry: IGeometry) : IGeometry	*Gets the actual geometry of the boundary of the object (which may or may not be a polygon).*
QueryEnvelope (in hDC: Long, in displayTransform: ITransformation, in drawGeometry: IGeometry, in Envelope: IEnvelope)	*Queries the envelope of the boundary of the object.*

Use the *IQueryGeometry* to find out the exact boundary of a callout. The *GetGeometry* method returns the polygon boundary of a *BalloonCallout*, or a *Polyline* of the leader line, accent bar, and border for a *LineCallout* coclass. *QueryEnvelope* is not implemented at ArcGIS 8.1; instead, you can return the *Envelope* of the result of *GetGeometry*.

MarkerTextBackground coclass



A MarkerTextBackground *draws a single glyph as the background to a piece of text. This class is ideal for drawing highway shields as labels.*

Earlier in this chapter, you saw that a *MultiLayerMarkerSymbol* provides the ability to draw one glyph on top of another but limits each layer to containing a single glyph. However, using a *MarkerTextBackground* coclass allows you to draw a string of text (many glyphs) with a single glyph as its background.

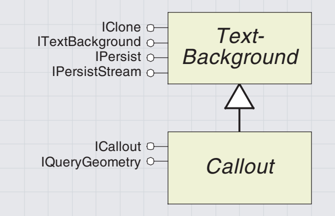
IMarkerTextBackground : ITextBackground	***Provides access to members that control the marker text background.***
ScaleToFit: Boolean	*Indicates if the marker symbol is scaled to fill the text box.*
Symbol: IMarkerSymbol	*The marker symbol.*

The *IMarkerTextBackground* interface provides two additional properties to the *ITextBackground* interface from which it inherits. Set the *MarkerSymbol* you wish to use as a background using the *Symbol* property—note that it is set by reference. The *ScaleToFit* property defaults to *False*—set this property to *True* if you want the *Symbol* to draw large enough to fit the entire text string. The *Symbol* object's *Size* property does not actually change, only its appearance when drawn.

The code below demonstrates how to create a *TextSymbol* resembling a highway route marker for Route 66 with a *MarkerTextBackground*. A *TextSymbol* is first created, then a *CharacterMarkerSymbol* is created to resemble a highway shield using the ESRI Transportation and Civic font. A *MarkerTextBackground* is created, and its *Symbol* property is set to the *CharacterMarkerSymbol*. Finally, the *MarkerTextBackground* is set as the *TextSymbol* object's *Background* property.

```
Dim pFTS As IFormattedTextSymbol
Set pFTS = New TextSymbol
pFTS.Size = 50
pFTS.Text = "66"

Dim pFont As stdole.IFontDisp
Set pFont = New stdole.StdFont
pFont.Name = "ESRI Transportation & Civic"

Dim pCharMarker As ICharacterMarkerSymbol
Set pCharMarker = New CharacterMarkerSymbol
pCharMarker.Font = pFont
' The highway shield is the 33rd Glyph in the font
pCharMarker.CharacterIndex = 33
' Below you set any properties which need to be based on the
' size of the TextSymbol
pCharMarker.XOffset = pFTS.Size / 7

Dim pMarkerBack As IMarkerTextBackground
Set pMarkerBack = New MarkerTextBackground
Set pMarkerBack.Symbol = pCharMarker
' Setting the ScaleToFit property means you don't need
' to set a Size on the MarkerSymbol
pMarkerBack.ScaleToFit = True
Set pFTS.Background = pMarkerBack
```

This symbol is created by the code sample.



A callout is a graphic drawn behind a string of text that includes a leader line, indicating a particular area.

Creating a *TextSymbol* with a *Callout* background is done in much the same way:

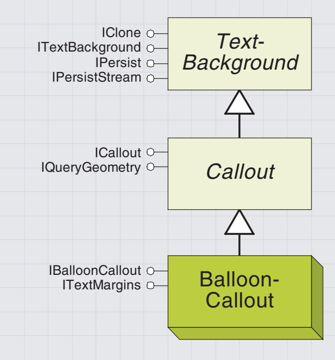
```
Dim pBalloonCallout as IBalloonCallout
Set pBalloonCallout = New BalloonCallout
Set pFTS.Background = pBalloonCallout
```

The *Callout* abstract class defines the common properties of the *BalloonCallout* and *LineCallout* backgrounds.

ICallout : IUnknown	Provides access to members that control the callout.
■—■ AnchorPoint: IPoint	*The anchor point.*
■—■ LeaderTolerance: Double	*The closest distance to the text the anchor point can be for the callout to draw.*

Use the *ICallout* interface to define an anchor point for a callout by setting the *AnchorPoint* property to an ESRI *Point* object. The *LeaderTolerance* property indicates the minimum distance between the *TextBackground* and the *AnchorPoint* for which to display a leader line. Remember that an anchor point is independent of any geometry used to draw the *TextBackground*. An anchor point is the location at which a leader line begins.

IQueryGeometry : IUnknown	Provides access to members that control geometry query.
← GetGeometry (in hDC: Long, in displayTransform: ITransformation, in drawGeometry: IGeometry) : IGeometry	*Gets the actual geometry of the boundary of the object (which may or may not be a polygon).*
← QueryEnvelope (in hDC: Long, in displayTransform: ITransformation, in drawGeometry: IGeometry, in Envelope: IEnvelope)	*Queries the envelope of the boundary of the object.*



A balloon callout draws a background graphic behind text and includes a predefined leader line.

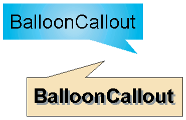
The *BalloonCallout* coclass draws a rectangular graphic behind a *TextSymbol* coclass. It has a leader line that ends by joining the callout at a predefined point.

IBalloonCallout : ICallout	Provides access to members that control the balloon callout.
■—■ Style: tagesriBalloonCalloutStyle	*The balloon callout style.*
■—□ Symbol: IFillSymbol	*The fill symbol.*

The *Style* property defines the shape of the graphic drawn behind a *TextSymbol* and should be set to one of the *esriBalloonCalloutStyle* constants.

Enumeration tagesriBalloonCalloutStyle	Balloon callout styles.
0 - esriBCSRectangle	*The balloon callout is a rectangle.*
1 - esriBCSRoundedRectangle	*The balloon callout is a rounded rectangle.*
2 - esriBCSOval	*The balloon callout is an oval.*

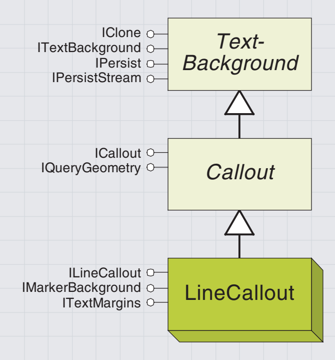
Note that the oval callout style is not implemented in ArcGIS 8.1.



ITextMargins : IUnknown	Provides access to members that control the text margins.
BottomMargin: Double	Value for the bottom margin.
LeftMargin: Double	Value for the left margin.
RightMargin: Double	Value for the right margin.
TopMargin: Double	Value for the top margin.
PutMargins (in Left: Double, in Top: Double, in Right: Double, in bottom: Double)	Sets the margins.
QueryMargins (out Left: Double, out Top: Double, out Right: Double, out bottom: Double)	Returns the margins.

Use the *ITextMargins* interface to define the margins of a callout. The margins indicate the gap, in points, between the minimum bounding box of the text and the boundary of the *TextBackground*. The default value is 5 points for each margin. You can either write to the margin properties or use the *PutMargins* method to set all the margins with a single method call.

The callout balloon can be filled by setting the *Symbol* property to any class implementing *IFillSymbol*.



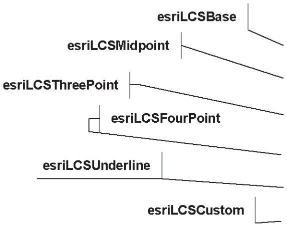
A line callout draws a background graphic behind text, consisting of a user-defined leader line, accent bar, and border.

The *LineCallout* coclass draws a rectangular graphic behind a *TextSymbol* coclass and includes an optional leader line, accent bar, and border.

ILineCallout : ICallout	Provides access to members that control the line callout.
AccentBar: ILineSymbol	The line symbol used to render the accent bar.
Border: IFillSymbol	The fill symbol used to render the border.
Gap: Double	The gap.
LeaderLine: ILineSymbol	The line symbol used to render the leader line.
Style: tagesriLineCalloutStyle	The line callout style.

The *Style* property defines the shape of the leader line and should be set to one of the *esriLineCalloutStyle* constants.

Enumeration tagesriLineCalloutStyle	Line callout styles.
0 - esriLCSBase	The line callout leader is a single line originating from the base or top of the accent bar.
1 - esriLCSMidpoint	The line callout leader is a single line originating from the midpoint of the accent bar.
2 - esriLCSThreePoint	The line callout leader is a 3-point line originating from the midpoint of the accent bar.
3 - esriLCSFourPoint	The line callout leader is a 4-point line originating from the midpoint of the accent bar.
4 - esriLCSUnderline	The line callout underlines the text.
5 - esriLCSCustom	A user defined line callout style.



Examples of each of the line callout styles.

Note that the custom callout style is not implemented at ArcGIS 8.1.

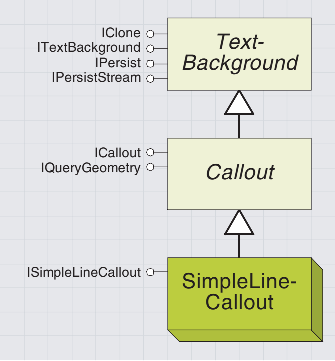
The *LeaderLine* property sets the symbol used to draw the leader line and can be set to any *LineSymbol* object. For more information, see the *LineSymbol* abstract class. Similarly, you can change the appearance of the accent bar by setting the *AccentBar* property. Note that both properties are set by reference.

An accent bar is a line drawn at the start or end of a line callout's border, separated from the border by a user-defined gap.The leader line starts from a point on the accent bar.

The spacing between the *Border* and *AccentBar* can be adjusted by setting the *Gap* property. This property indicates the separation between the center of the *AccentBar* and the edge of the *Border* as a distance in points and does not account for thick outlines on either the *AccentBar* or *Border*. To get the *AccentBar* to just touch the *Border*, you can use the following formula:

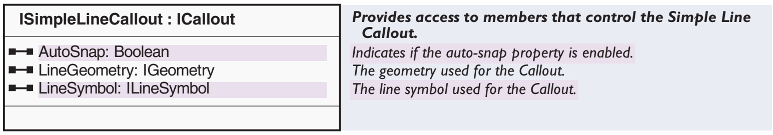
```
pLineCallout.Gap = (pLineCallout.Border.Outline.Width / 2) + _
                     (pLineCallout.AccentBar.Width / 2)
```

The *Border* property represents the rectangular background of the callout and can be filled by setting the *Border* property to any class implementing *IFillSymbol*.



A simple line callout draws a custom leader line to a text symbol.

The *SimpleLineCallout* coclass allows you to add a simple leader line to a *TextSymbol*. A *SimpleLineCallout* inherits from *ICallout* and is set onto a *TextSymbol* in the same way as the other callouts by setting the *Background* property of the *FormattedTextSymbol*.



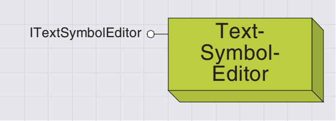
ISimpleLineCallout : ICallout — ***Provides access to members that control the Simple Line Callout.***

AutoSnap: Boolean	*Indicates if the auto-snap property is enabled.*
LineGeometry: IGeometry	*The geometry used for the Callout.*
LineSymbol: ILineSymbol	*The line symbol used for the Callout.*

To determine the appearance of the leader line, set the *LineSymbol* property to any existing *ILineSymbol* object. Set the *LineGeometry* to a *Polyline* object—this will determine the shape of your leader line. The last vertex in your *Polyline* will be replaced by the existing *AnchorPoint* of the callout.

You can use any shape of Polyline *as your leader line by using the* SimpleLineCallout*. For more information on creating* Polyline *objects, see Volume 2, Chapter 9, 'Shaping features with geometry'.*

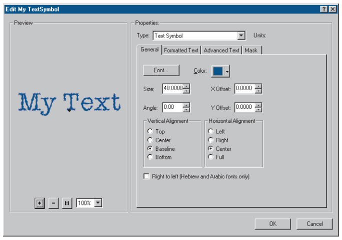
Use the *AutoSnap* property, in conjunction with the *LineGeometry* property, to determine if the *LineGeometry* will automatically change. If set to *True*, the first vertex of the *LineGeometry* will be drawn aligned to the current location of the *TextSymbol*. The existing vertex in the *LineGeometry* is not actually changed—only its position upon drawing.



The text symbol editor is the dialog box shown by ArcMap for editing the details of a text symbol.

The *TextSymbolEditor* provides an ideal way to allow a user to edit all the properties of a specific, preexisting *TextSymbol*.

ITextSymbolEditor : IUnknown	*Text Symbol Editor*
■━■ ShowUnits: Boolean	*Indicates whether to display the Units combo box.*
■━■ Title: String	*The title of the Text Symbol Editor dialog.*
← EditTextSymbol (TextSymbol: ITextSymbol, hWnd: Long) : Boolean	*Displays the Text Symbol Editor dialog for the given text symbol and returns a flag indicating if it changed.*


Edit My TextSymbol

Type: Text Symbol

Size: 40.0000

Angle: 0.00

X Offset: 0.0000

Y Offset: 0.0000

Vertical Alignment: ○ Top ○ Center ● Baseline ○ Bottom

Horizontal Alignment: ○ Left ○ Right ● Center ○ Full

□ Right to left (Hebrew and Arabic fonts only)

The ArcMap dialog box for editing text symbols.

The *EditTextSymbol* method takes an *ITextSymbol* parameter, which must be an existing *TextSymbol* object. This object is passed by reference and will be directly changed depending on the selections made in the dialog box. The *EditTextSymbol* method call will open the *TextSymbolEditor* dialog box. The *Title* property sets the title of the dialog box displayed, and the *ShowUnits* property determines if the *Units* option is shown to the user, allowing them to set size properties in units other than points.

```
Dim pTxtSym As ITextSymbol
Set pTxtSym = New TextSymbol
Dim pTextSymbolEditor As ITextSymbolEditor
Set pTextSymbolEditor = New TextSymbolEditor
pTextSymbolEditor.Title = "Edit My TextSymbol"
pTextSymbolEditor.ShowUnits = False
If Not pTextSymbolEditor.EditTextSymbol(pTxtSym, 0) Then
  MsgBox "User pressed Cancel"
Else
  'Do something with the edited TextSymbol, pTxtSym
End If
```

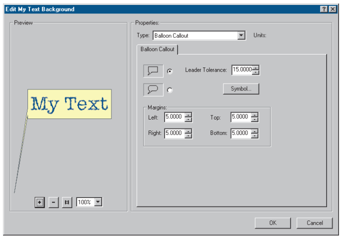
ITextBackgroundEditor
Text-
Background-
Editor

The text background editor is the dialog box shown by ArcMap to edit the details of a text symbol's background.

If a user clicks the Text Background button in the text symbol editor, they can access the text background editor and add a text background to the text symbol. However, using the text background editor directly restricts the user to setting the properties of the background for a specific text symbol object only.

The *TextBackgroundEditor* lets you edit all the properties of a preexisting *TextBackground* object, for example, a *BalloonCallout* or a *LineCallout* coclass.

ITextBackgroundEditor : IUnknown	***Provides a dialog for managing properties associated with Text Background.***
■━■ ShowUnits: Boolean	*Indicates whether to display the Units combo box.*
■━■ Title: String	*The title of the Text Background Editor dialog.*
← EditTextBackground (textBackground: ITextBackground, in previewSymbol: ITextSymbol, hWnd: Long) : Boolean	*Displays the Text Background Editor dialog for the given text background and returns a flag indicating if it changed.*


Edit My Text Background

Type: Balloon Callout

Leader Tolerance: 15.0000

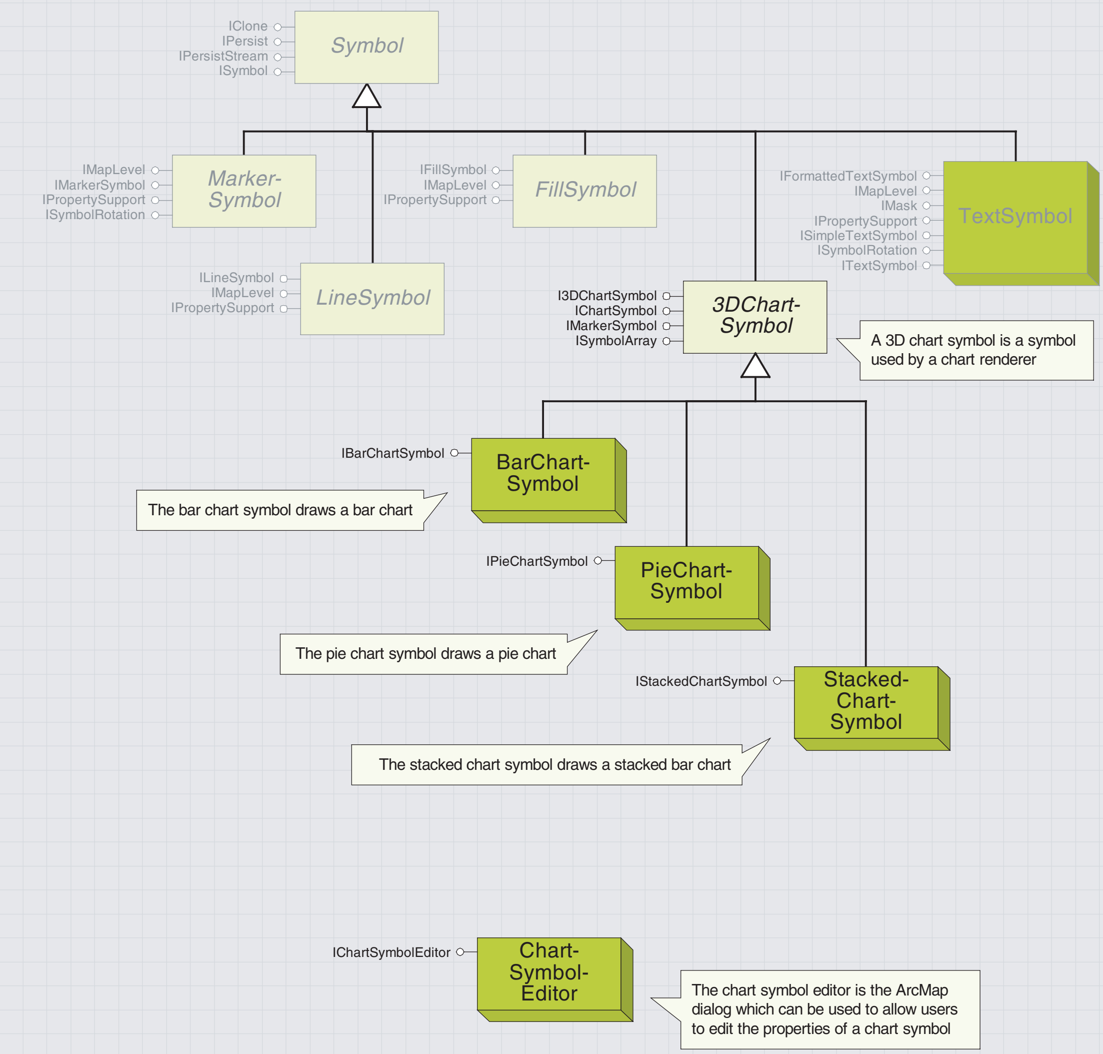
Margins: Left: 5.0000 Top: 5.0000 Right: 5.0000 Bottom: 5.0000

The ArcMap dialog box for editing text backgrounds

The *EditTextBackground* method takes an *ITextSymbol* parameter and an *ITextBackground* parameter. The *TextBackground* parameter, passed by reference, has its properties edited by the user. The *TextSymbol* is required to correctly display the *TextBackground* in the dialog box.

```
Dim pTxtBack As ITextBackground
Set pTxtBack = New BalloonCallout
Set pTxtBack.TextSymbol = pTxtSym ' pTxtSym is a pre-existing TextSymbol
Dim pTextBackgroundEditor As ITextBackgroundEditor
Set pTextBackgroundEditor = New TextBackgroundEditor
pTextBackgroundEditor.Title = "Edit My Text Background"
pTextBackgroundEditor.ShowUnits = False
If Not pTextBackgroundEditor.EditTextBackground(pTxtBack, pTxtSym, 0) Then
  MsgBox "User pressed Cancel"
Else  'Do something with the edited TextBackground
End If
```

3D chart symbol objects



A 3D chart symbol is a symbol used by a chart renderer

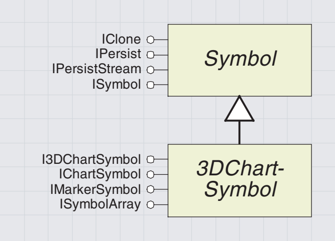
The bar chart symbol draws a bar chart

The pie chart symbol draws a pie chart

The stacked chart symbol draws a stacked bar chart

The chart symbol editor is the ArcMap dialog which can be used to allow users to edit the properties of a chart symbol

3DChartSymbol abstract class



3D chart symbols are used by ChartRenderers *to render* FeatureClasses *by drawing a pie chart, bar chart, or stacked bar chart for each* Feature*.*

A *3DChartSymbol* is an abstraction of the three types of chart symbol. It represents a marker symbol, which can be used by a *ChartRenderer* to symbolize geographical data by multiple attributes. Although they are generally used by a *ChartRenderer*, if all the properties are set appropriately you can also use the symbol as a *MarkerSymbol* to symbolize an individual *Feature* or *Element*.

The following sections describe how to set up the different coclasses that implement *I3DChartSymbol*. For more information on using these coclasses as part of a *ChartRenderer*, see the sections on feature renderers in this chapter.

IChartSymbol : IUnknown	***Provides access to properties common to all type of chart symbols.***
MaxValue: Double	*The maximum value.*
Value (in Index: Long) : Double	*The value at the index position.*

IChartSymbol is used to calculate the size of bars or pie slices in a chart symbol.

The maximum attribute value that can be represented on the chart is used to scale the other attribute values in a chart. You should always set this property when creating a *3DChartSymbol*. When creating a *ChartRenderer*, you should have access to the statistics of your FeatureClass—you can use these statistics to set the *MaxValue* property to the maximum value of the attribute or attributes being rendered.

For example, if there are two fields rendered with a chart symbol, one containing attribute values from 0 to 5 and one containing attribute values from 0 to 10, set *MaxValue* to 10.

```
Dim pChartSymbol as IShartSymbol
Set pChartSymbol = New BarChartSymbol
pChartSymbol.MaxValue = 10
```

The *Value* property contains an array of values indicating the relative height of each bar or width of each pie slice. If using the *ChartSymbol* in a *ChartRenderer*, you do not need to set this property. The *Value* array is populated repeatedly during the draw process by the *ChartRenderer*, using attribute values from the specified attribute *Fields* from the *FeatureClass* coclass to create a slightly different symbol for each *Feature*. All *Values* are set back to 0 after the draw has completed.

If you wish to use the symbol independently of a *ChartRenderer*, you should set the *Value* array with the values you wish to use in the bar or pie chart.

I3DChartSymbol : IUnknown	***Provides access to 3D properties of chart symbols.***
Display3D: Boolean	*Indicates if the chart symbol is 3D.*
Thickness: Double	*3D thickness of the chart symbol.*
Tilt: Long	*Tilt of 3D Display (0-90 degrees)*

I3DChartSymbol controls the characteristics of a chart symbol's 3D appearance. By default, *Display3D* is *True*, indicating that the chart will appear in 3D. Use *Thickness* and *Tilt* to control the 3D characteristics of the symbol.

ISymbolArray : IUnknown	***Provides access to members that work with an array of symbols.***
■—□ Symbol (in Index: Long) : ISymbol	*The symbol at the index position.*
■— SymbolCount: Long	*Returns the number of symbols.*
← AddSymbol (in Symbol: ISymbol)	*Adds a symbol to the array.*
← ClearSymbols	*Removes all symbols from the array.*
← DeleteSymbol (in Symbol: ISymbol)	*Delete the given symbol.*
← MoveSymbol (in Symbol: ISymbol, in toIndex: Long)	*Moves the given symbol to new index position.*

ISymbolArray stores the *FillSymbols* used to fill each bar or pie slice.

SymbolCount returns the number of symbols that have been added to the chart symbol using *AddSymbol*. Add a symbol for each attribute you intend to use in the *ChartRenderer*—check the *IRendererFields::FieldCount* property for the correct number of symbols to add. If you add too many symbols, these will be displayed by a bar chart as empty bars or by a pie chart as slices with zero thickness and may be visible in the *Legend*.

The code below demonstrates how you might use a *RandomColorRamp* to set the color of the symbols in a chart symbol, where *pRendererFields* is the *IRendererFields* interface of an existing *ChartRenderer*.

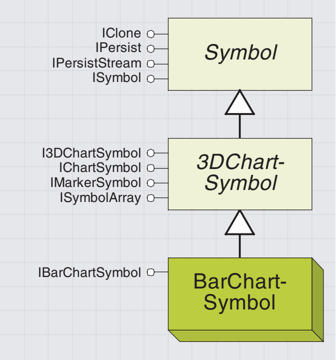
```
Dim pRandomCR As IRandomColorRamp, pFillSymbol as ISimpleFillSymbol
Set pRandomCR = New RandomColorRamp
pRandomCR.Size = 5
pRandomCR.CreateRamp True

Dim i As Integer
For i = 0 To pRendererFields.FieldCount - 1
  Set pFillSymbol = New SimpleFillSymbol
  pFillSymbol.Color = pRandomCR.Color(0)
  pSymbolArray.AddSymbol pFillSymbol
Next i
```

Use *ClearSymbols, DeleteSymbol,* and *MoveSymbol* to edit existing symbol arrays.

The chart symbols also implement *IMarkerSymbol*, which is discussed earlier in this chapter.

The *Size* property is used to specify the maximum height (or width if the bars are horizontal), in points, of the bar, stacked bar symbol, or the diameter of a pie chart symbol.

Note that if the symbols are scaled by the *ChartRenderer* (check *IStackedChartSymbol::Fixed, IPieChartRenderer::ProportionalBySum,* or *ProportionalByField*), the larger symbols may be larger than *Size*.



A *BarChartSymbol* is most commonly used by a *ChartRenderer* to draw a bar chart for each *Feature* rendered, where the bar heights are derived from attribute fields.

IBarChartSymbol : IUnknown	Provides access bar chart symbol properties.
Axes: ILineSymbol	The axis symbol.
ShowAxes: Boolean	Indicates if the axis are shown.
Spacing: Double	The spacing between bars in points.
VerticalBars: Boolean	Indicates if the bars are oriented vertically.
Width: Double	The width of each bar in points.

Bars can be oriented either vertically or horizontally using the *VerticalBars* property.

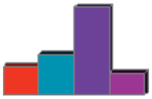
The thickness of each bar and the spacing between bars can be altered as shown using the *Width* and *Spacing* properties—you may wish to set these properties proportional to *IMarkerSymbol::Size*.

The axes for each *BarChartSymbol* can also be displayed using the *ShowAxes* property—set a *LineSymbol* as the *Axes* property to determine their appearance.

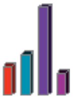
Features can be symbolized with a bar chart, each bar of which can represent the value of a different attribute.

VerticalBars = False

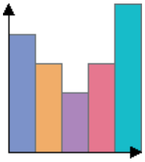
VerticalBars = True



Thickness = *20 and* Spacing = *0*



Thickness = *5 and* Spacing = *5*



Bar axes drawn for a bar chart symbol

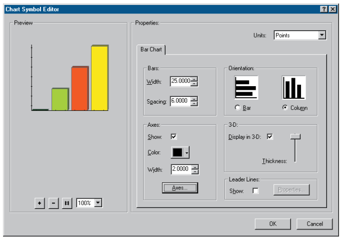


Chart Symbol Editor

Preview

Properties:

Units: Points

Bar Chart

Bars:

Width: 25.0000

Spacing: 6.0000

Orientation:

○ Bar ● Column

Axes:

Show: ☑

Color:

Width: 2.0000

Axes...

3D:

Display in 3D: ☑

Thickness:

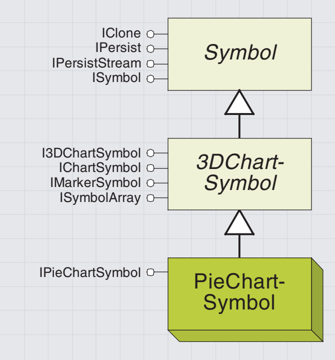
Leader Lines:

Show: □ Properties...

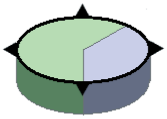
100%

OK Cancel

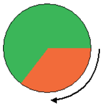
The ArcMap property page for the bar chart symbol



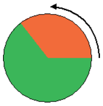
Features can be symbolized with a pie chart, where each slice can represent the value of a different attribute.



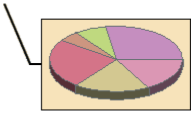
Pie chart symbol drawn with an outline



Clockwise = True



Clockwise = False



Pie chart symbol with background

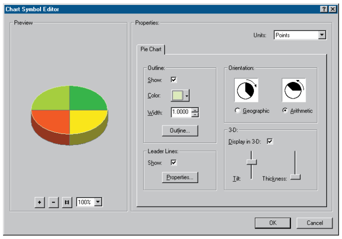


Chart Symbol Editor

Preview

100%

Properties:

Units: Points

Pie Chart

Outline:
Show: ☑
Color:
Width: 1.0000
Outline...

Orientation:
○ Geographic ● Arithmetic

Leader Lines:
Show: ☑
Properties...

3-D:
Display in 3-D: ☑
Tilt:
Thickness:

OK Cancel

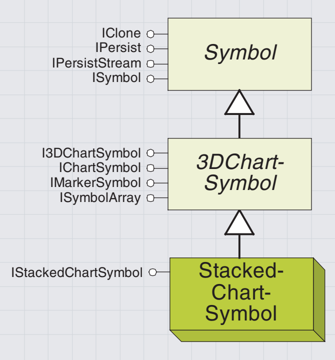
The ArcMap property page for the pie chart symbol

A *PieChartSymbol* is most commonly used by a *ChartRenderer* to draw a pie chart for each *Feature* rendered, where the proportion of each pie slice is derived from attribute fields.

IPieChartSymbol : IUnknown	Provides access to pie chart symbol properties.
Clockwise: Boolean	Indicates if the slices are drawn in a clockwise direction.
Outline: ILineSymbol	The chart outline symbol.
UseOutline: Boolean	Indicates if the outline symbol is drawn.

Use the properties of *IPieChartSymbol* to control the appearance of the pie chart. The pie chart symbol shown to the left was created by applying a *CartographicLineSymbol*, which had *LineDecorations* at each quarter length along the line.

You can also alter the orientation of the chart using the *Clockwise* property—use the *IMarkerSymbol::Angle* property to change the position of the first pie slice, if you wish.



Features can be symbolized with a stacked bar chart, where each section of the bar can represent the value of a different attribute.

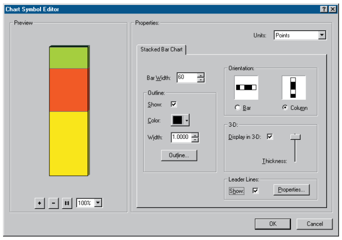


Chart Symbol Editor

Preview

100%

Properties:

Units: Points

Stacked Bar Chart

Bar Width: 60

Outline:

Show: ☑

Color: ■

Width: 1.0000

Outline...

Orientation:

○ Bar ● Column

3-D:

Display in 3-D: ☑

Thickness:

Leader Lines:

Show: ☑

Properties...

OK Cancel

The ArcMap property page for the stacked chart symbol

A *StackedChartSymbol* is most commonly used by a *ChartRenderer* to draw a stacked bar chart for each *Feature* rendered, where the proportion of each section of the bar is derived from attribute fields.

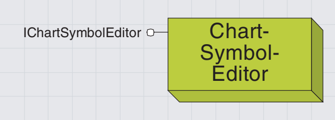
IStackedChartSymbol : IUnknown	Provides access to stacked chart symbol properties.
Fixed: Boolean	Indicates if the bars are of a fixed length (the alternative is graduated length bars).
Outline: ILineSymbol	The symbol for the chart outline.
UseOutline: Boolean	Indicates if the outline symbol is drawn.
VerticalBar: Boolean	Indicates if the bar is oriented vertically.
Width: Double	The width of the bar in points.

Use *IStackedChartSymbol* to specify the appearance of the stacked bar chart.

The *Outline* and *UseOutline* properties are similar to those on the *PieChartSymbol*.

The *Width* and *VerticalBar* properties are similar to those on the *BarChartSymbol*.

If the *Fixed* property is *False*, a *ChartRenderer* will scale the stacked bar chart according to the total of the attributes for each feature. If *True*, each bar chart has the same height; if *VerticalBar* is *False*, each bar chart has the same width.



The ArcMap Chart Symbol Editor dialog box edits the details of a chart symbol. The pages shown on the dialog box depend on the type of chart symbol used. For example, a bar chart symbol has a slightly different dialog box than a pie chart symbol.

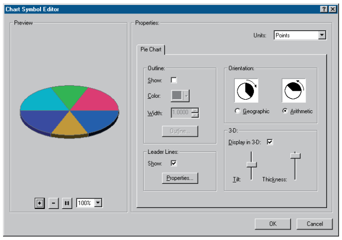


Chart Symbol Editor

Units: Points

Pie Chart

Outline:
Show: □
Width: 1.0000

Orientation:
○ Geographic ● Arithmetic

3-D:
Display in 3-D: ☑

Leader Lines:
Show: ☑

This is the Chart Symbol Editor dialog box for editing a pie chart symbol.

The *ChartSymbolEditor* provides an ideal way to allow a user to edit all the properties of a specific, preexisting *ChartSymbol*. It is very similar to the *SymbolEditor* coclass.

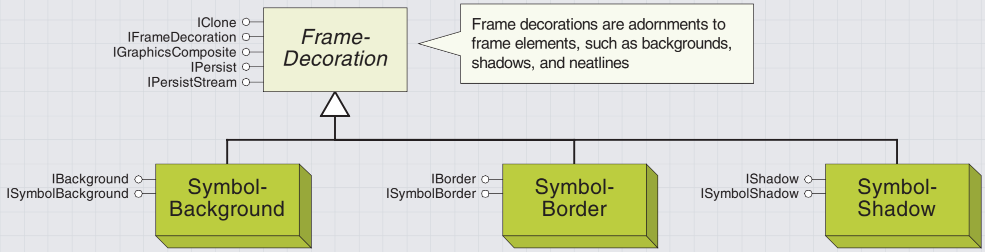
IChartSymbolEditor : IUnknown	***Provides access to members that control a dialog used to manage chart symbol properties .***
ShowUnits: Boolean	*Indicates if the units combo box is displayed.*
Title: String	*Title of the chart symbol editor dialog.*
EditChartSymbol (Symbol: IChartSymbol, hWnd: Long) : Boolean	*Displays the chart symbol editor dialog for the given chart symbol and returns a value describing whether the symbol was changed.*

The *EditChartSymbol* method takes an *IChartSymbol* parameter, which must be an existing object that supports *IChartSymbol* interface. This object is passed by reference and will be directly changed depending on the selections made in the dialog box—its coclass may even change.

The *EditChartSymbol* method call will open the *ChartSymbolEditor* dialog. To determine if the user clicked Cancel or OK, check the return value.

```
Dim pBarSymbol As IBarChartSymbol, pChartSymEditor As IChartSymbolEditor
Set pBarSymbol = New BarChartSymbol
Set pChartSymEditor = New ChartSymbolEditor
If Not pChartSymEditor.EditChartSymbol(pBarSymbol, 0) Then
  'Do something with the edited Symbol
End If
```

Frame decoration objects



Frame decorations are adornments to frame elements, such as backgrounds, shadows, and neatlines

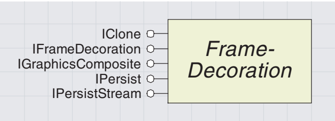
The symbol background draws a background fill for a frame element

The symbol border draws an outline for a frame element

The symbol shadow draws a shadow around a frame element

Frame decorations are used to determine how frame elements are displayed. You might use a frame decoration to alter the background of an active view, add a shadow to a group of graphic elements, or draw a neatline around a map.

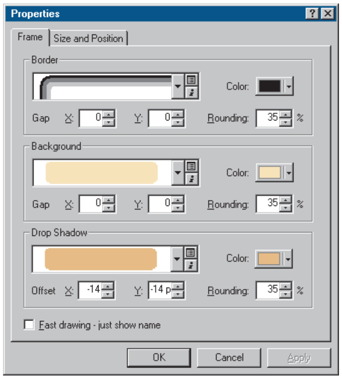
Careful use of frame decorations can create a coherent and neat page layout for your maps. Use similar decorations to visually group related frames or try using shadows and fills to emphasize other frames.



A frame decoration is used to draw a frame element.

A *FrameDecoration* is either a *SymbolBackground, SymbolBorder,* or *SymbolShadow* coclass used to draw a frame element. Use a *FrameDecoration* on any object supporting *IFrameProperties*, such as map surround frames or group elements.

IFrameDecoration : IUnknown	*Provides access to members that control frame decorations.*
Color: IColor	*Color of the frame decoration.*
CornerRounding: Integer	*Amount of corner rounding. 0 = fully square. 100 = fully round.*
HorizontalSpacing: Double	*Horizontal offset or gap between the decoration and the subject in points.*
Name: String	*Name of the frame decoration.*
VerticalSpacing: Double	*Vertical offset or gap between the decoration and the subject in points.*
Draw (in Display: IDisplay, in Geometry: IGeometry)	*Draws the decoration into the given display object.*
GetGeometry (in Display: IDisplay, in Shape: IGeometry) : IGeometry	*Geometry used to draw the decoration.*
QueryBounds (in Display: IDisplay, in Geometry: IGeometry, in Bounds: IEnvelope)	*Bounding rectangle of the geometry including the area covered by the border.*


Properties

Frame | Size and Position

Border
Color:
Gap X: 0 Y: 0 Rounding: 35 %

Background
Color:
Gap X: 0 Y: 0 Rounding: 35 %

Drop Shadow
Color:
Offset X: -14 Y: -14 p Rounding: 35 %

☐ Fast drawing - just show name

Frame decoration dialog box in ArcMap

The Draw *and* QueryBounds *methods can be used in a similar way to the* ISymbol::Draw *method, which should be referred to for further information. For more information on the* GetGeometry *method, refer to the* IQueryGeometry *interface, described with the* Callout *classes.*

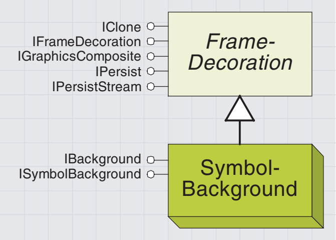
Setting the *Color* property will fill a frame with a single color. The *CornerRounding* property alters the frame from its default rectangle shape to a rounded shape; the maximum value of 100 indicates that along the shorter edge of the frame, the corners will be rounded to the center of the edge. The *Name* property corresponds to the name of the style of the border, background, or shadow if it was set from a style file.

VerticalSpacing and *HorizontalSpacing* refer to the gap, in points, between the frame and its subject, positive values indicating the frame draws outside the subject, and negative values indicating that it draws inside the subject.

The code that follows uses the *IFrameDecoration* properties to change each frame in a graphics container (*pGraphics*) to a rounded frame filled with the color *pColor*. We use a *SymbolBackground* coclass to make the *FrameDecoration*, although we only use the *IFrameDecoration* properties.

```
Dim pElement As IElement
pGraphics.Reset
Set pElement = pGraphics.Next
Do While Not pElement Is Nothing

  If TypeOf pElement Is IFrameElement Then
    Dim pFrameElement As IFrameElement
    Set pFrameElement = pElement
    Dim pFrameDec As IFrameDecoration
    Set pFrameDec = New SymbolBackground
    pFrameDec.Color = pColor
    pFrameDec.CornerRounding = 50
    pFrameElement.Background = pFrameDec
    pGraphics.UpdateElement pElement
  End If
  Set pElement = pGraphics.Next
Loop
```

A MapFrame *will only draw with unrounded corners, regardless of the* CornerRounding *property. However, the* MapSurroundFrame *can draw with a rounded frame.*

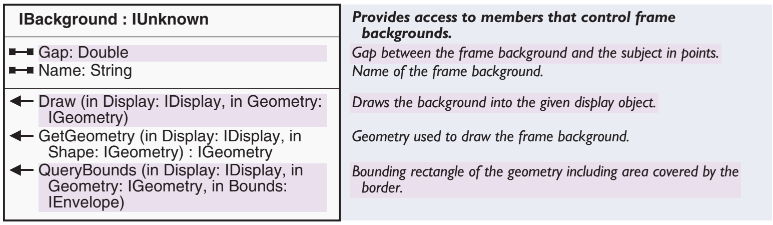


SymbolBackgrounds *can be used to change the appearance of the interior of a frame.*

A *SymbolBackground* is used to define how any frame element is filled. Set a *SymbolBackground* by value, as the *Background* property of any *IFrameElement* interface.

```
Dim pSymbolBackground as ISymbolBackground
Set pSymbolBackground = New SymbolBackground
pFrameElement.Background = pSymbolBackground
```

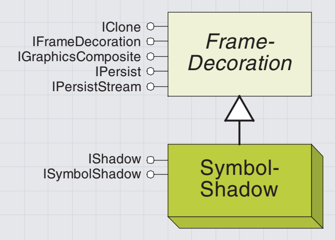
Alternatively, you can set a *SymbolBackground* using the *IFrameProperties::Background* property, which has the same effect.



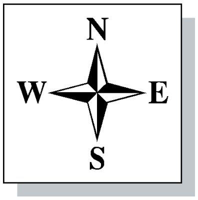
IBackground : IUnknown	Provides access to members that control frame backgrounds.
Gap: Double	Gap between the frame background and the subject in points.
Name: String	Name of the frame background.
Draw (in Display: IDisplay, in Geometry: IGeometry)	Draws the background into the given display object.
GetGeometry (in Display: IDisplay, in Shape: IGeometry) : IGeometry	Geometry used to draw the frame background.
QueryBounds (in Display: IDisplay, in Geometry: IGeometry, in Bounds: IEnvelope)	Bounding rectangle of the geometry including area covered by the border.

The *Gap* property reflects the *HorizontalSpacing* and *VerticalSpacing* properties of the *IFrameDecoration* interface, with *HorizontalSpacing* taking preference if the properties contain different values. This provides a simple way to set an equal horizontal and vertical gap for the frame.

ISymbolBackground : IBackground	Provides access to members that control the SymbolBackground object.
CornerRounding: Integer	Amount of corner rounding. 0 = fully square. 100 = fully round.
FillSymbol: IFillSymbol	Symbol used to draw the background.



You can draw shadows around a frame by using a SymbolShadow *object.*



Set the *FillSymbol* property to any *IFillSymbol* object to draw a frame filled with the pattern of your choice, as shown in this example:

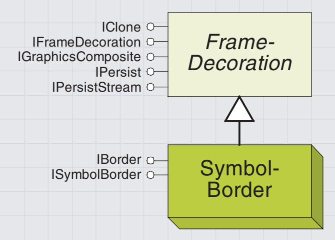
```
Dim pSimpleFill As ISimpleFillSymbol
Set pSimpleFill = New SimpleFillSymbol
pSimpleFill.Style = esriSFSCross
pSymbolBackground.FillSymbol = pSimpleFill
```

A *SymbolShadow* is used to create a dropped shadow. Set a *SymbolShadow* as the *Shadow* property on the *IFrameProperties* interface.

```
Dim pSymbolShadow as ISymbolShadow
Set pSymbolShadow = New SymbolShadow
pFrameElement.Shadow = pSymbolShadow
```

IShadow : IUnknown	Provides access to members that control frame drop shadows.
HorizontalSpacing: Double	Horizontal offset between the drop shadow and the subject in points.
Name: String	Name of the drop shadow.
VerticalSpacing: Double	Vertical offset between the drop shadow and the subject in points.
Draw (in Display: IDisplay, in Geometry: IGeometry)	Draws the drop shadow into the given display object.
GetGeometry (in Display: IDisplay, in Shape: IGeometry) : IGeometry	Geometry used to draw the drop shadow.
QueryBounds (in Display: IDisplay, in Geometry: IGeometry, in Bounds: IEnvelope)	Bounding rectangle of the geometry including the area covered by the border.

ISymbolShadow : IShadow	Provides access to members that control the SymbolBorder object.
CornerRounding: Integer	Amount of corner rounding. 0 = fully square. 100 = fully round.
FillSymbol: IFillSymbol	Symbol used to draw the shadow.



Neatlines can be drawn around frames using a SymbolBorder *object.*

Setting the *HorizontalSpacing* and *VerticalSpacing* properties determines the offset, in points, of the shadow from the frame, with positive values indicating a shadow to the top-right corner of the frame.

Ideally, a suitable *FillSymbol* for a shadow is a simple fill used for emphasis, not for elaborate decoration.

A *SymbolBorder* is used to define the appearance of the line drawn around a frame, as shown in this code example:

```
Dim pSymbolBorder as ISymbolBorder
Set pSymbolBorder = New SymbolBorder
pFrameElement.Border = pSymbolBorder
```

IBorder : IUnknown	***Provides access to members that control frame borders.***
■—■ Gap: Double	*Gap between the frame border and the subject in points.*
■—■ Name: String	*Name of the frame border.*
← Draw (in Display: IDisplay, in Geometry: IGeometry)	*Draws the frame border into the given display object.*
← GetGeometry (in Display: IDisplay, in Shape: IGeometry) : IGeometry	*Geometry used to draw the frame border.*
← QueryBounds (in Display: IDisplay, in Geometry: IGeometry, in Bounds: IEnvelope)	*Bounding rectangle of the geometry including the area covered by the border.*

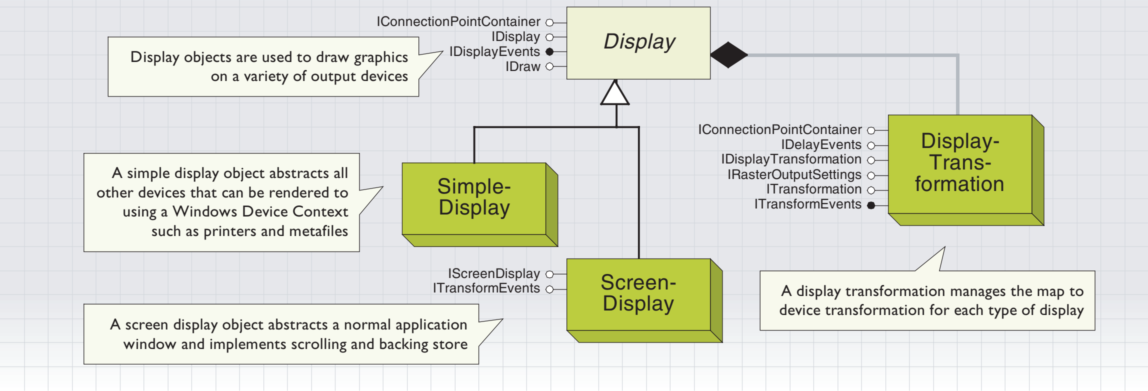
ISymbolBorder : IBorder	***Provides access to members that control the SymbolBorder object.***
■—■ CornerRounding: Integer	*Amount of corner rounding. 0 = fully square. 100 = fully round.*
■—■ LineSymbol: ILineSymbol	*Symbol used to draw the border.*

Set any *ILineSymbol* object as the *LineSymbol* property of a *SymbolBorder* coclass to emphasize the frame. This is shown in the following code example.

```
Dim pSimpleLine As ISimpleLineSymbol
Set pSimpleLine = New SimpleLineSymbol
pSimpleLine.Style = esriSLSSolid
pSymbolBorder.LineSymbol = pSimpleLine
```

To achieve a consistent look to your maps, you may wish to apply similar borders to related frame elements in a *PageLayout*. Remember that using too many elaborate and varied lines makes a layout look cluttered or confusing.

Display objects



Display objects are used to draw graphics on a variety of output devices

A simple display object abstracts all other devices that can be rendered to using a Windows Device Context such as printers and metafiles

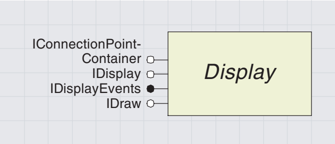
A screen display object abstracts a normal application window and implements scrolling and backing store

A display transformation manages the map to device transformation for each type of display

The Display *objects are a set of objects that allow application developers to easily draw graphics on a variety of output devices. These objects allow you to render shapes stored in real-world coordinates to a screen, printer, or export file.*

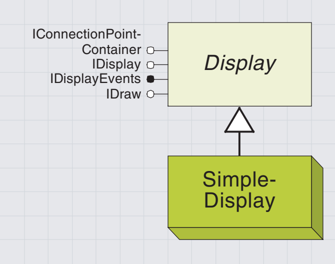
The display objects allow application developers to easily draw graphics on a variety of output devices. These objects allow you to render shapes stored in real-world coordinates to the screen, the printer, and export files. Application features such as scrolling, backing store, print "tiling", and printing to a frame can be easily implemented. If some desired behavior is not supported by the standard objects, custom objects can be created by implementing one or more of the standard display interfaces.

There are two standard display objects: *ScreenDisplay* and *SimpleDisplay*. The *ScreenDisplay* object abstracts a normal application window and implements scrolling and backing store. The *SimpleDisplay* abstracts all other devices that can be rendered to using a Windows Device Context, such as printers and metafiles.



The Display *object abstracts a drawing surface. A drawing surface is any hardware device, export file, or memory bitmap that can be represented by a Windows Device Context.*

IDisplay : IUnknown	***Provides access to members that control the Display.***
■— ClipEnvelope: IEnvelope	*The bounds of the clipping region. Use after StartDrawing and before FinishDrawing.*
■— ClipEnvelopes: ISet	*The clipping region as a set of envelopes. Use after StartDrawing and before FinishDrawing.*
■—■ ClipGeometry: IGeometry	*User-specified clip shape. This shape is merged with the invalid region to arrive at the actual clip region. Must be specified before StartDrawing.*
■—■ DisplayTransformation: IDisplayTransformation	*The transformation used by the display.*
■—□ Filter: IDisplayFilter	*Display filter. Must call while in a StartDrawing-FinishDrawing sequence. Set Filter to 0 to resume normal drawing.*
■— hDC: Long	*Current device context. Only use this between calls to StartDrawing and FinishDrawing.*
■—■ hPalette: Long	*Palette.*
■—■ IlluminationProps: IIlluminationProps	*Illumination properties used by the display.*
■—■ SuppressEvents: Boolean	*Indicates if display object suppresses events.*
← DrawMultipoint (in Multipoint: IGeometry)	*Draws specified multipoint on the display.*
← DrawPoint (in Point: IGeometry)	*Draws specified point on the display.*
← DrawPolygon (in Polygon: IGeometry)	*Draws specified polygon on the display*
← DrawPolyline (in Polyline: IGeometry)	*Draws specified line on the display*
← DrawRectangle (in rectangle: IEnvelope)	*Draws specified rectangle on the display.*
← DrawText (in Shape: IGeometry, in Text: String)	*Draws specified text on the display*
← FinishDrawing	*Completes drawing.*
← Progress (in VertexCount: Long)	*Call frequently during drawing process.*
← SetSymbol (in sym: ISymbol)	*Sets the symbol used for drawing. Four different symbols can be specified simultaneously: Marker, Line, Fill, Text.*
← StartDrawing (in hDC: Long, in cacheID: Integer)	*Prepare the display for drawing. Specify the device context and the cache to draw to (normally esriNoScreenCache).*

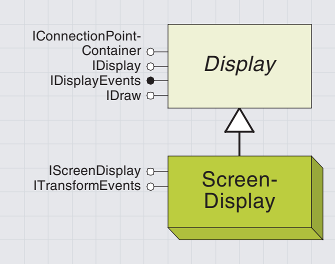


The SimpleDisplay *object abstracts devices such as printers and metafiles.*

Use the *IDisplay* interface to draw points, lines, polygons, rectangles, and text on a device. Access to the display object's *DisplayTransformation* object is provided by this interface.

IDisplayEvents : IUnknown	Provides access to members that control Display Events.
← DisplayFinished (in Display: IDisplay)	Notifies clients when drawing completes.
← DisplayInvalidated (in Display: IDisplay, in rect: IEnvelope, erase: Boolean, cacheID: Integer)	Notifies clients when display is invalidated.
← DisplayScrolled (in Display: IDisplay, in deltaX: Long, in deltaY: Long)	Notifies clients when display is scrolled.
← DisplayStarted (in Display: IDisplay)	Notifies clients when drawing starts.

IDisplayEvents is the outbound interface of the *Display* abstract class. This interface enables developers to listen for specific events occurring inside a display. For example, you may wish to know whenever a particular display is scrolled. This is the case for the *Map* object that needs to perform some redrawing operations whenever its screen display is scrolled.



The ScreenDisplay *object is a display device that abstracts a normal application window. In addition to managing the display attributes for the screen, a* ScreenDisplay *also manages other issues specific to Microsoft Windows, including backing stores (caches), scrolling, and invalidation.*

Several objects manage (cocreate) a *ScreenDisplay* object to help control their associated window. For example, both *Map* and *PageLayout* have their own associated *ScreenDisplay*, and so does the *MapInsetWindow*. The *AppDisplay* object does not instantiate a new *ScreenDisplay* object; instead, this object implements the *IScreenDisplay* interface. That is also what the *ScreenDisplay* object does.

A reference to a *ScreenDisplay* object is typically obtained via *IActiveView::ScreenDisplay* for the active views or *ILensWindow::ScreenDisplay* for the *MapInsetWindow*. *IAppDisplay* also has methods for returning a reference to the main screen of the application, the screen currently with focus, or any screen based on an index.

The *ScreenDisplay* object is cocreateable; one instance when you may have to create a new *ScreenDisplay* object is when creating a custom active view. However, as discussed above, this object is typically created by another object, such as the *Map* or *PageLayout* objects.

To learn about working with all of the *ScreenDisplay* objects in an ArcMap application simultaneously, see the section on *AppDisplay* in Chapter 4, 'Composing maps'.

ITransformEvents : IUnknown	Provides access to members that control Transform Events.
← BoundsUpdated (sender: IDisplayTransformation)	Notifies clients when the bounds is updated.
← DeviceFrameUpdated (sender: IDisplayTransformation, sizeChanged: Boolean)	Notifies clients when the device frame is updated.
← ResolutionUpdated (sender: IDisplayTransformation)	Notifies clients when the resolution is updated.
← RotationUpdated (sender: IDisplayTransformation)	Notifies clients when the rotation angle is updated.
← UnitsUpdated (sender: IDisplayTransformation)	Notifies clients when the units are updated.
← VisibleBoundsUpdated (sender: IDisplayTransformation, sizeChanged: Boolean)	Notifies clients when the visible bounds is updated.

ITransformEvents is an outbound interface on the *ScreenDisplay* and *DisplayTransformation* objects. Use this interface to respond to changes made to these objects.

The IScreenDisplay *interface manages the display attributes of a screen.* IScreenDisplay *also handles other issues specific to Windows, including the backing store, scrolling, and invalidation. Use* IScreenDisplay *to pan or rotate the display, invalidate the display, and access or draw the caches created by the application.*

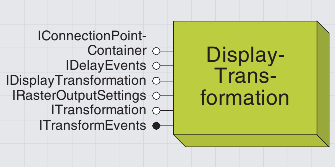
IScreenDisplay : IDisplay	*Provides access to members that control Screen Display.*
■–■ ActiveCache: Integer	*Screen cache where drawing occurs. Use rarely. Change cache inside StartDrawing/FinishDrawing sequence.*
■– CacheCount: Integer	*Number of screen caches.*
■– CacheMemDC (in Index: Integer) : Long	*Memory device context for the specified screen cache.*
■–□ CancelTracker: ITrackCancel	*Cancel tracker that is associated with the display.*
■–■ hWnd: Long	*Associated window handle.*
■–■ IsFirstCacheTransparent: Boolean	*Indicates if the bottom cache is transparent.*
■–■ IsFramed: Boolean	*Indicates if drawing occurs in a frame rather than on the whole window.*
■–■ ScaleContents: Boolean	*Indicates if the contents of the screen scale when a resize occurs. True means scale contents to fit new window size. False means contents stays the same with more or less of it showing.*
■–■ SuppressResize: Boolean	*Indicates if display resizing is suppressed. True means the display doesn't resize with the window. False ensures that the display is the same size as the window.*
■–■ UseScrollbars: Boolean	*Indicates if scrollbars should appear.*
■– WindowDC: Long	*Device context that was specified to StartDrawing. Only use this between calls to StartDrawing and FinishDrawing.*
◀– AddCache: Integer	*Creates a new cache and return its ID. The ID can be specified to StartDrawing to direct output to the cache. It can also be used with a number of other methods such as DrawCache and Invalidate.*
◀– DoScroll (in xDelta: Long, in yDelta: Long, in updateScreen: Boolean)	*Scrolls the screen by the specified amount.*
◀– DrawCache (in hDC: Long, in Index: Integer, in deviceRect: tagRECT, in cacheRect: tagRECT)	*Draws the specified screen cache to the specified window device context. Pass an empty rectangle to copy the full bitmap to the DC origin*
◀– Invalidate (in rect: IEnvelope, in erase: Boolean, in cacheIndex: Integer)	*Indicates if the specified rectangle is refreshed.*
◀– IsCacheDirty (in cacheIndex: Integer) : Boolean	*Indicates if the specified cache needs refreshing.*
◀– PanMoveTo (in mouseLocation: IPoint)	*Pans to a new point.*
◀– PanStart (in mouseLocation: IPoint)	*Prepares display for panning.*
◀– PanStop: IEnvelope	*Stops panning and returns new visible bounds.*
◀– RemoveAllCaches	*Removes all caches.*
◀– RemoveCache (in cacheID: Integer)	*Removes the specified cache.*
◀– RotateMoveTo (in pPoint: IPoint)	*Rotates to new point.*
◀– RotateStart (in mousePt: IPoint, in centerPt: IPoint)	*Prepares display for rotating. If centerPt is NULL, the center of the visible bounds is used.*
◀– RotateStop: Double	*Stops rotating and returns new angle.*
◀– RotateTimer	*Draws the rotated display. Call in response to WM_TIMER.*
◀– SetScrollbarHandles (in hWndHorzScrollbar: Long, in hWndVertScrollbar: Long)	*Optionally specify application supplied scrollbars.*
◀– StartRecording	*Starts recording all output to the recording cache.*
◀– StopRecording	*Stops recording to the recording cache.*
◀– TrackPan	*Interactively pans the screen.*
◀– TrackRotate	*Interactively rotates the screen.*
◀– UpdateWindow	*Forces a redraw.*

Two objects currently implement IScreenDisplay: AppDisplay *and* ScreenDisplay. *Both objects' implementation of* IScreenDisplay *is slightly different. For more details, see the component help for a particular member.*

IScreenDisplay inherits from *IDisplay*. This means that all properties and methods on *IDisplay* are callable directly from *IScreenDisplay*.

This simple VBA script for a *UIToolControl MouseDown* event pans the map display.

```
Private Sub UIToolControl1_MouseDown(ByVal button As Long, _
    ByVal shift As Long, ByVal x As Long, ByVal y As Long)
  Dim pScreenDisplay As IScreenDisplay
  Dim pActiveView As IActiveView
  Dim pMxDoc As IMxDocument
  Set pMxDoc = Application.Document
  Set pActiveView = pMxDoc.FocusMap
  Set pScreenDisplay = pActiveView.ScreenDisplay
  pScreenDisplay.TrackPan
End Sub
```



The display transformation defines how real-world coordinates are mapped to an output space.

As noted before, each *Display* object keeps a *DisplayTransformation* object to manage the map-to-device transformation. For example, units along the x-axis on the device actually represent map units along the y-axis. The *DisplayTransformation* also looks after the bounds of all the data loaded in the display as well as the visible bounds, which are used to pan and zoom the display.

In turn, each *Map*'s *DisplayTransformation* has a *SpatialReference* object that manages the *Map*'s current coordinate system. A reference to the *SpatialReference* object is set through *IDisplayTransformation::SpatialReference*. Other objects with a *DisplayTransformation* coclass, such as the *PageLayout*, do not cocreate a *SpatialReference* object; in this case, the *SpatialReference* property returns nothing.

The *DisplayTransformation* object is cocreateable, but there is rarely a case when this is necessary. If you are creating your own *ScreenDisplay* or *DisplayTransformation*, see the steps under the *IDisplayTransformation* discussion for preparing a transform for use. Obtain a reference to a *DisplayTransformation* via *IDisplay::DisplayTransformation*. Since *IScreenDisplay* inherits from *IDisplay*, you can also use *IScreenDisplay::DisplayTransformation*.

Three rectangles define the transformation. The Bounds *specifies the full extent in real-world coordinates. The* VisibleBounds *specifies what extent is currently visible. And the* DeviceFrame *specifies where the* VisibleBounds *appears on the output device. Since the aspect ratio of the* DeviceFrame *may not always match the aspect ratio of the specified* VisibleBounds*, the transformation calculates the actual visible bounds that fits the* DeviceFrame*. This is called the* FittedBounds *and is in real-world coordinates. All coordinates can be rotated about the center of the visible bounds by simply setting the transformation's* Rotation *property.*

IDisplayTransformation : ITransformation	***Provides access to members that control Display Transformation.***
Bounds: IEnvelope	*Full extent in world coordinates.*
ConstrainedBounds: IEnvelope	*Intersection of Bounds and VisibleBounds.*
DeviceFrame: tagRECT	*Visible extent in device coordinates.*
FittedBounds: IEnvelope	*Device frame in world coordinates.*
ReferenceScale: Double	*Reference scale for computing scaled symbol sizes.*
Resolution: Double	*Resolution of the device in dots (pixels) per inch.*
Rotation: Double	*Rotation angle in degrees.*
ScaleRatio: Double	*Scale between FittedBounds and DeviceFrame.*
SpatialReference: ISpatialReference	*Current spatial reference.*
SuppressEvents: Boolean	*Indicates if transformation object suppresses events.*
Units: esriUnits	*Units used by world coordinates.*
VisibleBounds: IEnvelope	*Visible extent in world coordinates.*
ZoomResolution: Boolean	*Indicates if resolution is tied to visible bounds. If true, zooming in magnifies contents (i.e., zoom in on page).*
FromMapPoint (in mapPoint: IPoint, out X: Long, out Y: Long)	*Calculates device coordinates corresponding to the map point.*
FromPoints (in pointDistance: Double) : Double	*Calculates a map distance corresponding to a point (1/72) distance.*
ToMapPoint (in X: Long, in Y: Long) : IPoint	*Calculates a point in map coordinates corresponding to the device point.*
ToPoints (in mapDistance: Double) : Double	*Calculates a distance in points (1/72 inch) corresponding to the map distance.*
TransformCoords (in mapPoints: _WKSPoint, in devPoints: tagPOINT, in numPoints: Long, in options: Long)	*Transforms a set of points or measurements from device to world space or vice versa. Use the flags specified by esriDisplayTransformEnum.*
TransformRect (in mapRect: IEnvelope, in devRect: tagRECT, in options: Long)	*Transforms a rectangle from device to world space or vice versa. Use the flags specified by esriDisplayTransformEnum.*

Use *IDisplayTransformation* for converting coordinates between real-world and device space and back.

To prepare a transform for use, follow these steps:

1. Set the full map extent with the *Bounds* property.
2. Set the visible map extent (zoom rectangle) with the *VisibleBounds* property.

3. Set the output area of the device using the *DeviceFrame* property.

4. Set the resolution of the output device using the *Resolution* property.

The *Map* and *PageLayout* objects follow these steps after creating their display objects.

The transform is based on the ratio between the *VisibleBounds* and the *DeviceFrame*. Normally, the *DeviceFrame* is simply the full extent of the device with the origin equal to (0,0). The transform object calculates the *FittedBounds* automatically, which is the visible map extent adjusted to fit the device.

```
Public Sub ZoomInCenter()
  Dim pMxDocument As IMxDocument
  Dim pActiveView As IActiveView
  Dim pDisplayTransform As IDisplayTransformation
  Dim pEnvelope As IEnvelope
  Dim pCenterPoint As IPoint

  Set pMxDocument = Application.Document
  Set pActiveView = pMxDocument.FocusMap
  Set pDisplayTransform = pActiveView.ScreenDisplay.DisplayTransformation
  Set pEnvelope = pDisplayTransform.VisibleBounds
  'In this case, we could have set pEnvelope to IActiveView::Extent
  'Set pEnvelope = pActiveView.Extent
  Set pCenterPoint = New Point

  pCenterPoint.x = ((pEnvelope.XMax - pEnvelope.XMin) / 2) + pEnvelope.XMin
  pCenterPoint.y = ((pEnvelope.YMax - pEnvelope.YMin) / 2) + pEnvelope.YMin
  pEnvelope.width = pEnvelope.width / 2
  pEnvelope.height = pEnvelope.height / 2
  pEnvelope.CenterAt pCenterPoint
  pDisplayTransform.VisibleBounds = pEnvelope
  pActiveView.Refresh
End Sub
```

To help you understand how the various display objects work together to solve common development requirements, several application scenarios are given along with details on their implementation. Use these patterns as a starting point for working with the display objects.

THE APPLICATION WINDOW

One of the most common tasks is to draw maps in the client area of an application window with support for scrolling and backing store. The display objects are used as follows to make this possible.

Initialization

The DeviceFrame *specifies the device rectangle where drawing takes place. Normally, it's the full pixel extent of the device or window, although it can be set to just a portion of the full device extent if desired.*

Start by creating a *ScreenDisplay* when the window is created. You'll also need to create one or more symbols to use for drawing shapes. Forward the application's hWnd to *pScreenDisplay.hWnd*. Obtain from the *ScreenDisplay* its *IDisplayTransformation* interface and set the full and visible map extents using *pTransformation.Bounds* and *pDisplayTransform.VisibleBounds*. The visible bounds determines the current zoom level. *ScreenDisplay* takes care of updating the display transformation's *DeviceFrame*. The *ScreenDisplay* monitors the window's messages and automatically handles common events such as window resizing or scrolling.

Create a Visual Basic Standard EXE project. Add a reference to the ESRI Object Library, add a picture box control to the form, then open up the code window and enter the code opposite. This code initializes the screen display object and attaches it to the form's window.

```
Private m_pScreenDisplay As IScreenDisplay
Private m_pFillSymbol As ISimpleFillSymbol

Private Sub Form_Load()
  Set m_pScreenDisplay = New ScreenDisplay
  m_pScreenDisplay.hWnd = Picture1.hWnd

  Set m_pFillSymbol = New SimpleFillSymbol

  Dim pEnv As IEnvelope
  Set pEnv = New Envelope

  pEnv.PutCoords 0, 0, 50, 50

  m_pScreenDisplay.DisplayTransformation.bounds = pEnv
  m_pScreenDisplay.DisplayTransformation.VisibleBounds = pEnv
End Sub
```

Drawing

The display objects define a generic *IDraw* interface, which makes it easy to draw to any display. As long as you use *IDraw* or *IDisplay* to implement your drawing code, you don't have to worry about what kind of device you're drawing to. A drawing sequence starts with *StartDrawing* and ends with *FinishDrawing*.

For example, create a routine that builds one polygon in the center of the screen and draws it. The shape is drawn using the default symbol. Here are the sample routines:

You may want to add a Beep *function call in order to signal each time the* MyDraw *method is called.This will be useful when experimenting with caches later.*

```
Private Function GetPolygon() As IPolygon
  Set GetPolygon = New Polygon

  Dim pPointCollection As IPointCollection
  Set pPointCollection = GetPolygon

  Dim pPoint As IPoint
  Set pPoint = New Point

  pPoint.PutCoords 20, 20
  pPointCollection.AddPoint pPoint

  pPoint.PutCoords 30, 20
  pPointCollection.AddPoint pPoint

  pPoint.PutCoords 30, 30
  pPointCollection.AddPoint pPoint

  pPoint.PutCoords 20, 30
  pPointCollection.AddPoint pPoint

  GetPolygon.Close
End Function

Private Sub MyDraw(pDisplay As IDisplay, hDC As esriCore.OLE_HANDLE)
  ' Draw from Scratch
  Dim pDraw As IDraw
  Set pDraw = pDisplay

  pDraw.StartDrawing hDC, esriNoScreenCache

  Dim pPoly As IPolygon
  Set pPoly = GetPolygon()

  pDraw.SetSymbol m_pFillSymbol
  pDraw.Draw pPoly

  pDraw.FinishDrawing
End Sub
```

This routine can be used to draw polygons to any device context. The first place we need to draw, however, is to a window. To handle this, write some code in the *Paint* method of the Picture Box that passes the application's *ScreenDisplay* pointer and Picture Box *HDC* to the *yDraw* routine.

Notice that the routine takes both a display pointer and a Windows device context.

```
Private Sub Picture1_Paint()
 MyDraw m_pScreenDisplay, Picture1.hDC
End Sub
```

Forwarding the *DC* allows the display to honor the clipping regions that Windows sets into the paint *HDC*.

ADDING DISPLAY CACHING

Some drawing sequences can take a while to complete. A simple way to optimize your application is to enable display caching. This refers to *ScreenDisplay*'s ability to record your drawing sequence into a bitmap and then use the bitmap to refresh the picture box's window whenever *Paint* method is called. The cache is used until your data changes and you call *IScreenDisplay::Invalidate* to indicate that the cache is invalid.

There are two kinds of caches: recording caches and user-allocated caches. Use recording to implement a display cache in the sample application's *Paint* method.

```
Private Sub Picture1_Paint()
  If (m_pScreenDisplay.IsCacheDirty(esriScreenRecording)) Then
    m_pScreenDisplay.StartRecording

    MyDraw m_pScreenDisplay, Picture1.hDC

    m_pScreenDisplay.StopRecording
  Else
    Dim rect As tagRECT
    m_pScreenDisplay.DrawCache Picture1.hDC, esriScreenRecording, rect, rect
  End If
End Sub
```

When you execute this code, you will see that nothing is drawn on the screen. This is due to the *ScreenRecording* cache not having its dirty flag set. To ensure that the *MyDraw* function is called when the first paint message is received, you must invalidate the cache. Add the following line at the end of the *Form_Load* method.

```
  m_pScreenDisplay.Invalidate Nothing, True, esriScreenRecording
```

Some applications, ArcMap for example, may require multiple display caches. To utilize multiple caches, follow these steps:

1. Add a new cache using *IScreenDisplay::AddCache*. Save the cache ID that is returned.
2. To draw to your cache, specify the cache ID to *StartDrawing*.
3. To invalidate your cache, specify the cache ID to *Invalidate*.
4. To draw from your cache, specify the cache ID to *DrawCache*.

To change the sample application to support its own cache, make the following changes:

- Add a member variable to hold the new cache.

```
Private m_lCacheID As Long
```

- Create the cache in the *Form_Load* method.

```
m_lCacheID = m_pScreenDisplay.AddCache
```

- Change the appropriate calls to use the *m_lCacheID* variable and remove the start and stop recording from the *Paint* method.

Pan, zoom, and rotate

A powerful feature of the display objects is the ability to zoom in and out on your drawing. It's easy to implement tools that let users zoom in and out or pan. Scrolling is handled automatically. To zoom in and out on your drawing, simply set your display's visible extent.

For example, add a command button to the form and place the following code, which zooms the screen by a fixed amount, in the *Click* event of the button.

```
Private Sub Command1_Click()
  Dim pEnv As IEnvelope

  Set pEnv = m_pScreenDisplay.DisplayTransformation.VisibleBounds
  pEnv.Expand 0.75, 0.75, True
  m_pScreenDisplay.DisplayTransformation.VisibleBounds = pEnv

  m_pScreenDisplay.Invalidate Nothing, True, esriAllScreenCaches
End Sub
```

ScreenDisplay implements *TrackPan,* which can be called in response to a mouse down event to let users pan the display. You can also rotate the entire drawing about the center of the screen by setting the *DisplayTransformation*'s *Rotation* property to a nonzero value. Rotation is specified in degrees. *ScreenDisplay* implements *TrackRotate*, which can be called in response to a mouse down event to let users interactively rotate the display.

Printing

Printing is very similar to drawing to the screen. Since you don't have to worry about caching or scrolling when drawing to the printer, a *SimpleDisplay* can be used. Create a *SimpleDisplay* object and initialize its transform by copying the *ScreenDisplay*'s transform. Set the printer transformation's *DeviceFrame* to the pixel bounds of the printer page. Finally, draw from scratch using the *SimpleDisplay* and the printer's *HDC*.

Output to a metafile

The *GDIDisplay* object can be used to represent a metafile. There's hardly any difference between creating a metafile and printing. If you specify 0 as the *lpBounds* parameter to *CreateEnhMetaFile*, the

MyDraw routine can be used. Just substitute *hMetafileDC* for *hPrinterDC*. If you want to specify a bounds to *CreateEnhMetafFile* (in *HIMETRIC* units), set the *DisplayTransformation*'s *DeviceFrame* to the pixel version of the same rectangle.

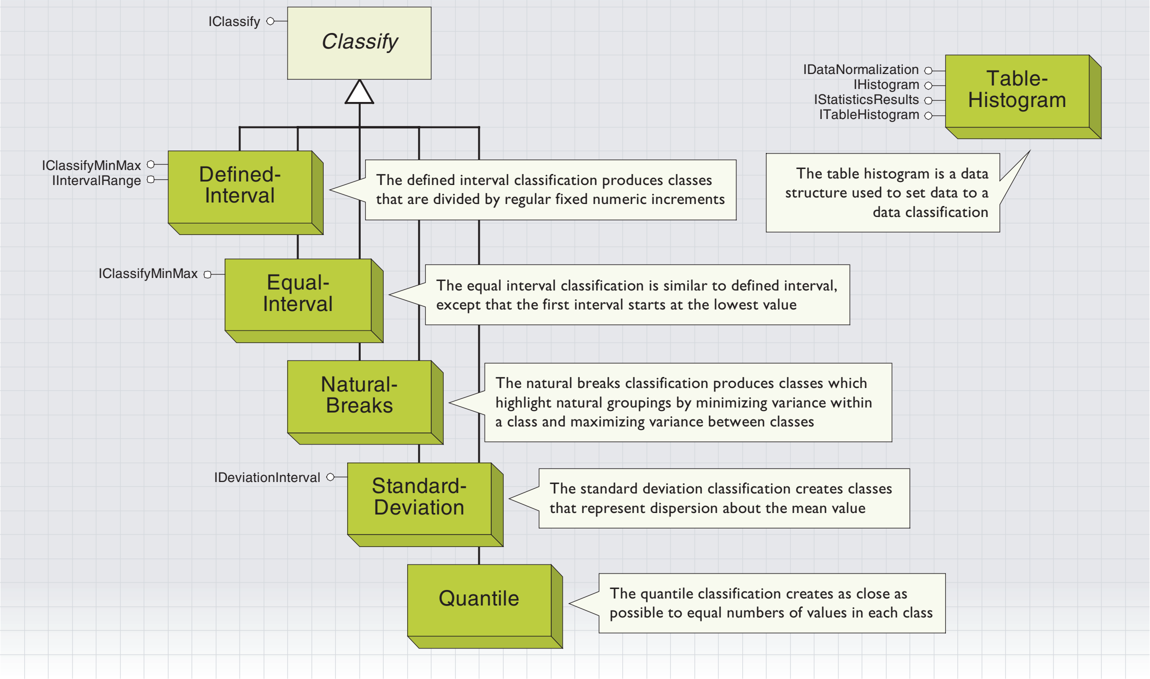
Print to a frame

Some projects may require output to be directed to some subrectangle of the output device. It's easy to handle this by setting the *DisplayTransformation*'s device frame to a pixel bounds that is less than the full device extent.

Filters

Very advanced drawing effects, such as color transparency, can be accomplished using display filters. Filters work along with a display cache to allow a rasterized version of your drawing to be manipulated. When a filter is specified to the display (using *IDisplay::putref_DisplayFilter*), the display creates an internal filter cache that is used along with the recording cache to provide raster info to the filter. Output is routed to the filter cache until the filter is cleared (that is, *putref_DisplayFilter(0)*). At that point, the display calls *IDisplayFilter::Apply*. *Apply* receives the current background bitmap (recording cache), the drawing cache (containing all of the drawing that happened since the filter was specified), and the destination HDC. The transparency filter performs alpha blending on these bitmaps and draws them to the destination HDC to achieve color transparency. New filters can be created to realize other effects.

Classify objects



The table histogram is a data structure used to set data to a data classification

The defined interval classification produces classes that are divided by regular fixed numeric increments

The equal interval classification is similar to defined interval, except that the first interval starts at the lowest value

The natural breaks classification produces classes which highlight natural groupings by minimizing variance within a class and maximizing variance between classes

The standard deviation classification creates classes that represent dispersion about the mean value

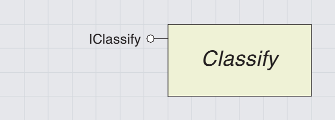
The quantile classification creates as close as possible to equal numbers of values in each class

This group of closely related objects can be used to group numeric values into classes. There are five types of classification objects: *DefinedInterval, EqualInterval, NaturalBreaks, Quantile,* and *Standard-Deviation* coclass.

The job of all classification objects is to take histogram data (values and frequencies) and, given a desired number of classes, compute appropriate break values between the classes. The breaks are in increasing value and, except for the first break, represent the highest value in the class. The range of values that a class covers can vary; this range is the class' interval.

If the values were from the attribute values of a feature layer, then, after determining the class breaks, you would typically setup a *Class-BreaksRenderer*. Also, the task of gathering the values and frequency counts from an attribute field can be made a lot easier by using the *TableHistogram* to retrieve the histogram data.

The histogram data is in the form of two arrays. The first of these is a sorted array of numeric values, and the second is a corresponding array of frequency counts of the values.



Classify objects apply one of several methods to statistically subdivide a set of numeric values into classes.

The *Classify* abstract class defines the *IClassify* interface shared by all classify objects.

IClassify : IUnknown	***Defines an interface for the classification methods.***
■— ClassBreaks: Variant	*The array of class breaks (double). ClassBreaks(0) is the minimum value in the dataset, and subsequent breaks represent the upper limit of each class.*
■— ClassID: IUID	*The CLSID for the classification object.*
■— MethodName: String	*The name of the classification method (based on choice of classification object).*
← Classify (NumClasses: Long)	*Classifies data into the specified number of classes.*
← SetHistogramData (in doubleArrayValues: Variant, in longArrayFrequencies: Variant)	*Adds data in form of a histogram (array of values (doubles) and a paired array of frequencies (longs)) to the classification.*

The *IClassify* interface is implemented by all the data classification objects; this is the interface used to pass in histogram data and then classify it into breaks. The *ClassID* and *MethodName* properties are used by user interface dialog boxes to identify the classification object and establish what the classification is called.

To pass numeric data into the classify object, the *SetHistogramData* method is used. This takes two safe arrays that must have the same number of elements and an index of zero for their first element. The first array is the numeric data values, defined as an array of double. This array must be sorted in increasing value order. The second array represents the frequency of occurrence of the values, that is, an integer count of the number of times a value occurs.

For example, if the two arrays were called *DataValues* and *DataFrequency,* the lowest value would be stored in *DataValue(0)*, and the number of times this value occurred would be stored in *DataFrequency(0).*

You could populate these arrays in code yourself, but if the data is available through the attribute field of a table, you can utilize the *TableHistogram* object to gather the data values and frequencies for you.

This VBA example illustrates populating a *NaturalBreaks* classify object with the numeric values from the 1997 population field of a feature class; this field is called “POP1997”. The variable *pFeatureLayer* is initialized to an object implementing *IFeatureLayer*.

```
Dim pTable As ITable
Dim pClassify As IClassify
Dim pTableHistogram As ITableHistogram
Dim pHistogram As IHistogram

' QI to a ITable from a feature layer
Set pTable = pFeatureLayer

' Create and setup a table histogram object to point at the table and
' attribute field
Set pTableHistogram = New TableHistogram
pTableHistogram.Field = "Pop1997"
```

```
Set pTableHistogram.Table = pTable
' Dim some variants, these will hold the safe arrays
Dim DataValues As Variant
Dim DataFrequencies As Variant

' QI to the table histogram interface and go and retrieve the data values
Set pHistogram = pTableHistogram
pHistogram.GetHistogram DataValues, DataFrequencies

' Create a classify object of our choice - equal interval in this case
Set pClassify = New EqualInterval

' Put the values and frequencies into the classify object
pClassify.SetHistogramData DataValues, DataFrequencies
```

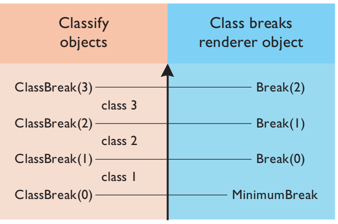
Having obtained the data values and frequencies, the next step is to compute some class breaks. Do this by calling the *Classify* method and specifying the number of classes you would like. You must supply the number of desired classes as a variable defined as a *Long*. Some classification algorithms will return a different number of class breaks to what you specified. The number of classes will be written back to the variable you supplied, so it is always best to recheck the number of class breaks after calling *Classify*.

```
Dim ClassBreaksArray() As Double ' Array to hold break values
Dim ClassCount As Long ' Now classify the data into 5 classes
ClassCount = 5
pClassify.Classify ClassCount

' ClassCount could have been modified so recheck this if necessary

' Retrieve the array of break values
ClassBreaksArray = pClassify.ClassBreaks
```

The array returned from the *ClassBreaks* method contains the break values between the classes. The first break value is the minimum break or lowest value in the lowest class, and other break values will be the last value in their class.

The following VBA code sets up a *ClassBreaksRenderer* object.

```
' Initialise a new class breaks renderer and supply the number of
' class breaks and the field to perform the class breaks on.
Dim pClassBreaksRenderer As IClassBreaksRenderer
Set pClassBreaksRenderer = New ClassBreaksRenderer
pClassBreaksRenderer.Field = "POP1997"

' First class break is the minimum value for the class breaks renderer
pClassBreaksRenderer.MinimumBreak = ClassBreaksArray(0)

' Set number of breaks to be number of classes returned from classification
pClassBreaksRenderer.BreakCount = ClassCount
```

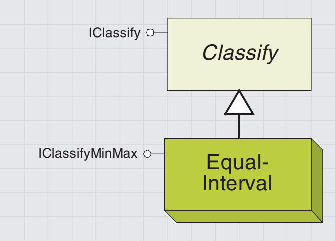


Take care when using the ClassBreak *property array against the* Break *and* MinimumBreak *properties in the* ClassBreaksRenderer *object.*

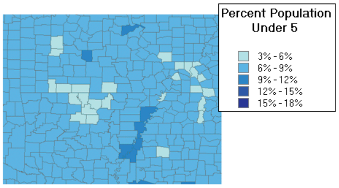
Note that the *Breaks* property array on the *ClassBreaksRenderer* has one less entry than the array returned from *Classify*. The first break value in the array returned from *Classify* is put into the *ClassBreakRenderers*' *MinimumBreak* property. Next, copy the break values into the *ClassBreaksRenderer* object. You can set up the symbol property of the classes at the same time.

In this VBA example, *breakIndex* is a *Long*, *pColor* is an *IColor*, *pFillSymbol* is an *ISimpleFillSymbol*, and *pEnumColors* is a cursor from a color ramp.

```
' Iterate through each class break, setting values and corresponding
' fill symbols for each polygon,
For breakIndex = 0 To pClassBreaksRenderer.BreakCount - 1
  ' Retrieve a color and set up a fill symbol,
  ' put this in the symbol array corresponding to the class value
  Set pColor = pEnumColors.Next
  Set pFillSymbol = New SimpleFillSymbol
  pFillSymbol.Color = pColor
  pClassBreaksRenderer.Symbol(breakIndex) = pFillSymbol

  ' Set the break value - note this is the highest value in the class
  pClassBreaksRenderer.Break(breakIndex) = ClassBreaksArray(breakIndex +1)
Next breakIndex
```



The equal interval classification is similar to defined interval, except that the first interval starts at the lowest value.



This map illustrates areas where there is differing population of infants relative to the population of the area. It is produced using an equal interval classification, where the minimum is 3 percent of the population being under 5, and then in bands of 3 percent, shows increasing numbers of under 5 (up to 18 percent of the population).

The *EqualInterval* coclass subdivides the data range by the number of classes to produce the equal value intervals for each class. Optionally, you can use the *IClassifyMinMax* interface to specify just minimum and maximum values instead of setting the data values using *IClassify::SetHistogramData*.

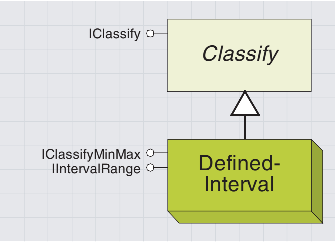
This classification emphasizes how data values fall within uniform ranges of values. In practice, it is similar to defined intervals but has the advantage that the lowest and highest classes span the same range of values as the rest of the classes. An example of an application of this classification is a map that depicts homes for sale divided into equal ranges of purchase costs.

IClassifyMinMax : IUnknown

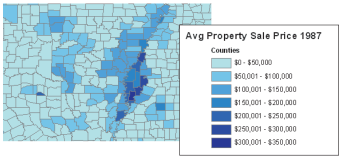
Defines an interface for classification methods that require only a minimum and maximum value to classify.

- Maximum: Double — *The maximum value.*
- Minimum: Double — *The minimum value.*

The *EqualInterval* object can additionally generate class breaks given only *Minimum* and *Maximum* values. In this case, you do not have to call *IClassify::SetHistogramData*. However, to be consistent with other classify objects, you can also call *IClassify::SetHistogramData*, which will override the minimum and maximum values. The *Minimum* and *Maximum* properties are write-only, and you must set both properties if you can use *IClassifyMinMax*.



The defined interval classification produces classes that are divided by regular fixed numeric increments.



This uses a defined interval classification to illustrate average house prices in different counties. The interval is $50,000, and so the class breaks are at multiples of this amount.

The *DefinedInterval* coclass represents a defined interval classification; this divides a set of attribute values into classes that are divided by precise numeric increments, such as 10, 100, or 500.

This classification works well for values that people are accustomed to seeing in rounded numbers, such as age distribution, income level, or elevation ranges. The disadvantage is that some of the classes, particularly the first and last, may contain a disproportionate number of values.

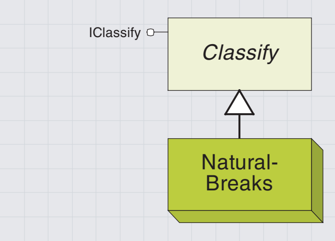
Use the *IIntervalRange* interface to retrieve a default interval or to set a different interval. When you are calling *IClassify::Classify,* the number of classes returned depends on the maximum data value divided by the interval.

IIntervalRange : IUnknown

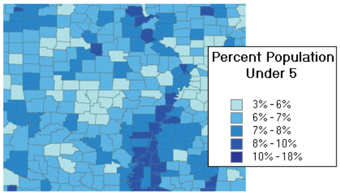
Interface for Methods that need an interval range

- Default: Double — *The Default Range for the data. Data must be added before calling*
- IntervalRange: Double — *The Interval Range. Call before Classify.*

First, set up the data values with *IClassify::SetHistogramData*. After this, you can use the *Default* property to retrieve the default interval. This would typically be the maximum data value divided by five, so by default you will have five classes. To override this, set a different interval into the *IntervalRange* property.



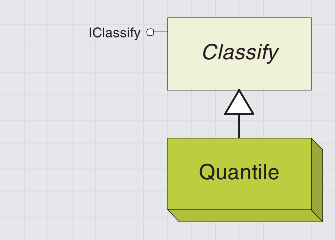
The natural breaks classification produces classes that highlight natural groupings by minimizing variance within a class and maximizing variance between classes.



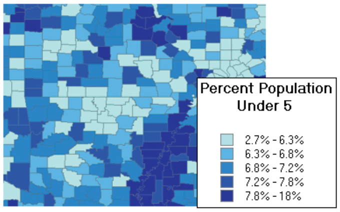
This map illustrates classes divided by the Jenks method into natural intervals. Since 6 percent to 8 percent of the population is infants under 5, this range has been split into two classes. Conversely, in only a few areas are infants more than 10 percent of the population, hence one class covers 10 percent to 18 percent.

The *NaturalBreaks* coclass uses a statistical formula to determine natural clusters of attribute values. The formula is known as Jenk's method. This attempts to minimize the variance within a class and to maximize the variance between classes. The natural-breaks classification is well suited to uneven distributions of attributes. Distinct natural groupings of attributes can be isolated and highlighted.

This classification only uses the *IClassify* interface, so there is nothing to set up other than calling *IClassify::SetHistogramData*.



The quantile classification creates as close as possible to equal numbers of values in each class.



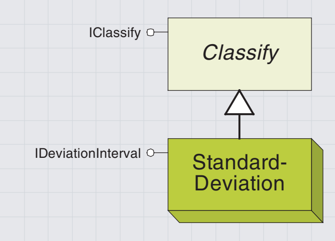
This map illustrates classes that contain equal numbers of features from the quantile classification.

The *Quantile* coclass creates an equal (or close to equal) number of values in each class. For example, if there were 12 values, then three classes would represent four values each.

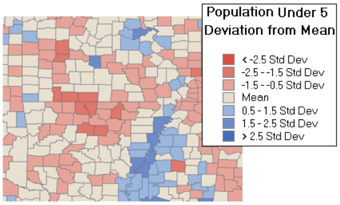
This classification is particularly effective for ranked values. A company can measure sales performance of business locations and draw the respective businesses in their rank of sales performance. This classification yields visually attractive maps because all of the classes have the same number of features.

However, this classification might obscure the natural distribution of values; clusters of values may be split or combined with other values. This classification is best applied to values that have a linear distribution. If you have an even number of classes, the value delimiting the middle classes is the same as the median of statistical sampling.

Because features are grouped by the number in each class, the resulting map can be misleading. Similar features can be placed in adjacent classes, or features with widely different values can be put in the same class. You can minimize this distortion by increasing the number of classes.



The standard deviation classification creates classes that represent dispersion about the mean value.



This classification scheme shows classes generated by the standard deviation classification.The class breaks are generated by successively adding or subtracting the standard deviation from the mean.A two-color ramp helps emphasize values above (shown in blue) and below (shown in red) the mean.

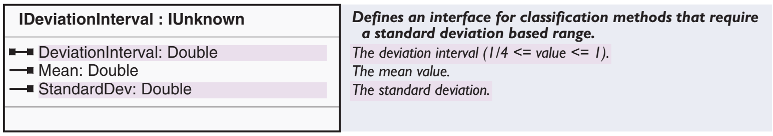
The *StandardDeviation* coclass represents dispersion about the mean, and this classification creates classes that represent this dispersion. The classes mainly have an interval that is either one whole or part (for example, a half or quarter) of a standard deviation. There will be one class (often labeled "the mean") that will straddle the mean value by the class interval. Other classes will be adjacent to this on either side, representing increasingly disperse values from the mean. The classes will all have the same interval except for the lowest and highest classes that cover the endpoints of the data range.

As with other classification objects, you put values into the classification with *IClassify::SetHistogramData*. Then you must use the *IDeviationInterval* interface to specify the mean and standard deviation values. Again, the *TableHistogram* object can be used here to calculate these values. Finally, you can produce the classes using the *IClassify::Classify method*.

The number of classes generated by *IClassify::Classify* is determined by the settings of the properties on *IDeviationInterval*, not by the value of the parameter passed to *IClassify::Classify*. However, you should still supply the parameter, as it will be modified to reflect the number of classes actually created.

This classification is intended for generally symmetric distributions of values that have a broad peak near the mean with the density of values diminishing away from the peak.

An example of a suitable map for this classification could be a population density or accident rates map. You would expect these values to have their greatest data density near a mean value, and values that vary significantly are scarce. The classic shape of this type of distribution is the bell curve.



IDeviationInterval : IUnknown

Defines an interface for classification methods that require a standard deviation based range.

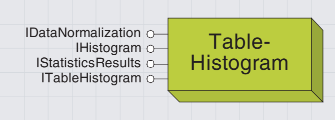
- DeviationInterval: Double — *The deviation interval (1/4 <= value <= 1).*
- Mean: Double — *The mean value.*
- StandardDev: Double — *The standard deviation.*

When setting up a *StandardDeviation* classify object, you must set the *Mean* and *StandardDev* properties to be used for the class breaks before you call *IClassify::Classify*. By default, the classes will have an interval of one standard deviation. However, you can set the *DeviationInterval* property to give you more classes. The *DeviationInterval* property specifies what fraction of a standard deviation you want the class intervals to be. Typically, you would set this to be a half or quarter to give you twice or four times as many classes.

This example VBA code uses the *IStatisticsResults* interface on the table histogram to get the mean and standard deviation values to populate the *StandardDeviation* classify object ready for classification.

In this example, *pTableHistogram* is an *ITableHistogram*. The data has already been gathered with *ITableHistogram::GetHistogramData* and placed into two arrays, *DataValues* and *DataFrequencies*.

```
' Create a classify object of our choice - StandardDeviation
Set pClassify = New StandardDeviation

' QI to the IDeviationInterval interface
Dim pDeviationInterval As IDeviationInterval
Set pDeviationInterval = pClassify

' DataValues and DataFrequencies are arrays that have already been
' populated using the TableHistogram object.
' Put the collected data into the classify object
pClassify.SetHistogramData DataValues, DataFrequencies

' QI to get the statistics result interface from the table
' histogram interface
Dim pStatisticsResult As IStatisticsResults
Set pStatisticsResult = pTableHistogram

' Set the mean and standard deviation into the classify object
pDeviationInterval.Mean = pStatisticsResult.Mean
pDeviationInterval.StandardDev = pStatisticsResult.StandardDeviation

' Our classes will be one standard deviation wide
pDeviationInterval.DeviationInterval = 1

' Now classify the data …
```



A histogram is a data structure mainly used to set data to a Classify *object.*

Generally, a histogram consists of two arrays, where the first array is an ordered list of values and the second is a paired list of frequencies. Though you can manually manage these arrays when working with a *Classify* object, typically it is easier to use a histogram object, especially when mapping normalized data, excluding features, or working with a sample of features.

Use a *TableHistogram* object if your data is contained in an object that supports the ITable interface. Alternatively, use a *DataHistogram* object if your data is stored in an array or in another histogram object. Finally, a third type of histogram, *TinHistogram* coclass, can be used if your data source is a TIN.

This section provides an overview of how to prepare and use a *TableHistogram* object to set data to a *Classify* object.

ITableHistogram : IUnknown	***Provides access to members that control a histogram created from tablular data.***
■-□ Exclusion: IDataExclusion	*Data exclusion options.*
■-■ Field: String	*Value field.*
■-■ NormField: String	*Normalization field.*
■-□ Sampling: IDataSampling	*Data sampling options.*
■-□ Table: ITable	*The associated table.*

Use *ITableHistogram::Table* and *ITableHistogram::Field* to specify the table and field that the histogram is based on.

Optionally, set *NormField* if you want to normalize by a field. Note that setting this property is equivalent to setting *IDataNormalization::-NormalizationField*.

Set the *Exclusion* object if you want to use a where clause to specify features that will not be included when the histogram is generated.

The *Sampling* property is also optional. Use this to specify a method for using only a subset of the features from the source table for the histogram.

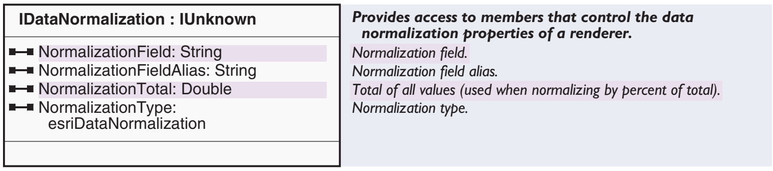
IHistogram : IUnknown	***Provides access to members that control histogram objects created from different data sources.***
—■ CustomMax: Double	*Custom maximum.*
—■ CustomMin: Double	*Custom minimum.*
← ExclusionDoModal (in parentHWnd: Long, ok: Boolean)	*Shows the exclusion dialog for the histogram.*
← GetHistogram (out doubleArrayValues: Variant, out longArrayFrequencies: Variant)	*Histogram as an array of values (doubles) and a paired array of frequencies (longs).*
← HasExclusion (Flag: Boolean)	*Indicates if the histogram uses exclusion.*
← HasSampling (Flag: Boolean)	*Indicates if the histogram uses data sampling.*
← ResetCustomMinMax	*Resets custom minimum and maximum.*
← SamplingDoModal (in parentHWnd: Long, ok: Boolean)	*Shows the sampling dialog for the histogram.*

IHistogram has properties and methods common to all histograms.

For a *TableHistogram*, use *GetHistogram* to generate the histogram based on the properties you set up via *ITableHistogram*. The method returns two arrays: the first is the values array (that is, the ordered list of values), and the second array contains the frequencies.

You can choose to use *CustomMin* and *CustomMax* to enforce end constraints on the data range.

HasExclusion and *HasSampling* provide feedback about whether or not a histogram is using exclusion or sampling, while *ExclusionDoModal* and *SamplingDoModal* open ArcGIS dialog boxes that allow users to work with exclusion and sampling properties, respectively.

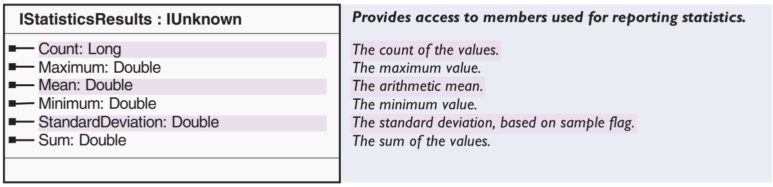


IDataNormalization : IUnknown	*Provides access to members that control the data normalization properties of a renderer.*
NormalizationField: String	*Normalization field.*
NormalizationFieldAlias: String	*Normalization field alias.*
NormalizationTotal: Double	*Total of all values (used when normalizing by percent of total).*
NormalizationType: esriDataNormalization	*Normalization type.*

Use *IDataNormalization* to set the normalization properties for your histogram.

As mentioned above, for a *TableHistogram* object, *NormalizationField* is the same as *ITableHistogram::NormField*.

Use *NormalizationType* to set the normalization flavor for your histogram.

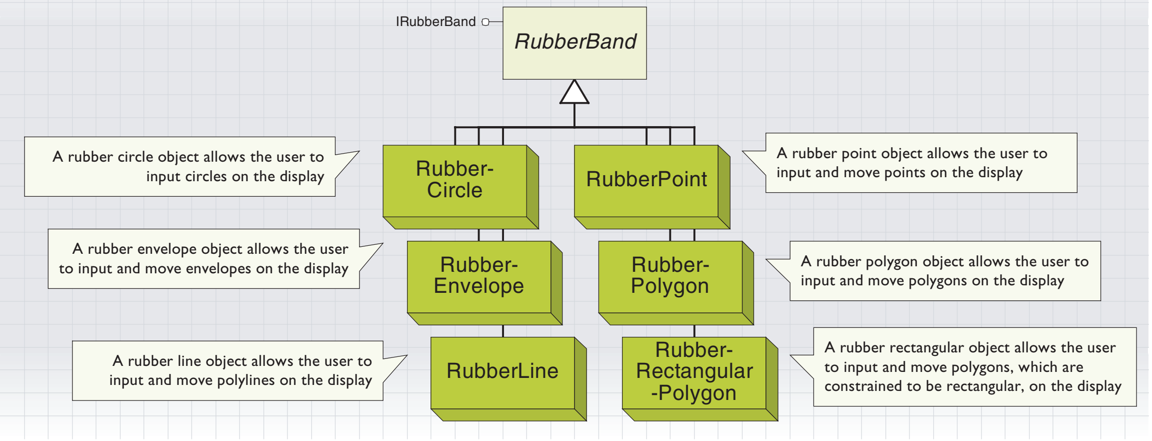


IStatisticsResults : IUnknown	*Provides access to members used for reporting statistics.*
Count: Long	*The count of the values.*
Maximum: Double	*The maximum value.*
Mean: Double	*The arithmetic mean.*
Minimum: Double	*The minimum value.*
StandardDeviation: Double	*The standard deviation, based on sample flag.*
Sum: Double	*The sum of the values.*

Once you have set up a *TableHistogram*, you can use *IStatisticsResults* to calculate some values that are needed when working with some *Classify* objects.

For example, to set up a *StandardDeviation* object, use this interface to calculate *IDeviationInterval::Mean* and *IDeviationInterval::StandardDeviation*.

Rubber band objects



A rubber circle object allows the user to input circles on the display

A rubber point object allows the user to input and move points on the display

A rubber envelope object allows the user to input and move envelopes on the display

A rubber polygon object allows the user to input and move polygons on the display

A rubber line object allows the user to input and move polylines on the display

A rubber rectangular object allows the user to input and move polygons, which are constrained to be rectangular, on the display

The *RubberPoint, RubberEnvelope, RubberLine, RubberPolygon, RubberRectangularPolygon,* and *RubberCircle* coclasses, all implementing the *IRubberBand* interface, allow the user to digitize geometries on the display using the mouse—either to create whole new geometry objects or to update existing ones. As such, they can be viewed as simple versions of the feedback objects that are covered later in this chapter.

Some examples of uses for these rubberbanding objects include dragging an envelope, forming a new polyline, or moving a point. Each of the above classes supports the *IRubberBand* interface, but the behavior depends on the class used.

IRubberBand *allows the user to interact with the display and either create new geometry objects using* TrackNew *or move existing ones with* TrackExisting. *Typically, this interface would be used in the* Mouse_Down *event of a tool.*

IRubberBand : IUnknown	***Provides access to members that control simple rubberbanding.***
← TrackExisting (in ScreenDisplay: IScreenDisplay, in Symbol: ISymbol, in Geometry: IGeometry) : Boolean	*Indicates if to move or reshape an existing shape on the specified screen in response to a mouse down event.*
← TrackNew (in ScreenDisplay: IScreenDisplay, in Symbol: ISymbol) : IGeometry	*Call in response to mouse down event to rubberband a new shape on the specified screen.*

The *IRubberband* interface has two methods, *TrackExisting* and *TrackNew,* which are used to move existing geometries and create new geometries, respectively. These methods would normally be called from within the code for a tool's *Mouse_Down* event, and they would then handle all subsequent mouse events themselves. They would capture subsequent mouse and keyboard events, such as *Mouse_Move, Mouse_Up,* and *Key_Down* events, and would complete when they received a *Mouse_Up* event or abort if the Esc key was pressed. Because the events are being trapped by the rubberband objects, no events will be raised in VBA.

This means that very little code is required to use them, although this comes at the expense of flexibility. Typically, these objects would be used for simple tasks such as dragging a rectangle or creating a new line. Operations that involve moving the vertices of existing geometries would require the feedback objects to be used instead.

The types of geometry that are returned for TrackNew *by each of the rubber objects are as follows:*

RubberCircle—ICircularArc

RubberEnvelope—IEnvelope

RubberLine—IPolyline

RubberPoint—IPoint

RubberPolygon—IPolygon

RubberRectangularPolygon—IPolygon

The *TrackNew* method takes two parameters: an *IScreenDisplay* object representing the *ScreenDisplay* to draw the *Rubberband* and an *ISymbol* object to use for drawing the rubberband. If no symbol is given, then the default symbol is used. The method returns a new geometry object—the type of geometry returned depends on which class was used. *RubberPolygon* class returns a *Polygon* object. If the method fails to complete (that is, if the user presses the Esc key), then *Nothing* is returned.

The following code shows how to use the *TrackNew* method of *IRubberBand* with a *RubberLine* object.

```
Private Sub UIToolControl1_MouseDown(ByVal button As Long, _
    ByVal shift As Long, ByVal x As Long, ByVal y As Long)
  Dim pRubberLine As IRubberBand
  Dim pGeom As IGeometry
  Dim pMXDoc As IMxDocument

  ' QI for the MXDocument interface
  Set pMXDoc = ThisDocument
  ' Create a new Rubber Line object
  Set pRubberLine = New RubberLine
  ' Track new polyline on current document's display using default symbol
  Set pGeom = pRubberLine.TrackNew(pMXDoc.ActiveView.ScreenDisplay, Nothing)
End Sub
```

The types of geometry that are expected by TrackExisting *for each of the rubber objects are as follows:*

RubberCircle—Not implemented

RubberEnvelope—IEnvelope

RubberLine—IPolyline

RubberPoint—IPoint

RubberPolygon—IPolygon

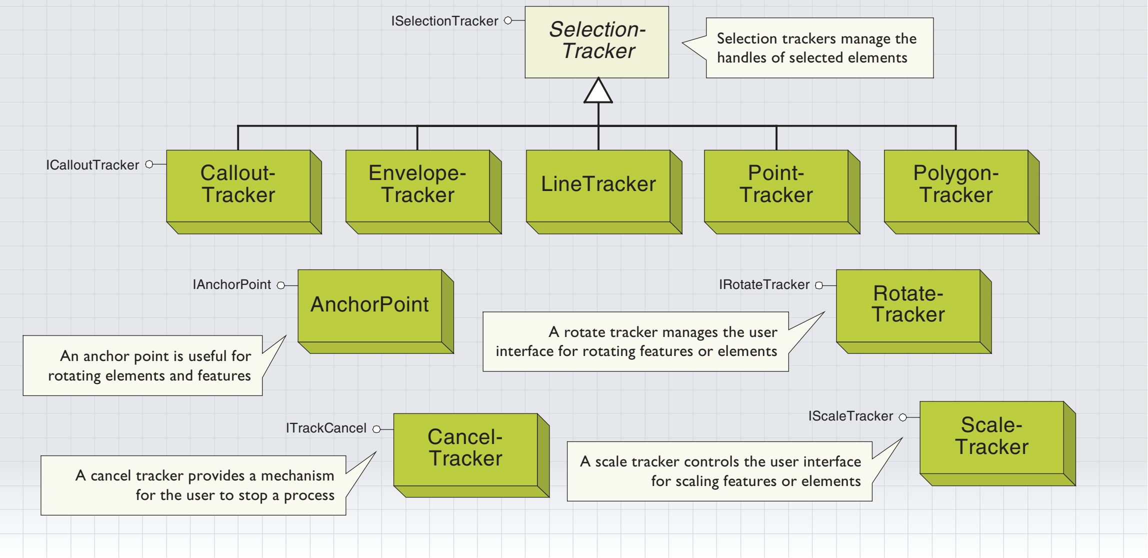
RubberRectangularPolygon—IPolygon

The *TrackExisting* method also takes *ScreenDisplay* and *Symbol* parameters as well as an *IGeometry* representing the input *Geometry*. This last parameter represents the geometry to move on the screen and is passed by reference so that it may be altered by the rubberband operation. The method returns a *Boolean,* which will be *True* unless the operation was interrupted by the user pressing the Esc key. The method will do nothing if the *Geometry* that is passed in does not intersect the current mouse location.

The following code illustrates how to move an existing polygon using the *TrackExisting* method of *IRubberBand* with a *RubberPolygon* object. *pGeomPoly* is declared as an *IPolygon* and is used to represent the *Polygon* to be moved.

```
Private Sub UIToolControl1_MouseDown(ByVal button As Long, _
    ByVal shift As Long, ByVal x As Long, ByVal y As Long)
  Dim pRubberPoly As IRubberBand
  Dim pMXDoc As IMxDocument
  Dim Success As Boolean

  ' QI for the MXDocument interface
  Set pMXDoc = ThisDocument
  ' Create a new Rubber Polygon object
  Set pRubberPoly = New RubberPolygon
  ' Move an existing Polygon on current doc's display using default symbol
  Success = pRubberPoly.TrackExisting(pMXDoc.ActiveView.ScreenDisplay, _
    Nothing, pGeomPoly)
End Sub
```

Selection tracker objects



Selection trackers manage the handles of selected elements

An anchor point is useful for rotating elements and features

A rotate tracker manages the user interface for rotating features or elements

A cancel tracker provides a mechanism for the user to stop a process

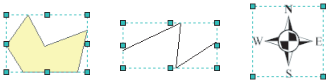
A scale tracker controls the user interface for scaling features or elements

There are three kinds of selection trackers; these can all be seen in ArcMap:

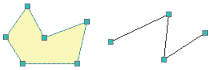
- An envelope tracker allows the user to move and resize the element. This functionality is implemented by the *EnvelopeTracker* object for all element types, including point, line, polygon, and group elements.
- A vertex edit tracker allows the user to move vertices of lines, polygons, curves, and curved text. This functionality is implemented by the *LineTracker* and *PolygonTracker* objects.
- A callout tracker allows the user to move a text callout. This functionality is implemented by the *CalloutTracker* objects.

The *PointTracker* object is not currently useful. Moving and resizing of point elements is handled by envelope trackers, the size of the envelope corresponding to the symbolized point.

Although the selection trackers are coclasses, you would only cocreate one if you were building your own custom element when implementing *IElement::SelectionTracker*.



The envelope tracker operates on all element types.



The line tracker and polygon tracker lets the user manipulate the vertices of polylines and polygons.

The callout tracker lets the user manipulate text callouts.

ISelectionTracker : IUnknown	Provides access to members that control the managing of selection handle tracking.
■— Bounds (in Display: IDisplay) : IEnvelope	The area covered by the tracker including handles.
—□ Display: IScreenDisplay	The display used by the tracker.
■—■ Geometry: IGeometry	Geometry used for tracking feedback.
■—■ Locked: Boolean	Indicates if the tracker is locked or not. Locked means nodes cannot be moved.
■—■ ShowHandles: Boolean	Indicates if the tracker is showing handles or not.
← Deactivate: Boolean	Cancel tracking.
← Draw (in Display: IDisplay, in hDC: Long, in Style: tagesriTrackerStyle)	Draw selection indicater. Usually a color outline with selection handles.
← HitTest (in Point: IPoint) : tagesriTrackerLocation	Check if mouse is over tracker. Return a TrackerLocation to indicate which handle mouse is over.
← OnKeyDown (in keyCode: Long, in Shift: Long) : Boolean	Special keypress processing while tracking.
← OnKeyUp (in keyCode: Long, in Shift: Long) : Boolean	Special keypress processing while tracking.
← OnMouseDown (in Button: Long, in Shift: Long, in X: Long, in Y: Long)	Begin tracking move or resize based on the location of the mouse over the tracker handles.
← OnMouseMove (in Button: Long, in Shift: Long, in X: Long, in Y: Long)	In process move or resize tracking.
← OnMouseUp (in Button: Long, in Shift: Long, in X: Long, in Y: Long)	Finish move or resize tracking.
← QueryCursor (in Point: IPoint) : Long	If the mouse is over the tracker, return an HCURSOR to indicate legal operations based on mouse's relation to selection handles: move resize, etc. Return 0 if mouse isn't over tracker.
← QueryMoveFeedback (in moveFeedback: IDisplayFeedback)	The move feedback for the selection tracker.
← QueryResizeFeedback (in resizeFeedback: IDisplayFeedback)	The resize feedback for the selection tracker.

The *ISelectionTracker* interface controls the selection handle user interface. You might use *ISelectionTracker* in order to provide different behavior than that of the standard ArcMap interface, for example, the Element Movement tool that snaps elements to a grid. However, it is more likely that you will use this interface when building a custom object such as an element.

You can gain access to selection trackers with *IElement::SelectionTracker*, *IElementEditVertices::GetMoveVerticesSelectionTracker,* or *IGraphicsContainerSelect::SelectionTracker*. When using *IElement*, you will get either an envelope tracker or edit vertices tracker, depending on the state of the element. This code example ensures that an envelope tracker is returned—if the element has a vertex edit tracker, it is changed to a envelope tracker and the document is refreshed.

```
Public Sub EnsureEnvelopeTracker(pElement As IElement)
  Dim pMxDoc As IMxDocument
  Set pMxDoc = ThisDocument

  Dim pScreenDisplay As IScreenDisplay
  Set pScreenDisplay = pMxDoc.ActiveView.ScreenDisplay

  If TypeOf pElement Is IElementEditVertices Then
    Dim pElemVert As IElementEditVertices
    Set pElemVert = pElement
    If pElemVert.MovingVertices Then
      pElemVert.MovingVertices = False
      pMxDoc.ActiveView.PartialRefresh esriViewGraphicSelection, Nothing, _
        pElement.SelectionTracker.Bounds(pScreenDisplay)
    End If
  End If
End Sub
```

After obtaining a reference to a selection tracker, always set the *Display* property before using it.

The *Geometry* property of a selection tracker applies to the tracker, not the element: for envelope trackers, the geometry is a polygon created from the envelope shape; for vertex edit trackers, the geometry is a polygon or polyline as appropriate. The *Geometry* property is updated when the user finishes reshaping the element with the selection tracker.

The *HitTest* method provides information about the position of the mouse. The returned values are defined by *esriTrackerLocation*:

Enumeration esriTrackerLocation	*ESRI mouse tracking location*
0 - LocationNone	*Outside of tracker*
1 - LocationInterior	*Within tracker envelope*
2 - LocationTopLeft	*At top left tracker handle*
3 - LocationTopMiddle	*At top middle tracker handle*
4 - LocationTopRight	*At top right tracker handle*
5 - LocationMiddleLeft	*At middle left tracker handle*
6 - LocationMiddleRight	*At middle right tracker handle*
7 - LocationBottomLeft	*At bottom left tracker handle*
8 - LocationBottomMiddle	*At bottom middle tracker handle*
9 - LocationBottomRight	*At bottom right tracker handle*

The enumeration names are most relevant to envelope trackers, but *HitTest* can also be used with vertex edit trackers and callout trackers. In these cases, the returned values are LocationNone, LocationInterior, and LocationTopLeft.

Many of the *ISelectionTracker* methods—for example, *OnMouseDown*—correspond to user interface events. When controlling a selection tracker with a user interface tool, pass on the tool events to the selection tracker, for example:

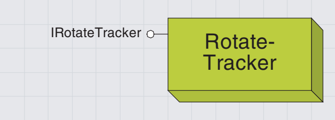
```
Private Sub UIToolControl1_MouseMove(ByVal button As Long, _
    ByVal shift As Long, ByVal x As Long, ByVal y As Long)
  If Not m_pSelTracker Is Nothing Then
    ' Pass on the mouse move event to selection tracker
    m_pSelTracker.OnMouseMove button, shift, x, y
  End If
End Sub
```

QueryMoveFeedback and *QueryResizeFeedback* return the feedback objects that the selection tracker is using.

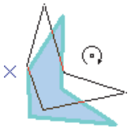
Draw is called by ArcMap if the element is selected, so normally you do not need to use this method (though it is important if you implement your own custom selection tracker).

ICalloutTracker : ISelectionTracker	***Provides access to members that control the callout feedback.***
■—□ Symbol: ISymbol	*The symbol containing the callout the tracker will use.*
■—■ SymbolGeometry: IGeometry	*Geometry used for drawing the symbol.*

You would normally only use the *ICalloutTracker* interface when building custom elements since the symbol and its geometry can be obtained from the element or the *ISelectionTracker::Geometry* method.



The rotate tracker object manages the user interface for rotating features or elements.



Note that the rotate tracker does not provide facilities for manipulation of the rotation origin—use the AnchorPoint *object to do this.*

RotateTracker manages the user interface for rotating features or elements.

IRotateTracker : IUnknown	*Provides access to members that control the rotation tracker.*
Angle: Double	*The angle.*
Cursor: Long	*If the mouse is over the tracker, return an HCURSOR to indicate legal operations based on mouse's relation to selection handles: move resize, etc. Return 0 if mouse isn't over tracker.*
Display: IScreenDisplay	*The display used by the tracker.*
Origin: IPoint	*The rotation origin.*
AddGeometry (in Geometry: IGeometry)	*Adds a geometry to be rotated.*
AddPoint (in Geometry: IGeometry, in sym: IMarkerSymbol)	*Adds a point and symbol to be rotated.*
ClearGeometry	*Clears all the geometries.*
Deactivate: Boolean	*Cancel tracking.*
OnKeyDown (in keyCode: Long) : Boolean	*Special keypress processing while tracking.*
OnMouseDown	*Begin tracking move or resize based on the location of the mouse over the tracker handles.*
OnMouseMove (mapPoint: IPoint)	*In process move or resize tracking.*
OnMouseUp: Boolean	*Finish move or resize tracking.*
Refresh	*Invalidate the portion of the screen covered by the tracker.*

The *IRotateTracker* interface controls the rotation user interface. After cocreating a *RotateTracker* object, use the members in the following order: *Display*, *Origin*, *ClearGeometry,* and then one or more calls to either *AddGeometry* or *AddPoint*. If you were rotating a single polygon element, you would need just one call to *AddGeometry* for the element geometry; however, a rotation tracker can handle a group of elements. Use *AddPoint* for features with marker symbology.

When using *AddGeometry* with elements whose size is determined by symbology, for example, text and marker elements, use the geometry of the element outline to get the correct feedback. This example function, given an element, returns a geometry suitable for *AddGeometry*:

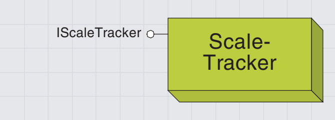
You can QI directly from most elements to ITransform2D, *which can be used to move, scale, and rotate them.*

```
Public Function GetElementGeometry(pElement As IElement, _
                                   pScreenDisplay As IScreenDisplay)
  Set GetElementGeometry = pElement.Geometry
  If TypeOf pElement Is IBoundsProperties Then
    Dim pBoundsProps As IBoundsProperties
    Set pBoundsProps = pElement
    If pBoundsProps.FixedSize Then
      Dim pPolygon As IPolygon
      Set pPolygon = New Polygon
      pElement.QueryOutline pScreenDisplay, pPolygon
      Set GetElementGeometry = pPolygon
    End If
  End If
End Function
```

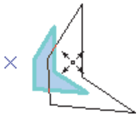
If you pass on the Key_Down *event to* OnKeyDown, *pressing "a" will prompt the user for an angle.*

The *OnMouseDown*, *OnKeyDown*, *OnMouseMove*, *OnMouseUp,* and *Deactivate* are all event handlers. Call these methods from the corresponding events in your tool. The *OnMouseMove* method will provide user interface feedback for the rotation.

Typically, you will choose to update the feature or element in question in conjunction with the *OnMouseUp* method. This returns a boolean indicating whether the element or feature was rotated. Get the amount of rotation from the *Angle* property; this can then be passed to *ITransform2D::Rotate*. For features, you may find *IFeatureEdit::RotateSet* useful.



The scale tracker manages the user interface for expansion or contraction of geometries by a scale ratio.



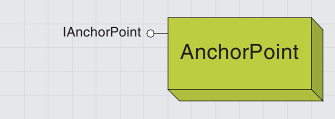
You can add the ArcMap Editor Scale Tool from the Customize dialog box.

In a similar way to the rotation tracker, the scale tracker can be applied to one or more elements or features.

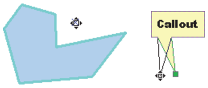
IScaleTracker : IUnknown	Provides access to members that control the scale tracker.
Cursor: Long	If the mouse is over the tracker, return an HCURSOR to indicate legal operations based on mouse's relation to selection handles: move resize, etc. Return 0 if mouse isn't over tracker.
Display: IScreenDisplay	The display used by the tracker.
Origin: IPoint	The scale origin.
ScaleFactor: Double	The scale factor.
AddGeometry (in Geometry: IGeometry)	Adds a geometry to be scaled.
ClearGeometry	Clears all the geometries.
Deactivate: Boolean	Cancel tracking.
OnKeyDown (in keyCode: Long) : Boolean	Special keypress processing while tracking.
OnMouseDown	Begin tracking move or resize based on the location of the mouse over the tracker handles.
OnMouseMove (mapPoint: IPoint)	In process move or resize tracking.
OnMouseUp: Boolean	Finish move or resize tracking.
Refresh	Invalidate the portion of the screen covered by the tracker.

The *IScaleTracker* interface controls the user interface for scaling objects. It works in a similar way to *IRotateTracker*.

The *ScaleFactor* property can be used to find out what scaling ratio was defined. If you pass on the key down event to *OnKeyDown*, pressing “F” will prompt the user for the scale factor.



The anchor point represents a point that can be used when manipulating elements and features.



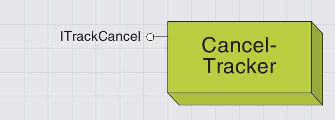
Anchor points can be useful in many situations—for rotating elements and features and moving the origin of a text callout.

When working with elements, anchor points can be considered a helper object, rather than an essential. You will first need to cocreate the anchor point and then manipulate it. This is useful when implementing your own tools and objects, for example, a custom rotation tool.

IAnchorPoint : IUnknown	Provides access to members that control the tracker anchor point.
Cursor: Long	Cursor displayed when mouse is over anchor.
Point: IPoint	Location of anchor point.
Symbol: ISymbol	Anchor point symbol.
Draw (in Display: IDisplay)	Draw the anchor.
HitTest (in Point: IPoint, in tol: Double) : Boolean	Check if mouse is over anchor.
MoveTo (in pPoint: IPoint, in Display: IDisplay)	Move the anchor.

The *IAnchorPoint* interface provides facilities for controlling anchor points.

IEditor::SelectionAnchor will return the anchor point being used by the editor, which you can subsequently manipulate.



A cancel tracker provides a mechanism for the user to stop a process.

The *CancelTracker* object is the favorite class of many users, though most probably don't realize it. Have you ever started a process and realized as soon as you did that it wasn't what you wanted? If the process employed the *CancelTracker* object, then you would be able to hit the escape key and halt the process before it had completed. The *CancelTracker* object is the object used by ArcObjects to monitor the Esc key (optionally, the space bar and mouse clicks as well) and terminate processes at the request of the user.

A *CancelTracker* is typically handed into or created just prior to functions that execute a lengthy operation. Just before such operations begin, *ITrackCancel::Reset* must be called; *Reset* sets the state of the *CancelTracker* to uncancelled and returns the internal counter, which is used to update progression to zero.

Within the innermost loop of the operation, *ITrackCancel::Continue* should be called to check whether the user has canceled the operation. By default, a cancellation occurs under the following circumstances:

- The Esc key has been pressed.
- The space bar has been pressed (disable with *CancelOnKeyPress* property).
- The left mouse button has been pressed (disable with *CancelOnClick* property).
- The right mouse button has been pressed (disable with *CancelOnClick* property).

If any of these actions occurs, the *ITrackCancel::Continue* method will return false and the operation's logic should then use this indicator to exit the loop.

Any object that exposes *IProgressor* or *IStepProgressor,* such as the *ProgressDialog* object, can be bound to the *CancelTracker* so that it will be updated correctly and efficiently and with no additional code within the operation itself. Once the progressor is connected to the *CancelTracker* via the *Progressor* property, it will be updated automatically as the operation is executed. If the progressor is a step progressor, the *MaxRange* should be set to equal the number of iterations that the operation will progress through; this number should also match the number of times *Continue* will be called in the operation's innermost loop.

In order for COM and various other parts of Windows to work correctly and responsively, Windows messages must be processed at regular intervals. For this reason, the *CancelTracker*'s implementation will process noninput (mouse, keyboard)-related messages every second during the operation if any such messages are pending. This default frequency may be changed utilizing the *ITrackCancel::CheckTime* property.

As a developer, you may use the *CancelTracker* several ways. Some ArcObjects commands (such as *IActiveView::Output*) take a

CancelTracker object as an input parameter as the following code snippet demonstrates:

```
Dim pCancel as ITrackCancel
Set pCancel = New CancelTracker
IActiveView::Output <OLE_handle>, <screen resolution>, <pixel bounds>, _
  <visible bounds>, pCancel
```

In this case, you can provide cancel capabilities by simply creating a *CancelTracker* object and passing it in to the *Output* method. The *Output* method will then take care of monitoring the Esc button and canceling the process if the user chooses to.

Another way to use a *CancelTracker* object is similar to the process above, but you as the developer are responsible for monitoring the object. An approach of this type would be used when the execution of your code could take a considerable amount of time and you want to give the user the option of canceling out of the process. The following VBA code demonstrates this process. The code is designed to loop through a set of selected network features and run the *Connect* method on them to ensure they are connected to the network. The *CancelTracker* object is included for aborting the process if the user accidentally selects too many features or just wants the process to stop.

```
Dim m_pTrackCancel As ITrackCancel

Sub testCancel()
  Dim pEd As IEditor, pEnumSel As IEnumFeature, pFeat As IFeature
  Dim pNetFeat As INetworkFeature, pUID As New UID
  pUID = “esricore.editor”
  Set pEd = Application.FindExtensionByCLSID(pUID)
  Set pEnumSel = pEd.EditSelection
  Set pFeat = pEnumSel.Next

  Set m_pTrackCancel = New CancelTracker
  pEd.StartOperation
  Do While Not pFeat Is Nothing
    If TypeOf pFeat Is INetworkFeature Then
      Set pNetFeat = pFeat
      pNetFeat.Connect
    End If

    ‘Check for a cancel
    If Not m_pTrackCancel.Continue Then
      MsgBox “Canceled!”
      pEd.StopOperation “Connect network features.”
       Exit Sub
    End If

    Set pFeat = pEnumSel.Next
  Loop
  pEd.StopOperation "Connect network features."
End Sub
```

This code could also be used in conjunction with a *ProgressDialog* object to provide a dialog box with a Cancel button to the user. For an example of how to use a *ProgressDialog* object with a *CancelTracker* object, see the Developer Sample 'Convert AV3 to AV8 Attribute Indexes'.

A *CancelTracker* object can be retrieved through a couple of different methods (*IAppDisplay::CancelTracker*, *IScreenDisplay::CancelTracker*, and others), but it is not recommended that you attempt to use the object when obtained in this manner. The *CancelTracker* object used with these interfaces is for internal use.

ITrackCancel : IUnknown	*Cancel tracking interface*
CancelOnClick: Boolean	*Indicates if mouse button clicks should be ignored when drawing.*
CancelOnKeyPress: Boolean	*Indicates if keypresses should be ignored when drawing.*
CheckTime: Long	*The amount of time to wait before Continue actually checks for user input.*
ProcessMessages: Boolean	*Obsolete.*
Progressor: IProgressor	*The progressor used to show progress during lengthy operations.*
TimerFired: Boolean	*Indicates if the timer has fired since last time TimerFired was checked.*
Cancel	*Cancels the associated operation.*
Continue: Boolean	*Called frequently while associated operation is progressing. A return value of false indicates that the operation should stop.*
Reset	*Resets the manager after the associated operation is finished.*
StartTimer (in hWnd: Long, in milliseconds: Long)	*Causes the tracker to watch for timer events.*
StopTimer	*Stops watching for timer events.*

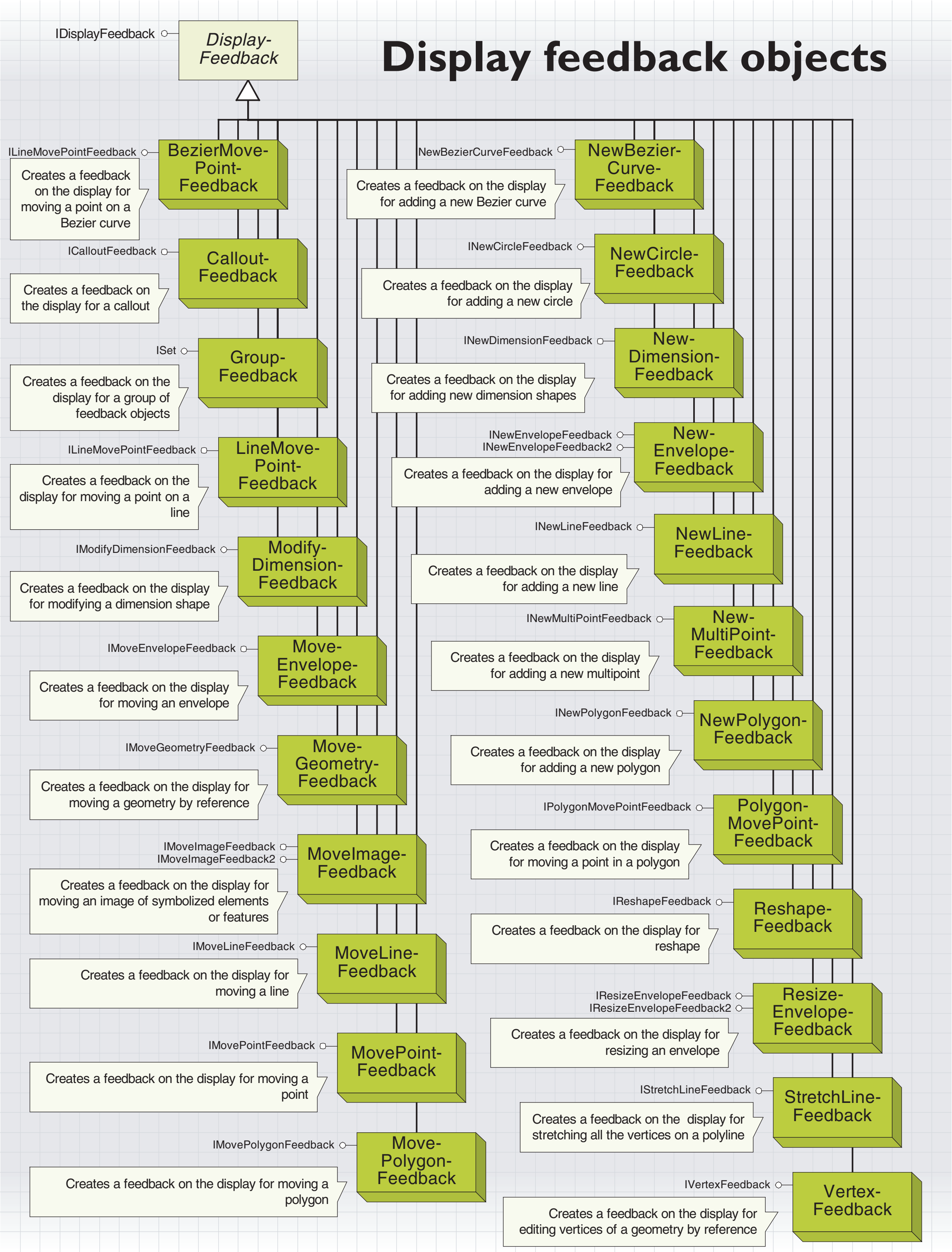
The *ITrackCancel* interface is the only interface implemented by the *CancelTracker* object and provides access to the properties of that object. Through this interface, the developer can monitor the *CancelTracker* object to determine if a cancellation has been executed by the user. The *ITrackCancel* also allows the developer to specify what actions constitute a cancellation.

The *Continue* property is the key property of the interface. When writing code with an *ITrackCancel* object, you should check the *Continue* property often to know when the operation should be halted (a value of *False* indicates the operation should be ended).

CancelOnClick and *CancelOnKeyPress* are the properties that allow the developer to specify the user actions that constitute a cancellation (a cancellation changes the *Continue* property to *False*).

The *Progressor* property can be used with a progress object (*ProgressAnimation*, *ProgressBar*, or *ProgressDialog*) to display the progress of a lengthy operation.

Display feedback objects



Creates a feedback on the display for moving a point on a Bezier curve

Creates a feedback on the display for a callout

Creates a feedback on the display for a group of feedback objects

Creates a feedback on the display for moving a point on a line

Creates a feedback on the display for modifying a dimension shape

Creates a feedback on the display for moving an envelope

Creates a feedback on the display for moving a geometry by reference

Creates a feedback on the display for moving an image of symbolized elements or features

Creates a feedback on the display for moving a line

Creates a feedback on the display for moving a point

Creates a feedback on the display for moving a polygon

Creates a feedback on the display for adding a new Bezier curve

Creates a feedback on the display for adding a new circle

Creates a feedback on the display for adding new dimension shapes

Creates a feedback on the display for adding a new envelope

Creates a feedback on the display for adding a new line

Creates a feedback on the display for adding a new multipoint

Creates a feedback on the display for adding a new polygon

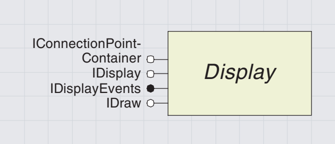
Creates a feedback on the display for moving a point in a polygon

Creates a feedback on the display for reshape

Creates a feedback on the display for resizing an envelope

Creates a feedback on the display for stretching all the vertices on a polyline

Creates a feedback on the display for editing vertices of a geometry by reference



The display feedback objects and interfaces are used to digitize new and existing geometries, such as points, polylines, envelopes, or polygons, on a map or page layout. These objects are used internally within the ArcMap application in the drawing and editing tools as well as being available to developers.

The set of objects that implement the *IDisplayFeedback* interface gives you fine-grained control over customizing the visual feedback when using the mouse to form shapes on the screen display. You can direct the precise visual feedback for tasks, such as adding, moving, or reshaping features or graphic elements. The objects can also be used without creating any features or elements for a task, such as measuring the distance between two points.

Typically, you would use the display feedback objects within code that handles the mouse events of a tool based on the *ITool* or *IUIToolControl* interfaces, such as *Mouse_Down* and *Mouse_Move*.

Which mouse events to program depends on the task at hand. For example, when adding a new envelope, you would program the display feedback objects in the *Mouse_Down*, *Mouse_Move*, and *Mouse_Up* events. Or, when digitizing a new polygon, you would program the *Mouse_Down*, *Mouse_Move*, and *Mouse_DblClick* events. When you are collecting points with the mouse to pass to the display feedbacks, you can use the *ToMapPoint* method on *IDisplayTransformation* to convert the current mouse location from device coordinates to map coordinates.

Although the feedback objects (excluding the *GroupFeedback* object) all have common functionality, their behavior does vary. These variations can be divided as follows:

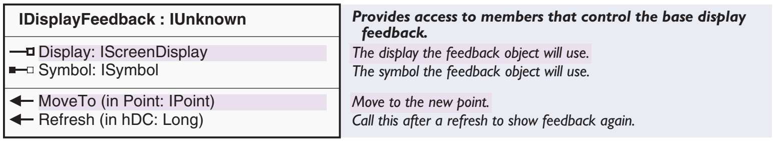
The display feedback objects also provide some of the base functionality for the rubberband objects described earlier. You should use the rubberband objects first if they suit your requirements; select the display feedback objects if you want greater control over the user interface when modifying graphics or features. This greater control comes at the cost of more code.

1. Feedbacks that return a new geometry. The interfaces for these objects have a *Stop* method that returns the new geometry. These objects are *NewEnvelopeFeedback, NewBezierCurveFeedback, NewDimensionFeedback, NewLineFeedback, NewPolygonFeedback, ModifyDimensionFeedback, MoveEnvelopeFeedback, MoveLineFeedback, MovePointFeedback, MovePolygonFeedback, BezierMovePointFeedback, LineMovePointFeedback, PolygonMovePointFeedback, ReshapeFeedback, ResizeEnvelopeFeedback,* and *StretchLineFeedback*.
2. Feedbacks that are for display purposes only. The developer is required to calculate the new geometry. For example, you can use the start and end mouse locations and calculate the delta x and delta y shifts, and then you can update or create the geometry from this. These feedback objects are *MoveGeometryFeedback, MoveImageFeedback, NewMultiPointFeedback,* and *VertexFeedback*.

Most of the interfaces contained in the display feedback objects are derived from the IDisplayFeedback *interface.*

The objects are used within the ArcMap application to allow graphic elements to be digitized and modified within the map (data view) and layout (layout view) and are also used by the ArcMap feature editing tools.

Some of the feedback objects have a *Constraint* property that determines how the feedback behaves. These constraints can specify, for example, that a *ResizeEnvelopeFeedback* maintains the aspect ratio of the input *Envelope*. The details of these constraints are given with the individual feedbacks.



IDisplayFeedback : IUnknown

Provides access to members that control the base display feedback.

Display: IScreenDisplay — *The display the feedback object will use.*

Symbol: ISymbol — *The symbol the feedback object will use.*

MoveTo (in Point: IPoint) — *Move to the new point.*

Refresh (in hDC: Long) — *Call this after a refresh to show feedback again.*

The *IDisplayFeedback* interface is used to define the common operations on all of the display feedback operations. These include moving, symbolizing, and refreshing the display feedbacks as well as setting a display feedback object's *Display* property (for example, setting it to *IActiveView::ScreenDisplay*).

The *IDisplayFeedback* interface is useful only in combination with one of the display feedback objects and its derived interfaces, for example, the *NewPolygonFeedback* object and its *INewPolygonFeedback* interface. Nearly all of the display feedback interfaces employ interface inheritance from *IDisplayFeedback*; hence, there is no need to use *QueryInterface* to access its methods and properties.

Typically, the *Display* and *Symbol* properties would be set when a display feedback object is initialized, while the *MoveTo* method would be called in a mouse move event. Setting the *Symbol* property is optional. If not set, a default symbol is used.

The *Refresh* method is used to redraw the feedback after the window has been refreshed (for example, when it is activated again), and it should be called in response to the *Tool*'s *Refresh* event. This would be *UIToolControl_Refresh* for *UIToolControl* in VBA, or *ITool_Refresh* if you are implementing *ITool* in VB or VC++. The *hDC* parameter, which is required by the *Refresh* method, is actually passed into the subroutine for you.

In the following example, a check is first made to see if *m_pNewPolyFeedback*, which is a member variable *NewPolygonFeedback* object, has been instantiated yet, that is, if the user is currently using the feedback. If it has been instantiated, then the *Refresh* method is called.

```
Private Sub UIToolControl1_Refresh(byVal hDC As Long)
  If Not m_pNewPolyFeedback Is Nothing Then
    m_pNewPolyFeedback.Refresh hDC
  End If
End Sub
```

The following code example shows how to use the *IDisplayFeedback* interface with the *INewEnvelopeFeedback* interface to create a display feedback that will allow the user to add a new polygon. Note that this code simply demonstrates the visual feedback; further code is required if you wish to add that drawn shape as a map element or feature.

The new envelope feedback object is declared as a member variable as follows:

```
Private pNewEnvFeed As INewEnvelopeFeedback
```

Other objects are locally declared—*pEnv* as *IEnvelope*, *pScreenDisp* as *IScreenDisplay*, *pLineSym* as *ISimpleLineSymbol*, and *pStartPoint* and *pMovePoint* as *IPoint*.

The following code would be placed in the *Mouse_Down* event to set up the *Display* and *Symbol* properties and to call *INewEnvelopeFeedback::Start* with the current mouse location in map units.

```
Set pNewEnvFeed = new NewEnvelopeFeedback
Set pNewEnvFeed.Display = pScreenDisp
Set pNewEnvFeed.Symbol = pLineSym
pNewEnvFeed.Start pStartPoint
```

The following line of code would be placed in the *Mouse_Move* event to move the display feedback to the current mouse location in map units, using the *MoveTo* method from *IDisplayFeedback*.

```
pNewEnvFeed.MoveTo pMovePoint
```

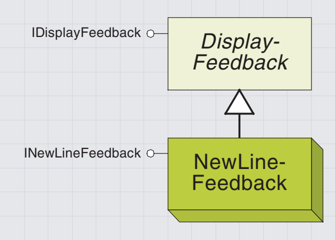
The following line of code would be placed in the *Mouse_Up* event to return the result using the *Stop* method from *INewEnvelopeFeedback*.

```
Set pEnv = pNewEnvFeed.Stop
```

The *NewLineFeedback*, *NewBezierCurveFeedback*, and *NewPolygonFeedback* coclasses would normally be used in a similar way. To form one of these new geometries, the user would use the mouse to click on the shape's starting point, move to a new location, click for any intermediate vertices, then move to the endpoint and double-click to finish. Therefore, to support this behavior, three different mouse events—*Mouse_Down*, *Mouse_Move,* and *Mouse_DblClick*—would be handled. An outline of how the feedback's methods typically relate to these events is given below.

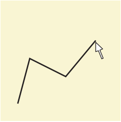
- *Mouse_Down—Start* adds the starting *Point*, or *Addpoint,* which adds subsequent *Points* and *Segments*.
- *Mouse_Move—MoveTo* is inherited from *IDisplayFeedback*, which moves the feedback onscreen.
- *Mouse_DblClick—Stop* returns the resulting single-part shape. For *NewLineFeedback* and *NewBezierCurveFeedback,* this would be a *Polyline* with one *Path*. For *NewPolygonFeedback,* this would be a *Polygon* with one *Ring*.

When the *Mouse_DblClick* event is fired, the *Mouse_Down* event is also fired only once, thus by simply clicking, moving, then double-clicking the mouse, a user will actually be firing *Mouse_Down* (*Start),* *Mouse_Move* (*MoveTo),* *Mouse_Down* (*AddPoint),* and *Mouse_DblClick* (*Stop).* Therefore, assuming that the convention shown above is used, a point will be added at the double-click location by the *Mouse_Down* event, even though the *Stop* method does not itself add a new point to the geometry.



The *NewLineFeedback* coclass allows the user to form a new *Polyline* geometry on the display. While the feedback is being used, the line shown on the screen is a series of segments made up of straight lines between each of the points clicked by the user. If the user opts to add no intermediate vertices, that is, they simply click at the start point (*Start*), move the mouse (*MoveTo*), and double-click at the end (*AddPoint* and *Stop*), then a polyline with only one segment will be generated.

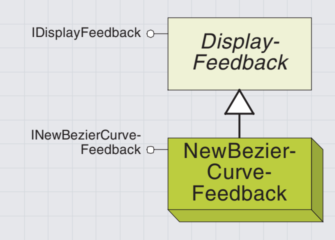
The new line feedback can be used to create a new single-part polyline object with as many vertices and segments as required.

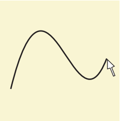


INewLineFeedback : IDisplayFeedback	***Provides access to members that control the new line display feedback.***
Constraint: tagesriLineConstraints	*The constraint on this rubberbander.*
AddPoint (in Point: IPoint)	*Creates a node at the given point.*
Start (in Point: IPoint)	*Begins a normal feedback at the given point.*
Stop: IPolyline	*Stops the feedback and returns the shape.*

This coclass uses *INewLineFeedback* to *Start*, *Stop*, *AddPoints,* and optionally apply a movement constraint. All other functionality is accessed through *IDisplayFeedback*.

The *Constraint* property is not functional at ArcGIS 8.1.





The new Bézier curve feedback can be used to create a new single-path polyline object in a similar manner to the new line feedback. The segments of this polyline will be Bézier curves rather than simple line segments.

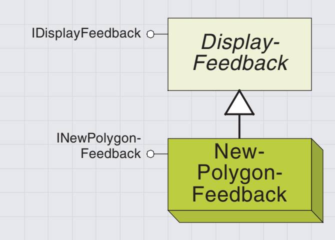
The *NewBezierCurveFeedback* coclass behaves in the same basic way as a *NewLineFeedback* in that the user is required to digitize a start point and endpoint, as well as any intermediate vertices. However, the difference is the geometry of the line that is first displayed and then returned by the feedback.

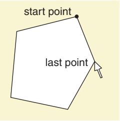
In a case where the same user input was supplied for both a *NewLineFeedback* and a *NewBezierCurveFeedback*, both return geometries would be *PolyLine* objects with the same vertices. However, the segments forming these *Polyline* objects would be of type *Line* and *BezierCurve*, respectively.

INewBezierCurveFeedback : IDisplayFeedback	***Provides access to members that control the new bezier curve display feedback.***
■–■ Constraint: tagesriLineConstraints	*The constraint on this rubberbander.*
← AddPoint (in Point: IPoint)	*Creates a node at the given point.*
← Start (in Point: IPoint)	*Begins a normal feedback at the given point.*
← Stop: IPolyline	*Stops the feedback and returns the shape.*

Enumeration tagesriLineConstraints	***ESRI line constraint.***
0 - esriLineConstraintsNone	*No line constraint.*
1 - esriLineConstraintsVertical	*Constrain line to vertical.*
2 - esriLineConstraintsHorizontal	*Constrain line to horizontal.*

INewBezierCurveFeedback is used to *Start*, *Stop*, and *AddPoints* to a *NewBezierCurveFeedback* object. *Constraint* is not yet implemented at ArcGIS 8.1.



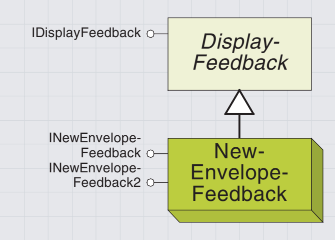


The new polygon feedback is used to create a new polygon in the same way as NewLineFeedback. *The feedback will automatically close the polygon by adding a segment to join the first and last points entered.*

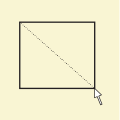
The use and behavior of the *NewPolygonFeedback* is again similar to the *NewLineFeedback*; however, the geometry that is displayed and returned is a closed *Polygon*. This means that when *Stop* is called, the start point will be added again as the finish point, thus closing the shape. At least three points should be added to the Feedback. *AddPoint* must be called a minimum of twice after the first point has been added using *Start*; otherwise a *Null Pointer* (*Nothing* in VB) is returned.

INewPolygonFeedback : IDisplayFeedback	***Provides access to members that control the new polygon display feedback.***
← AddPoint (in Point: IPoint)	*Creates a node at the given point.*
← Start (in Point: IPoint)	*Begins a normal feedback at the given point.*
← Stop: IPolygon	*Stops the feedback and returns the shape.*

Start, *Stop*, and *AddPoint* are the only three methods on this interface. *Start* will add the first point, while *AddPoint* will add subsequent points and segments, and *Stop* will return a *Polygon* if valid input, as described above, has been given.



In an application using the *NewEnvelopeFeedback* coclass, a user would typically define one corner of the envelope by pressing the mouse button down and then, while holding the mouse button down, move the mouse to the opposite corner and release it. This involves three events being handled (*Mouse_Down, Mouse_Move,* and *Mouse_Up*) and is a mechanism that is used in many areas with ArcMap, including the Zoom In, Zoom Out, and Select Features tools.



The new envelope feedback is perhaps the most useful and simplest of the feedbacks. It is used to allow the user to create a new envelope on the display, known as "dragging a rectangle".

INewEnvelopeFeedback2 : IUnknown	***Provides access to members that control the creation of a new envelope.***
AspectRatio: Double	*The aspect ratio for the custom constraint type.*
Constraint: esriEnvelopeConstraints	*The constraint on this rubberbander.*
Start (in Point: IPoint)	*Begins a normal feedback at the given point.*
Stop: IGeometry	*Stops the feedback and returns the shape.*

INewEnvelopeFeedback2 has two methods, *Start* and *Stop*, and two properties, *AspectRatio* and *Constraint*. Other members, such as *Display, MoveTo,* and *Symbol*, which are common to all of the feedbacks, are inherited from *IDisplayFeedback*.

The way in which INewEnvelopeFeedback2's *methods would typically relate to mouse events is given below.*

MouseDown—Start *(adds first corner point)*

MouseMove—MoveTo *(inherited from* IDisplayFeedback, *moves the feedback onscreen)*

MouseUp—Stop *(returns the resulting geometry)*

Start begins the feedback operation and takes the starting mouse location, while *Stop* completes the operation.

The inherited *MoveTo* method should typically be called for each *MouseMove* event between *Start* and *Stop*.

When the *Stop* method is called, it will return an *IGeometry* representing a rectangular polygon, that is, a polygon with four segments in a rectangle.

The maximum and minimum of this rectangle come from the coordinates of the point given with *Start* and the point from the last *MoveTo* method to be called. As a result, if *MoveTo* is never called, then an empty geometry will be returned; the *IsEmpty* property from *IGeometry* will return *True*.

INewEnvelopeFeedback2 *supersedes* INewEnvelopeFeedback *since it takes into consideration cases where the map's display is rotated. It does this by returning a rectangular* IPolygon *instead of an* IEnvelope *when* Stop *is called—when used with a rotated display it will return a polygon with sides parallel to the axes of the* DisplayTransformation.

The *Constraint* property allows you to specify how the feedback will behave and whether or not the feedback is forced to have a particular shape. The default value is zero, or no constraint.

If *esriEnvelopeConstraintsSquare* is applied, the feedback will be drawn with its width equal to its height, and only vertical movement of the mouse will affect the feedback's shape.

Alternatively, if *esriEnvelopeConstraintsAspect* is used, the feedback will be drawn using the current aspect ratio. In this case, if *AspectRatio* is greater than 1, only horizontal movement of the mouse will affect the feedback's shape, while if *AspectRatio* is less than or equal to 1, then the feedback's shape will be altered by vertical mouse movement only.

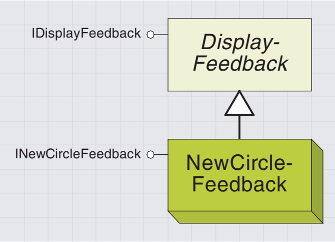
The *Constraint* property can be set at any time but will not have any effect until *MoveTo* is called.

INewEnvelopeFeedback *being used to track a rectangle on a map display that is rotated by 45°*

Enumeration tagesriEnvelopeConstraints	***ESRI envelope constraint.***
0 - esriEnvelopeConstraintsNone	*No envelope constraint.*
1 - esriEnvelopeConstraintsSquare	*Constrain envelope to square.*
2 - esriEnvelopeConstraintsAspect	*Constrain envelope aspect ratio.*

AspectRatio sets or returns the width-to-height ratio of a feedback that has an *AspectRatio* constraint, *esriEnvelopeConstraintsAspect*. *AspectRatio* is calculated as width divided by height, the default value is 1 (square), and it can only be altered by using the *AspectRatio* property.

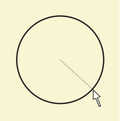
For example, if you wished to constrain your feedback to show an envelope that is three times as long as it is high, you would first set the feedback's *AspectRatio* property to three, then set its *Constraint* property to *esriEnvelopeConstraintsAspect*. Note that this property is only useful with feedbacks that have their *Constraint* property set to *esriEnvelopeConstraintsAspect*; it will not set or return the aspect ratio of a feedback that has a constraint property set to either *esriEnvelopeConstraintsNone* or *esriEnvelopeConstraintsSquare*.



The *NewCircleFeedback* allows the user to create a circular geometry on the display. Typically, this would be done by clicking at the point where the circle's center is to be and then moving the mouse to specify the circle's radius.

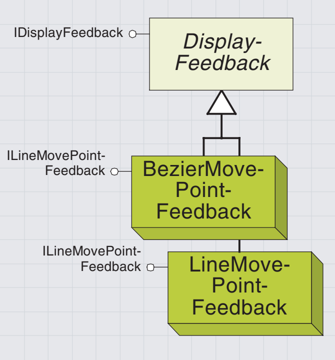
INewCircleFeedback : IDisplayFeedback	***Provides access to members that control the new circle feedback object.***
← Start (in Point: IPoint)	*Begins a circular feedback at the given point.*
← Stop: ICircularArc	*Stops the feedback and returns the circle.*

The new circle feedback is used to drag a Circle *on the display by specifying a center point and a radius. It returns an* ICircularArc.



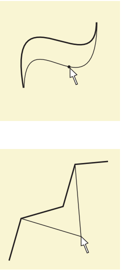
This very simple interface has only two methods of its own: *Start* and *Stop*. Like the other feedback interfaces, all other functionality is inherited from *IDisplayFeedback*. The *Start* method is used to specify the circle's center point, and *Stop* returns a new *ICircularArc*. The radius of the circle created depends on the distance between the *Start* point and the last point used in the inherited *MoveTo* method.

Note that the *ICircularArc*, which is returned from *Stop*, can be converted into an *IPolygon* by creating a new *Polygon* object, then adding the *ICircularArc* using the *AddSegment* method on the *ISegmentCollection* interface.



The *BezierMovePointFeedback* and *LineMovePointFeedback* coclasses allow the individual vertex of a *Polyline* object to be interactively moved on the display. They take an input *Polyline* and return a copy altered with the new vertex location. When the feedback is moved, the new vertex location is drawn along with the new locations of the adjacent segments—the type of segment used varies depending on which coclass is used.

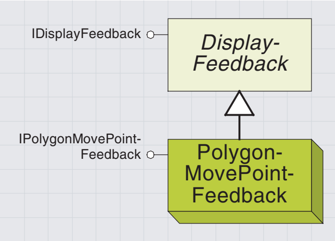
With the *LineMovePointFeedback* object, these segments are simple *Line* objects, while with the *BezierMovePointFeedback* object, these segments are *BezierCurve* objects. This difference affects both the way in which the feedback is drawn and the returned geometry. Both of these coclasses use the *ILineMovePointFeedback* interface to *Start* and *Stop* the feedback. This interface inherits from *IDisplayFeedback*, which it uses for all other behavior.



BezierMovePoint-Feedback *and* Line-MovePointFeedback *allow a vertex within an existing polyline object to be moved interactively and the line to be updated with the new vertex and segments. The updated segments will either be* Line *or* BezierCurve *objects depending on the coclass used.*

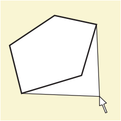
ILineMovePointFeedback : IDisplayFeedback	***Provides access to members that control the line move point display feedback.***
← Start (in Polyline: IPolyline, in pointIndex: Long, in Point: IPoint)	*Begins a move point feedback of the given shape. PointIndex is a zero based index into the polyline.*
← Stop: IPolyline	*Stops the feedback and returns the shape.*

This interface is implemented by both *LineMovePointFeedback* and *BezierMovePointFeedback*. The *Start* method is used to initiate the feedback operations, taking the input polyline, the index of the vertex to be moved, and the starting point (mouse location from which to calculate the movement). If the vertex index is invalid, then an error will be raised. Each time *MoveTo* is called, the vertex in question will be positioned at the *MoveTo* point, and the segments immediately adjacent to the vertex will also be redrawn. As stated above, the type of segments that are created, and therefore the way in which these segments both move and are drawn, depend on the coclass being used.



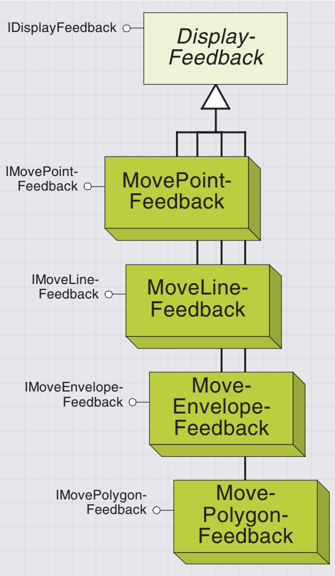
Like the *LineMovePointFeedback* and *BezierMovePointFeedback* coclasses, the *PolygonMovePointFeedback* coclass allows the user to move a vertex within an existing geometry—in this case, the geometry is a polygon. When the vertex is moved, the two adjoining segments are moved to use the new vertex location and are redrawn as lines.

IPolygonMovePointFeedback : IDisplayFeedback	***Provides access to members that control the polygon move point display feedback.***
← Start (in Polygon: IPolygon, in pointIndex: Long, in Point: IPoint)	*Begins a move point feedback of the given shape. PointIndex is a zero based index into the polygon.*
← Stop: IPolygon	*Stops the feedback and returns the shape.*



The polygon move point feedback is for use with an existing polyline or polygon geometry. This feedback allows an individual point (vertex) to be moved along with its connecting segments.

The *IPolygonMovePointFeedback* interface is very similar to *ILineMovePointFeedback*. It is used to start the feedback, which requires an input polygon, vertex index, and start location. It has a *Stop* method that stops the feedback and returns the new polygon geometry.



The move point, line, envelope, and polygon feedbacks are used to allow users to move a geometry on the display. Upon completion, the feedback objects will return a copy of the moved shape.

The feedbacks *MovePointFeedback, MoveLineFeedback, MoveEnvelopeFeedback,* and *MovePolygonFeedback* are used for moving existing geometries without altering their shapes. The geometries are offset from the current position, but no relative coordinates are altered.

Each of these feedbacks implements its own interface; these interfaces are very similar to one another among this set of feedbacks.

Each interface has two methods, *Start* and *Stop*, but like the other feedback interfaces, they make use of the methods and properties inherited from *IDisplayFeedback*, such as *MoveTo* and *Display*.

To *Start* a feedback requires an input shape, which is a geometry object of the correct type, and a starting mouse location, which is a *Point* object.

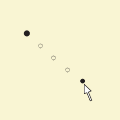
Each time *MoveTo* is called, the feedback draws a wireframe representation of the geometry, which is offset from the input shape by the difference between the starting location of the mouse and current location of the mouse.

When *Stop* is called, a new object is returned, which is the geometry of the wireframe drawn by the previous *MoveTo*.

These are the interfaces for moving entire geometries:

IMovePointFeedback : IDisplayFeedback	***Provides access to members that control the move point feedback.***
← Start (in Point: IPoint, in clickPoint: IPoint)	*Begins a move feedback of the given shape.*
← Stop: IPoint	*Stops the feedback and returns the shape.*

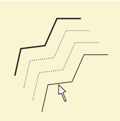
The *IMovePointFeedback* interface is used for moving points.



Applying the move point feedback

IMoveLineFeedback : IDisplayFeedback	***Provides access to members that control move line feedback.***
← Start (in Polyline: IPolyline, in Point: IPoint)	*Begins a move feedback of the given shape.*
← Stop: IPolyline	*Stops the feedback and returns the shape.*

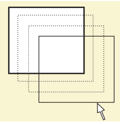
The *IMoveLineFeedback* interface is used for moving lines.



Applying the move line feedback

IMoveEnvelopeFeedback : IDisplayFeedback	***Provides access to members that control the move envelope feedback.***
← Start (in Envelope: IEnvelope, in Point: IPoint)	*Begins a move feedback of the given shape.*
← Stop: IEnvelope	*Stops the feedback and returns the shape.*

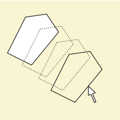
The *IMoveEnvelopeFeedback* interface is used for moving rectangles.



Applying the move envelope feedback

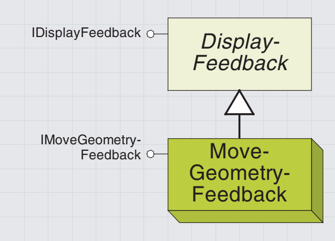
IMovePolygonFeedback : IDisplayFeedback	***Provides access to members that control the move polygon feedback.***
← Start (in Polygon: IPolygon, in Point: IPoint)	*Begins a move feedback of the given shape.*
← Stop: IPolygon	*Stops the feedback and returns the shape.*

The *IMovePolygonFeedback* interface is used for moving polygons.



Applying the move polygon feedback

MoveGeometryFeedback coclass

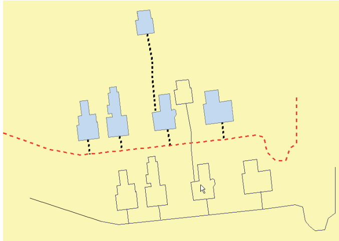


Allows multiple geometry objects of different types to be displayed and moved at the same time. This feedback is for display purposes only, and no objects are returned upon completion.

You can use a *MoveGeometryFeedback* to interactively move multiple geometry objects on the display at the same time. Each geometry that is added to the feedback is drawn using a wireframe and is moved (along with any other geometry objects that have been added) in a similar way to the individual "Move" feedbacks, such as *MovePointFeedback* and *MoveLineFeedback*.

The objects that are added to the feedback may have different *GeometryTypes* so that a *Point* object may be moved along with *Polygon* objects and *Envelope* objects. However, the behavior of the feedback differs from the simple "Move" feedbacks since it does not return a new object on completion. Therefore, if you wished to move the elements' or features' geometries, you would have to calculate the offset of the feedback (difference between the start and end mouse locations) and apply this offset to each of the geometries in turn.

For example, this could be done by caching the starting mouse location, comparing this to the final mouse location to calculate the delta x and delta y, and moving each of the geometries in question using the *Move* method on the *ITransform2d* interface.



The feedback display from moving multiple geometries

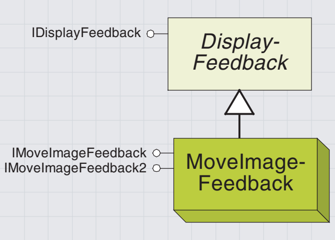
IMoveGeometryFeedback : IDisplayFeedback	*Provides access to members that control feedback for moving a group of geometry.*
← AddGeometry (in Geometry: IGeometry)	*Adds a geometry to be moved.*
← ClearGeometry	*Clears all the geometries.*
← Start (in Anchor: IPoint)	*Starts a move.*

IMoveGeometryFeedback is implemented by the *MoveGeometryFeedback* coclass and has three methods, *AddGeometry, Start,* and *ClearGeometry*. Other functionality is handled by the inherited *IDisplayFeedback* interface and its members, *MoveTo, Refresh, Display,* and *Symbol*.

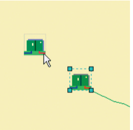
AddGeometry is used to add an *IGeometry* to an existing *MoveGeometryFeedback* and should be called for each geometry object that you wish to include in the feedback operation.

Start begins the feedback process, taking a starting anchor point (*IPoint*). This anchor point is used to calculate the delta x and delta y offset the first time *MoveTo* is called—subsequent offsets being calculated using the current and previous *MoveTo* points. Geometries cannot be added after *Start* has been called.

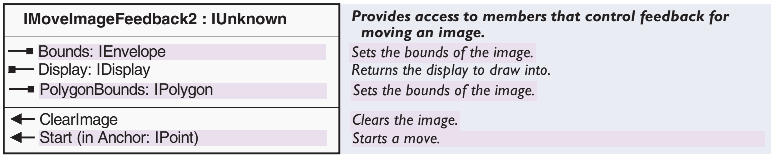
ClearGeometry simply removes any previously added geometries from the feedback but does not remove the feedback itself.



The *MoveImageFeedback* coclass is used to interactively move a symbolized version of a geometry or geometries on the display. The feedback has its own offscreen display into which you can draw your symbolized geometries. Each time the feedback is moved, this offscreen display is drawn centered at the new location. This means that to the user, the geometries will appear to be moving, for example, a *Tree* or a *Pipe* rather than simply a *Point* or a *Line*. Features, map elements, and selections may all be added to the feedback.



The move image feedback allows the creation of a feedback that shows map elements (or features) being moved along with their symbolization by drawing these objects into an offscreen display and then drawing this display each time the feedback is moved to a new location.



IMoveImageFeedback2 : IUnknown

Provides access to members that control feedback for moving an image.

Bounds: IEnvelope	*Sets the bounds of the image.*
Display: IDisplay	*Returns the display to draw into.*
PolygonBounds: IPolygon	*Sets the bounds of the image.*
ClearImage	*Clears the image.*
Start (in Anchor: IPoint)	*Starts a move.*

IMoveImageFeedback2 is implemented by the *MoveImageFeedback* coclass, and it has three properties, *Display*, *Bounds*, and *PolygonBounds* and two methods, *Start* and *ClearImage*.

Display is a Get property that allows access to the feedback's offscreen display. When a new *MoveImageFeedback* is created, it automatically creates a new one of these displays—it is to this that the various things to be moved (elements, features, and others) are drawn.

Care should be taken when using the Display *property since there is also a* Display *property on the inherited* IDisplayFeedback *interface that serves a very different purpose. In order to access the* Display *property for the* IDisplayFeedback *interface, you should explicitly* QI *for that interface; otherwise, it will default to the* IMoveImageFeedback *version of the property.*

The feedback's offscreen display can be accessed as shown below, where *pDisp* is an object declared as *IDisplay* and *pMvImageFeed* is an *IMoveImageFeedback*.

```
Set pDisp = pMvImageFeed.Display
```

Then, the mechanism for drawing to this display depends on what is to be drawn.

For map elements, the *Draw* method on the *IElement* interface may be used as follows, where *pDrawElem* is an *IElement* that you wish to add to the feedback:

```
pDrawElem.Draw pDisp, Nothing
```

IMoveImageFeedback2 supersedes IMoveImageFeedback since it has all of the methods and properties provided by the original interface as well as providing one additional property itself.

For features, it is slightly more complex since a *Symbol* should be provided and a *QI* will be required for *IFeatureDraw* on the *Feature* so that the *Draw* method may be called. In the following code example, *pFeat* is an *IFeature* that is to be added to the feedback.

```
Dim pFeatDraw As IFeatureDraw
Dim pSimpleFillSym As ISimpleFillSymbol
Set pSimpleFillSym = New SimpleFillSymbol
Set pFeatDraw = pFeat
pFeatDraw.Draw 1, pDisp, pSimpleFillSym, False, Nothing, esriDSNormal
```

The *Bounds* and *PolygonBounds* properties define the area to be covered by the feedback on the screen when the feedback operation begins. These are also used to determine the size of the offscreen display in map units. These two properties serve a similar purpose, so only one or the other should be used.

Bounds is the more simplistic of the two since it expects the input bounds as an *IEnvelope* and is therefore less suited for a situation where the map display is rotated.

PolygonBounds effectively supersedes *Bounds* and takes an *IPolygon*, thus allowing the bounds of geometries to be used, even if they are rotated.

For situations where multiple geometries are to be added to the feedback, the shapes or envelopes of these can be combined in a union to create a larger polygon or envelope that covers all of them. If neither of these properties is set, then an offscreen display will be created that corresponds in size to the whole of the *Map* object's *Display*; this may adversely affect performance and therefore is not recommended.

IMoveImageFeedback2 supersedes *IMoveImageFeedback* since it has all of the methods and properties provided by the original interface as well as providing one additional property itself.

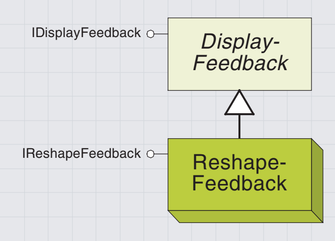
Start begins the feedback operation. It should be called once all of the drawing has been done to the feedback's display. Once *Start* has been called, the feedback can be moved using the inherited *MoveTo* method, which causes it to be redrawn at a new location.

The *ClearImage* method clears the offscreen display of the *MoveImageFeedback* object. Once this has been called, the feedback will no longer be visible but will still accept *MoveTo* requests. It is often used in combination with the inherited *Refresh* method, which is useful if the user has cancelled the feedback operation (for example, by pressing the Esc key) or when the feedback operation is complete.

The following code shows how a *MoveImageFeedback* might be used to show the movement of an *IElement* using the *MouseDown* and *MouseMove* events of a *UIToolControl*. This code does not actually move the element itself—this could be done in the *MouseUp* event by comparing the start and finish mouse locations to calculate the delta x and delta y and using the *Move* method on the *IGraphicElement* interface.

These objects are member variables: *m_pMvImageFeed* as *IMoveImage-Feedback*. The feedback itself, *m_pSelElem* As *IElement,* is assumed to be a valid element that you wish to show in the feedback, such as from the ActiveView's *BasicGraphicsLayer*.

```
Private Sub UIToolControl1_MouseDown(ByVal button As Long, _
   ByVal shift As Long, ByVal x As Long, ByVal y As Long)
  Dim pPnt As IPoint ' The current mouse location in map units
  Dim pMXDoc As IMxDocument ' The current document
  Dim pEnvBnds As IEnvelope ' Bounds of the element (including symbology)
  Dim pDispFeed As IDisplayFeedback, pDisp As IDisplay
  Set pMXDoc = ThisDocument ' QI for the MXDocument interface

  ' Transform the current mouse location into map coordinates
  Set pPnt = _
   pMXDoc.ActiveView.ScreenDisplay.DisplayTransformation.ToMapPoint(x, y)
  ' Create a new feedback object
  Set m_pMvImageFeed = New MoveImageFeedback

  ' QI for the IDisplayFeedback interface (because of ambiguity between
  ' the Display property of IMoveImageFeedback and IDisplayFeedback)
  Set pDispFeed = m_pMvImageFeed

  ' Use this interface to set the Display property to point to the
  ' ActiveView's Screendisplay
  Set pDispFeed.Display = pMXDoc.ActiveView.ScreenDisplay

  ' Now we can get a handle on the new feedback's Display. This display is
  ' then used to draw the element into (causing the element to be drawn
  ' when moving the feedback)
  Set pDisp = m_pMvImageFeed.Display

  ' Create a new envelope and use this to get the element's bounds
  ' (includes symbology) based upon the feedback's display
  Set pEnvBnds = New Envelope
  m_pSelElem.QueryBounds pDisp, pEnvBnds
  m_pMvImageFeed.Bounds = pEnvBnds ' Set the feedback's bounds
  m_pSelElem.Draw pDisp, Nothing ' Draw the element into off-screen display
  m_pMvImageFeed.Start pPnt ' Start at the current mouse location
End Sub

Private Sub UIToolControl1_MouseMove(ByVal button As Long, _
   ByVal shift As Long, ByVal x As Long, ByVal y As Long)

  ' Check that we are using a feedback
  If Not m_pMvImageFeed Is Nothing Then
    Dim pPnt As IPoint
    Dim pMXDoc As IMxDocument
    Set pMXDoc = ThisDocument ' QI for the MXDocument Interface

    ' Transform the current mouse location into map coordinates
    Set pPnt = _
     pMXDoc.ActiveView.ScreenDisplay.DisplayTransformation.ToMapPoint(x, y)
    m_pMvImageFeed.MoveTo pPnt ' Move the feedback to the current location
  End If
End Sub
```



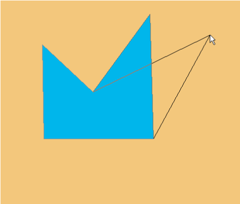
The reshape feedback reshapes an IPath *by either rotating and shifting the whole shape or just the segments adjacent to a given vertex.*

The *ReshapeFeedback* allows the user to reshape an object that supports the *IPath* interface. Such objects are the *Path* and *Ring* objects, which can represent one part of a *Polyline* or *Polygon*, respectively. The reshaping process can behave in two quite separate ways depending on how the *Stretch* parameter is set.

IReshapeFeedback : IDisplayFeedback	***Provides access to members that control the reshape display feedback.***
← Start (in Path: IPath, in Index: Long, in stretch: Boolean)	*Begins a feedback operation at the point.*
← Stop: IPath	*Finishes a reshape feedback operation.*

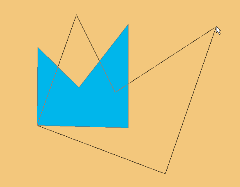
The *IReshapeFeedback* interface has two methods, *Start* and *Stop*.

The *Start* method takes the input geometry as an *IPath*, the index of the vertex that is being used, and a Boolean describing how the feedback should behave. The *Stop* method returns an *IPath*, which is a new object.



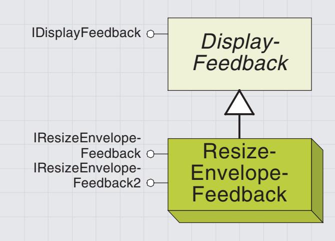
Reshaping feedback with the stretch option set

Both *Path* and *Ring* objects, which represent single parts of *Polyline* objects and *Polygon* objects, respectively, support the *IPath* interface. Therefore, the object underlying the returned *IPath* will be either a *Ring* or a *Path*, depending on the input object's class. Like the other feedback interfaces, *IReshapeFeedback* inherits from *IDisplayFeedback*, which it uses for moving, refreshing, symbolizing, and setting up the display. The behavior of the feedback depends on the combined factors of vertex index, stretch parameter, and whether the input object is a *Path* or a *Ring*.



Reshaping feedback with the stretch option off

If stretching is set (a *True* value for the *Stretch* parameter), then the whole shape may be scaled or rotated by the feedback and all of the segments may be altered. Conversely, if *Stretch* is *False*, then only one vertex and its adjacent segments may be altered. If stretching is used, then the shape is rotated and/or scaled around the start and endpoints of the path. For a *Ring,* these two points will be coincident and the shape can therefore only undergo a translation—it will maintain its relative shape. For a *Path*, however, this may not be the case and, as a result, the shape may become transformed or have its actual "shape" changed.



The resize envelope feedback is used for resizing an existing Envelope *object. Use the* ResizeEdge *property to specify which edge or corner to move. Constraints may optionally be used to further control the behavior of the feedback.*

A *ResizeEnvelopeFeedback* is used for resizing an existing *IGeometry* that is either an *IEnvelope* or a (rectangular) *IPolygon*. These geometries can be resized by moving their edges and corners. The corner or edge to be moved by the feedback operation must be specified, and you can also optionally apply a movement constraint, such as forcing the feedback's shape to be square.

IResizeEnvelopeFeedback2 : IUnknown	***Provides access to members that control the resize of an envelope.***
AspectRatio: Double	*The aspect ratio for the custom constraint type.*
Constraint: tagesriEnvelopeConstraints	*The constraint on this rubberbander.*
ResizeEdge: tagesriEnvelopeEdge	*The edge to rubberband.*
Start (in Envelope: IGeometry, in Point: IPoint)	*Begins a resize feedback of the given shape.*
Stop: IGeometry	*Stops the feedback and returns the shape.*

The *IResizeEnvelopeFeedback2* interface has two methods, *Start* and *Stop*.

Start is used to begin the feedback operation onscreen; it takes the starting mouse location as an *IPoint* and an input geometry as either an *IEnvelope* or a rectangular *IPolygon* (an *IPolygon* with four segments and a rectangular shape).

The *Stop* method completes the operation and returns an *IGeometry* that represents a rectangular *Polygon* coclass. The interface also has three properties: *ResizeEdge, Constraint,* and *AspectRatio*.

IResizeEnvelopeFeedback2 *supersedes* IResizeEnvelopeFeedback *since it takes into consideration cases where either the map's display or the input geometry is rotated and allows the rotation of the input geometry to be maintained. As a result, some of the interfaces used as input and return types differ from those used in* IResizeEnvelopeFeedback*. For example, the* Stop *method returns an* IGeometry *representing an* IPolygon*, rather than an* IEnvelope*.*

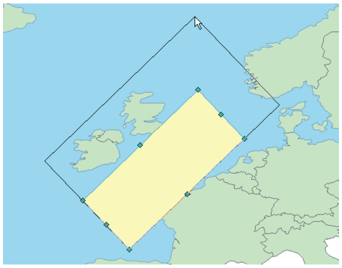
Enumeration tagesriEnvelopeEdge	***ESRI envelope edge location.***
0 - esriEnvelopeEdgeTopLeft	*Top left envelope edge.*
1 - esriEnvelopeEdgeTopMiddle	*Top middle envelope edge.*
2 - esriEnvelopeEdgeTopRight	*Top right envelope edge.*
3 - esriEnvelopeEdgeMiddleLeft	*Middle left envelope edge.*
4 - esriEnvelopeEdgeMiddleRight	*Middle right envelope edge.*
5 - esriEnvelopeEdgeBottomLeft	*Bottom left envelope edge.*
6 - esriEnvelopeEdgeBottomMiddle	*Bottom middle envelope edge.*
7 - esriEnvelopeEdgeBottomRight	*Bottom right envelope edge.*

ResizeEdge simply allows you to specify which edge or corner is to be moved by the feedback.

The *Constraint* property allows you to specify how the feedback will behave and whether or not the feedback is forced to have a particular shape. The default value is no constraint, or *esriEnvelopeConstraintsNone*.

If *esriEnvelopeConstraintsSquare* is applied, the feedback will be drawn with its width equal to its height, and only vertical movements of the mouse will affect the feedback's shape.

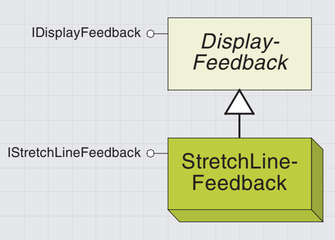
Alternatively, if *esriEnvelopeConstraintsAspect* is used, the feedback will be drawn, maintaining the aspect ratio of the input *IGeometry*. The *Constraint* property can be set at any time but will not have any effect until *MoveTo* is called. Note that the *AspectRatio* property is not fully implemented at this release, and therefore its value will not affect the feedback operation.

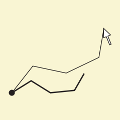


IResizeEnvelopeFeedback *being used to resize a* RectangleElement *that is rotated by 60°*

Enumeration tagesriEnvelopeConstraints	***ESRI envelope constraint.***
0 - esriEnvelopeConstraintsNone	*No envelope constraint.*
1 - esriEnvelopeConstraintsSquare	*Constrain envelope to square.*
2 - esriEnvelopeConstraintsAspect	*Constrain envelope aspect ratio.*

Like other feedback interfaces, *IResizeEnvelopeFeedback* inherits from *IDisplayFeedback* and uses that interface for common feedback functionality, such as symbolizing, moving, and setting the display property.





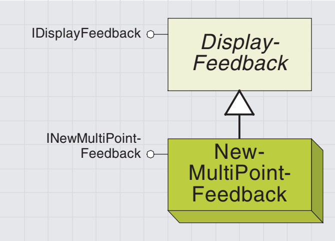
The stretch line feedback can be used to scale and rotate a polyline object about its FromPoint *or* ToPoint.

You can use a *StretchLineFeedback* object to scale or rotate an existing *Polyline* object. The scaling and rotation is done about an anchor point. The feedback is moved by shifting the nonanchored end of the polyline by the difference (delta x and delta y) between the current and original mouse locations. The whole polyline is moved to match up with this using a rigid stretch and, as a result, may be both scaled and rotated.

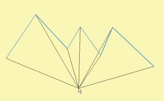
IStretchLineFeedback : IDisplayFeedback	***Provides access to members that control the stretch line display feedback.***
Anchor: IPoint	*Sets the anchor point of the curve.*
Start (in Polyline: IPolyline, in Point: IPoint)	*Begins a move of the given shape (a polyline).*
Stop: IPolyline	*Stops the feedback and returns the polyline.*

The *IStretchLineFeedback* interface has two methods, *Start* and *Stop*, and a write-only property, *Anchor*. Like other feedbacks, *Start* begins the feedback operation and takes an input *Polyline* object and a *Point*, which represents the starting mouse location in map units. *Stop* simply completes the feedback operation and returns a new *Polyline* object, which is a copy of the input that has been scaled and rotated as necessary.

The *Anchor* property is used to specify which end to use as the fixed point and can be set to either the *Polyline* object's *FromPoint* or *EndPoint*. If this property is not specified, then the default is to use the *FromPoint* as the anchor. The *Anchor* property should only be set after the *Start* method has been called. Other functionality is inherited from the *IDisplayFeedback* interface.



A *NewMultiPointFeedback*, unlike many other feedback objects, does not return a new geometry or alter the input geometry. Instead, it is used for visual feedback only and relies on you to update a geometry when appropriate. It takes a multipoint object as input and then, when *MoveTo* is called, it draws a line segment between the current mouse location and each of the points in the multipoint. It should not be confused with the other "New" feedbacks, such as *NewLineFeedback*, as it serves a very different purpose.

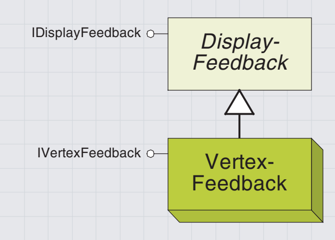


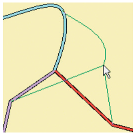
The new multipoint feedback draws a line between each point of multipoint and the mouse location.

INewMultiPointFeedback : IDisplayFeedback	***Provides access to members that control the new multipoint display feedback.***
Start (in Points: IPointCollection, in Point: IPoint)	*Begins a normal feedback at the given point.*
Stop	*Stops the feedback and returns the shape.*

INewMultiPointFeedback has only two methods, *Start* and *Stop*.

Start takes two input parameters: an object that supports *IMultipoint* and a starting location as an *IPoint*. When *Start* is called, a series of line segments are drawn onto the display, joining each point within the *IMultipoint* to the starting location. Each time *MoveTo* (inherited from *IDisplayFeedback*) is called, these lines are updated to join the multipoint points to the new mouse location. The *Stop* method does not return any objects but simply tells the feedback that operation is complete and to stop drawing and moving.





Vertex feedbacks are used to alter paths and rings by moving their vertices and any adjacent segments. Segments are added one by one with either their FromPoint *or* ToPoint *as an anchor. Multiple segments, which may come from different geometry objects, can be moved at the same time. No geometry objects are returned on completion.*

A *VertexFeedback* object allows one or more individual segments to be moved on the display by the user. Like the *NewMultiPointFeedback*, the *VertexFeedback* does not return an object at the end of the operation and is used for visual feedback only. The segments in question don't need to belong to the same geometry or even type of geometry. This allows, for example, a segment from a polygon to be moved along with some segments from a polyline or, alternatively, the moving of vertices (and segments) that are part of a shared polygon boundary.

IVertexFeedback : IDisplayFeedback	*Provides access to members that control the vertex feedback.*
← AddSegment (in Segment: ISegment, in fromPointIsAnchor: Boolean)	*Adds an edge to rubberband.*

The *IVertexFeedback* interface has only one member, the *AddSegment* method, which adds the segments and specifies which end to use as the anchor point.

Each time *AddSegment* is called, a check is made to see if the segment has already been added; if it has, then it is not added a second time. The methods used to move, symbolize, refresh, and setup the display are accessed through the inherited *IDisplayFeedback* interface. Since there is no *Start* method, the first call to *MoveTo* will begin the feedback operation, that is, draw the feedback, and the feedback will be redrawn with each subsequent *MoveTo*. To finish the operation, the feedback object should be cleared and the display refreshed.

The following Visual Basic example shows how you can use the *IVertexFeedback* interface to move segments from two different *Polyline* geometries. *m_pVertexFeed* represents the feedback object itself and is a member variable declared as *IVertexFeedback*, so it can be accessed in all of the tool's mouse events. The code assumes that you already have two pairs of segments (one pair from each of polylines A and B) that you wish to add to the feedback. These are represented by *pLnASeg1, pLnASeg2, pLnBSeg1,* and *pLnBSeg2*, which are declared as *ISegment*.

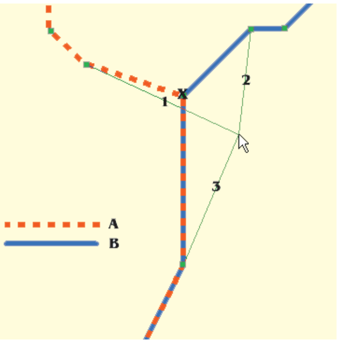
The following code would be placed in a tool's *Mouse_Down* event to initiate the feedback operation.

```
Dim pMXDoc As IMxDocument
Dim pPnt As IPoint

' QI for the IMXDocument interface
Set pMXDoc = ThisDocument

' Get the current mouse location in Map Units
Set pPnt = _
   pMXDoc.ActiveView.ScreenDisplay.DisplayTransformation.ToMapPoint(x, y)

' Create a new VertexFeedback
Set m_pVertexFeed = New VertexFeedback

' Set the Feedback's display property (to the ActiveView's ScreenDisplay)
```

```
Set m_pVertexFeed.Display = pMXDoc.ActiveView.ScreenDisplay

' Add the required segments to the feedback...
' Line A, Segment 1, using FromPt as anchor
m_pVertexFeed.AddSegment pLnASeg1, True
' Line A, Segment 2, using ToPt as anchor
m_pVertexFeed.AddSegment pLnASeg2, False

' Line B, Segment 1, using FromPt as anchor
m_pVertexFeed.AddSegment pLnBSeg1, True
' Line B, Segment 2, using ToPt as anchor
m_pVertexFeed.AddSegment pLnBSeg2, False

' Start the feedback operation by moving to the start point
m_pVertexFeed.MoveTo pPnt
```

The code below is used to move the feedback and should be placed in the *Mouse_Move* event of a tool.

```
If Not m_pVertexFeed Is Nothing Then ' Check that user is using feedback
  Dim pMXDoc As IMxDocument
  Dim pPnt As IPoint

  ' QI for the IMXDocument interface
  Set pMXDoc = ThisDocument
  ' Get the current mouse location in Map Units and move the feedback
  Set pPnt = _
    pMXDoc.ActiveView.ScreenDisplay.DisplayTransformation.ToMapPoint(x, y)
  m_pVertexFeed.MoveTo pPnt
End If
```

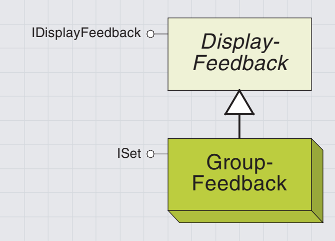


In this example, the user has hit point X, which is the endpoint of four different segments (two each from polylines A and B). Two of these segments are identical, while the other two are different.

The two different segments are both added to the feedback and become 1 and 2 in the feedback. Conversely, one of the duplicate segments is automatically rejected by AddSegment*, the remaining one becoming 3 in the feedback object. This rejection is useful because if two identical segments were added, the feedback would not draw correctly. However, care should still be taken when adding segments that are the reverse of one another, as these will not be rejected.*

The *Mouse_Up* event of the tool would be used to complete the feedback operation using the following code:

```
If Not m_pVertexFeed Is Nothing Then 'Check that user is using feedback
  Dim pMXDoc As IMxDocument

  ' QI for the IMXDocument interface
  Set pMXDoc = ThisDocument

  ' Refresh the ActiveView
  pMXDoc.ActiveView.Refresh

  ' Clear feedback object
  Set m_pVertexFeed = Nothing
End If
```



The group feedback is a special feedback that allows many different feedbacks to be controlled together. Any properties set or methods called through IDisplayFeedback *are passed on to every member, thus reducing the amount of code.*

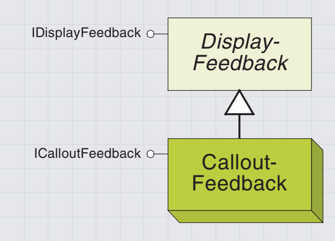
The *GroupFeedback* is different from the other *Feedback* objects—rather than being a feedback in its own right, it is simply a holder for one or more member *Feedback* objects.

The *GroupFeedback* supports the *ISet* interface, which allows these member feedbacks to be added, removed, found, and iterated through. All of the *Feedback* objects themselves support the *IDisplayFeedback*, which is used to handle common areas of functionality, such as refreshing, moving, and symbolizing. The *GroupFeedback* also supports the *IDisplayFeedback* interface, but when one of these methods or properties is called, the *GroupFeedback* simply passes this on to its member objects.

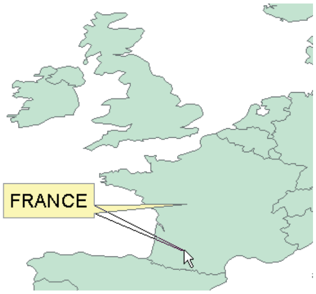
For example, if the *MoveTo* method was called on a *GroupFeedback*, then it would in turn call *MoveTo* on each of its member *Feedback* objects. This avoids having to call the method multiple times (once for each feedback) and can be very useful if two or more feedbacks are being used in conjunction—for example, if you wished to show two *Envelope* objects being resized simultaneously or to move a vertex that was shared by multiple geometries. The *Feedback* objects that can be added to the *GroupFeedback* should be instantiated before they are added.

The following code shows a new *GroupFeedback* being created along with two member feedbacks (a *NewLineFeedback* and a *NewBezierCurveFeedback*). The two member feedbacks are started individually and then added to the *GroupFeedback*, which is then used to collectively set up their *Display* and *Symbology* properties. This same mechanism could be used for applying the *MoveTo* method in the *MouseMove* event. In this code, *pPnt* is an *IPoint* representing the starting point in map units, and *pDisp* is an *IDisplay* representing the *ActiveView*'s *ScreenDisplay*.

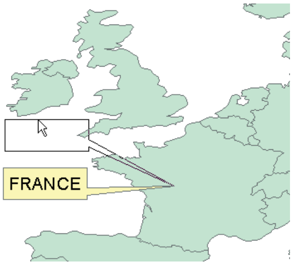
```
Dim pGrpFeedDisp As IDisplayFeedback
Dim pGrpFeedSet As ISet
Dim pNewLineFeedback As INewLineFeedback
Dim pNewBzFeedback As INewBezierCurveFeedback

' Create a new GroupFeedback object (with the IDisplayFeedback interface)
Set pGrpFeedDisp = New GroupFeedback
Set pGrpFeedSet = pGrpFeedDisp ' QI for the ISet interface

' Create 2 new feedbacks to add to GroupFeedback
Set pNewLineFeedback = New NewLineFeedback
Set pNewBzFeedback = New NewBezierCurveFeedback
' Set the new member Feedback's StartPoints
pNewLineFeedback.Start pPnt
pNewBzFeedback.Start pPnt

' Add the new member Feedbacks to the GroupFeedback
pGrpFeedSet.Add pNewLineFeedback
pGrpFeedSet.Add pNewBzFeedback
Set pGrpFeedDisp.Display = pDisp
```



A callout feedback is used to modify a callout object. For example, you can modify the display of a TextElement *by moving either the body of the callout or the* AnchorPoint*.*



Using a CalloutFeedback *object to move the anchorpoint of a* TextElement's Callout



Using a CalloutFeedback *object to move the body of* Callout *box*

A callout is a graphic that may be drawn as a background behind a *TextElement*. The *Callout* may also have a leader line to an anchor point.

A *CalloutFeedback* may be used to move either the *Callout* itself or the *AnchorPoint*. It returns a *Polyline* representing the new outline of the callout. This *Polyline* can be useful; however, in order to move the *Callout,* it is simpler to calculate the shift in x and y between the start and endpoints of the feedback operation, then move the callout by the specified amount.

ICalloutFeedback : IDisplayFeedback	***Callout feedback object.***
← MoveAnchorTo (in Point: IPoint)	*Moves the anchor point to the given point.*
← Start (in Symbol: ISymbol, in Geometry: IGeometry, in Point: IPoint)	*Begins a feedback of the given symbol.*
← Stop: IPolyline	*Stops the feedback and returns the shape.*

The *ICalloutFeedback* interface has three methods: *Start, Stop,* and *MoveAnchorTo*, as well as all of those that it inherits from *IDisplayFeedback* interface. As mentioned above, the *CalloutFeedback* can be used in two distinct ways—moving the *Callout* itself and moving the *AnchorPoint*.

The *Start* and *Stop* methods are used for both types of operation, while *MoveAnchorTo* is only used as an alternative to *MoveTo* when manipulating the *AnchorPoint*. Typically, an application detects whether or not a user has hit the *Callout* or its *AnchorPoint*, and this determines what operation is carried out.

The code below demonstrates how to use the *ICalloutFeedback* interface. The variables *m_pCalloutfeedback* and *m_PtStart* are declared as *ICalloutFeedback* and *IPoint*, respectively. *m_pSelElem* is declared as an *IElement* and represents a *TextElement* with an *IPoint* geometry and a *Callout* background that you wish to move. *m_BoolHitAnchor* represents a Boolean that specifies whether to move the *Callout* or the *AnchorPoint*.

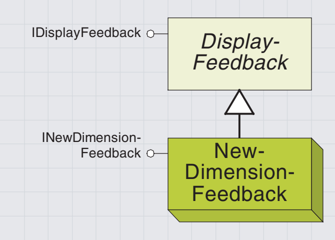
```
Private Sub UIToolControl1_MouseDown(ByVal button As Long, _
   ByVal shift As Long, ByVal x As Long, ByVal y As Long)
 Dim pMxDoc As IMxDocument
 Dim pTxtElem As ITextElement
 Dim pGeom As IGeometry
 Dim pHitTest As IHitTest
 Dim pFormTextSym As IFormattedTextSymbol

 'Get the document's BasicGraphicsLayer
 Set pMxDoc = ThisDocument
 ' Get the current mouse location in Map Units
 Set m_PtStart = _
    pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation.ToMapPoint(x, y)
 ' QI for ITextElement from IElement
 Set pTxtElem = m_pSelElem
 ' Get the TextSymbol and QI for IFormattedTextSymbol
 Set pFormTextSym = pTxtElem.Symbol
```

```
  ' Get the Element's geometry (either an IPoint or IPolyline)
  Set pGeom = m_pSelElem.Geometry
  ' Create a new CalloutFeedback
  Set m_pCalloutfeedback = New CalloutFeedback
  'Set the feedback's display
  Set m_pCalloutfeedback.Display = pMxDoc.ActiveView.ScreenDisplay
  ' Start the feedback, supplying the Callout's TextSymbol,
  ' Geometry and Starting location
  m_pCalloutfeedback.Start pFormTextSym, pGeom, m_PtStart

End Sub

Private Sub UIToolControl1_MouseMove(ByVal button As Long, _
        ByVal shift As Long, ByVal x As Long, ByVal y As Long)
  If Not m_pCalloutfeedback Is Nothing Then
    Dim pPnt As IPoint
    Dim pMxDoc As IMxDocument

    ' QI for MXDocument
    Set pMxDoc = ThisDocument
    ' Get the current mouse location in Map Units and...
    Set pPnt = _
      pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation.ToMapPoint(x, y)
    If m_BoolHitAnchor Then ' Move the AnchorPoint
      m_pCalloutfeedback.MoveAnchorTo pPnt
    Else ' Move the Feedback itself
      m_pCalloutfeedback.MoveTo pPnt
    End If
  End If
End Sub
```

The *MouseUp* event of the *UIToolControl* can be used to modify the *TextElement* with the updated *Callout*.

The following dimension feedback objects are used to create and modify *DimensionShape* objects. They are similar in some respects to other feedback objects, such as the *NewPolylineFeedback* and *PolygonMovePointFeedback*, but differ in other ways, including the following:

- The dimension feedback interfaces do not inherit from *IDisplayFeedback*. Instead, the coclasses support this interface; therefore, a *QueryInterface* is required when moving between the interfaces.
- The dimension feedback objects and interfaces are useful only in creating modifying (dimension) *Features* in a *FeatureClass*.
- The dimension feedback objects require knowledge of dimension objects rather than of geometry objects; therefore, reference should be made to the section covering *IDimensionShape* in Volume 2, Chapter 9, 'Shaping features with geometry'.



New dimension feedbacks allow the user to create a new DimensionShape *object by entering points on the display using the mouse. As the points are entered, a representation of the dimension being created is shown on the display—this dimension is dynamically updated with each mouse movement or click, including the value of the dimension's text.*

The *NewDimensionFeedback* is used for creating new *DimensionShape* objects. It is shown as a dimension object, which changes dynamically as the mouse is moved. Also, the text for the dimension is updated with each movement to reflect the size of the dimension in map units.

The *NewDimensionFeedback* coclass supports the *INewDimensionFeedback* interface, which has members specifically used for creating dimensions. This coclass also supports the *IDisplayFeedback* interface, which it uses for general feedback operations, specifically the *Display* property and the *MoveTo* and *Refresh* methods. Unlike many other feedback interfaces, *INewDimensionFeedback* does not inherit from *IDisplayFeedback*, and so a *QueryInterface* is required when switching between both interfaces.

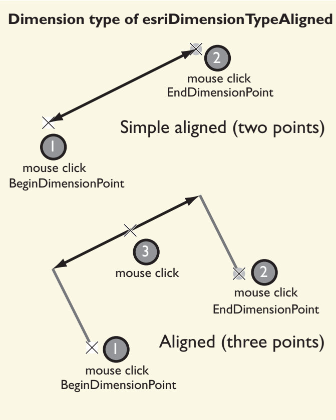
INewDimensionFeedback : IUnknown	***Provides access to memebers to control the display feedback for creating new dimension features.***
■━■ DimensionType: esriDimensionType	*The dimension type of the display feedback.*
■━■ ReferenceScale: Double	*The reference scale of the display feedback.*
■━■ ReferenceScaleUnits: esriUnits	*The reference scale units of the display feedback.*
━■ Style: IDimensionStyle	*The dimension style for the display feedback.*
← AddPoint (in Point: IPoint)	*Adds a point to the display feedback.*
← Start (in begin: IPoint)	*Starts the display feedback.*
← Stop: IDimensionShape	*Stops the display feedback and returns the points.*

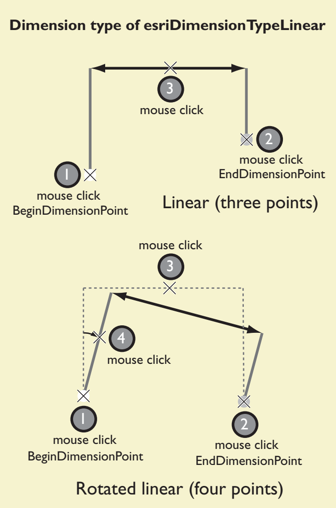
INewDimensionFeedback uses the *Start* method to add the *BeginDimensionPoint*, taking an *IPoint* in *MapUnits*. *AddPoint* should then be used for each subsequent point to be added.

Stop ends the feedback operation and returns an *IDimensionShape*, which can then be added to a *FeatureClass*.

The *DimensionType* property can be set to either aligned (the default) or linear. The type chosen affects the resulting geometry. The linear type constrains the angle of the dimension line to 0 or 90 degrees.

If the *DimensionType* is aligned (*esriDimensionTypeAligned*), then the required number of points is either two or three. The order in which the feedback expects these points to be added is *BeginDimensionPoint, EndDimensionPoint,* and optionally a *DimensionLinePoint* (to indicate the length of the extension lines).





For linear dimensions (*esriDimensionTypeLinear*), the required number of points is three. These are the *BeginDimensionPoint, EndDimensionPoint,* and *DimensionLinePoint*. Optionally, a fourth point may be added to represent the *ExtensionLineAngle*. If entered, this fourth point is taken in combination with the third point to calculate a new *DimensionLinePoint*—length of the extension line coming from the third point and the angle from the fourth.

The feedback's *ReferenceScale* and *ReferenceScaleUnits* properties determine at what map scale the text and symbology will be set (at which scale it will appear as intended). If this property is not set, then the reference scale of the *Map* will be used if set. If you are unable to see the symbology or text for your feedback, then it is likely that the reference scale properties are not correctly set.

Below is some VB code illustrating one method of creating a (simple) *LinearDimensionFeedback*. The code requires the *Mouse_Down* event to start the feedback (*BeginDimensionPoint*), *Mouse_Move* to move the feedback, and *Mouse_Down* again to complete the feedback (*EndDimensionPoint*). The variable *m_pNewDimFeed* is a member variable declared as an *INewDimensionFeedback*.

The following code should be placed in the *Mouse_Down* event of a *ITool* or *UIToolControl*.

```
Dim pPnt As IPoint
Dim pDispFeed As IDisplayFeedback
Dim pMXDoc As IMxDocument
Dim pDimShp As IDimensionShape

' QI for MXDocument
Set pMXDoc = ThisDocument
' Get the current mouse location in Map Units
Set pPnt = pMXDoc.ActiveView.ScreenDisplay. _
  DisplayTransformation.ToMapPoint(x, y)

' If user is not currently using the feedback then...
If m_pNewDimFeed Is Nothing Then
  ' Create a new NewDimensionFeedback object
  Set m_pNewDimFeed = New NewDimensionFeedback
  ' Set up the NewDimensionFeedback
  m_pNewDimFeed.DimensionType = esriDimensionTypeLinear
  m_pNewDimFeed.ReferenceScale = 100000
  m_pNewDimFeed.ReferenceScaleUnits = esriMeters
  ' QI for IDisplayFeedback
  Set pDispFeed = m_pNewDimFeed
  'Set the Feedback's Display
  Set pDispFeed.Display = pMXDoc.ActiveView.ScreenDisplay
  ' Then start at the current mouse location (BeginDimensionPoint)
  m_pNewDimFeed.Start pPnt
Else
  ' If the user is already using the feedback then...
```

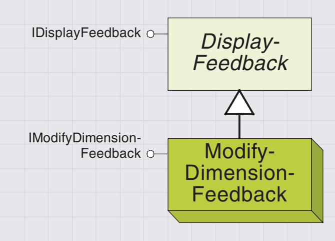
```
    ' Add the current mouse location (EndDimensionPoint)
    m_pNewDimFeed.AddPoint pPnt
    ' Stop the feedback and get the DimensionShape returned
    Set pDimShp = m_pNewDimFeed.Stop
    ' TODO: Now the result can be added to a Dimension FeatureClass
    ' Set the feedback to nothing for the next use
    Set m_pNewDimFeed = Nothing
  End If
```

This code is for the *Mouse_Move* event.

```
  ' Check that the user is currently using the feedback
  If Not m_pNewDimFeed Is Nothing Then
    Dim pMXDoc As IMxDocument
    Dim pPnt As IPoint
    Dim pDispFeed As IDisplayFeedback

    ' QI for MXDocument
    Set pMXDoc = ThisDocument
    ' Get the current mouse location in map units
    Set pPnt = pMXDoc.ActiveView.ScreenDisplay _
    .DisplayTransformation.ToMapPoint(x, y)
    ' QI for IDisplayFeedback and use this to move the feedback
    Set pDispFeed = m_pNewDimFeed
    pDispFeed.MoveTo pPnt
  End If
```

The *Style* property takes and returns an *IDimensionStyle* that determines how the feedback should be drawn when it is being used. If this property is not set, the default style is used. Typically, if you were to set this property, you would set it to match the dimension style of the *FeatureClass* (if a feature class is being used). For example, the following function retrieves the default *DimensionStyle* for the *Editor*'s current layer.

```
Private Function GetFCDefaultStyle() As IDimensionStyle
  ' This function assumes that the current
  ' edit layer is a Dimension FeatureClass

  Dim pEditLyrs As IEditLayers
  Dim pFClass As IFeatureClass
  Dim pDimClassExt As IDimensionClassExtension
  Dim StyleId As Integer

  Set pEditLyrs = Application.FindExtensionByName("ESRI Object Editor")
  Set pFClass = pEditLyrs.CurrentLayer.FeatureClass
  Set pDimClassExt = pFClass.Extension
  StyleId = pDimClassExt.DimensionStyles.DefaultStyleID
  Set GetFCDefaultStyle = pDimClassExt.DimensionStyles.GetStyle(StyleId)
End Function
```



You can use a ModifyDimensionFeedback *to change an existing* DimensionShape *by moving one of its handles:* BeginDimensionPoint, EndDimensionPoint, DimensionLinePoint, *or* TextPoint.

The *ModifyDimensionFeedback* coclass is similar to the *NewDimensionFeedback* in that it allows you to move a dynamic representation of a *Dimension* on the display and return the *DimensionShape* at the end of the operation. However, it differs in that it is used for editing an existing dimension shape object.

The *ModifyDimensionFeedback* coclass supports the *IModifyDimensionFeedback* and *IDisplayFeedback* interfaces and uses the latter for general feedback behavior—setting the *Display* and calling *MoveTo* and *Refresh*.

IModifyDimensionFeedback : IUnknown	*Provides access to memebers to control the display feedback for modifying existing dimension features.*
DimensionShape: IDimensionShape	*The Dimension shape*
DimensionType: esriDimensionType	*The dimension type of the display feedback.*
ReferenceScale: Double	*The reference scale of the display feedback.*
ReferenceScaleUnits: esriUnits	*The reference scale units of the display feedback.*
Style: IDimensionStyle	*The dimension style for the display feedback.*
GetHandles: IPointCollection	*The display feedback's handles.*
Start (in Handle: IPoint)	*Starts the feedback*
Stop: IDimensionShape	*Stops the feedback and returns the points.*

The *IModifyDimensionFeedback* shares several of the members of the *INewDimensionFeedback*, namely *DimensionType, ReferenceScale, ReferenceScaleUnits, Stop,* and *Style*. For information on these members, refer to the *INewDimensionFeedback* interface earlier in this chapter.

IModifyDimensionFeedback has the following members, which differ from *INewDimensionFeedback*: *DimensionShape, GetHandles,* and *Start*.

The *DimensionShape* property is used to specify the input dimension. It takes an *IDimensionShape* and needs to be set before starting the feedback operation.

Handle index	Meaning
0	BeginDimensionPoint
1	EndDimensionPoint
2	DimensionLinePoint
3	TextPoint

GetHandles returns an *IPointsCollection* representing all four of the editable points in the input *DimensionShape*. These points are the *BeginDimensionPoint, EndDimensionPoint, DimensionLinePoint,* and *TextPoint*. Note that this method can only be used once the *IDisplayFeedback::Display* property is set to a valid *IDisplay*.

The *Start* method allows the feedback method to commence and takes one of the *IPoint* objects from *GetHandles*. The behavior of the feedback depends on which member of the *PointsCollection* is used. For example, the following VB code fragment shows how a *ModifyDimensionFeedback* could be used to move the *EndDimensionPoint* of an existing *DimensionShape* by using the second *IPoint* returned from the *GetHandles* method.

The following code is extracted from the *Mouse_Down* event of a *UIToolControl* or *ITool*. *pModDimFeed* is a member variable declared as an *IModifyDimensionFeedback*, and *pDimShp* is locally declared as *IDimensionShape* representing an existing dimension that is being used as input to the feedback operation.

```
Dim pDispFeed As IDisplayFeedback
Dim pPtHndl As IPoint
Dim pMXDoc As IMxDocument
' QI for IMXdocument
Set pMXDoc = ThisDocument

' Create a new ModifyDimensionFeedback
Set m_pModDimFeed = New ModifyDimensionFeedback

' Set the ReferenceScale, ReferenceScaleUnits
m_pModDimFeed.ReferenceScale = 100000
m_pModDimFeed.ReferenceScaleUnits = esriMeters

' Set the DimensionType, and input DimensionShape
m_pModDimFeed.DimensionType = esriDimensionTypeAligned
Set m_pModDimFeed.DimensionShape = m_pDimShp

' QI for the IDisplayFeedback and set the Display
Set pDispFeed = m_pModDimFeed
Set pDispFeed.Display = pMXDoc.ActiveView.ScreenDisplay

' Now get the second handle (EndDimensionPoint)
Set pPtHndl = m_pModDimFeed.GetHandles.Point(1)

' Start the feedback operation to move the EndDimensionPoint
m_pModDimFeed.Start pPtHndl
```

Like the *INewDimensionFeedback* example in the previous section, the *Mouse_Move* event of the tool would be used to move the feedback by calling *MoveTo* on the associated *IDisplayFeedback* interface, and the operation would be completed by calling the *Stop* method to return an *IDimensionShape* representing the new shape.

6 Directing map output

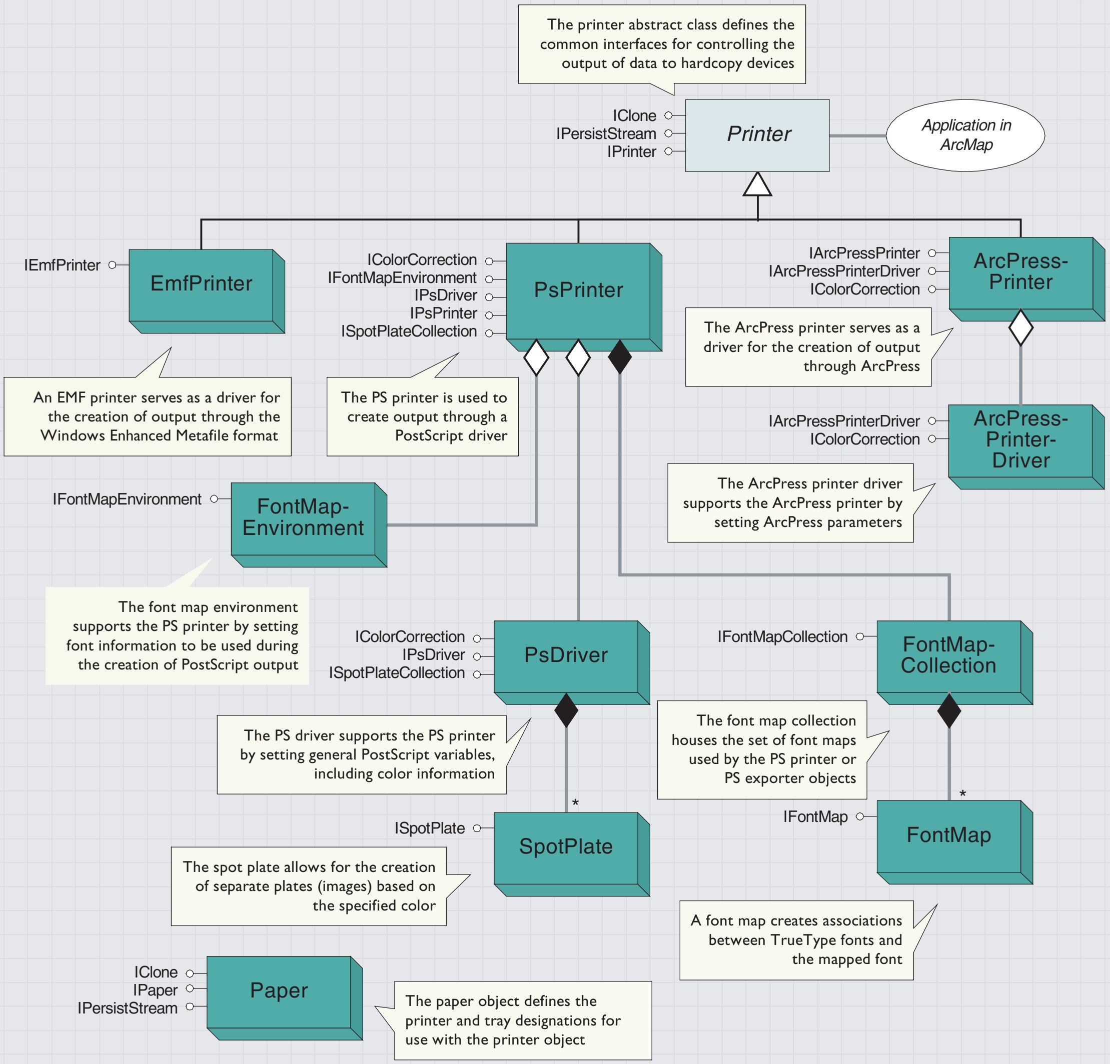
Larry Young

One of the primary tasks of a GIS professional is to make maps. The common requirement of these maps is to present information from geographic databases on a printed page. These printed maps range from large wall plots for display to smaller prints for inclusion into reports, magazines, and textbooks.

The ArcMap objects are used to display data and other information on the page; the Output objects are used to direct the information on that page to an output device or file.

This chapter discusses how to apply the Output objects to a hardcopy device—a plotter or printer—or to a file in formats such as JPEG, PostScript, and Enhanced Metafile. The two key Output objects are Printer, *which supports output to hardcopy devices, and* Exporter, *which controls output to a file. Files are used when the goal is to incorporate that information into another document or Web page.*

Printer objects



The printer abstract class defines the common interfaces for controlling the output of data to hardcopy devices

An EMF printer serves as a driver for the creation of output through the Windows Enhanced Metafile format

The PS printer is used to create output through a PostScript driver

The ArcPress printer serves as a driver for the creation of output through ArcPress

The ArcPress printer driver supports the ArcPress printer by setting ArcPress parameters

The font map environment supports the PS printer by setting font information to be used during the creation of PostScript output

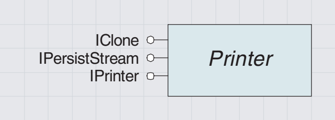
The PS driver supports the PS printer by setting general PostScript variables, including color information

The font map collection houses the set of font maps used by the PS printer or PS exporter objects

The spot plate allows for the creation of separate plates (images) based on the specified color

A font map creates associations between TrueType fonts and the mapped font

The paper object defines the printer and tray designations for use with the printer object



The Printer *abstract class specifies interfaces that control the output of data to hardcopy devices.*

Three printer objects inherit from the *Printer* abstract class: *EmfPrinter, ArcPressPrinter,* and *PsPrinter* object. Each object supports printing to a hardcopy device, but they all have different methods for achieving that goal.

The printer object you select to send output depends on the type of printing device you wish to use and what drivers you have available.

IPrinter : IUnknown	***Provides access to members that control the Printer Driver Interface.***
DriverName: String	*Indicates the name of Windows Printer Driver.*
FileExtension: String	*Indicates the File Extension associated with the Printer Driver.*
Filter: String	*Indicates the Filter used in CFileDialog.*
Name: String	*Indicates the Name of the IPrinter Driver.*
Paper: IPaper	*Provides access to members that control the IPaper interface.*
PrintableBounds: IEnvelope	*Indicates the area of the printer page that can be printed on.*
PrintToFile: String	*Indicates the named used for Print to File.*
Resolution: Integer	*Indicates the Printer Driver Resolution.*
SpoolFileName: String	*Indicates the Spool File Name which is from the Print Manager.*
StepProgressor: IStepProgressor	*Indicates that Updates to the Progress Bar is set.*
Units: esriUnits	*Indicates the units for PaperSize and PrintableBounds.*
DoesDriverSupportPrinter (in PrinterName: String) : Boolean	*Indicates if the Printer Name passed into function is supported by the IPrinter Driver.*
FinishPrinting	*Finishes Printing.*
QueryPaperSize (out Width: Double, out Height: Double)	*Returns the Page Size for the Printer.*
StartPrinting (in PixelBounds: IEnvelope, in hDcPrinter: Long) : Long	*Initializes Printing.*
VerifyDriverSettings: Boolean	*Indicates if the Printer Driver should validate the Printer Driver's local settings.*

The *IPrinter* interface is implemented by all printer objects.

The *Paper* property is initialized to the default printer of the system upon application startup. Create your own *Paper* object to use a different printer.

The *PrintToFile* property makes it possible to send output to a file.

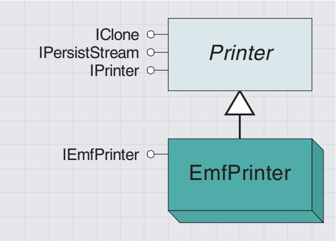
The *DoesDriverSupportPrinter* method allows the developer to determine if the specified printer can be used with the current driver object.

Use the *StartPrinting* method to return an hDC (handle to the device context of the printer) that can then be used with *IActiveView::Output* to send output to a printer. *IPrinter::FinishPrinting* should then be issued to flush everything out to the printer or plotter.

This sample VBA code demonstrates the use of the *EmfPrinter* object to produce output.

```
Public Sub PrintLayout ()
  'To test, add a layer to the map, and run procedure
  Dim pMxApp As IMxApplication
  Dim pMxDoc As IMxDocument
  Set pMxApp = Application
  Set pMxDoc = ThisDocument

  Dim pPrinter As IPrinter
  Dim pPaper As IPaper
  Dim pPageLayout As IPageLayout
  Set pPrinter = pMxApp.Printer
  Set pPrinter.Paper = pMxApp.Paper
  Set pPageLayout = pMxDoc.PageLayout

  Dim pActiveView As IActiveView
  Set pActiveView = pMxDoc.ActiveView

  Dim deviceframe As tagRECT
  Dim pDeviceFrame As IEnvelope

  ' Now set the printer object with the correct properties
  Set pDeviceFrame = New Envelope
  pPageLayout.Page.GetDeviceBounds pPrinter, 1, 0, pPrinter.Resolution, _
    pDeviceFrame
  deviceframe.Left = pDeviceFrame.xmin
  deviceframe.top = pDeviceFrame.ymin
  deviceframe.Right = pDeviceFrame.XMax
  deviceframe.bottom = pDeviceFrame.YMax

  ' Get the Visible Bounds if we are in Page Layout View
  Dim pVisibleBounds As IEnvelope
  Dim pPageLayoutView As IActiveView
  Set pPageLayoutView = pPageLayout
  If TypeOf pActiveView Is IPageLayout Then
    Set pVisibleBounds = New Envelope
    pPageLayout.Page.GetPageBounds pPrinter, 0, 0, pVisibleBounds
  End If

  Dim pEmfPrinter As IEmfPrinter
  Set pEmfPrinter = pPrinter

  ' Need to offset deviceBounds by xmin and ymin margins only for EmfPrinter
  If TypeOf pPrinter Is IEmfPrinter Then
    Dim pPrintableBounds As IEnvelope
    Set pPrintableBounds = pPrinter.PrintableBounds

    Dim dXmin As Double
    Dim dYmin As Double
    dXmin = pPrintableBounds.xmin
    dYmin = pPrintableBounds.ymin

    deviceframe.Left = deviceframe.Left - (dXmin * pPrinter.Resolution)
    deviceframe.top = deviceframe.top - (dYmin * pPrinter.Resolution)
    deviceframe.Right = deviceframe.Right - (dXmin * pPrinter.Resolution)
    deviceframe.bottom = deviceframe.bottom - (dYmin * pPrinter.Resolution)
  End If

  Dim lHDC As Long
  lHDC = pPrinter.StartPrinting(pDeviceFrame, 0)
  pActiveView.Output lHDC, pPrinter.Resolution, deviceframe, _
    pVisibleBounds, Nothing

  ' finishing the printing will flush everything out to the print spooler
  pPrinter.FinishPrinting
End Sub
```

EmfPrinter coclass



An EMF printer serves as a driver for the creation of output through the Windows Enhanced Metafile format.

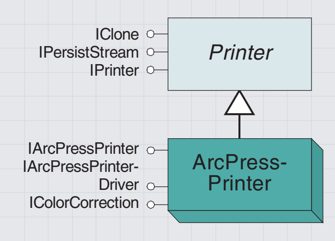
The *EmfPrinter* coclass is a type of printer object that serves as a driver for the Windows Enhanced Metafile format.

IEmfPrinter : IUnknown	*Provides access to members that control the EMF (Enhanced Windows Metafile) Printer Driver.*

IEmfPrinter is the only interface for the *EmfPrinter* coclass. The interface has no properties or methods; it is used to identify whether or not your printer object is of type *EmfPrinter*.

The following VBA code demonstrates that process. *pPrinter* is an object of type *IPrinter*.

```
If TypeOf pPrinter is IEmfPrinter then
  Dim pEmf as IEmfPrinter
  Set pEmf = pPrinter
End If
```



The ArcPress printer serves as a driver for the creation of output through ArcPress.

The *ArcPressPrinter* coclass is a type of printer object that represents the ArcPress™ printer driver.

ArcPress is ESRI's graphics rasterizer. ArcPress is composed of three basic modules: a graphics interpreter, a rasterizer, and several output filters.

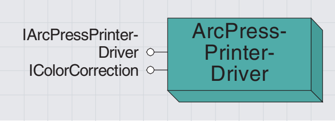
The graphics interpreter accepts PostScript files, CGM files, and all ESRI formats. The graphics interpreter translates the input to intermediate PostScript metafiles. The rasterizer then takes the intermediate files and converts them into a pure raster metafile. This raster metafile is then filtered through the printer driver or bitmap export driver (these are listed under the *Exporter* object) of your choice.

Do not attempt to use this object unless you have ArcPress installed on your system. The *ArcPressPrinter* coclass provides access to the driver but offers little control over the process. The *ArcPressPrinterDriver* (discussed next) can be used with the *ArcPressPrinter* object to set additional input parameters.

IArcPressPrinter : IUnknown	***Provides access to members that control the ArcPress printer driver.***
Driver: esriArcPressDriverPrinters	*Provides access to members that control the ArcPress Printer Driver.*

The *IArcPressPrinter* interface lets you identify a printer object as type *ArcPressPrinter*.

The lone property on the interface, *Driver*, allows you to set and retrieve which driver to use when outputting through ArcPress.



The ArcPress printer driver supports the ArcPress printer by setting ArcPress parameters.

ArcPressPrinterDriver is the coclass that does the work when you direct output through ArcPress. Through the supported interfaces on the object, you can set all the necessary parameters, from color to resolution, to ensure proper output from the ArcPress object. Use this object in conjunction with *ArcPressPrinter* when you want to control the parameters used by ArcPress to create hardcopy output.

IArcPressPrinterDriver: IUnknown	*Provides access to members that control the ArcPress printer driver formats.*
ArcPressSeparateImage: Boolean	*Indicates if the ArcPress Driver is using the Separate Image option.*
DitherDescription (in dither: esriArcPressDriverDithers) : String	*Indicates a description of the selected dither pattern.*
DitherDescriptionHelpText (in dither: esriArcPressDriverDithers) : String	*Indicates the help text description of the selected dither.*
DriverDescription (in Driver: esriArcPressDriverPrinters) : String	*Indicates a description of the ArcPress Printer Driver.*
DriverDescriptionHelpText (in Driver: esriArcPressDriverPrinters) : String	*Indicates the help text description of the ArcPress Printer Driver.*
DriverDither: esriArcPressDriverDithers	*Indicates the dither pattern of the ArcPress Printer Driver.*
DriverResolution (in Driver: esriArcPressDriverPrinters, in Index: Integer) : Integer	*Indicates the resolution of the selected ArcPress Printer Driver at the specified index.*
DriverResolutionCount (in Driver: esriArcPressDriverPrinters) : Integer	*Indicates the number of resolutions available for the selected ArcPress Printer Driver.*
InternalDriverName (in Driver: esriArcPressDriverPrinters) : String	*Indicates the internal ArcPress Printer Driver name.*
Orientation: Integer	*Indicates whether the page orientation is 1 = portrait or 2 = landscape.*
PaperSizeHeight: Double	*Indicates the height of the selected paper size.*
PaperSizeWidth: Double	*Indicates the width of the selected paper size.*
PrintableBounds: IEnvelope	*Indicates the Printer Margins.*
Resolution: Integer	*Indicates the resolution of the ArcPress Printer Driver.*
StepProgressor: IStepProgressor	*Indicates the progress bar to update.*
CreateRaster (in Driver: esriArcPressDriverPrinters, in InputFileName: String, in OutputFileName: String)	*Creates a Printer Format file from a PostScript input file.*

The *IArcPressPrinterDriver* interface sets a variety of input parameters for use with the ArcPress driver.

CreateRaster is used to create a printer format file based on an input PostScript file. The file that is created can then be sent to a plotter for output.

DitherDescription, DitherDescriptionHelpText, and *DriverDither* pertain to the method of dithering when the output device does not support as many colors as you are sending. Dithering refers to the display of colors, specifically, any color that should be solid but looks like it has small spots of another color. Use the *DriverDither* parameter to specify the type of dithering algorithm to apply when the output device does not support a sufficient number of colors (as is the case with a black-and-white printer).

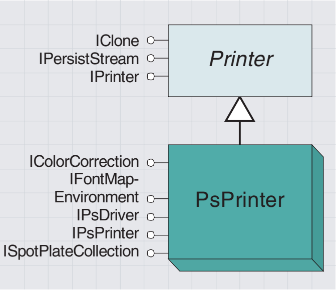
Use the *Resolution* and *PrintableBounds* properties with the *IActiveView::Output* statement to match the resolution and page size of the output to the device.

IColorCorrection : IUnknown	***Provides access to members that control the Color Correction Interface.***
■–■ CMYKCorrection (in dataType: esriColorCorrectionDataType, in Index: esriCMYKIndex) : Integer	*Indicates the Color Correction for the CMYK color model.*
■–■ Lightness (in dataType: esriColorCorrectionDataType) : Integer	*Indicates the Lightness Value of the HLS Color Model.*
■–■ Saturation (in dataType: esriColorCorrectionDataType) : Integer	*Indicates the Saturation Value of the HLS Color Model.*
■— SupportedColorCorrections: Integer	*Indicates the dataType supported: 1 Total, 2 Raster, and 4 Vector.*
■–■ UnderColorRemoval (in dataType: esriColorCorrectionDataType) : Integer	*Indicates the Under Color Removal Value.*

The *IColorCorrection* interface is implemented by the *ArcPressPrinterDriver* coclass and several other classes. It lets you manipulate the color parameters within the ArcPress driver through the CMYK and HLS models. Use this interface when you want to adjust the default color settings for the ArcPress driver.

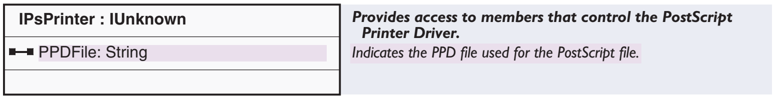
SupportedColorCorrections returns which data types are supported by the current object. The other properties use this value as input, so it is good practice to check this value before trying to access any other values.

PsPrinter coclass



The PsPrinter *is used to create output through a PostScript driver.*

The *PsPrinter* coclass is a type of printer object used to create output through a PostScript device driver. The coclass is an aggregation of the *PsDriver* and *FontMapEnvironment* classes. Use this coclass when you want to create hardcopy output through a PostScript driver.



IPsPrinter : IUnknown — ***Provides access to members that control the PostScript Printer Driver.***

PPDFile: String — *Indicates the PPD file used for the PostScript file.*

The *IPsPrinter* interface allows you to identify a printer object as type *PsPrinter* and allows for the setting of a filename to receive output (as opposed to sending output directly to a hardcopy device).

The VBA code that follows sends map data to an output device using the *PsPrinter* and *Printer* objects. The *ConvertRWToPixels* routine converts from the current units to pixels.

```
Dim pPsPrinter As IPsPrinter
Dim pPrinter As IPrinter
Dim lScreenResolution As Long
Dim hDc As OLE_HANDLE
Dim userRECT As tagRECT
Dim pMxDoc As IMxDocument
Dim pPaper As IPaper
Dim lDrvResolution As Long
Dim pMxApp As IMxApplication
Dim pDriverBounds As IEnvelope, pEnv As IEnvelope

Set pMxApp = Application
Set pMxDoc = ThisDocument
Set pPsPrinter = New PsPrinter
Set pPrinter = pPsPrinter
Set pPrinter.Paper = pMxApp.Paper

lScreenResolution = _
  pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation.Resolution
lDrvResolution = lScreenResolution
pPrinter.Resolution = ldrvResolution

Set pEnv = pMxDoc.ActiveView.Extent
userRECT.Top = 0
userRECT.Left = 0
userRECT.Right = ConvertRWToPixels(pEnv.Width)
userRECT.bottom = ConvertRWToPixels(pEnv.Height)

Set pDriverBounds = New Envelope
pDriverBounds.PutCoords userRECT.Left, userRECT.bottom, _
                        userRECT.Right, userRECT.Top
hDc = pPrinter.StartPrinting(pDriverBounds, 0)
pMxDoc.ActiveView.Output hDc, lScreenResolution, userRECT, pEnv, Nothing
pPrinter.FinishPrinting
```

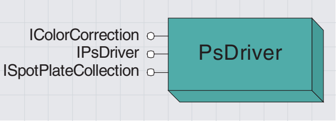
ISpotPlateCollection : IUnknown	***Provides access to members that control the Collection of Spot Plates.***
■— Count (Count: Long)	*Indicates the count of the Spot Plate collection.*
■— SpotPlate (Index: Long, SpotPlate: ISpotPlate)	*Indicates an ISpotPlate from the Spot Plate collection.*
← Add (SpotPlate: ISpotPlate)	*Adds an ISpotPlate to the Spot Plate collection.*
← Insert (Index: Long, SpotPlate: ISpotPlate)	*Inserts an ISpotPlate into the Spot Plate collection at position index.*
← Remove (Index: Long)	*Removes ISpotPlate at index from the Spot Plate collection.*
← RemoveAll	*Removes all ISpotPlates from the Spot Plate collection.*

Spot plates are used for color separation to produce CMYK plates.

The *ISpotPlateCollection* makes it possible to create plates based on the individual colors in the CMYK color model. The plates can then be used by publishers in the generation of printed material.

The *ISpotPlateCollection* interface contains a collection of individual *SpotPlate* objects. You can use this interface to add, remove, and generally keep track of the *SpotPlate* objects that have been defined. For more information, see the topic *SpotPlate* and *FontMapEnvironment* later in this chapter.

The *IFontMapEnvironment* interface is documented with the *FontMapEnvironment* coclass.



The PsPrinter *is used to create output through a PostScript driver.*

The *PSDriver* coclass, along with *FontMapEnvironment*, is aggregated into the *PsPrinter* coclass. This class provides access to all of the different parameters that can be set when outputting through a PostScript driver (excluding *Font* control).

Since the *PsPrinter* coclass aggregates the *PSDriver* coclass, the interfaces from *PSDriver* can be accessed from the *PsPrinter*.

For example, if you have an object named *pPsPrinter* defined as an *IPSPrinter*, the following VBA code allows you to access the *IPsDriver* interface on the *PSDriver* coclass.

```
Dim pPsDriver as IPSDriver
Set pPsDriver = pPsPrinter
```

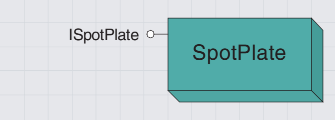
IPSDriver : IUnknown	***Provides access to members that control the PostScript Driver.***
ArcPressSeparateImage: Boolean	*Indicates the ArcPress Separate Image File flag to create a separate Image file for ArcPress.*
ArcPressSeparateImageRotate: Boolean	*Indicates the ArcPress Separate Image Rotate flag to Rotate Image 90 degress for ArcPress.*
Emulsion: esriPSDriverEmulsion	*Indicates the Emulsion setting for the PostScript Driver.*
FontMapCollection: IFontMapCollection	*Provides access to members that control the Font Map Collection for Font Mapping.*
FormName: String	*Indicates the printer page form. Uses Win32 DMPAPER_xxx constants.*
HalfTone (in HalfTone: esriPSDriverHalfTone) : Long	*Indicates the HalfTone DPI / LPI is being used.*
Image: esriPSDriverImage	*Indicates whether the Image setting for the PostScript Driver is Positive or Negative.*
ImageCompression: esriPSDriverImageCompression	*Provides access to members that control the Image Compression of the PostScript Driver.*
Marks: Integer	*Indicates if the PostScript Marks are being used.*
OneBitImageTransparency: Boolean	*Indicates the 1 Bit Image Transparency setting for the PostScript Driver.*
Orientation: Integer	*Indicates whether the printer page orientation is either 1 = portrait or 2 = landscape.*
PPDFile: String	*Indicates the PPD file to be used.*
PrintableBounds: IEnvelope	*Indicates the printers Printable Bounds that are used for Marks.*
PSLanguageLevel: esriPSDriverPSLanguageLevel	*Indicates the PostScript Driver Language Level.*
StepProgressor: IStepProgressor	*Indicates that the PostScript Driver will update a Progress Bar.*
UseEMFFrameBoxForPSBoundingBox: Boolean	*Indicates the PostScript Driver to use the ENHMETAHEADER rclFrame instead of rclBounds for the PostScript Bounding Box.*
CreatePS (in InputFileName: String, in OutputFileName: String)	*Indicates the Conversion of the EMF file to a EPS File.*

Through aggregation, the *IPSDriver* interface is also supported by the *PsPrinter* object. The interface provides access to the set of parameters that can be used to alter the output being produced by the PostScript driver.

The *ArcPressSeparateImage* and *ArcPressSeparateImageRotate* properties can be used to create separate images for use with ArcPress.

CreatePS takes an EMF file as input and outputs a PostScript file.

The *IColorCorrection* interface is documented with the *ArcPressPrinterDriver* coclass.



The spot plate allows for the creation of separate plates (images) based on the specified color.

The *SpotPlate* coclass allows for the creation of separate plates (images) based on the specified color. Each plate contains the plotting information for a single specified color.

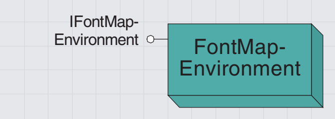
The *SpotPlate* objects are managed by the *ISpotPlate* interface object on the *PSDriver* coclass. Use this coclass when you need to create color separates of your plots for publishing purposes.

ISpotPlate : IUnknown	***Provides access to members that control the Spot Color Plate.***
Color: IPostScriptColor	*Indicates the Color for Separation.*
ScreenAngle: Double	*Indicates the Screen Angle for the Separation.*
Separate: esriPSDriverSeparates	*Indicates that the Separation will be used.*

ISpotPlate is the only interface supported by the *SpotPlate* coclass. This interface allows specification of the color separation (cyan, yellow, magenta, or black) to create with the PostScript driver.

The *Color* property takes an *IPostScriptColor* object, which sets saturation and overprint parameters for the separation.

Enumeration esriPSDriverSeparates	***Provides access to members that control the PostScript Driver Color Separation settings.***
1 - esriPSDriverSeparateCyan	*Provides access to members that control the Cyan Plate.*
2 - esriPSDriverSeparateMagenta	*Provides access to members that control the Magenta Plate.*
3 - esriPSDriverSeparateYellow	*Provides access to members that control the Yellow Plate.*
4 - esriPSDriverSeparateBlack	*Provides access to members that control the Black Plate.*
5 - esriPSDriverSeparateCustom	*Provides access to members that control the Custom Spot Color Plate.*



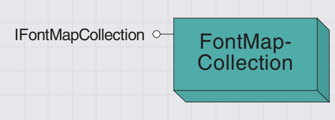
The font map environment supports the PS printer by setting font information to be used during the creation of PostScript output.

The *FontMapEnvironment* coclass is one of the aggregated coclasses (along with *PSDriver*) that make up the *PsPrinter* coclass. The object is used to determine the set of fonts used by the PostScript driver to produce the desired output.

IFontMapEnvironment : IUnknown	***Provides access to members that control the Font Mapping Environment.***
ApplyDefaultMappingDesc: String	*Indicates the Font Mapping checkbox description string.*
DefaultMapping: String	*Indicates the Default Font Mapping string.*
DefaultMappingsChoices: Variant	*Indicates the Default Mapping Choices for Font Substitution.*
FontMapCollection: IFontMapCollection	*Provides access to members that control the FontMap Collection.*
SaveMappings: Boolean	*Indicates whether to save font mappings.*

The *IFontMapEnvironment* interface tracks the collection of *FontMap* objects that have been defined and allows for additional settings for the default font mapping to use with the PostScript driver. Use this interface when you want to control the set of fonts used by the PostScript driver.

The *FontMapCollection* property returns a collection object to allow the developer to add and remove *FontMap* objects. Since the *FontMapCollection* property is read-only, you cannot create your own *FontMapCollection* object; you must instead manipulate the existing one.



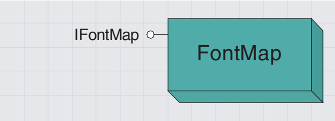
The font map collection houses the set of font maps used by the PS printer or PS exporter objects.

The *FontMapCollection* is a collection object whose life cycle is tied to that of the object that created it, such as *PsPrinter* or *PsExporter*. This object controls the set of *FontMap* objects defined for use with the PostScript driver. An object of this type is returned by *IFontMapEnvironment::FontMapCollection*. Use this object to make your adjustments to the font mapping environment.

By default, the collection returned by *IFontMapEnvironment::FontMapCollection* will have some values in it. These default values are defined by the system. You can then add additional *FontMap* objects to the collection.

IFontMapCollection : IUnknown	***Provides access to members that control the Collection of Font Map Objects.***
■— Count: Long	*Indicates the count of the FontMap collection.*
■— FontMap (in Index: Long) : IFontMap	*Indicates an IFontMap from the FontMap collection.*
← Add (in FontMap: IFontMap)	*Adds an IFontMap to the FontMap collection.*
← Insert (in Index: Long, in FontMap: IFontMap)	*Inserts an IFontMap into the FontMap collection at position index.*
← Remove (in Index: Long)	*Removes IFontMap at index from the FontMap collection.*
← RemoveAll	*Removes all IFontMaps from the FontMap collection.*

IFontMapCollection is the only interface implemented by the *FontMapCollection* object. This interface is a typical collection interface that allows *FontMap* objects to be added and removed from the collection. The interface also provides a count of and access to the individual objects contained in the collection.



A font map creates associations between TrueType™ fonts and the mapped font.

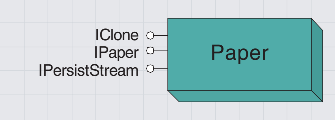
FontMap objects are created for inclusion in a *FontMapCollection* object. The life cycle of the *FontMap* object is based on the life cycle of the *FontMapCollection* object (which, in turn, has its life cycle based on that of the object that created it). The purpose of the object is to allow for the setting of font mapping properties for individual fonts. These properties are then used by the PostScript driver to create the hardcopy output.

Objects of this type are creatable, but the developer does not have the ability to set the necessary parameters for the object that is created.

IFontMap : IUnknown	***Provides access to members that control the Font Map Object.***
■— MappedFont: String	*Creates an association between the True Type Font and the Mapped Font.*
—■ Mapping (in TrueTypeFont: String) : String	*Creates an association between the True Type Font and the Mapped Font.*
■— TrueTypeFont: String	*Creates an association between the True Type Font and the Mapped Font.*

IFontMap is the only interface implemented by the *FontMap* object. This interface allows the developer to examine the font mapping that has been defined. The C++ programmer can define additional mapping through the *IFontMap::Mapping* property. The VB programmer will need to use the *IFontMap2::SetMapping* method to define additional font mapping.

IFontMap2 : IUnknown	***Provides access to members that control the Font Map 2 Object.***
← SetMapping (in TrueTypeFont: String, in MappedFont: String)	*Creates an association between the True Type Font and the Mapped Font.*



The paper object defines the printer and tray designations to use with the printer object.

The *Paper* object is a key object required by the *Printer* object. The *Paper* object is responsible for maintaining properties related to the paper and printer used with the *Printer* object.

When the application is started, a *Paper* object is automatically created based on the default printer for the system. To use another printer on the system, you must define a new *Paper* object and set it to the printer or plotter through the *PrinterName* property. The *Paper* object can then be associated with the *Printer* object through the *IPrinter::Paper* property.

The *Paper* object is basically a wrapper for the Microsoft *DevMode* and *DevNames* parameters. These two operating system wrappers define the printing environment through application programming interface (API) structures.

The *DevNames* structure contains strings that identify the driver, device, and output port names for a printer. The *DevMode* data structure contains information about the device initialization and environment of a printer.

The *PrinterInfo* property and *Attach* method use these structures in the form of pointers to OLE_HANDLEs. Because of the nature of these two parameters, VB developers cannot take advantage of them.

The following VBA code demonstrates how to create a *Paper* object, assign it to a particular device, then pass that object to a printer object.

```
Dim pPaper As IPaper
Dim pPrinter As IPrinter
Dim pPsPrinter As IPsPrinter

Set pPaper = New Paper
pPaper.PrinterName = "\\OMNI\Oakland"
Set pPsPrinter = New PsPrinter
Set pPrinter = pPsPrinter
Set pPrinter.Paper = pPaper
```

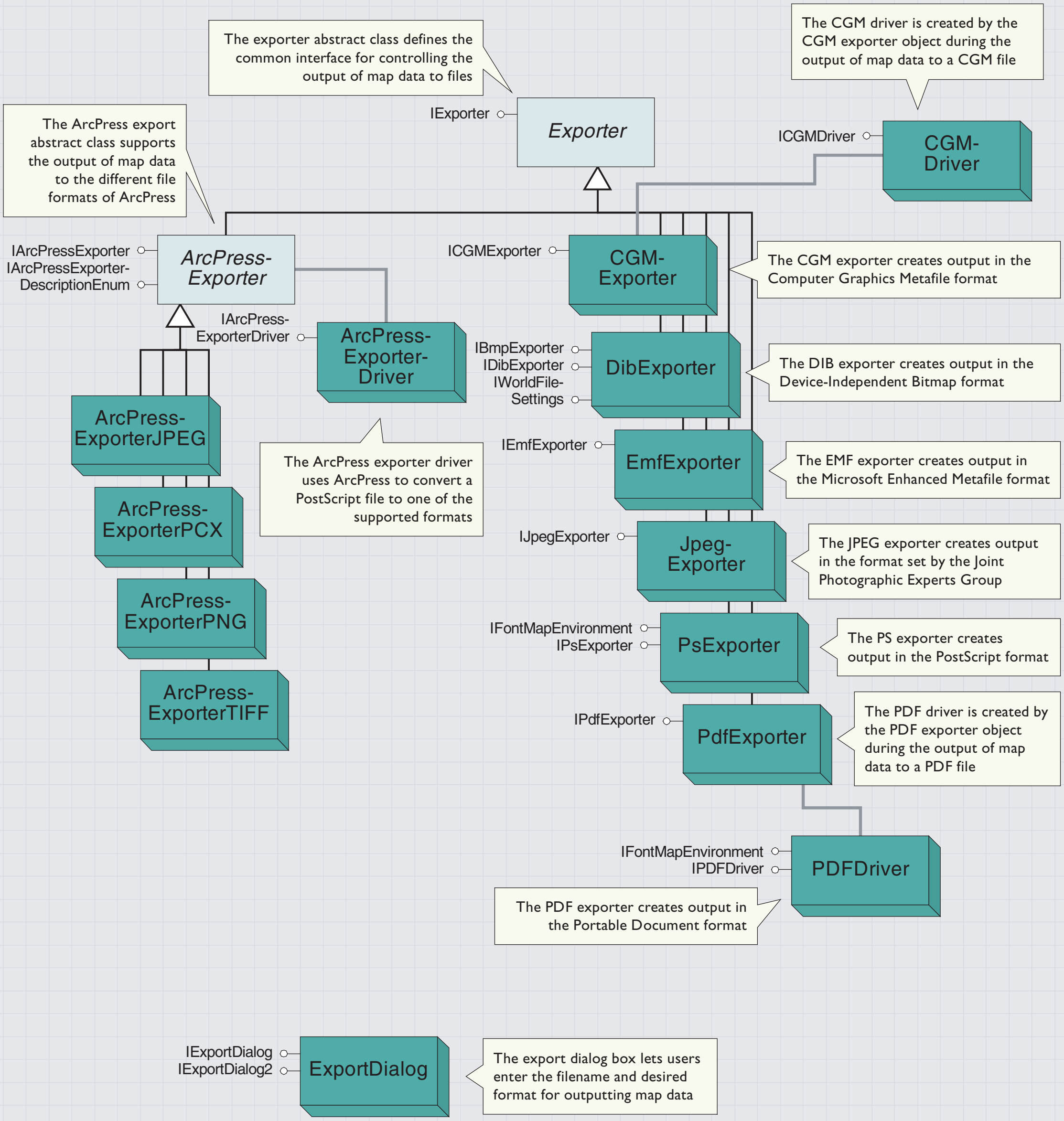
IPaper : IUnknown	***Accesses the default printer page settings.***
FormID: Integer	*Indicates the printer page form. Uses Win32 DMPAPER_xxx constants.*
FormName (FormName: String)	*Gets the Form Name.*
Forms: IEnumNamedID	*Enumerates the forms supported by the printer.*
Orientation: Integer	*Indicates whether the printer page orientation is 1 = portrait or 2 = landscape.*
PrintableBounds: IEnvelope	*Indicates the area of the printer page that can be printed on.*
PrinterInfo (out hDevMode: Long) : Long	*Displays the Print Setup Dialog.*
PrinterName: String	*Indicates the Printer Name.*
TrayID: Integer	*Indicates the printer tray. Uses Win32 DMBIN_xxx constants.*
Trays: IEnumNamedID	*Enumerates the trays supported by the printer.*
Units: esriUnits	*Indicates the units used by the other properties.*
Attach (in hDevMode: Long, in hDevNames: Long)	*Attaches an object to specified DEVMODE and DEVNAMES structures. This must be called before using other properties and methods.*
QueryPaperSize (out Width: Double, out Height: Double)	*Returns the size of the printer paper. The units property specifies the measurement units.*

The *IPaper* interface allows the developer to create an association between the *Paper* object and the hardcopy device. Once that association is created, form and paper properties can be retrieved and set through the interface.

Use the *PrinterName* property to specify which printer you want to use with the *Paper* object (see the coding example on the previous page).

The *PrinterInfo* property returns the information that serves as input to the *Attach* method. However, the parameters returned by *PrinterInfo* are not handled correctly by Visual Basic at this time. Do not try to use the *PrinterInfo* property with Visual Basic.

Exporter objects



The exporter abstract class defines the common interface for controlling the output of map data to files

The CGM driver is created by the CGM exporter object during the output of map data to a CGM file

The ArcPress export abstract class supports the output of map data to the different file formats of ArcPress

The CGM exporter creates output in the Computer Graphics Metafile format

The DIB exporter creates output in the Device-Independent Bitmap format

The ArcPress exporter driver uses ArcPress to convert a PostScript file to one of the supported formats

The EMF exporter creates output in the Microsoft Enhanced Metafile format

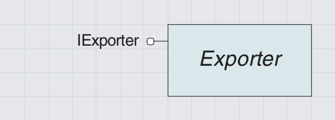
The JPEG exporter creates output in the format set by the Joint Photographic Experts Group

The PS exporter creates output in the PostScript format

The PDF driver is created by the PDF exporter object during the output of map data to a PDF file

The PDF exporter creates output in the Portable Document format

The export dialog box lets users enter the filename and desired format for outputting map data

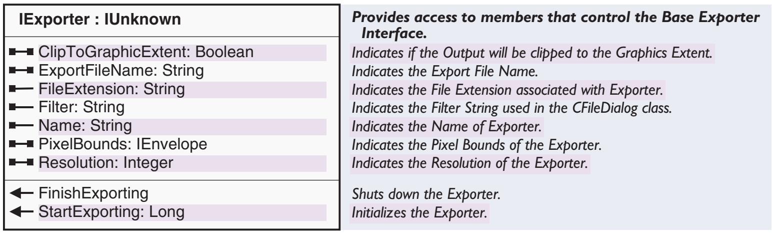


The exporter abstract class defines the common interface for controlling the output of map data to files.

The *Exporter* object class controls the production of softcopy output (files of different formats). The main purpose of the object is to support the coclasses underneath it.

There are seven file formats supported through specific drivers (DIB, CGM, EMF, JPEG, PostScript, PDF, and TIFF), and four formats supported through the ArcPress driver (JPEG, PCX, PNG, and TIFF). Each of these creatable subclasses inherits from the *Exporter* object.

It is possible to create file output from the descendants of the *Printer* abstract class, but you should only use this method when you plan to send the file to an output device at a later time. The printer objects create some printer-dependent files that you do not need unless you are going to direct the file to an output device.



IExporter : IUnknown	*Provides access to members that control the Base Exporter Interface.*
ClipToGraphicExtent: Boolean	*Indicates if the Output will be clipped to the Graphics Extent.*
ExportFileName: String	*Indicates the Export File Name.*
FileExtension: String	*Indicates the File Extension associated with Exporter.*
Filter: String	*Indicates the Filter String used in the CFileDialog class.*
Name: String	*Indicates the Name of Exporter.*
PixelBounds: IEnvelope	*Indicates the Pixel Bounds of the Exporter.*
Resolution: Integer	*Indicates the Resolution of the Exporter.*
FinishExporting	*Shuts down the Exporter.*
StartExporting: Long	*Initializes the Exporter.*

The *IExporter* interface is supported by all of the exporter objects, such as *CGMExporter*. The interface provides all the common parameters (such as filename and resolution) needed to export map data to a file. It will be necessary to use this interface to complete any exporting procedures.

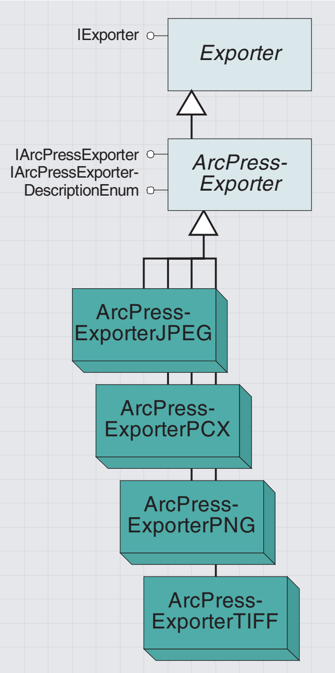
The *FileExtension, Filter,* and *Name* properties are based on the type of exporter object you create. For example, if you create a *JpegExporter* object, the *FileExtension* will be ".jpg".

PixelBounds specifies a destination rectangle in the output file.

StartExporting must be run during an exporting procedure, and it returns an hDC value that should be used with subsequent *IActiveView::Output* operations.

Here is some sample VBA code for using the *IExporter* interface through a *JpegExporter* object.

```
Sub Export()
  Dim pExporter As IExporter
  Dim pDriverBounds As IEnvelope
  Dim lScreenResolution As Long
  Dim hDc As OLE_HANDLE
  Dim userRECT As tagRECT
  Dim pMxDoc As IMxDocument
  Dim pActive As IActiveView
  Dim pEnv As IEnvelope

  Set pMxDoc = ThisDocument
  Set pEnv = pMxDoc.ActiveView.Extent

  lScreenResolution = _
    pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation.Resolution

  Set pExporter = New JpegExporter
  pExporter.ExportFileName = "C:\temp\ArcMapExport.jpg"
  pExporter.Resolution = lScreenResolution

  userRECT.top = 0
  userRECT.Left = 0
  userRECT.Right = ConvertRWToPixels(pEnv.Width)
  userRECT.bottom = ConvertRWToPixels(pEnv.Height)

  Set pDriverBounds = New Envelope
  pDriverBounds.PutCoords userRECT.Left, _
                          userRECT.bottom, _
                          userRECT.Right, _
                          userRECT.top
  pExporter.PixelBounds = pDriverBounds
  hDc = pExporter.StartExporting

  pMxDoc.ActiveView.Output hDc, lscreenResolution, userRECT, pEnv, Nothing
  pExporter.FinishExporting
End Sub

Private Function ConvertRWToPixels(RWUnits As Double) As Double
  Dim realWorldDisplayExtent As Double
  Dim pixelExtent As Long
  Dim sizeOfOnePixel As Double
  Dim pDT As IDisplayTransformation
  Dim deviceRECT As tagRECT
  Dim pEnv As IEnvelope
  Dim pMxDoc As IMxDocument

  Set pMxDoc = ThisDocument

  Set pDT = pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation
  deviceRECT = pDT.DeviceFrame
  pixelExtent = deviceRECT.Right - deviceRECT.Left
  Set pEnv = pDT.VisibleBounds

  realWorldDisplayExtent = pEnv.Width
  sizeOfOnePixel = realWorldDisplayExtent / pixelExtent
  ConvertRWToPixels = RWUnits / sizeOfOnePixel
End Function
```



The ArcPress export abstract class supports the output of map data to the different file formats of ArcPress.

The *ArcPressExporter* abstract class supports the file formats that are supported through the ArcPress driver, which are JPEG, PCX, PNG, and TIFF.

IArcPressExporter: IUnknown	***Provides access to members that control the ArcPress Exporter Driver.***
■─■ Driver: esriArcPressDriverExporters	*Indicates the Driver for the ArcPress Exporter.*
■─■ DriverResolution: Integer	*Indicates the ArcPress Printer Driver Resolution.*

The *IArcPressExporter* interface is supported by all of the ArcPress coclasses that produce output files through the ArcPress driver. The purpose of this interface is to provide generic properties (*Driver* and *DriverResolution*) for the ArcPress driver.

The *Driver* property sets or retrieves the output option for the type of driver you have. Use *IExporter::Name* to determine the type of object you have, then use the *Driver* property to determine the format option within the output object.

IArcPressExporterDescriptionEnum : IUnknown	***Provides access to an enumeration of descriptions of ArcPress Exporters.***
← NextDescription (out pDriver: esriArcPressDriverExporters, out driverDesc: String)	*Returns an ArcPress Export Driver description.*
← Reset	*Resets the enumerator.*

The *IArcPressExporterDescriptionEnum* interface is also supported by all of the file format-specific ArcPress drivers. This interface provides an enumeration of the supported file formats for the specific object.

For example, if you have an *ArcPressExporterTiff* object, then the enumeration will include the supported TIFF formats (*TIFF3_BW, TIFF4_BW,* and *TIFF6_RGB*). This interface would commonly be used when the developer wished to create a dialog box to allow the user to specify the type of output desired. To do this, choose between the object types (JPEG, PCX, PNG, and TIFF), then use this interface to display the available options within that format.

The *NextDescription* method returns a driver that can be plugged into the *IArcPressExporter::Driver* property to produce output in the desired format.

Each of these ArcPress coclasses—*ArcPressExporterJPEG, ArcPressExporterPCX, ArcPressExporterPNG,* and *ArcPressExporterTIFF*—are used to create output files in the respective formats. They only support the interfaces inherited from the *Exporter* and *ArcPressExporter* abstract classes. Use the *IExporter::Name* property to determine if you have a class of this type.

This is a summary of each of the formats supported by ArcPress:

Tag Image File Format (TIFF), developed by Aldus® Corporation, is an industry standard for data storage and data transfer across operating system environments and applications. It is one of the most versatile bitmaps available. At this time, ArcPress supports groups 3 and 4, which use CCITT Encoding for compression to encode 1-bit image data. The

TIFF 3 and TIFF 4 formats provide an excellent format for the transmission of high-quality monochrome images in modem and facsimile protocol used in machines and modems. TIFF 6 is an uncompressed group 6 for 24-bit RGB color images. ArcPress can generate:

- 1-bit (Monochrome)—Group 3 TIFF
- 1-bit (Monochrome)—Group 4 TIFF
- 24-bit (True Color)—Group 6 TIFF

The Joint Photographic Experts Group (JPEG) is a combined committee of researchers from ISO and ANSI. Their goal is to set industry standards "for the transmission of graphics and image data over digital communications networks." Their result is "a compression method that is capable of compressing continuous-tone image data with pixel depth of 6 to 24 bits with reasonable speed and efficiency." (*Encyclopedia of Graphics File Formats*, 1994). The ArcPress-created JPEG format does not have any legal restrictions.

ArcPress can generate:

- 8-bit (Grayscale) JPEG
- 24-bit (True Color) JPEG

PCX (PC Paintbrush File Format), developed by Z-soft, also known as DCX and PCC, is a common exchange and storage format for MS–DOS® and Microsoft Windows applications. It is used with PC Paintbrush and Microsoft Paintbrush for Windows. It is also commonly used for clip art in many desktop publishing applications. PCX provides hardware-dependent formats designed for specific types of display hardware. Image data is compressed using a variation of Run Length Encoding (RLE), which is quick and efficient at file size reduction.

ArcPress can generate:

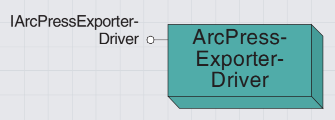
- 1-bit (Monochrome) PCX
- 8-bit (Grayscale) PCX
- 8-bit (256 Colors) PCX
- 24-bit (True Color) PCX

The Portable Network Graphics (PNG) format was originally developed to replace GIF to overcome the legal entanglements of the LZW compression scheme; it is rising in popularity. The PNG, or "ping", format provides several useful features that include stream ability, progressive display, and 100 percent loss-less compression. PNG is also completely hardware and platform independent.

ArcPress can generate:

- 1-bit (Monochrome) PNG
- 8-bit (Grayscale) PNG
- 8-bit (256 Colors) PNG
- 24-bit (True Color) PNG

ArcPressExporterDriver coclass

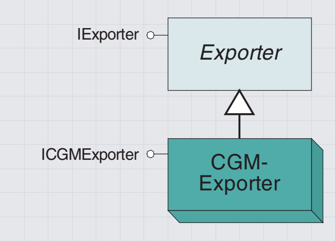


The ArcPress exporter driver uses ArcPress to convert a PostScript file to one of the supported formats.

The *ArcPressExporterDriver* class is a standalone class (does not inherit from any other class) used to convert a PostScript file to one of the supported ArcPress file formats. This object is cocreated internally by the core functionality as part of the output process through the ArcPress drivers.

IArcPressExporterDriver: IUnknown	***Provides access to members that control the ArcPress exporter driver formats.***
■━■ Resolution: Integer	*Indicates the Resolution of the ArcPress Exporter Driver.*
← CreateRaster (in Driver: esriArcPressDriverExporters, in InputFileName: String, in OutputFileName: String)	*Creates an Export Format file from the PostScript input file.*

The purpose of the *IArcPressExporterDriver* interface is to allow you to set a resolution, then use the *CreateRaster* method to convert a PostScript file to one of the supported ArcPress file formats (JPEG, PCX, PNG, and TIFF).



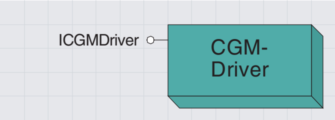
The CGM exporter creates output in the Computer Graphics Metafile format.

The *CgmExporter* coclass creates output files in the Computer Graphics Metafile (CGM) format. Create an object of this type when you want to generate your map output as a CGM file. The *CgmExporter* coclass internally cocreates the *CgmDriver* coclass. The *CgmDriver* coclass does all the work in producing an output file in the CGM format.

ICGMExporter : IUnknown	***Provides access to members that control the CGM (Computer Graphics Metafile) Exporter Interface.***
← QueryCGMDriver: ICGMDriver	*Returns Interface ICGMDriver.*

The *ICgmExport* interface provides the ability to query for the CGM driver being used with the object. The *CgmDriver* object can then be used to set additional parameters to use when outputting to the CGM format.

The *CgmDriver* coclass is creatable by the developer, but it is also internally created by the *CgmExporter* object. The *CgmDriver* object does all the work in producing CGM files as output.



The CGM driver is created by the CGM exporter object during the output of map data to a CGM file.

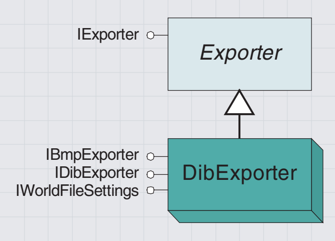
ICGMDriver : IUnknown	***Provides access to members that control the CGM (Computer Graphics Metafile) Driver.***
■-■ CGMProfile: esriCGMProfile	*Indicates the CGM profile.*
■-■ CGMVersion: esriCGMVersion	*Indicates the CGM version.*
■-■ PolygonizeText: Boolean	*Indicates whether text is to be converted to polygons.*
← CreateCGM (in InputFileName: String, in OutputFileName: String)	*Indicates the Conversion of the EMF file to a CGM File.*

ICGMDriver is the only interface supported by the *CgmDriver* coclass. This interface allows the developer to set additional parameters before outputting map data to the CGM format.

CreateCGM requires the input of an EMF file to produce the CGM output file. The developer can avoid having to create the EMF file by using the *CgmExporter* object (and the inherited *IExporter* interface) to generate output.

This is some VBA code for exporting through the *CGMExporter* object. The *ConvertRWToPixels* routine can be found with the *IExporter* sample code.

```
Sub CGMExport()
  Dim pExporter As IExporter, pCGMDriver As ICGMDriver
  Dim pDriverBounds As IEnvelope, pCGMExporter As ICGMExporter
  Dim screenResolution As Long
  Dim hDc As OLE_HANDLE
  Dim userRECT As tagRECT
  Dim pMxDoc As IMxDocument
  Dim pActive As IActiveView
  Dim pEnv As IEnvelope

  Set pMxDoc = ThisDocument
  Set pEnv = pMxDoc.ActiveView.Extent

  screenResolution = _
    pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation.Resolution
  Set pExporter = New CGMExporter
  pExporter.ExportFileName = "C:\temp\ArcMapExport2.cgm"
  pExporter.Resolution = screenResolution
  Set pCGMExporter = pExporter
  Set pCGMDriver = pCGMExporter.QueryCGMDriver
  pCGMDriver.PolygonizeText = True

  userRECT.top = 0
  userRECT.Left = 0
  userRECT.Right = ConvertRWToPixels(pEnv.Width)
  userRECT.bottom = ConvertRWToPixels(pEnv.Height)

  Set pDriverBounds = New Envelope
  pDriverBounds.PutCoords userRECT.Left, userRECT.bottom, _
                          userRECT.Right, userRECT.top
  pExporter.PixelBounds = pDriverBounds
  hDc = pExporter.StartExporting

  pMxDoc.ActiveView.Output hDc, screenResolution, userRECT, pEnv, Nothing
  pExporter.FinishExporting
End Sub
```



The DIB exporter creates output in the device-independent bitmap format.

The *DibExporter* coclass creates output files in the DIB (device-independent bitmap) format. BMP files store graphics in the DIB format; the default file extension for this object type is .bmp. Create an object of this type when you want to generate your map as a BMP file.

The *IExporter::Resolution* property cannot be set when using an object of this type.

IDibExporter : IUnknown	***Provides access to members that control the DIB (Windows Device Independent Bitmap) Exporter Interface.***
BackgroundColor: IColor	*Indicates the background color of the DIB.*
BitsPerPixel: Integer	*Indicates the color depth of the DIB.*
HDIB: Long	*Indicates the Handle to in-memory DIB. Valid only after ReleaseDC has been called.*
Height: Integer	*Indicates the height of the DIB. If width or height is zero, screen size is used.*
IsInMemory: Boolean	*Indicates if the bitmap should be written to memory. If false, file writes to Path specified. If true, uses HDIB to get the memory handle after ReleaseDC has been called.*
Width: Integer	*Indicates the width of the DIB. If width or height is zero, screen size is used.*

IDibExporter is implemented only by the *DibExporter* coclass and the only object that implements this interface. This interface provides DIB- or BMP-specific properties the developer can set before outputting map data to files in this format.

IBmpExporter : IUnknown	***Provides access to members that control the BMP (Bitmap) Exporter Interface.***
Bitmap: Long	*Indicates the Windows Bitmap handle.*
Palette: Long	*Indicates the Windows Bitmap color palette.*

The *IBmpExporter* interface provides access to the OLE_Handles used during the export process. These handles can be used to send additional information to the BMP file.

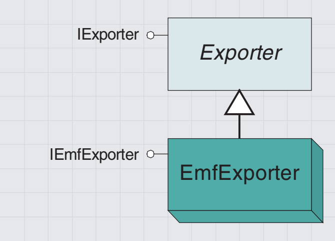
IWorldFileSettings : IUnknown	***Provides access to members that control the World File Exporter Interface.***
MapExtent: IEnvelope	*Indicates the Map Extent.*
OutputWorldFile: Boolean	*Indicates if a World File will be created.*

The *IWorldFileSettings* interface is implemented exclusively by the *DibExporter* and *TiffExporter* coclasses. The interface allows the developer to specify whether a world file (a file containing information about the spatial extent of the data within the file) will be created during the output process.

The *MapExtent* property sets the spatial extent of the map data being outputted.

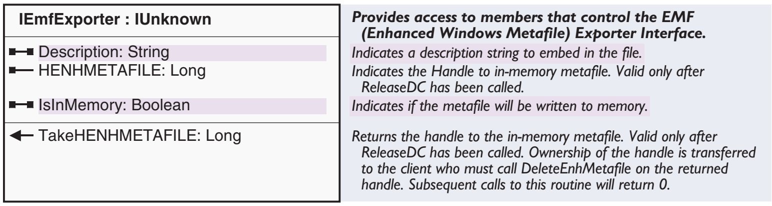
This VBA code uses the *DibExporter* object and its *IDibExport* and *IWorldFileSettings* interfaces to output a BMP file with a related world file:

```
Sub BMPExport()
  Dim pExporter As IExporter, pDibExporter As IDibExporter
  Dim pDriverBounds As IEnvelope, pWorldFile As IWorldFileSettings
  Dim hDc As OLE_HANDLE
  Dim userRECT As tagRECT
  Dim pMxDoc As IMxDocument
  Dim pActive As IActiveView
  Dim pEnv As IEnvelope

  Set pMxDoc = ThisDocument
  Set pEnv = pMxDoc.ActiveView.Extent
  Set pExporter = New DibExporter
  pExporter.ExportFileName = "C:\temp\ArcMapExport.bmp"
  Set pDibExporter = pExporter
  pDibExporter.IsInMemory = False
  Set pWorldFile = pExporter
  pWorldFile.OutputWorldFile = True
  pWorldFile.MapExtent = pEnv

  userRECT.top = 0
  userRECT.Left = 0
  userRECT.Right = ConvertRWToPixels(pEnv.Width)
  userRECT.bottom = ConvertRWToPixels(pEnv.Height)

  Set pDriverBounds = New Envelope
  pDriverBounds.PutCoords userRECT.Left, _
                          userRECT.bottom, _
                          userRECT.Right, _
                          userRECT.top
  pExporter.PixelBounds = pDriverBounds
  hDc = pExporter.StartExporting

  pMxDoc.ActiveView.Output hDc, pExporter.Resolution, userRECT, pEnv, _
    Nothing
  pExporter.FinishExporting
End Sub
```



The EMF exporter creates output in the Microsoft Enhanced Metafile format.

The *EmfExporter* coclass creates output files in the EMF format. Create an object of this type when you want to generate your map output as an EMF file.



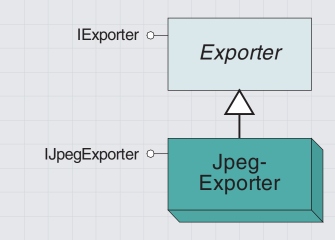
IEmfExporter : IUnknown

Provides access to members that control the EMF (Enhanced Windows Metafile) Exporter Interface.

- Description: String — *Indicates a description string to embed in the file.*
- HENHMETAFILE: Long — *Indicates the Handle to in-memory metafile. Valid only after ReleaseDC has been called.*
- IsInMemory: Boolean — *Indicates if the metafile will be written to memory.*
- TakeHENHMETAFILE: Long — *Returns the handle to the in-memory metafile. Valid only after ReleaseDC has been called. Ownership of the handle is transferred to the client who must call DeleteEnhMetafile on the returned handle. Subsequent calls to this routine will return 0.*

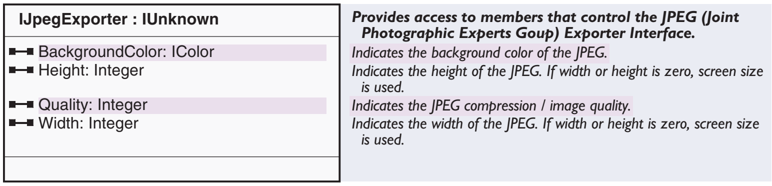
IEmfExporter is implemented only by the *EmfExporter* coclass and the only object that implements this interface. This interface provides EMF-specific properties the developer can set or retrieve before outputting map data in this format.

The *IsInMemory* property sets or returns whether the Metafile will be written to memory. Be sure this property is set to *True* before trying to use the *HENHMETAFILE* or *TakeHENHMETAFILE* properties.



The JPEG exporter creates output in the format set by the Joint Photographic Experts Group.

The *JpegExporter* coclass will create output files in the JPEG format. Create an object of this type when you want to generate your map output as a JPG file.



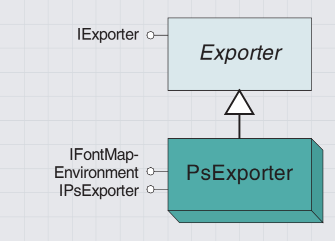
IJpegExporter : IUnknown

Provides access to members that control the JPEG (Joint Photographic Experts Goup) Exporter Interface.

- BackgroundColor: IColor — *Indicates the background color of the JPEG.*
- Height: Integer — *Indicates the height of the JPEG. If width or height is zero, screen size is used.*
- Quality: Integer — *Indicates the JPEG compression / image quality.*
- Width: Integer — *Indicates the width of the JPEG. If width or height is zero, screen size is used.*

IJpegExporter is implemented only by the *JpegExporter* coclass and the only object that implements this interface. This interface provides JPEG-specific properties the developer can set or retrieve before outputting map data in this format.

PsExporter coclass



The PsExporter *creates output in the PostScript format.*

The *PsExporter* coclass creates output files in the PostScript format. Create an object of this type when you want to generate your map output in the PostScript format.

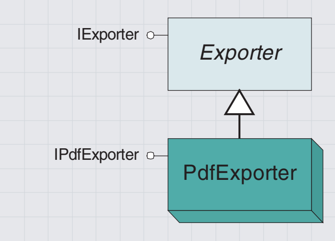
IPsExporter : IUnknown	*Provides access to members that control the EPS (Encapsulated PostScript) Exporter Interface.*
← QueryPSDriver: IPSDriver	*Returns Interface IPSDriver.*

IPsExporter is implemented only by the *PsExporter* coclass. *PsExporter* is the only object that implements this interface. The interface provides the ability to query for the PostScript driver being used by the object.

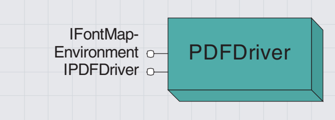
The *IFontMapEnvironment* interface is documented with the *FontMapEnvironment* coclass.

The *PsDriver* coclass is internally created by the *PsExporter* coclass and is documented earlier in this chapter.

PDFExporter and PDFDriver coclasses



The PDFExporter *creates output in the Portable Document Format.*



The PDF driver is created by the PDFExporter *object during the output of map data to a PDF file.*

The *PDFExporter* coclass generates output files in the Portable Document Format (PDF). Create an object of this type when you want to generate your map output in PDF.

This object internally creates the *PDFDriver* coclass to generate output in PDF.

IPDFExporter : IUnknown	***Provides access to members that control the PDF (Portable Document Format) Exporter Interface.***

IPDFExporter is implemented only by the *PDFExporter* coclass. This interface doesn't support any properties or methods, but you can use it to identify the object as being type *PDFExporter*.

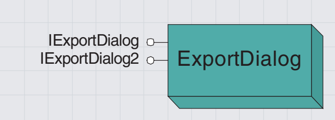
The *PDFDriver* coclass is creatable by the developer, but it is also internally created by the *PDFExporter* object. The *PDFDriver* object does all the work in producing PDF files as output.

IPDFDriver : IUnknown	***Provides access to members that control the PDF (Portable Document Format) Driver.***
■—□ FontMapCollection: IFontMapCollection	*Provides access to members that control the Font Map Collection for Font Mapping.*
← CreatePDF (in InputFileName: String, in OutputFileName: String)	*Indicates the Conversion of the EMF file to a EPS File.*

IPDFDriver is implemented only by the *PDFDriver* coclass. This interface allows the developer to set additional parameters before outputting map data to PDF.

CreatePDF requires the input of an EMF file to produce the PDF output file. The developer can avoid having to create the EMF file by using the *PDFExporter* object (and the inherited *IExporter* interface) to generate output.

The *IFontMapEnvironment* interface is documented with the *FontMapEnvironment* coclass.

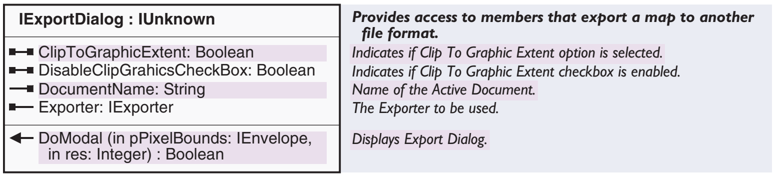


The Export dialog box displays a dialog box for users to enter filename and desired format for outputting map data.

The *ExportDialog* coclass creates a dialog box for the user to enter in the export filename and desired format. After qualified entries have been made in the dialog box, the appropriate exporter object is created; you can get that object through the *IExportDialog::Exporter* property for further processing.

As the VBA code below demonstrates, the *ExportDialog* object presents the simplest method for the developer to write code to allow the user to produce output in the desired file format.

```
Sub OutputInFileFormat()
  Dim pDialog As IExportDialog, bOut As Boolean, pEnv As Ienvelope
  Dim hDc As OLE_HANDLE, pMxDoc As IMxDocument
  Dim pExporter As IExporter, pDriverBounds As IEnvelope
  Dim userRECT As tagRECT, lRes As Long, screenResolution As Long
  Set pEnv = New Envelope
  Set pMxDoc = ThisDocument
  Set pDialog = New ExportDialog
  bOut = pDialog.DoModal(pEnv, lRes)
  If Not bOut Then Exit Sub

  Set pEnv = pMxDoc.ActiveView.Extent
  userRECT.top = 0
  userRECT.Left = 0
  userRECT.Right = ConvertRWToPixels(pEnv.Width)
  userRECT.bottom = ConvertRWToPixels(pEnv.Height)
  screenResolution = _
    pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation.Resolution

  Set pExporter = pDialog.Exporter
  pExporter.Resolution = screenResolution
  Set pDriverBounds = New Envelope
  pDriverBounds.PutCoords userRECT.Left, userRECT.bottom, _
                          userRECT.Right, userRECT.top
  pExporter.PixelBounds = pDriverBounds

  hDc = pExporter.StartExporting
  pMxDoc.ActiveView.Output hDc, screenResolution, userRECT, pEnv, Nothing
  pExporter.FinishExporting
End Sub

Private Function ConvertRWToPixels(RWUnits As Double) As Double
  Dim realWorldDisplayExtent As Double
  Dim pixelExtent As Long
  Dim sizeOfOnePixel As Double
  Dim pDT As IDisplayTransformation
  Dim deviceRECT As tagRECT
  Dim pEnv As IEnvelope
  Dim pMxDoc As IMxDocument

  Set pMxDoc = ThisDocument
  Set pDT = pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation
  deviceRECT = pDT.DeviceFrame
  pixelExtent = deviceRECT.Right - deviceRECT.Left
  Set pEnv = pDT.VisibleBounds

  realWorldDisplayExtent = pEnv.Width
  sizeOfOnePixel = realWorldDisplayExtent / pixelExtent
  ConvertRWToPixels = RWUnits / sizeOfOnePixel
End Function
```



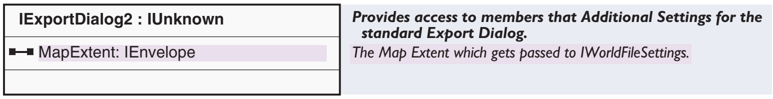
IExportDialog : IUnknown

Provides access to members that export a map to another file format.

ClipToGraphicExtent: Boolean	Indicates if Clip To Graphic Extent option is selected.
DisableClipGrahicsCheckBox: Boolean	Indicates if Clip To Graphic Extent checkbox is enabled.
DocumentName: String	Name of the Active Document.
Exporter: IExporter	The Exporter to be used.
DoModal (in pPixelBounds: IEnvelope, in res: Integer) : Boolean	Displays Export Dialog.

IExportDialog is implemented only by the *ExportDialog* object. The interface provides a method for capturing user input specifying output file parameters.

The *Exporter* property returns the *IExporter* interface on the object created based on the user selection in the dialog box. Be sure to determine the type of exporter before trying to perform specific operations on the object.



IExportDialog2 : IUnknown

Provides access to members that Additional Settings for the standard Export Dialog.

MapExtent: IEnvelope	The Map Extent which gets passed to IWorldFileSettings.

The *IExportDialog2* interface was added at ArcGIS 8.1 to allow for the setting and retrieval of the map extent. The map extent gets passed to the *IWorldFileSettings::MapExtent* property when output is being sent through the *TiffExporter* and *DibExporter* objects and is ultimately saved with the file.

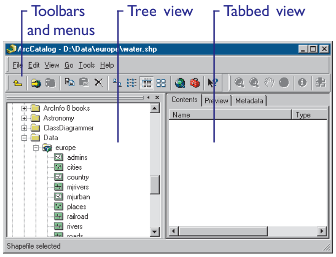
7

Working with the Catalog

Larry Young, Aleta Vienneau, Keith Ludwig

The Catalog is the place where you can assemble connections to all the data you need to use. When you choose a connection, you can access the data to which it's linked, whether it's a folder on a local disk or a database on the network. Together, your connections create a catalog of geographic data sources.

This chapter reveals how the ArcObjects components let you: browse for maps and data • inspect features with the contents view • explore the data through thumbnails • look at geographic data with geography view • inspect the attributes of a geographic data source with a table view • view and create metadata • search for maps and data • use data in ArcMap and ArcToolbox • manage data sources • create layers with the Catalog

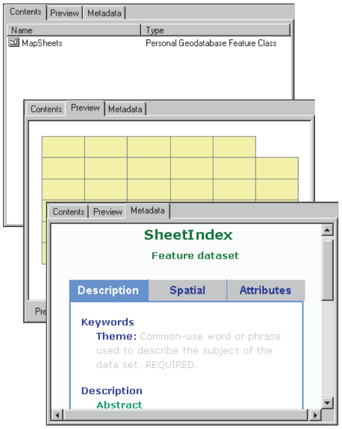


When you select an item in the tree view, that becomes the selection location—the items you select in the contents view become the selected set of objects at that location.

ArcCatalog is the application you use to browse and manage all of your local and remote GIS data. It is patterned after Windows Explorer to promote rapid familiarity and ease of use.

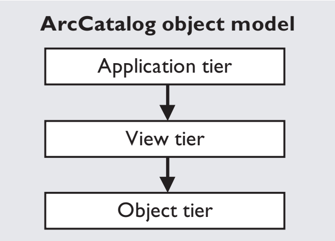
The user interface consists of three main elements: a tree view, a tabbed view, and a set of toolbars and menus. The tree view depicts your data holdings in a hierarchical structure of names and icons. The tabbed view is really a set of data views, each of which appears on its own tab, and one of which is active at any given time. These data views let you visualize your data in a variety of ways. The toolbars and menus contain all the tools and commands that enable you to manipulate and work with your data.

The three primary data views are contents view, metadata view, and preview view:


Contents Preview Metadata
Name Type
MapSheets Personal Geodatabase Feature Class
Contents Preview Metadata
Contents Preview Metadata
Pre
SheetIndex
Feature dataset
Description Spatial Attributes
Keywords
Theme: Common-use word or phrase used to describe the subject of the data set. REQUIRED.
Description
Abstract

- Contents view displays an iconic list of all the children of the selection location, just like its counterpart in Windows Explorer. By default, this is the active view when you start up ArcCatalog.
- Metadata view shows all the metadata associated with the current selection. By default, the format comes from an ESRI style sheet, but this can be customized.
- Preview view is a set of data views, one of which may be active at any given moment (just like the tabbed view). By default, preview chooses whichever data view is most natural and appropriate for displaying the current selection. For example, if you've selected a shapefile, Preview will show you its geography by default. However, a dropdown menu at the bottom of the preview allows you to override this and explicitly pick the view you wish to use.

ARCHITECTURE


ArcCatalog object model

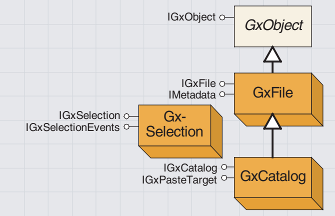
The Gx prefix through ArcCatalog refers to an early internal prerelease name of ArcCatalog: "GX", short for the "geographic explorer".

The object model for ArcCatalog closely mirrors the actual user interface experience. The running application is represented by the *GxApplication* object. Its major purpose is to manage the three main interface elements—the tree view (*GxTreeView*), the active tabbed view (*IGxApplication::View*), and the toolbars and menus. It also represents the starting point for developers that wish to customize or augment the standard application behavior. From the application object, you can navigate to all the objects within ArcCatalog and execute methods on them.

The object model consists of three separate but related tiers of functionality—the object tier, the view tier, and the application tier.

Object tier

The object tier is the bottom level in the object model. *GxObjects* represent individual data items and are as they appear in the tree view and the contents view. Different types of *GxObjects* are used for different types of data. For example, the *GxLayer* object represents layer files,



Behind the user interface, two objects serve as the heart and soul of ArcCatalog—the catalog object, GxCatalog, *and the current selection object,* GxSelection. *The Catalog represents your actual tree of data and is shown through the tree view. The selection itself is really composed of two parts: a location and a set of objects at that location.*

whereas the *GxMap* object encapsulates map documents. Within the *GxObject* tier, two objects are of supreme importance: the catalog object (*GxCatalog*) and the current selection (*GxSelection*).

The Catalog represents your actual tree of data, as is shown in the tree view. From the *GxCatalog* object, you can navigate to any of its descendants to access and manipulate them. Most often, however, you will work with the selection, which is composed of two parts: a location and a set of selected objects at that location. When you select an item in the tree view, that becomes the selection location; the items you select in the contents view become the selected set of objects at that location. Most operations in ArcCatalog work on the current selection.

The object tier is extensible. To add custom *GxObjects*, create an object that supports at least *IGxObject*. (Typically, you'll also want to implement *IGxObjectUI* and *IGxObjectEdit*.) You also need to write a *GxObjectFactory* that knows how to manufacture your custom *GxObjects*. This factory is used by *ArcCatalog* as folders are expanded to detect what objects exist within that folder.

View tier

The view tier is the middle tier. Its views display individual *GxObjects* in a host of different ways. They represent different user interfaces on the *GxObjects*. Different *GxViews* are used for different tasks. For example, to rapidly browse for a data set, you might use the *GxContentsView* because it has different list styles. To look for data with certain attributes, use the *GxDocumentationView*. *GxGeographicView* is extremely useful for seeing what the dataset actually looks like before you use it.

ArcCatalog offers a simple framework for hosting *GxViews*. The tree view is always available (even though it can be shown and hidden by the user as desired). It is the primary navigation tool within ArcCatalog and is used to establish the current selection location. The selection location governs what is shown by the other *GxViews*.

ArcCatalog offers two ways to show the other views: as tabbed views or as previews. Tabbed views show up as individual tabs within the main ArcCatalog window. By default, there are three: Contents, Preview, and Metadata. However, a developer can add as many as they want.

Previews show up as combo box choices within the Preview tab and are generally used for those views that show static views of the data (such as geography, table, 3D, and so on). Regardless of the view style chosen, the actual implementation of the *GxView* is not affected. It is the same for either. However, other than the visual differentiation, there is a minor functional difference between the two view types.

Tabbed views can only be chosen manually. However, previews are automatically chosen depending on what kind of object is currently selected. If the Preview tab is active, when the user changes the selection location, ArcCatalog uses the *IGxView::Applies* method to ask each registered preview if it can handle the type of object selected. If the current preview supports it, no switching occurs. However, if the current preview does not support it, the first view that says that it can support it is chosen as the active preview. Users may, of course, switch the preview to a different one afterwards, but the automatic switching logic still occurs when the selection changes.

Application tier

The top tier of ArcCatalog, the application tier, is dominated by the *GxApplication* and its associated menus and toolbars. It manages the lifetime of the *GxCatalog* and its descendants and manages all the *GxViews*.

When the application starts up, ArcCatalog creates *GxDiskConnection* objects for each folder connected at the root and populates the Catalog tree.

If this is the first time you've started ArcCatalog, it will add all your local drives as folder connections to get you started. Also at this level, ArcCatalog creates and adds any *GxObject* objects that are registered in the *CATID_GxRootObjects ("ESRI Gx Root Objects")* component category.

Several root objects are supplied by default—the Database Connections folder, the Coordinate Systems folder, the Geocoding Services folder, the Internet Servers folder, and the Search Results folder. Typically, these root objects act as containers of other objects and therefore implement *IGxObjectContainer*, but this is not a requirement.

When any container object is expanded in ArcCatalog, its children are retrieved via the *Children* property of *IGxObjectContainer* and are then shown in the tree view (and possibly the contents view). Most container objects have hardwired knowledge about what their children are. A notable exception is the *GxFolder*. It discovers its list of children dynamically using a set of *GxObjectFactory* objects.

When a *GxFolder* is first asked for its children, it loops over all the registered *GxObjectFactory* objects (in the *CATID_GxObjectFactories* component category) and calls their *GetChildren* methods, passing in the directory path and a list of filenames. The object factory responds by returning an enumeration of *GxObject* objects for everything that it recognizes within that folder. For example, the *GxObjectFactory* for shapefiles looks for all files that have a .shp extension and creates and returns *GxShapefile* objects for each one of them.

As an optimization, ArcCatalog actually calls *HasChildren* first on the factory before calling *GetChildren*—in response, the factory should do a quick scan of the folder first to see if there are any children. This saves looping over all the filenames, since *HasChildren* can return *True* once the first valid file is found.

Then, using the *IGxObjectUI* interface, ArcCatalog asks each child for an icon to use for display purposes. If the object doesn't support this interface, a default icon is used instead. Its name is shown next to the icon, and, in details view, its type information (derived from the *IGxObject::Category* property) is also displayed.

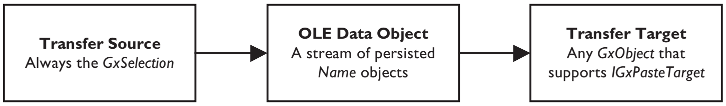
DATA TRANSFER (VIA DRAG/DROP AND COPY/PASTE)

ArcCatalog uses the standard OLE data transfer mechanism for both drag and drop and copy and paste. This is always the case, whether or not it is acting as the source of the operation, the destination, or both. To fully understand how drag/drop and copy/paste works, it is best to look at how ArcCatalog behaves when it is both the source and destination.

Drag/drop within ArcCatalog

When it detects that a drag operation has started, ArcCatalog packages the selected *GxObjects* into a data object (*IDataObject*) and passes this to OLE.

ArcCatalog packages the selected *GxObjects* up as follows. First, the current selection of *GxObjects* is identified (via the *GxSelection* object). Then, each *GxObject* in the selection is asked for its internal name object via the *InternalNameObject* property. Those that return nothing for this property aren't considered. All of the internal *Name* objects are then persisted into a stream that is placed into an OLE data object. To persist them into this stream, ArcCatalog creates a *NameFactory* utility object, then invokes its *PackageNames* method. This data object is then passed over to OLE to let it proceed with the operation.


Transfer Source
Always the *GxSelection*
OLE Data Object
A stream of persisted *Name* objects
Transfer Target
Any *GxObject* that supports *IGxPasteTarget*

Then OLE takes over. If the operation is a drag/drop, OLE enters a modal event loop while the drag takes place. During this event loop, OLE checks to see where the mouse is currently located. If the mouse enters an *hWnd* that is registered as a drop target, OLE invokes the *IDropTarget* interface on it, first calling *DragEnter*, then *DragOver*, and *DragLeave* as necessary. (To register an *hWnd* as a potential drop target, call the Win32 method *RegisterDragDrop*.) If the user releases the mouse over the *hWnd*, OLE calls the *Drop* method.

Since ArcCatalog is the destination for the data transfer in this example, ArcCatalog handles the *IDropTarget* requests from OLE. It does so as follows. As the mouse moves within the tree or contents view, ArcCatalog checks to see if target *GxObject* is a valid recipient for the data transfer. Any object that supports *IGxPasteTarget* is considered. Here's that interface:

```
interface IGxPasteTarget:
Function CanPaste(names as IEnumName, moveOperation as Boolean) as Boolean
Function Paste(names as IEnumName, moveOperation as Boolean) as Boolean
```

ArcCatalog transforms the drag data into a more usable form, namely, an enumeration of *Name* objects (*IEnumName*). It then calls *CanPaste* to determine if the drop target can accept the *Names* being dragged. In response, the potential target enumerates through the list of *Names* to see if it can handle them. For example, the *GxDatabase* object checks to make sure all the *Name* objects are actually *DatasetNames* (that is, they support *IDatasetName*). Other objects might check to make sure the *Name* objects support *IFileName*. If the target *GxObject* decides it can accept a drop, it returns *True*. If the data isn't supported, it returns *False*. The *GxObject* must also indicate if the drag operation represents a move or a copy. It does so by setting the value of the *moveOperation* parameter to *True* or *False*.

When the user releases the mouse button, OLE calls *IDropTarget::Drop*. ArcCatalog responds by calling the *IGxPasteTarget::Paste* method on the *GxObject*, again passing in the list of *Names*. It also passes in *True* or *False* for *moveOperation* to indicate if the operation is to be a move or just a copy. At this point, the target *GxObject* must carry out the actual data transfer operation in whatever fashion makes sense for the data. (For example, *GxDatabase* handles data transfers by issuing geodatabase schema changes and cursor requests to physically move rows from one place to another. Other transfer targets might behave similarly, or do something entirely different, depending on the kind of data involved.) If the data transfer involves changes that should be reflected in the ArcCatalog tree or contents views, be sure to call *Refresh* to make those changes visible.

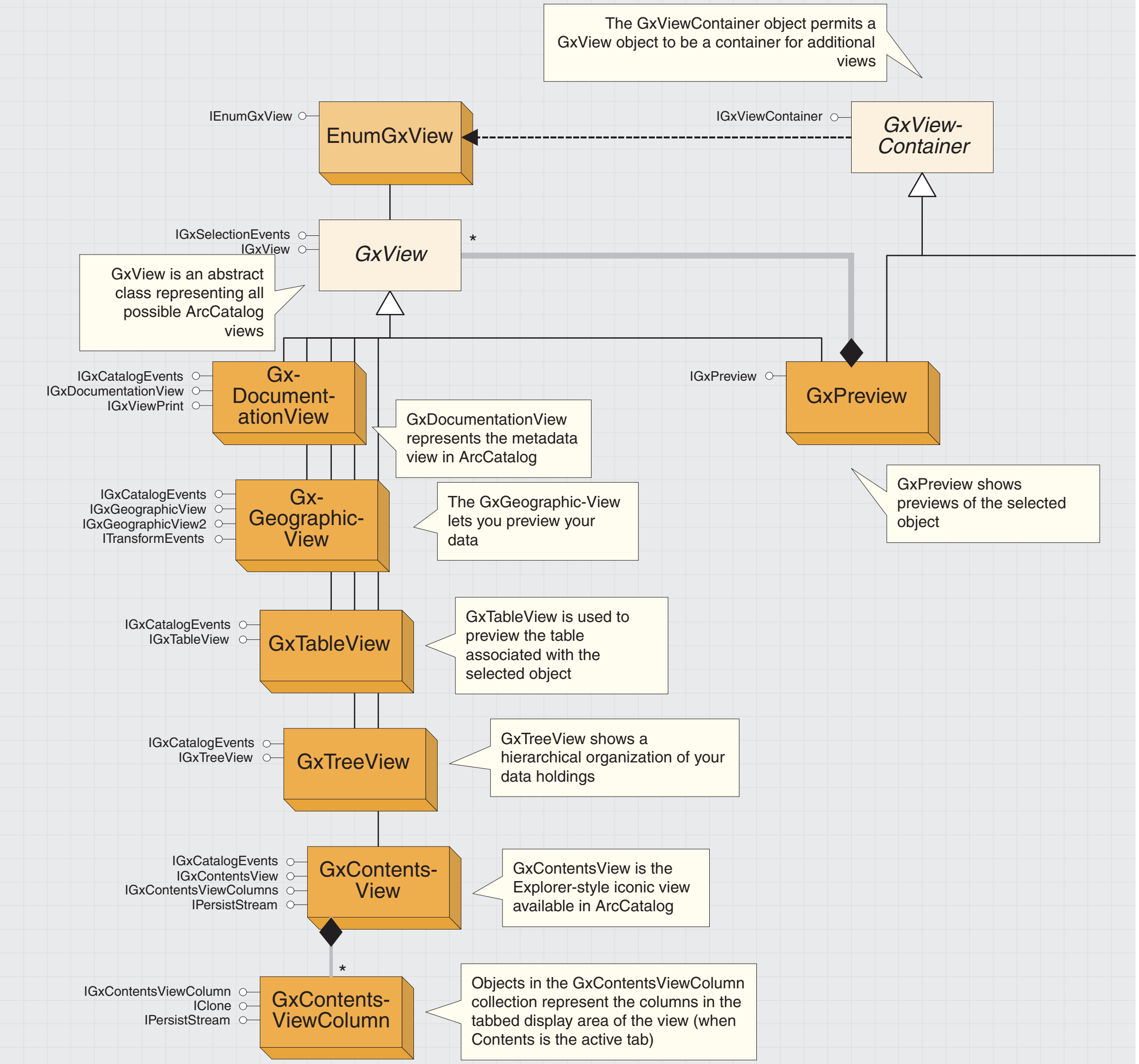
The target *GxObject* also needs to indicate whether or not an actual move was carried out if *moveOperation* was initially *True*. It does so by setting this parameter to *True* or *False* before returning. Finally, if the data transfer operation succeeded, the function returns *True*; otherwise it returns *False*.

COPY/PASTE IN ArcCatalog

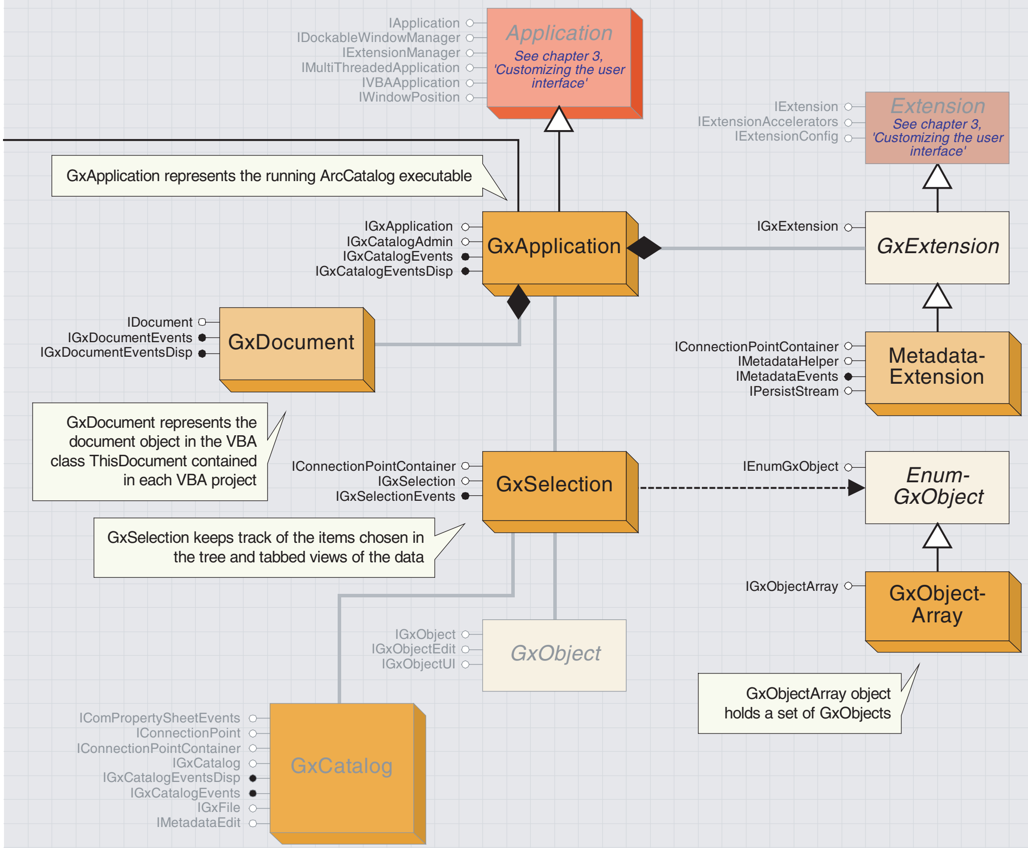
If the transfer operation is a copy/paste instead of a drag/drop, the situation is very similar—only a few things are different. First, when the copy is initiated, ArcCatalog packages up the selected *GxObjects* into a data object as before (by asking them for their internal *Names*). It then places this data object onto the OLE clipboard, where it remains available for other applications to paste it.

Whenever the current selection location changes in ArcCatalog (either manually or programmatically), ArcCatalog needs to check to see if the *Paste* command should be enabled. It does this by calling *IGxPasteTarget::CanPaste* on the current location. The desirable aspect of this behavior is that the implementation for *IGxPasteTarget* is the same for the target, regardless of the type of data transfer operation (copy/paste or drag/drop). It responds in exactly the same way as it does for the drag/drop case. If the user selects the *Paste* command, ArcCatalog invokes the *Paste* method on the current location.

GxView objects


The GxViewContainer object permits a GxView object to be a container for additional views
IEnumGxView
EnumGxView
IGxViewContainer
GxView-Container
IGxSelectionEvents
IGxView
GxView
*
GxView is an abstract class representing all possible ArcCatalog views
IGxCatalogEvents
IGxDocumentationView
IGxViewPrint
Gx-Document-ationView
IGxPreview
GxPreview
GxDocumentationView represents the metadata view in ArcCatalog
GxPreview shows previews of the selected object
IGxCatalogEvents
IGxGeographicView
IGxGeographicView2
ITransformEvents
Gx-Geographic-View
The GxGeographic-View lets you preview your data
IGxCatalogEvents
IGxTableView
GxTableView
GxTableView is used to preview the table associated with the selected object
IGxCatalogEvents
IGxTreeView
GxTreeView
GxTreeView shows a hierarchical organization of your data holdings
IGxCatalogEvents
IGxContentsView
IGxContentsViewColumns
IPersistStream
GxContents-View
GxContentsView is the Explorer-style iconic view available in ArcCatalog
*
IGxContentsViewColumn
IClone
IPersistStream
GxContents-ViewColumn
Objects in the GxContentsViewColumn collection represent the columns in the tabbed display area of the view (when Contents is the active tab)

GxApplication and related objects

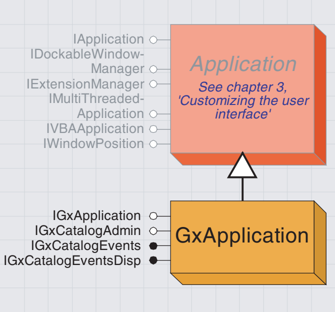


GxApplication represents the running ArcCatalog executable

GxDocument represents the document object in the VBA class ThisDocument contained in each VBA project

GxSelection keeps track of the items chosen in the tree and tabbed views of the data

GxObjectArray object holds a set of GxObjects



GxApplication *represents the running ArcCatalog application.*

GxApplication is the object that represents the running ArcCatalog executable. It creates and manages the user interface—the tree view, the tabbed views, and the menus and toolbars—and initializes the Catalog tree by creating the *GxCatalog* root object.

Typically, developers will start their navigation of the object model from *GxApplication* and work their way down to the object they need to manipulate. All commands and tools are passed a reference to the *GxApplication* in their *OnCreate* method.

GxApplication supports *IApplication* and *IGxApplication*. *IApplication* is common to both ArcMap and ArcCatalog and is described in detail in Chapter 3, 'Customizing the user interface'.

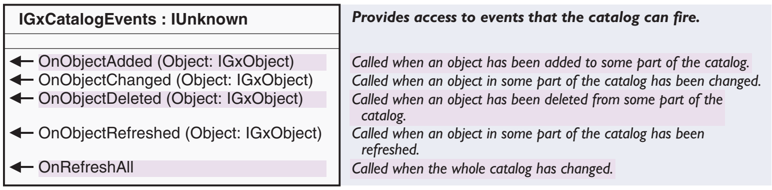
IGxApplication : IUnknown	*Gx Application object.*
■—■ AreaOfInterest: IEnvelope	*The default area of interest for the application.*
■— CanDeleteSelection: Boolean	*Indicates if the current selection can be deleted.*
■— CanRenameSelection: Boolean	*Indicates if the current selection can be renamed.*
■— Catalog: IGxCatalog	*The current catalog.*
—■ Location: String	*The location to the specified path. If the path isn't yet part of the catalog, it is added as a folder connection.*
■— SelectedObject: IGxObject	*The first selected object, or the location if no objects are selected.*
■— Selection: IGxSelection	*The selection.*
■— TreeView: IGxTreeView	*The tree view.*
■— View: IGxView	*The current view.*
■—■ ViewClassID: IUID	*The current view's class ID.*
← DeleteSelection	*Deletes the current selection.*
← ExpandSelection	*Expands the current selection.*
← Refresh (in startingPath: String)	*Refreshes the catalog tree starting at the specified path. If startingPath is 0 or the empty string, the entire catalog is refreshed.*
← RenameSelection	*Renames the current selection.*
← ShowContextMenu (in X: Long, in Y: Long)	*Displays a context menu for the current selection.*

The *IGxApplication* interface is unique to ArcCatalog and is used to control certain aspects of its behavior. For example, through the *IGxApplication* interface, you can delete or expand the current selection (through *DeleteSelection* and *ExpandSelection*) or force a refresh of a certain part of the Catalog tree (through *Refresh*).

The *Catalog* property returns the *GxCatalog* object, which represents the root of the Catalog data tree. From there, you can use *IGxObject-Container::Children* to enumerate through the Catalog's descendants.

The *TreeView* property gives you access to ArcCatalog's tree view. From this *GxTreeView*, you can ensure that a certain descendant is visible or initiate a renaming operation.

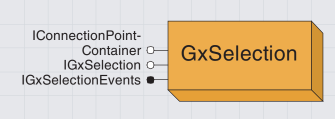
The *View* property gives you access to the active *GxView*, whatever it happens to be. It might be one of the built-in views—for example, *GxContentsView, GxPreview,* or *GxMetadataView*—or it might be a developer-added one. From here, you can manipulate the active view in whatever fashion is native to it.



IGxCatalogEvents : IUnknown	Provides access to events that the catalog can fire.
← OnObjectAdded (Object: IGxObject)	Called when an object has been added to some part of the catalog.
← OnObjectChanged (Object: IGxObject)	Called when an object in some part of the catalog has been changed.
← OnObjectDeleted (Object: IGxObject)	Called when an object has been deleted from some part of the catalog.
← OnObjectRefreshed (Object: IGxObject)	Called when an object in some part of the catalog has been refreshed.
← OnRefreshAll	Called when the whole catalog has changed.

IGxCatalogEvents interface is the events interface implemented by *GxApplication*. This interface allows developers to attach code to the various events fired by ArcCatalog, such as when objects are added or deleted.

When a refresh is performed on ArcCatalog (when the user clicks the View menu and clicks Refresh), only the *Location* object (the selected object in the tree view) is passed to the *OnObjectRefreshed* event. However, everything underneath this object is refreshed.

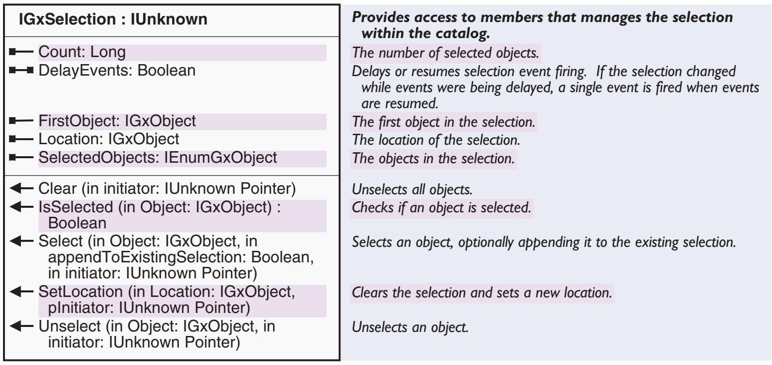


GxSelection *keeps track of items chosen in the tree view.*

The *GxSelection* object keeps track of the items chosen in the tree and tabbed views of the data. A *GxSelection* object can be created, but more commonly it is retrieved from the *GxApplication* (*IGxApplication::-Selection*). What is selected is key in determining what context menus to display when the user right-clicks and in determining copy/paste capabilities of the objects.

Here is some VBA code that uses the *GxSelection* object to loop through the selected set of objects and display their categories:

```
Dim pApp As IGxApplication, pGxSel As IGxSelection, _
  pEnumGxObj As IEnumGxObject
Dim pGxObj As IGxObject
Set pApp = Application
Set pGxSel = pApp.Selection
Set pEnumGxObj = pGxSel.SelectedObjects
Set pGxObj = pEnumGxObj.Next
Do While Not pGxObj Is Nothing
  Debug.Print pGxObj.Category
  Set pGxObj = pEnumGxObj.Next
Loop
```



IGxSelection : IUnknown	**Provides access to members that manages the selection within the catalog.**
Count: Long	*The number of selected objects.*
DelayEvents: Boolean	*Delays or resumes selection event firing. If the selection changed while events were being delayed, a single event is fired when events are resumed.*
FirstObject: IGxObject	*The first object in the selection.*
Location: IGxObject	*The location of the selection.*
SelectedObjects: IEnumGxObject	*The objects in the selection.*
Clear (in initiator: IUnknown Pointer)	*Unselects all objects.*
IsSelected (in Object: IGxObject) : Boolean	*Checks if an object is selected.*
Select (in Object: IGxObject, in appendToExistingSelection: Boolean, in initiator: IUnknown Pointer)	*Selects an object, optionally appending it to the existing selection.*
SetLocation (in Location: IGxObject, pInitiator: IUnknown Pointer)	*Clears the selection and sets a new location.*
Unselect (in Object: IGxObject, in initiator: IUnknown Pointer)	*Unselects an object.*

The *IGxSelection* interface is implemented by the *GxSelection* object and provides access to the objects selected in the tree and tabbed views of ArcCatalog. Use this interface when you want to determine what is selected or make changes to what is selected.

The *Location* method returns the *IGxObject* selected in the tree view (there can be only one), while the *SelectedObjects* method returns an enumeration of objects selected in the tabbed view.

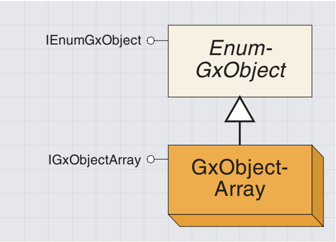
FirstObject returns the first object selected in the tabbed view.

The methods that change the selection require an initiator parameter, which can be set to nothing. Calling one of these methods will fire the *SelectionChanged* event, and *SelectionChanged* will pass on the initiator parameter. The initiator is the object initiating the change.

The selection methods (*Clear, IsSelected, Select,* and *Unselect*) all operate on the selected objects in the tabbed view.

The following VBA code demonstrates how to use the *SetLocation* method to change the selection in tree view:

```
Dim pApp As IGxApplication
Dim pSel As IGxSelection
Dim pObject As IGxObject
Dim ln As Long
Set pApp = Application
Set pObject = pApp.Catalog.GetObjectFromFullName _
 ("d:\tools\various\labeling.txt", ln)
Set pSel = pApp.Selection
pSel.SetLocation pObject, Nothing
```



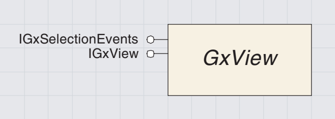
The GxObjectArray *object holds a set of* GxObjects.

The *GxObjectArray* object holds a set of *GxObjects*. The object is not returned by a method on any other object; therefore, it is up to the developer to create and manipulate an object of this type.

A few of the methods in the ArcCatalog object model take *IEnumGxObject* variables as input. Without the *GxObjectArray* class, developers would need to create their own custom class to implement *IEnumGxObject*.

IGxObjectArray : IUnknown	***Provides access to members that manage an array of GX objects.***
Count: Long	*The number of objects in the array.*
Empty	*Removes all objects from the array.*
Insert (in Index: Long, in gxObject: IGxObject)	*Inserts an object into the array before the specified index. If index is -1, the object is inserted at the end.*
Item (in Index: Long) : IGxObject	*The object at the given index in the array.*
Remove (in Index: Long)	*Removes the object at the specified index in the array.*

The *IGxObjectArray* interface is implemented by the *GxObjectArray* class and provides the ability to manipulate the set of *GxObjects* maintained by the class. Through this interface, the developer can insert, remove, and retrieve the objects within the array.



GxView is an abstract class that represents all possible ArcCatalog views. There are five types of GxViews: GxContentsView, GxGeographicView, GxPreview, GxTableView, and GxTreeView.

There are two types of views: tabbed views and previews. They are implemented exactly the same but are registered in separate component categories depending on the look and feel desired.

Tabbed views show up as individual tabs in the ArcCatalog main window. They are always available regardless of the type of the current selection.

Previews are different—they are only available under the Preview tab and only show up if they are appropriate for the type of the current selection. The *Applies* property determines this. If the view does apply, it shows up as a possible choice in the preview dropdown combo box. If it doesn't apply, it does not show up. *Applies* has no effect when the view is registered as a tabbed view.

At the appropriate times, ArcCatalog calls *Activate* and *Deactivate* on the *GxView* to inform it that it is becoming active or inactive. In response, the view typically should refresh itself and establish or release references to any resources that it needs for interaction with the user.

IGxView : IUnknown	*Provides access to members that control the GxView.*
ClassID: IUID	*The class ID of the view.*
DefaultToolbarCLSID: IUID	*The class ID of the view's default toolbar. Not currently used.*
hWnd: Long	*The view's window handle.*
Name: String	*The name of the view.*
SupportsTools: Boolean	*Indicates if the view supports tools.*
Activate (in Application: IGxApplication, in Catalog: IGxCatalog)	*Activates the view.*
Applies (in Selection: IGxObject) : Boolean	*Indicates if the view can display the given object.*
Deactivate	*Deactivates the view.*
Refresh	*Refreshes the view.*
SystemSettingChanged (in Flag: Long, in section: String)	*Informs the view that a system setting has changed.*

A *GxView* must minimally support the *IGxView* interface, which ArcCatalog uses to negotiate with the view. It asks the view for an *hWnd* to display through the *hWnd* property. It reparents this *hWnd* so that it is a child of an ArcCatalog *hWnd*. It also guarantees events are passed to the *hWnd* correctly and that it is resized when the ArcCatalog window is resized. Developers that wish to create their own custom views must implement this interface.

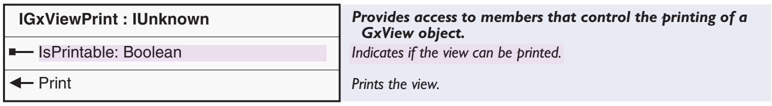
Use the *Activate* property to hold on to the *GxApplication* and *GxCatalog* objects that are passed in as parameters. The *Deactivate* property releases these references.

DefaultToolbarCLSID provides a reference to the default toolbar for the particular view. The default toolbar for a view contains tools that are appropriate for the current type of *GxView*.

If the *SupportsTools* property returns *True*, ArcCatalog will intercept mouse events normally destined for the view and instead send them to the active tool.

The following VBA code uses the *Name* property of the *IGxView* interface to determine if you are looking at a preview. If you are, then the class ID of the preview is changed to a table view.

```
Dim pApp As IGxApplication, pGxView As IGxView
Set pApp = Application
Set pGxView = pApp.View
If UCase(pGxView.Name) = "PREVIEW" Then
'The above line could be replaced with "If TypeOf pGxView Is IGxPreview  Then"
  Dim pPrev As IGxPreview, pUID As New UID
  Set pPrev = pGxView
  Debug.Print pPrev.ViewClassID
  pUID = "{9C34344D-99DC-11D2-AF6A-080009EC734B}"
  pPrev.ViewClassID = pUID
End If
```



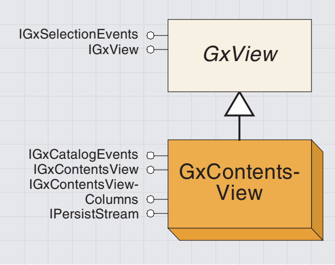
IGxViewPrint : IUnknown

Provides access to members that control the printing of a GxView object.

IsPrintable: Boolean — *Indicates if the view can be printed.*

Print — *Prints the view.*

GxViews optionally support the *IGxViewPrint* interface to allow the user to print the current display. This is especially handy for the metadata view, as it allows users to create scripts to print nicely formatted metadata for a batch of objects at once.



The Explorer-style iconic view available in ArcCatalog is the GxContentsView.

The *GxContentsView* coclass shows the children of the current selection location in a variety of styles: large icons, list, report, and thumbnails. You can set the style it uses by changing the *DisplayStyle* property on *IGxContentsView*.

Here is some VBA code for checking the current view to determine if it is a *GxContentsView*. This code also accesses properties associated with that view.

```
Sub test1()
  Dim pApp As IGxApplication, pView As IGxView
  Dim pContView As IGxContentsViewColumns, pCol As IGxContentsViewColumn
  Set pApp = Application
  Set pView = pApp.View
  If TypeOf pView Is IGxContentsViewColumns Then
    Set pContView = pView
    Set pCol = pContView.ColumnByIndex(0)
    Debug.Print pCol.Caption & ", " & pCol.PropertyName
  End If
End Sub
```

IGxContentsView : IUnknown	***Provides access to members that control the GxContentsView.***
AllowMultiSelect: Boolean	*Indicates if multiple objects can be selected.*
DisplayStyle: tagesriContentsViewStyle	*The current display style.*
ObjectFilter: IGxObjectFilter	*The object filter used for controlling what objects are displayed.*
BeginRename	*Starts a rename operation on the current selection.*

The *IGxContentsView* interface is implemented by the *GxContentsView* object. It provides the ability to change how users interact with a view of that type. What types of files are displayed, how they are displayed, and whether more than one can be selected at a time are all controlled through the interface.

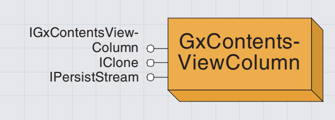
Constrain the set of objects displayed by supplying an object filter through the *ObjectFilter* property. For a discussion of what filters are available and how to create your own, see the introductory section in this chapter on *GxDialog* and *GxObjectFilters*.

IGxContentsViewColumns : IUnknown	***Provides access to members that control the columns of GxContentsView.***
ColumnByIndex (in Index: Long) : IGxContentsViewColumn	*Get a column by its index.*
ColumnByProperty (in Property: String) : IGxContentsViewColumn	*Get a column by its property.*
ColumnCount: Long	*Get the total number of columns (include both visible and invisible columns)*
InsertColumn (in Index: Long, in pColumn: IGxContentsViewColumn)	*Inserts a GxContentsViewColumn before the specified index. If index is -1, the column is inserted at the end.*
RemoveAllColumns	*Removes all columns except Name and Type column (they are always shown).*
RemoveColumn (in pColumn: IGxContentsViewColumn)	*Removes a GxContentsViewColumn.*
UpdateColumns	*Refresh columns in contents view after insert or remove columns.*

The *IGxContentsViewColumns* interface serves as a container for the *GxContentsViewColumn* objects contained within the *GxContentsView* object. The objects in the collection represent the columns in the tabbed display area of the view (when Contents is the active tab).

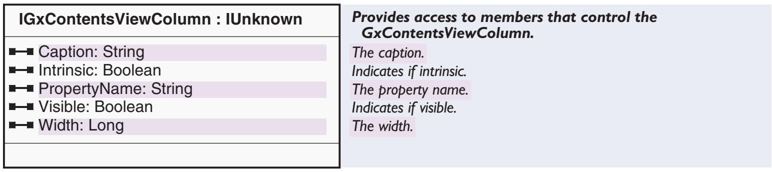
After using the *InsertColumn* method to add your new column, execute the *UpdateColumn* method to refresh the column list.

RemoveAllColumns will not remove the *Name* and *Type* columns. These columns cannot be removed. Keep in mind that removal of columns is not just for that session, it is permanent.



GxContentsViewColumn *objects represent the columns of information displayed when the Contents tab is the active view.*

GxContentsViewColumn objects represent the columns of information displayed when the Contents tab is the active view. The developer has the ability to create and add additional columns of information to customize the contents view for displaying specific information.



IGxContentsViewColumn : IUnknown

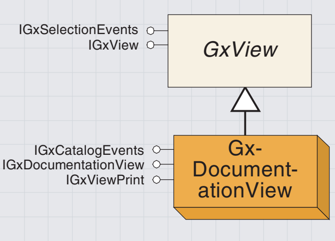
Provides access to members that control the GxContentsViewColumn.

Caption: String	*The caption.*
Intrinsic: Boolean	*Indicates if intrinsic.*
PropertyName: String	*The property name.*
Visible: Boolean	*Indicates if visible.*
Width: Long	*The width.*

The *IGxContentsViewColumn* interface provides access to the properties of the columns contained within the *GxContentsView* object. The column properties allow you to set the width, visibility, and caption of the column.

Intrinsic properties (*Intrinsic* property set to *True*) are properties such as *Name, Category,* and *Size*. These are not really useful unless you add your own *GxObject* through a new workspace factory; if you do this, you have the ability to add object-specific special properties.

The *PropertyName* property is based on keywords within the metadata for the object. Make sure you have metadata with the specific keyword before using it as a *PropertyName*.



The GxDocumentationView *object opens the Metadata Properties dialog box.*

The metadata view in ArcCatalog is represented by *GxDocumentationView*. Since it is a *GxView*, it naturally supports *IGxView*. However, to manipulate it, you will want to work with *IGxDocumentationView*. This interface allows you to do three things: edit the metadata using a custom editor through *Edit*, edit the metadata properties with a default editor via *EditProperties*, and force the metadata to be updated with respect to the object's current attributes through *Synchronize*.

To build a custom editor, create an object that implements *IMetadataEditor* interface, then inform the metadata extension object to use it through its *IMetadataHelper::Editor property*.

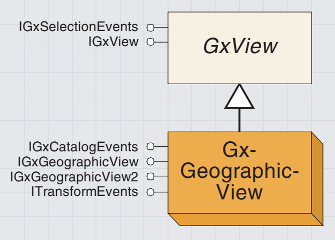
GxDocumentationView also implements *IGxViewPrint* to enable you to print the well-formatted metadata.

IGxDocumentationView : IUnknown	***Provides access to members that edit metadata.***
← Edit	*Opens the current metadata editor.*
← EditProperties	*Opens the Metadata Properties dialog box.*
← Synchronize	*Writes the current property values to the metadata.*

The *IGxDocumentationView* is implemented by *GxDocumentationView*. It provides a set of methods for manipulating the metadata associated with an object. Through this interface, the developer can open the editor associated with the metadata, access the metadata properties, or apply the edits made to the metadata.

The following VBA code brings up the default editor for the metadata associated with the selected object:

```
Dim pApp As IGxApplication, pGxView As IGxView, _
  pDocView As IGxDocumentationView
Set pApp = Application
Set pGxView = pApp.View
If TypeOf pGxView Is IGxDocumentationView Then
  Set pDocView = pGxView
  pDocView.Edit
End If
```



The GxGeographicView *appears on the Preview tab.*

When you want to preview your data, use *GxGeographicView*. It is available through the Preview tab in ArcCatalog. It displays the geography of the selected dataset in its window. By default, the *GxGeographicView* object shows up on the Preview tab page; however, the object implements *IGxView* like the other *GxView* objects and can be used as its own tab.

A set of standard manipulation tools is provided for zooming, panning, and performing identify. However, you can easily add your own tools, which can work with this view in whatever fashion you would like. You can do this by accessing the map or map display objects from the *IGxGeographicView* interface. Internally, the view uses the services of these two objects to display the selected item, and you can manipulate them as well.

The following VBA method accesses the geographic view's map (as an *IActiveView*) and zooms in a fixed amount:

```
Public Sub ZoomIn()
   Dim pApp As IGxApplication
   Set pApp = Application
   If Not TypeOf pApp.View Is IGxPreview Then Exit Sub

   Dim pPreview As IGxPreview
   Set pPreview = pApp.View
   If Not TypeOf pPreview.View Is IGxGeographicView Then Exit Sub

   Dim pGeoView As IGxGeographicView
   Set pGeoView = pPreview.View
   Dim pActiveView As IActiveView
   Set pActiveView = pGeoView.Map

   Dim pExtent As IEnvelope
   Set pExtent = pActiveView.Extent
   pExtent.Expand 0.75, 0.75, True
   pActiveView.Extent = pExtent
   pActiveView.Refresh
End Sub
```

Newer versions of ArcCatalog also support previewing a map document's page layout within the geographic view. In these cases, you can use the new *IGxGeographicView2* interface and access its *ActiveView* property. It will contain a reference to a page layout object if the selected item refers to a map document (*GxMap*). You can manipulate this object in any way you desire.

IGxGeographicView : IUnknown	*Provides access to members that control the GxGeographicView.*
DisplayedLayer: ILayer	*The layer object currently being displayed.*
Map: IMap	*The map object that is used to draw the layer.*
MapDisplay: IScreenDisplay	*The display object that is used to draw the layer.*

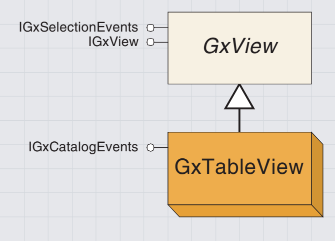
The *IGxGeographicView* interface is implemented by the *GxGeographicView* object. It provides access to the map and screen display that preview the currently selected object. Through this interface, the developer can retrieve the layer being displayed, then use the map and screen display properties to show additional information within the view.

The *DisplayedLayer* property is set to *Nothing* when the selected object cannot be previewed in the *GxGeographicView*. The following VBA code demonstrates how you might check for this condition:

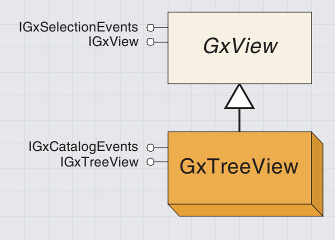
```
Sub GxGeographicViewDisplayLayer()
  Dim pApp As IGxApplication
  Dim pView As IGxView
  Dim pPreview As IGxPreview
  Dim pGeo As IGxGeographicView

  Set pApp = Application
  Set pView = pApp.View

  If TypeOf pView Is IGxPreview Then
    Set pPreview = pView
    If TypeOf pPreview.View Is IGxGeographicView Then
      Set pGeo = pPreview.View
      If pGeo.DisplayedLayer Is Nothing Then
        Debug.Print "nothing is displayed"
       Else
        Debug.Print "something is there"
       End If
    End If
  End If
End Sub
```

IGxGeographicView2 : IUnknown	***Provides access to more members that control the GxGeographicView.***
ActiveView: IActiveView	*The active view object(either map or page layout).*

The *IGxGeographicView2* interface provides access to the *IActiveView* of the map being used to preview the current selection.



GXTableView *is accessed via the preview viewer. It shows a table view of the class.*



The tree view displays your data holdings in a parent–child structure.

The *GxTableView* object is similar to the *GxGeographicView* in that it is used to preview data. By default, it is accessed through the Preview tab. As the name implies, the *GxTableView* coclass is used to preview the table associated with the selected object. The coclass is a type of *GxView*, so it implements the *IGxView* interface, but it does not implement any additional interfaces.

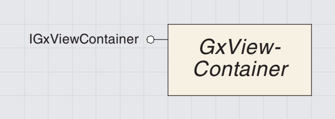
The tree view is represented by *GxTreeView*; it shows a hierarchical organization of your data holdings as parents and children. It is unlikely you will need to interact programmatically with the tree view other than to force it to reveal a particular *GxObject* (through the *IGxTreeView::EnsureVisible* method) or to initiate a renaming operation (through *BeginRename*).

IGxTreeView : IUnknown	***Provides access to members that control the GxTreeView.***
← BeginRename	*Starts a rename operation on the current selection.*
← EnsureVisible (Object: IGxObject)	*Ensures that the current selection is visible, scrolling/expanding if necessary.*
← ExpandSelection (in Selection: IGxSelection)	*Instructs the tree view to expand the current selection.*

The *IGxTreeView* interface is implemented only by the *GxTreeView* object. It provides the ability to manipulate the object selected in the tree view. Through this interface, the developer can begin a rename process, ensure the visibility of the object, or expand the node in the tree view.

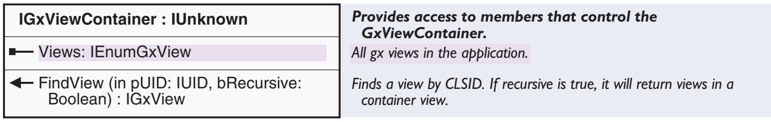
The following VBA code begins the rename process for the selected object in the tree view:

```
Dim pApp As IGxApplication, pTreeView As IGxTreeView
Set pApp = Application
Set pTreeView = pApp.TreeView
pTreeView.BeginRename
```



The GXViewContainer *supports holding more than one* GXView *within it.*

The *GxViewContainer* object permits a *GxView* object to be a container for additional views. The *GxPreview* coclass is the only type of *GxViewContainer* object currently implemented in ArcCatalog. Out of the box, the *GxPreview* object contains the *GxGeographicView* and *GxTableView* objects. This functionality is exposed in the user interface through the Geography and Table options on the Preview tab in ArcCatalog.



IGxViewContainer : IUnknown — *Provides access to members that control the GxViewContainer.*

Views: IEnumGxView — *All gx views in the application.*

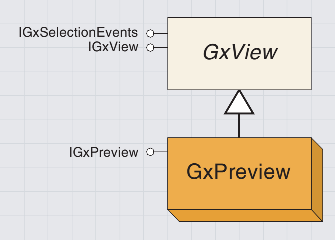
FindView (in pUID: IUID, bRecursive: Boolean) : IGxView — *Finds a view by CLSID. If recursive is true, it will return views in a container view.*

The *IGxViewContainer* interface provides access to the views within the container. It is not possible to add additional views to the container through this interface. Additional views must be added by registering a component in the ESRI GxPreviews category.

The *Views* property returns an enumeration of all the valid views in the container for the currently selected object.

The following VBA code demonstrates how to find the table view through the *IGxViewContainer* interface when the Preview tab is active:

```
Dim pApp As IGxApplication, pGxView As IGxView
Set pApp = Application
Set pGxView = pApp.View
If TypeOf pGxView Is IGxViewContainer Then
  Dim pViewCont As IGxViewContainer, pUID As New UID, pView As IGxView
  Set pViewCont = pGxView
  pUID = "{9C34344D-99DC-11D2-AF6A-080009EC734B}"
  Set pView = pViewCont.FindView(pUID, False)
  If pView Is Nothing Then
    MsgBox "could not find it"
  End If
End If
```



The GXPreview *coclass contains the geographic and table views as well as any user-defined views.*

The *GxPreview* coclass is the only type of *GxView* that is also a type of *GxViewContainer*. The class is implemented as a tab within ArcCatalog, but within that tab is a container for additional views. These views provide previews of the selected object, depending on which ones are applicable. For example, the geography and table previews are available for a shapefile, while only the table preview is available for a table.

IGxPreview : IUnknown	*Provides access to members that control the GxPreview.*
SupportedViewClassIDs: ISet	*A list of the class IDs for the views that are supported given the current selection.*
View: IGxView	*The current view.*
ViewClassID: IUID	*The class ID of the current view.*

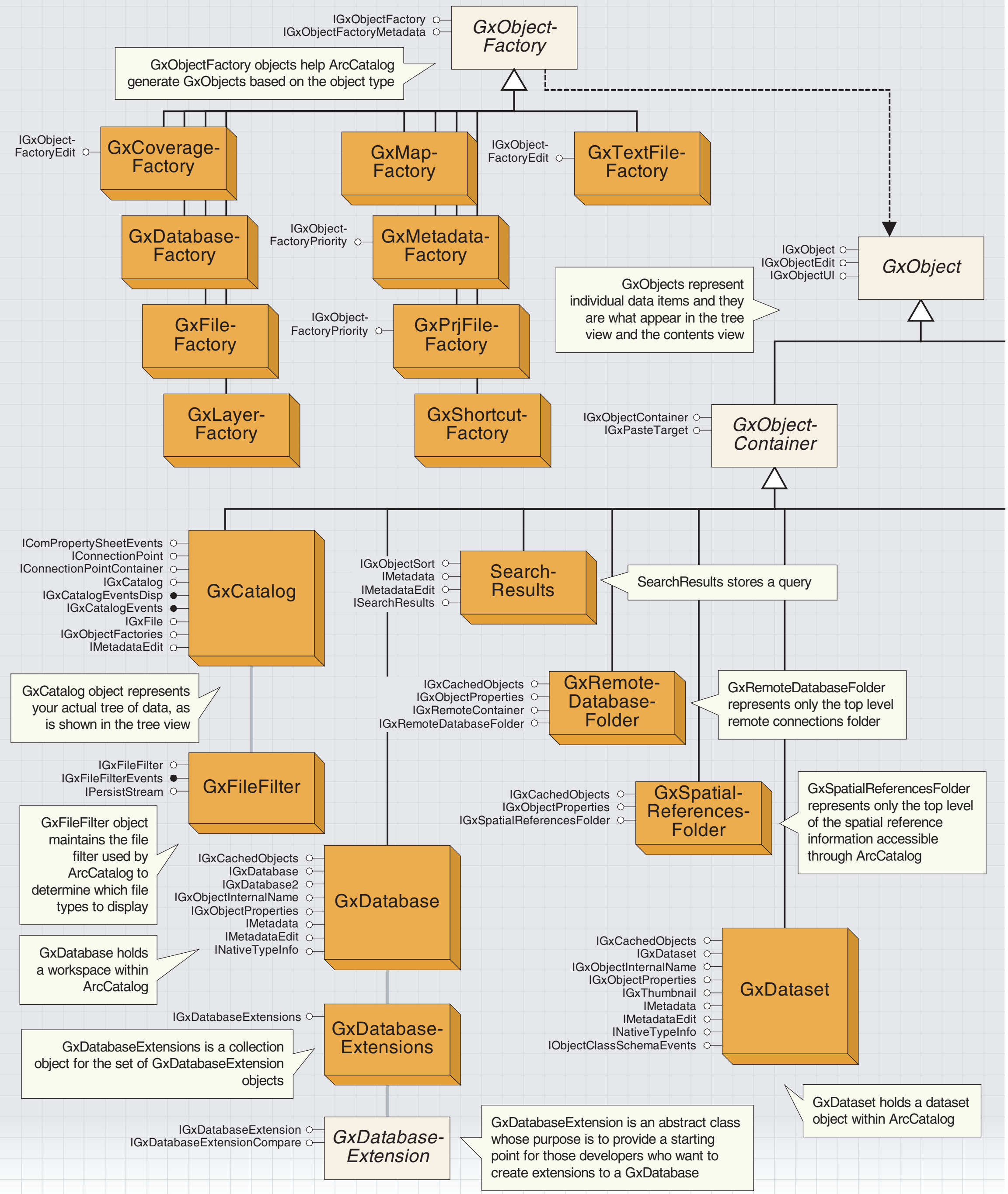
The *IGxPreview* interface is implemented by the *GxPreview* object. It provides access to the supported views for the selected object. Use this interface when you want to find out what the supported views are, or to retrieve or set the current view.

The *ViewClassID* property sets and retrieves the current view through its UID. Setting the UID is the only way to change the current view within the *GxPreview* object.

The following VBA code updates the *ViewClassID* to the *GxTableView* preview (your code should make sure the *GxTableView* view is one of the support views before setting the property):

```
Sub UpdateViewClassID()
  Dim pApp As IGxApplication, pGxView As IGxView
  Set pApp = Application
  Set pGxView = pApp.View
  If TypeOf pGxView Is IGxPreview Then
    Dim pPrev As IGxPreview, pUID As New UID
    Set pPrev = pGxView
    Debug.Print pPrev.ViewClassID
    pUID = "{9C34344D-99DC-11D2-AF6A-080009EC734B}" 'GUID for GxTableView
    pPrev.ViewClassID = pUID
  End If
End Sub
```

GxObject and



GxObjectFactory objects help ArcCatalog generate GxObjects based on the object type

GxObjects represent individual data items and they are what appear in the tree view and the contents view

SearchResults stores a query

GxCatalog object represents your actual tree of data, as is shown in the tree view

GxRemoteDatabaseFolder represents only the top level remote connections folder

GxSpatialReferencesFolder represents only the top level of the spatial reference information accessible through ArcCatalog

GxFileFilter object maintains the file filter used by ArcCatalog to determine which file types to display

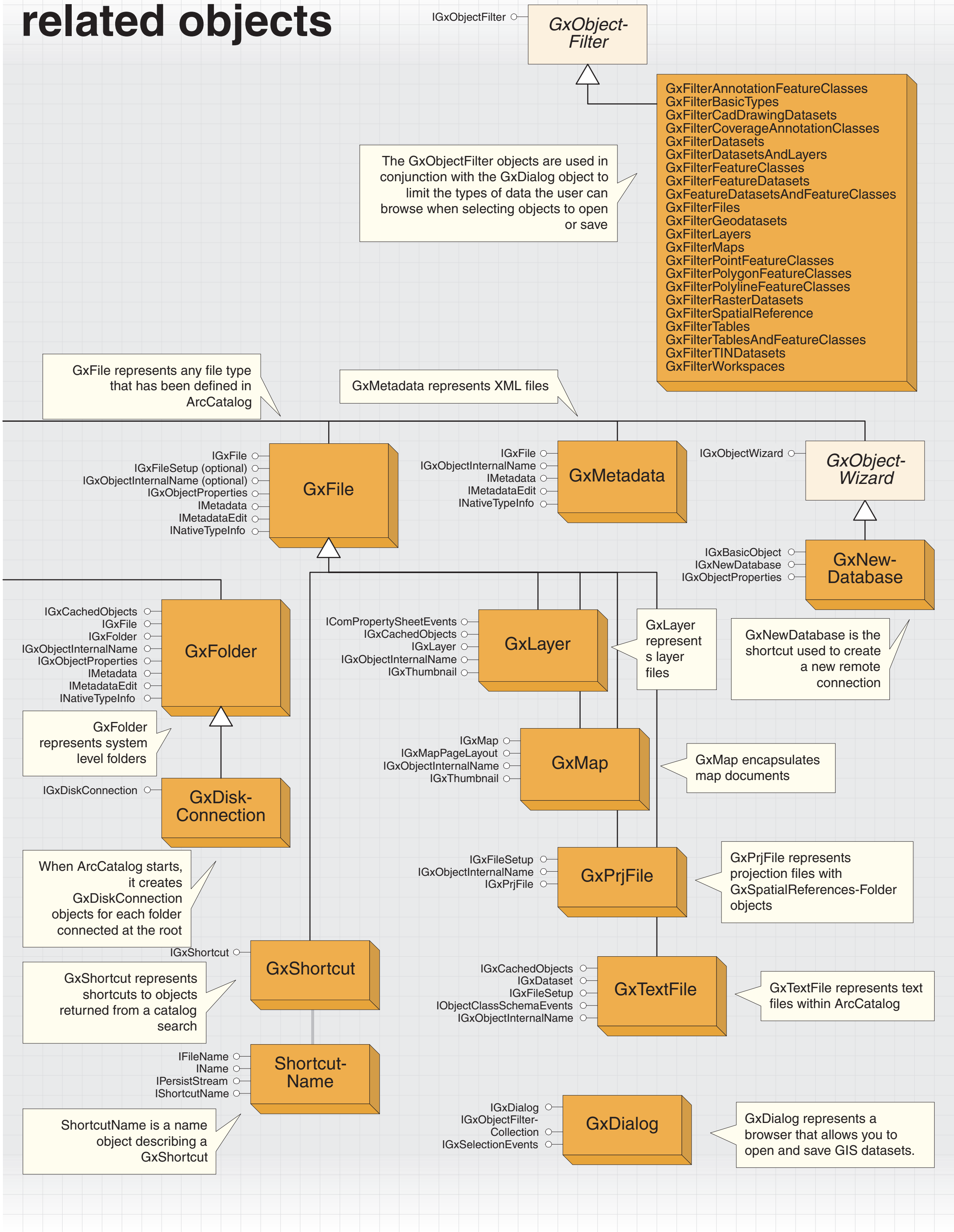
GxDatabase holds a workspace within ArcCatalog

GxDatabaseExtensions is a collection object for the set of GxDatabaseExtension objects

GxDatabaseExtension is an abstract class whose purpose is to provide a starting point for those developers who want to create extensions to a GxDatabase

GxDataset holds a dataset object within ArcCatalog

related objects



The GxObjectFilter objects are used in conjunction with the GxDialog object to limit the types of data the user can browse when selecting objects to open or save

GxFile represents any file type that has been defined in ArcCatalog

GxMetadata represents XML files

GxLayer represent s layer files

GxNewDatabase is the shortcut used to create a new remote connection

GxFolder represents system level folders

GxMap encapsulates map documents

When ArcCatalog starts, it creates GxDiskConnection objects for each folder connected at the root

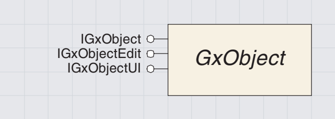
GxPrjFile represents projection files with GxSpatialReferences-Folder objects

GxShortcut represents shortcuts to objects returned from a catalog search

GxTextFile represents text files within ArcCatalog

ShortcutName is a name object describing a GxShortcut

GxDialog represents a browser that allows you to open and save GIS datasets.



GxObject is perhaps the most important abstract class in ArcCatalog. Every item that shows up in the tree and list views is a GxObject of one sort or another. There are several dozen types of GxObjects, ranging from GxDatabase to GxPrjFile.

GxObjects should be viewed as a means to an end, meaning you should always work with the objects that they are encapsulating. This is very important if objects are to be stored in data structures for later use. For example, when using the GxDialog to access datasets on a disk, you should not store the GxObjects returned for later use; instead, store the dataset objects that are encapsulated by the GxObject.

If you want to create your own custom GxObject, you need to first implement IGxObjectFactory, which actually returns GxObjects. Then, you need to implement the IGxObject and IGxObjectUI interfaces to show the GxObject within ArcCatalog.

You can implement various methods under the IGxObject interface to provide specific operations on this object. For example, the Category property would show the category in the Type column in details view.

The IGxObjectUI interface allows you to specify a bitmap for your custom GxObject so that it shows up in the tree view. There are methods to show small icons and large icons so that they show up accordingly in the details/list/icons view types in the contents view.

Using the *IGxObject* interface, ArcCatalog calls *Attach* to initialize the object, passing in references to its parent and the *GxCatalog* object. The object should hold onto these references, then release them when ArcCatalog calls the *Detach* method. This behavior is necessary to guarantee that no circular dependencies develop between the object and its parent, or the *GxCatalog* coclass.

ArcCatalog relies on three separate properties to retrieve information about the textual name of the object:

- *Name* indicates the short name of the object including its extension (if any).
- *BaseName* returns the name without the filename extension (if it has one).
- *FullName* returns a string identifying the fully qualified pathname of the object starting at the root level. This is not necessarily a path to a file on disk since the object might exist within a database hierarchy somewhere. It is a fully qualified path within the context of ArcCatalog. It is made up of the names of all its *GxObjects* parents, each separated from the other with a backslash ("\") character.

The easiest way for an object to assemble and return this path is to call the *ConstructFullName* utility method on the *GxCatalog* object, passing in itself as a parameter.

IGxObject : IUnknown	***Provides access to members that are common to all GxObjects.***
BaseName: String	*The base name of the object (i.e. no extension).*
Category: String	*The category of the object.*
ClassID: IUID	*The class ID of this object.*
FullName: String	*The full name of the object.*
InternalObjectName: IName	*The Name for the internal object that this GxObject represents.*
IsValid: Boolean	*Indicates if the object is still valid.*
Name: String	*The short name of the object.*
Parent: IGxObject	*The parent of the object.*
Attach (in Parent: IGxObject, in pCatalog: IGxCatalog)	*Attaches the object to its parent and the catalog.*
Detach	*Instructs the object to detach itself from its parent and the catalog.*
Refresh	*Updates the object and any children of the object.*

In order to be a *GxObject*, an object only needs to support *IGxObject*, though it will usually implement a number of other interfaces as well. To start with, however, it must support *IGxObject* since ArcCatalog uses this interface to set up and tear down the object, as well as to retrieve certain critical information from it during its lifetime. The *IGxObject* interface provides read-only access to the description of the object, such as name, parent, and category.

InternalObjectName is used for data-transfer operations. If you want your object to participate in drag-and-drop or copy-and-paste operations, you need to return something for this property. This property represents the actual data object that your *GxObject* manages. For example, database objects, such as *GxDatabase* and *GxDataset*, wrap underlying geodatabase entities, such as workspaces and datasets. It is these underlying objects that *InternalObjectName* references, not the

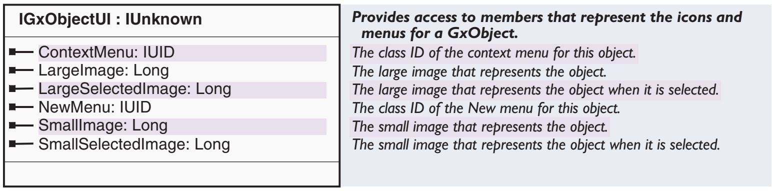
GxObject itself. Moreover, this property indirectly references these underlying objects via a *Name* object (sometimes also called a moniker).

ArcCatalog calls *Refresh* on your object whenever it needs to ensure your state is up to date. Mostly, this happens as a direct result of the user forcing a refresh of a part of the *GxCatalog* tree. It is your object's responsibility to release and re-create its internal state, then propagate the *Refresh* call onto any children it has.

IsValid is called periodically by ArcCatalog to verify that your object is in a legitimate state. Typically, it does so prior to performing critical operations involving your object, such as data transfer or the like.

Here is some VBA code to loop through the selected objects in the tabbed view and print their categories.

```
Dim pApp As IGxApplication, pGxSel As IGxSelection, _
  pEnumGxObj As IEnumGxObject
Dim pGxObj As IGxObject
Set pApp = Application
Set pGxSel = pApp.Selection
Set pEnumGxObj = pGxSel.SelectedObjects
Set pGxObj = pEnumGxObj.Next
Do While Not pGxObj Is Nothing
  Debug.Print pGxObj.Category
  Set pGxObj = pEnumGxObj.Next
Loop
```



IGxObjectUI : IUnknown	***Provides access to members that represent the icons and menus for a GxObject.***
ContextMenu: IUID	*The class ID of the context menu for this object.*
LargeImage: Long	*The large image that represents the object.*
LargeSelectedImage: Long	*The large image that represents the object when it is selected.*
NewMenu: IUID	*The class ID of the New menu for this object.*
SmallImage: Long	*The small image that represents the object.*
SmallSelectedImage: Long	*The small image that represents the object when it is selected.*

During an object's lifetime, ArcCatalog uses the *SmallImage, SmallSelectedImage, LargeImage,* and *LargeSelectedImage* properties of the optional *IGxObjectUI* interface to determine what images to use when displaying the object in the tree and contents views. Your object should return HBITMAPs for these properties.

Since these properties are requested frequently, you should load the images only once and cache them for later retrieval, rather than loading them each time they are requested. If you choose not to implement *IGxObjectUI*, ArcCatalog can still display and work with your object, but it will use a generic icon in the various views.

ContextMenu and *NewMenu* return GUIDs that indicate the menus that will display when the user attempts to manipulate the object through the ArcCatalog user interface.

IGxObjectEdit : IUnknown	**Provides access to members that edit/modify a GxObject.**
← CanCopy: Boolean	*Indicates if the object can be copied.*
← CanDelete: Boolean	*Indicates if the object can be deleted.*
← CanRename: Boolean	*Indicates if the object can be renamed.*
← Delete	*Deletes the object.*
← EditProperties (in hParent: Long)	*Presents a modal dialog to allow editing the object's properties.*
← Rename (in newShortName: String)	*Renames the object.*

An object should implement the *IGxObjectEdit* interface if its properties can be edited by the user within the context of ArcCatalog. This interface consists of several important properties and methods.

Rename assigns a new short name to the object (if you return *True* for the *CanRename* property).

If you return *True* for the *CanDelete* property, *Delete* physically deletes the object and all its associated underlying data—ArcCatalog handles deleting the *GxObject*, but it is the object's responsibility to delete all underlying and associated data that the object represents or wraps.

CanCopy indicates if the object is a valid source for a copy operation; a return value of *True* enables the *Copy* command/menu item in ArcCatalog. (However, to fully enable an object to participate in data-transfer operations, you also need to implement the *IGxObject::InternalObjectName* property as described in the earlier discussion on data transfer.)

The *EditProperties* method brings up a dialog box appropriate to the object that allows the user to manipulate its internal properties and state. It is entirely up to you to decide what can and cannot be manipulated through this dialog box, but a good rule of thumb is that properties about the object, not the actual data contained by the object, should appear here.

For example, if the object is a table, this dialog box might show a list of all the columns present and their data types and permit the user to edit this information. However, the actual rows of data in the table would not be presented in this dialog box.

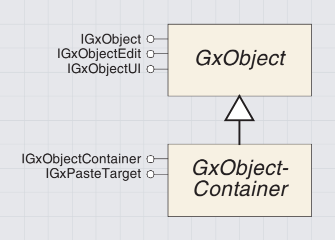
IGxPasteTarget : IUnknown	**Provides access to members for pasting objects.**
← CanPaste (in names: IEnumName, out moveOperation: Boolean) : Boolean	*Indicates if the specified names may be pasted into this object. On output, moveOperation indicates if a subsequent paste operation would represent a move, or merely a copy, operation.*
← Paste (in names: IEnumName, moveOperation: Boolean) : Boolean	*Pastes the specified names into this object. On input, moveOperation indicates if this is a move operation. On output, it indicates if the objects have been moved, or merely copied.*

The *IGxPasteTarget* interface is implemented by those *GxObjects* that can have other objects pasted into them. For example, the *GxDataset* implements *IGxPasteTarget* because it is possible to paste feature classes into an object of this type through the ArcCatalog user interface. The interface provides methods for testing whether or not a set of name objects can be pasted and methods to actually perform the paste.

Use *CanPaste* to determine if at least one object in the current set can be pasted before executing the *Paste* method.

IGxObjectInternalName : IUnknown	*Provides access to members that manage the name object that the GX object represents.*
■—□ InternalObjectName: IName	*Returns a Name for the internal object that this GxObject represents.*

IGxObjectInternalName is an optional interface for the different types of *GxObjects*. This interface provides access to the internal name of the object that implements it through the *InternalObjectName* interface.



GxObjectContainer *provides access to members that manage child* GxObjects.

Some types of *GxObjects* may also be supported by the *GxObjectContainer* abstract class. This container class is for *GxObjects* that contain other *GxObjects* within them. For example, the *GxDatabase* object can contain *GxDataset* objects (among other things), so the *GxDatabase* object is also a type of *GxObjectContainer*.

IGxObjectContainer : IUnknown	*Provides access to members that manage child GxObjects.*
AreChildrenViewable: Boolean	*Indicates if the objects children are available for viewing in the tree-view.*
Children: IEnumGxObject	*An enumeration of the child objects.*
HasChildren: Boolean	*Indicates if the object has any children.*
AddChild (in child: IGxObject) : IGxObject	*Adds a new child and returns a reference to it. However, if a duplicate already exists, the function returns the existing child instead.*
DeleteChild (in child: IGxObject)	*Deletes the specified child object.*

If an object can contain other objects as children, it must implement the *IGxObjectContainer* interface. This interface exposes methods and properties to access and manipulate the children of the object.

The *HasChildren* property indicates if the object presently has any children.

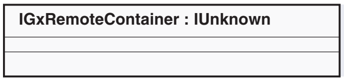
Children returns an enumeration of the current set of children.

AreChildrenViewable indicates if the children should show up as items in the tree view within ArcCatalog; usually, this makes sense, but in certain cases you might want to prevent this from happening.

The last two methods, *AddChild* and *DeleteChild*, do not have to be implemented—they are only used when a container is up and running in ArcCatalog and the user wishes to either create new items in that container or remove items from it. They aren't required since doing a *Refresh* on the container (or one of its ancestors) will refresh its set of children as well.

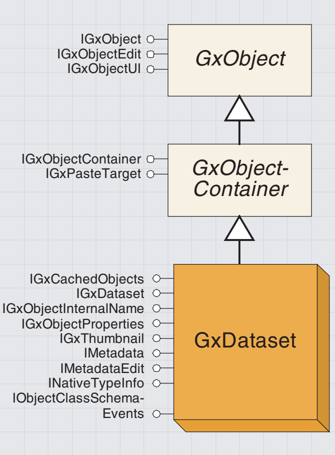
The following VBA code demonstrates how to loop through the children of a *GxObjectContainer* object:

```
Dim pApp As IGxApplication, pGxSel As IGxSelection, pGxObj As IGxObject
Set pApp = Application
Set pGxSel = pApp.Selection
Set pGxObj = pGxSel.Location
If TypeOf pGxObj Is IGxObjectContainer Then
  Dim pGxObjCont As IGxObjectContainer, pEnum As IEnumGxObject
  Dim pObject As IGxObject
  Set pGxObjCont = pGxObj
  Set pEnum = pGxObjCont.Children
  Set pObject = pEnum.Next
  Do While Not pObject Is Nothing
    Debug.Print pObject.Category
    Set pObject = pEnum.Next
  Loop
End If
```



Identifies an object that contains objects from a remote source.

GxObjectContainer objects that are based on remote connections implement the *IGxRemoteContainer* interface. The *GxRemoteDatabaseFolder* object is an example of a container object for remote database connections. The interface has no properties or methods, but it does identify the implementing object as a remote container object.

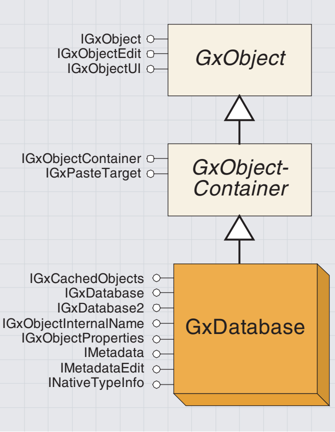


GxDataset *holds a dataset object within ArcCatalog.*

The *GxDataset* object holds an *IDatabase* object within ArcCatalog. The coclass is a descendant of both *GxObject* and *GxObjectContainer*.

IGxDataset : IUnknown	***Provides access to members that manages the properties of a GX dataset object.***
Dataset: IDataset	*The associated dataset.*
DatasetName: IDatasetName	*The associated dataset name.*
Type: esriDatasetType	*The type of the associated dataset.*

The *IGxDataset* interface provides access to the dataset itself. Through this interface, the developer can retrieve the *IDataset* or the *IDatasetName* object along with the type of dataset. This interface is implemented by several different types of dataset objects including *GxCadDataset, GxCoverageDataset, GxShapefileDataset,* and *GxVpf-Dataset*.



GxDatabase *represents a database in ArcCatalog.*

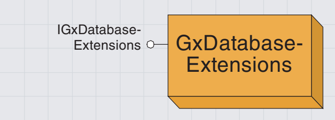
The *GxDatabase* object holds an *IWorkspace* object within ArcCatalog. The coclass is a descendant of both *GxObject* and *GxObjectContainer*. The *GxDatabase* object pertains to a geodatabase database.

IGxDatabase : IUnknown	***Provides access to members that manage the properties of a GX database object.***
IsConnected: Boolean	*Indicates if the database is connected.*
IsRemoteDatabase: Boolean	*Indicates if the database is remote.*
Workspace: IWorkspace	*The associated workspace.*
WorkspaceName: IWorkspaceName	*The workspace name.*
Disconnect	*Disconnects or releases the connection to the underlying database.*

The *IGxDataset* interface provides access to the workspace itself. Through this interface, the developer can retrieve the *IWorkspace* or the *IWorkspaceName* object along with the type of dataset. This interface is implemented by several different types of database objects including *GxCoverageDatabase, GxPcCoverageDatabase,* and *GxPre70Coverage-Database*.

IGxDatabase2 : IUnknown	***Provides access to members that manage the properties of a GX database object.***
IsEnterpriseGeodatabase: Boolean	*Indicates if the database is an enterprise geodatabase.*

The *IGxDatabase2* is implemented by the *GxDatabase* object. It provides access to the *IsEnterpriseGeodatabase* property. As the name implies, the property indicates whether or not the database is an enterprise database (an ArcSDE database).



The GxDatabaseExtensions *object is a collection object for the set of* GxDatabaseExtension *objects.*

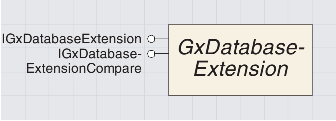
Each geodatabase can have a set of extensions associated with it (such as the *GxGeocodingServiceExtension*). The *IGxDatabaseExtensions* interface allows access to those extensions.

To obtain a *GxDatabaseExtensions* object, simply create one. The following VBA code shows you how to do that.

```
Dim pGxDataExts As IGxDatabaseExtensions
Set pGxDataExts = New GxDatabaseExtensions
Debug.Print pGxDataExts.Count
```

IGxDatabaseExtensions : IUnknown	***Provides access to members that return GX database extensions.***
Count: Long	*The number of database extensions.*
GetExtension (in Index: Long) : IGxDatabaseExtension	*Get an extension.*

The *IGxDatabaseExtensions* interface is implemented by the *GxDatabaseExtensions* object. It provides access to the extensions held within the collection.



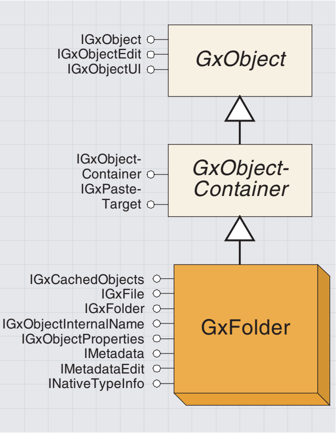
GxDatabaseExtension *provides a starting point for developers who want to create extensions to a* GxDatabase.

GxDatabaseExtension is an abstract class that provides a starting point for those developers who want to create extensions to a *GxDatabase*. The Geocoding service (*GxGeocodingServiceExtension*) is an example of a *GxDatabaseExtension* that supports the creation of address-matching services for use with ArcMap. Developers might want to develop their own extensions to support custom services.

IGxDatabaseExtension : IUnknown	***Provides access to members that manage a GX database extension.***
Catalog: IGxCatalog	*Attach the catalog to the database extension.*
Name: String	*The name of the extension.*
Compare (in gxObject1: IGxObject, in gxObject2: IGxObject, in Ascending: Boolean) : Long	*Check if the objects are children and if yes compare them.*
GetChildren (in Workspace: IWorkspace) : IEnumGxObject	*Get children.*
HasChildren (in Workspace: IWorkspace) : Boolean	*Verify if this extension has children.*

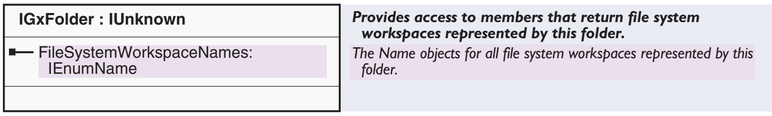
All *GxDatabaseExtension* objects implement the *IGxDatabaseExtension* interface. The *GxGeocodingServiceExtension* object is an example of an extension that allows the creation of address-matching services. The interface provides the ability to check whether or not an extension has children defined for it and to compare selected objects.

The *Compare* method determines whether or not objects are being displayed in the correct order. If the *Long* value returned is positive, then item one should be listed before item two; if zero, then the items are the same item; if negative, then item two should be listed before item one. As an example, if the only difference between two objects is the name, then the result will be positive if item one's name is alphabetically before item two's; otherwise, the result will be negative (unless reverse sorting—*Ascending* is *True*—is turned on).



GxFolder *represents system-level folders.*

The *GxFolder* object represents system-level folders (directories). These folders represent workspaces if they contain ArcCatalog-supported data (such as coverages, shapefiles, or CAD drawings).


IGxFolder : IUnknown

FileSystemWorkspaceNames: IEnumName

Provides access to members that return file system workspaces represented by this folder.

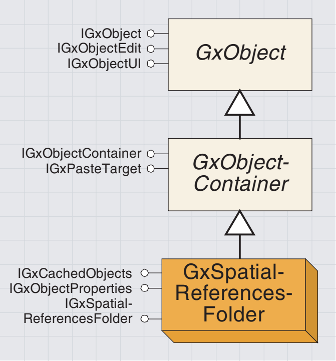
The Name objects for all file system workspaces represented by this folder.

The *GxFolder* object implements the *IGxFolder* interface. The purpose of the interface is to provide access to the workspace *Name* objects that may be part of the folder.

FileSystemWorkspaceNames returns an enumeration of *Name* objects. *Name* objects only apply when the folder contains coverages. For more information on *Name* objects, see Volume 2, Chapter 8, 'Accessing the geodatabase'.

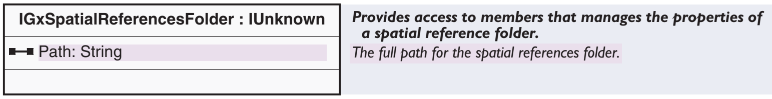
The following sample VBA code uses the *IGxFolder* interface to display the *Name* objects within a selected folder:

```
Dim pApp As IGxApplication, pGxSel As IGxSelection, _
  pEnumGxObj As IEnumGxObject
Dim pGxObj1 As IGxObject, pGxFolder As IGxFolder, pEnumName As IEnumName
Dim pName As IName
Set pApp = Application
Set pGxSel = pApp.Selection
If pGxSel.Count > 0 Then
  Set pEnumGxObj = pGxSel.SelectedObjects
  Set pGxObj1 = pEnumGxObj.Next
  If Not TypeOf pGxObj1 Is IGxFolder Then Exit Sub
  Set pGxFolder = pGxObj1
  Set pEnumName = pGxFolder.FileSystemWorkspaceNames
  Set pName = pEnumName.Next
  Do While Not pName Is Nothing
    Debug.Print pName.NameString
    Set pName = pEnumName.Next
  Loop
End If
```



GxSpatialReferencesFolder *represents the top level of the spatial reference information that is accessible through ArcCatalog.*

The *GxSpatialReferencesFolder* object represents the top level of the spatial reference information that is accessible through ArcCatalog. The *Type* of folder, as listed in ArcCatalog, is Coordinate Systems Folder. This is a root-level folder that contains additional folders that hold the different types of supported spatial references.


IGxSpatialReferencesFolder : IUnknown

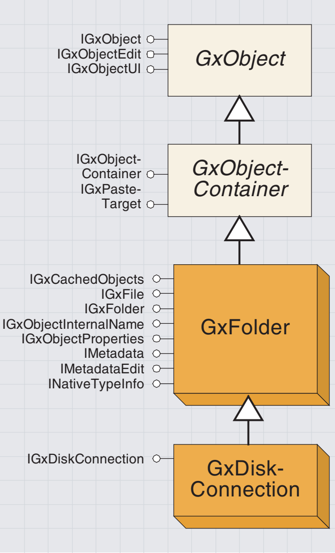
Path: String

Provides access to members that manages the properties of a spatial reference folder.

The full path for the spatial references folder.

The *GxSpatialReferencesFolder* object implements the *IGxSpatialReferencesFolder* interface. The interface allows for the retrieval and setting of the path to the spatial reference files on the system.

GxDiskConnection and GxRemoteDatabaseFolder



When ArcCatalog starts, it creates GxDiskConnection *objects for each folder connected at the root.*

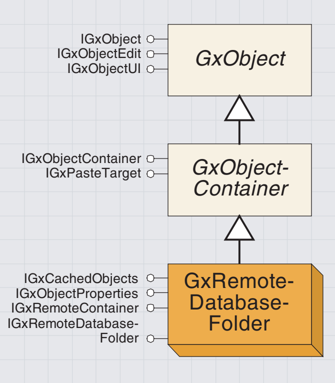
The *GxDiskConnection* object represents the top-level disk connections. For example, the c:\ and d:\ drives on your local machine are *GxDiskConnection* objects (as well as *GxObjects*). Also, any additional remote folders the user adds with the Connect to Folder button are *GxDiskConnection* objects.

IGxDiskConnection : IUnknown

Identifies an object that represents a connection to disk.

Only the *GxDiskConnection* object implements the *IGxDiskConnection* interface. The interface does not support any properties or methods but allows the developer to determine whether or not the current *GxObject* is also a *GxDiskConnection* object. This can be accomplished through the following VBA code:

```
Dim pApp As IGxApplication, pGxSel As IGxSelection, pGxObj As IGxObject
Set pApp = Application
Set pGxSel = pApp.Selection
Set pGxObj = pGxSel.FirstObject
If TypeOf pGxObj Is IGxDiskConnection Then
  Debug.Print "The user picked a GxDiskConnection object"
End If
```



GxRemoteDatabaseFolder *represents the top-level remote connections folder.*

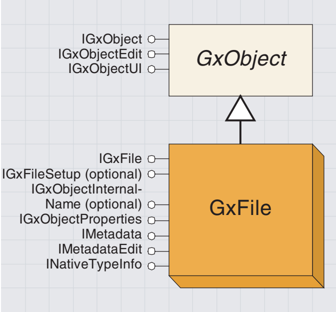
The *GxRemoteDatabaseFolder* object represents the top-level remote connections folder. There is only one object of this type. The *Type* of folder, as listed in ArcCatalog, is Database Connections Folder. This is a root-level folder that contains connection files to remote databases (for example, SDE® or OLE DB). The remote part is intended to correspond to the Feature Database Object (FDO) remote database type, *esriRemoteDatabaseWorkspace*, but it's possible to create an OLE DB connection to something local on your machine, as well as a remote machine.

IGxRemoteDatabaseFolder : IUnknown

Provides access to members that defines the remote databases folder.

■━ Path: String — *The value of the Path property.*

The *GxRemoteDatabaseFolder* object implements the *IGxRemoteDatabaseFolder* interface. The interface allows for the retrieval and setting of the path to the connection files for the remote databases.



A GxFile *object represents any file type that has been defined in ArcCatalog.*

The user can define file types that they want to have displayed in ArcCatalog through the File Types tab on the Options dialog box (or through *IGxFileFilter::AddFileType*). The files that are then displayed in the Catalog are *GxFile* objects.

For example, you may choose to have .txt files displayed within ArcCatalog. Using the *IGxFile* interface, *GxFile* objects can be manipulated based on the application associated with the file. For example, .doc files could be opened inside of Microsoft Word.

The following VBA code creates a new *GxFile* object and opens it in edit mode based on the application associated with the file (Microsoft Word, in the case of a .doc file):

```
Dim pFile As IGxFile
Set pFile = New GxFile
pFile.Path = "d:\tools\various\labeling.doc"
pFile.Edit
```

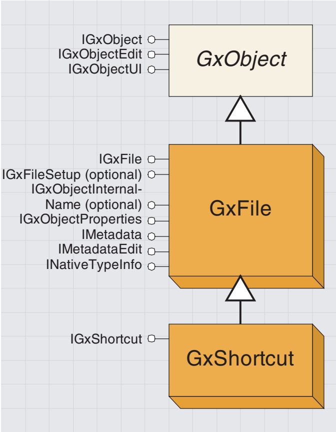
IGxFile : IUnknown	***Provides access to members that manages a file object.***
Path: String	*The full path for the file.*
Close (in saveChanges: Boolean)	*Closes the file, optionally saving changes.*
Edit	*Opens an editor to modify the file.*
New	*Creates a new file.*
Open	*Opens the file.*
Save	*Saves changes without closing the file.*

The *GxFile* object and several other types of *GxObjects* implement the *IGxFile* interface. The interface allows for the writing of information onto disk. Be sure methods that you attempt to apply to the selected object are valid for that object. For example, *IGxFile::Open* has no effect on a .txt file associated with the NotePad application, while *IGxFile::Edit* opens the file in edit mode.

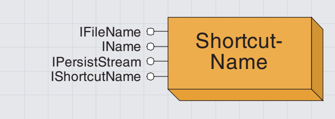
Updating the *Path* property changes the file associated with the current instance of the *GxObject*, but it does not change what is selected in ArcCatalog.

The *Close, Edit, New, Open,* and *Save* methods have varying affects on the object, depending on the application associated with it. Be sure you are applying the correct methods based on the *IGxFile* you are manipulating. Use error checking to ensure your application will not fail when one of the methods does.

GxShortcut and ShortcutName



GxShortcut *represents shortcuts to objects returned from a Catalog search.*



ShortcutName *is a name object that describes a* GxShortcut.

The *GxShortcut* objects represent shortcuts to objects returned from a Catalog search; they do not represent system shortcut files. *GxShortcut* objects are found under the Search Results heading in tree view.

These objects provide a way to access the *GxObjects* returned by a search without having to copy the data to a new location. The *GxShortcut* objects provide a path to the location of the real object and allow you to access the object directly.

IGxShortcut : IUnknown	***Provides access to members that manages the target of a shortcut object.***
■—□ Target: IGxObject	*The value of the Target property.*
■—■ TargetLocation: String	*The location of the target.*

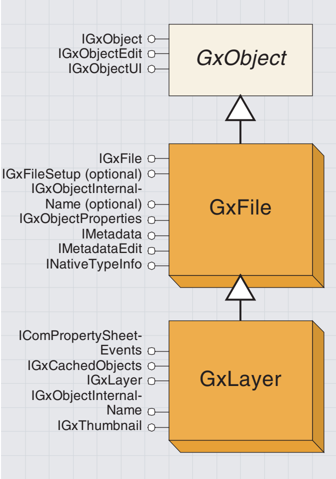
The *IGxShortcut* interface is implemented by the *GxShortcut* object. It provides access to the path and the actual object associated with the shortcut. Use this interface when you want to access the object returned by a search or when you want to determine the path to the object.

A *ShortcutName* is a name object that describes a *GxShortcut*. If you call *IGxObject::InternalObjectName* on a *GxShortcut*, you will get a *ShortcutName* coclass.

GxShortcuts have a special name object because the layer factories need to know how to deal with them. The *CanCreate* and *Create* methods on a layer factory take a name object. In the case of a shortcut, this name object needs to delegate to the target's name object so that a layer is created on the *GxObject* to which the shortcut is pointing.

IShortcutName : IUnknown	***Provides access to members that define the target for the shortcut name.***
■—□ TargetName: IName	*The value of the TargetName property.*

The *IShortcutName* interface is implemented by the *ShortcutName* object. It provides access to the *Name* object for the layer to which the shortcut points. The majority of developers will not use this object and interface.



GxLayer *encapsulates a map layer.*

The *GxLayer* object represents a layer file that points to a data source. Layer files do not represent the data source itself but instead, the layer file created for that data source. Through the *GxLayer* object, the developer can access the layer and the system path to that layer (*IGxFile::PathName*).

The following VBA code demonstrates how to create a *GxLayer* object (in this case pointing to a CAD file) from the selected item:

```
Dim pLayerFactory As ILayerFactory, pApp As IGxApplication, _
  pGxObject As IGxObject
Dim pName As IName

Set pLayerFactory = New CadLayerFactory
Set pApp = Application

Set pGxObject = pApp.SelectedObject
' Use GetObjectFromFullName if you want to specify a path to a file on disk
Set pName = pGxObject.InternalObjectName

If Not pLayerFactory.CanCreate(pName) Then
  MsgBox "Cannot create layer"
  Exit Sub
End If

Dim pEnum As IEnumLayer, pLayer As ILayer, pGxLayer As IGxLayer, _
  pFile As IGxFile
Set pEnum = pLayerFactory.Create(pName)
Set pGxLayer = New GxLayer
Set pFile = pGxLayer
pFile.Path = "C:\temp\mylayer.lyr"
Set pGxLayer.layer = pEnum.Next
pFile.Save
```

IGxLayer : IUnknown — ***Provides access to members that manage a GX layer object.***

Layer: ILayer — *The associated layer.*

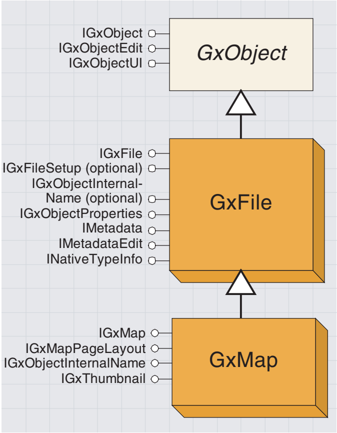
The *GxLayer* object implements the *IGxLayer* interface. It provides access to the *ILayer* the object represents. Use this interface when you want to access or update the properties of the layer.

The following VBA code demonstrates how to update the renderer for a layer through the *IGxLayer* interface:

```
Sub ChangeLayerProps()
  Dim pGxCat As IGxCatalog
  Dim pGxLayer As IGxLayer
  Dim pGxObj As IGxObject
  Dim pEnumGxObj As IEnumGxObject

  Set pGxCat = New GxCatalog
  Dim lNum As Long
```

```
    Dim v As Variant

    Set v = pGxCat.GetObjectFromFullName("d:\data\uslakes layer.lyr", lNum)
    If TypeOf v Is IEnumGxObject Then
      Set pEnumGxObj = v
      Set pGxObj = pEnumGxObj.Next
    Else
      Set pGxObj = v
    End If
    Set pGxLayer = pGxObj
    Dim pGFLayer As IGeoFeatureLayer
    Set pGFLayer = pGxLayer.Layer
    Set pGFLayer.Renderer = MakeFillRenderer

    Dim pEvent As IComPropertySheetEvents
    Set pEvent = pGxLayer
    pGxLayer.Layer.Visible = True
    pEvent.OnApply
  End Sub
```

The last three lines of the routine (use of *IComPropertySheetEvents*) are important because they force *Save* to be called for the layer. Without them, the changes to the renderer would not be persisted.



GxMap *encapsulates map documents.*

The *GxMap* object represents a map document that has been stored to a file (.mxd). The object provides browsing support for map documents within ArcCatalog and provides access to the page layout within the document. The page layout can be displayed as a thumbnail when browsing map documents.

IGxMap : IUnknown	*Identifies a GX object that corresponds to an ArcMap document.*

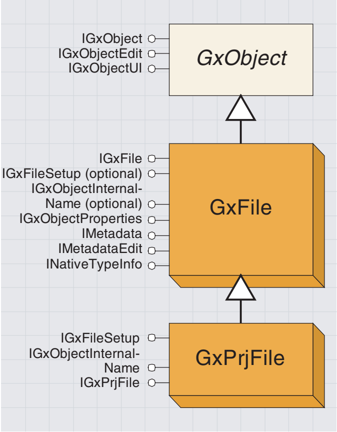
The *GxMap* object implements the *IGxMap* interface. This interface doesn't have any properties or methods, but it can be used to identify an object as type *GxMap*. The following VBA code demonstrates how this can be accomplished:

```
Dim pApp As IGxApplication, pSel As IGxSelection, pObj As IGxObject
Set pApp = Application
Set pSel = pApp.Selection
Set pObj = pSel.FirstObject
If pSel.Count < 1 Then Exit Sub
If TypeOf pObj Is IGxMap Then
  MsgBox "You selected a map!!"
End If
```

IGxMapPageLayout : IUnknown	*Provides access to members that returns the page layer for a map document.*
PageLayout: IPageLayout	*The page layout object in the map document.*

The *GxMap* object implements the *IGxMapPageLayout* interface. The interface provides access to the page layout within the map document. The page layout can then be examined to determine the data within it and the extent of the data.

The *GxPrjFile* object represents projection files with *GxSpatialReferencesFolder* objects. While browsing in ArcCatalog, you will find *GxPrjFile* objects within folders under the Coordinate Systems heading. These files represent one defined projection.

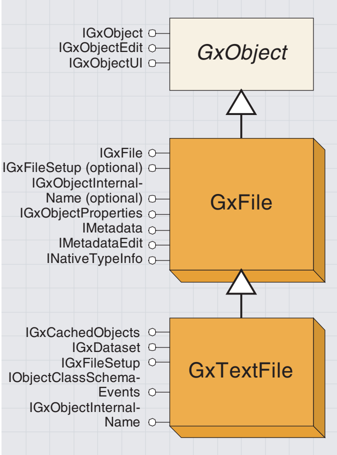


GxPrjFile *represents projection files with* GxSpatialReferencesFolder *objects.*

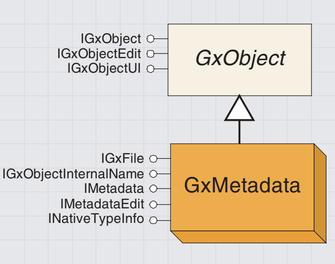
IGxPrjFile : IUnknown	*Provides access to members that returns the properties of a PRJ file.*
SpatialReference: ISpatialReference	*The spatial reference property of the PRJ file.*

The *IGxPrjFile* interface is implemented by the *GxPrjFile* object. It provides access to the projection information for the file. The projection information is returned as an *ISpatialReference*. The following VBA code demonstrates one method for determining if a *GxPrjFile* object is selected:

```
Dim pApp As IGxApplication, pSel As IGxSelection, pObj As IGxObject
Set pApp = Application
Set pSel = pApp.Selection
Set pObj = pSel.FirstObject
If pSel.Count < 1 Then Exit Sub
If TypeOf pObj Is IGxPrjFile Then
  MsgBox "You selected a project file!!"
End If
```



GxTextFile *represents text files within ArcCatalog.*



The GxMetadata *object represents XML files.*

The *GxTextFile* object represents .txt files within ArcCatalog. *GxTextFile* objects are also a type of *GxFile* object, but this type of object must have the .txt extension.

The following VBA code creates a new *GxTextFile* object and opens it in edit mode based on the application associated with the file (NotePad, in the case of a .txt file):

```
Dim pFile As IGxFile
Set pFile = New GxTextFile
pFile.Path = "d:\tools\various\labeling.txt"
pFile.Edit
```

The following VBA code demonstrates one method for determining whether or not a *GxTextFile* object is selected:

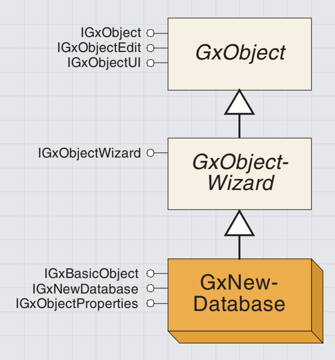
```
Dim pApp As IGxApplication, pSel As IGxSelection, pObj As IGxObject
Set pApp = Application
Set pSel = pApp.Selection
Set pObj = pSel.FirstObject
If pSel.Count < 1 Then Exit Sub
If TypeOf pObj Is IGxTextFile Then
  MsgBox "You selected a text file!!"
End If
```

In general, metadata for the different types of objects is stored in XML files associated with the object. For example, metadata for a parcels shapefile (parcels.shp) is stored in a file called parcels.shp.xml. Metadata files of this type (associated with a data type supported by ArcCatalog) will not show up in the tree and tabbed views of ArcCatalog. In order to see metadata objects within ArcCatalog, they cannot be associated with another support object.

IMetadata : IUnknown	*Provides access to members that manage and update metadata.*
■━■ Metadata: IPropertySet	*The PropertySet containing metadata.*
← Synchronize (in Action: tagesriMetadataSyncAction, in Interval: Long)	*Updates metadata with the current properties; may create metadata if it doesn't already exist.*

The *GxMetadata* object implements the *IMetadata* interface and all other objects that support metadata (the majority of *GxObject* types). Use this interface when you want to access the set of metadata associated with an object or when you want to create new metadata for the object.

The *Synchronize* method updates metadata for an object after changes have been made, but it also generates a new set of metadata if it doesn't already exist.



GxNewDatabase *provides funtionality to define the workspace factory object to use when creating a workspace.*

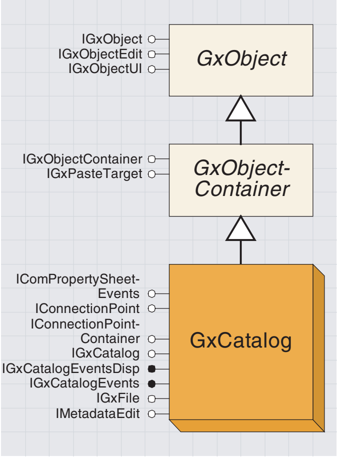
The *GxNewDatabase* object is the shortcut used to create a new remote connection. There's one instance of this object for each type of FDO remote workspace factory (for example, ArcSDE™ or OLE DB). It's the icon that invokes the wizard to create a new connection file.

IGxNewDatabase : IUnknown

Provides access to members that defines a new database shortcut.

WorkspaceFactory: IWorkspaceFactory — *The value of the workspace factory property.*

The *IGxNewDatabase* interface is implemented by the *GxNewDatabase* object. It provides the ability to specify the *WorkspaceFactory* object to use. Developers only use this interface when they want to create a shortcut in ArcCatalog for users to create a connection to a custom data type.



The GxCatalog *object represents your actual tree of data, as is shown in the tree view.*

The *GxCatalog* object represents your actual tree of data, as is shown in the tree view (the top-level object in the tree view). From the *GxCatalog* object, you can navigate to any of its descendants to access and manipulate them. The *GxCatalog* object is a type of *GxObject* and a type of *GxObjectContainer* because it is an item in the tree view and it contains additional *GxObjects*.

The *GxCatalog* object is also an event source, as it monitors the adding, deleting, and changing of the *GxObjects* within the Catalog through the *IGxCatalogEvents* interface.

IGxCatalog : IUnknown	*Provides access to members that manages a GX catalog.*
■— FileFilter: IGxFileFilter	*The file filter.*
—■ Location: String	*The location to the specified path. If the path isn't yet part of the catalog, it is added as a folder connection.*
■— SelectedObject: IGxObject	*The first selected object, or the location if no objects are selected.*
■— Selection: IGxSelection	*The selection.*
← Close	*Closes the catalog object. Clients that create a catalog object must call this method when they are finished using it.*
← ConnectFolder (in folderPath: String) : IGxFolder	*Adds a folder connection to the catalog and returns the folder object.*
← ConstructFullName (in Object: IGxObject) : String	*Constructs the full name for an object.*
← DisconnectFolder (in folderPath: String)	*Removes a folder connection from the catalog.*
← GetObjectFromFullName (in FullName: String, out numFound: Long) : Variant	*Finds an object in the catalog tree given its full name. Returns a Variant containing an IGxObject or IEnumGxObject (if duplicate names were encountered), along with the number of objects found.*
← ObjectAdded (in Object: IGxObject)	*Called when a new object has been added to part of the catalog.*
← ObjectChanged (in Object: IGxObject)	*Called when an existing object from part of the catalog has been changed.*
← ObjectDeleted (in Object: IGxObject)	*Called when an existing object has been deleted from part of the catalog.*
← ObjectRefreshed (in Object: IGxObject)	*Called when an existing object has been refreshed.*

The *GxCatalog* object implements the *IGxCatalog* interface. It lets you connect and disconnect folder objects. It also maintains the file filter associated with ArcCatalog.

GetObjectFromFullName returns a variant because it is possible to get more than one *GxObject* back from this method. For example, if you use this method on a CAD file, it returns two objects: one for the CAD file and one for the CAD dataset.

The *SelectedObject* method returns the first selected object in the tabbed view of ArcCatalog.

The following VBA code uses the *Location* property to change the selected folder in the tree view to “d:\tools”:

```
Dim pApp As IGxApplication, pCat As IGxCatalog
Set pApp = Application
Set pCat = pApp.Catalog
pCat.Location = "d:\tools"
```

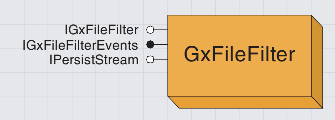
IGxObjectFactories : IUnknown	**Provides access to members that manage a collection of GX object factories.**
■— Count: Long	*The number of registered Gx object factories.*
■— EnabledGxObjectFactories: IEnumGxObjectFactory	*The enabled Gx object factories (sorted by priority).*
■— GxObjectFactory (in Index: Long) : IGxObjectFactory	*The specified Gx object factory.*
■— GxObjectFactoryCLSID (in Index: Long) : IUID	*The CLSID of the specified Gx object factory.*
■— IsEnabled (in Index: Long) : Boolean	*Indicates if a specific Gx object factory is enabled.*
← EnableGxObjectFactory (Index: Long, bEnabled: Boolean)	*Enables or disables a Gx object factory.*

The *IGxObjectFactories* interface is implemented by the *GxCatalog* object. It provides access to the *GxObjectFactory* objects registered in the ESRI GX Object Factories category. Developers use this interface when they want to enable or disable an object factory or simply get access to one of the defined object factories.

The *EnableGxObjectFactory* method can enable or disable an object factory based on the value that is passed in.

The following VBA code demonstrates how to loop through the defined object factories and display their enabled properties:

```
Dim pObjFactories As IGxObjectFactories, lLoop As Long
Dim pObjFact As IGxObjectFactory
Set pObjFactories = New GxObjectFactories
For lLoop = 0 To pObjFactories.Count - 1
  Set pObjFact = pObjFactories.GxObjectFactory(lLoop)
  If pObjFact Is Nothing Then
    Debug.Print "Nothing at Index " & lLoop
  Else
    Debug.Print pObjFact.Name & " - " & pObjFactories.IsEnabled(lLoop)
  End If
Next lLoop
```



The GxFileFilter *object maintains the file filter used by ArcCatalog to determine which file types to display.*

The *GxFileFilter* object maintains the file filter used by ArcCatalog to determine which file types to display. Use this object when you want to manipulate the file types being displayed. The *GxFileFilter* object monitors changes made to the file filter through the *IGxFileFilterEvents* interface.

IGxFileFilter : IUnknown	***Provides access to members that manages the properties for filtering file types.***
■— FileTypeCount: Long	*The number of file types for the filter.*
← AddFileType (in Extension: String, in Description: String, in filePathImage: String)	*Add the file type to the collection.*
← DeleteFileType (in Index: Long)	*Remove the file type.*
← Filter (in FilePath: String) : Boolean	*Checks to see if the indicated file passes the filter.*
← FindFileType (in Extension: String) : Long	*The index of the file filter or -1.*
← GetFileType (in Index: Long, out Extension: String, out Description: String, out imageFile: String, out SmallBitmap: Long, out largeBitmap: Long)	*Returns a file type information by index.*

The *GxFileFilter* object implements the *IGxFileFilter* interface. It lets you manipulate the file types displayed by ArcCatalog. Through this interface, you can add additional file types to the filter, remove file types, and determine whether or not a particular file will be displayed.

The *Filter* method returns a *Boolean* that indicates whether or not the specified file will be displayed in ArcCatalog based on the current file filter.

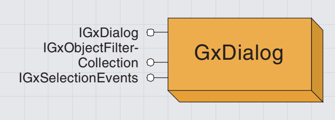
The *FindFileType* method returns an index that indicates the position of the specified file extension within the filter list. A value of -1 indicates the extension was not found. Do not include the "." when passing in the extension.

The following VBA code demonstrates how to use the *AddFileType* method to add the ".aml" file type to the filter. The file type is displayed with the default icon since you are not specifying one with the last parameter of *AddFileType*.

```
Dim pApp As IGxApplication, pCat As IGxCatalog, pFileFilter As IGxFileFilter
Set pApp = Application
Set pCat = pApp.Catalog
Set pFileFilter = pCat.FileFilter
pFileFilter.AddFileType "aml", "Workstation ArcInfo Macro files", " "
```

IGxFileFilterEvents : IUnknown	***Provides access to events that the ArcCatalog file filter can fire.***
← OnDefinitionChanged	*Called when the file filter definition has changed.*

The *GxFileFilter* object implements the *IGxFileFilterEvents* interface. It monitors when the file filter is changed. Developers might want to attach code to this event based on what file types have been added or removed from the filter.



GxDialog allows you to bring up a "mini-catalog" browser that allows you to open or save GIS datasets.

The *GxDialog* object controls the browser functionality of ArcCatalog. For example, when a user right-clicks a dataset, points to Import, then clicks Coverage to Geodatabase, the *GxDialog* object is employed in the browser that pops up, allowing the user to select a coverage.

The *GxDialog* object can be used within ArcCatalog and ArcMap to provide browser capabilities. The Intersect sample tool provides the capability to intersect two layers in the map and create a new geodatabase layer or a shapefile. The *GxDialog* object is used in that tool to allow the user to browse to a location for the layer or shapefile to create.

What the user can select or specify when using a *GxDialog* browser is based on the filters (*GxObjectFilter*) held by the object. The *GxDialog* object maintains a collection of these filters, and the developer has the ability to create his or her own filter to add to the collection. As an example, the Intersect sample tool uses a custom filter to specify that output must go to a geodatabase layer or a shapefile.

IGxDialog : IUnknown	***Provides access to members that control the GxDialog.***
AllowMultiSelect: Boolean	*Indicates if multiple items may be selected. False, by default.*
ButtonCaption: String	*The caption to use for the Open or Save button.*
FinalLocation: IGxObject	*The dialog's final location.*
InternalCatalog: IGxCatalog	*The catalog object used internally by the GxDialog.*
Name: String	*The text in the Name text box (only for DoModalSave).*
ObjectFilter: IGxObjectFilter	*The object filter.*
RememberLocation: Boolean	*Indicates if the dialog should use the final location as the next starting location. True, by default.*
ReplacingObject: Boolean	*Indicates if an object already exists with the name supplied by the user, and is being replaced.*
StartingLocation: Variant	*The dialog's starting location. This can be an IGxObject or a text-string containing the full name of an object.*
Title: String	*The dialog's title.*
DoModalOpen (in parentWindow: Long, out Selection: IEnumGxObject) : Boolean	*Opens the dialog to choose data.*
DoModalSave (in parentWindow: Long) : Boolean	*Opens the dialog to save data.*

The *IGxDialog* interface is implemented by the *GxDialog* object and provides access to the properties of the dialog box object and methods for displaying the dialog box during open or save operations. Use this interface when you want to access the properties of the dialog box or when you wish to display the dialog box for input from the end user.

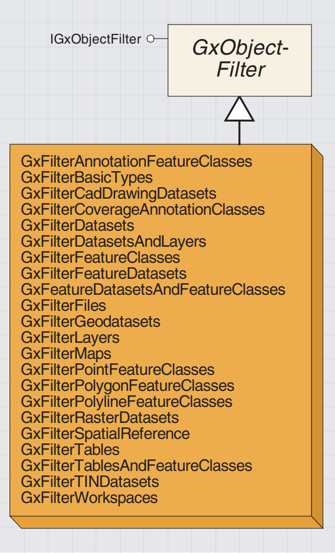
ObjectFilter returns the filter that is currently active in the dialog box. If the dialog box is not currently open (through *DoModalOpen* or *DoModalSave*), this property will return the default filter.

IGxObjectFilterCollection : IUnknown	***Provides access to members that manages a collection of GX object filters.***
AddFilter (in Filter: IGxObjectFilter, in defaultFilter: Boolean)	*Add a filter to the filter collection, and specify if it is to selected by default.*
RemoveAllFilters	*Remove all filters from the filter collection.*

The *GxDialog* object implements the *IGxObjectFilterCollection* interface. It provides access to the set of filters used by the *GxDialog* object. Even though a collection of filters can be attached to a *GxDialog* object, only one filter is actually active at a time. The active filter is specified through the dialog box when *DoModalOpen* or *DoModalSave* is executed through the *IGxDialog* interface. Use the *IGxObjectFilterCollection* interface when you want to remove all of the filters or when you want to add an additional filter to the object.

The following VBA code demonstrates how to use the *IGxObjectFilterCollection* interface to add existing filters to a *GxDialog* object:

```
Dim pGxDialog As IGxDialog
Dim pShpFilter As IGxObjectFilter
Dim pLyrFilter As IGxObjectFilter
Dim pFilterCol As IGxObjectFilterCollection
Dim pEnumGx As IEnumGxObject

Set pShpFilter = New GxFilterShapefiles
Set pLyrFilter = New GxFilterLayers

Set pGxDialog = New GxDialog
Set pFilterCol = pGxDialog

pFilterCol.AddFilter pShpFilter, False
pFilterCol.AddFilter pLyrFilter, True 'pLyrFilter is the default filter.
pGxDialog.Title = "Browse Data"
pGxDialog.DoModalOpen 0, pEnumGx
```


IGxObjectFilter
GxObject-Filter
GxFilterAnnotationFeatureClasses
GxFilterBasicTypes
GxFilterCadDrawingDatasets
GxFilterCoverageAnnotationClasses
GxFilterDatasets
GxFilterDatasetsAndLayers
GxFilterFeatureClasses
GxFilterFeatureDatasets
GxFeatureDatasetsAndFeatureClasses
GxFilterFiles
GxFilterGeodatasets
GxFilterLayers
GxFilterMaps
GxFilterPointFeatureClasses
GxFilterPolygonFeatureClasses
GxFilterPolylineFeatureClasses
GxFilterRasterDatasets
GxFilterSpatialReference
GxFilterTables
GxFilterTablesAndFeatureClasses
GxFilterTINDatasets
GxFilterWorkspaces

The GxObjectFilter *objects are used in conjunction with the* GxDialog *object to limit the types of data the user can browse when selecting objects to open or save.*

There are over thirty types of *GxObjectFilter* objects the developer can use in the code. They can also create their own code depending on how they want their users to apply the *GxDialog* object. Through the use of objects of this type, the developer can determine which types of objects the user can choose for open and save operations when browsing data.

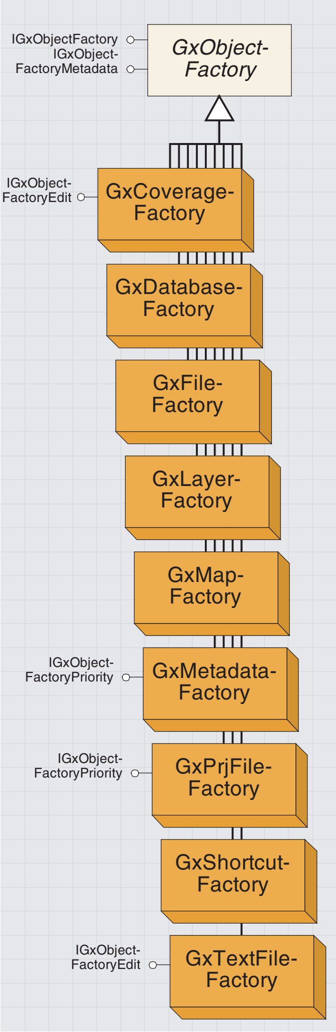
IGxObjectFilter : IUnknown	*Provides access to members that defines a GX object filter.*
Description: String	*A string that describes what this filter does.*
Name: String	*A user-friendly name identifying this filter.*
CanChooseObject (in Object: IGxObject, result: tagesriDoubleClickResult) : Boolean	*Indicates if the given object can be chosen.*
CanDisplayObject (in Object: IGxObject) : Boolean	*Indicates if the given object can be displayed.*
CanSaveObject (in Location: IGxObject, in newObjectName: String, objectAlreadyExists: Boolean) : Boolean	*Indicates if a new object named newObjectName could be saved in the specified location. If objectAlreadyExists is set to True, a confirmation dialog will appear asking if the existing object should be replaced.*

All *GxObjectFilter* objects implement the *IGxFileFilter* interface. The interface allows for the specification of the file types that can be chosen for open and save operations when using a *GxDialog* browser object. Developers normally only access this interface when they are implementing it as part of a custom object filter. (Review the Intersect sample for an example of a custom *GxObjectFilter*.)

The following Visual Basic code demonstrates how to create a custom filter within a class:

```
Option Explicit

Implements IGxObjectFilter

Dim basicFilter As IGxObjectFilter

Private Sub Class_Initialize()
  Set basicFilter = New GxFilterBasicTypes
End Sub

Private Sub Class_Terminate()
  Set basicFilter = Nothing
End Sub

Private Function IGxObjectFilter_CanChooseObject(ByVal Object As _
  esriCore.IGxObject, result As esriCore.esriDoubleClickResult) As Boolean
  Dim canChoose As Boolean
  canChoose = False
  If TypeOf Object Is IGxFile Then
    Dim ext As String
    ext = GetExtension(Object.Name)
    If LCase(ext) = ".shd" Or LCase(ext) = ".pal" Then canChoose = True
  End If
  IGxObjectFilter_CanChooseObject = canChoose
End Function
```

```
Private Function IGxObjectFilter_CanSaveObject(ByVal Location As _
  esriCore.IGxObject, ByVal newObjectName As String, _
  objectAlreadyExists As Boolean) As Boolean

End Function

Private Property Get IGxObjectFilter_Name() As String
  IGxObjectFilter_Name = "Custom filter"
End Property

Private Property Get IGxObjectFilter_Description() As String
  IGxObjectFilter_Description = "Browses for .shd and .pal files."
End Property

Private Function IGxObjectFilter_CanDisplayObject(ByVal Object As _
  esriCore.IGxObject) As Boolean
  Dim canDisplay As Boolean
  canDisplay = False
  If basicFilter.CanDisplayObject(Object) Then
    canDisplay = True
  ElseIf TypeOf Object Is IGxFile Then
    Dim ext As String
    ext = GetExtension(Object.Name)
    If LCase(ext) = ".shd" Or LCase(ext) = ".pal" Then canDisplay = True
  End If
  IGxObjectFilter_CanDisplayObject = canDisplay
End Function

Private Function GetExtension(fileName As String) As String
 Dim extPos As Long
  extPos = InStrRev(fileName, ".")
  If extPos > 0 Then
    GetExtension = Mid(fileName, extPos)
  Else
    GetExtension = ""
  End If
End Function
```



GxObjectFactory *objects help ArcCatalog generate* GxObjects *based on the object type.*

At the top level, the *Catalog* object is made up of a set of *GxObjects*. All these objects support the *IGxObject* interface along with some other interfaces.

There are a core set of *GxObjects* within ArcCatalog, such as catalog, disk connections, folders, and files. Basically, whenever a folder is asked for its children, it iterates over all registered *GxObjectFactories* to return *GxObjects*. Object factories know what types of files to return as *GxObjects*. These returned *GxObjects* are then populated in the Catalog by implementing *IGxObject* interface. Developers can easily extend the core set of *GxObjects* by implementing their own *GxObjectFactories*. After creating your own *GxObjectFactory*, the class must be registered under ESRI GX Object Factories for it to be considered.

The implementation of a custom *GxObjectFactory* class for .txt files may look something like this in Visual Basic:

```
Option Explicit

Implements IGxObjectFactory

Private Property Set IGxObjectFactory_Catalog(ByVal RHS As _
 esriCore.IGxCatalog)

End Property

Private Function IGxObjectFactory_GetChildren(ByVal parentDir As String, _
 ByVal fileNames As esriCore.IFileNames) As esriCore.IEnumGxObject
 Dim f As String
 Dim children As IGxObjectArray
 Set children = New GxObjectArray
 Do
  f = fileNames.Next
  If f <> "" Then
    If UCase(Right(f, 4)) = ".TXT" Then
     Dim child As IGxObject
     Set child = New GxTextFile
     f = child.Name
     children.Insert -1, child
     Set child = Nothing
     fileNames.Remove
    End If
   End If
 Loop Until f = ""
 Set IGxObjectFactory_GetChildren = children
End Function

Private Function IGxObjectFactory_HasChildren(ByVal parentDir As String, _
 ByVal fileNames As esriCore.IFileNames) As Boolean
 Dim f As String
 Do
  f = fileNames.Next
```

```
    If f <> "" Then
      If UCase(Right(f, 4)) = ".TXT" Then
        IGxObjectFactory_HasChildren = True
        Exit Do
      End If
    End If
  Loop Until f = ""
End Function

Private Property Get IGxObjectFactory_Name() As String
  IGxObjectFactory_Name = "GxMyCustomFactory"
End Property
```

IGxObjectFactory : IUnknown	***Provides access to members that define a GX object factory.***
Catalog: IGxCatalog	*Attach the catalog to the object factory.*
Name: String	*The name of the object factory.*
GetChildren (in parentDir: String, in fileNames: IFileNames) : IEnumGxObject	*Returns an enumeration of objects corresponding to one or more of the given file names supported by the object factory.*
HasChildren (in parentDir: String, in fileNames: IFileNames) : Boolean	*Indicates if any of the specified files are supported by the object factory.*

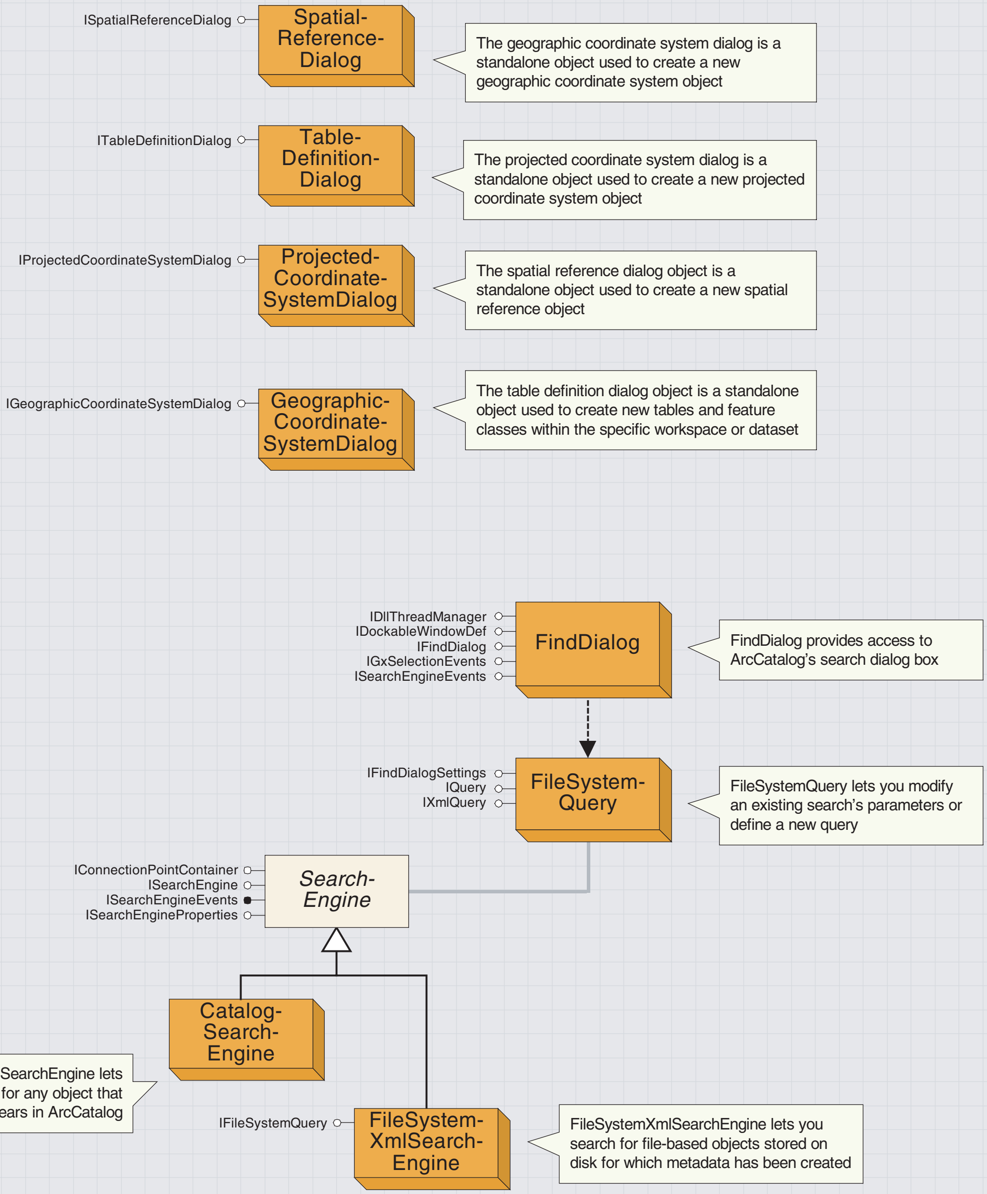
All *GxObjectFactory* classes implement the *IGxObjectFactory* interface. The interface allows *GxObjectFactory* objects to return the name of the factory and information about the potential children of the object.

IGxObjectFactoryMetadata : IUnknown	***Provides access to members that returns a GX object from some metadata.***
GetGxObjectFromMetadata (in metadataPath: String) : IGxObject	*Given a path to some metadata, constructs the corresponding gx object.*

All *GxObjectFactory* classes that support metadata implement the *IGxObjectFactoryMetadata* interface. The interface allows *GxObjectFactory* objects to return *GxObjects* when metadata paths are sent in. When creating your own *GxObjectFactory*, implement this interface if you want to support the defining of metadata on your custom objects.

ArcCatalog

FindDialog and related objects



The geographic coordinate system dialog is a standalone object used to create a new geographic coordinate system object

The projected coordinate system dialog is a standalone object used to create a new projected coordinate system object

The spatial reference dialog object is a standalone object used to create a new spatial reference object

The table definition dialog object is a standalone object used to create new tables and feature classes within the specific workspace or dataset

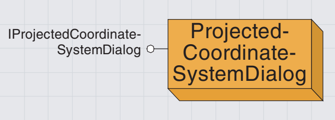
FindDialog provides access to ArcCatalog's search dialog box

FileSystemQuery lets you modify an existing search's parameters or define a new query

The CatalogSearchEngine lets you search for any object that appears in ArcCatalog

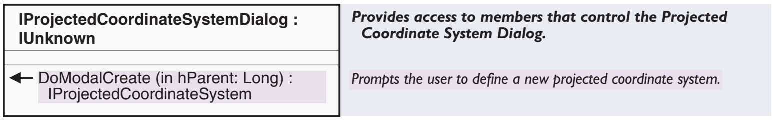
FileSystemXmlSearchEngine lets you search for file-based objects stored on disk for which metadata has been created

ProjectedCoordinateSystemDialog coclass


IProjectedCoordinate-SystemDialog
Projected-Coordinate-SystemDialog

The projected coordinate system dialog box is a standalone object that creates a new projected coordinate system object.

The *ProjectedCoordinateSystemDialog* object is a standalone object used to create a new *IProjectedCoordinateSystem* object. As a developer, you should create an object of this type when you need to create a custom projection under the Projected Coordinate System category.



IProjectedCoordinateSystemDialog : IUnknown

Provides access to members that control the Projected Coordinate System Dialog.

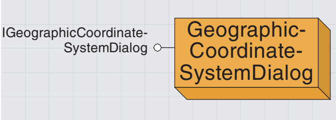
← DoModalCreate (in hParent: Long) : IProjectedCoordinateSystem

Prompts the user to define a new projected coordinate system.

The *IProjectedCoordinateSystemDialog* interface is implemented by the *ProjectedCoordinateSystemDialog* object. It displays a dialog box for creating a new custom projection.

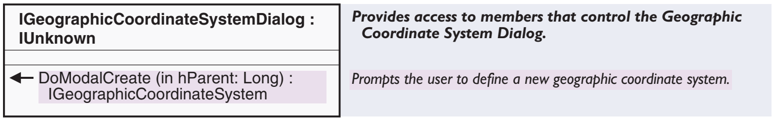
The following VBA code demonstrates how to use the dialog box to create a new projection and store it in the appropriate folder:

```
Dim pProjD As IProjectedCoordinateSystemDialog
Dim pProj As IProjectedCoordinateSystem
Set pProjD = New ProjectedCoordinateSystemDialog
Set pProj = pProjD.DoModalCreate(0)

Dim spRefEnviron As ISpatialReferenceFactory
Set spRefEnviron = New SpatialReferenceEnvironment

Dim pSpatialReference As ISpatialReference
Set pSpatialReference = pProj
spRefEnviron.ExportESRISpatialReferenceToPRJFile & "c:\arcgis\arcexe81" &_
  "\Coordinate Systems\projected coordinate systems\polar\abc.prj", _
  pSpatialReference
```



The geographic coordinate system dialog box is a standalone object used to create a new geographic coordinate system object.

The *GeographicCoordinateSystemDialog* object is a standalone object used to create a new *IGeographicCoordinateSystem* object. As a developer, you should create an object of this type when you need to create a custom projection under the Project Coordinate System category.


IGeographicCoordinateSystemDialog :
IUnknown
DoModalCreate (in hParent: Long) :
IGeographicCoordinateSystem

Provides access to members that control the Geographic Coordinate System Dialog.

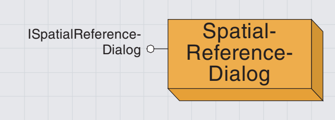
Prompts the user to define a new geographic coordinate system.

The *IGeographicCoordinateSystemDialog* interface is implemented only by the *GeographicCoordinateSystemDialog* object. It displays a dialog box for creating a new custom projection.

The following VBA code demonstrates how to use the dialog box:

```
Dim pGeoD As IGeographicCoordinateSystemDialog
Dim pGeo As IGeographicCoordinateSystem0
Set pGeoD = New GeographicCoordinateSystemDialog
Set pGeo = pGeoD.DoModalCreate(0)
```

SpatialReferenceDialog coclass



The spatial reference dialog box object is a standalone object used to create a new spatial reference object.

The *SpatialReferenceDialog* object is a standalone object that creates a new *ISpatialReference* object. As a developer, you should create an object of this type when you need to generate or edit a spatial reference object.

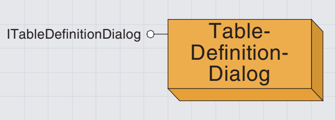
As an example, *ISpatialReference* objects are needed in ArcCatalog when creating a new feature dataset, as the following VBA code demonstrates:

```
Dim pApp As IGxApplication, pSel As IGxSelection, pGxObj As IGxObject
Set pApp = Application
Set pSel = pApp.Selection
Set pGxObj = pSel.Location
'Make sure object selected in the tree view is a database object
If Not TypeOf pGxObj Is IGxDatabase Then Exit Sub

Dim pFeatWork As IFeatureWorkspace
Dim pSpatDiag As ISpatialReferenceDialog
Dim pSpat As ISpatialReference, pGxData As IGxDatabase2
Set pGxData = pGxObj
Set pFeatWork = pGxData.Workspace
Set pSpatDiag = New SpatialReferenceDialog
Set pSpat = pSpatDiag.DoModalCreate(True, False, False, 0)

If Not pSpat Is Nothing Then
  pFeatWork.CreateFeatureDataset "My New Dataset", pSpat
End If
```

ISpatialReferenceDialog : IUnknown	***Provides access to members that control the Spatial Reference Dialog.***
← DoModalCreate (in hasXY: Boolean, in HasZ: Boolean, in HasM: Boolean, in hParent: Long) : ISpatialReference	*Prompts the user to define a new spatial reference.*
← DoModalEdit (in inputSpatialReference: ISpatialReference, in hasXY: Boolean, in HasZ: Boolean, in HasM: Boolean, in coordPageReadOnly: Boolean, in domainPageReadOnly: Boolean, in hParent: Long) : ISpatialReference	*Displays/edits the properties of the given spatial reference.*

The *ISpatialReferenceDialog* interface is implemented by the *SpatialReferenceDialog* object. It displays dialog boxes for editing and creating *ISpatialReference* objects. Use this interface when you want to present your users with the standard dialog box for manipulating a spatial reference.

DoModalEdit and *DoModalCreate* arguments limit the pages of the wizard that will be displayed. For example, passing a *HasZ* value of *True* displays the page that sets z-values.



The table definition dialog box object is a standalone object used to create new tables and feature classes within the specific workspace or dataset.

The *TableDefinitionDialog* object is a standalone object that creates new tables (*ITable*) and feature classes (*IFeatureClass*) within the specific workspace or dataset. As a developer, you should create an object of this type when you want to give your users the capability to create new tables or feature classes through the standard dialog box.

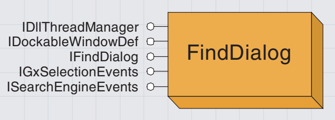
ITableDefinitionDialog : IUnknown	***Provides access to members that control the Table Definition Dialog.***
← DoModalCreateFeatureClass (in Parent: IUnknown Pointer, in hParent: Long) : IFeatureClass	*Displays the dialog to define a new feature class.*
← DoModalCreateTable (in Workspace: IFeatureWorkspace, in hParent: Long) : ITable	*Displays the dialog to define a new table.*

The *ITableDefinitionDialog* interface is implemented by the *TableDefinitionDialog* object. It displays a dialog box for creating a new table of a feature class.

For the first parameter of *DoModalCreateFeatureClass*, pass in an *IFeatureDataset* or an *IFeatureWorkspace*, depending on whether or not you want the feature class to be created within a dataset.

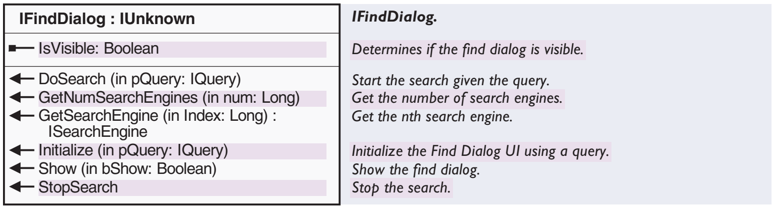
The following VBA code demonstrates how to create a new feature class within the dataset selected in the tree view of ArcCatalog:

```
Dim pApp As IGxApplication, pSel As IGxSelection, pGxObj As IGxObject
Set pApp = Application
Set pSel = pApp.Selection
Set pGxObj = pSel.Location
If Not TypeOf pGxObj Is IGxDataset Then Exit Sub

Dim pDataset As IDataset, pGxData As IGxDataset
Dim pTableDiag As ITableDefinitionDialog, pFeatClass As IFeatureClass
Set pGxData = pGxObj
Set pDataset = pGxData.Dataset
Set pTableDiag = New TableDefinitionDialog
Set pFeatClass = pTableDiag.DoModalCreateFeatureClass(pDataset, 0)
```



FindDialog provides access to the ArcCatalog Search dialog box.

The *FindDialog* provides access to the ArcCatalog Search dialog box.



IFindDialog : IUnknown — *IFindDialog.*

- IsVisible: Boolean — *Determines if the find dialog is visible.*
- DoSearch (in pQuery: IQuery) — *Start the search given the query.*
- GetNumSearchEngines (in num: Long) — *Get the number of search engines.*
- GetSearchEngine (in Index: Long) : ISearchEngine — *Get the nth search engine.*
- Initialize (in pQuery: IQuery) — *Initialize the Find Dialog UI using a query.*
- Show (in bShow: Boolean) — *Show the find dialog.*
- StopSearch — *Stop the search.*

The *IFindDialog* interface lets you execute a search programmatically.

The *IsVisible* property indicates whether or not the Search dialog box is open.

The *Show* method lets you open and close the Search dialog box. On opening, the dialog box is initialized based on the selected object in ArcCatalog; if the object is a search result, the dialog box represents its search criteria. The *Initialize* method can be used to initialize the dialog box to represent the search parameters defined by a separate query (the use of *FileSystemQuery* is discussed in detail later in this section). The example below shows how to open the Search dialog box.

```
Dim pFindDialog As IFindDialog
Set pFindDialog = New FindDialog
pFindDialog.Show true
```

You can change the query's parameters by setting its properties with the *IQuery* and *IFindDialogSettings* interfaces, with the exception of the search engine used and the location in which the search should begin. You must set those properties separately by enabling the appropriate search engine and then setting its location string (use of *SearchEngine* is discussed later in this chapter).

The Search dialog box must have been shown once before the available search engines can be retrieved; however, if the *Show* command is used with the parameter *False*, the dialog box will be initialized but will not appear. The following example shows how this can be accomplished:

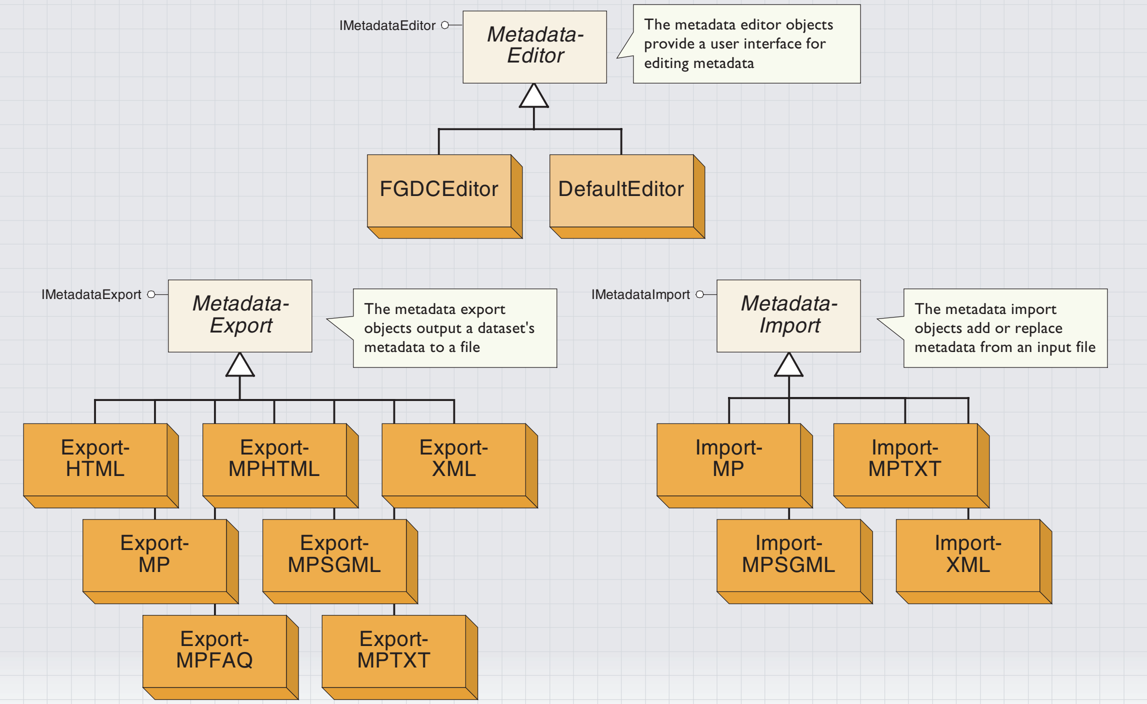
```
Dim pSearchEngine As ISearchEngine
Dim pSEProperties As ISearchEngineProperties
Dim i As Long

pFindDialog.Show False
For i = 0 To (pFindDialog.GetNumSearchEngines - 1)
  Set pSearchEngine = pFindDialog.getSearchEngine (i)
  Select Case pSearchEngine.Name
    Case "Catalog"
      pSearchEngine.Enabled = True
      Set pSEProperties = pSearchEngine
      pSEProperties.LocationString = "C:\Temp\data"
    Case "File system"
      pSearchEngine.Enabled = False
    End Select
  Next
```

The *DoSearch* method initiates a search using the parameters defined by the input *FileSystemQuery* object. Before the search starts, the query is saved as a *SearchResults* object in the Search Results folder in ArcCatalog. The new search is selected in the Catalog tree, and when objects are found, shortcuts to those objects are automatically added to the search results, which are listed in the Contents tab. The Search dialog box must have been opened once before the search will execute successfully.

It is important to note that when one search engine is enabled, other search engines are not disabled automatically. If more than one search engine is enabled, the search will be executed once with each enabled search engine. The results from all search engines will appear in the Contents tab.

You can use *StopSearch* to halt the search at any point in time after the search has started. If *StopSearch* immediately follows *DoSearch*, the query is saved but the search does not execute.

Metadata objects



The metadata editor objects provide a user interface for editing metadata

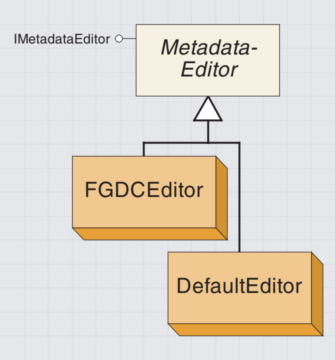
The metadata export objects output a dataset's metadata to a file

The metadata import objects add or replace metadata from an input file

Most objects that appear in ArcCatalog can have metadata. However, you cannot create metadata or read metadata that already exists for datasets accessed using an OLE DB, ArcSDE 3, or an ArcSDE for Coverages database connection. For all other datasets and files (except standalone XML documents), ArcCatalog will by default create and update metadata automatically when you view metadata in the Metadata tab in ArcCatalog; this process, known as synchronization, is described in detail in Volume 2, Chapter 8, 'Accessing the geodatabase'. The only requirement is that the location of the data is writable. For example, you can create metadata for a coverage that is stored on your computer but not for one that resides on a CD–ROM. Within a geodatabase, you must be the owner of an object to be able to create or update its metadata.

Metadata can be created for folders, folder connections, and geodatabases themselves manually or programmatically, but they don't support synchronization. Metadata can be edited manually in ArcCatalog using a metadata editor, a metadata importer, or the Metadata Properties dialog box. The contents of standalone XML documents can be modified the same way. For example, you might use a metadata editor to describe the project for which a folder or personal geodatabase was created.

ArcCatalog organizational objects—the root of the Catalog tree and the Database Connections, Internet Servers, Geocoding Services, Coordinate Systems, and Search Results folders—don't support metadata. The objects you use to create database and Internet server connections and new geocoding services don't support metadata either.



A MetadataEditor *object provides a user interface for editing metadata. You can create your own custom metadata editor.*

Two metadata editors are supplied with ArcCatalog: the *FGDCEditor* and the *DefaultEditor*.

The *FGDCEditor* allows you to create metadata following the FGDC standard; it is the metadata editor that is available by default when you click the Edit Metadata button in ArcCatalog.

The *DefaultEditor* is the Options page in the Metadata Properties dialog box; it works differently from other metadata editors.

You can build your own custom metadata editor, which can be opened in place of the *FGDCEditor* when the Edit Metadata button is clicked. You might do this to allow users to create metadata following a different metadata standard or to add specific information used by your organization to the metadata, such as the current state of a data-creation project. To build your own editor, create a class that implements *IMetadataEditor* and register it with the Component Categories Manager utility in the Metadata Editors category. There is an example of a custom metadata editor in the ArcObjects Developer Samples.

IMetadataEditor : IUnknown	*Provides access to members that define a metadata editor.*
Name: String	*Name of the metadata editor.*
Edit (in props: IPropertySet, in hWnd: Long) : Boolean	*Shows the metadata editor and indicates if the metadata property set was modified.*

The *IMetadataEditor* interface controls a metadata editor.

When using a metadata editor, the *Name* property is read-only. This property is defined when the *IMetadataEditor* interface is implemented. The name value will appear in the Metadata Editors dropdown list in the Metadata tab in the ArcCatalog Options dialog box.

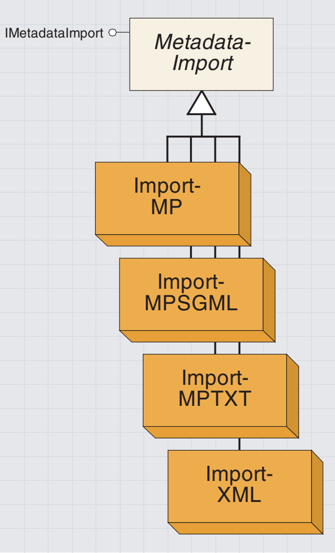
One way to open a metadata editor programmatically is to use *IMetadataHelper::Editor* to control which editor will appear, then *IGxDocumentationView::Edit* to show the editor. *IGxDocumentationView::Edit* in turn calls the *Edit* method on the *IMetadataEditor* interface.

When using the *Edit* method directly, two parameters must be passed in: an XML property set whose contents will be modified and the number zero. *Edit* also returns a value indicating whether or not the contents of the XML property set were modified; if this value is true, the changes should be saved to the original object. The DLL that contains the metadata editor must be referenced as part of your project. This example opens the FGDC editor.

```
  Dim pPS As IPropertySet
  Set pPS = pMetadata.Metadata

  Dim pMetaEdit As IMetadataEditor
  Set pMetaEdit = New MetaEditor.MetaEdit

  Dim bModified As Boolean
  bModified = pMetaEdit.edit(pPS, 0)
If bModified Then pMetadata.Metadata = pPS
```

The MetaEditor DLL contains the class named *MetaEdit*, which implements the *IMetadataEditor* interface. An XML property set containing metadata is retrieved from a *GxObject* or a *Name* object, and then passed to the *Edit* method, which opens a form. If you modify any values with the form, a flag is set. When the dialog box is closed, the *Edit* method's return value is set to the value of the flag. Your code should check the return value and then act accordingly; if the return value is true, save the changes to the metadata with the original object.

When the *Edit* method is implemented, you define how the editor will modify the XML property set. It may open a form where each control on the form lets users set the value of a specific metadata element. It may also set the value of several additional elements automatically, such as the time when the changes were saved or the name of the user who made the changes.



The metadata import objects are used to replace the existing metadata with new definitions from a file.

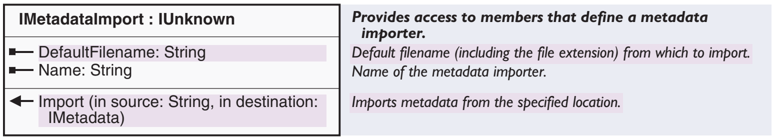
The *MetadataImport* objects work in the same way as the Import Metadata button in ArcCatalog, with one exception. The Import Metadata dialog box provides the option to synchronize imported metadata with the dataset after the importing is complete. When importing is initiated programmatically, this option isn't available; setting the appropriate *Sync* attributes and initiating synchronization must also be accomplished programmatically.

Each *MetadataImport* coclass corresponds to a different format of metadata in the input file. The following table summarizes the supported metadata import and export formats.

Import coclass	Export coclass	Metadata format
ImportMP	ExportMP	FGDC CSDGM (XML): the XML format that can be imported and exported by the FGDC metadata parser utility.
ImportMPSGML	ExportMPSGML	FGDC CSDGM (SGML): the SGML format that can be imported and exported by mp; mp is used to generate the result.
ImportMPTXT	ExportMPTXT	FGDC CSDGM (TXT): the text format that can be imported and exported by mp; mp is used to generate the result.
ImportXML	ExportXML	XML: imports and exports XML documents as-is; essentially creates a copy of the XML document.
	ExportMPHTML	FGDC CSDGM (HTML): the HTML output that can be generated by mp; mp is used to generate the result.
	ExportMPFAQ	FGDC CSDGM (FAQ): the FAQ-style HTML output that can be generated by mp; mp is used to generate the result.
	ExportHTML	HTML: HTML output is created by using ArcCatalog's current stylesheet to transform the metadata.

There are more export than import formats because XML can be readily presented as HTML, but not vice versa. For more information about the FGDC's metadata parser utility, mp, see http://geology.usgs.gov/tools/metadata/tools/doc/mp.html.

You can build your own custom metadata importer by creating a class that implements *IMetadataImport*, then registering it with the Component Categories Manager utility in the Metadata Importers category. There is an example custom metadata importer in the ArcObjects Developer Samples.



IMetadataImport : IUnknown

DefaultFilename: String
Name: String

Import (in source: String, in destination: IMetadata)

Provides access to members that define a metadata importer.

Default filename (including the file extension) from which to import.

Name of the metadata importer.

Imports metadata from the specified location.

The *IMetadataImport* interface lets you import existing metadata from a file.

When using a metadata importer, the properties *DefaultFileName* and *Name* are read-only. These properties are defined when the *IMetadataImport* interface is implemented.

The *Name* value appears in the Format dropdown list in the Import Metadata dialog box. If an importer's default filename is "aFile.abc", for example, then after choosing an importer in the Format list, the extension of the filename in the Location text box changes to match the extension of the default filename, which in this example is "abc". Also, when you click the Browse button, the default filename of the selected metadata format appears in the File name text box, and its file extension appears as the default option in the Files of type dropdown list.

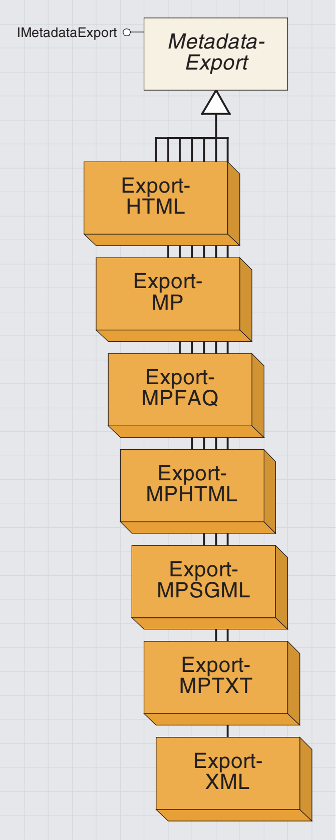
The default location in which to look for input files is initially C:\Temp and thereafter is the ArcCatalog current working directory.

When the *Import* method is used, two parameters must be passed in: the path of the file whose contents will be imported and the *IMetadata* interface, which provides access to the metadata that should be modified as a result of importing metadata. The following example imports metadata for an ArcCatalog object from a text file that is formatted according to mp's requirements.

```
Dim pApp As IGxApplication
Dim pGxObject As IGxObject

Set pApp = Application
Set pGxObject = pApp.SelectedObject

Dim pMetadata as IMetadata
Set pMetadata = pGxObject

Dim pMetadataImport as IMetadataImport
Set pMetadataImport = New ImportMPTXT

pMetadataImport.Import "C:\stuff\fgdc_metadata.txt", pMetadata
MsgBox "Finished import in format: " & pMetadataImport.Name
```

When the *Import* method is implemented, it defines exactly what is recorded in the metadata when the importer is used. For example, it may open a file, extract some information, set specific elements in the original metadata document, then save the results.

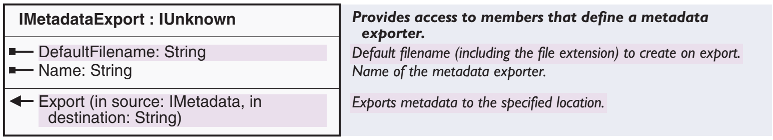
Or, the importer may set specific elements in the metadata without opening a file at all; this is one possible method for adding standard blocks of information, such as contact information, to metadata documents. The metadata importers that are provided replace all existing metadata with the contents of the imported file.



The MetadataExport *objects are used to make an output file of a dataset's metadata.*

The *MetadataExport* objects work in the same way as the Export Metadata button in ArcCatalog. Each *MetadataExport* coclass corresponds to a different format for the output file (see the table in the *MetadataImport* section).

You can build your own custom metadata exporter by creating a class that implements *IMetadataExport*, then registering it with the Component Categories Manager utility in the "Metadata Exporters" category. There is an example custom metadata importer in the ArcObjects Developer Samples.



IMetadataExport : IUnknown

Provides access to members that define a metadata exporter.

DefaultFilename: String	*Default filename (including the file extension) to create on export.*
Name: String	*Name of the metadata exporter.*
Export (in source: IMetadata, in destination: String)	*Exports metadata to the specified location.*

The *IMetadataExport* interface lets you export information in the metadata document to an output file.

When using a metadata exporter, the properties *DefaultFileName* and *Name* are read-only. These properties are defined when the *IMetadataExport* interface is implemented. The name value appears in the Format dropdown list in the Export Metadata dialog box. The default filename defines the filename and extension, which are used by default in the same way as is described for the *IMetadataImport* interface. The default location in which output files will be placed is initially C:\Temp and thereafter is the ArcCatalog current working directory.

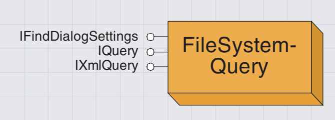
When the *Export* method is used, two parameters must be passed in: the *IMetadata* interface, which references the information that will be exported, and the path of the output file that will be created. The following example exports metadata for an ArcCatalog object to an XML file that satisfies mp's requirements.

```
Dim pApp As IGxApplication
Set pApp = Application

Dim pGxObject As IGxObject
Set pGxObject = pApp.SelectedObject

Dim pMetaData As IMetadata
Set pMetaData = pGxObject

Dim pMetadataExport As IMetadataExport
Set pMetadataExport = New ExportHTML

pMetadataExport.Export pMetaData, pMetadataExport.DefaultFilename
MsgBox "Finished export in format: " & pMetadataExport.Name
```

ExportMP uses *IXmlPropertySet::SaveAsFile* to create an output XML file in the manner that they are created by mp. The _MPXML stylesheet is used to transform the elements in the original metadata XML property set. It orders the metadata elements according to the hierarchy defined by the FGDC standard and removes the elements defined in the ESRI Profile. *ExportMP* also specifies a header that adds the XML version notation and a reference to the FGDC's DTD to the top of the output file. For the resulting XML to be valid, its elements must be ordered and their values must conform to the rules defined by the DTD. Since the ESRI profile elements are not defined in the FGDC's DTD, their presence would cause validation to fail. The other MP exporters also transform the metadata using the _MPXML style sheet. They pass the resulting XML file to mp. In turn, mp processes the XML and then writes an output file in the appropriate format to disk.

When exporting with the *ExportMP, ExportXML, ExportMPHTML, ExportMPFAQ,* and *ExportHTML* coclasses, do not use their default filenames, "metadata.xml" and "metadata.htm", respectively. When files with these names are placed inside a folder, they are assumed to contain metadata for that folder; their contents appear in the Metadata tab when the folder is selected in the Catalog tree, and incorrect assumptions may be made.

When the *Export* method is implemented, it defines exactly what is recorded in the output file. For example, it might create a new file, extract some information from the metadata, store it in an appropriate format within that file, then save the results.



FileSystemQuery lets you modify an existing search's parameters or define a new query.

The *FileSystemQuery* coclass lets you modify an existing search's parameters or define a new query. The *FileSystemQuery* coclass has three interfaces: *IFindDialogSettings, IQuery,* and *IXmlQuery*. The *IXmlQuery* interface builds the XSL Patterns expressions that correspond to the query parameters that are used to evaluate whether or not a dataset's metadata satisfies the search criteria. Typically, you would not use this interface.

You can build your own custom query object by creating a class that implements *IQuery*. You might do this to support a custom searching application in which additional properties or methods are required to define the search parameters.

IFindDialogSettings : IUnknown	***IFindDialogSettings Interface.***
■—■ BackgroundMap: String	*The full name of the background map associated with this query.*

The *IFindDialogSettings* interface lets you specify which dataset will be used as a map when the geographic extent of the search is defined using the Search dialog box.

The *BackgroundMap* property specifies the complete path that identifies the dataset.

IQuery : IUnknown	***IQuery Interface.***
■— ClassID: IUID	*The class ID of this object.*
■—■ DatasetName: String	*The name of the dataset to be searched for.*
■—□ DatasetType: INativeType	*The type of the dataset to be searched for.*
■—■ Date1: String	*The start date or first date.*
■—■ Date2: String	*The end date or second date.*
■—■ DateOperator: tagesriFindDateOperator	*The type of the date operator.*
■—■ DateType: tagesriFindDateType	*The type of the date to be searched for.*
■— EngineProperties: IPropertySet	*The set of search engine properties.*
■—□ Envelope: IEnvelope	*The envelope of the dataset to be searched for in decimal degrees.*
■—■ EnvelopeOperator: tagesriFindEnvelopeOperator	*The spatial operator on the envelope.*
■—■ IsCaseSensitive: Boolean	*Indicates if the comparison of the name property is case sensitive.*
■—■ NameOfQuery: String	*The name of the query.*
■—□ NativeEnvelope: IEnvelope	*The envelope of the dataset to be searched for in the dataset's coordinate system.*
■— NumFieldQueries: Long	*The number of field queries.*
← AddFieldQuery (in Type: tagesriFindFieldType, in op: tagesriFindFieldOperator, in Value: String, in Tag: String)	*Adds a field query.*
← GetFieldQuery (in Index: Long, out Type: tagesriFindFieldType, out op: tagesriFindFieldOperator, out Value: String, out Tag: String)	*Returns the nth field query.*
← Load (in pPropertySet: IPropertySet)	*Loads the query from the given PropertySet.*
← Save (in pPropertySet: IPropertySet)	*Saves the query from the given PropertySet.*

The *IQuery* interface lets you access and modify the search parameters.

The *ClassID* property is read-only. It identifies the type of query object that is represented by the search parameters. This information is essential if parameters are being retrieved from a query that was saved to disk. For example, if you define a new query using the *FileSystemQuery* coclass, the *ClassID* property reflects the UID of that coclass. If the query was instead defined using a custom query object, the appropriate object would be indicated by the *ClassID* property.

When creating a new *FileSystemQuery*, you are required to set only two parameters using the *IQuery* interface: *DatasetName*, which establishes the name of the object you want to find, and *NameQuery*, which defines the name of the query itself; all other properties are set to their default values. The dataset name may include an asterisk (*) as a wildcard character; use the dataset name "*" to select objects with any name. The following code demonstrates how to create a new query.

```
Dim pQuery As IQuery
Set pQuery = New FileSystemQuery

pQuery.DatasetName = "*"
pQuery.NameOfQuery = "My Search"
```

In addition to the *DatasetName* and *FileSystemQuery* properties, the query's search engine properties must be set or the search will not run. The query's *EngineProperties* property returns a property set. Modify the property set in order to change which search engine will be used to execute the query or how the search engine operates.

When a new query object is created, its *EngineProperties* property set doesn't contain any properties. An easy way to define the property set's contents is by creating the appropriate search engine, setting its properties, and then saving them to the *EngineProperties* property set. The example below shows how to change the location where the search will begin.

```
Dim pCatalogSE As ISearchEngineProperties
Set pCatalogSE = New CatalogSearchEngine
pCatalogSE.LocationString = “D:\Data”
pCatalogSE.Save pPS
```

The Catalog search engine adds the "EngineCLSID" and "CatalogLocation" properties. The file system XML search engine adds the "EngineCLSID", "FileSystemLocation", and "IncludeSubFolders" properties. The Catalog location property can identify any location in the Catalog, such as a database connection, for example, "Database Connections\My ArcSDE Connection.sde". The file system location property can identify any disk location on the network, for example, "\\aComputer\public".

The methods defined in the *IPropertySet* interface can also be used to add and remove properties and modify their values. The example below shows how to retrieve a previously defined query from an existing *SearchResults* object, modify its start location, and then execute the query.

```
Dim pGxApp As IGxApplication
Dim pGxObject As IGxObject
Set pGxApp = Application
Set pGxObject = pGxApp.SelectedObject

Dim pSearchResults As ISearchResults
Dim pQuery As IQuery
```

ArcCatalog

```
Set pSearchResults = pGxObject
Set pQuery = pSearchResults.Query

Dim pPropSet As IPropertySet
Set pPropSet = pQuery.EngineProperties
pPropSet.SetProperty “FileSystemLocation”, “C:\mystuff”

pFindDialog.DoSearch pQuery
```

Other properties of the *IQuery* interface may optionally be set. For keyword-style searches, use *NumFieldQueries*—it returns the current number of field queries that have been defined. *GetFieldQuery* returns the parameters of the appropriate field query. Use the *AddFieldQuery* method to add to the list of field queries.

To search for a value in one of the predefined query fields, specify the appropriate field type, operator, and value and provide an empty string for the *Tag* parameter. To search for a value in another metadata element that isn’t in the predefined list, specify the user-defined field type and the appropriate operator and value, and for the *Tag* parameter, specify the name string that identifies the metadata element.

The example below adds two field queries, one that looks for “roads” in the abstract and another that looks for the name of the project, “My Project”, in the supplemental information element. For information about how to construct your own name string, see Volume 2, Chapter 8, ‘Accessing the geodatabase’.

```
pQuery.AddFieldQuery esriFindFieldTypeAbstract, _
  esriFindFieldOperatorIncludes, "roads", ""
pQuery.AddFieldQuery esriFindFieldTypeUserDefined, _
  esriFindFieldOperatorIncludes, "My Project", "idinfo/descript/supplinf"
```

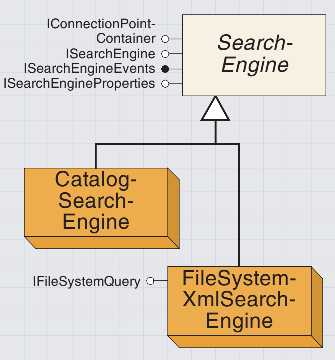
To search using date information in the metadata, set the *DateType, DateOperator, Date1,* and *Date2* properties appropriately. The date type defines whether you are looking for a date, how current the data is, when the metadata was last updated, or when the data was published.

The date operator defines how to compare the date in the metadata with the dates provided; for example, you might want to look for objects whose metadata was updated during the previous 30 days. For after, before, during, and equal date comparisons, dates must be specified in the format yyyymmdd; for example, “20000601” refers to the date June 1, 2000. For after, before, and equal comparisons, only the *Date1* property is used. For previous searches, *Date1* should be the appropriate number of days, such as “30”.

Set the *DatasetType* property if you want to search for specific objects or data formats. To search by the geographic location of the dataset, you need to set the *Envelope* and *NativeEnvelope* properties appropriately.

The *Envelope* property defines the search extent in decimal degrees, while the *NativeEnvelope* property defines the search extent in a dataset’s projected coordinates. Both search extents should be defined. If appropriate, both the native search extent and the decimal degrees search extent may contain decimal degrees values.

These extent values will be compared against the Bounding Coordinate and Local Bounding Coordinate metadata elements, which contain decimal degrees extent and native extent values, respectively.



The CatalogSearchEngine *lets you search for any object that appears in ArcCatalog.*

FileSystemXmlSearchEngine *lets you search for file-based objects stored on disk for which metadata has been created.*

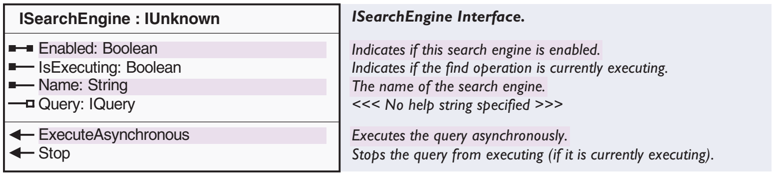
Two search engines are supplied with ArcCatalog: the *CatalogSearchEngine* and the *FileSystemXmlSearchEngine*.

The *CatalogSearchEngine* lets you search for any object that appears in ArcCatalog including objects that are stored within geodatabases and are available on ArcIMS services. It is the default search engine. When searching by the dataset's name, type, and extent, metadata need not be created.

The *FileSystemXmlSearchEngine* lets you search for file-based objects stored on disk for which metadata has been created. It is faster than the *CatalogSearchEngine*.

Use the search engine object directly rather than through the Find dialog box if you want to define and run the search using a custom search interface or if you want to customize how the search results are compiled. For example, a custom search interface might use terminology that is specific to your organization. Similarly, you might create an HTML page listing the search results, rather than have ArcCatalog generate shortcuts to the datasets that were found.

You can build your own custom search engine by creating a class that implements *ISearchEngine* and registering it with the Component Categories Manager utility in the ESRI GX Search Engines category. You might do this to support a custom searching application that communicates with metadata stored within a relational database rather than with XML files on disk.



ISearchEngine : IUnknown	*ISearchEngine Interface.*
Enabled: Boolean	*Indicates if this search engine is enabled.*
IsExecuting: Boolean	*Indicates if the find operation is currently executing.*
Name: String	*The name of the search engine.*
Query: IQuery	*<<< No help string specified >>>*
ExecuteAsynchronous	*Executes the query asynchronously.*
Stop	*Stops the query from executing (if it is currently executing).*

The *ISearchEngine* interface provides access to the search engine itself.

The *Enabled* property lets you enable or disable a search engine that has been retrieved from the Find dialog box.

The *Name* property returns the name of the search engine.

IsExecuting indicates whether or not the search engine is currently working.

If you are using the search engine independently from the Find dialog box, *Query* lets you set the query that will be executed, *ExecuteAsynchronous* starts the query, and *Stop* ends it. The query's engine properties must be set to use this search engine object.

ISearchEngineEvents : IUnknown	*ISearchEngineEvents Interface.*
← ObjectFound (in anObject: IGxObject, in Location: String)	*Called when the find operation has found an object.*
← SearchCanceled	*Called when the find operation was explicitly canceled.*
← SearchFailed	*Called when the find operation has terminated prematurely.*
← SearchFinished	*Called when the find operation has finished executing.*
← SearchLocationChanged (in Location: String)	*Called when the find operation searches a new folder/container.*

While the search is continuing, you may listen and respond to events using the *ISearchEngine* interface.

The *ObjectFound* event occurs when an object is found whose properties or metadata satisfies the search criteria.

The *SearchCancelled* event occurs when the search is stopped.

The *SearchFailed* event occurs when an error has occurred.

The *SearchFinished* event occurs when the search is complete.

The *SearchLocationChanged* event occurs when the search begins looking inside a new folder.

ISearchEngineProperties : IUnknown	*ISearchEngineProperties Interface.*
■─■ LocationString: String	*A string describing the starting location of a search.*
← Edit (in parentHWnd: Long)	*Returns the name of the search engine.*
← Load (in pPropertySet: IPropertySet)	*Loads the search engine properties from the given PropertySet.*
← Save (in pPropertySet: IPropertySet)	*Saves the search engine properties to the given PropertySet.*

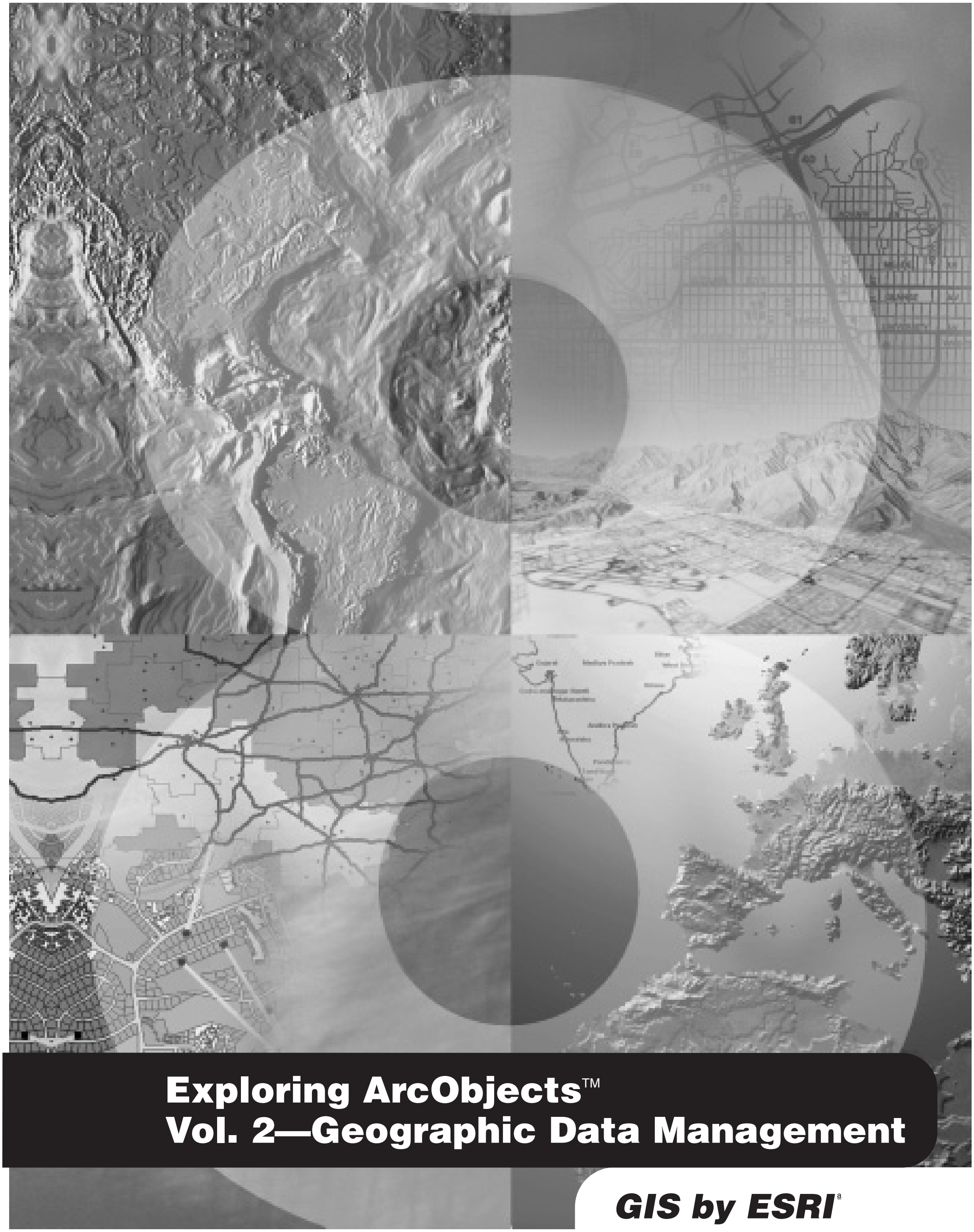
The *SearchEngineProperties* interface can set a search engine's properties after the search engine has been retrieved from the Find dialog box.

The *LocationString* property can set the location in which the search should begin.

Alternatively, the *Edit* method can be used to open a dialog box that provides an interactive method for defining the search engine's properties. For the Catalog search engine, a *GxDialog* appears that lets you define its location string. For the file system XML search, a dialog appears; in addition to letting you set the location string, you can check a box indicating whether or not subfolders should be searched.

Save will record all of the search engine's properties in a property set (not an XML property set), which can then be modified using the *IPropertySet* interface.

Load will set the search engine's properties using the parameters defined in an existing property set.



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Contributing Writers
Julio Andrade, Eleanor Blades, Patrick Brennan, Tom Brown, Euan Cameron, Scott Campbell, Jillian Clark, Jim Clarke, Chris Davies, Cory Eicher, Ryan Gatti, Shelly Gill, Erik Hoel, Melita Kennedy, Allan Laframboise, Russell Louks, Keith Ludwig, Gary MacDougall, Glenn Meister, Sud Menon, Jason Pardy, Bruce Payne, Ghislain Prince, Sentha Shanmugam, Brad Taylor, Steve Van Esch, Aleta Vienneau, Michael Waltuch, Steve Wheatley, Larry Young, Michael Zeiler

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8

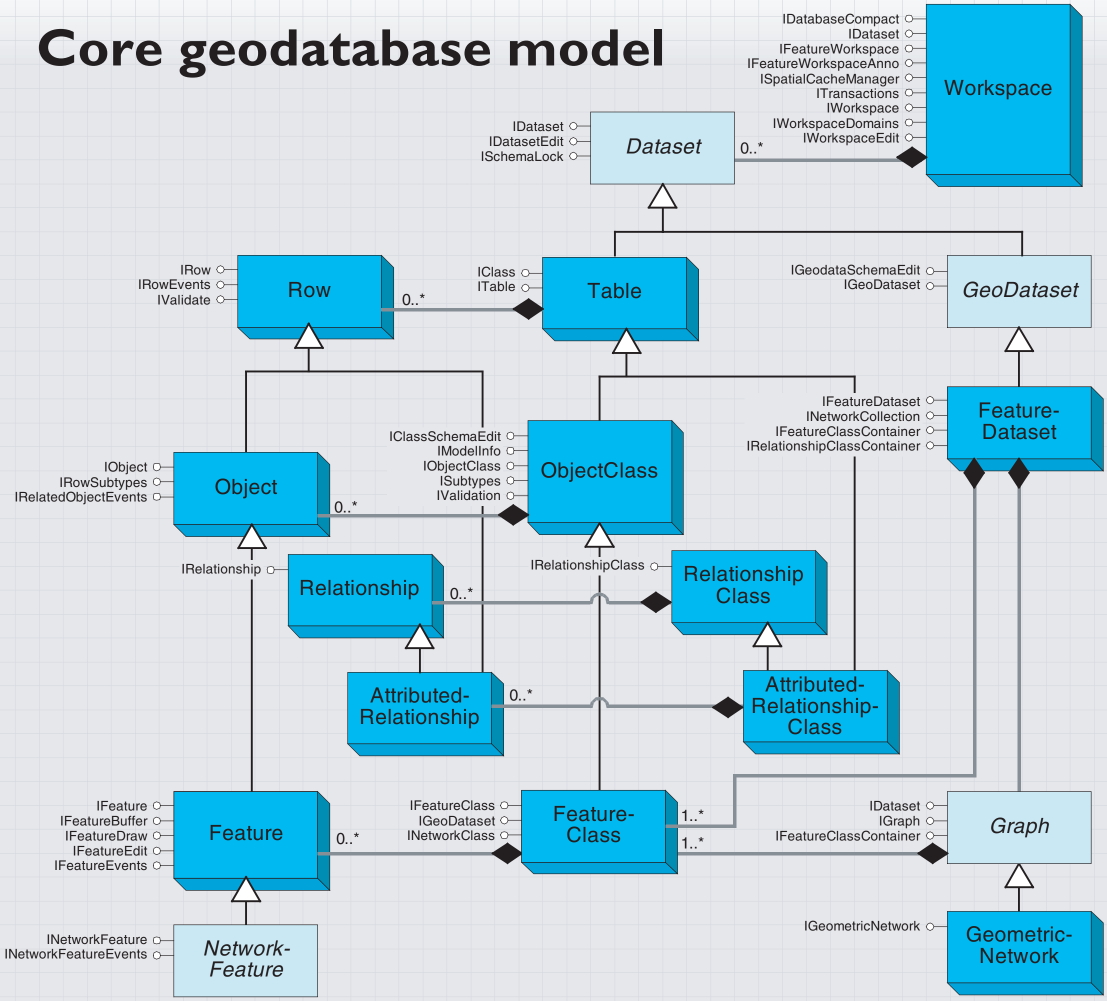
Accessing the geodatabase

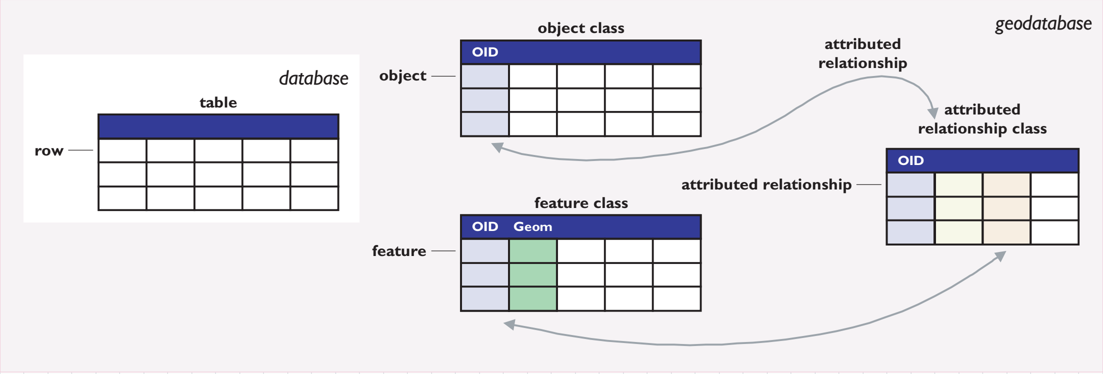
Jim Clarke, Sud Menon, Erik Hoel, Brad Taylor, Gary MacDougall, Patrick Brennan, Glenn Meister, Larry Young, Tom Brown

The geodatabase is a repository of geographic data built on standard industry-relational and object-relational database technology. You can access and manage your organization's data through the geodatabase data access objects in ArcObjects™.

The topics covered in this chapter include: controlling data through the workspace and name objects • partitioning data with the dataset objects • grouping like data with table, object class, and feature class objects • accessing discrete entities with rows, objects, and features • selecting and querying features • establishing relationships among features and objects • customizing with class extensions • working with annotation and dimension features • organizing linear data with geometric networks • using versions to provide multiuser access to editing geographic data • converting geographic data • joining tables • referencing linear events with dynamic segmentation • using x,y events

Core geodatabase model

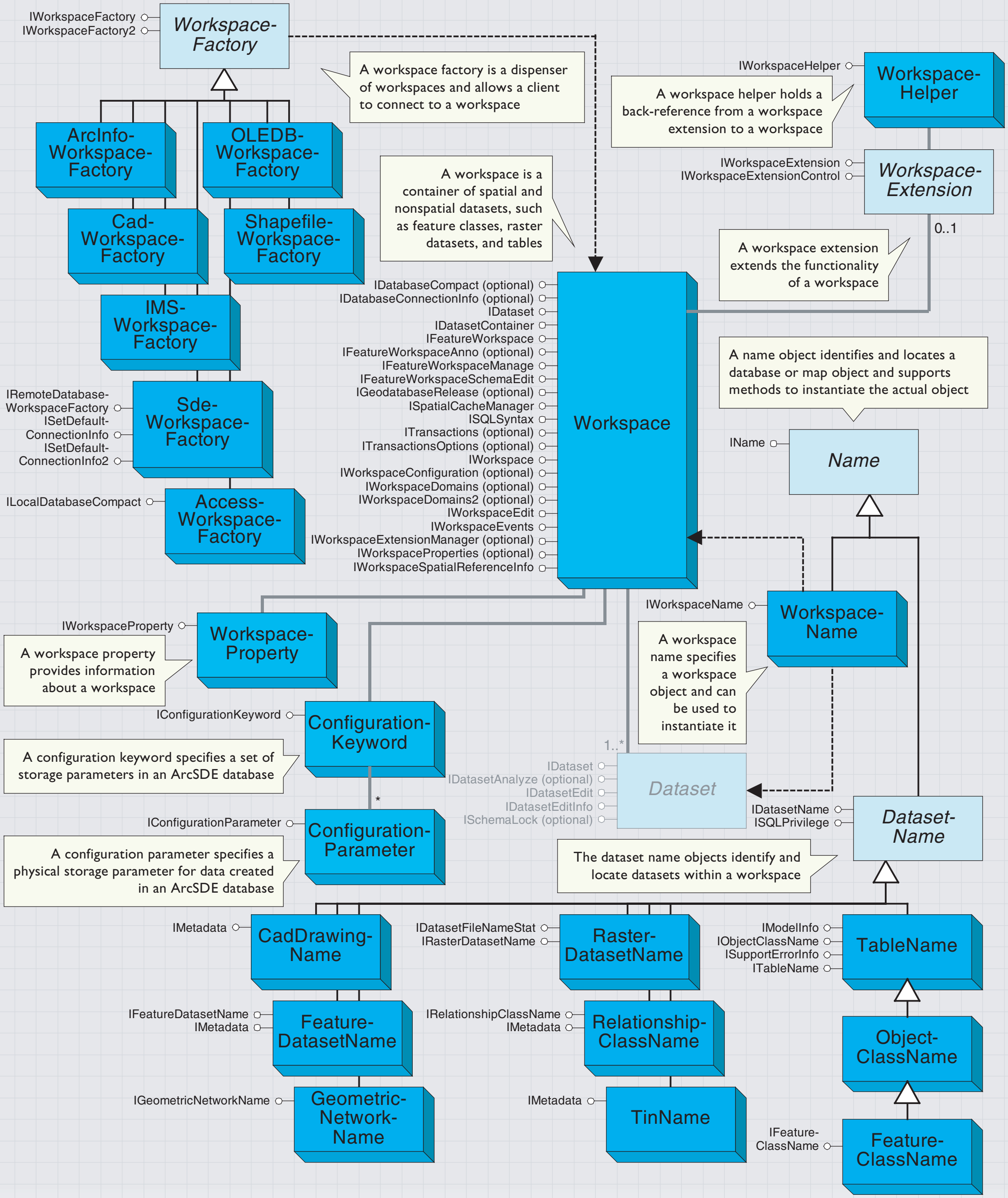




This chapter presents the developer's view of the geodatabase data access objects in ESRI® ArcGIS™ 8.1. The diagram is a simplified view of the most important geodatabase objects, which are summarized as follows:

- A workspace in the geodatabase data model corresponds to a geodatabase, an ArcInfo™ coverage workspace, or a folder with shapefiles.
- A dataset is the highest-level container of data.
- A geodataset is a dataset that contains geographic data.
- A feature dataset is composed of graphs and feature classes.
- A graph represents a set of topologically related feature classes.
- A geometric network is a type of graph that represents a one-dimensional network such as a utility or transportation system.
- A table is a collection of rows that have attributes stored in columns.
- A row is a record in a table. All rows in a table share the same set of fields.
- An object class is a type of table that stores nonspatial objects.
- An object is an entity with attributes and an object identifier.
- A feature class is a type of object class that stores spatial objects.
- A feature is an object with a geometric shape.
- A network feature is a feature that participates in a linear network, called a geometric network.
- A relationship class represents relationships through embedded foreign keys.
- A relationship is an association between objects or features; it controls behavior when objects or features are moved or deleted.
- An attributed relationship class is a type of table that stores relationships.
- An attributed relationship can represent many-to-many relationships as well as attributes on relationships.

Workspace and name objects



A workspace factory is a dispenser of workspaces and allows a client to connect to a workspace

A workspace helper holds a back-reference from a workspace extension to a workspace

A workspace is a container of spatial and nonspatial datasets, such as feature classes, raster datasets, and tables

A workspace extension extends the functionality of a workspace

A name object identifies and locates a database or map object and supports methods to instantiate the actual object

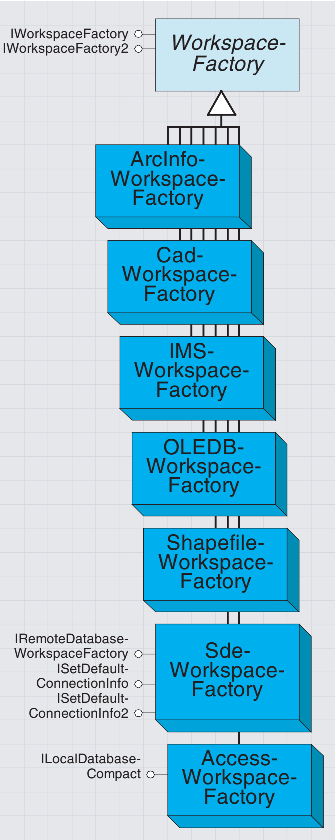
A workspace property provides information about a workspace

A workspace name specifies a workspace object and can be used to instantiate it

A configuration keyword specifies a set of storage parameters in an ArcSDE database

A configuration parameter specifies a physical storage parameter for data created in an ArcSDE database

The dataset name objects identify and locate datasets within a workspace



A workspace factory allows a client to connect to a specified workspace.

A *WorkspaceFactory* is a dispenser of workspaces and allows a client to connect to a workspace specified by a set of connection properties. A workspace represents a database or a data source that contains one or more datasets. Examples of datasets include tables, feature classes, and relationship classes.

A *WorkspaceFactory* is a cocreatable, singleton object. (A singleton object can only be instantiated once in a process.) A *WorkspaceFactory* maintains a pool of currently connected, active workspaces that are being referenced by the application. Connection properties are specified using a *PropertySet* object and can be saved to a connection file.

A *WorkspaceFactory* also supports methods that can be used to browse and manage file system workspaces and methods to manage connection files for remote database workspaces.

IWorkspaceFactory : IUnknown	***Provides access to members that create and open workspaces and supply workspace factory information.***
■— WorkspaceDescription (in plural: Boolean) : String	*A singular or plural description of the type of workspace the workspace factory opens/creates.*
■— WorkspaceType: esriWorkspaceType	*The type of workspace the workspace factory opens/creates.*
← ContainsWorkspace (in parentDirectory: String, in fileNames: IFileNames) : Boolean	*Indicates if parentDirectory contains a valid workspace, or is a valid file-system workspace.*
← Copy (in WorkspaceName: IWorkspaceName, in destinationFolder: String, out workspaceNameCopy: IWorkspaceName) : Boolean	*Copies a workspace to the specified destination folder.*
← Create (in parentDirectory: String, in Name: String, in ConnectionProperties: IPropertySet, in hWnd: Long) : IWorkspaceName	*Creates a new workspace specified by the directory, file name, and connection properties.*
← GetClassID: IUID	*The class ID of the WorkspaceFactory.*
← GetWorkspaceName (in parentDirectory: String, in fileNames: IFileNames) : IWorkspaceName	*Retrieves the workspace name of a workspace from the given list of file names.*
← IsWorkspace (in FileName: String) : Boolean	*True if the specified file identifies a workspace supported by the workspace factory.*
← Move (in WorkspaceName: IWorkspaceName, in destinationFolder: String) : Boolean	*Moves a workspace to the specified destination folder.*
← Open (in ConnectionProperties: IPropertySet, in hWnd: Long) : IWorkspace	*Opens the workspace specified by the connection properties.*
← OpenFromFile (in FileName: String, in hWnd: Long) : IWorkspace	*Opens the workspace specified by the given file name.*
← ReadConnectionPropertiesFromFile (in FileName: String) : IPropertySet	*The connection properties from the specified file.*

The *WorkspaceType* property returns information on the type of *Workspace* managed by the *WorkspaceFactory*.

Workspaces are classified into the following types specified by the *esriWorkspaceType* enumeration:

Enumeration esriWorkspaceType	***Workspace types.***
0 - esriFileSystemWorkspace	*File system Workspace.*
1 - esriLocalDatabaseWorkspace	*Local database Workspace.*
2 - esriRemoteDatabaseWorkspace	*Remote database Workspace.*

Shapefiles and ArcInfo workspaces are examples of *esriFileSystemWorkspace*. A personal geodatabase stored in Microsoft® Access is an example of an *esriLocalDatabaseWorkspace*. An enterprise geodatabase stored in an RDBMS, such as Oracle®, DB2®, SQL Server™, or Informix®, and accessed via ArcSDE™ is an example of an *esriRemoteDatabaseWorkspace*.

The connection properties for an *esriRemoteDatabaseWorkspace* specify the server and instance to connect to, and may be saved in a connection file on the file system.

The *Open* and *OpenFromFile* methods are the primary methods in this interface. The *Open* method takes as input a property set of connection properties that specify to which workspace to connect.

To connect to an enterprise geodatabase, use IWorkspaceFactory::Open. *To access other workspaces,* IWorkspaceFactory::OpenFromFile *is usually easiest.*

In the case of file system workspaces and local database workspaces, a single property named DATABASE, whose value is the pathname to the workspace, is usually all that is required.

In the case of remote database workspaces accessed via ArcSDE, the properties usually include the USER, PASSWORD, DATABASE, SERVER, INSTANCE, and VERSION properties of the database being connected to. The DATABASE property is optional and is required for ArcSDE instances that manage multiple databases (for example, SQL Server). The VERSION property specifies the version to connect to in the case of a multiversioned database. If no version is supplied, then a connection to the default version will be returned.

This example connects to an ArcSDE for Oracle geodatabase.

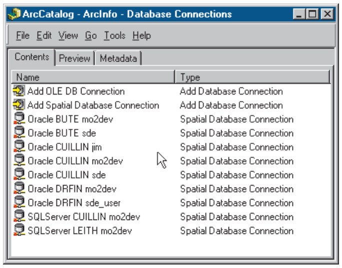
```
Dim pWorkspace As IWorkspace
Dim pWorkspaceFactory As IWorkspaceFactory

Dim pPropSet As IPropertySet
Set pPropSet = New PropertySet
With pPropSet
  .SetProperty "SERVER", "cuillin"
  .SetProperty "INSTANCE", "esri_sde"
  .SetProperty "USER", "scott"
  .SetProperty "PASSWORD", "tiger"
  .SetProperty "VERSION", "SDE.DEFAULT"
End With
Set pWorkspaceFactory = New SdeWorkspaceFactory
Set pWorkspace = pWorkspaceFactory.Open(pPropSet, 0)
```

The *OpenFromFile* method takes the pathname of a file or directory that represents either an *esriFileSystemWorkspace*, an *esriLocalDatabaseWorkspace*, or a connection file to an *esriRemoteDatabaseWorkspace* and returns an interface on the specified workspace. Clients of these methods can then proceed to open and access datasets in the workspace. If these methods are called with insufficient properties, then the user will be presented with a connection dialog box that will prompt for the required properties.

The *ContainsWorkspace* and *GetWorkspaceName* methods are useful when browsing the file system for workspaces. The *ContainsWorkspace* method is given a parent directory and the list of filenames in the directory to be examined. It returns *True* if the parent directory represents a workspace covered by this factory or if the parent directory contains a workspace or a connection file to a workspace covered by this factory. The *GetWorkspaceName* method is given a parent directory and the list of filenames in the directory to be examined. It returns a *WorkspaceName* object representing the workspace and removes any filenames representing the workspace or its datasets from the input list of filenames.

The *Copy* and *Move* methods can be used to copy or move workspaces or connection files between folders in the file system. The Boolean result indicates if the operation was successful. In the case of remote database workspaces, these operations work on the connection file representing the workspace.

The *Create* method can be used to create a new *esriFileSystemWorkspace* or *esriLocalDatabaseWorkspace* or to create a connection file to an *esriRemoteDatabaseWorkspace*. The optional *connectionProperties* parameter specifies any additional connection properties needed, such as the server, instance, user, and password, in the case where a connection file to a remote database workspace is being created. If no connection properties are specified, then this method will result in a dialog box being displayed that prompts the user for the required properties.



Name	Type
Add OLE DB Connection	Add Database Connection
Add Spatial Database Connection	Add Database Connection
Oracle BUTE mo2dev	Spatial Database Connection
Oracle BUTE sde	Spatial Database Connection
Oracle CUILLIN jim	Spatial Database Connection
Oracle CUILLIN mo2dev	Spatial Database Connection
Oracle CUILLIN sde	Spatial Database Connection
Oracle DRFIN mo2dev	Spatial Database Connection
Oracle DRFIN sde_user	Spatial Database Connection
SQLServer CUILLIN mo2dev	Spatial Database Connection
SQLServer LEITH mo2dev	Spatial Database Connection

IRemoteWorkspaceFactory *manages connection files for enterprise geodatabases.*

IRemoteDatabaseWorkspaceFactory : IUnknown

Provides access to members that manage remote database connection information.

← DeleteConnectionFile (in PathName: String)

Deletes the remote database workspace connection file.

← EditConnectionFile (in PathName: String, in hWnd: Long) : IWorkspaceName

Edits the properties of a remote database workspace connection file.

← RenameConnectionFile (in oldPathName: String, in newName: String) : IWorkspaceName

Renames the remote database workspace connection file.

The *IRemoteDatabaseWorkspaceFactory* is an optional interface, supported by remote database workspaces, that contains additional methods for connection file management.

ISetDefaultConnectionInfo : IUnknown

Provides default connection information for a remote database.

← SetParameters (in server: String, in instance: String, in user: String, in Password: String, in versName: String)

Sets SDE connection property parameters.

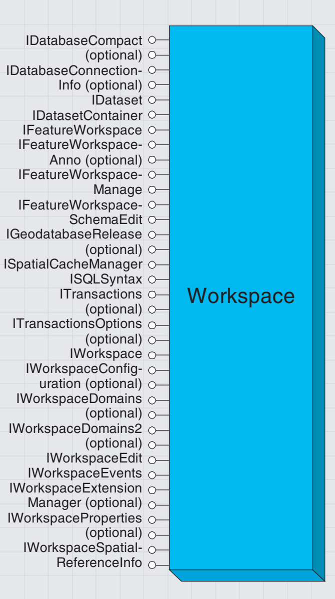
ISetDefaultConnectionInfo is an optional interface supported by the *SDEWorkspaceFactory*. It allows you to set default values for the user, such as a password and version connection properties on a per-server and -instance basis. These default values will be used by the *Open* method in those cases where the caller of the method does not supply values for these properties at call time and by the *OpenFromFile* method in those cases where the connection file contains partial connection information.

You can get a workspace's connection string using the ConnectionString *property on* IWorkspaceName2.

IWorkspaceFactory2 : IUnknown	***Provides access to members that create and open workspaces and supply workspace factory information.***
← Open (in connectStr: String, in hWnd: Long) : IWorkspace	*Opens the workspace specified by a connection string.*

The *IWorkspaceFactory2* interface allows you to open a workspace using a string that describes the connection properties. Compare this example with the previous example for *IWorkspaceFactory*.

```
Dim pWorkspaceFactory2 As IWorkspaceFactory2
Set pWorkspaceFactory2 = New SdeWorkspaceFactory
Dim pWorkspace As IWorkspace
Dim strConnect As String
strConnect = "SERVER=cuillin;INSTANCE=esri_sde;USER=scott; _
  PASSWORD=tiger;VERSION=SDE.DEFAULT"
Set pWorkspace = pWorkspaceFactory2.Open(strConnect, 0)
```


IDatabaseCompact (optional)
IDatabaseConnectionInfo (optional)
IDataset
IDatasetContainer
IFeatureWorkspace
IFeatureWorkspaceAnno (optional)
IFeatureWorkspaceManage
IFeatureWorkspaceSchemaEdit
IGeodatabaseRelease (optional)
ISpatialCacheManager
ISQLSyntax
ITransactions (optional)
ITransactionsOptions (optional)
IWorkspace
IWorkspaceConfiguration (optional)
IWorkspaceDomains (optional)
IWorkspaceDomains2 (optional)
IWorkspaceEdit
IWorkspaceEvents
IWorkspaceExtensionManager (optional)
IWorkspaceProperties (optional)
IWorkspaceSpatialReferenceInfo
Workspace

A workspace is a container of datasets.

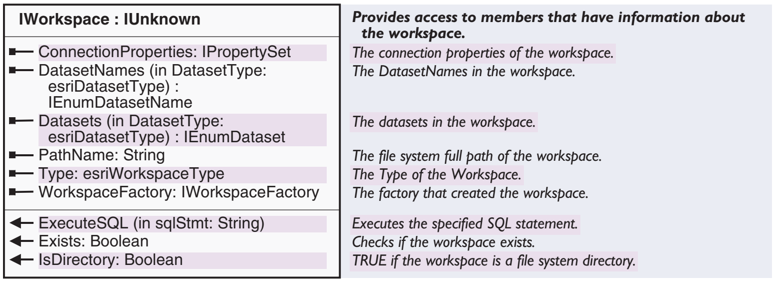
Though a workspace is a container of datasets, all workspaces support the IDataset *interface and return a workspace name as the value of the* FullName *property; in addition, the value of the* DatasetType *property for a workspace is* esriDTContainer.

A *Workspace* is a container of spatial and nonspatial datasets such as feature classes, raster datasets, and tables. It provides methods to instantiate existing datasets and to create new datasets.

Workspaces are classified into types specified by the *esriWorkspaceType* enumerator: *esriFileSystemWorkspace, esriLocalDatabaseWorkspace,* and *esriRemoteDatabaseWorkspace*.

Shapefiles and ArcInfo workspaces are examples of *esriFileSystemWorkspace*. A personal geodatabase stored in Microsoft Access is an example of an *esriLocalDatabaseWorkspace*. An enterprise geodatabase stored in an RDBMS, such as Oracle, DB2, SQL Server, or Informix, and accessed via ArcSDE is an example of an *esriRemoteDatabaseWorkspace*.

A *Workspace* hands out a *WorkspaceName* name object as the value of its *FullName* property. The *WorkspaceName* for a workspace can be persisted, for example, in a map document. An application can call the *Open* method on the workspace name after loading it from persistent storage in order to connect to and get an object reference to the workspace.



IWorkspace : IUnknown	*Provides access to members that have information about the workspace.*
ConnectionProperties: IPropertySet	*The connection properties of the workspace.*
DatasetNames (in DatasetType: esriDatasetType) : IEnumDatasetName	*The DatasetNames in the workspace.*
Datasets (in DatasetType: esriDatasetType) : IEnumDataset	*The datasets in the workspace.*
PathName: String	*The file system full path of the workspace.*
Type: esriWorkspaceType	*The Type of the Workspace.*
WorkspaceFactory: IWorkspaceFactory	*The factory that created the workspace.*
ExecuteSQL (in sqlStmt: String)	*Executes the specified SQL statement.*
Exists: Boolean	*Checks if the workspace exists.*
IsDirectory: Boolean	*TRUE if the workspace is a file system directory.*

The *WorkspaceFactory* property can be used to get a reference back to the workspace factory for this workspace.

The *ConnectionProperties* property of a workspace returns the set of named connection properties for this workspace.

This example greets the user of the selected dataset in the ArcMap table of contents (if the dataset belongs to an ArcSDE geodatabase).

```
Public Sub GetUser()
  Dim pMxDoc As IMxDocument
  Set pMxDoc = ThisDocument
  If pMxDoc.SelectedItem Is Nothing Then
    Exit Sub
  End If

  If TypeOf pMxDoc.SelectedItem Is IDataset Then
    Dim pDataset As IDataset
    Set pDataset = pMxDoc.SelectedItem
    Dim pWorkspace As IWorkspace
    Set pWorkspace = pDataset.Workspace
    If pWorkspace.Type = esriRemoteDatabaseWorkspace Then
```

```
      Dim pPropSet As IPropertySet
      Set pPropSet = pWorkspace.ConnectionProperties
      MsgBox "Hello " & pPropSet.GetProperty("USER")
    End If
  End If
End Sub
```

The Datasets *and* DatasetNames *methods let you find out what datasets are in the workspace. Use* DatasetNames *if possible for better performance.*

The *Datasets* and the *DatasetNames* methods can be used by an application to enumerate over the set of datasets in a workspace. The *Datasets* method returns an enumerator over the datasets in the workspace of the specified dataset type. The *DatasetNames* method returns an enumerator over the dataset names in the workspace for the specified dataset type.

Browsing applications should use the *DatasetNames* method to obtain name objects. These dataset name objects contain the essential properties of the corresponding dataset objects and are faster to retrieve. If the actual dataset specified by a name object is required (for example, because the user selected it), then it can easily be instantiated by calling the *Open* method on the name object.

Using a dataset type of *esriDTAny* will return all the datasets or dataset names in the workspace across all dataset types. Note that only the top-level datasets in the workspace are returned by these methods. In particular, if a workspace contains both standalone feature classes and additional feature classes that are part of a feature dataset, then getting *Datasets* or *DatasetNames* properties on the workspace with a dataset type of *esriDTFeatureClass* will return only the standalone feature classes. In order to get the feature class names within a feature dataset, the application needs to get the *FeatureClassNames* property on the top-level feature dataset name returned by the workspace.

The *ExecuteSQL* method can be used to send an arbitrary SQL statement to the underlying database for execution. The statement can be any DDL or DML statement but cannot return any result sets. The syntax for the SQL is as required by the underlying database. The workspace supports an optional *ISQLSyntax* interface that provides information to applications on aspects of the SQL syntax for the underlying database.

To determine if a workspace supports the *ExecuteSQL* method, an application can check the value of the *canExecuteSQL* workspace property via the optional *IWorkspaceProperties* interface. In general, *ExecuteSQL* is supported only on local and remote database workspaces.

IFeatureWorkspace *provides access to feature classes, feature datasets, and tables, and also to methods to create them.*

IFeatureWorkspace : IUnknown	*Feature Workspace Interface.*
← CreateFeatureClass (in Name: String, in Fields: IFields, in CLSID: IUID, in EXTCLSID: IUID, in FeatureType: esriFeatureType, in ShapeFieldName: String, in ConfigKeyword: String) : IFeatureClass	*Creates a new standalone FeatureClass under the workspace.*
← CreateFeatureDataset (in Name: String, in SpatialReference: ISpatialReference) : IFeatureDataset	*Creates a new feature dataset.*
← CreateQueryDef: IQueryDef	*Creates a query definition object.*
← CreateRelationshipClass (in relClassName: String, in OriginClass: IObjectClass, in DestinationClass: IObjectClass, in forwardLabel: String, in backwardLabel: String, in Cardinality: esriRelCardinality, in Notification: esriRelNotification, in IsComposite: Boolean, in IsAttributed: Boolean, in relAttrFields: IFields, in OriginPrimaryKey: String, in destPrimaryKey: String, in OriginForeignKey: String, in destForeignKey: String) : IRelationshipClass	*Creates a new relationship class.*
← CreateTable (in Name: String, in Fields: IFields, in CLSID: IUID, in EXTCLSID: IUID, in ConfigKeyword: String) : ITable	*Creates a new table.*
← OpenFeatureClass (in Name: String) : IFeatureClass	*Opens an existing feature class.*
← OpenFeatureDataset (in Name: String) : IFeatureDataset	*Opens an existing feature dataset.*
← OpenFeatureQuery (in queryName: String, in pQueryDef: IQueryDef) : IFeatureDataset	*Opens a FeatureDataset containing a single FeatureClass defined by the specified query.*
← OpenRelationshipClass (in Name: String) : IRelationshipClass	*Opens an existing relationship class.*
← OpenRelationshipQuery (in pRelClass: IRelationshipClass, in joinForward: Boolean, in pSrcQueryFilter: IQueryFilter, in pSrcSelectionSet: ISelectionSet, in TargetColumns: String, in DoNotPushJoinToDB: Boolean) : ITable	*Table of a relationship join query.*
← OpenTable (in Name: String) : ITable	*Opens an existing table.*

The *IFeatureWorkspace* interface is used to access and manage datasets that are a key component of a feature-based geodatabase: *Tables* and *ObjectClasses*, *FeatureClasses, FeatureDatasets,* and *RelationshipClasses*.

All of the *Open* methods (such as *OpenTable*) take a dataset name as input. When working with an enterprise geodatabase, the name may be fully qualified (for example, "database.owner.tablename" or "owner.tablename") using the qualification character appropriate to the underlying database (see *ISQLSyntax*). If the input name is not fully qualified, then it is qualified using the currently connected user for the workspace.

When working with geodatabases (personal or enterprise), the workspace keeps a running object table of instantiated datasets. Multiple calls to open an already instantiated dataset will return a reference to the already instantiated dataset.

The *OpenTable* method can be used to open any existing table or object class in the workspace given its fully qualified name. The table object returned will always support the *ITable* interface. The returned table object will support additional interfaces depending on the type of table—for example, *ObjectClasses* will additionally support the *IObjectClass* interface.

The *OpenFeatureClass* method can be used to open any existing feature class in the workspace given its fully qualified name. Note that every feature class in a geodatabase has a unique fully qualified name, and the *OpenFeatureClass* method can be used to directly open *FeatureClasses* that are part of a *FeatureDataset.*

This example opens a shapefile as a feature class.

```
Public Sub OpenFeatureClass_Example()
  Dim pWorkspaceFactory As IWorkspaceFactory
  Set pWorkspaceFactory = New ShapefileWorkspaceFactory

  Dim pFeatureWorkspace As IFeatureWorkspace
  Set pFeatureWorkspace = _
    pWorkspaceFactory.OpenFromFile("D:\Data\Esridata\USA", 0)

  Dim pFeatureClass As IFeatureClass
  Set pFeatureClass = pFeatureWorkspace.OpenFeatureClass("States")
  MsgBox "There are " & pFeatureClass.FeatureCount(Nothing) & " states"
End Sub
```

The *OpenFeatureDataset* method can be used to open any existing feature dataset in the workspace given its fully qualified name. At ArcGIS 8.1, opening a feature dataset does not automatically instantiate all the feature classes in the feature dataset.

The *OpenRelationshipClass* method can be used to open any existing relationship class in the workspace, given its fully qualified name.

The *OpenFeatureQuery* method can be used to open a virtual feature class whose definition is based on a *QueryDef* created using the *CreateQueryDef* method. The *QueryDef* can involve multiple tables as long as one of them is a feature class; the resulting virtual feature class can be used to construct a feature layer that can be added to *Map*.

The *CreateQueryDef* method can be used to create a new query definition object that can be evaluated returning a cursor. For more information, see the section on *QueryFilters, QueryDefs,* and *Cursors*.

The *CreateTable* method can be used to create a new table or object class in the workspace. The optional *CLSID* and *EXTCLSID* parameters allow the calling application to specify the GUIDs for the COM coclasses that implement the instance and the class extension behavior for an object class. If no *CLSID* is passed in, then the resulting table is not registered in the geodatabase object class data dictionary (it will support the *IObjectClass* interface but will have an *ObjectClassID* of -1). Valid values for *CLSID* are *esriCore.Object* or any nonspatial COM object that aggregates *esriCore.Object*. *CLSID* must be set if *EXTCLSID* is set. The optional *configurationKeyword* parameter allows the application to control the physical layout for this table in the underlying RDBMS—for

For an example of how to create a shape field, see the documentation on GeometryDef*.*

example, in the case of an Oracle database, the configuration keyword controls the tablespace in which the table is created, the initial and next extents, and other properties. The *configurationKeywords* for an ArcSDE instance are set up by the ArcSDE data administrator; the list of available keywords supported by a workspace may be obtained using the *IWorkspaceConfiguration* interface at ArcGIS 8.1. For more information on configuration keywords, refer to the ArcSDE documentation. For an example of applying *CreateTable*, see the *Field* object.

The *CreateFeatureClass* method can be used to create a standalone feature class that is not part of a *FeatureDataset*. It takes, in addition to all the parameters that *CreateTable* takes, a *featureType* parameter that specifies the category of features to be stored in this feature class (such as *esriFTSimple, esriFTComplexEdgeFeature,* and others) and a *shapeFieldName*. The *shapeFieldName* identifies the name of the field in the input fields collection, of type *Geometry*, that represents the shape field for the feature class. The *GeometryDef* object associated with the shape *Field* object must be fully set up with information on both the spatial reference (the projected or geographic coordinate system and the coordinate domain and the coordinate precision) and the spatial index for the shape *Field*.

Relationship classes associate objects through foreign key attribute values.They have their own section later in this chapter.

The *CreateFeatureDataset* method can be used to create a new *FeatureDataset*. Methods supported by the returned feature dataset allow the creation of feature classes in the feature dataset.

The *CreateRelationshipClass* method can be used to create a new standalone relationship class that is not part of a *FeatureDataset*. For a description of the various parameters, see the discussion of relationship classes. If the cardinality is many-to-many or if the relationship class is attributed, the relationship class is implemented as a separate data table whose name is the name of the relationship class. The *relAttrFields* parameter is optional—a value of 0 or *Nothing* may be passed in for nonattributed relationship classes.

Many-to-many or attributed relationship classes require specification of all four key fields—the *OriginPrimaryKey* and the *DestinationPrimaryKey* are the primary key fields for the origin and destination object classes. *OriginForeignKey* and the *DestinationForeignKey* are the names of the corresponding foreign keys created in the data table that represent the relationship class.

If the relationship class is one-to-one or one-to-many and not attributed, then the relationship class is implemented as a foreign key field in the destination object class (the *OriginForeignKey*) that references the primary key field in the origin object class (the *OriginPrimaryKey*). In this case, the *OriginPrimaryKey* and the *OriginForeignKey* must be supplied.

IFeatureWorkspaceAnno is used to create geodatabase annotation feature classes. Annotation has its own section later in this chapter.

IFeatureWorkspaceAnno : IUnknown	*Feature Workspace Annotation Helper Interface.*
← AddSymbolCollection (in Name: String, in SymbolCollection: IUnknown Pointer)	*Updates the symbol collection in the class extension.*
← CreateAnnotationClass (in Name: String, in Fields: IFields, in CLSID: IUID, in EXTCLSID: IUID, in ShapeFieldName: String, in ConfigKeyword: String, in dstFeatureDataset: IFeatureDataset, in srcFeatureClass: IFeatureClass, in AnnoProperties: IUnknown Pointer, in ReferenceScale: IUnknown Pointer, in SymbolCollection: IUnknown Pointer, in AutoCreate: Boolean) : IFeatureClass	*Creates a new annotation feature class in the workspace.*
← ReplaceSymbolCollection (in Name: String, in SymbolCollection: IUnknown Pointer)	*Replaces the symbol collection in the class extension.*

IFeatureWorkspaceAnno is an optional interface supported by workspaces that represent geodatabases; it contains specialized methods for creating geodatabase annotation feature classes.

Symbol collections are an alternative to storing a symbol with each individual annotation.

The *CreateAnnotationClass* method creates a new annotation feature class that may or may not be feature linked via a relationship class to features in a source feature class (the feature class being annotated). The *CLSID* property must be set to *esriCore.AnnotationFeature*, and the *EXTCLSID* property must be set to *esriCore.AnnotationFeatureClassExtension*. The *srcFeatureClass* parameter specifies the source feature class and may be set to zero or *Nothing* for nonfeature-linked annotation. The *AnnoProperties* parameter specifies the labeling properties to be used for the annotation and must support the *IAnnotateLayerPropertiesCollection* interface. The *ReferenceScale* parameter specifies the reference scale to be used for the annotation. The *SymbolCollection* parameter specifies the symbols that will be referenced by the annotation elements for the annotation features in this feature class and must support the *ISymbolCollection* interface. The *autoCreate* parameter applies to feature-linked annotation; setting it to *True* results in a new annotation feature being automatically created when a new feature in the source feature class is created.

The *AddSymbolCollection* and *ReplaceSymbolCollection* may be used to augment and replace the symbol collection associated with an annotation feature class. Use extreme caution when using these methods—there may be existing annotation features in the annotation feature class that have annotation elements that may reference symbols by ID. Deleting the symbol for such an ID or replacing it with a different symbol may leave the geometry of the annotation feature out of phase with its symbol, resulting in subsequent problems during drawing and selection. These methods are for use by specialized data loaders that can guarantee the integrity of referenced symbols.

DeleteByName *will remove damaged datasets.*

IFeatureWorkspaceManage : IUnknown	*Feature Workspace Manage Interface.*
← AnalyzeIndex (in TableName: String, in Index: String)	*Analyzes the index to generate DBMS statistics.*
← AnalyzeTable (in TableName: String, in tableComponents: Long)	*Analyzes the table to generate DBMS statistics.*
← CanDelete (in aName: IName) : Boolean	*Checks if an object can be deleted.*
← CanRename (in aName: IName) : Boolean	*True if an object can be renamed.*
← DeleteByName (in aName: IDatasetName)	*Deletes an object by its name.*
← IsRegisteredAsObjectClass (in Name: String) : Boolean	*Checks if an object is registered as an object class.*
← IsRegisteredAsVersioned (in aName: IName) : Boolean	*Checks if an object is registered as versioned.*
← ValidateField (in pInField: IField) : IField	*Validates a field, performing type conversion if necessary.*

The *IFeatureWorkspaceManage* interface contains utility methods that help in the management of feature workspaces.

The *AnalyzeTable* and *AnalyzeIndex* methods can be used to acquire DBMS statistics on tables and table indexes. Having up-to-date statistics on a table is key to efficient query performance on the table and a key requirement for efficient queries against versioned tables. Note that datasets that are based on tables support the *IDatasetAnalyze* method; to analyze all of the tables in a feature dataset, use the *IDatasetAnalyze::Analyze* method on the feature dataset.

The *DeleteByName* method can be used to delete a dataset given its name object. It can be useful when cleaning up partially loaded datasets that cannot be instantiated because of incomplete information. It is controlled through the ArcCatalog Delete command. Note that *IDataset::Delete* is directly available as a method on instantiated datasets.

IFeatureWorkspaceSchemaEdit *can be useful when recovering from an error in opening a custom feature class.*

IFeatureWorkspaceSchemaEdit : IUnknown	*Feature Workspace Schema Edit Interface.*
← AlterClassExtensionCLSID (in Name: String, in ClassExtensionCLSID: IUID, in classExtensionProperties: IPropertySet)	*Changes the class extension COM class associated with this database class.*
← AlterInstanceCLSID (in Name: String, in InstanceCLSID: IUID)	*Changes the instance COM class associated with this database class.*

The *IClassSchemaEdit* interface on an instantiated object class allows an application to change the behavior associated with an object class by changing the GUIDs, specifying the class instance and class extension COM classes. There are times where instantiation of an object class may fail such as when one or more necessary COM classes referenced by the object class are not installed or available. In these cases, the methods in *IFeatureWorkspaceSchemaEdit* can be used to alter the GUIDs, specifying the class instance and class extension COM classes for an object class, given only the name of the object class.

IWorkspaceSpatialReferenceInfo : IUnknown	***Provides access to spatial reference information for the workspace.***
SpatialReferenceInfo: IEnumSpatialReferenceInfo	*The defined Spatial References in the Workspace.*

IWorkspaceSpatialReferenceInfo is an optional interface that can be used by an application to retrieve the set of spatial references that are referenced by geodatasets in a geodatabase (ArcSDE or Access workspace). It has a read-only property, *SpatialReferenceInfo*, that returns an enumerator that supports the *IEnumSpatialReferenceInfo* interface. The latter has a *Next* method that can be used to iterate over the spatial references and their spatial reference IDs (SRID) within the geodatabase.

ISQLSyntax *helps to avoid making assumptions about your database environment, leading to code that is more portable and generic. For example, you will be able to write queries that work against both personal and enterprise geodatabases.*

ISQLSyntax : IUnknown	***Provides access to members that supply information about SQL functionality.***
GetDelimitedIdentifierCase: Boolean	*True if DBMS's quoted identifiers are case sensitive.*
GetFunctionName (in sqlFunc: esriSQLFunctionName) : String	*DBMS dependent SQL function names.*
GetIdentifierCase: Boolean	*True if DBMS's identifiers are case sensitive.*
GetInvalidCharacters: String	*The list of invalid characters used in literals (if any).*
GetInvalidStartingCharacters: String	*The list of invalid characters used in literals (if any).*
GetKeywords: IEnumBSTR	*The list of DBMS-specific reserved keywords.*
GetSpecialCharacter (in sqlSC: esriSQLSpecialCharacters) : String	*Special DBMS dependent SQL characters.*
GetStringComparisonCase: Boolean	*True if string comparisons are case sensitive.*
GetSupportedClauses: Long	*Supported SQL clauses.*
GetSupportedPredicates: Long	*Supported SQL predicates.*
ParseColumnName (in FullName: String, out dbName: String, out ownerName: String, out TableName: String, out ColumnName: String)	*Given a column name, determine its qualification parts.*
ParseTableName (in FullName: String, out dbName: String, out ownerName: String, out TableName: String)	*Given a table name, determine its qualification parts.*
QualifyColumnName (in TableName: String, in ColumnName: String) : String	*Given a table name and column name, returns its fully qualified name.*
QualifyTableName (in dbName: String, in ownerName: String, in TableName: String) : String	*Given a database, owner, and table name, returns its fully qualified name.*

Applications can use the *ISqlSyntax* interface to help them construct SQL queries and where clauses that are database-system independent.

The *GetSpecialCharacter* can be used to return the DBMS-dependent character that represents an SQL special character, including the following:

- *esriSQL_WildcardManyMatch* (% in SQL_92, * in Jet 4.0)
- *esriSQL_WildcardSingleMatch* (_ in SQL_92, ? in Jet 4.0)
- *esriSQL_DelimitedIdentifierPrefix* (“ in SQL-92, [in Jet 4.0)
- *esriSQL_DelimitedIdentifierSuffix* (“ in SQL-92,] in Jet 4.0)

Applications should use the *ParseTableName* and *ParseColumnName* methods to split the fully qualified name for a dataset or for a column in a table into its components (database, owner, table, column). Applications that wish to be RDBMS independent should not assume that “.” is the delimiter used to separate the components of a fully qualified dataset name. Note that both the *IDataset::Name* property for a dataset in a geodatabase and the *IDatasetName::Name* property for a dataset name object return the fully qualified name for the dataset (the name object for the dataset, obtained using the *IDataset::FullName* property itself).

Applications should use the *QualifyTableName* and *QualifyColumnName* methods to construct fully qualified dataset and column names.

ITransactions : IUnknown	*Transaction management interface.*
■— InTransaction (pInTransaction: Boolean)	*Returns true if there is already a transaction in progress.*
← AbortTransaction	*Aborts the current transaction.*
← CommitTransaction	*Commits the current transaction.*
← StartTransaction	*Begins a new transaction.*

ITransactions is an optional interface that allows an application to explicitly control database transactions. The interface does not support nested transactions. The *InTransaction* property should be used to test if the workspace is already within a transaction. Applications are responsible for starting a new transaction (using the *StartTransaction* method) on the workspace only if the workspace is not already within a transaction. An application is responsible for stopping only those transactions (using *CommitTransaction* or *AbortTransaction*) that were started by the application.

Applications can use transactions to manage direct updates, for example, updates made outside of an edit session on object and feature classes that are tagged as not requiring an edit session.

When using transactions to manage direct updates, applications are responsible for discarding any cached row objects at transaction boundaries.

ITransactions *is not the normal way of handling geodatabase updates. Only use this interface outside of edit sessions.*

Applications should not use transactions when performing updates within an edit session (for information on edit sessions, see the documentation on *IWorkspaceEdit* below). In the context of an edit session, transactions are managed by the workspace and automatically started and stopped as needed.

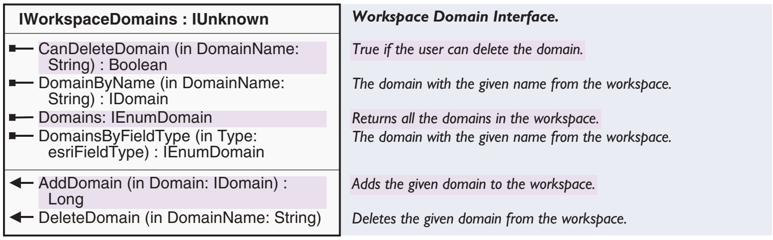
As in most database environments, your transaction will be committed if you make schema modifications.

Applications should be aware that DDL operations made through the ArcObjects geodatabase data access objects (for example, deleting a feature dataset or creating a new feature class) use database transactions to ensure integrity of the data dictionary tables and commit the transaction at the end of the operation. Applications should not invoke DDL operations within an application transaction—application transactions should be restricted to DML operations (such as data updates).

ITransactionsOptions : IUnknown	*Transaction options interface.*
■—■ AutoCommitInterval: Long	*The autocommit interval is the number of modification operations before a database commit is executed.*

The *ITransactionOptions* is an optional interface on SDE workspaces that can be used to control the autocommit interval for application-begun transactions. Setting the *AutoCommitInterval* to 0 turns auto-commit off and ensures that the transaction will not commit until the application calls *CommitTransaction*.

Domains constrain the valid values for a field. Since a single domain can be applied to fields in many different object classes, domains are managed at the workspace level.



IWorkspaceDomains : IUnknown — *Workspace Domain Interface.*

CanDeleteDomain (in DomainName: String) : Boolean — *True if the user can delete the domain.*

DomainByName (in DomainName: String) : IDomain — *The domain with the given name from the workspace.*

Domains: IEnumDomain — *Returns all the domains in the workspace.*

DomainsByFieldType (in Type: esriFieldType) : IEnumDomain — *The domain with the given name from the workspace.*

AddDomain (in Domain: IDomain) : Long — *Adds the given domain to the workspace.*

DeleteDomain (in DomainName: String) — *Deletes the given domain from the workspace.*

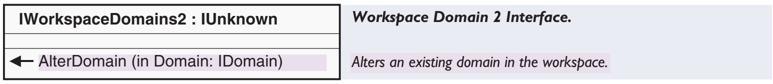
Domains are applied to fields via attribute rules. See the section on domains and validation later in this chapter.

The *IWorkspaceDomains* interface is used for managing the collection of domains found within a workspace. Domains may be shared between fields in different object classes, thus they are managed (that is, created and deleted) at the workspace level. It is important to keep in mind that a domain may not be deleted from a workspace if any field in an object class currently uses it. Domain names are also unique across a workspace; if you attempt to add a domain to a workspace and the specified name is already associated with an existing domain, an error will be returned.

Three of the four properties on the *IWorkspaceDomain* interface are used for returning to the user the domains that are currently associated with the workspace. The user can either request all of the domains (*Domains*), a particular domain by name (*DomainByName*), or all the domains that may be associated with a given field type (*DomainsByFieldType*).

The fourth property on the *IWorkspaceDomains* interface, *CanDeleteDomain*, is used in conjunction with the *DeleteDomain* method. If the user attempts to delete a domain from a workspace rather than handling errors that may result during *DeleteDomain* (that is, the domain is in use), the user may first test whether the domain can be deleted via this property.

The *AddDomain* method is used when adding a new domain to a workspace. An error will be returned if the domain name already exists on an existing domain within the workspace. *AddDomain* will return the identifier of the domain once it is added to the workspace. *DeleteDomain* will delete the domain from the workspace if the domain is not associated with any fields.



IWorkspaceDomains2 : IUnknown — *Workspace Domain 2 Interface.*

AlterDomain (in Domain: IDomain) — *Alters an existing domain in the workspace.*

The *IWorkspaceDomains2* interface was added to enable a user to modify an existing domain. Without this interface, in order to modify an existing domain, it would first be necessary to disassociate it with all fields, delete the domain, create a new (and modified) domain, then reassociate it with the appropriate fields. Note that schema locks are acquired when altering a domain.

The *AlterDomain* method allows the user to take an existing domain, modify it, then call *AlterDomain,* passing it as an argument. Alternatively, the user may create a new instance of a domain with the same name, owner, and field type as an existing domain. The existing domain would be replaced with the new domain. The identifier of the new domain would be modified to match that of the existing domain that is being altered.

Use IWorkspaceEdit *to manage editing sessions when the editing tools in ArcMap™ are unavailable or not required.*

IWorkspaceEdit : IUnknown	***Workspace Editing Interface.***
← AbortEditOperation	*Aborts an edit operation.*
← DisableUndoRedo	*Disables Undo and Redo of edit operations.*
← EnableUndoRedo	*Enables Undo and Redo of edit operations.*
← HasEdits (pHasEdits: Boolean)	*True if there are any completed edit operations that need to be saved.*
← HasRedos (pHasRedos: Boolean)	*True if there are any completed undos that can be redone.*
← HasUndos (pHasUndos: Boolean)	*True if there are any completed edit operations that can be undone.*
← IsBeingEdited: Boolean	*True if the workspace is being edited.*
← RedoEditOperation	*Causes a Redo to be performed on the last undo.*
← StartEditing (withUndoRedo: Boolean)	*Starts editing the workspace.*
← StartEditOperation	*Begins an edit operation.*
← StopEditing (in saveEdits: Boolean)	*Stops editing the workspace.*
← StopEditOperation	*Ends an edit operation.*
← UndoEditOperation	*Causes an Undo to be performed on the last edit operation.*

The *IWorkspaceEdit* interface allows the application to start and stop edit sessions during which the objects in a geodatabase can be updated. An edit session corresponds to a long transaction. The only changes to data that an application sees within an edit session are changes that are made by the application. Changes made by other concurrently executing applications (if allowed) are not seen until the edit session is saved or discarded.

Edit operations provide undo/redo functionality.

An edit session is begun using the *StartEditing* method. The *withUndoRedo* parameter can be used to suppress undo/redo logging if the workspace supports such suppression.

If undo/redo facilities are required, all related changes to objects in the database within an edit session should be grouped into edit operations. An edit operation is begun using the *StartEditOperation* method. An edit operation may be thought of as a short transaction nested within the long transaction corresponding to the edit session.

Applications are responsible for calling the *AbortEditOperation* method to abort an edit operation if errors are detected within the methods executed for an edit operation.

Applications are responsible for calling *StopEditOperation* to mark the end of a successfully completed edit operation. Completed edit operations can be thought of as being pushed onto an undo stack.

The *UndoEditOperation* can be used to roll the state of the edit session back to what it was prior to the execution of the edit operation at the top of the undo stack. Undoing an edit operation pops the edit operation from the Undo stack and adds it to a Redo stack.

The *RedoEditOperation* rolls the state of the edit session forward to what it was after the execution of the edit operation at the top of the Redo stack, pops the redone edit operation from the Redo stack, and pushes it back onto the Undo stack. Performing a new edit operation clears the Redo stack.

The FDO_E_VERSION_REDEFINED *error corresponds to the message you get in ArcMap when trying to save edits after another person has been editing the same version, even when there are no conflicts. ArcMap merges the other person's edits into your edit session (by using* IVersionEdit::Reconcile*).You can make this happen automatically in ArcMap by clicking the Tools menu and clicking Options.*

The *StopEditing* method is used to end an edit session. The *saveEdits* parameter controls whether or not edits are saved or discarded. A multiversioned database can support multiple concurrent edit sessions on the same version of the database. In such a scenario, *StopEditing* will return an error code of *FDO_E_VERSION_REDEFINED* if it detects that the database state associated with the version being edited is no longer the same as it was at the beginning of the edit session (indicating that the version was modified by some other edit session). In this case, the application is responsible for calling the *IVersionEdit::Reconcile* method to reconcile the edit session against the current state of the version being edited. *StopEditing* may be called again after reconciliation.

The geodatabase guarantees "unique instancing" of row objects retrieved from the database within an edit session. Any data access call that retrieves a nonrecycling object with a particular object ID will return the in-memory instance of the object if the object has already been instantiated by the application. Such behavior is needed to ensure application correctness when updating complex object models—for example, models with relationship-based messaging or models with network features where updates to the geometry of a feature affect the geometry of topologically related features.

The example below shows a simple edit session on a workspace. Note that if the user chooses to undo the edit operation, there will be no outstanding edits, so the prompt to save the work will not appear. For this reason, all object editing should be done within an edit session. The geodatabase data access APIs (such as *IRow::Store, ITable::Update,* and *ITable::Insert*) will fail if you attempt to use them outside of an edit session on object and feature classes that are marked as requiring an edit session to ensure unique instancing semantics. Use *IObjectClassInfo2::CanBypassEditSession* to determine the situation.

```
Public Sub WorkspaceEdit()
  Dim pWorkspaceFactory As IWorkspaceFactory
  Set pWorkspaceFactory = New AccessWorkspaceFactory

  Dim pFeatureWorkspace As IFeatureWorkspace
  Set pFeatureWorkspace = pWorkspaceFactory.OpenFromFile("D:\Usa.mdb", 0)

  Dim pFeatureClass As IFeatureClass
  Set pFeatureClass = pFeatureWorkspace.OpenFeatureClass("States")

  Dim pWorkspaceEdit As IWorkspaceEdit
  Set pWorkspaceEdit = pFeatureWorkspace

  Dim pFeature As IFeature
  Dim iResponse As Integer
  Dim bHasEdits As Boolean
  pWorkspaceEdit.StartEditing True
  pWorkspaceEdit.StartEditOperation
  Set pFeature = pFeatureClass.GetFeature(1)
  pFeature.Delete
  pWorkspaceEdit.StopEditOperation

  iResponse = MsgBox("Undo operation?", vbYesNo)
  If iResponse = vbYes Then
   pWorkspaceEdit.UndoEditOperation
  End If

  pWorkspaceEdit.HasEdits bHasEdits
  If bHasEdits Then
   pWorkspaceEdit.StopEditing MsgBox("Save edits?", vbYesNo)
  End If
End Sub
```

Following the editing rules on this page will help ensure geodatabase integrity, particularly where custom objects and geodatabase behavior is concerned.

The rules for correct object editing on a geodatabase are summarized below:

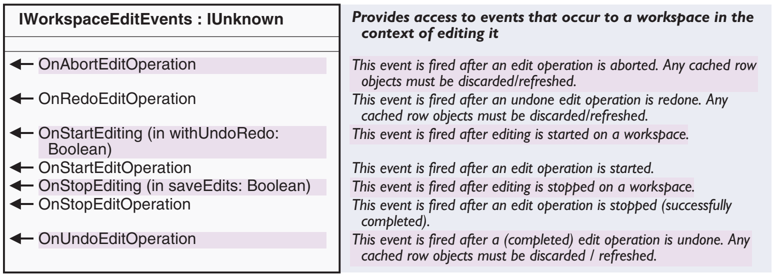
1. All object editing should be done within an edit session.
2. Group changes into edit operations.
3. Discard all references to row objects retrieved at the edit session boundary (on *StartEditing*). If references to row objects will be maintained across edit operations, then discard all references and refetch objects in response to the undo, redo, and abort edit operation calls made by the application, as well as the reconcile call made within an edit session on versioned databases. In the context of ArcMap, these calls are made by the editor, which broadcasts corresponding editor events via the *IEditorEvents* and *IEditorEvents2* interfaces. Personal and enterprise geodatabase workspaces support the *IWorkspaceEditEvents* and the *IVersionEvents* outbound interfaces and directly broadcast these events.
4. Use nonrecycling search cursors to fetch objects that are to be updated (using any of the *Search, GetRow,* or *GetRows* methods supported by tables, feature classes, and selection sets). Recycling cursors should only be used for drawing and read-only access to object states.
5. Always fetch all properties of the objects to be edited. Query filters should always use “*” for the subfields property (attempts to instan-

Trapping workspace edit events can simplify your code since one procedure can handle a situation that can be caused in several different ways.

tiate nonrecycling cursors with less than all fields will still result in all row object fields being hydrated).

6. After changing a row object, call the *IRow::Store* method to mark the object as changed and trigger propagation of the *OnChanged* message; propagate messages to related objects by calling the *IRow::Store* method on the object. Delete objects by calling the *IRow::Delete* method on the object, which triggers the *OnDelete* message. Stored and deleted objects within an edit operation are automatically and periodically flushed to the underlying database as needed to ensure read/query consistency and update efficiency. Use the set versions of these methods (for example, *IRowEdit::DeleteSet*) if updates or deletions are being made to a set of objects in order to increase performance.
7. Update and insert cursors are bulk data-loading and data-update APIs designed to perform direct updates and inserts outside of an edit session on simple data during the data-loading phase of a project. Avoid using these APIs in editing applications. Using these APIs within an edit session or on complex objects (objects with nonsimple row or feature behavior, or on objects participating in composite relationships or relationships with notification) negates any performance advantages they may have.

For more information related to the above rules, see the documentation in this chapter on rows, objects, features tables, object classes, and feature classes.



IWorkspaceEditEvents : IUnknown	***Provides access to events that occur to a workspace in the context of editing it***
← OnAbortEditOperation	*This event is fired after an edit operation is aborted. Any cached row objects must be discarded/refreshed.*
← OnRedoEditOperation	*This event is fired after an undone edit operation is redone. Any cached row objects must be discarded/refreshed.*
← OnStartEditing (in withUndoRedo: Boolean)	*This event is fired after editing is started on a workspace.*
← OnStartEditOperation	*This event is fired after an edit operation is started.*
← OnStopEditing (in saveEdits: Boolean)	*This event is fired after editing is stopped on a workspace.*
← OnStopEditOperation	*This event is fired after an edit operation is stopped (successfully completed).*
← OnUndoEditOperation	*This event is fired after a (completed) edit operation is undone. Any cached row objects must be discarded / refreshed.*

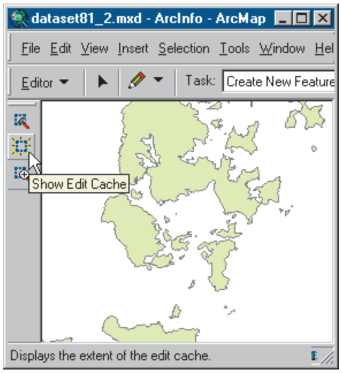
IWorkspaceEditEvents is an outbound interface supported by personal and enterprise geodatabase workspaces. Clients can listen for and be notified of all the significant editing events (such as *OnStartEditing* and *OnUndoEditOperation*) via this interface. In response to these events, clients should discard or refresh (that is, discard and refetch) cached row objects within the application. Clients should also listen for and respond to the notifications in *IVersionEdit* events.

This example of edit event handling shows the code from a very simple form with a button to start editing:

```
Dim m_pWorkspace As IWorkspace
Dim WithEvents m_pWEditEvents As WorkspaceEditEvents

Private Sub Form_Load()
  Dim pWSF As IWorkspaceFactory
  Set pWSF = New AccessWorkspaceFactory
  Set m_pWorkspace = pWSF.OpenFromFile("D:\Usa.mdb", 0)
  Set m_pWEditEvents = m_pWorkspace
End Sub

Private Sub cmdStart_Click()
  Dim pWorkspaceEdit As IWorkspaceEdit
  Set pWorkspaceEdit = m_pWorkspace
  pWorkspaceEdit.StartEditing False
End Sub

Private Sub m_pWEditEvents_OnStartEditing(ByVal withUndoRedo As Boolean)
  MsgBox "Editing started"
End Sub
```

ISpatialCacheManager : IUnknown	*Spatial Cache Management Interface.*
■— CacheExtent: IEnvelope	*The extent of the spatial cache.*
■— CacheIsFull: Boolean	*True if the spatial cache is full.*
← EmptyCache	*Empties the spatial cache.*
← FillCache (pExtent: IEnvelope)	*Fills the spatial cache using the specified extent.*

ISpatialCacheManager is an optional interface that can be used to enable and disable feature caching within a specified spatial envelope. Enabling feature caching improves the performance of all spatial searches whose query geometry lies within the cached area and improves the performance of all queries that retrieve features by object ID (for example, *GetRow, GetFeature, GetRows,* and *GetFeatures*). At the release of ArcGIS 8.1, caching of features using *ISpatialCacheManager* requires that there be an active edit session.


dataset81_2.mxd - ArcInfo - ArcMap
File Edit View Insert Selection Tools Window Hel
Editor
Task: Create New Feature
Show Edit Cache
Displays the extent of the edit cache.

The edit cache in ArcMap

The *CacheExtent* property returns the envelope that represents the current boundary of the cached area. An empty envelope is returned if the cache is empty (the cache is not active).

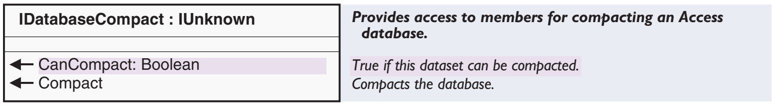
The *CacheIsFull* property returns *True* if the cache is full (the cache is active).

The *FillCache* method is used to make the cache active and to set the boundary of the cache. Calling this method causes the workspace to fetch objects from the database and fill the cache. The time to fill the cache and the amount of memory consumed with the cache depend on the extent of the cache and the density and size of features in the feature classes being cached.

Workspace properties provide a generic way of storing a variety of information about a workspace's capabilities.

The *EmptyCache* method empties the cache and makes it inactive.

Use of the cache is transparent to editing applications. Objects retrieved using nonrecycling cursors may be updated and stored by the editing application as in the uncached case; the geodatabase takes care of ensuring read/query consistency when queries are issued against updated objects. The cache is exposed to end users as the edit cache in ArcMap (available on the Object Editors menu at ArcGIS 8 and in the Edit Cache toolbar at ArcGIS 8.1). The cache improves performance significantly for network editing when working with remote databases.



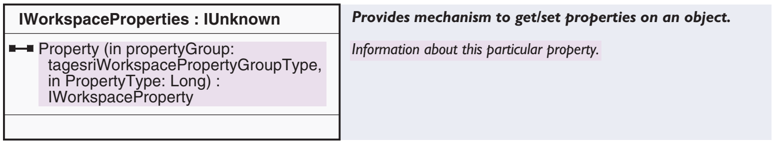
IDatabaseCompact : IUnknown

Provides access to members for compacting an Access database.

CanCompact: Boolean — *True if this dataset can be compacted.*

Compact — *Compacts the database.*

IDatabaseCompact is an optional interface supported by personal geodatabases (Microsoft Access workspaces) that allows compaction of an Access database using the services of the Jet Engine.



IWorkspaceProperties : IUnknown

Provides mechanism to get/set properties on an object.

Property (in propertyGroup: tagesriWorkspacePropertyGroupType, in PropertyType: Long) : IWorkspaceProperty — *Information about this particular property.*

A workspace may have a set of properties that may be queried using the optional *IWorkspaceProperties* interface.

Properties are organized into property groups identified by an enumeration. Within a property group, each property is identified by an enumeration. The property groups supported at ArcGIS 8.1 are *esriWorkspacePropertyGroup* and *esriWorkspaceTablePropertyGroup*.

The following are the properties in *WorkspacePropertyGroup*.

esriWorkspacePropCanExecuteSQL is *True* if the workspace supports the *IWorkspace:: ExecuteSQL* method. Note that all feature workspaces accept some form of the SQL where clause.

esriWorkspacePropCanEdit is *True* if the workspace supports edit sessions that are managed with the *IWorkspaceEdit* interface.

esriWorkspacePropIsReadonly is *True* if the workspace cannot be updated.

esriWorkspacePropSupportsQualifiedNames is *True* if the workspace supports qualified names.

esriWorkspacePropSupportsMetadata is *True* if the workspace supports user metadata accessed via the *IMetadata* interface and

Although the workspace property may indicate an operation is supported by the workspace, the operation may still fail on a particular dataset, for example, due to a lack of privileges.

exposed to the user in ArcCatalog.

esriWorkspacePropCanAnalyze is *True* if the workspace supports the *Analyze* method on tables in the workspace.

The following are the properties in the *esriTablePropertyGroup*.

esriTablePropRowCountIsCalculated is *True* if the *ITable::RowCount* method requires calculation, that is, *True* if getting the row count is an expensive operation.

esriTablePropCanAddField is *True* if this workspace supports adding fields to tables. Note that if *True*, the *ITable::AddField* method may still fail on specific tables, for example, because of a lack of privileges.

esriTablePropCanDeleteField is *True* if this workspace supports deleting fields from tables. The method may still fail on a specific table, for example, because of a lack of privileges.

esriTablePropCanAddIndex is *True* if this workspace supports adding indexes to tables. The method may still fail on a specific table, for example, because of a lack of privileges.

esriTablePropCanDeleteIndex is *True* if this workspace supports deleting indexes for tables. The method may still fail on a specific table, for example, because of a lack of privileges.

Applications can use the above properties to determine the capability of the workspace they are working with. Note that if the optional *IWorkspaceProperties* interface is not implemented, applications should assume that the above capabilities are supported.

Applications should always be prepared to deal with the absense of optional interfaces or with failure when executing methods on mandatory interfaces, for example, because of privileges or licensing issues.

The *IWorkspaceProperties::Property* method takes as input the enumerations for the desired property group and the property type and returns the value of the requested property as a *WorkspaceProperty* object.

This ArcCatalog-based example enables a button if the selected dataset can be quickly row counted (this is true for personal geodatabases).

```
Private Function UIButtonControl1_Enabled() As Boolean
  Dim pGxApp As IGxApplication
  Set pGxApp = Application

  Dim pGxObject As IGxObject
  Set pGxObject = pGxApp.SelectedObject
  If pGxObject Is Nothing Then Exit Function

  If TypeOf pGxObject Is IGxDataset Then
```

Configuration keywords are used by ArcSDE databases.

```
    Dim pDatasetName As IDatasetName
    Dim pName As IName
    Dim pWorkspace As IWorkspace
    Set pDatasetName = pGxObject.InternalObjectName
    Set pName = pDatasetName.WorkspaceName
    Set pWorkspace = pName.Open

    If TypeOf pWorkspace Is IWorkspaceProperties Then
      Dim pWProps As IWorkspaceProperties
      Dim pWProp As IWorkspaceProperty
      Set pWProps = pWorkspace
      Set pWProp = pWProps.Property(esriWorkspaceTablePropertyGroup, _
                                esriTablePropRowCountIsCalculated)
      UIButtonControl1_Enabled = pWProp.PropertyValue
    Else
      UIButtonControl1_Enabled = True
    End If
  End If
End Function
```

If the geodatabase is not at the current release, it may not support all of the functionality of the geodatabase at the software release you are running.

IWorkspaceConfiguration : IUnknown	Provides access to configuration keywords.
ConfigurationKeywords: IEnumConfigurationKeyword	The available configuration keywords.

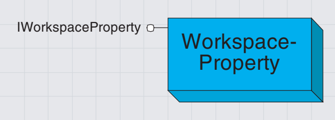
IWorkspaceConfiguration is an optional interface that allows you to get an enumeration of the configuration keywords for an ArcSDE workspace. You can determine if the workspace supports the reporting of configuration keywords by using the *IWorkspaceProperties* interface. Many data creation methods make use of configuration keywords, for example, *IFeatureWorkspace::CreateFeatureClass*.

IGeodatabaseRelease : IUnknown	Provides access to members that provide information about the release version of a geodatabase.
BugfixVersion: Long	Geodatabase bugfix version level.
CanUpgrade: Boolean	Indicates if the geodatabase can be upgraded with this interface. If not, then another utility must be used to upgrade it.
CurrentRelease: Boolean	Indicates if the geodatabase is at the current release level.
MajorVersion: Long	Geodatabase major version level.
MinorVersion: Long	Geodatabase minor version level.
Upgrade	Upgrade the database to the current release level.

IGeodatabaseRelease is an optional interface that determines which version of the geodatabase system tables a particular geodatabase has.

For personal geodatabases, *IGeodatabaseRelease* can both check and upgrade the geodatabase release version. For ArcSDE geodatabases, you can check the current release, but you cannot upgrade. A separate utility is required for upgrading the geodatabase release version for ArcSDE geodatabases.

IWorkspaceExtensionManager : IUnknown	Provides access to members that manage a workspace extension.
Extension (in Index: Long) : IWorkspaceExtension	The workspace extension at this index.
ExtensionCount: Long	The number of workspace extensions.
FindExtension (in pGUID: IUID, out ppWorkspaceExtension: IWorkspaceExtension)	Finds the specified workspace extension by its globally unique ID.



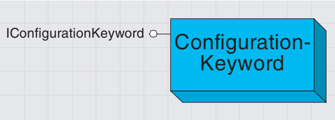
A WorkspaceProperty *object provides information about a workspace.*

A workspace property value is typically a Boolean that indicates whether an action is feasible.

A *WorkspaceProperty* class provides information about a workspace.

IWorkspaceProperty : IUnknown	***The Workspace property object.***
IsReadOnly: Boolean	*Indicates this property is read-only.*
IsSupported: Boolean	*Indicates this property is supported.*
PropertyValue: Variant	*The value of this property.*

The *IWorkspaceProperty* interface is supported by *WorkspaceProperty* objects that are returned by the *IWorkspaceProperties::Property* method. If the *IsSupported* property returns *False*, then the workspace does not support determination of the specified property (the property group/ property type was added at a later release than the component with which the application is working). The *PropertyValue* is returned as a *Variant*. Applications are responsible for checking the type of the variant and accessing the appropriate member value.



A ConfigurationKeyword *object specifies a set of storage parameters in an ArcSDE database.*

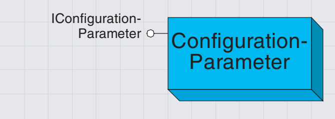
Configuration keywords can be of two types:

- *esriConfigurationKeywordGeneral*, which references storage parameters for creating feature classes and tables
- *esriConfigurationKeywordNetwork*, which references storage parameters for creating geometric networks

An enumeration of *ConfigurationKeyword* objects for an ArcSDE workspace is returned by the *IWorkspaceConfiguration* interface.

IConfigurationKeyword : IUnknown	***Provides access to members to supply information about configuration keywords.***
Comments: String	*Any additional comments about the keyword.*
ConfigurationParameters: IEnumConfigurationParameter	*Configuration parameters included in this keyword.*
Description: String	*The description of the keyword.*
KeywordType: esriConfigurationKeywordType	*The type of the keyword.*
Name: String	*The name of the keyword.*

The *IConfigurationKeyword* interface provides information about a configuration keyword. For example, through this interface, you can retrieve a name, description, and the set of configuration parameters that this keyword represents.

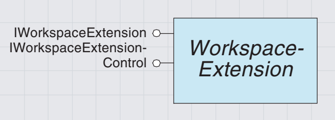


A ConfigurationParameter *object specifies a physical storage parameter for data created in an ArcSDE database.*

An enumeration of *ConfigurationParameter* objects is returned by the *IConfigurationKeyword* interface.

IConfigurationParameter : IUnknown	***Provides access to members to supply information about configuration paramters.***
ConfigurationString: String	*The configuration string defined by the parameter.*
Name: String	*The name of the parameter.*

The *IConfigurationParameter* interface provides access to the string for a configuration parameter.



A workspace representing a geodatabase can have one or more workspace extensions. A workspace extension extends the functionality of a workspace in some way, for example, by managing a new type of custom dataset or by maintaining custom data dictionary information on datasets.

A workspace extension is usually used in conjunction with an application or editor extension that acts as the client of the workspace extension.

The *Workspace* instantiates all *WorkspaceExtensions* that are registered in the component category *CATID_GeodatabaseWorkspaceExtensions* at connect time. An application extension can find a workspace extension by its well-known GUID and invoke methods supported by the extension as appropriate.

IWorkspaceExtension : IUnknown	***Provides access to members that supply workspace extension information.***
DataDictionaryTableNames (out ppPrivateNames: IEnumBSTR)	*Returns any data dictionary tables that should not be exposed to browsers and should not participate in edit sessions.*
GUID: IUID	*The GUID that identifies this WorkspaceExtension.*
Name: String	*The Name for this WorkspaceExtension.*
PrivateDatasetNames (in dtype: esriDatasetType, out ppPrivateNames: IEnumBSTR)	*The private datasets that should not be exposed to browsers.*

IWorkspaceExtension is a mandatory interface that must be supported by all workspace extensions.

The *GUID* property returns the well-known GUID for the extension and is guaranteed to be unique.

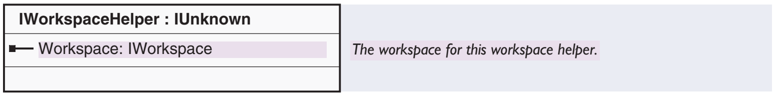
The *Name* property is the name of the extension.

The *PrivateDatasetNames* and *DataDictionaryNames* properties return the names of tables and datasets that are private to the extension and will not be exposed to browsing clients by the workspace.

IWorkspaceExtensionControl : IUnknown	***Provides access to members that manage the life of a workspace extension.***
Init (in pWorkspaceHelper: IWorkspaceHelper)	*Initializes the extension, passing in a reference to its workspace helper.*
Shutdown	*Informs the extension that its workspace helper (and workspace) are going away.*

IWorkspaceExtensionControl is a mandatory interface that must be supported by all workspace extensions. This interface is used by the workspace to manage the lifetime of the workspace extension. The workspace cocreates the workspace extension and calls the *Init* method, handing it a back reference to the workspace via the workspace helper argument. The workspace helper implements a weak reference on the workspace. The extension can keep a strong reference on the workspace helper (for example, in a member variable) but should not keep a strong reference on the workspace. Extensions should get the workspace from the workspace helper in order to make any method calls on the workspace and release the reference after making the method calls.

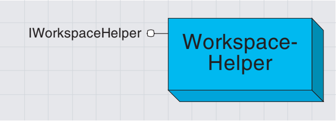
The *Shutdown* method informs the workspace extension that the workspace has been released by all clients and is about to go away. In response, the workspace extension should release its reference on the workspace helper. Any subsequent calls by the application to the workspace extension should return an error.



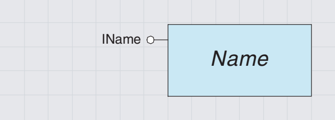
IWorkspaceHelper : IUnknown

Workspace: IWorkspace — *The workspace for this workspace helper.*

The *IWorkspaceHelper* interface is implemented by a *WorkspaceHelper* object. A *WorkspaceHelper* object holds a weak reference to a *Workspace*. Use of a workspace helper object allows a *Workspace* to hold references to a set of workspace extensions, each of which can hold a back reference to the workspace via a workspace helper.



A workspace helper holds a weak reference to a workspace, forming a back reference from a workspace extension to a workspace.



A Name *object identifies and locates a database or map object and supports methods to instantiate the actual named object.*

A *Name* object is a persistable software object that identifies and locates a geodatabase object, such as a dataset or a workspace, or a map object such as a layer.

A *Name* object supports an *Open* method that allows the client to get an instance of the actual object (for example, the dataset or workspace) given the name object. A name object thus acts as a moniker that supports binding to the named object.

The geodatabase supports methods on workspaces that hand out name objects that can be used by browsing clients to display the names of datasets in the workspace and to instantiate any specific dataset.

Name *objects are cocreatable and can also be used to specify datasets that are yet to be created, for example, the output dataset to be created by a geoprocessing operation.There are several kinds of* Name *objects, for example, workspace, table, feature class, feature dataset, raster, and relationship class name objects.*

Name objects may also carry properties that describe the object being named. A browsing client can use these properties to display additional information about the object being named. A *Name* object may also support methods to access metadata, or methods to change permissions on the actual object. In these cases, a name object can be used as a lightweight surrogate of the actual object until such time as further properties of the object are needed or additional methods on the object need to be called.

IName : IUnknown	***Provides access to members that work with Name objects.***
■—■ NameString: String	*The name string of the object.*
← Open: IUnknown Pointer	*Opens the object referred to by this name.*

The *Open* method lets you instantiate the actual object given the name object. This example takes a feature class name and instantiates the corresponding feature class.

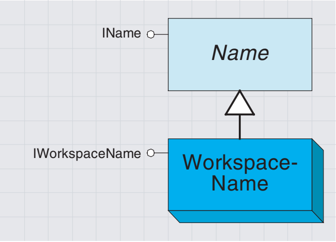
```
Dim pName as IName
Set pName = pFeatureClassName
Set pFeatureClass = pName.Open
```

Name *objects may be persisted (serialized) using the* IPersistStream *interface.* Name *objects are the mechanism used to save references to the datasets corresponding to the layers in a map when the map is saved as a map document.*

The *NameString* property is reserved for future use. When implemented, it will return a string representation of the locational component of the name object that may be persisted by applications.

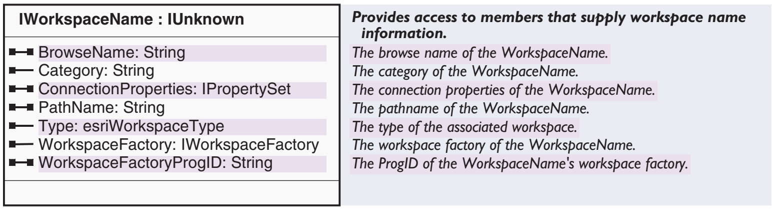
ArcCatalog™ uses name objects intensively for browsing data. This example gets a name object for the currently selected item and, if it is a dataset, shows its category.

```
Dim pGxApp As IGxApplication
Set pGxApp = Application
Dim pGxObject As IGxObject
Set pGxObject = pGxApp.SelectedObject
Dim pName As IName
Set pName = pGxObject.InternalObjectName

If TypeOf pName Is IDatasetName Then
  Dim pDatasetName As IDatasetName
  Set pDatasetName = pName
  MsgBox pDatasetName.Category
End If
```



A workspace name specifies a workspace object and can be used to instantiate it. The workspace is specified using the connection properties for the workspace.

A workspace name is a key component of any dataset name for datasets in the workspace.



IWorkspaceName : IUnknown	***Provides access to members that supply workspace name information.***
■—■ BrowseName: String	*The browse name of the WorkspaceName.*
■— Category: String	*The category of the WorkspaceName.*
■—■ ConnectionProperties: IPropertySet	*The connection properties of the WorkspaceName.*
■—■ PathName: String	*The pathname of the WorkspaceName.*
■— Type: esriWorkspaceType	*The type of the associated workspace.*
■— WorkspaceFactory: IWorkspaceFactory	*The workspace factory of the WorkspaceName.*
■—■ WorkspaceFactoryProgID: String	*The ProgID of the WorkspaceName's workspace factory.*

The *IWorkspaceName* interface lets you access the properties of a workspace name.

To create a new workspace name, you must set the *WorkspaceFactoryProgID* property followed by either *PathName* or *ConnectionProperties*. This example creates a new workspace name for a personal geodatabase.

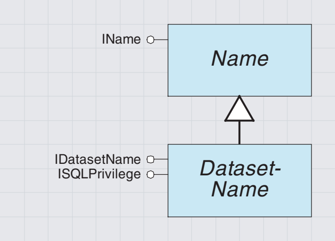
```
Dim pWorkspaceName As IWorkspaceName
Set pWorkspaceName = New WorkspaceName
pWorkspaceName.WorkspaceFactoryProgID = "esricore.AccessWorkspaceFactory"
pWorkspaceName.PathName = "D:\data\geodatabases\Usa.mdb"
```

At the end of the example above, the name object could be referring to an existing workspace or one that is to be created. If the workspace already exists, it can be opened with *IName::Open*—effectively, this procedure is equivalent to opening a workspace using *Open* or *OpenFromFile* on *IWorkspaceFactory*. If the workspace does not exist and is to be created, use *IWorkspaceFactory::Create*.

In some circumstances, you may already have a full workspace object but require a workspace name instead. The code below shows you how.

```
Dim pWorkspaceName As IWorkspaceName
Dim pDataset As IDataset
Set pDataset = pWorkspace ' Workspaces implement IDataset
Set pWorkspaceName = pDataset.FullName
```

The *Type*, *Category*, *WorkspaceFactoryProgID*, and *BrowseName* properties all return information on the workspace; for more information, refer to the documentation on *Workspace* in this chapter.



Dataset name objects identify and locate datasets within a workspace.

DatasetName is an abstract class that covers *Name* objects for datasets in a workspace.

DatasetName objects identify and locate datasets within a workspace. In addition, they may carry additional properties that describe the named dataset.

DatasetName objects support methods to access metadata for the named object (via the optional *IMetadata* interface) and to manage privileges for the dataset (via the *ISQLPriveleges* interface).

The *DatasetName* object for any existing dataset can be obtained by reading the *IDataset::FullName* property. *DatasetName* objects may also be created to specify new datasets that are to be created by some operation.

IDatasetName : IUnknown	***Provides access to members that supply dataset name information.***
Category: String	*The category of the dataset.*
Name: String	*The name of the dataset.*
SubsetNames: IEnumDatasetName	*Subset names contained within this dataset name.*
Type: esriDatasetType	*The type of the dataset.*
WorkspaceName: IWorkspaceName	*The WorkspaceName of the DatasetName.*

The *IDatasetName* interface provides access to the basic properties of a dataset name object.

The *Name* property returns the identifier for the dataset within the context of its workspace. Note that the value of the name property of the dataset name object (*IDatasetName::Name*) is the same as the value of the name property for the dataset (*IDataset::Name*).

The *WorkspaceName* property returns the workspace name object for the workspace containing the dataset being specified by this dataset name object.

You can use the *IDataset::FullName* interface to get a dataset name object from the actual dataset object. This example goes from a feature class to a feature class name.

```
Dim pFeatureClassName As IFeatureClassName
Dim pDataset As IDataset
Set pDataset = pFeatureclass
Set pFeatureClassName = pDataset.FullName
```

A dataset name can also refer to a dataset that does not yet exist. This is useful when creating new data, for example, with feature data converters. This code makes a new feature class name—the key properties to set are *Name* and *WorkspaceName*.

```
Dim pWorkspaceName As IWorkspaceName
Set pWorkspaceName = New WorkspaceName
pWorkspaceName.WorkspaceFactoryProgID = "esricore.AccessWorkspaceFactory"
pWorkspaceName.PathName = "D:\data\geodatabases\Usa.mdb"

Dim pFeatureClassName As IFeatureClassName
Set pFeatureClassName = New FeatureClassName
```

```
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatureClassName
pDatasetName.Name = "Land_use"
Set pDatasetName.WorkspaceName = pWorkspaceName
```

ISQLPrivilege : IUnknown	***Provides access to members for granting and revoking privileges to database users.***
SQLPrivileges: Long	*The database privileges.*
Grant (in UserName: String, in privileges: Long, in withGrant: Boolean)	*Grants privileges for the database user.*
Revoke (in UserName: String, in privileges: Long)	*Revokes privileges for the database user.*

The *ISQLPrivilege* optional interface provides information about the permissions you have on a database object; it also provides information about how to change the permissions for other users. It only applies to those datasets that are stored within a multiuser SQL environment, most typically an ArcSDE geodatabase. *ISQLPrivilege* controls access to database objects.

Enumeration esriSQLPrivilege	***SQL Privileges.***
1 - esriSelectPrivilege	*Select.*
2 - esriUpdatePrivilege	*Update.*
4 - esriInsertPrivilege	*Insert.*
8 - esriDeletePrivilege	*Delete.*

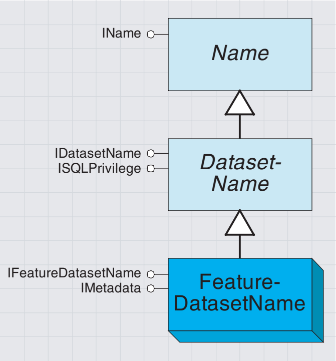
The *esriSQLPrivilege* enumeration defines values that can be used with *ISQLPrivilege*.

The values may be bitwise OR'd together if more than one privilege applies (note that this is equal to summing the integer values). For example, if the *SQLPrivileges* property returns a value of 9, this would mean that you have select and delete permission on the dataset but not insert or update. A value of 15 indicates full privileges.

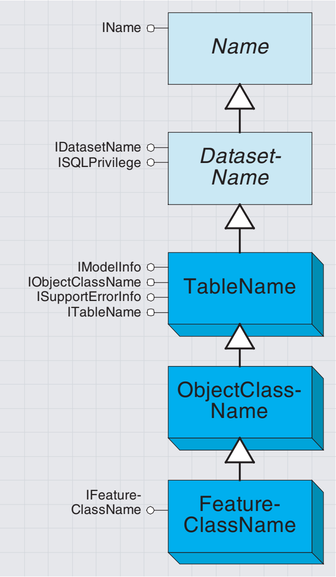
The following example grants select and update privileges to a user called Scott. The dataset name could be a feature dataset, in which case Scott would receive the privileges on all the contents of the feature dataset.

```
If TypeOf pDatasetName Is ISQLPrivilege Then
  Dim pSQLPriv As ISQLPrivilege
  Set pSQLPriv = pDatasetName
  pSQLPriv.Grant "Scott", _
    esriSelectPrivilege + esriUpdatePrivilege, False
End If
```

A *FeatureDatasetName* object is a name object that identifies and locates a feature dataset.



A feature dataset name identifies and locates a feature dataset.



These name objects identify tables, object classes, and feature classes.

IFeatureDatasetName : IUnknown	Provides access to members that hand out enumerated subset names in the feature dataset.
FeatureClassNames: IEnumDatasetName	An enumerator over the feature class names in this FeatureDataset.
GeometricNetworkNames: IEnumDatasetName	An enumerator over the geometric network names in this FeatureDataset.
RelationshipClassNames: IEnumDatasetName	An enumerator over the relationship class names in this FeatureDataset.
TableNames: IEnumDatasetName	An enumerator over the table (non spatial object class) names in this FeatureDataset.

The *IFeatureDatasetName* interface supports methods to get the name objects identifying the feature classes, relationship classes, and geometric networks within the named feature dataset without opening the feature dataset.

A *TableName* object is a name object that identifies and locates a table or object class.

ITableName : IUnknown	Table Name Interface.

ITableName is an identity interface with no methods.

IObjectClassName : IUnknown	Provides access to the objects class ID.
ObjectClassID: Long	The object class ID.

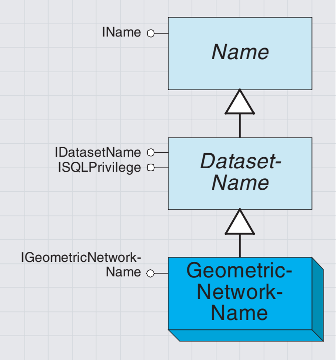
The *ObjectClassID* property can be used to obtain the ID for this object class within a workspace that represents a geodatabase (for example, within an Access or ArcSDE workspace). A value of -1 is returned if the table is not registered as an object class.

A *FeatureClassName* identifies and locates a feature class in a workspace and supports obtaining some key properties of the feature class without having to open (instantiate) it.

IFeatureClassName : IUnknown	
FeatureDatasetName: IDatasetName	The Feature Dataset Name object.
FeatureType: esriFeatureType	The feature type for this feature class name.
ShapeFieldName: String	The spatial column name for this feature class name.
ShapeType: tagesriGeometryType	The feature class shape type.

The *IFeatureClassName* includes the *FeatureType*, the *ShapeType*, the *ShapeFieldName*, and the name object for the parent feature dataset in the case of feature classes that are contained within a feature dataset. Note that this last property is null for standalone feature classes.

A *GeometricNetworkName* object identifies and locates a geometric network in a workspace.

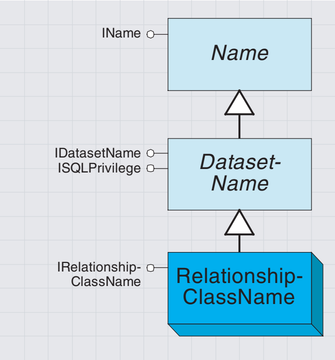


A geometric network name identifies a geometric network in a workspace.

IGeometricNetworkName : IUnknown	Geometric Network Name Interface.
FeatureDatasetName: IDatasetName	The Feature Dataset Name that the network belongs to.

The *FeatureDatasetName* property in the *IGeometricNetworkName* interface returns the name object for the feature dataset containing the geometric network.

A *RelationshipClassName* identifies and locates a relationship class in a workspace and supports obtaining some key properties of the feature class without having to open (instantiate) it.

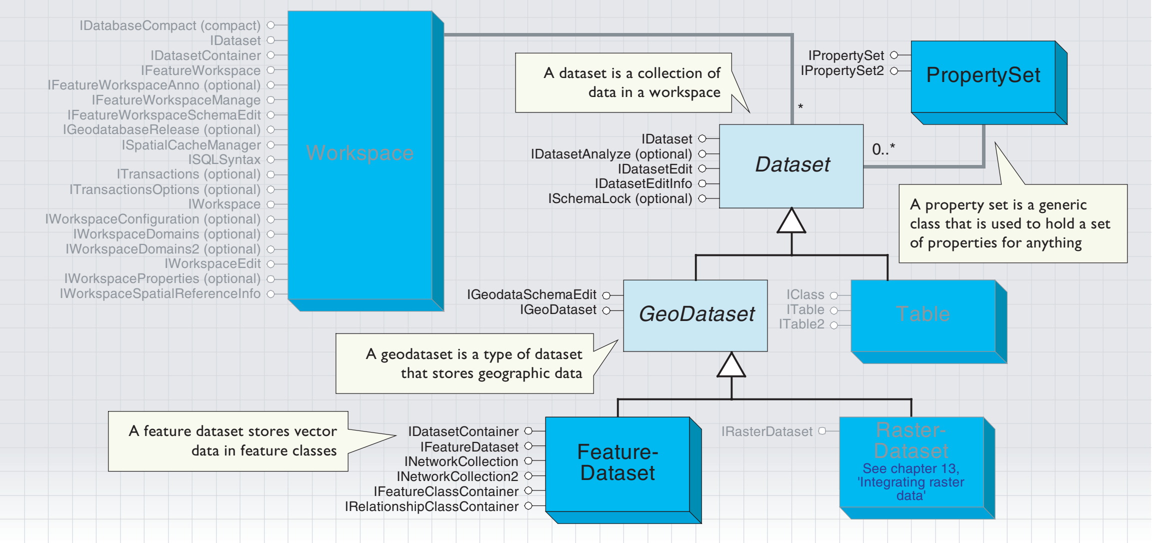


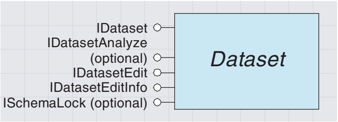
A relationship class name identifies a relationship class in a workspace.

IRelationshipClassName : IUnknown	*Feature Class Name Interface.*
Cardinality: esriRelCardinality	*The Cardinality.*
FeatureDatasetName: IDatasetName	*The Feature Dataset Name object.*
IsAttributed: Boolean	*True if Attributed.*
IsComposite: Boolean	*True if Composite.*
Notification: esriRelNotification	*The Notification.*

The *IRelationshipClassName* interface includes the *Cardinality, Notification, IsAttributed,* and *IsComposite* properties, and also the name object for the parent feature dataset in the case of relationship classes that are contained within a feature dataset.

Dataset objects


IDatabaseCompact (compact)
IDataset
IDatasetContainer
IFeatureWorkspace
IFeatureWorkspaceAnno (optional)
IFeatureWorkspaceManage
IFeatureWorkspaceSchemaEdit
IGeodatabaseRelease (optional)
ISpatialCacheManager
ISQLSyntax
ITransactions (optional)
ITransactionsOptions (optional)
IWorkspace
IWorkspaceConfiguration (optional)
IWorkspaceDomains (optional)
IWorkspaceDomains2 (optional)
IWorkspaceEdit
IWorkspaceProperties (optional)
IWorkspaceSpatialReferenceInfo
Workspace
A dataset is a collection of data in a workspace
*
IPropertySet
IPropertySet2
PropertySet
IDataset
IDatasetAnalyze (optional)
IDatasetEdit
IDatasetEditInfo
ISchemaLock (optional)
Dataset
0..*
A property set is a generic class that is used to hold a set of properties for anything
IGeodataSchemaEdit
IGeoDataset
GeoDataset
IClass
ITable
ITable2
Table
A geodataset is a type of dataset that stores geographic data
A feature dataset stores vector data in feature classes
IDatasetContainer
IFeatureDataset
INetworkCollection
INetworkCollection2
IFeatureClassContainer
IRelationshipClassContainer
Feature-Dataset
IRasterDataset
Raster-Dataset
See chapter 13, 'Integrating raster data'



A workspace is a container of named datasets. Examples of datasets include tables, feature classes, relationship classes, feature datasets, and geometric networks.

Dataset is an abstract class that represents a named collection of data in a workspace.

Datasets may contain other datasets. All datasets support the *IDataset* interface and may optionally support other interfaces, including *IDatasetEdit, ISchemaLock,* and *IMetadata.*

IDataset : IUnknown	**Provides access to members that supply dataset information.**
BrowseName: String	*The browse name of the dataset.*
Category: String	*The category of the dataset.*
FullName: IName	*The associated name object.*
Name: String	*The name of the dataset.*
PropertySet: IPropertySet	*The set of properties for the dataset.*
Subsets: IEnumDataset	*Datasets contained within this dataset.*
Type: esriDatasetType	*Returns the type of the dataset.*
Workspace: IWorkspace	*The workspace containing this dataset.*
CanCopy: Boolean	*True if this dataset can be copied.*
CanDelete: Boolean	*True if this dataset can be deleted.*
CanRename: Boolean	*True if this dataset can be renamed.*
Copy (in copyName: String, in copyWorkspace: IWorkspace) : IDataset	*Copies this dataset to a new dataset with the specified name.*
Delete	*Deletes this dataset.*
Rename (in Name: String)	*Renames this dataset.*

IDataset *is also available from* Workspace, FeatureLayer, TIN, RasterBand, *and* Graph *objects, as well as those objects covered by the* Dataset *abstract class. Use the* Type *property to determine what kind of* Dataset *you have. This can greatly simplify code compared to the alternative of using the* Typeof *operator. The* esriDatasetType *enumeration lists the possibilities.*

The *IDataset* interface provides information about datasets and high-level management facilities such as *Copy, Delete,* and *Rename.*

The *Type* property returns the enumerated type for the dataset, such as *esriDTTable* or *esriDTFeatureDataset*. This code example shows *IDataset* in use on three different objects: *FeatureClass, FeatureDataset,* and *Workspace* coclass. It assumes a valid *IFeatureClass* pointer.

```
Dim pDataset As IDataset
Set pDataset = pFeatureClass
```

```
Debug.Print pDataset.Name & " " & pDataset.Type
If Not pFeatureClass.FeatureDataset Is Nothing Then
  Set pDataset = pFeatureClass.FeatureDataset
  Debug.Print pDataset.Name & " " & pDataset.Type
End If
Set pDataset = pDataset.Workspace
Debug.Print pDataset.Name & " " & pDataset.Type
```

The *Copy, Delete,* and *Rename* methods are not available in all circumstances. For example, you may not copy a *FeatureDataset* coclass. You should normally use the *CanCopy, CanDelete,* and *CanRename* properties in conjunction with these methods.

The *FullName* property returns a *Name* object for the dataset. The *Name* object can be persisted, and provides a way to get back to the dataset in a future session of the application via the *Open* method on the *Name* object. The *Subsets* property returns other *Dataset* objects contained in this dataset. The *Workspace* property returns the containing workspace for this dataset.

The *PropertySet* property is used to return any additional intrinsic properties (but not metadata properties) that may apply to the dataset. Examples of intrinsic properties for which explicit methods exist include the *SpatialReference* and *Extent* methods, both of which are available on the *IGeoDataset* interface. In most cases, this *PropertySet* will be empty.

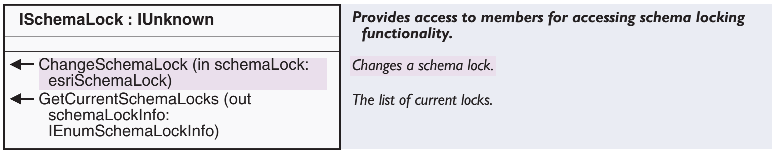
IDatasetEdit::IsBeingEdited *will be true even if no changes have yet been made to the dataset, as long as that dataset can be edited within the session.*

IDatasetEdit : IUnknown	***Provides access to members about the status of datasets being edited.***
← IsBeingEdited: Boolean	*True if the dataset is being edited.*

An edit session is begun on a *Workspace* using the *IWorkspaceEdit::StartEditing* method. Once an edit session has been started on a workspace, the *IsBeingEdited* method on the *IDatasetEdit* interface can be used to determine if a particular *Dataset* is participating in the edit session. The reasons why a dataset may not participate include: the connected user has no privileges or permission to edit the dataset, the connected user is not licensed to edit this type of dataset, or the dataset is not versioned.

IDatasetEditInfo : IUnknown	***Provides access to members that maintain dataset editing information.***
■— CanEdit: Boolean	*True if the dataset supports edit sessions with the ability to discard edits on save.*
■— CanRedo: Boolean	*True if the dataset supports edit sessions with the ability to redo undone operations.*
■— CanUndo: Boolean	*True if the dataset supports edit sessions with the ability to undo individual edit operations.*

The *IDatasetEditInfo* interface can be used to determine the editing capabilities of a dataset before an edit session is begun.



IScheamLock : IUnknown

ChangeSchemaLock (in schemaLock: esriSchemaLock) — Changes a schema lock.

GetCurrentSchemaLocks (out schemaLockInfo: IEnumSchemaLockInfo) — The list of current locks.

Provides access to members for accessing schema locking functionality.

Schema locks prevent clashes with other users when you are changing the structure of your geodatabase.

The *ISchemaLock* interface is used to establish an exclusive lock on a dataset when changing its schema (that is, the dataset structure rather than the data itself) or when performing other operations that require exclusive access to the data.

There are two kinds of locks, exclusive and shared. You would normally only use *ISchemaLock* to gain exclusive locks since shared locks are applied automatically when you access the object. A shared lock prevents another user from gaining an exclusive lock.

Examples of operations that should acquire a schema lock include adding a field to a feature class, associating a new class extension with a feature class, and building a geometric network on a set of feature classes.

This function tries to get an exclusive lock on a dataset:

```
Public Function GetExclusiveLock(pDataset As IDataset) As Boolean
On Error GoTo ErrorHandle

  Dim pWorkspaceFactory As IWorkspaceFactory
  Dim pWorkspace As IWorkspace
  Dim pFeatureWorkspace As IFeatureWorkspace

  Set pWorkspaceFactory = New AccessWorkspaceFactory
  Set pWorkspace = pWorkspaceFactory.OpenFromFile("D:\Maps\water.mdb", 0)
  Set pFeatureWorkspace = pWorkspace

  Dim pFeatureClass As IFeatureClass
  Set pFeatureClass = pFeatureWorkspace.OpenFeatureClass("streams")
  Set pDataset = pFeatureClass

  Dim pSchLock As ISchemaLock
  Set pSchLock = pDataset
  pSchLock.ChangeSchemaLock esriExclusiveSchemaLock
  GetExclusiveLock = True
  Exit Function
ErrorHandle:
  MsgBox "Failed to get exclusive lock on " & pDataset.Name _
      & vbCr & Err.Description
  GetExclusiveLock = False
End Function
```

ISchemaLockInfo : IUnknown	Provides access to members that supply schema lock information.
SchemaLockType: esriSchemaLock	The schema lock type.
TableName: String	The name of the table with the schema lock.
UserName: String	The user who has the schema lock.

The *ISchemaLockInfo* interface provides information about a schema lock, for example, whether it is shared or exclusive and, for ArcSDE geodatabases, the name of the user who has the lock. You can access *ISchemaLockInfo* through *ISchemaLock::GetCurrentSchemaLocks* and then by stepping through the returned schema lock enumerator object.

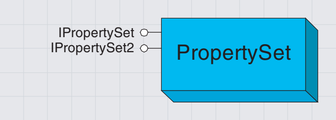
DBMS statistics are important for efficient query performance—this is most relevant to enterprise geodatabases. You can determine whether your geodatabase supports DBMS statistics with IWorkspaceProperties.

IDatasetAnalyze : IUnknown	Analyze Interface.
AllowableComponents: Long	Return the allowable components to be analyzed.
Analyze (in tableComponents: Long)	Analyze the dataTo update/generate DBMS statistics.

IDatasetAnalyze is an optional interface that updates database table and index statistics for the dataset.

When applied to a feature dataset, *Analyze* updates the statistics for all of the tables.

The *AllowableComponents* property indicates which parts of the table or feature class can be analyzed. The returned value is based on the *esriTableComponents* enumeration. Members from this enumeration can be bitwise or'd together in a similar way to *esriSQLPrivilege* Constants.



A property set holds a set of properties for a variety of objects.

PropertySet is a generic class that is used to hold a set of properties for anything.

IPropertySet : IUnknown	***Provides access to members for managing a PropertySet.***
■— Count: Long	*The number of properties contained in the property set.*
← GetAllProperties (out names: Variant, out Values: Variant)	*The name and value of all the properties in the property set.*
← GetProperties (in names: Variant, out Values: Variant)	*The values of the specified properties.*
← GetProperty (in Name: String) : Variant	*The value of the specified property.*
← IsEqual (in PropertySet: IPropertySet) : Boolean	*True if the property set is the same as the input property set.*
← RemoveProperty (in Name: String)	*Removes a property from the set.*
← SetProperties (in names: Variant, in Values: Variant)	*The values of the specified properties.*
← SetProperty (in Name: String, in Value: Variant)	*The value of the specified property.*

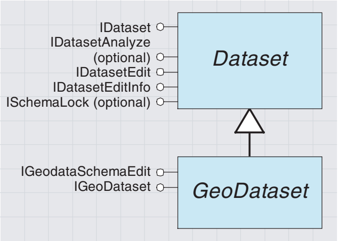
IPropertySet contains one property for the number of properties and several methods to set and retrieve properties.

IPropertySet2 : IUnknown	***Provides access to members for managing a PropertySet.***
← IsEqualNoCase (in PropertySet: IPropertySet) : Boolean	*True if the property set is the same as the input property set.*

IPropertySet2 has a method to compare an input property set to the current property set.

One example for the use of a property set is to hold the properties required for opening up an SDE® workspace, as shown in the example code below.

```
'Example of how to use a property set to open an SDE workspace.
Dim pPropset As IPropertySet
Set pPropset = New PropertySet
With pPropset
  .SetProperty "Server", m_SDEServerName
  .SetProperty "Instance", m_SDEServerInst
  .SetProperty "user", m_SDEServerUserName
  .SetProperty "password", m_SDEServerPass
  .SetProperty "version" , m_SDEVersionName
End With

Dim pFactSDE As IWorkspaceFactory
Set pFactSDE = New SdeWorkspaceFactory

Dim pWorkSpaceSDE As IWorkspace
Set pWorkSpaceSDE = pFactSDE.Open(pPropset, Me.hWnd)
```



A geodataset is a geographic dataset.

GeoDataset is an abstract class representing geographic datasets, which may also be referred to as spatial datasets. Examples of *GeoDatasets* include *FeatureDatasets, FeatureClasses, Tins,* and *RasterDatasets*. Examples of *Datasets* that are not *GeoDatasets* include nonspatial *ObjectClasses* and *RelationshipClasses*. A key property of a *GeoDataset* is the *SpatialReference* in which it is defined.

IGeoDataset : IUnknown	***GeoDataset Interface.***
■— Extent: IEnvelope	*The extent of the GeoDataset.*
■— SpatialReference: ISpatialReference	*The spatial reference of the GeoDataset.*

The *IGeoDataset* interface provides information about spatial datasets—in particular, their spatial reference and geographic extent.

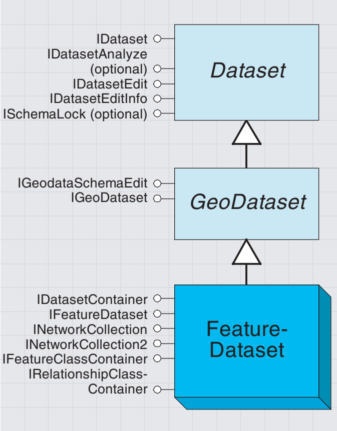
This code zooms to the extent of a layer:

```
Dim pGeoDataset As IGeoDataset
Set pGeoDataset = pLayer
pActiveView.Extent = pGeoDataset.Extent
pActiveView.Refresh
```

IGeoDatasetSchemaEdit : IUnknown	***Interface to change the schema of a GeoDataset.***
■— CanAlterSpatialReference: Boolean	*True if the spatial reference of the dataset can be altered.*
◄— AlterSpatialReference (in SpatialReference: ISpatialReference)	*Alters the spatial reference of the dataset to match the coordinate system of the input spatial reference, does not reproject the data.*

The *IGeoDatasetSchemaEdit* interface is an optional interface that allows you to change the spatial reference associated with an existing dataset.

Note that the *AlterSpatialReference* method does not project or otherwise modify the existing data in the dataset—this method merely rewrites the spatial reference associated with the dataset. The caller is responsible for ensuring the correctness and appropriateness of the supplied spatial reference. Its most common use is to supply a spatial reference for a dataset whose spatial reference is currently tagged as *Unknown*.



A feature dataset is a dataset that contains feature classes that share the same spatial reference as the feature dataset. Feature datasets can also contain geometric networks and relationship classes.

Feature classes that store simple features can be organized either inside or outside a feature dataset. Those outside a feature dataset are called standalone feature classes. Feature classes that store topological features, for example, those participating in geometric networks, must be contained within a feature dataset to ensure a common spatial reference.

A *FeatureDataset* is a dataset that exists only in a geodatabase workspace; all the datasets contained in the *FeatureDataset* are also part of the same geodatabase.

When programming with feature classes, you need to remember that the feature class may or may not belong to a feature dataset. This code to get the workspace for a feature class assumes a feature dataset exists and therefore may fail.

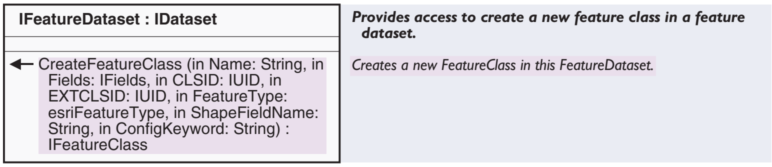
```
' This excerpt won't work for standalone feature classes
Dim pFeatureDataset As IFeatureDataset
Set pFeatureDataset = pFeatureClass.FeatureDataset
Dim pWorkspace As IWorkspace
Set pWorkspace = pFeatureDataset.Workspace
```

This piece of code will work for both standalone feature classes and those in feature datasets.

```
Dim pDataset As IDataset
Set pDataset = pFeatureClass
Dim pWorkspace As IWorkspace
Set pWorkspace = pDataset.Workspace
```

Each dataset in a geodatabase must have a unique name. In particular, each feature class in a geodatabase must have a unique name independent of the feature dataset that contains it. Note that this is different from a file system model, where two folders may contain files with the same local name within the folder.

The *OpenFeatureClass* method available in the *IFeatureWorkspace* interface on a workspace may be used to open any feature class in the workspace, including both standalone feature classes and feature classes within a feature dataset, given the (unique) name of the feature class.



IFeatureDataset : IDataset

← CreateFeatureClass (in Name: String, in Fields: IFields, in CLSID: IUID, in EXTCLSID: IUID, in FeatureType: esriFeatureType, in ShapeFieldName: String, in ConfigKeyword: String) : IFeatureClass

Provides access to create a new feature class in a feature dataset.

Creates a new FeatureClass in this FeatureDataset.

Use the *CreateFeatureClass* method in the *IFeatureDataset* interface to create a new feature class within a *FeatureDataset*. The arguments to this method are the same as to the *CreateFeatureClass* method in *IFeatureWorkspace* interface. However, this method requires that the spatial reference specified for the feature class to be created matches the spatial reference of the feature dataset. Note that the spatial reference for the feature class to be created is specified in the *GeometryDef* property of the *Field* object for the *Shape* field in supplied *Fields* collection.

This bit of code lists the feature classes in a feature dataset.

```
Dim pEnumDataset As IEnumDataset
Dim pDataset As IDataset
pEnumDataset = pFeatureDataset.Subsets
' Loop through each dataset, checking if it is a feature class
Set pDataset = pEnumDataset.Next
Do Until pDataset Is Nothing
  If pDataset.Type = esriDTFeatureClass Then
    Debug.Print pDataset.Name
  End If
  Set pDataset = pEnumDataset.Next
Loop
```

If you just need to browse the available datasets, an alternative interface to use is *IFeatureDatasetName*. For more details, see the section on *Name* objects.

IFeatureClassContainer : IUnknown	***Provides access to members that return feature classes by name, ID and index.***
Class (in ClassIndex: Long) : IFeatureClass	*The FeatureClass associated with the specified index value.*
ClassByID (in ID: Long) : IFeatureClass	*Retrieves a FeatureClass given its ID.*
ClassByName (in Name: String) : IFeatureClass	*Retrieves a FeatureClass given its name.*
ClassCount: Long	*The number of FeatureClasses in this container.*
Classes: IEnumFeatureClass	*An enumerator over the FeatureClasses.*

The *IFeatureClassContainer* interface provides access to feature classes. For feature datasets, it can be seen as an alternative to the functionality available from other interfaces. However, *IFeatureClassContainer* is also implemented by *Graphs* (and hence *GeometricNetworks*), for which it is more essential—it returns the feature classes participating in the network, which can't be done with *Name* objects.

Each object class in a geodatabase has a unique ID accessible via the *ObjectClassID* method in the *IObjectClass* interface or the *FeatureClassID* method in the *IFeatureClass* interface. The *ClassByID* method finds a feature class in a feature dataset given its object class ID.

INetworkCollection : IUnknown	***Provides access to members that create and maintain information about geometric networks.***
GeometricNetwork (in Index: Long) : IGeometricNetwork	*The GeometricNetwork associated with the specified index value.*
GeometricNetworkByName (in Name: String) : IGeometricNetwork	*Retrieves a GeometricNetwork given its Name.*
GeometricNetworkCount: Long	*The number of GeometricNetworks in this FeatureDataset.*
CreateGeometricNetwork (in Name: String, in NetworkType: esriNetworkType, in BuildNormalizedTables: Boolean) : IGeometricNetwork	*Creates a new GeometricNetwork in this FeatureDataset.*

The *INetworkCollection* interface provides access to the geometric networks in the feature dataset and also lets you create them.

If your intention is only to browse for the set of networks in a feature dataset, then it is not necessary to open the feature dataset and invoke methods on *INetworkCollection*. The *GeometricNetworkNames* method on a *FeatureDatasetName* object can be used to efficiently obtain this information.

INetworkCollection2 : INetworkCollection	Provides access to members that create and maintain information about geometric networks.
← CreateGeometricNetworkEx (in Name: String, in NetworkType: esriNetworkType, in BuildNormalizedTables: Boolean, in ConfigKeyword: String) : IGeometricNetwork	Creates a new GeometricNetwork with a configuration keyword in this FeatureDataset.

The *INetworkCollection2* interface provides access to members that create and maintain information about geometric networks.

IRelationshipClassContainer : IUnknown	Provides access to members that create, add and hand out relationship classes.
■— RelationshipClasses: IEnumRelationshipClass	An enumerator over the RelationshipClasses in this container.
← AddRelationshipClass (in pRelClass: IRelationshipClass)	Transfers ownership of a relationship class to this container.
← CreateRelationshipClass (in relClassName: String, in OriginClass: IObjectClass, in DestinationClass: IObjectClass, in forwardLabel: String, in backwardLabel: String, in Cardinality: esriRelCardinality, in Notification: esriRelNotification, in IsComposite: Boolean, in IsAttributed: Boolean, in relAttrFields: IFields, in OriginPrimaryKey: String, in destPrimaryKey: String, in OriginForeignKey: String, in destForeignKey: String) : IRelationshipClass	Creates a new relationship class in this container.

The *IRelationshipClassContainer* interface lets you create a relationship class within a feature dataset rather than a workspace. The *AddRelationshipClass* method is effectively superseded by *IDatasetContainer::AddDataset*.

IDatasetContainer *will let you move a standalone feature class into a feature dataset and vice versa.*

IDatasetContainer : IUnknown	Provides access to adding datasets to the dataset container.
← AddDataset (in pDatasetToAdd: IDataset)	Adds a dataset to the dataset collection.

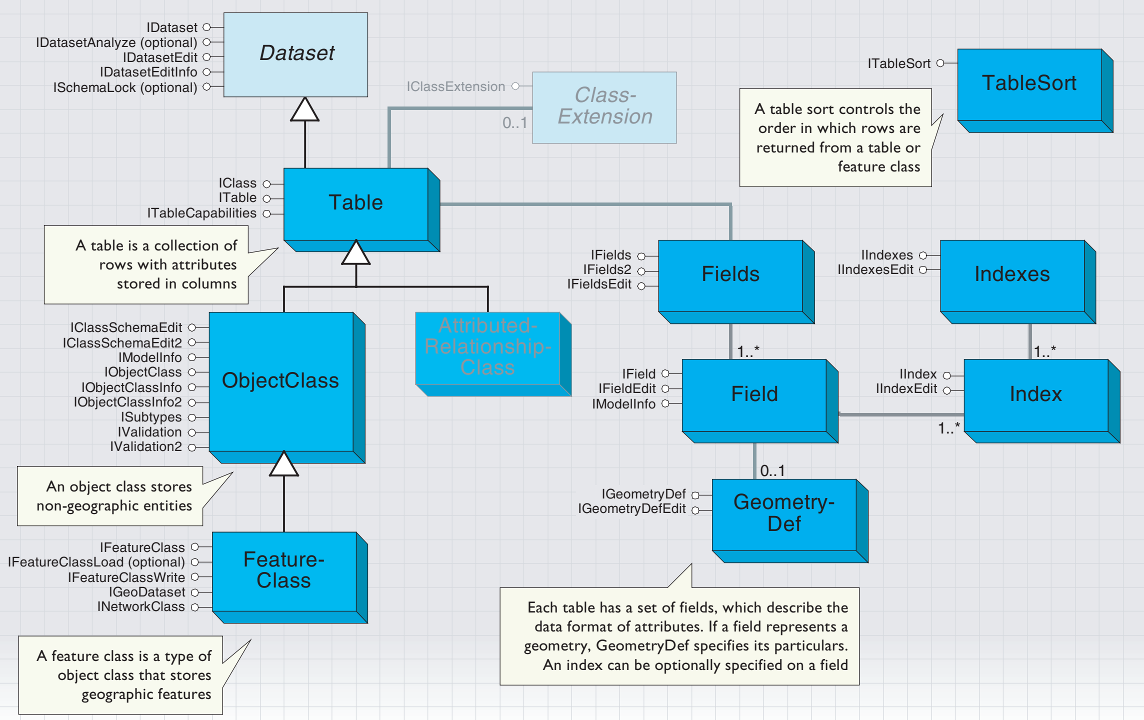
The *IDatasetContainer* interface lets you move datasets between feature datasets and workspaces—both objects implement the interface.

Note that when moving feature classes into a feature dataset, the spatial reference of the source feature class must match the spatial reference of the target feature dataset into which it is being moved.

The following example changes a dataset (for example, a feature class or relationship class) from a feature dataset to being standalone in a workspace or vice versa.

```
Public Sub MoveDataset(pFeatureDataset As IFeatureDataset, _
                       pDataset As IDataset, bRequireStandalone As Boolean)
  Dim pDatasetContainer As IDatasetContainer
  If bRequireStandalone Then
    Set pDatasetContainer = pFeatureDataset.Workspace
  Else
    Set pDatasetContainer = pFeatureDataset
  End If
  pDatasetContainer.AddDataset pDataset
End Sub
```

Table, object class, and feature class objects



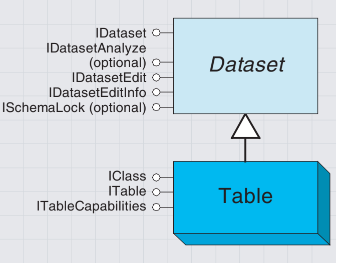
A table sort controls the order in which rows are returned from a table or feature class

A table is a collection of rows with attributes stored in columns

An object class stores non-geographic entities

A feature class is a type of object class that stores geographic features

Each table has a set of fields, which describe the data format of attributes. If a field represents a geometry, GeometryDef specifies its particulars. An index can be optionally specified on a field



A table has one or more columns and a collection of unordered rows.

A *Table* object has one or more columns, referred to as fields, and contains an unordered collection of rows. For each field, each row has exactly one value in the data type of the field.

A *Table* is a *Dataset;* properties such as the name of the table, the persistable name object for the table, and the workspace containing the table may be obtained via the *IDataset* interface. In relational terms, a *Table* object represents an RDBMS table or view. In objected-oriented terms, a *Table* object represents an *ObjectClass* or a *RelationshipClass* in a geodatabase. A *Table* object hands out *Row* objects that support application-callable methods, depending on the type of data stored in the table.

The *Name* property of a *Table*, accessible via the *IDataset* interface, returns its fully qualified name. The level of qualification may vary depending on the host DBMS. For example, a table named “pipes” owned by a user named “gas” may be called “pipes” on Access, “gas.pipes” on Oracle, and “mydb.gas.pipes” on SQL Server. The *ParseTableName* method on the *ISqlSyntax* interface supported by the table’s workspace can be used to split the fully qualified name into its components.

IClass : IUnknown	Provides access to members that return information about and manage the class.
CLSID: IUID	The GUID for the COM Class (CoClass) corresponding to instances of this object class.
EXTCLSID: IUID	The GUID for the COM Class (CoClass) corresponding to the class extension for this object class.
Extension: IUnknown Pointer	The extension for this object class.
ExtensionProperties: IPropertySet	The extension properties for this object class.
Fields: IFields	The fields collection for this object class.
HasOID: Boolean	True if the class has an object identity (OID) field.
Indexes: IIndexes	The indexes collection for this object class.
OIDFieldName: String	The name of the field corresponding to the OID.
AddField (in Field: IField)	Adds a field to this object class.
AddIndex (in Index: IIndex)	Adds an index to this object class.
DeleteField (in Field: IField)	Deletes a field from this object class.
DeleteIndex (in Index: IIndex)	Deletes an index from this object class.
FindField (in Name: String) : Long	The index of the field with the specified name.

You don't need to QI to use IClass—ITable, IObjectClass, *and* IFeatureClass *inherit its members.*

All tables support the *IClass* interface. Since the *ITable* interface (described next) inherits from *IClass*, applications usually do not have to explicitly perform a *QueryInterface* for this interface.

The *CLSID* property returns the globally unique identifier for the software component (COM coclass) that represents the row objects stored and handed out by this table. Examples of the value of this property include the CLSIDs representing *esricore.Row, esriCore.Object, esricore.Feature,* and *esricore.AttributedRelationship.*

The EXTCLSID *and* CLSID *properties return the GUIDs for the COM classes associated with the table and its objects. This is useful with custom objects and features. See the section on class extensions later in this chapter.*

The *EXTCLSID* property returns the globally unique identifier for the software component (COM coclass) that represents the class extension associated with this *Table*. Class extensions are a mechanism whereby a developer can associate additional class-level methods written in COM with an *ObjectClass* in the database.

The *CLSID* and *EXTCLSID* and other similar properties for a *Table* are stored in the geodatabase as part of the data dictionary information for the database. These properties link the behavior of the class (as implemented by software components in a DLL) with the data in the table.

The *Extension* property returns an interface on the *ClassExtension* associated with this *Table*.

The *HasOID* property may be used to test if this table has an *ObjectId* column. Tables representing object classes and attributed relationship classes in a geodatabase will have an *ObjectId* column whose unique values are assigned by the geodatabase when new objects and attributed relationships are created. The Register With Geodatabase command available on the context menu of a table in ArcCatalog can be used to register a preexisting table in an RDBMS as an object class; this process will add an *ObjectId* column to the table if needed.

The *IClass* interface also contains methods (inherited by *ITable*) to manage the collection of fields and indexes for a *Table*.

This code finds the number of indexes on an object class.

```
Dim pIndexes As IIndexes
Set pIndexes = pTable.Indexes
MsgBox "There are " & pIndexes.IndexCount & " indexes"
```

ITable is the main interface for working with tables.

ITable : IClass	**Provides access to members that return information about and manage tables.**
← CreateRow: IRow	*Creates a row in the database with a system assigned object ID and null property values.*
← CreateRowBuffer: IRowBuffer	*Creates a row buffer that can be used with an insert cursor.*
← DeleteSearchedRows (in QueryFilter: IQueryFilter)	*Delete the rows in the database selected by the specified query*
← GetRow (in OID: Long) : IRow	*The row from the database with the specified object ID.*
← GetRows (in oids: Variant, in Recycling: Boolean) : ICursor	*The cursor of rows based on a set of object IDs.*
← Insert (in useBuffering: Boolean) : ICursor	*Returns a cursor that can be used to insert new rows.*
← RowCount (in QueryFilter: IQueryFilter) : Long	*The number of rows selected by the specified query.*
← Search (in QueryFilter: IQueryFilter, in Recycling: Boolean) : ICursor	*An object cursor that can be used to fetch row objects selected by the specified query.*
← Select (in QueryFilter: IQueryFilter, in selType: esriSelectionType, in selOption: esriSelectionOption, in selectionContainer: IWorkspace) : ISelectionSet	*A selection that contains the object ids selected by the specified query.*
← Update (in QueryFilter: IQueryFilter, in Recycling: Boolean) : ICursor	*Returns a cursor that can be used to update rows selected by the specified query.*
← UpdateSearchedRows (in QueryFilter: IQueryFilter, in Buffer: IRowBuffer)	*Update the Rows in the database selected by the specified query.*

The *ITable* interface is the principal interface for working with tables. It inherits from *IClass* and provides additional methods that allow you to query, select, insert, update, and delete rows from the table.

You can delete an object through the API by getting a row object from a table and calling the Delete *method on the row object, getting an update cursor from a table and calling the* DeleteRow *method when positioned on the row object to be deleted, or calling the* DeleteSearchedRows *method on the table using a where clause that includes the row object.*

All modifications to rows in the table through this interface will preserve object behavior associated with the table. For example, deleting rows from a table that represents a "parent" object class that participates in a composite relationship with a "part" object class, using any of the supported methods for deleting objects, will delete rows from the related "part" object class.

The *CreateRow* method creates a new row in the underlying database with a system-assigned object ID value. A row object representing the created row is returned to the caller. The row object returned has the system assigned object ID as the value of the *OIDField*. All other fields are initialized to null values if they can be made null, and to built-in default values appropriate to the type of the field if they cannot be made null. The caller is responsible for setting the desired field values into the row and calling the *Store* method on the row. If the table represents an object class with subtypes, then it is the caller's responsibility to set the default subtype code into the row and call the *InitDefaultValues* method on the row before storing (if that is the desired result). For tables without object behavior, insert cursors offer a more efficient way for inserting new rows. For more information, see the documentation on the *Insert* method below.

The *CreateRowBuffer* method creates a new row buffer object in memory and returns it to the caller. No row is created in the database. The returned row buffer does not have an object ID value. The caller can set values into the row buffer and use it as an argument to the *InsertRow* method on an insert cursor; the latter is obtained by calling the *Insert* method on the *Table*.

The *GetRow* method returns an existing row object given its object ID value. The caller can query the returned row object for additional object-specific interfaces. The retrieved row may be modified; calling

Store on the row object after changing it will trigger messages to related objects and will mark the row for committing to the database.

The *GetRows* method returns a cursor that may be used to retrieve a set of rows specified by the input array of object ID values. To understand the meaning of the recycling parameter, see the description of the *Search* method below. It is far more efficient to retrieve a set of rows using the *GetRows* method than it is to retrieve each individual row using the *GetRow* method.

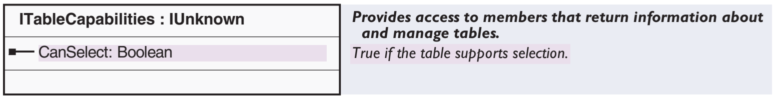
The Search, Insert, *and* Update *methods create different kinds of cursors for operating on individual rows. See the section on cursors later in this chapter.*

The *Search* method returns a "search" cursor that can be used to retrieve rows specified by a query filter. The recycling parameter controls row object allocation behavior. Recycling cursors rehydrate a single row object on each fetch and can be used to optimize read-only access, for example, when drawing. It is illegal to maintain a reference on a row object returned by a recycling cursor across multiple calls to *NextRow* on the cursor. *Row* objects returned by a recycling cursor should not be modified. Nonrecycling cursors return a separate row object on each fetch. The objects returned by a nonrecycling cursor may be modified and stored with polymorphic behavior. The geodatabase guarantees "unique instance semantics" on nonrecycling row objects fetched during an edit session. If the row object to be retrieved by a call to search has already been instantiated and is being referenced by the calling application, then a reference to the existing row object is returned.

The *Insert* method returns an "insert" cursor that can be used to bulk insert rows. It offers significantly faster performance than multiple calls to *CreateRow* and *Store* for tables storing simple rows and simple features (that is, for tables whose *CLSID* is *esriCore.Row, esricore.Object,* or *esricore.Feature*). Insert cursors on tables containing custom rows and objects use the *CreateRow* and *Store* methods to achieve polymorphism, and there is no difference in performance in these cases.

The *Update* method returns an "update" cursor that can be used to update or delete rows. It offers somewhat faster performance than multiple calls to *Store* or *Delete* on row objects fetched using a nonrecycling search cursor for tables storing simple rows and simple features. There is no difference in performance for custom features.

The *Select* method returns a selection set that holds either row IDs or row objects from the *Table*, depending on the selection option. Multiple selection sets can be created on the same table. It is up to a client application or object to keep a reference on created selections and use them as appropriate. For example, a *FeatureLayer* creates and uses selections on a *FeatureClass* (a type of *Table*).

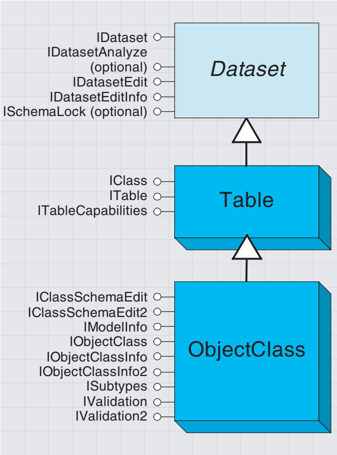

ITableCapabilities : IUnknown

CanSelect: Boolean

Provides access to members that return information about and manage tables.

True if the table supports selection.

The *ITableCapabilities* interface complements *ITable*. Use *CanSelect* to determine if you can open a selection set on the table. A situation where *CanSelect* will be *False* is a standalone database table without an OID column.



An object class is a type of table containing row objects that represent entities, each of which is modeled as an individual object with properties and behavior.

In this sense, the table must be registered with the geodatabase to be an object class since the geodatabase is responsible for linking object behavior with database rows.

An object class is a table whose rows represent entities, modeled as objects with properties and behavior. The row objects handed out by an object class support the *IRow* and the *IObject* interfaces.

An object class may participate in any number of relationship classes that relate its instances to objects (entities) in other object classes.

An object class may contain a discriminating field, referred to as the subtype field, that may be used to partition its instances into a number of subtypes. All subtypes share the same field definition and are stored in the same table; however, individual subtypes may differ in the default values and domains assigned to fields. The subtyping mechanism can also be used in defining attribute and connectivity rules that apply to the instances of the object class. The subtyping mechanism is a lightweight alternative to creating multiple subclasses, and each is represented by its own object class.

An object class has a nonnegative object class ID that is unique within the geodatabase. This ID is assigned to the object class at the time that it is created or at the time that an existing table in the RDBMS is registered with the geodatabase as an object class. The *Name* of the object class is the same as the name of the table in the DBMS in which the objects in the object class are stored; it follows the same fully qualified naming conventions.

An object class may have an *AliasName* property that is stored as part of its definition by the geodatabase. The *AliasName* may be retrieved and used for display purposes by applications.

An object class may have a *ModelName* property that is stored as part of its definition by the geodatabase. The model name is not exposed to end users and, if defined, can be used as a search key to find an object class by a standard model name that is adhered to across databases. A model name must be unique across the workspace.

IObjectClass : IClass	***Provides access to members that return information about an object class.***
■— AliasName: String	*The alias name of the object class.*
■— ObjectClassID: Long	*The unique ID for the object class.*
■— RelationshipClasses (in role: esriRelRole) : IEnumRelationshipClass	*The relationship classes in which this object class participates in for the specified role.*

Exceptions to the notion that object classes are registered in the geodatabase are coverages, INFO™ tables, shapefiles, nonregistered ArcSDE layers, and nonregistered DBMS tables. These are also considered as valid object classes in order to keep a simple object model while providing rich functionality in ArcGIS applications. A subset of intrinsic geodatabase behavior, such as subtypes and relationships, may be unavailable with these nonregistered object classes.

All object classes support the *IObjectClass* interface; this interface inherits from the *IClass* interface. The *CLSID, EXTCLSID,* and *Extension* for an *ObjectClass* may be obtained via the corresponding methods inherited from *IClass*.

For programming convenience, preexisting tables in the host RDBMS also support the *IObjectClass* interface even if they have not been registered with the geodatabase. Such tables can be distinguished from registered object classes because they return an *ObjectClassID* of -1 and return *False* to the *HasOID* method. New object classes in a geodatabase that are created using the *CreateTable* method on the *IFeatureWorkspace* interface are automatically registered with the geodatabase and assigned an object class ID.

If no *AliasName* has been defined for an object class, then the *AliasName* is equal to the *Name*.

The *RelationshipClasses* property can be used to retrieve the relationship classes in which the *ObjectClass* participates with a specified role (origin, destination, or both). The following example illustrates its use.

```
Dim pRelClass As IRelationshipClass
Dim pEnumRelClass As IEnumRelationshipClass
Set pEnumClass = pObjectClass.RelationshipClass (esriRelRoleAny)
Set pRelClass = pEnumRelClass.Next
Do Until pRelClass Is Nothing
  MsgBox pRelClass.OriginClass.AliasName & ":" & _
    pRelClass.DestinationClass.AliasName
  Set pRelClass = pEnumRelClass.Next
Loop
```

IClassSchemaEdit *modifies the properties of an object class. Use* ISchemaLock *in conjunction with this interface.*

IClassSchemaEdit : IUnknown	***Provides access to member to modify an object class schema.***
← AlterAliasName (in Name: String)	*The alias name of the object class.*
← AlterClassExtensionCLSID (in ClassExtensionCLSID: IUID, in classExtensionProperties: IPropertySet)	*Changes the class extension COM class associated with this database class.*
← AlterDefaultValue (in FieldName: String, in Value: Variant)	*The default value of the object class field.*
← AlterDomain (in FieldName: String, in Domain: IDomain)	*The default domain of the object class field.*
← AlterFieldAliasName (in FieldName: String, in AliasName: String)	*The alias name of the object class field.*
← AlterFieldModelName (in FieldName: String, in ModelName: String)	*The model name of the object class field.*
← AlterInstanceCLSID (in InstanceCLSID: IUID)	*Changes the instance COM class associated with this database class.*
← AlterModelName (in Name: String)	*The model name of the object class.*
← RegisterAsObjectClass (in suggestedOIDFieldName: String, in ConfigKeyword: String) : Long	*Registers this class with the database, assigning it a class ID and creating an object ID column.*

IClassSchemaEdit2 : IUnknown	***Provides access to modify an object class's extension properties.***
← AlterClassExtensionProperties (in classExtensionProperties: IPropertySet)	*Changes the class extension properties associated with this object class.*

The *IClassSchemaEdit* and *IClassSchemaEdit2* interfaces are used to modify the properties of an object class, such as the class extension, model name, and so on. You can use the *RegisterAsObjectClass* method in this interface to register a preexisting table with the geodatabase. This process assigns the table an object class ID and creates an entry for the object class in the geodatabase data dictionary.

Note that a table must be registered as an object class with the geodatabase before schema properties, such as the *CLSID,* may be assigned or modified.

When using these interfaces to alter an object class, you should first acquire an exclusive lock using the *ISchemaLock* interface. This will ensure that another application or user does not have the class open while you are trying to modify its schema.

IModelInfo : IUnknown	Provides access to the model name of the field.
ModelName: String	The model name of the field.

The *IModelInfo* interface can be used to access the model name of the object class. You can alter the model name with either *IModelInfo* or *IClassSchemaEdit*. Note that *IModelInfo* is also available on the lightweight *TableName* object.

ISubtypes : IUnknown	Provides access to members that return and modify subtype information.
DefaultSubtypeCode: Long	The default subtype associated with the class.
DefaultValue (in SubtypeCode: Long, in FieldName: String) : Variant	The default value for the associated attribute.
Domain (in SubtypeCode: Long, in FieldName: String) : IDomain	The domain given the subtype and field.
HasSubtype: Boolean	True if the table has subtypes.
SubtypeFieldIndex: Long	The subtype field index.
SubtypeFieldName: String	The subtype field name.
SubtypeName (in SubtypeCode: Long) : String	The subtype name.
Subtypes: IEnumSubtype	The subtypes associated with the class.
AddSubtype (in SubtypeCode: Long, in SubtypeName: String)	Adds the subtype to the set of associated subtypes.
DeleteSubtype (in SubtypeCode: Long)	Deletes the subtype from the set of associated subtypes.

Although all objects in a feature class or object class must have the same behavior and attributes, not all objects have to share the same default values and validation rules. You can group features and objects into subtypes. Subtypes differentiate objects based on their rules.

The *ISubtypes* interface is used to manage and query the subtypes, domains, and default values associated with an object class. Some of these properties can also be set—default subtype codes, the field containing the subtype code, default values, and the domain associated with a field subtype pair. Domains are discussed later in this chapter.

Every *ObjectClass* has a default subtype code. If the user has not explicitly specified a default subtype or a subtype field, then *DefaultSubtypeCode* will return a subtype code of 0. Additionally, you can query the HasSubtype property—a value of *False* indicates an absence of a default subtype code, *True* indicates the presence of a default subtype code.

If the client instead asks for the enumeration of subtypes associated with an *ObjectClass* and no subtype has been previously added to the *ObjectClass*, then the enumerator will contain a single entry with a code of 0. The subtype field index value will be -1 if a default subtype has not been previously specified. Subtypes may only be short or long integers (*esriFieldTypeSmallInteger* or *esriFieldTypeInteger*). If a subtype code already exists when you set the default subtype code, it will be deleted. A subtype field must have been specified prior to setting the subtype code value.

IValidation provides methods to carry out validation and also to manage rules.

Every type of field, except for *esriFieldTypeShape*, may have a default value. When setting the default value (which may be assigned on a subtype basis), it will be checked against the field's associated *Domain* (if one exists) for validity.

IValidation : IUnknown	***Provides access to members that manage rules and validate them.***
▪— Rules: IEnumRule	*The rules associated with the class.*
▪— RulesByField (in FieldName: String) : IEnumRule	*The rules associated with the attribute.*
▪— RulesBySubtypeCode (in SubtypeCode: Long) : IEnumRule	*The rules associated with the subtype.*
← AddRule (in rule: IRule)	*Adds the rule to the set of associated rules.*
← DeleteRule (in rule: IRule)	*Deletes the rule from the set of associated rules.*
← Validate (in Selection: IQueryFilter, in Workspace: IWorkspace) : ISelectionSet	*Validates the selection.*
← ValidateSelection (in Selection: ISelectionSet, in Workspace: IWorkspace) : ISelectionSet	*Validates the selection.*
← ValidateSet (in Selection: ISet) : ISet	*Validates the set.*

IValidation2 : IUnknown	***Validation Interface***
← AlterRule (in rule: IRule)	*Alters the existing validation rule.*

The *IValidation* and *IValidation2* interfaces are used when triggering the validation process on an *ObjectClass*.

There are two similarly named interfaces: IValidation validates sets of objects, whereas IValidate validates a single object and returns the reason for invalidity.

The *IValidation* interface serves two primary roles. First, all rule management behavior is exposed. Second, methods are provided for triggering the validation process on either sets of objects, selection sets of objects, or by objects that are specified via a *QueryFilter*. Note that it is also possible to trigger validation on a single object via the *IValidate* interface found on the *Row* object. If the *QueryFilter* is null, then validation is across all objects in the class. Objects found to be invalid are returned in either *Sets* or *SelectionSets*, depending on the validation method being called. Validation is only supported on SQL-based datasets.

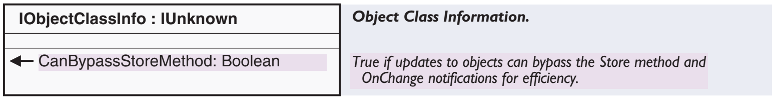
Error messages indicating why the returned objects are invalid are not provided. In order to determine why the object is invalid, you must call *IValidate::Validate* on the object. A string containing the reason why the object is invalid is returned. Only the first of possibly many reasons is provided. This is a side effect of the validation process—once an object is determined to be invalid, continued validation on the object ceases and it is added to the returned collection of invalid objects.

The *AlterRule* method is used to change the characteristics of an existing rule. At ArcGIS 8.1 it can only be used to change connectivity rules.

The following VBA code fragment validates all the objects in the object class, then displays a message box indicating why each of the invalid objects is considered invalid.

```
Dim pValidation as IValidation, pSelectionSet as ISelectionSet
Set pValidation = pObjectClass

'Validate all of the objects in the object class
```

```
Set pSelectionSet = pValidation.Validate(nothing, pWorkspace)
If pSelectionSet.Count = 0 Then Exit Sub
Dim pIDs as IEnumIDs
Set pIDs = pSelectionSet.IDs

'Iterate through each of the invalid objects in the selection set
Dim i as Long, lID as Long, pRow as IRow, pValidate as IValidate
For i = 0 To (pSelectionSet.Count - 1)
  lID = pIDs.Next
  Set pRow = pTable.GetRow(lID)
  Set pValidate = pRow
  MsgBox "Invalid Object:" & lID & vbCr & "Reason: " & _
    pValidate.Validate
Next i
```



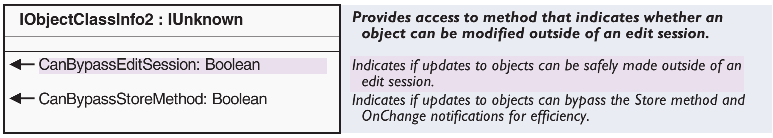
IObjectClassInfo : IUnknown

CanBypassStoreMethod: Boolean

Object Class Information.

True if updates to objects can bypass the Store method and OnChange notifications for efficiency.

CanBypassStore *indicates whether or not it is essential to use* IRow::Store *when changing an object.*



IObjectClassInfo2 : IUnknown

CanBypassEditSession: Boolean

CanBypassStoreMethod: Boolean

Provides access to method that indicates whether an object can be modified outside of an edit session.

Indicates if updates to objects can be safely made outside of an edit session.

Indicates if updates to objects can bypass the Store method and OnChange notifications for efficiency.

The *IObjectClassInfo* and *IObjectClassInfo2* interfaces provide some additional information on object classes that may be of interest to some applications.

CanBypassStoreMethod is a convenience method that returns *True* if the instances of this object class have no custom behavior associated with creating or updating objects, and if the object class does not participate in composite relationship classes or in relationship classes that require object notification.

A return value of *True* implies that insert cursors handed out by the geodatabase will internally bypass the *CreateRow* and *Store* mechanisms when creating objects. A return value of *False* indicates that insert cursors will not bypass custom *Store* or *OnChanged* behavior implemented by the custom row object for this class.

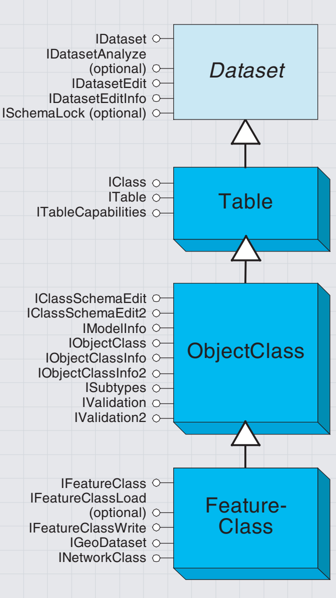
By default, this method returns *False* for custom object classes. The developer of a custom object class can change this behavior by implementing this interface on the class extension associated with the class, then returning *True* for the method.

CanBypassEditSession is a convenience method that returns *True* if the instances of this object class can be created or updated outside of a geodatabase edit session (an edit session is begun using the *StartEditing* method on the *IWorkspaceEdit* interface supported by a workspace).

If *True* is returned, then applications may update the data in this object class using any of the data-updating interfaces and methods described here without starting an edit session. In this case, applications are responsible for starting host database transactions as appropriate, and for discarding cached object states across transaction boundaries when running on a multiuser database.

If *False*, then applications should make modifications to the data in this object class within an edit session for correct multiuser behavior, and for correct management of database states internally cached by the geodatabase for the objects in this object class.

This method returns *False* for network feature classes. By default, this method returns *True* for nonnetwork custom object classes. The developer of a nonnetwork custom object class can change this behavior by implementing this interface on the class extension associated with the class, then returning *True* for the method.



A feature class is an object class whose objects are features.

Typically, features in a feature class are closely related thematically. That is, a hydrology feature class would have features such as permanent streams, intermittent streams, and rivers. For guidance on structuring feature types within a geodatabase, see Modeling Our World: The ESRI Guide to Geodatabase Design.

A *FeatureClass* is an *ObjectClass* whose objects are features, that is, a feature class is a collection of spatial entities, modeled as objects with properties and behavior. All of the features in a feature class share the same attribute schema (they have the same set of named fields). The row objects handed out by a feature class support the *IRow, IObject,* and *IFeature* interfaces.

A feature class has a distinguished field of type *Geometry*, referred to as the shape field. The shape field stores the geometry (referred to as the shape property) for the features in the *FeatureClass*.

IFeatureClass : IObjectClass	*Controls the behavior and properties of a feature class.*
AreaField: IField	*The geometry area field.*
FeatureClassID: Long	*The unique ID for the Feature Class.*
FeatureDataset: IFeatureDataset	*The feature dataset that contains the feature class.*
FeatureType: esriFeatureType	*The type of features in this feature class.*
LengthField: IField	*The geometry length field.*
ShapeFieldName: String	*The name of the default shape field.*
ShapeType: tagesriGeometryType	*The type of the default shape for the features in this feature class.*
CreateFeature: IFeature	*Create a new feature, with a system-assigned object ID and null property values.*
CreateFeatureBuffer: IFeatureBuffer	*Create a feature buffer that can be used with an insert cursor.*
FeatureCount (in QueryFilter: IQueryFilter) : Long	*The number of features selected by the specified query.*
GetFeature (in ID: Long) : IFeature	*Get the feature with the specified object ID.*
GetFeatures (in fids: Variant, in Recycling: Boolean) : IFeatureCursor	*Get a cursor of rows given a set of object IDs.*
Insert (in useBuffering: Boolean) : IFeatureCursor	*Returns a cursor that can be used to insert new features*
Search (in Filter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor	*Returns an object cursor that can be used to fetch feature objects selected by the specified query.*
Select (in QueryFilter: IQueryFilter, in selType: esriSelectionType, in selOption: esriSelectionOption, in selectionContainer: IWorkspace) : ISelectionSet	*Returns a selection That contains the object ids selected by the specified query.*
Update (in Filter: IQueryFilter, in Recycling: Boolean) : IFeatureCursor	*Returns a cursor that can be used to update features selected by the specified query*

Many of the IFeatureClass *methods are equivalent to* ITable *methods, except feature-based interfaces, rather than row-based interfaces, are returned.*

The properties exposed in the *IFeatureClass* interface can be used to obtain key information about a *FeatureClass*.

The *ShapeField* property returns the name of the *Field* that stores the shape values for features in the class. The *AreaField* and *LengthField* properties return the names of the fields that store the area and length of the feature as derived from the value of its shape if the underlying spatial database maintains such fields.

The *ShapeType* property returns the geometry type of the *ShapeField*.

The *FeatureType* property returns the enumerated base type for the features stored in this feature class, such as *esriFTSimple, esriFTAnnotation,* or *esriFTComplexEdge*. A custom feature with complex behavior will return a feature type based on the base class from which it is derived.

The *FeatureClassID* for a feature class is identical to the *ObjectClassID* for the feature class obtained via the *IObjectClass* interface.

The *FeatureDataset* property returns a reference to the containing feature dataset if this feature class is not a standalone feature class.

Note that some of the above properties are directly available on the feature class name object and can be used by browsing applications without instantiating a feature class object.

This code example uses the table of contents in ArcMap to get a *FeatureClass* object.

```
Dim pFeatcls As IFeatureClass
Dim pFeatLayer As IFeatureLayer
Dim pDoc As IMxDocument
Dim pMap As IMap
Dim pDoc As ThisDocument
Set pMap = pDoc.Maps.Item(0)
Set pFeatLayer = pMap.Layer(0)
Set pFeatcls = pFeatLayer.FeatureClass
```

This code example uses the *Workspace* object to return a *FeatureClass* object.

```
Dim pFact As IWorkspaceFactory
Dim pWorkspace As IWorkspace
Dim pFeatws As IFeatureWorkspace
Dim pFeatcls As IFeatureClass
Set pFact = New AccessWorkspaceFactory
Set pWorkspace = pFact.OpenFromFile("C:\data\usa.mdb", 0)
Set pFeatws = pWorkspace
Set pFeatcls = pFeatws.OpenFeatureClass("states")
```

The *IFeatureClass* interface also has additional methods (described below) that allow you to query, select, insert, update, and delete features from the feature class. These methods are redundant given the corresponding methods in *ITable* but are provided for convenience. For a more complete description, see the documentation of the corresponding methods in *ITable*.

Calling the *CreateFeature* and *GetFeature* methods on a feature class (via the *IFeatureClass* interface on the feature class) has the same effect as calling the *CreateRow* and *GetRow* methods on the *FeatureClass* (via the *ITable* interface on the feature class), except that the *IFeatureClass* methods return *IFeature* interfaces on the returned row object.

Calling the *CreateFeatureBuffer* method in *IFeatureClass* has the same effect as calling the *CreateRowBuffer* interface in *ITable,* except that the *IFeatureClass* methods return an *IFeatureBuffer* interface on the created row buffer.

Calling the *GetFeatures* method in *IFeatureClass* has the same effect as calling the *GetRows* method in *ITable,* except that the *IFeatureClass* method returns the *IFeatureCursor* interface on the returned cursor.

Calling the *Search, Update,* and *Insert* methods in *IFeatureClass* has the same effect as calling the corresponding methods in *ITable* except that the *IFeatureClass* methods return the *IFeatureCursor* interface on the returned cursor.

INetworkClass can be used on feature classes taking part in a geometric network.

Calling the *Select* method in *IFeatureClass* has the same effect as calling the corresponding method in *ITable*.

INetworkClass : IFeatureClass	Provides access to members that return information about geometric networks, field weighting, and ancillary roles.
FieldToWeightMapping (in FieldIndex: Long) : Long	The specified field to Weight mapping for the logical network.
GeometricNetwork: IGeometricNetwork	The geometric network in which this class participates.
NetworkAncillaryRole: esriNetworkClassAncillaryRole	The possible network ancillary roles of the contained Features.

The *INetworkClass* interface is supported by feature classes that participate in a geometric network. The *FeatureType* property of such feature classes will be either *esriFTSimpleJunction, esriDTSimpleEdge, esriFTComplexJunction,* or *esriFTComplexEdge*.

The *GeometricNetwork* property returns a reference back to the geometric network in which this network feature class participates.

The *NetworkAncillaryRole* property returns the network ancillary role played by this feature class in the geometric network.

Enumeration esriNetworkFeatureAncillaryRole	NetworkFeature Ancillary Role types.
0 - esriNFARNone	Ancillary Role None.
1 - esriNFARSource	Ancillary Role Source.
2 - esriNFARSink	Ancillary Role Sink.

These are the valid constants for the *NetworkAncillaryRole* property.

The *FieldToWeightMapping* property returns the numeric index of the network weight to which the specified input field in the feature class is mapped. A value of -1 indicates that the specified field is not a network weight field.

IFeatureClassLoad will toggle load-only mode for a feature class.

IFeatureClassLoad : IUnknown	Provides access to the load mode of a GDB feature class.
LoadOnlyMode: Boolean	True if the feature class is in load-only mode.

IFeatureClassLoad is an optional interface that is supported by feature classes in an ArcSDE database and can be used to improve the performance of data loading.

Putting a feature class in load-only mode drops the spatial index on the feature class prior to data loading.

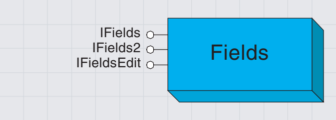
Taking a feature class out of load-only mode rebuilds the spatial index after data loading.

While a feature class is in load-only mode, other applications cannot work with the feature class. A feature class should be placed in load-only mode only after acquiring an exclusive schema lock on the feature class via the *ISchemaLock* interface.

In general, IFeatureClassWrite *should only be used when implementing custom features that bypass* IFeature::Store.

IFeatureClassWrite : IUnknown	***Provides access to low level.***
← RemoveFeature (in Feature: IFeature)	*Deletes a feature from the database, does not trigger OnDelete event.*
← RemoveFeatures (in features: ISet)	*Deletes a set of features from the database, does not trigger OnDelete events.*
← WriteFeature (in Feature: IFeature)	*Stores a feature to the database, does not trigger OnStore event.*
← WriteFeatures (in features: ISet)	*Stores a set of features to the database, does not trigger OnStore events.*

The *IFeatureClassWrite* interface provides low-level write access to feature class data. Any associated object behavior is not triggered.



The Fields object represents a collection of columns in a table. The term field is synonymous with column.

Each table in a database has an ordered collection of fields; there is always at least one field in a table. The ordered collection behaves like a list, so it is possible to access individual fields by a numbered position (or index) in the list.

A *Fields* collection can also exist independently of a table; for example, when creating an index on a table you need to define which fields take part in the index. There are many interfaces that either require or return a *Fields* collection; these include *IClass* (therefore also *IObjectClass* and *IFeatureClass), ICursor, IIndex, IFeatureClassDraw, IRowBuffer, ISimpleDataConverter, ITableSort,* and *IValidate.*

IFields : IUnknown	***Provides access to members that return information about the fields.***
■— Field (in Index: Long) : IField	*The field at the specified index in the fields collection.*
■— FieldCount: Long	*The number of fields in the fields collection.*
← FindField (in Name: String) : Long	*Finds the index of the named field in the fields collection.*
← FindFieldByAliasName (in Name: String) : Long	*Finds the index of the field with the alias name in the fields collection.*

The *IFields* interface provides information about a *Fields* collection and provides access to individual fields. This example finds any fields in a feature class that have a distinct alias name.

```
Set pFields = pFeatureClass.Fields
For i = 0 To (pFields.FieldCount - 1)
  Set pField = pFields.Field(i)
  If (pField.Name <> pField.AliasName) Then
    Debug.Print pField.Name & ":" & pField.AliasName
  End If
Next i
```

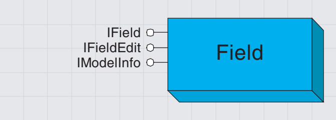
When changing the schema of a table in a multiuser environment, for example, by adding or deleting fields, you should first gain an exclusive schema lock on the table. For more details, see the section on ISchemaLock.

When using *IFields::FindField*, remember that there are equivalent methods on *IClass* and *ICursor*—they are shortcuts that save you from having to get the *Fields* collection.

When programming with ArcMap, there is a distinction between *IFields* and two other interfaces, *ILayerFields* and *ITableFields*. *ILayerFields* is particular to an ArcMap layer so, for example, an alias name belongs to the field as defined in that layer rather than being stored with the underlying table.

IFieldsEdit : IFields	***Provides access to members that modify a fields collection.***
—□ Field (in Index: Long) : IField	*The field at the specified position.*
—■ FieldCount: Long	*The number of fields in this field collection.*
← AddField (in Field: IField)	*Add a field to the fields collection.*
← DeleteAllFields	*Delete all the fields from the fields collection.*
← DeleteField (in Field: IField)	*Delete a field from the fields collection.*

The *IFieldsEdit* interface is used when creating a fields collection. You cannot use it to insert a new field in the middle of a *Fields* collection that belongs to an existing table.



The field object represents a column in a table.

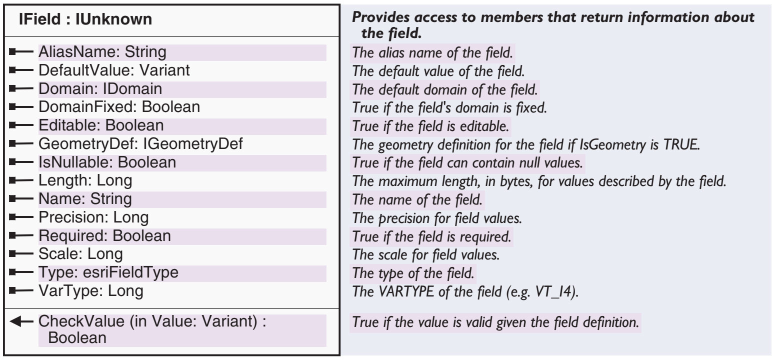
A field has many properties, the most obvious ones being name and datatype. The *esriFieldType* enumeration lists the possible datatypes.

This table shows the equivalent field data types in the ArcCatalog user interface, ArcObjects™, Visual Basic®, and a selection of DBMSs.

ArcCatalog	IFields::Type (esriFieldType)	IFields::VarType (VBA variable type)	Access	SQL Server	Oracle
Short Integer	esriFieldTypeSmallInteger	vbInteger	Number (Integer)	smallint	NUMBER
Long Integer	esriFieldTypeInteger	vbLong	Number (Long Integer)	int	NUMBER
Float	esriFieldTypeSingle	vbSingle	Number (Single)	float(8), or numeric if precision and scale specified	NUMBER
Double	esriFieldTypeDouble	vbDouble	Number (Double)	float(8), or numeric if precision and scale specified	NUMBER
Text	esriFieldTypeString	vbString	Text	varchar	VARCHAR2
Date	esriFieldTypeDate	vbDate	Date/Time	datetime	DATE
Object ID	esriFieldTypeOID	vbLong	AutoNumber (Long Integer)	int	NUMBER(9)
Geometry	esriFieldTypeGeometry	vbDataObject	OLE Object	int	NUMBER(9)) or SDO_GEOMETRY, dependent on configuration
Blob	esriFieldTypeBlob	vbObject	OLE Object	image	LONG RAW or BLOB, dependent on configuration

Field objects are not appropriate for use with INFO-based data such as coverages. The equivalent object is an *ArcInfoItem*. For more details, see the section on coverage-specific interfaces.

The IField *interface is used for read-only access to the field's properties.*



IField : IUnknown	***Provides access to members that return information about the field.***
AliasName: String	*The alias name of the field.*
DefaultValue: Variant	*The default value of the field.*
Domain: IDomain	*The default domain of the field.*
DomainFixed: Boolean	*True if the field's domain is fixed.*
Editable: Boolean	*True if the field is editable.*
GeometryDef: IGeometryDef	*The geometry definition for the field if IsGeometry is TRUE.*
IsNullable: Boolean	*True if the field can contain null values.*
Length: Long	*The maximum length, in bytes, for values described by the field.*
Name: String	*The name of the field.*
Precision: Long	*The precision for field values.*
Required: Boolean	*True if the field is required.*
Scale: Long	*The scale for field values.*
Type: esriFieldType	*The type of the field.*
VarType: Long	*The VARTYPE of the field (e.g. VT_I4).*
CheckValue (in Value: Variant) : Boolean	*True if the value is valid given the field definition.*

This example adds all the editable, nonshape fields to a combobox.

```
Dim i As Long
Dim pField As IField
For i = 0 To (pFields.FieldCount - 1)
  Set pField = pFields.Field(i)
  If (pField.Editable And pField.Type <> esriFieldTypeGeometry) Then
     Form1.myComboBox.AddItem (pField.AliasName)
   End If
Next i
```

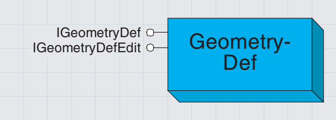
The IFieldEdit *interface is used when creating new fields. You should not use it to modify fields; use* IClassSchemaEdit *for that purpose. In general, when modifying fields, the restrictions that apply in ArcCatalog also apply in ArcObjects; for example, you cannot change the name or type of a field.*

IFieldEdit : IField	***Provides access to members that edit the field properties.***
AliasName: String	*The alias name of the field.*
DefaultValue: Variant	*The default value of the field.*
Domain: IDomain	*The default domain of the field.*
DomainFixed: Boolean	*True if the field's domain cannot be modified.*
Editable: Boolean	*Determines if the field can be edited. This should always be set to True.*
GeometryDef: IGeometryDef	*The geometry definition if IsGeometry is True.*
IsNullable: Boolean	*True if field values can be null.*
Length: Long	*The maximum length, in bytes, for field values.*
Name: String	*The name of the field.*
Precision: Long	*The precision for field values.*
Required: Boolean	*True if the field is required.*
Scale: Long	*The scale for field values.*
Type: esriFieldType	*The type for the field.*

When a Field *is created, the* Editable *property is set to* True *by default. If the* Editable *property has been set to* False*, it may not be reset to* True*. However, an* Editable *property set to* True *can be reset to* False*.*

This example creates a new table with two fields. Note the use of *IFieldsEdit::FieldCount* to set the number of fields that are to be added.

```
Public Sub CreateNewTable(sName As String, pFeatWorkspace As IFeatureWorkspace)
   Dim pTable As ITable
   Dim pField As IField
   Dim pFields As IFields
   Dim pFieldEdit As IFieldEdit
   Dim pFieldsEdit As IFieldsEdit

   'Create new Fields collection
   Set pFields = New Fields
   Set pFieldsEdit = pFields
   pFieldsEdit.FieldCount = 2

   'Create Object ID Field
   Set pField = New Field
   Set pFieldEdit = pField
   With pFieldEdit
      .Name = "OBJECTID"
      .AliasName = "FID"
      .Type = esriFieldTypeOID
   End With
   Set pFieldsEdit.Field(0) = pField

   'Create text Field
   Set pField = New Field
   Set pFieldEdit = pField
   With pFieldEdit
      .Length = 30
      .Name = "Owner"
      .Type = esriFieldTypeString
   End With
   Set pFieldsEdit.Field(1) = pField
   Set pTable = pFeatWorkspace.CreateTable(sName, pFields, _
                    Nothing, Nothing, "")
End Sub
```



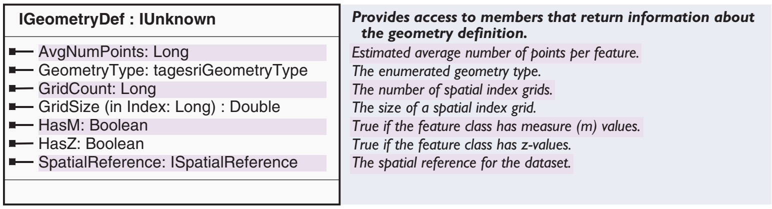
The GeometryDef *object defines the spatial qualities of a feature class. The most fundmental spatial quality is the* Geometry *type, for example, point, line, and polygon. Other information necessary to define the feature class includes the spatial referencing system, whether the vertices have height or measure data, and, for geodatabases, the spatial index parameters.*

The *GeometryDef* coclass can be accessed from a shape field, a field of type *esriFieldTypeGeometry*. The actual geometry type is defined by the *esriGeometryType* enumeration, although currently only four values are acceptable with respect to *GeometryDef* objects: *esriGeometryPoint, esriGeometryMultipoint, esriGeometryPolyline,* and *esriGeometryPolygon*.

Beware of confusion between the *esriGeometryType* enumeration and the similarly named *esriFeatureType* and *esriShapeType*.

ArcObjects Enumeration	Values	Interfaces that use the enumeration
esriGeometryType Type of geometry in a geodatabase. Those in bold are valid for feature classes, others are component geometry types.	**esriGeometryPoint** **esriGeometryMultipoint** **esriGeometryPolyline** **esriGeometryPolygon** esriGeometryNull esriGeometryAny esriGeometryBag esriGeometryLine esriGeometryCircularArc esriGeometryEllipticArc esriGeometryBezier3Curve esriGeometryPath esriGeometryRing esriGeometryEnvelope esriGeometryMultiPatch esriGeometryTriangleStrip esriGeometryTriangleFan esriGeometryRing3D esriGeometryRay esriGeometrySphere	IFeatureClass::ShapeType IGeometry::GeometryType IGeometryDef::GeometryType also IGeometryDefEdit, IGeometryFactory, IEditSketchExtension, IGridConversionOp, IDimensionConstructor
esriFeatureType Feature types defined by feature class extensions	esriFTSimple esriFTSimpleJunction esriFTSimpleEdge esriFTComplexJunction esriFTComplexEdge esriFTAnnotation esriFTCoverageAnnotation esriFTDimension	IFeature::FeatureType IFeatureClass::FeatureType IFeatureClassDescription::FeatureType IFeatureWorkspace::CreateFeatureClass IFeatureDataset::CreateFeatureClass also, IGeometricNetwork and INetworkLoader
esriShapeType Type of geometry in a shapefile	see ArcObjects help for full list	IESRIShape, IGeometryFactory

This table shows the different roles of these enumerations:



IGeometryDef : IUnknown — *Provides access to members that return information about the geometry definition.*

- AvgNumPoints: Long — *Estimated average number of points per feature.*
- GeometryType: tagesriGeometryType — *The enumerated geometry type.*
- GridCount: Long — *The number of spatial index grids.*
- GridSize (in Index: Long) : Double — *The size of a spatial index grid.*
- HasM: Boolean — *True if the feature class has measure (m) values.*
- HasZ: Boolean — *True if the feature class has z-values.*
- SpatialReference: ISpatialReference — *The spatial reference for the dataset.*

The *IGeometryDef* interface provides read-only access to the *GeometryDef* properties. The code below shows how to get to *IGeometryDef* from a feature class.

```
Dim lGeomIndex As Long
Dim sShpName As String
Dim pFields As IFields
Dim pField As IField
Dim pGeometryDef As IGeometryDef
```

```
sShpName = pFeatureClass.ShapeFieldName
Set pFields = pFeatureClass.Fields
lGeomIndex = pFields.FindField(sShpName)
Set pField = pFields.Field(lGeomIndex)
Set pGeometryDef = pField.GeometryDef
```

The *AvgNumPoints*, *GridCount,* and *GridSize* properties are all attributes of the geodatabase spatial index. Shapefiles will return 0 for *GridCount*.

IGeometryDefEdit *is used to initialize a* GeometryDef *object.*

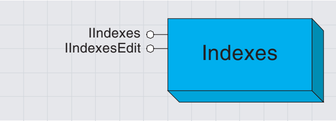
IGeometryDefEdit : IGeometryDef	***Provides access to members that modify the geometry definition.***
AvgNumPoints: Long	*The estimated average number of points per feature.*
GeometryType: tagesriGeometryType	*The geometry type.*
GridCount: Long	*The number of spatial index grids.*
GridSize (in Index: Long) : Double	*The size of a spatial index grid.*
HasM: Boolean	*True if the feature class will support m-values.*
HasZ: Boolean	*True if the feature class will support z-values.*
SpatialReference: ISpatialReference	*The spatial reference of the dataset.*

The *IGeometryDefEdit* interface is used when creating a *GeometryDef* object. You would normally use this interface when defining a new feature class.

You cannot use *IGeometryDefEdit* to modify an existing *GeometryDef* that is attached to a feature class. Use *IGeoDatasetSchemaEdit* to make changes in this way.

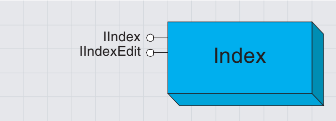
This code fragment shows *IGeometryDefEdit* being used in the creation of a new shape field. Note that the spatial reference is not set, so the resulting feature class will either have an unknown spatial reference or be inherited from a feature dataset.

```
Dim pField As IField, pFields As IFields
Dim pFieldEdit As IFieldEdit, pFieldsEdit As IFieldsEdit
'Create new Fields collection
Set pFields = New Fields
Set pFieldsEdit = pFields
pFieldsEdit.FieldCount = 1
Dim pGeoDef As IGeometryDef, pGeoDefEdit As IGeometryDefEdit
Set pGeoDef = New GeometryDef
Set pGeoDefEdit = pGeoDef
With pGeoDefEdit
  .GeometryType = esriGeometryPolyline
  .GridCount = 1
  .GridSize(0) = 200
End With

'Create Shape Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
  .Name = "SHAPE"
  .Type = esriFieldTypeGeometry
Set .GeometryDef = pGeoDef
End With
```



The Indexes *object represents a collection of indexes on a table.*

Each of the IFieldEdit, IGeometryDefEdit, *and* IIndexEdit *objects have a similar relationship to their shorter-named companion interfaces. With Visual Basic, you cannot rely on the inherited members when the member name is the same in both interfaces.*



The Index *object represents an index on a table. There are two types of indexes: spatial and attribute.*

The *Indexes* collection object operates in a very similar way to the *Fields* collection object.

IIndexes : IUnknown	***Provides access to members that return information about the index collection.***
■— Index (in pos: Long) : IIndex	*The index at the specified position in the indexes collection.*
■— IndexCount: Long	*The number of indexes in the indexes collection.*
← FindIndex (in Name: String, out pos: Long)	*Finds the position of the named index in the indexes collection.*
← FindIndexesByFieldName (in FieldName: String) : IEnumIndex	*The set of indexes for a given field name (if any).*

The *IIndexes* interface provides access to individual indexes. It is obtained from a table or feature class by using *IClass::Indexes*.

```
Dim pIndexes as IIndexes
Set pIndexes = pTable.Indexes
MsgBox pIndexes.IndexCount
```

IIndexesEdit : IIndexes	***Provides access to members that modify the indexes collection.***
—□ Index (in pos: Long) : IIndex	*The index at the specified position.*
—■ IndexCount: Long	*The number of indexes in this indexes collection.*
← AddIndex (in Index: IIndex)	*Add an index to the indexes collection.*
← DeleteAllIndexes	*Delete all the indexes from the indexes collection.*
← DeleteIndex (in Index: IIndex)	*Delete an index from the indexes collection.*

Although *IIndexEdit* inherits members from *IIndex*, Visual Basic requires that you *QI* to *IIndex* to use those members that have the same name as a member of *IIndexEdit*.

Spatial indexes exist on the shape field of a feature class. Some of the spatial index parameters, for example, the grid size, are only accessible through the *GeometryDef* object available from the shape field. The spatial index is created automatically when a geodatabase feature class is created, so you do not have to create the spatial index with ArcObjects. However, it is possible to delete and re-create the spatial index.

Attribute indexes are based on an ordered list of one or more fields in a table. The order of the list determines which field is used first when resolving data queries. There is a limit of ten fields in a geodatabase attribute index.

For geodatabases, there is one attribute index that is automatically created. This is the index on the Object ID. Another point to note is that you can access indexes created in the native environment of the DBMS.

For shapefiles, both spatial and attribute indexes can be manipulated, though note the usual limit of one field in an attribute index.

Index objects are not appropriate for use with INFO-based data such as coverages. The equivalent functionality is available from the *IArcInfoTable* interface. For more details, see the section on coverage-specific interfaces.

IIndex *interface is used for read-only access to the properties of an index.*

IIndex : IUnknown	*Provides access to members that return information about the index.*
■— Fields: IFields	*The fields collection for this index.*
■— IsAscending: Boolean	*True if the index is based on ascending order.*
■— IsUnique: Boolean	*True if the index is unique.*
■— Name: String	*The name of the index.*

This code extract shows a check on whether the index is spatial or based on the geodatabase object ID. If not, it prints out the list of field names.

```
Dim j As Long
Dim pFields As IFields
Dim pField As IField

Set pFields = pIndex.Fields
Set pField = pFields.Field(0)
If (pField.Type <> esriFieldTypeGeometry _
And pField.Type <> esriFieldTypeOID) Then
  For j = 0 To pFields.FieldCount - 1
    Set pField = pFields.Field(j)
    Debug.Print pField.name
  Next
End If
```

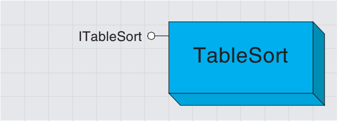
The IIndexEdit *interface is used when creating new indexes.You cannot use* IIndexEdit *to modify an existing index—to do this, delete and re-create it.*

IIndexEdit : IIndex	*Provides access to members that modify the index.*
—□ Fields: IFields	*The fields collection for this index.*
—■ IsAscending: Boolean	*True if the index is to be ascending.*
—■ IsUnique: Boolean	*True if the index is to be unique.*
—■ Name: String	*The name of the index.*

IIndexEdit operates in a similar way to *IFieldEdit*. This code extract adds a new index to a table.

```
Public Sub AddIndex(pTable As ITable, sFieldName As String)

  'Set up fields
  Dim pFields As IFields
  Dim pFieldsEdit As IFieldsEdit
  Dim pField As IField
  Dim i As Long
  Set pFields = New Fields
  Set pFieldsEdit = pFields
  pFieldsEdit.FieldCount = 1

  i = pTable.FindField(sFieldName)
  If (i = -1) Then
    MsgBox sFieldName & " not found"
    Exit Sub
  End If
  Set pField = pTable.Fields.Field(i)
  Set pFieldsEdit.Field(0) = pField
  Dim pIndex As IIndex
  Dim pIndexEdit As IIndexEdit
  Set pIndex = New Index
  'QI for IIndexEdit
  Set pIndexEdit = pIndex

  With pIndexEdit
    Set .Fields = pFields
    .name = "Idx_1"
  End With

  'Add index to table
  pTable.AddIndex pIndex

End Sub
```

When changing indexes on a table in a multiuser environment, you should first gain an exclusive schema lock on the table. For more details, see the section on *ISchemaLock*.



A table sort controls the order in which rows are returned from a table or object class.

The *TableSort* class allows control over the order in which rows are returned from a table or feature class. To use *TableSort*, an instance of the class is first created, then properties are set to specify the data and the sort options, and finally a method is executed to perform the sort. Once this is done, you can open a cursor or retrieve a sorted list of row IDs.

ITableSort : IUnknown	*Table Sorting Object.*
Ascending (in Field: String) : Boolean	*Field sort order.*
CaseSensitive (in Field: String) : Boolean	*Character fields case sensitive. Default: False.*
Compare: ITableSortCallBack	*Compare call back interface. Specify Null (default) for normal behavior.*
Cursor: ICursor	*The cursor of the data to sort on. Ensure that sorting fields are available. Cancels SelectionSet.*
Fields: String	*Comma list of field names to sort on.*
IDByIndex (in Index: Long) : Long	*Get an ID by its index value.*
IDs: IEnumIDs	*List of sorted IDs.*
QueryFilter: IQueryFilter	*Set query filter on table or selection set.*
Rows: ICursor	*Cursor of sorted rows.*
SelectionSet: ISelectionSet	*The selection set as a source of the data to sort on. Cancels Cursor.*
SortCharacters (in Field: String) : Long	*Number of characters to sort on, for string fields. A null (default) sorts on the whole string.*
Table: ITable	*The table as a source of the data to sort on.*
Sort (in pTrackCancel: ITrackCancel)	*Sort rows.*

The *ITableSort* interface allows you to set properties, perform the sort, and retrieve the data in sorted order.

The *Fields* and *Table* properties must always be set, but the rest are optional.

The *Fields* property is a comma-delimited list of the fields to be sorted. When the sort method is called, the first field is sorted, then the second field, and so on. The *Table* property specifies the table or object class on which the sort is to be performed. Alternatively, the *Cursor* property may be used to indicate the data to be sorted. If you use the *Cursor* property, you must also set the *Table* property to the table referenced by the cursor.

The *Ascending, CaseSensitive, Compare, QueryFilter, SelectionSet,* and *SortCharacters* properties may also be used to further define how the data is to be sorted.

Once the desired sorting properties have been set, the sort method must be called to order the rows. Either the *Rows* property or the *IDs* property can then be used to access the data in sorted order. The following example shows how to perform a sort on a *Table* from a personal geodatabase.

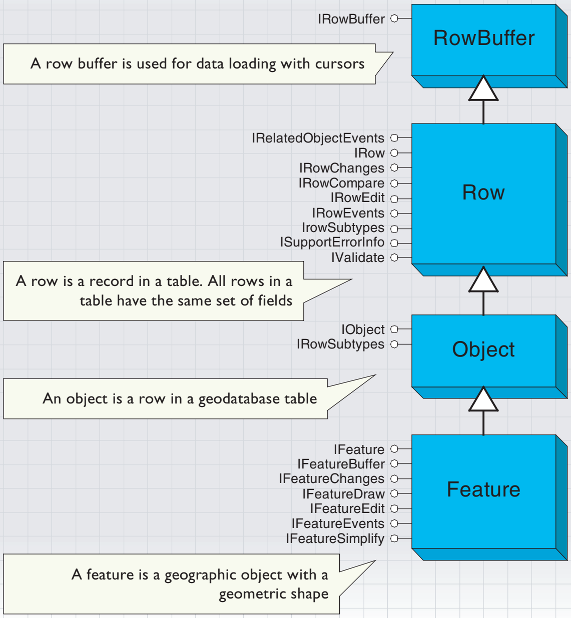
```
Dim pTableSort As ITableSort
Set pTableSort = New esriCore.TableSort

Dim pQueryFilter As IQueryFilter
Set pQueryFilter = New QueryFilter
pQueryFilter.WhereClause = "[LAST_NAME] like 'A*'"
```

```
With pTableSort
  .Fields = "last_name, first_name"
  .Ascending("last_name") = False
  .Ascending("first_name ") = True
  .CaseSensitive("last_name") = True
  .CaseSensitive("first_name ") = True
  Set .QueryFilter = pQueryFilter
  Set .Table = pTable
End With

pTableSort.sort Nothing

Dim pCursor As ICursor
Set pCursor = pTableSort.Rows

Dim pRow As IRow
Set pRow = pCursor.NextRow

Do While Not pRow Is Nothing
  Debug.Print pRow.Value(2) & ",  " & pRow.Value(1)
  Set pRow = pCursor.NextRow
Loop
```

Using customization, you can sort objects on any criteria.

A custom class that implements *ITableSortCallBack* can be used to apply a user-defined sorting algorithm instead of the default. The *Compare* property gives the *TableSort* object access to an instance of this custom class.

Row, object, and feature objects

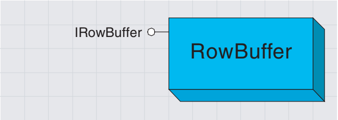


A row buffer is used for data loading with cursors

A row is a record in a table. All rows in a table have the same set of fields

An object is a row in a geodatabase table

A feature is a geographic object with a geometric shape



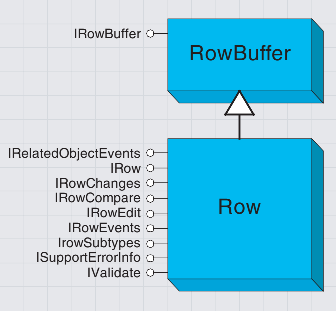
A row buffer is an object that is capable of holding the state of a row. Row buffers are used primarily during data loading.

A *RowBuffer* is a transient object that is capable of holding the state of a row but has no object identity. It is used primarily during data loading as the argument to the *InsertRow* method on an insert cursor. A *RowBuffer* is obtained from a *Table* using the *CreateRowBuffer* method.

IRowBuffer : IUnknown	***Row Buffer Interface.***
▪— Fields: IFields	*The Fields collection for this row buffer.*
▪—▪ Value (in Index: Long) : Variant	*Return the value of the field with the specified index.*

The *IRowBuffer* interface contains methods to access the state (the set of field values) for a row buffer. These methods take as an argument the numeric index of the field to be accessed.

Row class



The row object represents a persistent row in a table that is being made available to application programs as a software object that can be manipulated.

A *Row* object is an instantiated software object that represents a persistent row in a *Table*. A row object is normally obtained from a cursor on a table (for example, *ICursor::NextRow*) or fetched directly given its object ID (for example, *ITable::GetRow*).

Once retrieved, clients may query the row object for additional interfaces and invoke methods on the row object. The *CLSID* property of a *Table* determines the type of row object returned by the *Table*.

A new persistent row object is created using the *ITable::CreateRow* method. The act of creating the row assigns it identity. Note that applications should use the *CreateRow* method to create new persistent row objects, as opposed to directly cocreating the row objects. The latter will not create a row in the underlying persistent store.

A *Row* has a set of *Fields*. The set of *Fields* for a *Row* is the same as the set of *Fields* for its *Table*. In particular, the numeric index of a field in the *Fields* collection of its table is the same as the numeric index of the field in the *Fields* collection of the row, which is the same as the numeric index used to access the value of the field from the row. This means that application programs can and should cache field numeric indexes using the *FindField* method on the *Table* object, rather than invoking the *FindField* method once per row returned by a *Cursor*.

IRow : IRowBuffer	***Row Interface.***
HasOID: Boolean	*True if the row has an OID.*
OID: Long	*The OID for the row.*
Table: ITable	*The table for the row.*
Delete	*Deletes the row.*
Store	*Stores the row.*

The *IRow* interface inherits from *IRowBuffer* and includes methods to get and set the values for the *Fields* in the *Row*, given the numeric index of the *Field* for the *Row,* which is the same as the numeric index of the *Field* in the *Table* for the *Row* (see note above).

The *OID* property returns the unique object identifier for the *Row* that distinguishes it from other rows in the *Table*. If the *HasOID* property returns *False*, then this row was returned from a *Table* that lacked a geodatabase-managed *OIDField*.

The *Store* method is called by an application once it has modified the values of a *Row*. Calling the *Store* method triggers the following actions:

1. The *IRowEvents::OnChanged* method is called for the *Row* being stored (the *OnNew* method is called if this is a newly created row being stored for the first time). A custom row object can implement the *IRowEvents::OnChanged* method and take some special action when it is called—for example, update a special column in the row.
2. The *IRelatedObjectEvents::RelatedObjectChanged* method is called for related objects in a related object class if the table for this row is an object class that participates in relationship classes with notification.

Once *Store* is called on a *Row* object, all subsequent queries against the *Table* within the same edit session using the geodatabase API will reflect the modified state of the row object.

Calling IRow::Delete *will also delete any relationships the row has.*

The *Delete* method is called by an application to delete a row object from the database. Calling the *Delete* method triggers the following actions:

1. The *IRowEvents::OnDelete* method is called for the *Row* being deleted. A custom row object can implement the *IRowEvents::OnDelete* method and take some special action when it is called.
2. All relationships in which the row object participates are automatically deleted.

Once *Delete* is called on a *Row* object, all subsequent queries against the *Table* within the same edit session using the geodatabase API will reflect the deleted state of the row object.

The changes made to a row object using the *Store* and *Delete* methods will be committed to persistent store if the containing edit session is saved and no conflicts are detected. If the changes were made outside of an edit session, then the application program is responsible for directly managing underlying database transactions using the *ITransactions* interface on the *Workspace*.

This example shows the creation of a row, then an update, followed by the deletion of the row.

```
Dim pRow As IRow
Dim i As Long
i = pTable.FindField("Name")

' Insert Row
Set pRow = pTable.CreateRow
pRow.Value(i) = "Exploits"
pRow.Store

' Update Row
pRow.Value(i) = "Badger"
pRow.Store

' Delete Row
pRow.Delete
```

IRowEdit *contains additional methods to edit row objects.The* IRowEdit *interface contains additional methods to edit row objects.*

IRowEdit : IUnknown	***Implement this interface to customize object editing.***
← DeleteSet (in Rows: ISet)	*Deletes the set of rows.*

The *DeleteSet* method can be used to delete a set of rows from a *Table*. The application program is responsible for collecting the set of row objects to be deleted into a *Set* object. A single member of the set is then arbitrarily picked and the *DeleteSet* method is invoked on the picked row, passing the entire set (including the picked row) as argument.

It is more efficient to call this method once rather than calling the *Delete* method multiple times when the deleted row objects participate in relationships that need to be automatically deleted.

Use IRowEvents *to implement custom row objects.*

IRowEvents : IUnknown	***Row Events.***
← OnChanged	*An after event that is fired when a custom object is changed.*
← OnDelete	*An after event that is fired when a custom object is deleted.*
← OnInitialize	*An after event that is fired when a custom object is initialized.*
← OnNew	*An after event that is fired when a custom object is stored for the first time.*
← OnValidate	*An after event that is fired when a custom object is validated.*

The *IRowEvents* interface allows implementers of custom row objects to take special action in response to changes made to the state of a row object. The geodatabase calls the methods in the *IRowEvents* interface as changes are made to the state of a row object (see the description of the *IRow::Store* and *IRow::Delete* methods above).

The *OnChanged* method is called by the geodatabase when an application program calls *Store* on an existing *Row* object.

The *OnNew* method is called by the geodatabase when an application program calls *Store* on a newly created *Row* object.

The *OnDelete* method is called by the geodatabase when an application program calls *Delete* on a *Row* object. In the case of network features, the *OnDelete* method is called after any necessary connectivity updates have been made. (For example, deleting a junction deletes the edge features for which it serves as an endpoint junction.) Thus, it is not possible, from within *OnDelete,* to navigate to other network features that were connected prior to the initial *Delete* operation being called.

The *OnInitialize* method is called by the geodatabase after hydrating a cocreated *Row* object with its state (its set of field values) but before handing the *Row* to an application program. This is an opportunity for the *Row* object to initialize further state and derived member variables.

The *OnValidate* method is unused (deprecated).

IRowChanges *lets you read the field values as they were after the previous call to* Store*.*

IRowChanges : IUnknown	***Row Changes.***
■— OriginalValue (in Index: Long) : Variant	
■— ValueChanged (in Index: Long) : Boolean	

The *IRowChanges* interface allows clients of a row object to determine the values that were changed for the row object within a *Store* cycle. Once the *Store* method call returns to the calling application program, the information regarding the values that were changed is cleared and is no longer available. A custom object in its *OnChanged* or *OnNew* implementation and a related object in its implementation of the *RelatedObjectChanged* method may make use of this information.

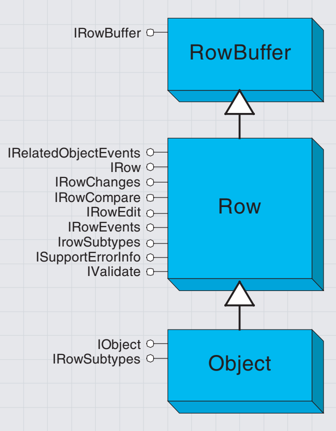
The *ValueChanged* method returns *True* if the value for the specified field was changed since the last call to *Store* on the row object.

The *OriginalValue* method returns the value for the specified field as it existed prior to the first update made to the row object since the last call to *Store* on the row object.

IValidate *tests a row against its geodatabase rules. See the section on domains and validation rules later in this chapter.*

IValidate : IUnknown	***Provides access to members to validate individual features.***
← GetInvalidFields: IFields	*Returns all invalid fields.*
← GetInvalidRules: IEnumRule	*The set of all invalid rules.*
← GetInvalidRulesByField (in FieldName: String) : IEnumRule	*The set of all invalid rules for the specified field.*
← Validate (out errorMessage: String) : Boolean	*Validates the row.*

The *IValidate* interface is used to test a row against the geodatabase rules defined for its object class. While the *IValidation* interface will validate a whole set of rows at once, *IValidate* operates on just one row; this can be useful if you want to validate the row immediately. *IValidate* also offers more detailed information on the failures; the *Validate* method returns an error message; and the other methods help identify what is wrong.



An object is an instance of an object class and represents an entity.

An *ObjectClass* is a *Table* whose *Row* objects represent entities. The *Row* objects handed out by an *ObjectClass* support the *IRow* and the *IObject* interface and are referred to as *Object* objects or simply as Objects. An alternative name for *Object* object in this context is Entity object.

IObject : IRow	*Object Interface.*
Class: IObjectClass	*The object class for the row.*

The *IObject* interface is almost identical to *IRow*, from which it inherits. The only additional property is a direct link to the object class. For information on how to use this interface, see the discussion for *IRow*.

IRowSubtypes : IUnknown	*Row Subtypes Interface.*
SubtypeCode: Long	*The subtype for the row.*
InitDefaultValues	*The default values of the row.*

The instances of an *ObjectClass* may be partitioned into a number of subtypes. The *IRowSubtypes* interface on an *Object* contains methods that allow determination and modification of the *Subtype* to which an *Object* belongs and allow initialization or resetting of the field values of an *Object* to the default values defined for its subtype. For a description of how these default values are set up during data definition, see the *ISubtypes* interface on *ObjectClass*.

It is important to note that when *Objects* are programmatically created via the *CreateRow* method on the *ITable* interface (or for features with the *CreateFeature* method on the *IFeatureClass* interface), the default subtype is not automatically set, nor are the default values initialized. When using ArcMap, these tasks are automatically performed. However, if you are programmatically creating an *Object* (or Feature) that has default values, the following VBA code fragment indicates the proper sequence that should be followed.

```
'Assume that we have an IFeatureClass pointer
Dim pFeature As IFeature
Set pFeature = pFeatureClass.CreateFeature

'Get the default subtype code for the feature class
Dim defaultSubtype As Long, pSubtypes As ISubtypes
Set pSubtypes = pFeatureClass
defaultSubtype = pSubtypes.DefaultSubtypeCode

'Set the subtype and initialize the default values for the feature
Dim pRowSubtypes As IRowSubtypes
Set pRowSubtypes = pFeature
pRowSubtypes.SubtypeCode = defaultSubtype
pRowSubtypes.InitDefaultValues
```

IRelatedObjectEvents *is relevant only to developers of custom objects and features.*

IRelatedObjectEvents : IUnknown	*Provides access to events that occur when related objects change, move, or rotate.*
← RelatedObjectChanged (in RelationshipClass: IRelationshipClass, in objectThatChanged: IObject)	*Notifies this object that a related object changed.*
← RelatedObjectMoved (in RelationshipClass: IRelationshipClass, in objectThatChanged: IObject, in MoveVector: ILine)	*Notifies this object that a related object moved.*
← RelatedObjectRotated (in RelationshipClass: IRelationshipClass, in objectThatChanged: IObject, Origin: IPoint, Angle: Double)	*Notifies this object that a related object rotated.*
← RelatedObjectSetMoved (in RelationshipClass: IRelationshipClass, in objectsThatNeedToChange: ISet, in objectsThatChanged: ISet, MoveVector: ILine)	*Notifies this object that a set of objects with relationships to the input set of objects moved.*
← RelatedObjectSetRotated (in RelationshipClass: IRelationshipClass, in objectsThatNeedToChange: ISet, in objectsThatChanged: ISet, Origin: IPoint, Angle: Double)	*Notifies this object that a set of objects with relationships to the input set of objects rotated.*

The *IRelatedObjectEvents* interface is relevant only to developers of custom objects and features. It is similar to *IRowEvents* except that the methods are called by the geodatabase in response to events on a related object.

A custom object can implement this interface in order to respond to these events, for example, if a change in the attribute of a related object needs to trigger a change in the attributes of this object.

The *RelatedObjectChanged* method is called when a related object has changed.

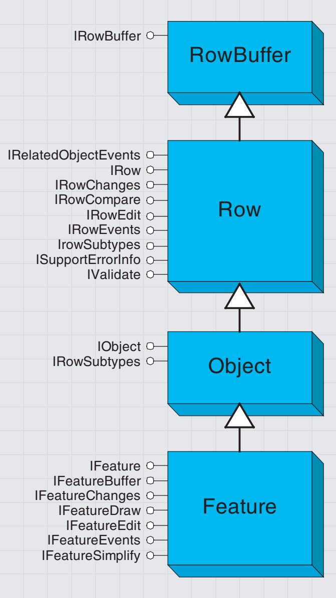
The *RelatedObjectMoved* method is called when a related object has moved.

The *RelatedObjectRotated* method is called when a related object has rotated.

The *RelatedObjectSetMoved* method is called when a set of objects in the related object class has moved. The *objectsThatChanged* argument represents the set of objects in the related object classes that have moved. The *objectsThatNeedToChange* argument represents the set of objects in the object class of this object that are related to the objects that moved. This object is itself a member of the *objectsThatNeedToChange*.

The *RelatedObjectSetRotated* method is called when a set of objects in the related object class has moved. Its arguments are similar to the arguments for *RelatedObjectSetMoved*.

A custom object developer wishing to respond to related object events must implement all the methods in this interface. When any method in this interface is invoked, the custom object receiving the message can determine what it was about the related object that changed using the *IRowChanges* and the *IFeatureChanges* interfaces on the related object. Note that in the case of the *RelatedObjectChanged* message, any of the field values of the related object might have changed, including the value of the shape field.



A feature is an object with a geometric shape.

A *Feature* is a spatial *Object*. It is also a member of a feature class, being a row in the feature class table. A feature has an associated shape, the type of which is defined by the feature class. The possible shape objects are *Point, Multipoint, Polyline,* and *Polygon*—these are all objects in the Geometry object model. For more details, see the discussion on the *GeometryDef* object.

Mostly you will deal with simple features, but there are various special kinds as defined by the *esriFeatureType* enumeration. These include annotation, dimension, and various network features.

Enumeration esriFeatureType	***Feature Types.***
1 - esriFTSimple	*Simple Feature.*
7 - esriFTSimpleJunction	*Simple Junction Feature.*
8 - esriFTSimpleEdge	*Simple Edge Feature.*
9 - esriFTComplexJunction	*Complex Junction Feature.*
10 - esriFTComplexEdge	*Complex Edge Feature.*
11 - esriFTAnnotation	*Annotation Feature.*
12 - esriFTCoverageAnnotation	*Coverage Annotation Feature.*
13 - esriFTDimension	*Dimension Feature.*

Using C++, you can also define your own custom features with specialized behavior. One thing to note is that all features still have the same core geometry types of point, multipoint, line, and polygon; an example of this is the annotation feature, whose geometry type is polygon—this represents the envelope of the text element.

All the discussion for *Row* and *Object* is appropriate to *Feature* objects. In fact, because you will normally be dealing with geographic data, you will deal with features much more than simple rows.

IFeature : IObject	***Feature Interface.***
Extent: IEnvelope	*The extent of the feature.*
FeatureType: esriFeatureType	*The type of the feature.*
Shape: IGeometry	*Returns a reference to the default shape for the feature.*
ShapeCopy: IGeometry	*Returns a cloned copy of the default shape for the feature.*

The *IFeature* interface extends *IObject* and *IRow,* from which it inherits. The additional facilities are to do with the shape of the feature. You can use the *Shape* property to get or set the shape. This can be much more convenient than the alternative of using the *Value* property since you don't have to work out the index of the shape field.

The *Shape* property is the main link in ArcObjects between the geometry and geodatabase object models.

The *ShapeCopy* property is a cloned copy of the feature's *Shape*. It is commonly used when modifying the geometry of a set of features.

IFeatureBuffer : IRowBuffer	***Feature Buffer Interface.***
■–□ Shape: IGeometry	*The default shape in the feature buffer.*

The *IFeatureBuffer* interface is the same as *IRowBuffer* except it applies to feature buffers rather than row buffers. It is for use primarily with insert and update-feature cursors.

Use IFeatureDraw *to implement custom features with special display qualities.*

IFeatureDraw : IUnknown	***Interface for custom drawing by a feature.***
■–□ InvalidArea: IInvalidArea	*The area to be drawn.*
← Draw (in drawPhase: tagesriDrawPhase, in Display: IDisplay, in Symbol: ISymbol, in symbolInstalled: Boolean, in Geometry: IGeometry, in DrawStyle: esriDrawStyle)	*Draws the feature on the display.*

The *IFeatureDraw* interface is only relevant to custom features and so is currently limited to C++ programmers. You would implement *IFeatureDraw* in order to provide customised display for a feature, for example, displaying buildings as points when zoomed out to a small scale and as polygons at larger scales.

Use IFeatureEdit *to split features or to operate on sets of features.*

IFeatureEdit : IRowEdit	***Implement this interface to customize feature editing.***
← BeginMoveSet (in features: ISet, in Start: IPoint) : IDisplayFeedback	*Prepares the set of features for a move operation.*
← MoveSet (in features: ISet, in MoveVector: ILine)	*Moves the set of features through a distance and direction specified by moveVector.*
← RotateSet (in features: ISet, in Origin: IPoint, in Angle: Double)	*Rotates the set of features according to the specified origin and angle.*
← Split (in Point: IGeometry) : ISet	*Splits the feature.*
← SplitAttributes (baseFeature: IFeature)	*Splits the feature attributes.*

The *IFeatureEdit* interface offers specialized editing facilities on features.

The *MoveSet, RotateSet,* and *IRowEdit::DeleteSet* methods are unusual in that they are applied to a single feature, but they operate on a whole set. There is no need to call these methods for each separate feature in the set.

In the case of simple features, you need to call this method once for every feature class contained in the set. Thus, if the selection contains ten simple features, five from class A and five from class B, you will need to call this method on one member of the set from class A and on one member of the set from class B. When you call these methods on a feature, the method will be applied to all other features contained in the set that are also in the same feature class.

In the case of network features, it is only necessary to call these methods on one network feature found in a given geometric network. Thus, if all of the network features found in the set are contained in a single geometric network, you will only need to call these methods on one network feature. However, if there are two (or more) geometric networks represented in the network features contained in the set, then the call will need to be made two (or more) times—once for each geometric network.

In practice, it is actually quite simple to implement the appropriate calling behavior because the set that is passed as the first argument is winnowed (that is, features contained in the set that are processed are removed from the set), and the set is automatically reset. Thus, you can effectively *Next* through the set and achieve the proper behavior.

The following VBA code fragment illustrates this behavior.

```
'Assume p_Set (ISet) and pMoveVector (ILine) already exist.
Dim pUnknown As IUnknown, pFeatureEdit As IFeatureEdit
Set pUnknown = p_Set.Next

Do While Not pUnknown Is Nothing
  Set pFeatureEdit = pUnknown
  pFeatureEdit.MoveSet p_Set, pMoveVector

  Set pUnknown = p_Set.Next
Loop
```

When a feature is split, two new features are created. You can define a policy on how the attribute values of the new features are populated—this can be done with ArcCatalog or by using the domain and attribute rule objects.

Split and *SplitAttributes* operate on single features. *Split* divides polylines by points or polygons by polylines. Other kinds of split geometries are not currently supported. The new features are automatically stored and the old features deleted. *SplitAttributes* implements the split policy for attributes belonging to domains. It is not necessary to call *SplitAttributes* after using *Split*—this is done automatically.

Here is how you would split the selected polygon features by a polyline:

```
Public Sub SplitFeatures(pSelectionSet As ISelectionSet, _
                              pPolyLine As IPolyline)

  ' open a feature cursor on the selected features that
  ' intersect the splitting geometry
  Dim pFeatCursor As IFeatureCursor
  Dim pSpatialFilter As ISpatialFilter
  Set pSpatialFilter = New SpatialFilter
  Set pSpatialFilter.Geometry = pPolyLine
  pSelectionSet.Search pSpatialFilter, True, pFeatCursor

  ' Clean up the splitting geometry
  ' This is necessary because, for polygons, IFeatureEdit::Split
  ' relies internally on ITopologicalOperator::Cut
  Dim pTopoOpo As ITopologicalOperator
  Set pTopoOpo = pPolyLine
  pTopoOpo.Simplify

  ' Loop through the features and split them
  Dim pFeature As IFeature
  Set pFeature = pFeatCursor.NextFeature
  Do Until pFeature Is Nothing
    Dim pFeatureEdit As IFeatureEdit
    Set pFeatureEdit = pFeature
    pFeatureEdit.Split pPolyLine
    Set pFeature = pFeatCursor.NextFeature
  Loop
End Sub
```

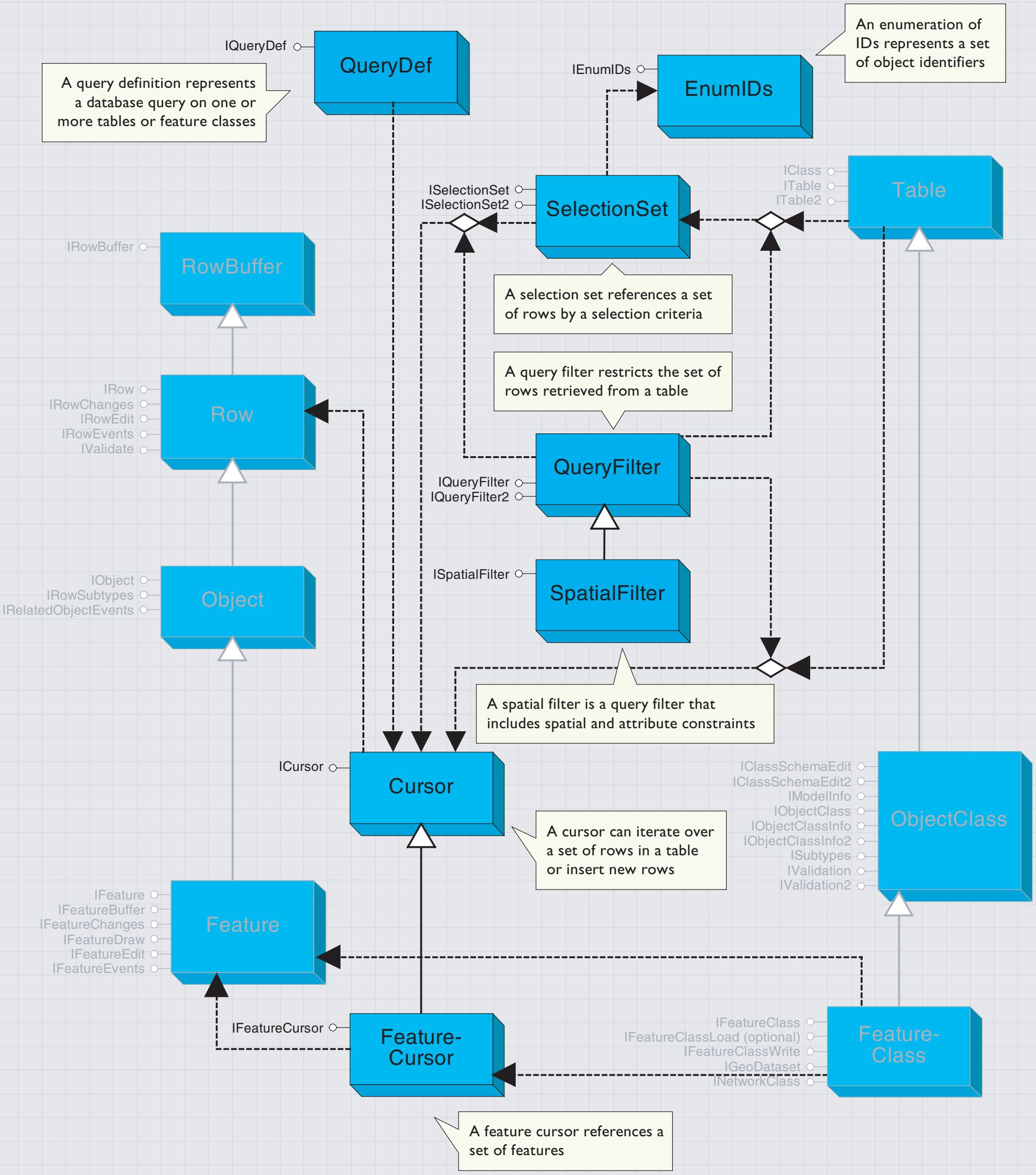
An equivalent method to *Split* for merging features is not currently available in ArcObjects; you have to program it the long way using *ITopologicalOperator::Union, IFeature::Delete,* and, if necessary, *IDomain::MergePolicy*.

Use IFeatureEvents *to implement custom features.*

IFeatureEvents : IUnknown	***Feature Events.***
← InitShape	*Initialize the shape.*
← OnMerge	*An after event that is fired when features have been merged, on each deleted input feature.*
← OnSplit	*An after event that is fired when a feature is split, on the deleted input feature.*

The *IFeatureEvents* interface is only relevant to custom features and so is currently limited to C++ programmers. For simple features, these methods are triggered by the geodatabase, but no action is taken. If you create a custom feature, you may choose to reimplement *IFeatureEvents* to achieve certain functionality. *IRowEvents* complements this interface.

Query, cursor, and selection objects



A query definition represents a database query on one or more tables or feature classes

An enumeration of IDs represents a set of object identifiers

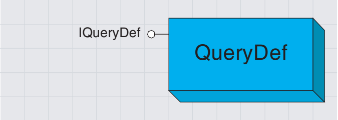
A selection set references a set of rows by a selection criteria

A query filter restricts the set of rows retrieved from a table

A spatial filter is a query filter that includes spatial and attribute constraints

A cursor can iterate over a set of rows in a table or insert new rows

A feature cursor references a set of features



A QueryDef *object represents a database query on one or more tables or feature classes.*

Since QueryDef *objects rely on SQL, they are not supported for shapefile and coverage data.*

A *QueryDef* object represents a database query on one or more tables or feature classes.

A *QueryDef* may be evaluated, resulting in the execution of the query on the database server. The results of the query are returned to the application as a cursor. The application can iterate over the cursor to fetch the row objects in the result set of the query. The row objects returned by a cursor on a *QueryDef* are always of type *esriCore.Row*—they never have custom behavior or support additional interfaces, even if the table names specified in the *QueryDef* correspond to tables representing *ObjectClasses* with behavior. The row objects returned by evaluating a *QueryDef* are read-only—these row objects do not reference a parent table, and the *Store* method may not be called on them. Attempting to *Store* a row object returned by evaluating a *QueryDef* will result in an error.

The ExecuteSQL *method available on the* IWorkspace *interface can be used to send an arbitrary SQL statement to the database server (for example, an INSERT or an UPDATE statement); however, unlike evaluation of* QueryDefs, *the* ExecuteSQL *method does not return a result set.*

The primary use of *QueryDefs* is to directly evaluate database queries on arbitrary tables. They can be used to join tables with the assurance that the join query will execute in the underlying RDBMS. All of the tables in a *QueryDef* must belong to the same workspace (RDBMS). A *QueryDef* may include geometry fields in the specification of the list of fields to be returned but may not include geometry fields in the where clause specification unless the underlying DBMS is a spatially extended DBMS that supports geometric types, and unless the geometry fields for feature classes are using those native DBMS geometry types for storage.

IQueryDef : IUnknown	***Defines an attribute based query.***
▪—▪ SubFields: String	*The comma-delimited list of field names for the query.*
▪—▪ Tables: String	*The comma-delimited list of table names for the query.*
▪—▪ WhereClause: String	*The where clause for the query.*
← Evaluate: ICursor	*Evaluate the query and return a cursor on the result set.*

The *IQueryDef* interface is used to set up and define the query and also provides an *Evaluate* method that is used to execute the query, returning a cursor.

This example shows how to create a *QueryDef* that defines a join between USA counties and states. A valid pointer to the workspace containing the data is assumed.

```
Dim pQueryDef As IQueryDef
Set pQueryDef = pFeatureWorkspace.CreateQueryDef
pQueryDef.Tables = "Counties, States"
pQueryDef.SubFields = "COUNTIES.Shape, COUNTIES.NAME, _
 STATES.STATE_ABBR"
pQueryDef.WhereClause = "COUNTIES.STATE_FIPS = STATES.STATE_FIPS"
```

Note that *QueryDef* objects cannot be cocreated. They can only be created from the *IFeatureWorkspace* interface. This guarantees that all tables in the query are within the same workspace.

The *SubFields* property is optional when creating *QueryDef* objects. The default value is "*", which means that all fields are returned.

The *OpenFeatureQuery* method on a workspace (available in the *IFeatureWorkspace* interface) can be used to create a *FeatureClass* that is based on a *QueryDef*. Such a feature class may be added to a *Map* (as a *FeatureLayer*) and may be used to visually represent the results of a database join query. Such a *FeatureClass* is similar in concept to an ArcSDE view.

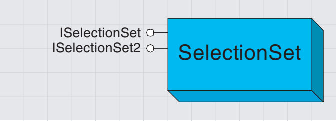
The following example adds a new layer to a map based on the *QueryDef* created in the previous example. The *IQueryDef::SubFields* property must define one and only one spatial field in order to create the feature class.

```
Dim pFeatureClass As IFeatureClass
Dim pFeatureClassContainer As IFeatureClassContainer
Set pFeatureClassContainer = pFeatureWorkspace.OpenFeatureQuery _
     ("My counties join", pQueryDef)
If (pFeatureClassContainer.ClassCount <> 1) Then
  MsgBox "Failed to create feature class by query"
Else
  Set pFeatureClass = pFeatureClassContainer.Class(0)
End If
' Add feature class as layer to the map
Dim pMap As IMap, pDoc As IMxDocument
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
Dim pFeatureLayer As IFeatureLayer
Set pFeatureLayer = New FeatureLayer
Set pFeatureLayer.FeatureClass = pFeatureClass
pFeatureLayer.Name = pFeatureClass.AliasName
pMap.AddLayer pFeatureLayer
```

The SQL syntax used with *QueryDef* objects is the same as that of the underlying database holding the data. An application can use the *ISqlSyntax* interface on a *Workspace* to determine information about the SQL syntax for the database, such as the delimiter character used in qualifying table and field names and the identifier quote character. Additional notes on SQL syntax may be found in the discussion on query filters later in this chapter.

QueryDefs represent a subset of the queries that may be made against an SQL database using the SQL SELECT statement. *QueryDefs* map onto simple SQL select statements of the form: SELECT <field names > FROM <list of table names> WHERE <where-clause referencing only tables in from list of tables>.

QueryDefs do not guarantee to support SQL statements that do not map onto the above simple form. In particular, *QueryDefs* do not guarantee to support ORDER BY and GROUP BY clauses embedded within the *WhereClause* property, nested SELECT statements or correlated subqueries in the *WhereClause* property, AS keywords embedded in the *SubFields* property, the use of table aliases in the *Tables* property, the use of Aggregate functions (for example, MIN, MAX, and SUM), or the use of DISTINCT clauses. Support for such capabilities is not guaranteed across all configurations, and applications that rely on such capabilities risk failure.



A selection set allows an application to reference a set of rows from a table or feature class that matches some application-specified criteria.

A *SelectionSet* object allows an application to reference a selected set of rows all belonging to a single table or feature class.

Selection sets are normally used throughout ArcObjects when a temporary subset of rows or features is required for some operation. It is important to note that the selection set only applies to a single table; you cannot sensibly combine two selection sets from different tables.

A selection set can be based on either a set of *ObjectIDs* that correspond to the selected rows, or on an actual set of row objects, instantiated and referenced by the selection set. In either case, the selection set provides methods to iterate over the set of row objects in the selection. The *SelectionType* property of a selection set, specified by an application at the time that it creates the selection set, determines the type of representation (object IDs or *Row* object references) used by the *SelectionSet*.

Enumeration esriSelectionType	***Selection Type.***
1 - esriSelectionTypeIDSet	*ID set.*
2 - esriSelectionTypeSnapshot	*Snapshot.*
3 - esriSelectionTypeHybrid	*Snapshot if small, else an ID set.*

A *SelectionSet* of type *esriSelectionTypeIDSet* represents the selection using a set of object IDs. The object IDs may be physically stored either in a separate database table or in memory (as a hash table or bitmap), depending on the type of data source.

A *SelectionSet* of type *esriSelectionTypeSnapshot* represents the selection as a set of instantiated *Row* objects in memory.

A *SelectionSet* of type *esriSelectionTypeHybrid* represents the selection as *Row* objects in memory for small selections and as a set of object IDs for large selections.

ID set selections are capable of representing very large selections and are usually the best choice for an application. The data source is requeried each time the selected rows are iterated over (using the *Search* method on the selection set). This ensures that the selection is dynamic and responds automatically to changes in the data made by this or other applications.

Snapshot selections are very fast to iterate over, as no further queries are issued against the data source once the selection is created. They can be memory intensive and should be used only for small sets of rows. The data in a snapshot selection is a snapshot of the rows in the database at the time the selection is created. The “unique instance semantics” guaranteed by the geodatabase during an edit session will ensure that snapshot selection sets instantiated after editing is begun will see any changes made to the row objects by any part of the application. The editing application is responsible for refreshing the selection (using the *Refresh* method on the selection) whenever it calls an Undo, Redo, or Abort edit operation during an edit session or whenever it calls the *RefreshVersion* method on a version outside an edit session.

Hybrid selections combine the benefits of snapshot and ID set selections and can be used if both cases are likely to occur. The *SelectionSet* internally switches between using a snapshot and ID set representation, depending on the size of the selection; the choice of size parameter is internal to the *SelectionSet* and cannot be controlled by the application.

A selection set is typically created from a table or feature class using the *Select* method on the table. A query filter is used to specify the subset of rows to include in the selection set:

```
Dim pSelectionSet As ISelectionSet
Set pSelectionSet = pFeatureClass.Select(pQueryFilter, _
  esriSelectionTypeHybrid, esriSelectionOptionNormal, Nothing)
```

The last parameter in the code sample is set to Nothing. *This parameter can be used to pass in an alternative workspace in which to store the ID set selection as a scratch table, but can usually be safely set to* Nothing *at the release of ArcGIS 8.1. The default for ID set selections on tables in a database workspace is to store them in a scratch table in the same database as the feature class or table being selected from. The default for ID set selections on tables in a file-based workspace is to store the selection sets in memory. In both cases, passing in* Nothing *for the last parameter suffices.*

An application can create multiple *SelectionSets* on a *Table* or *FeatureClass* coclass. The *SelectionSets* reference their target table, but the latter have no knowledge of the selection sets that reference them. Applications are responsible for associating the created selection sets with the target table as appropriate. For example, a *FeatureLayer* in ArcMap holds a reference to a geodatabase *FeatureClass* and also to a *SelectionSet* that it creates on the feature class—at draw time the selected features are retrieved and drawn in a distinguished manner.

ISelectionSet : IUnknown	***Manages a set of selected table rows or features.***
■— Count: Long	*The number of OIDs in the selection set.*
■— FullName: IName	*The full name of the selection set.*
■— IDs: IEnumIDs	*Enumerates the object IDs in the selection set.*
■— Target: ITable	*The Table or FeatureClass over which the selection set is defined.*
◄— Add (in OID: Long)	*Adds an object id to the selection set.*
◄— AddList (in Count: Long, in OIDList: Long)	*Adds a list of object id's to the selection set.*
◄— Combine (in otherSet: ISelectionSet, in setOp: esriSetOperation, out resultSet: ISelectionSet)	*Combines this selection set with another selection set using the specified set operation.*
◄— MakePermanent	*Makes the SelectionSet permanent. By default SelectionSets are deleted when released.*
◄— Refresh	*Refreshes the state of a snapshot selection.*
◄— RemoveList (in Count: Long, in OIDList: Long)	*Removes a list of object IDs from the selection set.*
◄— Search (in pQueryFilter: IQueryFilter, in Recycling: Boolean, out ppCursor: ICursor)	*Returns a cursor that can be used to retrieve the objects specified by a query over this selection set.*
◄— Select (in QueryFilter: IQueryFilter, in selType: esriSelectionType, in selOption: esriSelectionOption, in selectionContainer: IWorkspace) : ISelectionSet	*Returns a new selection that contains the object IDs selected by a query over this selection set.*

The *ISelectionSet* interface is used to manage and query the selection set.

The *Search* method is used to iterate over the rows in the selection set and returns a cursor. Note that the *Search* method takes a query filter that can be used to further restrict the set of rows in the selection that are returned for ID set selections. Using a query filter with hybrid selections will force the representation of the selection to become an ID set selection.

The *Select* method is used to create a new selection based on a subset of the current selection using a query filter to specify the restriction.

The *Add, AddList,* and *RemoveList* methods can be used to alter the selection set by adding and removing rows specified by object IDs.

SelectionSets are geodatabase data-access objects and are user-interface independent, but they are put to work within the context of the ArcMap object model. Use the IFeatureSelection::SelectionSet *method on a* FeatureLayer *to get or set the selection set associated with a* FeatureLayer. *Use the* ITableSelection::SelectionSet *to get or set the selection set associated with a* StandAloneTable *object. Note that a* StandAloneTable *is an ArcMap object similar to a* FeatureLayer *and references a [geodatabase]* Table *just as a* FeatureLayer *references a* FeatureClass.

The *Combine* method can be used to combine two *SelectionSets* using the standard set operations of union, intersection, difference, and symmetric difference. Only use *Combine* on two selection sets from the same target—it doesn't make sense to mix lists of IDs from different datasets.

The *MakePermanent* method and the *FullName* property are placeholders for a future release when persistent selection sets may be supported, but they are not currently implemented. An application wishing to persist a selection set should extract the set of object IDs for the rows in the selection set (reading the *IDs* property) and persist them.

ISelectionSet2 : IUnknown	***Manages a set of selected table rows or features***
← Update (in pQueryFilter: IQueryFilter, in Recycling: Boolean, out ppCursor: ICursor)	*Returns a cursor that can be used to update the objects specified by a query over this selection set*

The *ISelectionSet2* interface provides a method *Update* that creates an update cursor on the selection set; this can be used to update and delete rows from the table or feature class of the selection set. For more information about update cursors, see the section on cursor objects.

This example returns the average population of the selected features in a counties feature layer; it illustrates a transition from using ArcMap objects to using the geodatabase data-access objects.

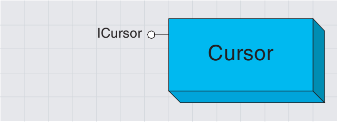
You don't have to use selection sets in order to select features in ArcMap. There are simpler ways, such as IFeatureSelection::SelectFeatures. *Selection sets are most useful when operating on already selected features or when working completely independently of the ArcMap selection.*

```
Dim pFeatureSelection As IFeatureSelection
Set pFeatureSelection = pFeatureLayer

Dim pSelectionSet As ISelectionSet
Set pSelectionSet = pFeatureSelection.SelectionSet

Dim pFeatureCursor As IFeatureCursor
pSelectionSet.Search Nothing, True, pFeatureCursor

Dim pDataStats As IDataStatistics
Set pDataStats = New DataStatistics
Set pDataStats.Cursor = pFeatureCursor
pDataStats.Field = "POP1990"
MsgBox pDataStats.Statistics.Mean
```

As described in this section, the main interface for geodatabase selection sets is *ISelectionSet*. There are, however, some other similarly named interfaces in ArcObjects—the following table summarizes these other interfaces.

ArcObjects has many interfaces with "selection" in their name. Only some of them are related to selection sets.

Interface	Relation to SelectionSet	Notes
ISelection	None	Provides clipboard facilities, for example, cut and paste of features.
IFeatureSelection	Can return or take *SelectionSet*	Controls selection on an ArcMap feature layer.
ITableSelection	Can return or take *SelectionSet*	Controls selection on an ArcMap table.
ISelectFeaturesOperation	Takes *SelectionSet* as input	Makes a selection with Undo/Redo facilities.
ISelectionEnvironment	None	Defines tolerances and other parameters for selecting objects with ArcMap.
ISelectionSetBarriers	None	Defines a set of barrier features in network solving.
ISelectionTracker	None	Manages selection handle tracking for graphic elements.

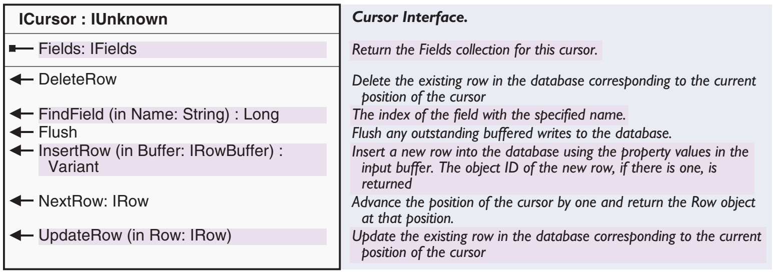


A cursor is a data-access object that can be used to either iterate over the set of rows in a table or query, or insert new rows into a table.

A *Cursor* is a data-access object that can either be used to iterate over the set of rows in a table or query or insert new rows into a table.

There are three forms of *Cursor*, referred to as search, insert, and update cursors. Each of these types of cursors is returned by the corresponding method (*Search, Insert,* or *Update*) on a *Table* or *FeatureClass* object. The *Search* and *Update* methods take a *QueryFilter* as input, which can be used to restrict the set of rows returned.

A *Search* cursor can be used to retrieve rows specified by a query filter; it supports a *NextRow* method. An *Update* cursor can be used to positionally update and delete rows specified by a query filter; it supports the *NextRow, UpdateRow,* and *DeleteRow* method. An *Insert* cursor is used to insert rows into a table and supports the *InsertRow* method. All of these methods are available in the single *ICursor* interface—it is your responsibility to make the calls appropriate to the type of cursor.



ICursor : IUnknown	***Cursor Interface.***
Fields: IFields	*Return the Fields collection for this cursor.*
DeleteRow	*Delete the existing row in the database corresponding to the current position of the cursor*
FindField (in Name: String) : Long	*The index of the field with the specified name.*
Flush	*Flush any outstanding buffered writes to the database.*
InsertRow (in Buffer: IRowBuffer) : Variant	*Insert a new row into the database using the property values in the input buffer. The object ID of the new row, if there is one, is returned*
NextRow: IRow	*Advance the position of the cursor by one and return the Row object at that position.*
UpdateRow (in Row: IRow)	*Update the existing row in the database corresponding to the current position of the cursor*

For more information on rules for programming against the geodatabase, see the database considerations topic in Volume 1, Chapter 2, 'Developing with ArcObjects'.

The type of row objects returned by a cursor (the interfaces and methods supported by the row object) depends on the type of *Table* (*ObjectClass, FeatureClass,* or *AttributedRelationship* class) and its associated behavior. Search cursors returned by evaluating a *QueryDef* always return simple row objects.

The *NextRow* method on a search or update cursor returns the next row in the result set to the application. The row object returned is allocated and hydrated by the cursor, and a reference to it is handed to the application. To retrieve all rows in a result set containing N rows, the application must make N calls to *NextRow*. In VB, a call to *NextRow* after the last row in the result set has been retrieved returns *Nothing*. In C++, a call to *NextRow* after the last row in the result set has been retrieved returns a value of *S_FALSE* and sets the output row reference to 0.

Cursors are forward only; they do not support backing up and retrieving rows that have already been retrieved or making multiple passes over data. If an application needs to make multiple passes over the data, the application needs to reexecute the query that returned the cursor. If both executions of the query are made within the same edit session (or database transaction with the appropriate level of isolation), the application is guaranteed not to see any changes made to the data by other concurrently executing applications.

This example shows a very simple cursor operation. It prints out the value of the first field for each row in a table.

```
Dim pCursor As ICursor
Dim pRow As IRow
Set pCursor = pTable.Search(Nothing, False)
Set pRow = pCursor.NextRow
Do Until pRow Is Nothing
  Debug.Print pRow.Value(0)
  Set pRow = pCursor.NextRow
Loop
```

Note that no data is fetched from the database until the *NextRow* method is called.

When you are using a cursor and changing the underlying data at the same time, you may be concerned about the cursor operation and positioning. The situation, summarized by the table below, is actually quite simple.

Cursor type	Method	Effect on position
Search	*NextRow*	Advances position by one
	ITable::CreateRow followed by *IRow::Store*	No effect (the new row does not belong to the cursor)
	Change values, followed by *IRow::Store*	No effect
	IRow::Delete	Moves position back by one
Insert	*InsertRow*	Not applicable—insert cursors do not have position, you may not use *NextRow*
Update	*NextRow*	Advances position by one
	UpdateRow	No effect
	DeleteRow	Moves position back by one

Cursors are of either the recycling or nonrecycling kind. Recycling cursors offer performance advantages, but should only be used for reading data, not for writing.

A *Cursor* has a recycling property that controls how it allocates row objects. Recycling cursors allocate a single row object and rehydrate it on each fetch. They can be used to optimize read-only access, for example, when drawing. It is illegal to maintain a reference on a row object returned by a recycling cursor across multiple calls to *NextRow* on the cursor. Row objects returned by a recycling cursor should not be modified. Nonrecycling cursors return a separate row object on each fetch. The objects returned by a nonrecycling cursor may be modified (setting the *IRow::Value* property or any other custom accessor supported by the *Row*) and stored with polymorphic behavior. The geodatabase guarantees “unique instance semantics” on nonrecycling row objects fetched during an edit session. If the row object to be retrieved by a call to *NextRow* has already been instantiated in the calling application, then a reference to the existing row object will be returned.

Rows always have the same set of fields as the table. If the query filter specifies subfields, then the other fields in the row will have values of VT_EMPTY.

All *Row* objects retrieved from a *Table* using a *Cursor* logically contain the same ordered set of fields, and this set is the same as the ordered set of fields for the *Cursor* and the *Table*. In particular, the numeric index of a field in the *Fields* collection of the table is the same as the numeric index of the field in the *Fields* collection of the cursor, which is the same as the numeric index of the field for the row. So, the *FindField* method needs to be used only once per table or cursor. If the query filter used in generating a cursor does not include certain fields, then the resulting row objects will still logically contain these fields; however, they will not have hydrated values for these fields. If an application accesses these field values for the row, a variant of type empty (*VT_EMPTY*) will be returned. Note that this value is different from the *Null* value (*VT_NULL*) that is returned when the value of a fetched field is null.

The UpdateRow *and* DeleteRow *methods are only used with update cursors.*

The *UpdateRow* method can be used to update the row at the current position of an update cursor (making a call to *NextRow* on a cursor returns a *Row* and positions the cursor on that *Row*). After fetching a *Row* object using *NextRow*, the application can modify the *Row* as needed and then call *UpdateRow*, passing in the modified *Row*. This is an alternative to calling *Store* on the retrieved row. Using a recycling update cursor can be faster than calling *Store* on the rows returned by a search cursor when performing direct updates outside an edit session on simple data. If the row objects for the table are not simple (they don't have custom behavior or participate in composite relationships or relationships with notification), then calling *UpdateRow* on the cursor will generate a call to *Store* on the row object to trigger the custom behavior, and there will be no performance gain.

The *DeleteRow* method can be used to delete the row at the current position of an *Update* cursor (that is, to delete the *Row* returned by the last call to *NextRow* on this cursor). After fetching the *Row* object using *NextRow*, the application should call *DeleteRow* on the cursor to delete the row. The application is responsible for discarding the husk deleted row object. Using a recycling update cursor to delete rows can be faster then calling *Delete* on the rows returned by a *Search* cursor when performing direct updates outside an edit session on simple data. If the row objects for the table are not simple (they don't have custom behavior) or participate in composite relationships or relationships with notification, then *DeleteRow* on the cursor will generate a call to *Delete* on the row object in order to trigger custom behavior, and there will be no performance gain.

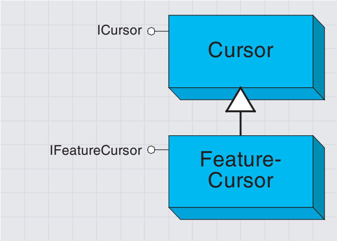
Insert cursors are used to bulk insert rows. Using an insert cursor offers significantly faster performance for data loading into simple tables and feature classes (tables whose *CLSID* is *esriCore.Row, esricore.Object,* or *esricore.Feature*) than the alternative: making multiple calls to *CreateRow* on the table followed by calling *Store* on the created row.

Insert cursors can be used for fast data loading.

Insert cursors on tables that contain custom rows and objects internally use the *CreateRow* and *Store* methods to achieve polymorphism, and there is no difference in performance in these cases. The *InsertRow* method takes a *RowBuffer* as an argument.

Applications obtain a *RowBuffer* using the *CreateRowBuffer* method on the *Table* object into which rows are to be inserted. Each call to *InsertRow* on the cursor creates a new row in the database whose initial values are set to the values in the input row buffer. The object ID for the created row is returned by the *InsertRow* method.

The *UseBuffering* method argument to the *Insert* method on a table returns an insert cursor that buffers rows on the clients and sends them to the server in batches for increased performance. The application is responsible for calling *Flush* on the insert cursor after all rows have been inserted. If a call to *Flush* is not made, the cursor will flush its buffers on destruction (when the application releases all references on the cursor). However, relying on the destructor to flush the insert cursor does not give the application the chance to detect errors that may arise on the call to flush (for example, if the tablespace [disk] for the *Table* in the underlying database fills up).



A feature cursor is a cursor that references features.

The *FeatureCursor* object is a kind of *Cursor* object. It performs in the same way, except it is based on a feature class rather than a generic table.

IFeatureCursor : IUnknown	*Feature Cursor Interface.*
Fields: IFields	*Return the Fields collection for this cursor.*
DeleteFeature	*Delete the existing Feature in the database corresponding to the current position of the cursor*
FindField (in Name: String) : Long	*The index of the field with the specified name.*
Flush	*Flush any outstanding buffered writes to the database.*
InsertFeature (in Buffer: IFeatureBuffer) : Variant	*Insert a new Feature into the database using the property values in the input buffer. The ID of the new Feature is returned*
NextFeature: IFeature	*Advance the position of the cursor by one and return the Feature object at that position.*
UpdateFeature (in Object: IFeature)	*Update the existing Feature in the database corresponding to the current position of the cursor*

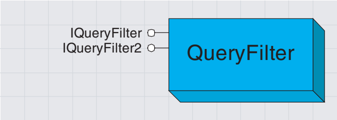
The *IFeatureCursor* interface provides access to a set of features in a feature class. It operates in the same way as *ICursor*, although it does not inherit from that interface. This saves you from having to use *QueryInterface* when dealing with features rather than rows.

Feature cursors can be used as an input to *IFeatureCursorBuffer*, which lets you spatially buffer the features by a distance. Don't confuse this interface with *IFeatureBuffer*, which applies to data buffers used with insert and update feature cursors. You can draw the features from a cursor on the display. For more information, see the *IFeatureRenderer::Draw* method.

ICursor	⟷	IFeatureCursor
ITable	⟷	IFeatureClass
IRow	⟷	IFeature
IRowBuffer	⟷	IFeatureBuffer

All the discussion for Cursor *objects is appropriate to feature cursors—there is a direct correspondence between the methods on the various interfaces.*

QueryFilter coclass



A query filter specifies a filter for tabular data based on attribute values.

A *QueryFilter* object specifies a filter for tabular data based on attribute values. It is used to restrict the set of rows or the set of columns retrieved from a single table or feature class. The primary use of a query filter is to specify the set of rows to be returned when opening a cursor on a *Table*. It is also used in a number of other cases where a subset of the data in a table needs to be specified.

Some scenarios of using a *QueryFilter* include opening a cursor on some of the rows in a table, selecting features in ArcMap, deleting some features meeting certain criteria, counting the number of features satisfying a condition, and defining which features will be rendered on the map.

IQueryFilter : IUnknown	*Filters data based on attribute values and or relationships.*
OutputSpatialReference (in FieldName: String) : ISpatialReference	*Gets the spatial reference in which to output geometry for a given field.*
SubFields: String	*The comma-delimited list of field names for the filter.*
WhereClause: String	*The where clause for the filter.*
AddField (in subField: String)	*Appends a single field name to the list of subfields.*

The *IQueryFilter* interface is used to define a filter to make a subset of tabular data. *AddField* and *SubFields* control which columns will belong to the resulting subset. *WhereClause* controls which rows or features will be returned.

If the desired fields specified in the *SubFields* property include a *Geometry Field*, then the *OutputSpatialReference* property can be used to specify the *SpatialReference* in which the geometries for that field should be returned. The *FieldName* argument should be set to the name of the *Geometry Field*. If no output spatial reference is specified, then the geometries for features are returned in the native spatial reference.

The example below shows how to select features for the State of California. This code will work on any feature layer with a STATE_NAME attribute—*QueryFilters* are not specific to any particular dataset.

```
Dim pQueryFilter As IQueryFilter
Set pQueryFilter = New QueryFilter
pQueryFilter.WhereClause = "STATE_NAME = 'California'"
Dim pFeatureSelection As IFeatureSelection
Set pFeatureSelection = pFeatureLayer
pFeatureSelection.SelectFeatures pQueryFilter, _
  esriSelectionResultNew, False
```

There is no need to specify a *WhereClause* if you just want to filter the fields of data. You can also normally use the VB keyword “Nothing” in place of a *QueryFilter* for those methods that require one—for example, to count the features in a feature class.

```
MsgBox "num features:" & pFeatureClass.FeatureCount(Nothing)
```

You can use the *SubFields* property to improve performance when using query filters. The performance gain comes from just fetching the field values that you require rather than all the data for each row. The default value for *SubFields* is “*”, which indicates that all field values will be returned. It isn’t necessary to set the subfields when the query filter is used in a context in which no attribute values are fetched, for example, when selecting features.

Not all SQL SELECT statements can be made into query filters.

A *QueryFilter* has properties named *SubFields* and *WhereClause* and represents a subset of the single table queries that may be made against a table in a SQL database using the SQL SELECT statement. *QueryFilters* map on to simple SQL select statements of the form SELECT <field names > FROM <table name> WHERE <where-clause that references only table name>.

Query filters are supported across all the workspace types, including shapefiles and coverages. Use the ISqlSyntax interface to make generic code.

QueryFilters do not support ORDER BY or GROUP BY clauses embedded within the *WhereClause* property, nested SELECT statements or correlated subqueries in the *WhereClause* property, AS keywords embedded in the *SubFields* property, Aggregate functions (for example, MIN, MAX, SUM), or DISTINCT clauses.

The SQL syntax used to specify the *WhereClause* of *QueryFilter* objects is the same as that of the underlying database holding the data. An application can use the *ISqlSyntax* interface on a *Workspace* to determine information about the SQL syntax used, such as the delimiter character used in qualifying table and field names and the identifier quote character. This information is available for the different types of workspaces (ArcSDE:Oracle, ArcSDE:SqlServer, Access, shapefile, coverage, and others). Unlike *QueryDef* objects, *QueryFilter* objects are supported across all the workspace types, including shapefiles and coverages.

There are two differences in *WhereClause* syntax that are particular to Microsoft® Access. These differences are noted below:

Personal geodatabases use different wildcard characters because they are based on Microsoft Access.

	Single character match	Multiple character match	Example: Find states beginning with an ‘M’
Access	‘?’	‘*’	State_Name like ‘M*’
ArcSDE, shapefile, coverage	‘_’	‘%’	State_Name like ‘M%’

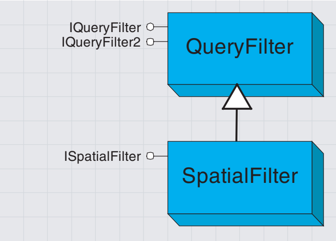
1. Access is case insensitive to field values, whereas ArcSDE and shapefiles are case sensitive. For example, “State_name = ‘florida’” returns one USA state in Access but none with shapefiles and ArcSDE. The example “State_name = ‘Florida’” returns one feature in all cases.

2. The wildcards for the *Like* predicate are different in Access.

IQueryFilter2 : IUnknown — ***Filters data based on attribute values and or relationships.***

SpatialResolution: Double — *The spatial resolution in which to output geometry.*

The *IQueryFilter2* interface allows specification of the desired *SpatialResolution* as part of the query. It can be used as a filter criteria for data sources (ArcIMS® feature classes) that support filtering of feature data based on spatial resolution. Features whose geometry extent is smaller than the specified spatial resolution will not be returned.



A spatial filter is a query filter that includes both spatial and attribute constraints.

A *SpatialFilter* is a *QueryFilter* that includes both spatial and attribute constraints. A *SpatialFilter* can be used to restrict the set of features retrieved from a feature class using both spatial and attribute restrictions.

A spatial filter has a single query geometry that specifies the geometry against which the features in the feature class will be tested. Because ArcObjects supports a number of different geometry types, including both single and multipart geometries and geometry collections, one way of expressing a complex spatial query is by building an appropriate query geometry to pass as input to the spatial filter.

A spatial filter has a single geometric shape that is used in the query. You can form more complicated spatial queries by using several spatial filters in succession.

You can use spatial filters everywhere that query filters are used, as long as the dataset to be queried has a spatial field. Some example tasks might be:

- Selecting features that overlap a search area
- Finding features near another feature
- Defining a limited geographic area for feature display

ISpatialFilter : IQueryFilter	*Filters data based on a spatial relationship.*
FilterOwnsGeometry: Boolean	*Return the state of the owner of the query geometry.*
Geometry: IGeometry	*The query geometry used to filter results.*
GeometryEx (in Geometry: IGeometry) : Boolean	*The the query geometry used to filter results.*
GeometryField: String	*The name of the Geometry field to which the filter applies.*
SearchOrder: tagesriSearchOrder	*The search order used by the filter.*
SpatialRel: esriSpatialRelEnum	*The spatial relationship checked by the filter.*
SpatialRelDescription: String	*The array elements which describe the spatial relation between the query geometry and the requested geometries. There are 9 chars in this string which can be either 'F', 'T' or '*'; for example, 'FF*TTT***' represents CONTAIN.*

The *ISpatialFilter* interface is used to define a query with geographic criteria.

You must always set these three properties: *Geometry, GeometryField,* and *SpatialRel*. The *GeometryEx* method may be used to set the query geometry in the case of large query geometries where the application is willing to surrender ownership of the geometry to the filter. In this case, the filter may modify (project) the query geometry in place if the spatial reference of the query geometry is different from the native spatial reference of the feature class or the requested output spatial reference. The spatial reference in which the features should be returned by the query is specified using the *OutputSpatialReference* property in the *IQueryFilter* interface.

This simple example shows a simple selection of features that intersect a given shape. It assumes an existing feature layer and a valid geometry pointer (perhaps derived from end user input).

```
Dim pSpatialFilter As ISpatialFilter
Set pSpatialFilter = New SpatialFilter
```

```
With pSpatialFilter
  Set .Geometry = pGeometry
  .GeometryField = pFeatureLayer.FeatureClass.ShapeFieldName
  .SpatialRel = esriSpatialRelIntersects
End With

Dim pFeatureSelection As IFeatureSelection
Set pFeatureSelection = pFeatureLayer
pFeatureSelection.SelectFeatures pSpatialFilter, _
  esriSelectionResultNew, False
```

ISpatialFilter inherits the members of *IQueryFilter*—the example above could be extended by setting the *WhereClause* property on the spatial filter.

Enumeration esriSpatialRelEnum	*Queryable Spatial Relationships.*
0 - esriSpatialRelUndefined	*No defined spatial relationship.*
1 - esriSpatialRelIntersects	*Query geometry intersects target geometry.*
2 - esriSpatialRelEnvelopeIntersects	*Envelope of query geometry intersects envelope of target geometry.*
3 - esriSpatialRelIndexIntersects	*Query geometry intersects index entry for target geometry (primary index filter).*
4 - esriSpatialRelTouches	*Query geometry touches target geometry.*
5 - esriSpatialRelOverlaps	*Query geometry overlaps target geometry.*
6 - esriSpatialRelCrosses	*Query geometry crosses target geometry.*
7 - esriSpatialRelWithin	*Query geometry is within target geometry.*
8 - esriSpatialRelContains	*Query geometry contains target geometry.*
9 - esriSpatialRelRelation	*Query geometry IBE(Interior-Boundary-Exterior) relationship with target geometry.*

The *SpatialRel* property takes an enumeration that defines the relationship between the query geometry and the target feature geometry; this must be satisfied for the target feature to be returned by the query. The spatial relationships supported are the basic Clementini relationships, specified as part of the OpenGIS® Simple Feature data-access standard.

The five basic Clementini relationships are Disjoint, Touches, Overlaps, Crosses, and Within. For documentation on *IRelationalOperator,* see Chapter 9, 'Shaping features with geometry'. For more details on these five spatial relationships, see *Modeling Our World.*

esriSpatialRelIntersects, esriSpatialRelTouches, esriSpatialRelCrosses, esriSpatialRelOverlaps, esriSpatialRelWithin, and *esriSpatialRelContains* map to the corresponding Clementini relationships. Intersects maps to Not(Disjoint), Contains(a,b) maps to Within(b,a), and the rest correspond directly to the Clementini relationship.

esriSpatialRelEnvelopeIntersects is *True* if the envelope of the query geometry intersects the envelope of the target geometry.

esriSpatialRelIndexIntersects may be specified as the filter spatial relationship if the application is prepared to deal with features that do not intersect the query geometry, as long as all features that do intersect the query geometry are returned. This is a hint to the database that only the primary filter based on the spatial index needs to be applied; this results in faster query execution. This can be appropriate for drawing applications that rely on clipping to do the secondary filtering.

		Query geometry		
		Interior	Boundary	Exterior
Target feature class	Interior	T	T	*
	Boundary	T	T	*
	Exterior	*	*	*

*The values in this diagram translate into the nine-character string reading from left to right and top to bottom (TT*TT***).*

esriSpatialRelRelate may be specified as the filter spatial relationship if the application wishes to directly specify the relationships between the topological interior, boundary, and exterior of the query geometry and the topological interior, boundary, and exterior of the target geometry, using the dimensionally extended nine-intersection model. The spatial relationships between the components are specified using a string of nine characters that is set as the value for the *esriSpatialRelDescription* property of the filter.

The characters are drawn from the alphabet {T, F, *} and indicate the dimension of the point set resulting from the intersection of the two components that map to that character position. F indicates no intersection, T indicates intersection, and * indicates don't care. The mapping of components to character position in the string is shown in the diagram to the left. The character string is constructed by reading out the entries in the 3 x 3 matrix in the order left to right and top to bottom.

Spatial filters support the five basic Clementini relationships between the query and target geometries.

Some of the spatial relationships exposed to the end user in the ArcMap Select By Location dialog box do not correspond directly to the basic Clementini relationships described above. These spatial relationships can be implemented using the Clementini spatial filter relationships combined with preprocessing and postprocessing. Preprocessing is used to assemble the appropriate query geometry (for example, in the case of distance-based relationships, using buffer). Postprocessing can be used to further restrict retrieved geometries returned by the Clementini operator. The following table shows examples of such processing:

	Select by location dialog		Context	Equivalent constant
Select features that…	intersect	…the query geometry	all	*esriSpatialRelIntersects*
Select features that…	are within a distance of	…the query geometry	all	pre-process of buffering followed by *esriSpatialRelIntersects*
Select features that…	contain	…the query geometry	all	*esriSpatialRelWithin*
Select features that…	are contained by	…the query geometry	all	*esriSpatialRelContains*
Select features that…	completely contain	…the query geometry	all	*esriSpatialRelWithin*, followed by postprocess to remove polygons whose boundaries touch or overlap
Select features that…	are completely within	…the query geometry	all	*esriSpatialRelContains*, followed by postprocess to remove polygons whose boundaries touch or overlap
Select features that…	have their center in	…the query geometry	all	*esriSpatialRelIntersects*, followed by postprocess using *IArea::Centroid* and *IRelationalOperator::Disjoint*
Select features that…	share a line segment with	…the query geometry	query and target geometries linear	*esriSpatialRelOverlaps*
Select features that…	share a line segment with	…the query geometry	other cases	*esriSpatialRelTouches*
Select features that…	share a point with	…the query geometry	all	*esriSpatialRelTouches*
Select features that…	are identical to	…the query geometry	all	*esriSpatialRelIntersects*, followed by postprocess using *IRelationalOperator::Equals*
Select features that…	are crossed by the outline of	…the query geometry	query and target geometries polygonal	*esriSpatialRelOverlaps*
Select features that…	are crossed by the outline of	…the query geometry	other cases	*esriSpatialRelCrosses*

The SearchOrder *property can have a big effect on performance.*

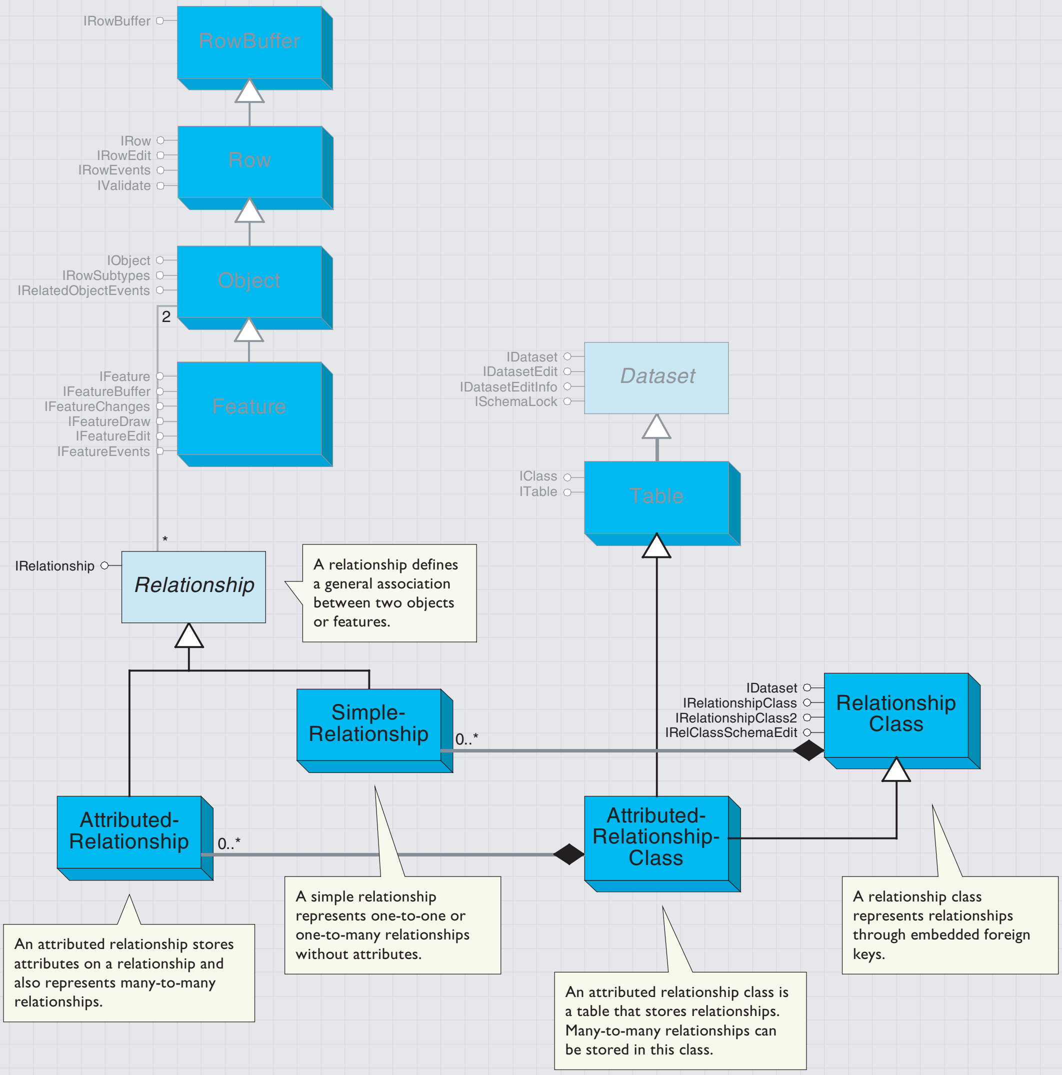
The *SpatialRelDescription* property is only used when *SpatialRel* is set to *esriSpatialRelRelation*. You can use it to define various complex spatial relationships.

The *SearchOrder* property determines whether the spatial part of the query is performed before the attribute part of the query. By default, the spatial relationship is tested first, but in the case of queries where the attribute criteria are much more specific than the spatial, it is better to change the *SearchOrder*. An example of this kind of query might be “find all worldwide cities with population greater than a million that are not in Spain”.

If you want to want to query a feature class based on a collection of shapes, for example, “select the cities that are within the selected states”, you have several different options. One option is to apply successive spatial filters for each query shape. Another option is to make a single multipart query shape from the collection of original query shapes, then use a single spatial filter. The following example shows how to form a single geometry from the selected features in a layer.

```
Dim pFeatureSelection As IFeatureSelection
Set pFeatureSelection = pFeatureLayer

Dim pSelectionSet As ISelectionSet
Set pSelectionSet = pFeatureSelection.SelectionSet

Dim pEnumGeom As IEnumGeometry
Dim pEnumGeometryBind As IEnumGeometryBind

Set pEnumGeom = New EnumFeatureGeometry
Set pEnumGeometryBind = pEnumGeom
pEnumGeometryBind.BindGeometrySource Nothing, pSelectionSet

Dim pGeomFactory As IGeometryFactory
Set pGeomFactory = New GeometryEnvironment

Dim pGeom As IGeometry
Set pGeom = pGeomFactory.CreateGeometryFromEnumerator(pEnumGeom)
```

Relationship objects



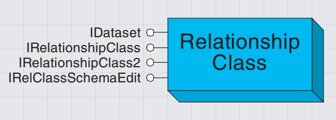
A relationship defines a general association between two objects or features.

A simple relationship represents one-to-one or one-to-many relationships without attributes.

A relationship class represents relationships through embedded foreign keys.

An attributed relationship stores attributes on a relationship and also represents many-to-many relationships.

An attributed relationship class is a table that stores relationships. Many-to-many relationships can be stored in this class.



A RelationshipClass is an association between two object classes; one is the origin class and the other the destination class. The relationship class represents a set of relationships between the objects belonging to two classes.

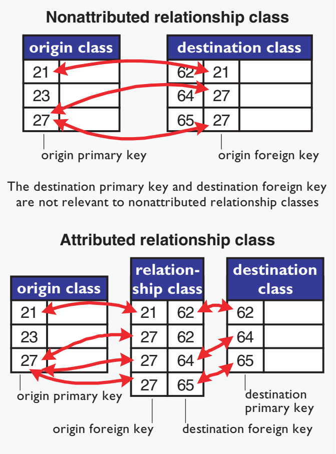
You can create a relationship class with either *IRelationshipClassContainer* or *IFeatureWorkspace*. *RelationshipClass* objects implement *IDataset* (useful for getting the name or the workspace), but they do not implement *IClass* (unless they are attributed). This is because a nonattributed relationship class does not have any fields of its own.

IRelationshipClass : IUnknown	***Provides access to members that return information about the relationship class, create relationships, relationship rules, and get related objects.***
BackwardPathLabel: String	*The backward path label for the relationship class.*
Cardinality: esriRelCardinality	*The cardinality for the relationship class.*
DestinationClass: IObjectClass	*The destination object olass.*
DestinationForeignKey: String	*The relationship destination foreign key.*
DestinationPrimaryKey: String	*The relationship destination primary key.*
FeatureDataset: IFeatureDataset	*The feature dataset, if any, to which this relationship class belongs.*
ForwardPathLabel: String	*The forward path label for the relationship class.*
IsAttributed: Boolean	*True if the relationships in this relationship class have attributes.*
IsComposite: Boolean	*True if the relationship class represents a composite relationship in which the origin object class represents the composite object.*
Notification: esriRelNotification	*The notification direction for the relationship class.*
OriginClass: IObjectClass	*The origin object class.*
OriginForeignKey: String	*The relationship origin foreign key.*
OriginPrimaryKey: String	*The relationship origin primary key.*
RelationshipClassID: Long	*The relationship class ID.*
RelationshipRules: IEnumRule	*Gets the relationship rules that apply to this relationship class.*
AddRelationshipRule (in rule: IRule)	*Adds a relationship rule to this relationship class.*
CreateRelationship (in OriginObject: IObject, in DestinationObject: IObject) : IRelationship	*Creates a new relationship between the two specified objects.*
DeleteRelationship (in OriginObject: IObject, in DestinationObject: IObject)	*Deletes the relationship that associates the two specified objects.*
DeleteRelationshipRule (in rule: IRule)	*Deletes a relationship rule from this relationship class.*
DeleteRelationshipsForObject (in anObject: IObject)	*Deletes all relationships that apply to a specified object.*
DeleteRelationshipsForObjectSet (in anObjectSet: ISet)	*Deletes all relationships that apply to the specified origin or destination object set.*
GetObjectsMatchingObjectSet (in pSrcObjectSet: ISet) : IRelClassEnumRowPairs	*Gets rows pairs of objects that are related to the specified origin or destination object set.*
GetObjectsRelatedToObject (in anObject: IObject) : ISet	*Gets the objects that are related to the specified object.*
GetObjectsRelatedToObjectSet (in anObjectSet: ISet) : ISet	*Gets the objects that are related to the specified origin or destination object set.*
GetRelationship (in OriginObject: IObject, in DestinationObject: IObject) : IRelationship	*Gets the relationship that associates the two specified objects.*
GetRelationshipsForObject (in anObject: IObject) : IEnumRelationship	*Gets all relationships that apply to a specified object.*
GetRelationshipsForObjectSet (in anObjectSet: ISet) : IEnumRelationship	*Gets all relationships that apply to the specified origin or destination object set.*

The *IRelationshipClass* interface provides information about a relationship class, functionality to create and delete individual relationships, and methods to find related objects. The members of this interface can be split into three logical groups: the properties that correspond to how the relationship class was created, the object-to-object methods that deal with individual relationships, and the relationship rules methods.

The *OriginPrimaryKey, OriginForeignKey, DestinationPrimaryKey,* and *DestinationForeignKey* properties can be somewhat confusing—their uses are different depending on whether the relationship class is attributed.

The object-to-object methods, such as *GetObjectsRelatedToObjectSet*, make use of the *ISet* interface, which manipulates a set of generic objects. When adding objects to a set with a cursor, make sure that the



Comparing the implementation of relationships between nonattributed and attributed relationship classes cursor recycling is turned off, as shown in this example (which deletes all the relationships for features with areas less than a certain value).

```
Dim pQueryFilter As IQueryFilter
Set pQueryFilter = New QueryFilter
pQueryFilter.WhereClause = "Shape_Area < 25"

Dim pFCursor As IFeatureCursor
Set pFCursor = pFeatureClass.Search(pQueryFilter, False)
Dim pFeature As IFeature
Set pFeature = pFCursor.NextFeature
Dim pFeatSet As ISet
Set pFeatSet = New esriCore.Set

Do While Not pFeature Is Nothing
  pFeatSet.Add pFeature
  Set pFeature = pFCursor.NextFeature
Loop
pFeatSet.Reset
MsgBox pFeatSet.count
pRelClass.DeleteRelationshipsForObjectSet pFeatSet
```

When using *CreateRelationship*, remember that this operation will write a value into the foreign key field. Therefore, it is possible that you could overwrite, and therefore delete, an existing relationship. Similarly, *DeleteRelationship* will remove the foreign key value, so that field must allow null values unless you want to ensure that all objects in the class belong to relationships.

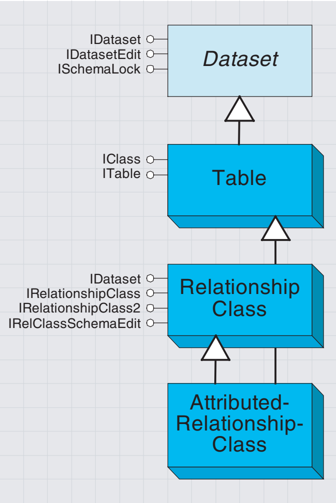
IRelationshipClass2 : IUnknown	***Provides access to members that get related object row pairs within a query filter specification.***
← GetObjectsMatchingObjectArray (in pSrcObjectArray: IArray, in pQueryFilterAppliedToMatchingObjects: IQueryFilter) : IRelClassEnumRowPairs	*Gets row pairs of objects that are related to the specified origin or destination object array that also meet the query filter expression.*
← GetObjectsMatchingObjectSetEx (in pSrcObjectSet: ISet, in pQueryFilterAppliedToMatchingObjects: IQueryFilter) : IRelClassEnumRowPairs	*Gets row pairs of objects that are related to the specified origin or destination object set that also meet the query filter expression.*

The *IRelationshipClass2* interface was added to provide a method to get matching objects.

An *AttributedRelationshipClass* is a special kind of relationship class and is also a kind of table known as the relationship table. For nonattributed relationship classes, the relationships are stored with the objects themselves in the foreign key values. For attributed relationship classes, the relationships are defined by the objects in conjunction with the rows in the relationship table.

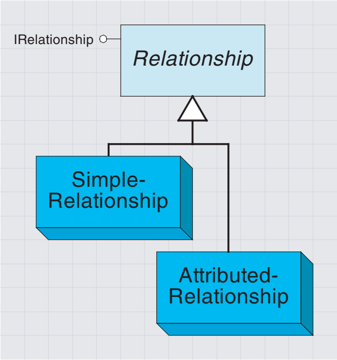
A good way of testing whether you have an *AttributedRelationshipClass* object is as follows:

```
If TypeOf pRelClass Is ITable Then
  Debug.Print "Attributed Relationship Class"
End If
```



An attributed relationship class stores many-to-many relationships and relationships with attributes.

The *IRelationshipClass::IsAttributed* property only returns *True* if there are extra relationship attributes beyond those required to relate the objects. The *IRelationshipClass::GetRelationship* method is useful for accessing the relationship attributes.



Simple relationships relate two objects or features through a foreign key. Attributed relationships are required to store many-to-many relationships and to keep attributes on a relationship.

Relationship is an abstract class that covers *SimpleRelationship* and *AttributedRelationship* objects. A relationship represents a pair of related objects or features. For more details, see the *RelationshipClass* topic.

IRelationship : IUnknown	***Provides access to members that return information about the relationship.***
DestinationObject: IObject	*The destination object.*
OriginObject: IObject	*The origin object.*
RelationshipClass: IRelationshipClass	*The relationship class to which this relationship belongs.*

The *IRelationship* interface provides read-only information about a relationship. It is most useful with attributed relationships since it can form a bridge between the attribute information, which is in row form, and the related objects.

When dealing with relationships, you will normally use the *IRelationshipClass* interface rather than *IRelationship*.

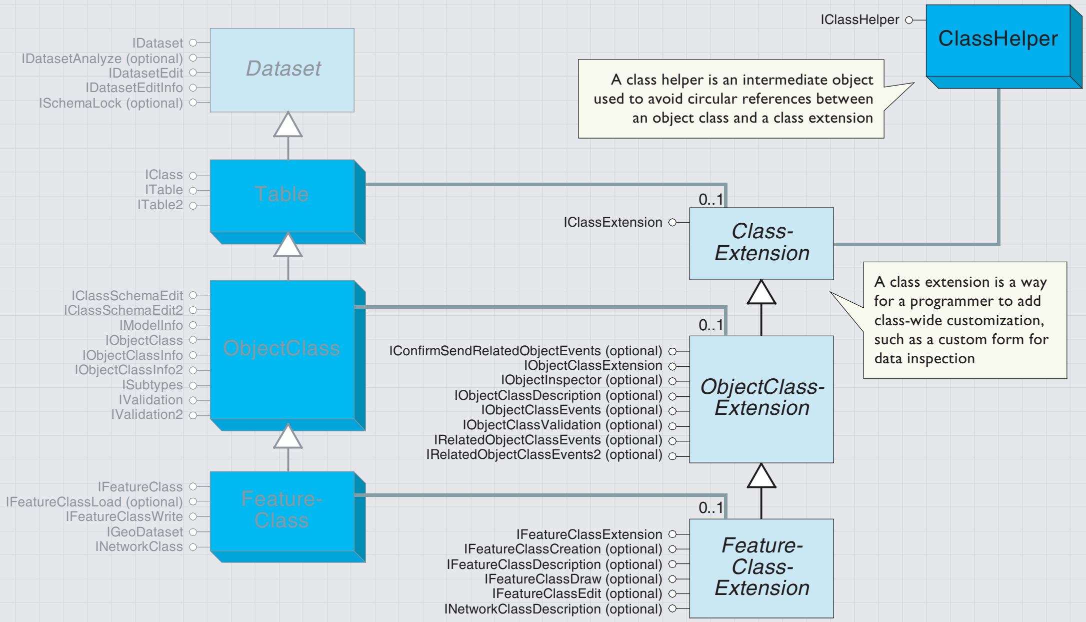
The *SimpleRelationship* object represents a pair of related geodatabase objects or features. There are no attribute values associated with the relationship.

You should not cocreate a simple relationship. Instead, use *IRelationshipClass::CreateRelationship*.

The *AttributedRelationship* object is a kind of row that represents a pair of related objects or features with extra information about the pairing. The extra information is stored in the row.

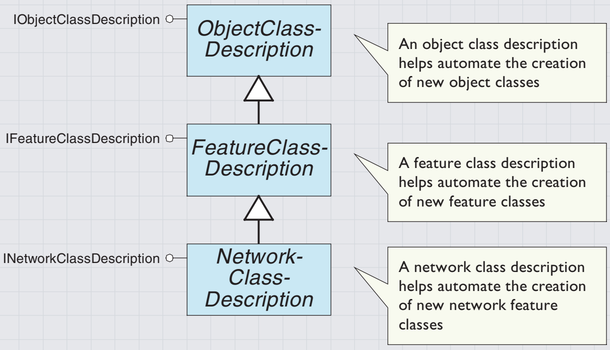
You should not cocreate an attributed relationship. Instead, use *IRelationshipClass::CreateRelationship*.

Class extension objects


IClassHelper
ClassHelper
IDataset
IDatasetAnalyze (optional)
IDatasetEdit
IDatasetEditInfo
ISchemaLock (optional)
Dataset
IClass
ITable
ITable2
Table
0..1
IClassExtension
Class-Extension
IClassSchemaEdit
IClassSchemaEdit2
IModelInfo
IObjectClass
IObjectClassInfo
IObjectClassInfo2
ISubtypes
IValidation
IValidation2
ObjectClass
0..1
IConfirmSendRelatedObjectEvents (optional)
IObjectClassExtension
IObjectInspector (optional)
IObjectClassDescription (optional)
IObjectClassEvents (optional)
IObjectClassValidation (optional)
IRelatedObjectClassEvents (optional)
IRelatedObjectClassEvents2 (optional)
ObjectClass-Extension
IFeatureClass
IFeatureClassLoad (optional)
IFeatureClassWrite
IGeoDataset
INetworkClass
Feature-Class
0..1
IFeatureClassExtension
IFeatureClassCreation (optional)
IFeatureClassDescription (optional)
IFeatureClassDraw (optional)
IFeatureClassEdit (optional)
INetworkClassDescription (optional)
Feature-Class-Extension

A class helper is an intermediate object used to avoid circular references between an object class and a class extension

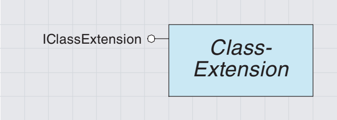
A class extension is a way for a programmer to add class-wide customization, such as a custom form for data inspection



An object class description helps automate the creation of new object classes

A feature class description helps automate the creation of new feature classes

A network class description helps automate the creation of new network feature classes



A ClassExtension *is an object that gives developers the ability to customize and extend advanced Geodatabase functionality.*

A *ClassExtension* allows developers to implement optional interfaces to customize geodatabase behavior. A *ClassExtension* can also be used to add additional behavior to an *ObjectClass* or *FeatureClass* by supporting custom interfaces.

IClassExtension : IUnknown	***Class Extension Interface.***
← Init (in pClassHelper: IClassHelper, in pExtensionProperties: IPropertySet)	*Initializes the extension, passing in a reference to its class helper.*
← Shutdown	*Informs the extension that its class helper is going away.*

The *IClassExtension* interface is the main interface required for implementing a *ClassExtension*.

A class helper prevents circular references from occurring in Visual Basic.

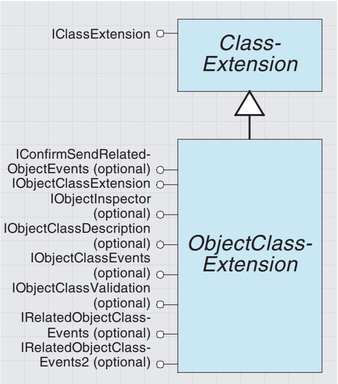
The *Init* method provides a pointer to the *ClassHelper* object that should be used to access the *Extension* object's *ObjectClass*. A *ClassExtension* should not maintain a reference to the *ObjectClass* directly, but rather should access it via the *ClassHelper* as necessary. In addition to the *ClassHelper*, a *PropertySet* contains any data stored with the *ObjectClass*.

The value of *PropertySet* can be modified by using *IClassSchemaEdit::AlterClassExtensionCLSID* or *IClassSchemaEdit2::AlterClassExtensionProperties*. If the properties do not exist for the *Extension*, the *pExtensionProperties* argument will be *Nothing*.

The *Init* method is called when the *ObjectClass* is opened for the first time. Before the *ObjectClass* is closed, the *Shutdown* method is called.

This code demonstrates how to implement a simple *ClassExtension* that utilizes *ClassExtension* properties to store a symbol that may be used for custom feature drawing.

```
Implements IClassExtension

Private m_pClassHelper As esriCore.IClassHelper
Private m_pSymbol As ISymbol

Private Sub IClassExtension_Init(ByVal pClassHelper As _
  esriCore.IClassHelper, ByVal pExtensionProperties As _
  esriCore.IPropertySet)
    Set m_pClassHelper = pClassHelper

    If Not pExtensionProperties Is Nothing Then
        Set m_pSymbol = pExtensionProperties.GetProperty("Symbol")
     End If
End Sub

Private Sub IClassExtension_Shutdown()
    Set m_pClassHelper = Nothing
End Sub
```


IClassExtension
Class-Extension
IConfirmSendRelated-ObjectEvents (optional)
IObjectClassExtension
IObjectInspector (optional)
IObjectClassDescription (optional)
IObjectClassEvents (optional)
IObjectClassValidation (optional)
IRelatedObjectClass-Events (optional)
IRelatedObjectClass-Events2 (optional)
ObjectClass-Extension

An object class extension is any class extension associated with an object class.

An *ObjectClassExtension* is any *ClassExtension* associated with an *ObjectClass* coclass.

IObjectClassExtension : IUnknown	*Object Class Extension Identity Interface.*

The *IObjectClassExtension* interface is a required identity interface.

IObjectInspector : IUnknown	*Custom object/feature property inspector.*
hWnd: Long	*The window handle for the inspector.*
Clear	*Clears the inspector before inspecting another object.*
Copy (in srcRow: IRow)	*Copies the values from srcRow to the row being edited.*
Inspect (in Objects: IEnumRow, in Editor: IEditor)	*Inspects the properties of the features.*

The *IObjectInspector* interface is an optional interface that provides the ability to replace the ArcMap default *ObjectInspector* with a custom one. Custom *ObjectInspectors* are easily implemented using a *Form* that implements *IObjectInspector*.

The *ObjectClassExtension* delegates method calls directly to the *Form* as necessary.

The *hWnd* property provides a window handle to the form that will be displayed. This value could come from a *Form*'s *hWnd* property.

The *Inspect* method passes in the currently selected objects in the *ObjectInspector* tree and a pointer to the *Editor*.

If the *Objects* parameter enumeration contains more than one *Row*, the edits should be applied to all *Objects* passed in. The *Copy* method should create a new *Object* and set its attributes equal to those in the *Row* parameter. The *Clear* method should clear the display of the current values.

IObjectClassValidation : IUnknown	*Object Class Validation Interface.*
ValidateField (in Row: IRow, in FieldName: String) : String	*Validates the row's specified attribute.*
ValidateRow (in Row: IRow) : String	*Validates the row.*

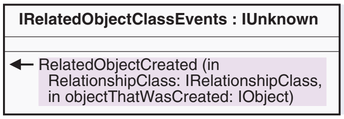
The *IObjectClassValidation* interface is an optional interface that provides custom validation of *Objects*. This validation is in addition to geodatabase validation of domains, relationship rules, and connectivity rules. After successfully completing all native validation within the geodatabase, the *ValidateRow* method is called. Effectively, this is the last type of validation performed when validating an object.

The *ValidateField* method is called when *IValidate::GetInvalidFields* is called on an *Object* of the associated *ObjectClass*.

The *ValidateRow* method is called by an *Object*'s *IValidate::Validate* and by the *Validate* methods on the *IValidation* interface of the associated *ObjectClass*. *ValidateRow* should be used to validate database or spatial relationships in addition to field values. If the field or row is invalid, an appropriate error string should be returned. Otherwise, a zero-length string is returned.

The following code demonstrates simple custom validation that requires the value of the field to be divisible by two.

```
Implements IClassExtension
Implements IObjectClassExtension
Implements IObjectClassValidation

Private m_pClassHelper As esriCore.IClassHelper
Private m_lValueIndex As Long
Private Const MYVALUE_FIELDNAME As String = "MyValue"

Private Sub IClassExtension_Init(ByVal pClassHelper _
  As esriCore.IClassHelper, ByVal pExtensionProperties As
esriCore.IPropertySet)
  Set m_pClassHelper = pClassHelper

  Dim pClass As esriCore.IClass
  Set pClass = m_pClassHelper.Class
  m_lValueIndex = pClass.FindField(MYVALUE_FIELDNAME)
End Sub

Private Sub IClassExtension_Shutdown()
  'Release helper here.
  Set m_pClassHelper = Nothing
End Sub

Private Function IObjectClassValidation_ValidateField(ByVal Row As _
  esriCore.IRow, ByVal FieldName As String) As String
  Dim sErrStr As String
  sErrStr = ""

  If FieldName = MYVALUE_FIELDNAME Then
    Dim lMyvalue As Long
    lMyvalue = Row.Value(m_lValueIndex)

    Dim lModValue As Long
    lModValue = lMyvalue Mod 2
    If lModValue > 0 Then
      sErrStr = "Field value is not divisable by 2."
     End If
    IObjectClassValidation_ValidateField = sErrStr
  End If
End Function

Private Function IObjectClassValidation_ValidateRow(ByVal Row _
  As esriCore.IRow) As String

  IObjectClassValidation_ValidateRow = _
    IObjectClassValidation_ValidateField(Row, MYVALUE_FIELDNAME)
End Function
```


IRelatedObjectClassEvents : IUnknown

RelatedObjectCreated (in RelationshipClass: IRelationshipClass, in objectThatWasCreated: IObject)

Provides access to events that occur when related objects are created.

Notifies this object class that a related object was created.

The *IRelatedObjectClassEvents* interface is an optional interface that is implemented to receive messages about newly created objects in related *ObjectClasses*.

The only method on this interface is *RelatedObjectCreated*. The *RelationshipClass* argument is useful for establishing new relationships. Since an *ObjectClass* often participates in many relationships, the properties of *RelationshipClass* can be used to modify behavior of this method.

This code demonstrates how to automatically create a new object and relate it to the new related object.

```
Implements IClassExtension
Implements IObjectClassExtension
Implements IRelatedObjectClassEvents

Private m_pClassHelper As esriCore.IClassHelper

Private Sub IClassExtension_Init(ByVal pClassHelper As _
  esriCore.IClassHelper, ByVal pExtensionProperties As _
  esriCore.IPropertySet)

  Set m_pClassHelper = pClassHelper
End Sub

Private Sub IClassExtension_Shutdown()
  'Release helper here.
  Set m_pClassHelper = Nothing
End Sub

Private Sub IRelatedObjectClassEvents_RelatedObjectCreated(ByVal _
  RelationshipClass As esriCore.IRelationshipClass, ByVal _
  objectThatWasCreated As esriCore.IObject)

  Dim pTable As ITable
  Set pTable = m_pClassHelper.Class

  Dim pObject As esriCore.IObject
  Set pObject = pTable.CreateRow
  pObject.Store

  Dim pRelationship As IRelationship
  Set pRelationship = _
  RelationshipClass.CreateRelationship(objectThatWasCreated, _
  pObject)
End Sub
```

IConfirmSendRelatedObjectEvents : IUnknown	***Provides access to events that occur when related objects change, move, or rotate, and confirms that the event should be sent.***
← ConfirmSendRelatedObjectChanged (in RelationshipClass: IRelationshipClass, in objectThatChanged: IObject) : Boolean	*Notifies this object that a related object changed and asks if events should be sent.*
← ConfirmSendRelatedObjectMoved (in RelationshipClass: IRelationshipClass, in objectThatChanged: IObject, in MoveVector: ILine) : Boolean	*Notifies this object that a related object moved and asks if events should be sent.*
← ConfirmSendRelatedObjectRotated (in RelationshipClass: IRelationshipClass, in objectThatChanged: IObject, Origin: IPoint, Angle: Double) : Boolean	*Notifies this object that a related object rotated and asks if events should be sent.*
← ConfirmSendRelatedObjectSetMoved (in RelationshipClass: IRelationshipClass, in objectsThatChanged: ISet, MoveVector: ILine) : Boolean	*Notifies this object that a set of objects with relationships to the input set of objects moved and asks if events should be sent.*
← ConfirmSendRelatedObjectSetRotated (in RelationshipClass: IRelationshipClass, in objectsThatChanged: ISet, Origin: IPoint, Angle: Double) : Boolean	*Notifies this object that a set of objects with relationships to the input set of objects rotated and asks if events should be sent.*

The *IConfirmSendRelatedObjectEvents* is an optional interface used to confirm the messaging of related objects.

When an *Object* that participates in a *Relationship* is modified, moved, or rotated (alone or in a set), its related objects will be messaged if relationship notification is set in that direction. Typically, a related object is only interested in certain changes on an object. The properties of this interface allow an *ObjectClassExtension* to prevent or confirm that messages should be sent.

Each property on *IConfirmSendRelatedObjectEvents* corresponds to a method on *IRelatedObjectEvents* (for example, *ConfirmSendRelatedObjectChanged* corresponds to *RelatedObjectChanged*).

The decision to confirm the sending of messages is based on criteria, such as a particular field being changed. An object can be analyzed for which fields have been modified by accessing the *IRowChanges* interface or the *IFeatureChanges* interface for shape information.

Eliminating unnecessary calls to *IRelatedObjectEvents* optimizes editing performance.

The following code demonstrates how to use *IFeatureChanges* to confirm the sending of the *RelatedObjectChanged* message when the shape field is modified.

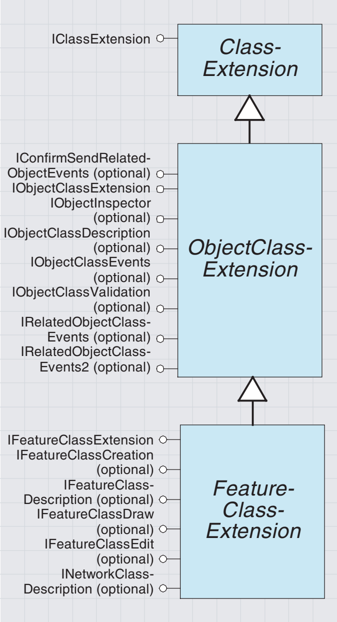
```
Private Function _
  IConfirmSendRelatedObjectEvents_ConfirmSendRelatedObjectChanged _
  (ByVal RelationshipClass As esriCore.IRelationshipClass, ByVal _
  objectThatChanged As esriCore.IObject) As Boolean
  Dim pFeatureChanges As IFeatureChanges
  Set pFeatureChanges = objectThatChanged
  IConfirmSendRelatedObjectEvents_ConfirmSendRelatedObjectChanged = _
   pFeatureChanges.ShapeChanged
End Function
```

IObjectClassEvents : IUnknown	Provides access to events that occur with an object class.
← OnChange (in obj: IObject)	*This event is fired when an object's attributes or geometry is updated.*
← OnCreate (in obj: IObject)	*This event is fired when a new object is created in the object class.*
← OnDelete (in obj: IObject)	*This event is fired when an object is deleted from the object class.*

The *IObjectClassEvents* interface is an optional interface for an *ObjectClassExtension*, implemented for monitoring changes to the *Objects* in the *ObjectClass*.

The methods on this interface will be called by an *ObjectClass* before notifying other related and external objects. The *OnCreate* method is called when a new object is created. The *OnChange* method is called when an existing object is modified. The *OnDelete* method is called when objects in that class are deleted.

FeatureClassExtension abstract class


IClassExtension
Class-Extension
IConfirmSendRelatedObjectEvents (optional)
IObjectClassExtension
IObjectInspector (optional)
IObjectClassDescription (optional)
IObjectClassEvents (optional)
IObjectClassValidation (optional)
IRelatedObjectClassEvents (optional)
IRelatedObjectClassEvents2 (optional)
ObjectClass-Extension
IFeatureClassExtension
IFeatureClassCreation (optional)
IFeatureClassDescription (optional)
IFeatureClassDraw (optional)
IFeatureClassEdit (optional)
INetworkClassDescription (optional)
Feature-Class-Extension

A feature class extension is a class extension related to a feature class.

A *FeatureClassExtension* is a *ClassExtension* related to a *FeatureClass*.

IFeatureClassExtension : IUnknown	***Feature Class Extension Identity Interface.***

The *IFeatureClassExtension* interface is a required identity interface. It has no properties or methods, but it identifies a feature class extension.

IFeatureClassCreation : IUnknown	***Feature Class Creation Interface.***
■— CanCreateFromPoint: Boolean	*True if the features in this feature class know how to create their shapes given an input point geometry.*

The *IFeatureClassCreation* interface is an optional interface used to specify that new *Features* of this class can be created with a single point. If *Features* can be created from a point, the *CanCreateFromPoint* property returns *True*.

IFeatureClassDraw : IUnknown	***Feature Class Drawing Information Interface.***
■— CustomRenderer: Variant	*The custom renderer for the FeatureClass.*
■— CustomRendererPropPageCLSID: IUID	*The custom renderer's property page CLSID.*
■— ExclusiveCustomRenderer: Boolean	*Returns whether the custom renderer is exclusive or not.*
■— RequiredFieldsForDraw: IFields	*The required fields for drawing a Feature.*
← DoesCustomDrawing: Boolean	*Returns whether the FeatureClass does custom drawing.*
← HasCustomRenderer: Boolean	*Returns whether the FeatureClass has a custom renderer.*

The *IFeatureClassDraw* interface is an optional interface used to specify custom drawing behavior in ArcMap.

Before a *FeatureLayer* draws *Features* in a *FeatureClass*, it checks the *FeatureClassExtension* for support of this interface. Custom drawing can be achieved through the use of a custom *Renderer* or through the use of a custom *Feature* that implements *IFeatureDraw::Draw*.

If using a custom *Renderer*, the *ExclusiveCustomRenderer* property can be used to restrict the available *Renderers* to the custom one for the *FeatureClass*. If the custom *Renderer* is configurable, a configuration property page can be specified with the *CustomRendererPropPageCLSID* property. If you are using a custom *Feature* that utilizes extra fields beyond the *Shape* for drawing, you must specify those fields in the *RequiredFieldsForDraw* property or they will not be returned in the *FeatureLayer*'s *FeatureCursor*.

IFeatureClassEdit : IUnknown	***Feature Class Extension Editing Properties Interface.***
■— CanEditWithProjection: Boolean	*Returns whether or not the associated feature class can be edited in projected spaces.*
■— CustomSplitPolicyForRelationship (in Row: IRow, in relClass: IRelationshipClass) : esriRelationshipSplitPolicy	*The custom split policy for handling relationships.*
← HasCustomSplitPolicyForRelationship: Boolean	*Returns whether the feature class has a custom split policy for handling relationships.*

The *IFeatureClassEdit* interface is an optional interface used for specifying advanced editing configuration.

ArcMap supports the editing of simple *Features* in a different *SpatialReference* than that of the *FeatureDataset*. If the associated *FeatureClass* is of type *esriFTSimple*, editing of the *FeatureClass* from within a different *SpatialReference* can be prevented by implementing the *CanEditWithProjection* property and returning *False*.

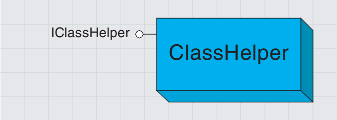
When a *Feature* with related objects is split, the geodatabase automatically maintains or deletes the related objects, depending on the type of relationship.

In the case of simple relationships, the related objects will be preserved and a new relationship is created with the *Feature* containing the larger part of the *Shape*. In the case of composite relationships, the related objects are deleted. If this is not the desired behavior, return *True* for the *HasCustomSplitPolicy* method.

Through the *CustomSplitPolicyForRelationship* property, a custom split policy can be specified according to *Subtype* and *Relationship*. The supported split policies are defined in the *esriRelationshipSplitPolicy* enumeration and described in the following table.

Enumeration value	Behavior
esriRSPUseDefault	The default behavior, which is *EsriRSPPreserveOnLargest* for simple relationships and *esriRSPDeleteParts* for composite relationships.
esriRSPPreserveOnLargest	Preserve related objects and create a relationship with the *Feature* with the largest part of the split geometry.
esriRSPPreserveOnSmallest	Preserve related objects and create a relationship with the *Feature* with the smallest part of the split geometry.
esriRSPPreserveOnAll	Preserve related objects and create a relationship with both *Features*. This option is not valid with relationships with 1..1 cardinality or composite relationships.
esriRSPDeleteRelationship	Delete the relationship.
esriRSPDeleteParts	Delete the related *Objects*.

CLASSHELPER CLASS

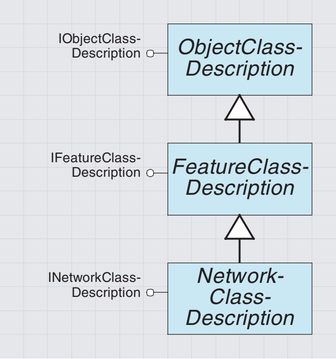


The class helper is an intermediate object used to prevent circular references between an ObjectClass *and a* ClassExtension.

A *ClassHelper* is passed as an argument to the *Init* method on *IClassExtension* interface.

IClassHelper : IUnknown	***Class Helper Interface.***
■— Class: IClass	*The class for this class helper.*

The *Class* property should be used by the *ClassExtension* to get a pointer to the current *ObjectClass*. A *ClassExtension* should not keep the pointer in a class level variable, but rather should retrieve it from the *ClassHelper* as needed.


IObjectClass-Description
ObjectClass-Description
IFeatureClass-Description
FeatureClass-Description
INetworkClass-Description
Network-Class-Description

An object class description helps automate the creation of new object classes in ArcCatalog.

A feature class description helps automate the creation of new feature classes in ArcCatalog.

A network class description helps automate the creation of new network classes in ArcCatalog.

An *ObjectClassDescription* allows developers to implement configuration interfaces that automate the creation of new *ObjectClasses* by predefining required information for *ObjectClasses, FeatureClasses,* and *NetworkFeatureClasses*.

IObjectClassDescription : IUnknown	*Object Class Description Interface.*
AliasName: String	*The alias name of this class.*
ClassExtensionCLSID: IUID	*The CLSID of the class extension Com Class that implements class level behavior.*
InstanceCLSID: IUID	*The CLSID of the Com Class that implements instance level behavior.*
ModelName: String	*The model name of this class.*
ModelNameUnique: Boolean	*True the model name of this class is unique.*
Name: String	*The name for this class, for example, ESRI Simple Junction Feature.*
RequiredFields: IFields	*Returns descriptions of the set of required fields for this class.*

The *IObjectClassDescription* interface is an optional interface that provides configuration information for ArcCatalog to use when creating a new *ObjectClass* or *FeatureClass*. This interface can be implemented on a *ClassExtension* or a separate coclass. Regardless of where the interface is implemented, the implementing coclass must be registered to the ESRI GeoObject Class Descriptions category using the Component Category Manager. If a *FeatureClass* is being created, the *ClassDescription* (or *ClassExtension*) must also implement *IFeatureClassDescription*.

When implementing the *RequiredFields* property, it is necessary to include an OID field, a geometry field (if a *FeatureClass*), subtype field, ancillary role, or enabled field (if a *NetworkFeature* type), in addition to any other attributes.

The following code example demonstrates a simple implementation of *IObjectClass*.

```
Implements IObjectClassDescription

Private Property Get IObjectClassDescription_AliasName() As String
   IObjectClassDescription_AliasName = "My Object Class"
End Property

Private Property Get IObjectClassDescription_ClassExtensionCLSID() As _
  esriCore.IUID
  Dim pUID As UID
  Set pUID = New UID
  pUID.Value = "{82D4EA61-72F6-11d4-80EA-00C04F601565}"
  Set IObjectClassDescription_ClassExtensionCLSID = pUID
End Property

Private Property Get IObjectClassDescription_InstanceCLSID() As _
  esriCore.IUID
  Dim pUID As UID
  Set pUID = New UID
  pUID.Value = "{82D4EA60-72F6-11d4-80EA-00C04F601565}"
  Set IObjectClassDescription_InstanceCLSID = pUID
End Property
```

```
Private Property Get IObjectClassDescription_ModelName() As String
  IObjectClassDescription_ModelName = "MyObjectClass"
End Property

Private Property Get IObjectClassDescription_ModelNameUnique() As _
  Boolean
  IObjectClassDescription_ModelNameUnique = True
End Property

Private Property Get IObjectClassDescription_Name() As String
  IObjectClassDescription_Name = "MyObjectClass"
End Property

Private Property Get IObjectClassDescription_RequiredFields() As _
  esriCore.IFields
    Dim pFieldsEdit As IFieldsEdit
    Dim pFieldEdit As IFieldEdit

    Set pFieldsEdit = New Fields
    pFieldsEdit.FieldCount = 3

    'Add OID Field
    Set pFieldEdit = New Field
    pFieldEdit.Name = "OID"
    pFieldEdit.Type = esriFieldTypeOID

    Set pFieldsEdit.Field(0) = pFieldEdit

    'Add Shape Field
    Set pFieldEdit = New Field
    pFieldEdit.Name = "SHAPE"

    Dim pGeoDef As IGeometryDef
    Dim pGeoDefEdit As IGeometryDefEdit
    Set pGeoDef = New GeometryDef
    Set pGeoDefEdit = pGeoDef
    pGeoDefEdit.GeometryType = esriGeometryPolygon

    pFieldEdit.Type = esriFieldTypeGeometry
    Set pFieldEdit.GeometryDef = pGeoDefEdit
    Set pFieldsEdit.Field(1) = pFieldEdit

    'Add other Fields
    Set pFieldEdit = New Field
    pFieldEdit.Name = "MyValue"
    pFieldEdit.Type = esriFieldTypeString
    Set pFieldsEdit.Field(2) = pFieldEdit
    Set IObjectClassDescription_RequiredFields = pFieldsEdit
End Property
```

IFeatureClassDescription : IUnknown	***Feature Class Description Interface.***
■— FeatureType: esriFeatureType	*The esriFeatureType for the instances of this class.*
■— ShapeFieldName: String	*The name of the field containing the shape.*

The *IFeatureClassDescription* interface provides additional information to ArcCatalog for the creation of *FeatureClasses*.

The interface's two properties define the *FeatureType* and *ShapeFieldName* for the *FeatureClass*.

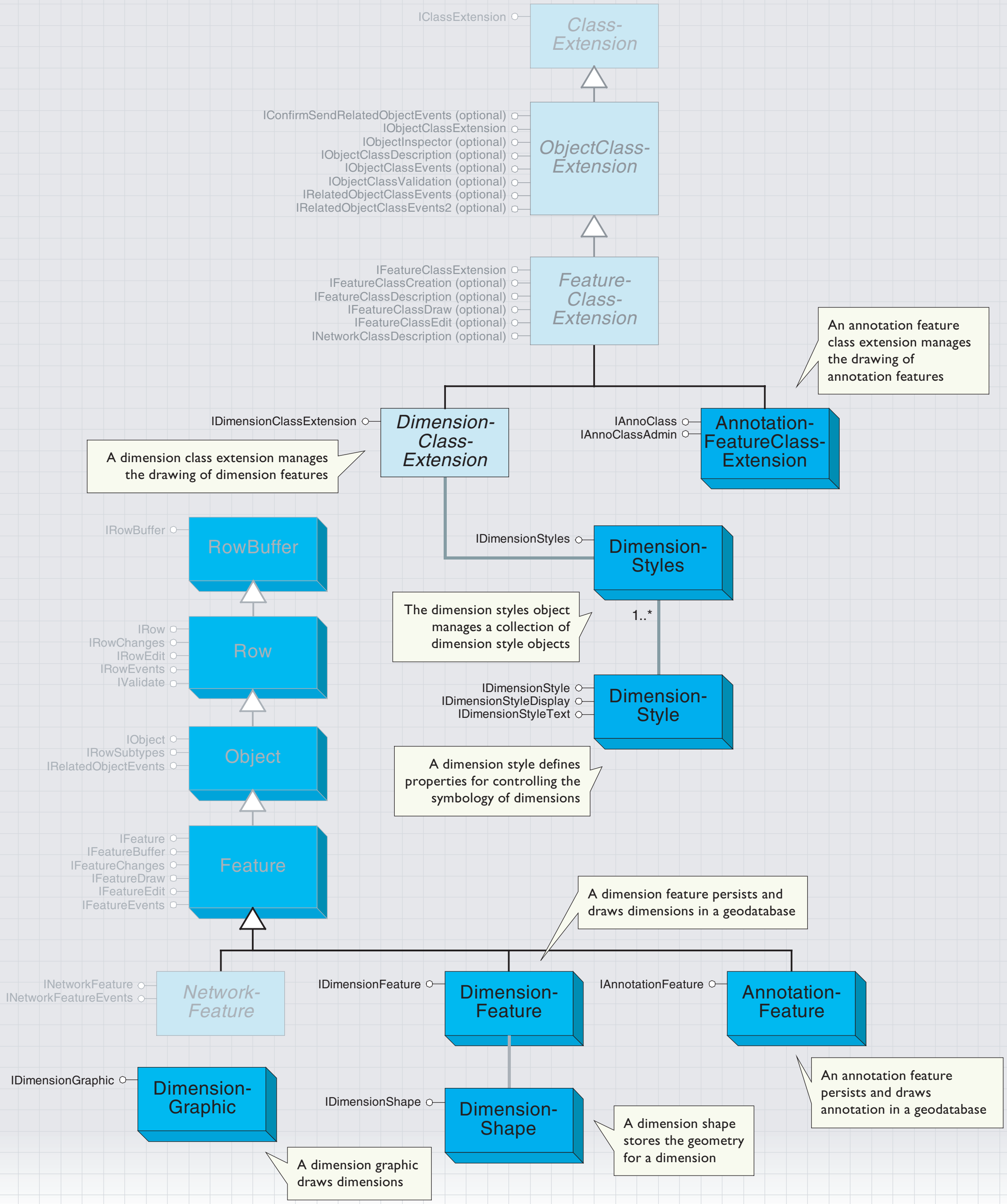
The *ShapeFieldName* is the name of the field defined with *esriFieldTypeGeometry* in the *RequiredFields* property of *IObjectClassDescription*.

INetworkClassDescription : IUnknown	***Network Class Description Interface.***
■— EnabledFieldName: String	
■— NetworkAncillaryRoleFieldName: String	

The *INetworkClassDescription* interface provides additional information to ArcCatalog for the creation of *NetworkFeatureClasses*. The names of the *Enabled* field and the *AncilliaryRole* field can be specified with the two properties of this interface. These fields should be included in the *RequiredFields* property of *IObjectClassDescription*.

Note that this interface is not yet available in ArcCatalog at ArcGIS 8.1, but you can implement it.

Annotation and dimension objects



An annotation feature class extension manages the drawing of annotation features

A dimension class extension manages the drawing of dimension features

The dimension styles object manages a collection of dimension style objects

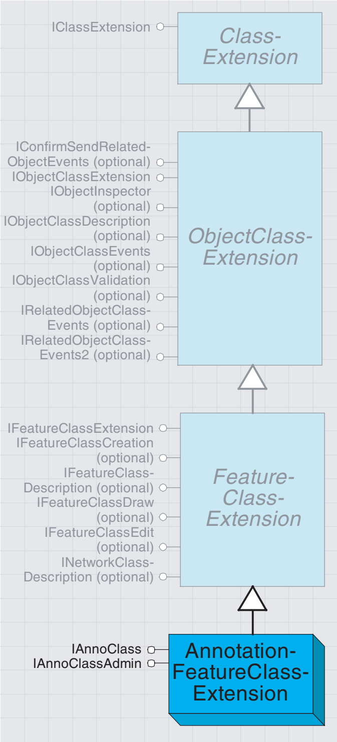
A dimension style defines properties for controlling the symbology of dimensions

A dimension feature persists and draws dimensions in a geodatabase

An annotation feature persists and draws annotation in a geodatabase

A dimension shape stores the geometry for a dimension

A dimension graphic draws dimensions


IClassExtension
Class-Extension
IConfirmSendRelated-ObjectEvents (optional)
IObjectClassExtension
IObjectInspector (optional)
IObjectClassDescription (optional)
IObjectClassEvents (optional)
IObjectClassValidation (optional)
IRelatedObjectClass-Events (optional)
IRelatedObjectClass-Events2 (optional)
ObjectClass-Extension
IFeatureClassExtension
IFeatureClassCreation (optional)
IFeatureClass-Description (optional)
IFeatureClassDraw (optional)
IFeatureClassEdit (optional)
INetworkClass-Description (optional)
Feature-Class-Extension
IAnnoClass
IAnnoClassAdmin
Annotation-FeatureClass-Extension

The annotation feature class extension manages the drawing of annotation features.

Annotation features persist and draw text or graphic elements stored in the geodatabase. An annotation feature class (*AnnoClass*) can be feature-linked or standalone. Feature-linking allows the text of the annotation to be derived from the value of a related feature. The lifetime of the annotation is also controlled by the lifetime of the related feature.

Annotation feature classes are created using methods on the *IFeatureWorkspaceAnno* interface on a geodatabase workspace.

Annotation features can persist (store) either an entire symbol inline or an ID for a group symbol. These two persistence mechanisms balance performance with flexibility.

Storing the symbol inline allows the modification of the symbol on a *Feature*-instance basis. Unfortunately, this method increases the size of a *Row* dramatically and may cause performance degradation when drawing large numbers of features in a multiuser environment.

A more efficient but less flexible alternative is to use group symbols. Group symbols are stored as properties of the *AnnotationFeatureClassExtension*. The *AnnotationFeature* stores an ID that references a symbol in the extension's *SymbolCollection*. Group symbol IDs are set using the *IGroupSymbolElement* interface on an *AnnotationFeature*'s *TextElement*. A small number of commonly changed attributes can be overridden with no performance penalties using the *IGroupSymbolElement* interface. Once an *AnnotationFeature* has an element with a group symbol, it is important that the symbol is not removed or modified in the *SymbolCollection*.

The *AnnotationFeatureClassExtension* is used to configure the drawing properties and symbology for annotation features. The *IAnnoClass* interface is used to access the *AnnotationLayerProperties* and group symbols. The *IAnnoClassAdmin* interface is used to update the properties of the class. ArcMap and ArcCatalog primarily use these interfaces.

IAnnoClass : IUnknown	***Provides access to members that control the annotation class.***
■— AnnoProperties: IAnnotateLayerPropertiesCollection	*The labeling properties annotation classes.*
■— ElementFieldIndex: Long	*The element field index.*
■— FeatureClass: IFeatureClass	*The feature class.*
■— FeatureIDFieldIndex: Long	*The feature ID field index.*
■— ReferenceScale: Double	*The reference scale.*
■— ReferenceScaleUnits: esriUnits	*The units of the reference scale.*
■— Symbol (in SymbolID: Long) : ISymbol	*The symbol associated with the given ID.*
■— SymbolCollection: ISymbolCollection	*The symbol collection.*
■— Version: Integer	*The version of the annotation class.*
← Draw (annoFeature: IAnnotationFeature, Display: IDisplay, Symbol: ISymbol)	*Draws the given annotation feature.*

The *IAnnoClass* interface provides access to the properties that control drawing and placement of annotation.

The *ReferenceScale* property is the scale at which the annotation's symbol will be drawn at its configured point size. The drawing of symbols is then scaled proportionally based on the reference scale and the current scale of the display's transformation.

The *ReferenceScaleUnits* property is only required when the *SpatialReference* of the annotation feature class is unknown.

The *Draw* method provides optimized drawing of a single *AnnotationFeature* coclass.

IAnnoClassAdmin : IUnknown	Provides access to members that control the annotation class admin interface.
AnnoProperties: IAnnotateLayerPropertiesCollection	The labeling properties annotation class.
AutoCreate: Boolean	Indicates if an annotation is to be automatically created when a feature is created.
ReferenceScale: Double	The reference scale.
ReferenceScaleUnits: esriUnits	The units of the reference scale.
SymbolCollection: ISymbolCollection	The symbol collection.
UpdateProperties	Updates the property set.

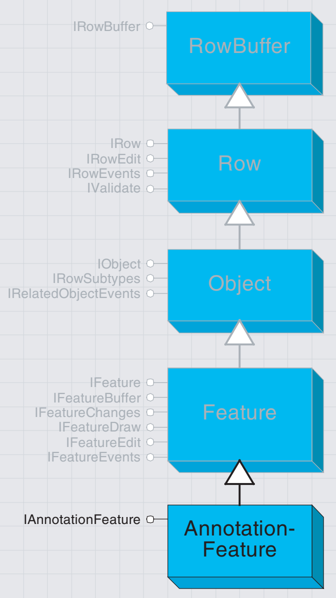
The *IAnnoClassAdmin* interface is used to modify the drawing properties of the *AnnotationFeatureClass*.

In a versioned geodatabase, these properties apply to all versions and are not versioned. After creating an *AnnotationFeatureClass*, modifying these properties may cause problems with the drawing and selection of *AnnotationFeatures*.

Adding new symbols to the *SymbolCollection* or changing the *AutoCreate* property are the only recommended modifications. Deleting or modifying symbols in the *SymbolCollection* requires updating all *AnnotationFeatures* whose elements reference the group symbol.

When adding new symbols to the *SymbolCollection*, it is necessary to assign an ID that is not already in use.

As with any schema-related change, an exclusive schema lock should be obtained before calling the *UpdateProperties* method.



An annotation feature object persists and draws annotation in the geodatabase.

The *AnnotationFeature* persists and draws *GraphicElements* that are stored in the geodatabase. For labeling, a *TextElement* is used. *AnnotationFeatures* can be linked to *Features* in a related *FeatureClass.*

IAnnotationFeature : IUnknown	***Provides access to members that control the annotation feature.***
Annotation: IElement	*The annotation element for the feature.*
LinkedFeatureID: Long	*Feature ID.*

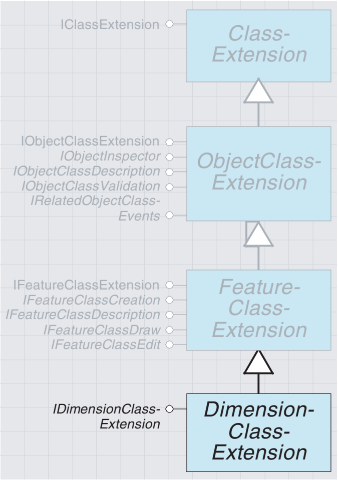
The *IAnnotationFeature* interface is used for relating *AnnotationFeatures* to other features or updating the graphic of the *Annotation*.

The *Annotation* property accepts any *GraphicElement*. If a *TextElement* is used, a group symbol can be assigned by using the *IGroupSymbol* interface. A *TextElement* that does not use a group symbol will have a group symbol ID of -1.

To relate an *AnnotationFeature* to another *Feature* (a *RelationshipClass* must already exist), assign the OID of the related feature to the *LinkedFeatureID* property. If the *AnnotationFeature* is not linked, the *LinkedFeatureID* property is -1. After updating either of these properties, the *IFeature::Store* methods must be called.

The following code sample demonstrates how to update the text of an *AnnotationFeature*:

```
Public Sub UpdateText(pAnnoFeature As IAnnotationFeature)
  Dim pElement As IElement
  Set pElement = pAnnoFeature.Annotation

  If TypeOf pElement Is ITextElement Then
    Dim pTextElement As ITextElement
    Set pTextElement = pElement
    pTextElement.Text = InputBox("Replace '" & pTextElement.Text & "' with:")
    pAnnoFeature.Annotation = pElement
    Dim pFeature As IFeature
    Set pFeature = pAnnoFeature
    pFeature.Store
  End If
End Sub
```



The dimension class extension manages the drawing of dimension features.

The *DimensionClassExtension* is used to configure the drawing properties and symbology for *DimensionFeatures*.

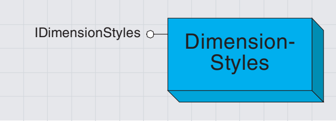
IDimensionClassExtension : IUnknown	***Provides access to members that control the dimension class extension for a dimension feature class.***
DimensionStyles: IDimensionStyles	*The collection of dimension styles associated with the dimension feature class.*
NativeTransformation: ITransformation	*The native display transformation of the dimension feature class.*
ReferenceScale: Double	*The reference scale of the dimension feature class.*
ReferenceScaleUnits: esriUnits	*The reference scale units of the dimension feature class.*
ResetProperties	*Resets the in state of the dimension feature class properties.*
UpdateProperties	*Updates the dimension featrue class' properties.*

The *IDimensionClassExtension* interface provides access to the *DimensionStyles* collection and the reference scale drawing properties.

The *ReferenceScale* property defines the scale at which symbols are drawn (at their defined size).

The *ReferenceScaleUnits* property is only used when the *DimensionFeatureClass*'s spatial reference is *Unknown*. Changing the *ReferenceScale* after the *FeatureClass* contains *Features* is not recommended, as those *Features*' geometries are controlled by the *ReferenceScale* property.

After making changes to any of the *IDimensionClassExtension* properties, it is necessary to call the *UpdateProperties* method. Changes can also be discarded by calling the *ResetProperties* method if *UpdateProperties* has not been called. As with any schema-related modification, an exclusive schema lock should be obtained on the *FeatureClass* before calling *UpdateProperties*.



The DimensionStyles *object manages a collection of* DimensionStyle *objects.*

The *DimensionStyles* coclass is used to retrieve, create, and delete the *DimensionStyles* coclass.

IDimensionStyles : IUnknown	*Provides access to memebers that control a collection of dimension styles for a dimension feature class.*
■—■ DefaultStyleID: Long	*The ID of the defualt dimension style.*
← AddStyle (in Style: IDimensionStyle)	*Adds a style to the collection.*
← DeleteStyle (in ID: Long)	*Deletes a dimension style.*
← FindStyle (in Name: String) : IDimensionStyle	*Find a dimension style by name.*
← GetStyle (in ID: Long) : IDimensionStyle	*A dimension style.*
← GetStyles: IEnumDimensionStyle	*All the dimension styles in the collection.*
← RenameStyle (in ID: Long, in Name: String)	*Renames a dimension style.*

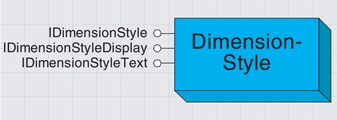
The *DimensionStyles* interface provides methods and properties for managing *DimensionStyle* objects.

In order to add a new *DimensionStyle* object, create a new *DimensionStyle* coclass, modify it, and call the *Add* method. When a style is added, a *StyleID* is automatically assigned to that *Style*.

The *DefaultStyleID* property specifies which style should be used by default in ArcMap. *DimensionStyle* objects can be retrieved by ID or name using the *GetStyle* and *FindStyle* methods.

Existing *DimensionStyle* objects can be renamed using the *Rename* method. Styles can only be deleted and not modified.

If a *DimensionStyle* is deleted, it is important to reassign a new *DimensionStyle* to existing *DimensionFeatures* that reference the deleted style.



A dimension style defines properties for controlling the symbology of dimensions.

The *DimensionStyle* coclass supports three interfaces for managing the symbology, behavior, and text of a *Dimension*.

IDimensionStyle : IUnknown	***Provides access to members that control the properties of a dimension style***
ID: Long	*ID of the style*
Name: String	*Name of the style*

The *IDimensionStyle* interface provides properties for identifying *DimensionStyles* coclass.

The *ID* property is read-only; it is assigned to a *DimensionStyle* when it is added to a *DimensionStyles* collection.

The *Name* property provides a label for the style and is set before adding a *DimensionStyle* to the *DimensionStyles* collection. The *Name* property must be unique within a *DimensionStyles* collection.

IDimensionStyleDisplay : IUnknown	***Provides access to members that control a dimension style's display***
BaselineHeight: Double	*Height of the construction for creating baseline dimensions with this style.*
BeginMarkerSymbol: IMarkerSymbol	*Symbol used for the begin arrow.*
DimensionLineDisplay: esriDimensionDisplay	*Dimension line display of the style.*
DimensionLineSymbol: ILineSymbol	*Symbol used for the dimension line.*
DrawLineOnFit: Boolean	*Indicates if a dimension line should be drawn between the extension lines for an inward dimension.*
EndMarkerSymbol: IMarkerSymbol	*Symbol used for the end arrow.*
ExtensionLineDisplay: esriDimensionDisplay	*Extension line display of the style.*
ExtensionLineOffset: Double	*Length of the extension line offset.*
ExtensionLineOvershot: Double	*Length of the extension line overshot.*
ExtensionLineSymbol: ILineSymbol	*Symbol used for the extension lines.*
MarkerDisplay: esriDimensionDisplay	*Arrow display of the style.*
MarkerFit: esriDimensionMarkerFit	*Arrow fit policy of the style.*
MarkerFitTolerance: Double	*Arrow fit tolerance of the style.*

The *IDimensionStyleDisplays* interface is used to control the display properties of the various parts of a *Dimension*.

The *esriDimensionDisplay* enumeration defines four values for use with several properties.

Enumeration esriDimensionDisplay	***Dimension display options***
0 - esriDimensionDisplayBoth	*Display both dimension parts.*
1 - esriDimensionDisplayBegin	*Only display the beginning dimension part.*
2 - esriDimensionDisplayEnd	*Only display the end dimension part.*
3 - esriDimensionDisplayNone	*Do not display any dimension parts.*

The *MarkerFit* property controls a *Dimension*'s behavior for fitting the text and label.

Enumeration esriDimensionMarkerFit	***Dimension Marker Fit Options***
0 - esriDimensionMarkerFitNone	*Do not fit markers with text.*
1 - esriDimensionMarkerFitTolerance	*Fit markers with text using the length of the dimension line.*
2 - esriDimensionMarkerFitText	*Fit markers when overlapping the text.*

The *esriDimensionMarkerFit* enumeration defines three values.

Setting *MarkerFit* to *esriDimensionMarkerFitTolerance* moves markers outside of extension lines if the *MarkerFitTolerance* is exceeded.

Setting *MarkerFit* to *esriDimensionMarkerFitText* moves markers to the outside if colliding with text. This option does not apply to custom text positions.

When the markers are moved because of a fit, a line will be drawn between the markers based on the *DrawLineOnFit* property.

The *BaselineHeight* property specifies the height above the selected *Dimension* at which new *Dimensions* will be created when using the Baseline Dimension tool in ArcMap.

IDimensionStyleText : IUnknown	***Privides access to members that control a dimension style's text.***
Align: Boolean	*Indicates if the text should be aligned with the dimension line.*
ConvertUnits: Boolean	*Indicates if the length of the dimension needs to be converted for display.*
DisplayPrecision: Long	*Precision for the value displayed by the dimension text.*
DisplayUnits: esriUnits	*Units the length of the dimension text is displayed in.*
Expression: String	*Text expression for the style.*
ExpressionParserName: String	*Text expression parser for the text expression for the style.*
ExpressionSimple: Boolean	*Indicates if the text expression is simple or custom for the style.*
ExtendLineOnFit: Boolean	*Indicates if the dimension line will be extended to underline the text on inward dimensions.*
prefix: String	*Prefix for the text expression for the style.*
Suffix: String	*Suffix for the text expression for the style.*
TextDisplay: esriDimensionTextDisplay	*Text display setting for the style.*
TextFit: esriDimensionTextFit	*Text fit policy for the style.*
TextSymbol: ITextSymbol	*Symbol used for the text.*

The *IDimensionStyleText* interface contains properties that control how the text of a *Dimension* is displayed.

The *Align* property forces the text to align to the angle of the *DimensionLine*. If the *Align* property is *False*, the *TextSymbol*'s angle is used.

The *ConvertUnits* property specifies whether or not the value of the text will be converted from the *FeatureClass*'s native units to the units of the *DisplayUnits* property.

The text can be formatted using the *DisplayPrecision* property and the *TextDisplay* property.

The *esriDimensionTextDisplay* enumeration defines four values for formatting the text string.

Enumeration esriDimensionTextDisplay	***Dimension Text Display Options***
0 - esriDimensionTDValueOnly	*Only display the value of the dimension length.*
1 - esriDimensionTDPrefixSuffix	*Display the value of the dimension length with a prefix and suffix.*
2 - esriDimensionTDExpression	*Display a text string derived from a custom expression.*
3 - esriDimensionTDNone	*Do not display any text.*

The text string can also be determined from an expression specified in the *Expression* property. The expression can be a simple concatenation of column values and strings or a function written in scripting language.

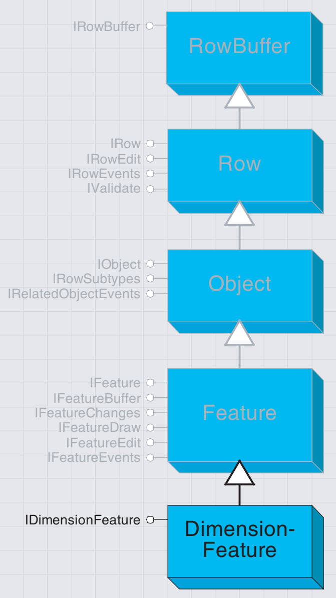
The name of the parser for the expression is specified in the *ExpressionParserName* property. The currently available parsers are "VB Script" and "Java Script".

The *TextFit* property determines where the text will be placed if it does not fit between the markers after they have been moved (due to marker fit settings).

The *esriDimensionTextFit* enumeration defines three values for this behavior.

Enumeration esriDimensionTextFit	***Dimension Text Fit Options***
0 - esriDimensionTextFitNone	*Do not fit the text*
1 - esriDimensionTextFitMoveBegin	*Move the text outside the begin extension line*
2 - esriDimensionTextFitMoveEnd	*Move the text outside the end extension line*

When the markers are moved because of a fit, a line will be drawn between the markers based on the *DrawLineOnFit* property.



The DimensionFeature *object persists and draws dimensions in the geodatabase.*

The *DimensionFeature* coclass draws dimensions using a *DimensionStyle* coclass. The feature's *DimensionShape* determines the placement and length of the *Dimension*.

IDimensionFeature : IUnknown	*Provides access to members that control a dimension feature.*
CustomLength: Double	*The dimension feature's custom or user-defined length.*
DimensionLineDisplay: esriDimensionDisplay	*The dimension line display for the feature.*
DimensionShape: IDimensionShape	*The dimension feature's shape.*
DimensionType: esriDimensionType	*The dimension type of the feature.*
ExtensionLineDisplay: esriDimensionDisplay	*The extension line display of the feature.*
Length: Double	*The dimension feature's length.*
MarkerDisplay: esriDimensionDisplay	*The arrow display of the feature.*
StyleID: Long	*The dimension feature's style ID.*
UseCustomLength: Boolean	*Indicates if this dimension feature displays the dimension length or a custom length.*

The *IDimensionFeature* provides properties for setting the style and placement of a *DimensionFeature*.

The *StyleID* property should be a valid ID from the class' *DimensionStyles* collection. If the current ID is invalid, the *DimensionFeature* will draw its boundary in red.

The *DimensionShape* property defines the placement of the elements of a *Dimension*. The location and size of the *DimensionFeature* are determined entirely by the *DimensionShape*; it is not necessary to use the *IFeature::Shape* property.

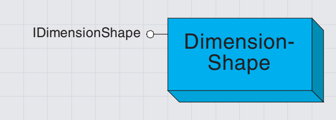
The *DimensionType* property defines the type of the *Dimension* as linear or aligned and affects how the Edit tool behaves with the *DimensionFeature* during shape modification.

The *DimensionLineDisplay, ExtensionLineDisplay,* and *MarkerDisplay* properties are values that override the values of the current *DimensionStyle* coclass.

A custom value for the *DimensionFeature*'s text can be set using the *CustomLength* property and by setting the *UseCustomLength* property to *True*.

The following code demonstrates how to set a custom value for the *DimensionFeature*'s text.

```
Public Sub SetCustomLength(pDimensionFeature As IDimensionFeature, _
    dValue As Double)
  pDimensionFeature.CustomLength = dValue
  pDimensionFeature.UseCustomLength = True

  Dim pFeature As IFeature
  Set pFeature = pDimensionFeature
  pFeature.Store
End Sub
```



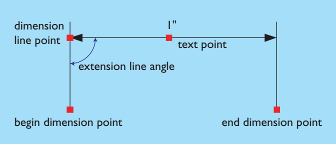
The DimensionShape *object stores the geometry for a* Dimension.

The *DimensionShape* coclass stores points for a dimension's measurements. The *DimensionFeature* and *DimensionGraphic* use *DimensionShapes* to draw and store dimensions.

IDimensionShape : IUnknown	***Provides access to members that control a dimension shape.***
■—□ BeginDimensionPoint: IPoint	*The begin dimension point.*
■—□ DimensionLinePoint: IPoint	*The point which describes the height of the dimension line.*
■—□ EndDimensionPoint: IPoint	*The end dimension point.*
■—■ ExtensionLineAngle: Double	*The angle of the extension lines in radians.*
■—■ TextAngle: Double	*The angle of the text in radians.*
■—□ TextPoint: IPoint	*The point for the text placement.*

The *IDimensionShape* interface supports properties for the definition of a dimension's location and measurement.

The *BeginDimensionPoint* and *EndDimensionPoint* properties define the dimension's measurement point.



The components of a DimensionShape

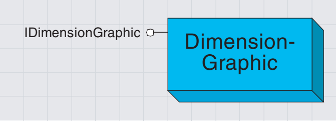
The *DimensionLinePoint* property determines the height of the dimension line above the baseline.

To create a two-point dimension, the *DimensionLinePoint* must be the same value as the *BeginDimensionPoint*.

The *ExtensionLineAngle* property defines the angle between the dimension line and the extension line in degrees. The default angle is 90 degrees; oblique dimensions have angles less than or greater than 90 degrees.

The *DimensionShape* supports a custom text location using the *TextPoint* property.

For the default location of the dimension text, the *TextPoint*'s *IGeometry::IsEmpty* property should be *True*.



The DimensionGraphic *object draws dimensions.*

The *DimensionGraphic* is used for dynamically rendering dimensions using a *DimensionStyle* and *DimensionShape*.

IDimensionGraphic : IUnknown	*Provides access to members that control a dimension graphic.*
CustomLength: Double	*The custom length of the dimension graphic.*
DimensionShape: IDimensionShape	*The begin dimension point.*
Length: Double	*The length of the dimension graphic.*
NativeTransformation: ITransformation	*The native transformation for the dimension graphic.*
NativeUnits: esriUnits	*The native units of the dimension graphic.*
Style: IDimensionStyle	*The dimension style.*
UseCustomLength: Boolean	*Indicates if a custom length is displayed for the dimension graphic.*
Draw (in hDC: Long, in Transformation: ITransformation)	*Draws the dimension style.*
GetDefaultTextPoint: IPoint	*The default location of the dimension text placement.*
GetMask (in hDC: Long, in Transformation: ITransformation, in Mask: IGeometry)	*The dimension graphic mask.*
QueryBoundary (in hDC: Long, in Transformation: ITransformation, in Boundary: IPolygon)	*The boundary of the dimension style.*
UpdateShape (in hDC: Long, in Transformation: ITransformation, in pFeature: IFeature)	*Updates the dimension geometries for the dimension graphic.*

The *IDimensionGraphic* interface provides methods and properties for drawing dimensions.

The *Style* property sets the *DimensionStyle* for the *DimensionGraphic*.

The *DimensionShape* defines the location of the dimension's measurements and text.

The *Length* property returns the current calculated length for the *Dimension*. A custom length value can be specified using the *CustomLength* and *UseCustomLength* properties.

If the current *DimensionShape* contains a nonempty *TextPoint*, the default location for the text is available through the *GetDefaultTextPoint* method.

If the current *DimensionStyle* supports text value conversion, the native units and transformation can be set with the *NativeUnits* and *NativeTransformation* properties.

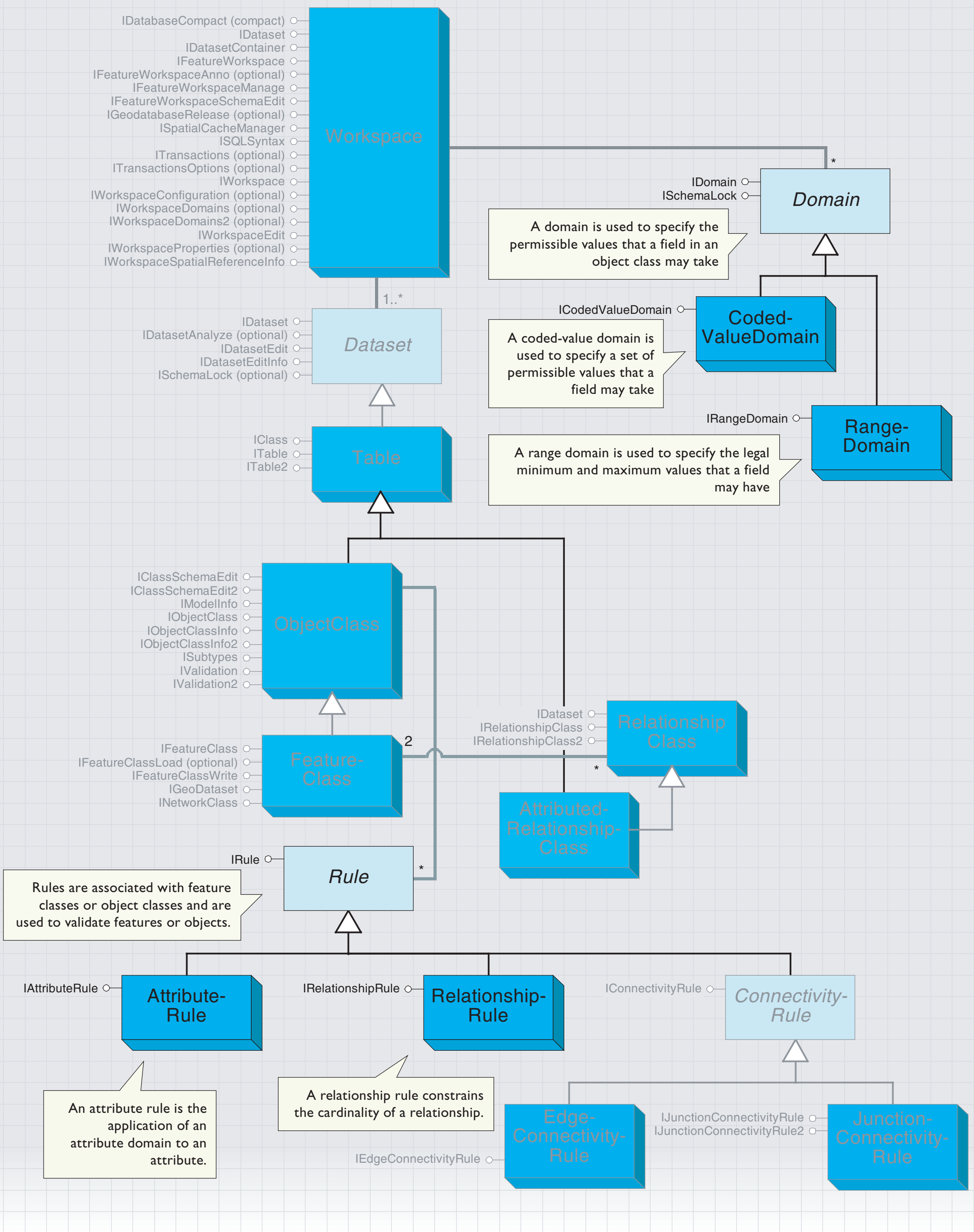
The *Draw* method draws a dimension on the device context specified by the *hDC* parameter using the transformation specified in the *pTransformation* parameter.

The *QueryBoundary* method returns the *Envelope* of the dimension.

The *GetMask* method returns the outline polygon of the dimension.

If the properties of the *DimensionGraphic* are changed, it is necessary to call the *UpdateShape* method to recalculate the dimension. The *pFeature* parameter of the *UpdateShape* method is only necessary when the current style uses a text expression.

Domain and validation rule objects



A domain is used to specify the permissible values that a field in an object class may take

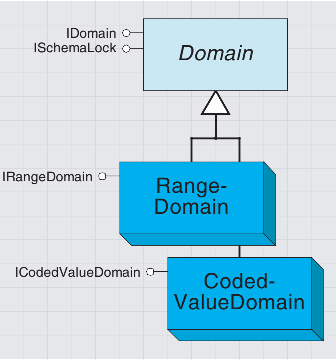
A coded-value domain is used to specify a set of permissible values that a field may take

A range domain is used to specify the legal minimum and maximum values that a field may have

Rules are associated with feature classes or object classes and are used to validate features or objects.

An attribute rule is the application of an attribute domain to an attribute.

A relationship rule constrains the cardinality of a relationship.



A domain is used to specify the permissible values that a field in an object class may take.

A *Domain* is an abstract class that defines an interface used by *RangeDomain* and *CodedValueDomain* coclasses to constrain the permissible values that may be associated with a particular field on an object or feature class. *Domains* are assigned on a subtype basis.

Domains are used by the ArcMap property inspector to constrain the values that the user can enter for a field, as well as during the validation process within the geodatabase.

A *Domain* may be shared by any number of fields. *Domains* are associated with a *Field* object. Domains are added to a dataset at the workspace level through *IWorkspaceDomains::AddDomain*.

IDomain : IUnknown	Provides access to members that return and modify domains and their merge and split policies.
Description: String	The description of the domain.
DomainID: Long	The ID of the domain.
FieldType: esriFieldType	The field type of the field.
MergePolicy: esriMergePolicyType	The merge policy.
Name: String	Gets the name of the domain.
Owner: String	Gets the owner of the domain.
SplitPolicy: esriSplitPolicyType	The split policy.
Type: esriDomainType	The domain type.
MemberOf (in Value: Variant) : Boolean	Returns whether the value is a valid member of the domain.

The *IDomain* interface provides access to the common properties shared across both types of *Domains*. Each of the properties are read–write except for the *Type* property. When creating and assigning a *Domain* to a particular field, the client is required to set the *Name* and *FieldType* properties.

For information on the *ISchemaLock* interface, see the documentation on the *Dataset* abstract class.

A range domain is used to specify the legal minimum and maximum values that a field may have.

RangeDomains may be associated with fields that are either numeric fields (such as *esriFieldTypeSmallInteger* or *esriFieldTypeDouble*) or date fields. *RangeDomains* may not be associated with string or character fields (*esriFieldTypeString*).

IRangeDomain : IUnknown	Provides access to members that return and modify range domain values.
MaxValue: Variant	The maximum value for the associated attribute.
MinValue: Variant	The minimum value for the associated attribute.

The *IRangeDomain* interface allows the client to either examine the minimum and maximum range values of an existing object or set the range values in a new *RangeDomain* that they are in the process of creating.

A coded value domain is used to specify a set of permissible values that a field may take.

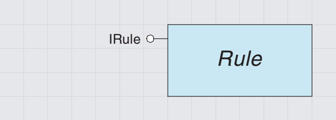
CodedValueDomains store a set of (value, name) pairs that represent the discrete values that a field may take. The value is what is actually persisted inside a field; the name is what is displayed by the ArcMap property inspector. The name can be considered to be a human-readable string that describes what the value represents. In contrast to *RangeDomains*, *CodedValueDomains* may also be associated with string fields (*esriFieldTypeString*)—the value may be a string.

ICodedValueDomain : IUnknown	Provides access to members that return and modify coded value domain values.
■— CodeCount: Long	The number of codes for the associated attribute.
■— Name (in Index: Long) : String	The code name for the specified code index.
■— Value (in Index: Long) : Variant	The value for the specified code index.
← AddCode (in Value: Variant, in Name: String)	Adds a (value, name) code.
← DeleteCode (in Value: Variant)	Deletes a code with the specified value.

The *ICodedValueDomain* interface provides the mechanism for adding and removing the (value, name) pairs from a *CodedValueDomain*. In addition, it provides properties that allow users to examine the (value, name) pairs on an index basis. Thus, this index value must be between 0 and *CodeCount* -1 or an error will be returned.

The following VBA® code fragment demonstrates how a user could use these properties in order to display all the (value, name) pairs associated with a *CodedValueDomain*.

```
Dim pCodedValueDomain as ICodedValueDomain
Set pCodedValueDomain = pDomain  'assume an existing domain
Dim lCount as Long
lCount = pCodedValueDomain.CodeCount

'Iterate through the coded value pairs
Dim i As Long, vValue As Variant, sName As String
For i = 0 To lCount - 1
  vValue = pCodedValueDomain.Value(i)
  sName = pCodedValueDomain.Name(i)
  MsgBox "value: " & vValue & vbCr & "name: " & sName
Next i
```



A rule is used during the process of validation.

Rules are associated with object classes and are used during the process of validating objects within an object class. There are three categories of rules that are subclassed from the *Rule* abstract class. They are attribute rules (*AttributeRule*), relationship rules (*RelationshipRule*), and connectivity rules *(ConnectivityRule)*, further broken down into *JunctionConnectivityRule* and *EdgeConnectivityRule*.

Associating a rule with a class does not guarantee that all objects within the class will always be valid; the validation process still needs to be run through the Editor toolbar or with *IValidation::Validate*. Through the *IValidation* interface (found on the *Object* class), the set of currently defined rules can be accessed, new rules can be added, and objects can be validated.

Creating a class extension can extend the types of rules that can be defined for an object class. By implementing *IObjectClassValidation* (along with *IClassExtension*), any type of custom validation rule can be coded.

IRule : IUnknown	***Provides access to members that return information about rules.***
Category: Long	*The name associated with the validation rule.*
Helpstring: String	*The helpstring associated with the validation rule.*
ID: Long	*The ID of the validation rule.*
Type: esriRuleType	*The type associated with the validation rule.*

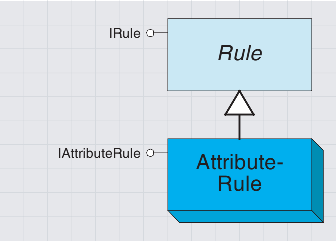
IRule is a generic interface that supports validation rules on an object class. Use this interface when you want to determine the type of rule and the helpstring associated with it.

Helpstring displays the message associated with the rule. This message is displayed during the process of validating a single feature when that feature is found to be invalid. The helpstring of the first (of possibly many) validation rule that is found to be invalid is displayed through the ArcMap user interface.

Type specifies the type of rule (attribute, relationship, or connectivity) and can be used to determine what validation rule object you are holding. Alternatively, you can attempt to probe for the appropriate interfaces (for example, if the *Rule* supports *IAttributeRule*, then it is an *AttributeRule*).

The following VBA code extracts the rules defined for a layer called “pipes” and prints the type of the rule and helpstring associated with the rule.

```
Private Sub GetRules()
  Dim pDoc As IMxDocument, pMap As IMap, pFLayer As IFeatureLayer
  Dim lLoop As Long
  Set pDoc = ThisDocument
  Set pMap = pDoc.FocusMap

  'Find the feature layer containing "pipes"
  For lLoop = 0 To pMap.LayerCount - 1
  For lLoop = 0 To pMap.LayerCount - 1
    If pMap.Layer(lLoop).Name = "pipes" Then
      Set pFLayer = pMap.Layer(lLoop)
       Exit For
    End If
  Next lLoop

  If pFLayer Is Nothing Then Exit Sub

  Dim pObjClass As IValidation, pEnumRule As IEnumRule, pRule As IRule
  Set pObjClass = pFLayer.FeatureClass
  Set pEnumRule = pObjClass.Rules
  Set pRule = pEnumRule.Next

  Do While Not pRule Is Nothing
    If TypeOf pRule Is IAttributeRule Then
      Debug.Print "Attribute rule - " & pRule.Type & " - " & _
        pRule.Helpstring
    ElseIf TypeOf pRule Is IRelationshipRule Then
      Debug.Print "Relationship rule - " & pRule.Type & " - " & _
        pRule.Helpstring
    ElseIf TypeOf pRule Is IJunctionConnectivityRule Then
      Debug.Print "JunctionConnectivity rule - " & pRule.Type & " - " & _
        pRule.Helpstring
    ElseIf TypeOf pRule Is IEdgeConnectivityRule Then
      Debug.Print "EdgeConnectivity rule - " & pRule.Type & " - " & _
        pRule.Helpstring
    End If

    Set pRule = pEnumRule.Next
  Loop
End Sub
```

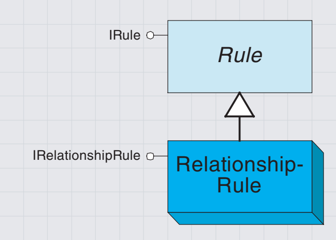


An attribute rule applies an attribute domain to a field of an object class.

The *AttributeRule* class is used to define attribute-specific rules on an object class. This type of rule applies a specified domain to a field name with a specific subtype. Domains can be used to limit the attribute values to a set of valid values or to a range of values. Domains can also define how values in the field are distributed during a split or merge. The process of associating a domain with a field in an object class creates an *AttributeRule* as a side effect—thus, it is generally not the case that users must explicitly create *AttributeRules*.

IAttributeRule : IRule	***Provides access to members that return, modify, and validate attribute rules.***
DomainName: String	*The domain name associated with the attribute rule.*
FieldName: String	*The field name associated with the attribute rule.*
SubtypeCode: Long	*The subtype code.*
Validate (in Row: IRow, out errorMessage: String) : Boolean	*Validates the rule.*

IAttributeRule is an interface that inherits directly from *IRule*. This interface provides access to the characteristics of the attribute rule, such as the field name, domain name, and subtype code.



A RelationshipRule *constrains the cardinalities between two subtypes that participate in a* RelationshipClass.

DestinationMaximumCardinality *and* DestinationMinimumCardinality *are only applicable in 1–M and M–N relationships.* OriginMaximumCardinality *and* OriginMinimumCardinality *are only applicable in M–N relationships.*

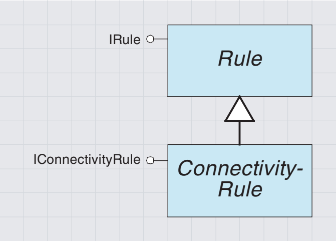
The *RelationshipRule* class further constrains the relationship cardinalities associated with pairs of subtypes between the two object classes that participate in a *RelationshipClass*. Thus, if the *RelationshipClass* is a one-to-many relationship, a *RelationshipRule* may, for example, constrain the cardinalities between two subtypes to be one–three. The *RelationshipRule* may not conflict with the *RelationshipClass*. For example, a one-to-many *RelationshipClass* may not have any associated relationship rules that constrain the cardinalities to be two to two. One *RelationshipRule* is necessary for each subtype pair that participates in the *RelationshipClass*.

IRelationshipRule : IRule	***Provides access to members that supply information about, modify, and manage relationship rules.***
DestinationClassID: Long	*The ID of the destination ObjectClass.*
DestinationMaximumCardinality: Long	*The maximum cardinality value of the destination ObjectClass.*
DestinationMinimumCardinality: Long	*The minimum cardinality value of the destination ObjectClass.*
DestinationSubtypeCode: Long	*The subtype value of the destination ObjectClass.*
OriginClassID: Long	*The ID of the origin ObjectClass.*
OriginMaximumCardinality: Long	*The maximum cardinality value of the origin ObjectClass.*
OriginMinimumCardinality: Long	*The minimum cardinality value of the origin ObjectClass.*
OriginSubtypeCode: Long	*The subtype value of the origin ObjectClass.*

The *IRelationshipRule* interface inherits from *IRule*. This interface provides access to the various parameters of a relationship rule that are used to refine the cardinalities between subtypes participating in the *RelationshipClass*. Use this interface when you want to set or retrieve these parameters.

DestinationMaximumCardinality and *DestinationMinimumCardinality* are only applicable in one-to-many and many-to-many relationships.

OriginMaximumCardinality and *OriginMinimumCardinality* are only applicable in many-to-many relationships.



A connectivity rule constrains the type of network connectivity that may be established between edges and junctions in the geometric network.

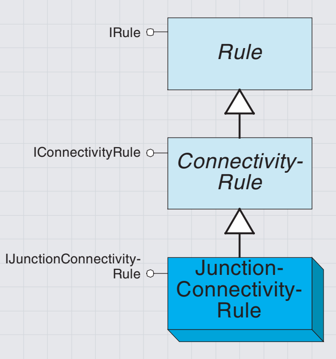
Within a geometric network, any edge may connect to any junction. *ConnectivityRules* are used to constrain the permissible connectivity between edges and junctions. There are two types of connectivity rules that can be applied. *JunctionConnectivityRules* are placed on junction object classes and determine the valid types of edges that can be connected. *EdgeConnectivityRules* are placed on edge object classes and determine the valid types of junction or edges (through a junction) that can be connected. Connectivity rules can only be established between network feature classes.

It is important to note that if one *ConnectivityRule* is specified, then they all must be specified. Otherwise, the validation process on *NetworkFeatures* will report a very large number of invalid features. You must also remember to include the default (or orphan) junction when specifying all the *ConnectivityRules*.

IConnectivityRule : IRule	***Identity interface for connectivity rules.***

The *IConnectivityRule* interface inherits from *IRule*. This interface currently has no properties or methods; it serves only to identify an object as being of type *ConnectivityRule*.

The *JunctionConnectivityRule* class is a type of *ConnectivityRule* that constrains the possible valid network connections that may exist between a pair of edge and junction subtypes. It may also constrain the cardinalities of the connectivity relationships.



Junction connectivity rules specify which edges can connect to a junction.

IJunctionConnectivityRule : IConnectivityRule	***Provides access to members that supply information about, modify, and manage junction-edge connectivity rules.***
■■ EdgeClassID: Long	*The ID of the NetworkEdge FeatureClass.*
■■ EdgeMaximumCardinality: Long	*The maxnimum cardinality value of the NetworkEdge FeatureClass.*
■■ EdgeMinimumCardinality: Long	*The minimum cardinality value of the NetworkEdge FeatureClass.*
■■ EdgeSubtypeCode: Long	*The subtype value of the NetworkEdge FeatureClass.*
■■ JunctionClassID: Long	*The ID of the NetworkJunction FeatureClass.*
■■ JunctionMaximumCardinality: Long	*The maximum cardinality value of the NetworkJunction FeatureClass.*
■■ JunctionMinimumCardinality: Long	*The minimum cardinality value of the NetworkJunction FeatureClass.*
■■ JunctionSubtypeCode: Long	*The subtype value of the NetworkJunction FeatureClass.*

The *IJunctionConnectivityRule* interface inherits from *IConnectivityRule*. This interface defines the junction connectivity properties and the valid types of edges that can connect to them. Use this interface when you want to define or manipulate rules between an edge and a junction.

All *ConnectivityRules* are specified on a class subtype basis; thus, *EdgeSubtypeCode* and *JunctionSubtypeCode* must be specified when subtypes have been defined for the object class. The cardinality properties may be optionally specified.

IJunctionConnectivityRule2 : IJunctionConnectivityRule

Provides access to members that supply information about, modify, and manage junction-edge connectivity rules.

DefaultJunction: Boolean	*True if the junction corresponds to the default junction.*

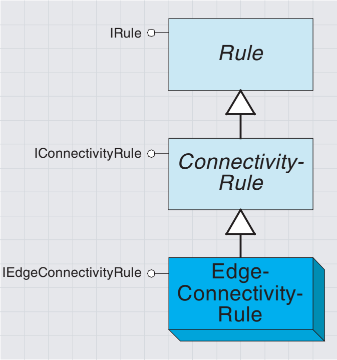
The *IJunctionConnectivityRule2* interface on the *JunctionConnectivityRule* class is used to specify whether or not the associated *JunctionFeature* serves as the default junction for the associated *EdgeFeature*. Among all the junction connectivity rules that are associated with a particular edge class and subtype pair, only one junction connectivity rule may serve as the default.

When the *EdgeFeature* is created during the edit session, the default junction (as specified in the associated *JunctionConnectivityRule*) will be placed at either of the possible two freestanding endpoints (for example, the end of a cul-de-sac). If a default junction has not been specified in this manner, then the standard system default junction (or orphan junction) will be connected at the freestanding endpoint.

DefaultJunction returns *True* when the defined junction (class ID and subtype) is the default junction to be added with the defined edge (class ID and subtype).

The following VBA code checks the validity of the nodes at the end of the selected edge feature based on *JunctionConnectivityRules*.

```
Public Sub CheckConnectivityRules()
  Dim pMxDoc As IMxDocument, pMap As IMap
  Set pMxDoc = ThisDocument
  Set pMap = pMxDoc.FocusMap

  Dim pFeatures As IEnumFeature, pFeature As IFeature, _
    sValidationResult As String
  Set pFeatures = pMap.FeatureSelection
  Set pFeature = pFeatures.Next

  Do While Not pFeature Is Nothing
    If TypeOf pFeature Is IEdgeFeature Then
      Dim pValidation As IValidation, pRules As IEnumRule, _
        pRule As IRule, i As Long
      Dim pJuncFeature As IFeature, pJuncSubtype As IRowSubtypes
      Dim pEdgeFeature As IEdgeFeature
      Dim bFromValid As Boolean, bToValid As Boolean

      Set pEdgeFeature = pFeature
      Set pValidation = pFeature.Class
      Set pRules = pValidation.Rules
      bFromValid = False
      bToValid = False

      For i = 0 To 1
       If i = 0 Then 'Get from Junction
        Set pJuncFeature = pEdgeFeature.FromJunctionFeature
      Else 'Get to Junction
       Set pJuncFeature = pEdgeFeature.ToJunctionFeature
       End If


      Set pJuncSubtype = pJuncFeature

      pRules.Reset
      Set pRule = pRules.Next

      Do While Not pRule Is Nothing
        If TypeOf pRule Is IJunctionConnectivityRule Then
         Dim pJuncConnRule As IJunctionConnectivityRule
          Set pJuncConnRule = pRule

          If pJuncConnRule.JunctionClassID = _
           pJuncFeature.Class.ObjectClassID And _
           pJuncConnRule.JunctionSubtypeCode = _
           pJuncSubtype.SubtypeCode Then
              If i = 0 Then
                bFromValid = True
              Else
                bToValid = True
              End If
            End If
           End If

          Set pRule = pRules.Next
         Loop
       Next i
     End If

     'Compose the message
     If bFromValid Then
      sValidationResult = "Junctiion on FROM end is valid."
     Else
      sValidationResult = "Junction on FROM end is not valid."
     End If
     If bToValid Then
      sValidationResult = _
        sValidationResult & "- Junction on TO end is valid."
     Else
      sValidationResult = _
        sValidationResult & "- Junction on TO end is not valid."
     End If

    MsgBox sValidationResult
    Set pFeature = pFeatures.Next
  Loop
End Sub
```



An edge connectivity rule constrains to what type of edge a particular edge may connect.

The *EdgeConnectivityRule* class is a type of *ConnectivityRule* that defines the permissible relationship between two edge features. In addition, it specifies all the valid junctions that may exist at the connection point between the two edges. It is also possible to specify the default junction that will be placed at the point of connectivity between the two edges.

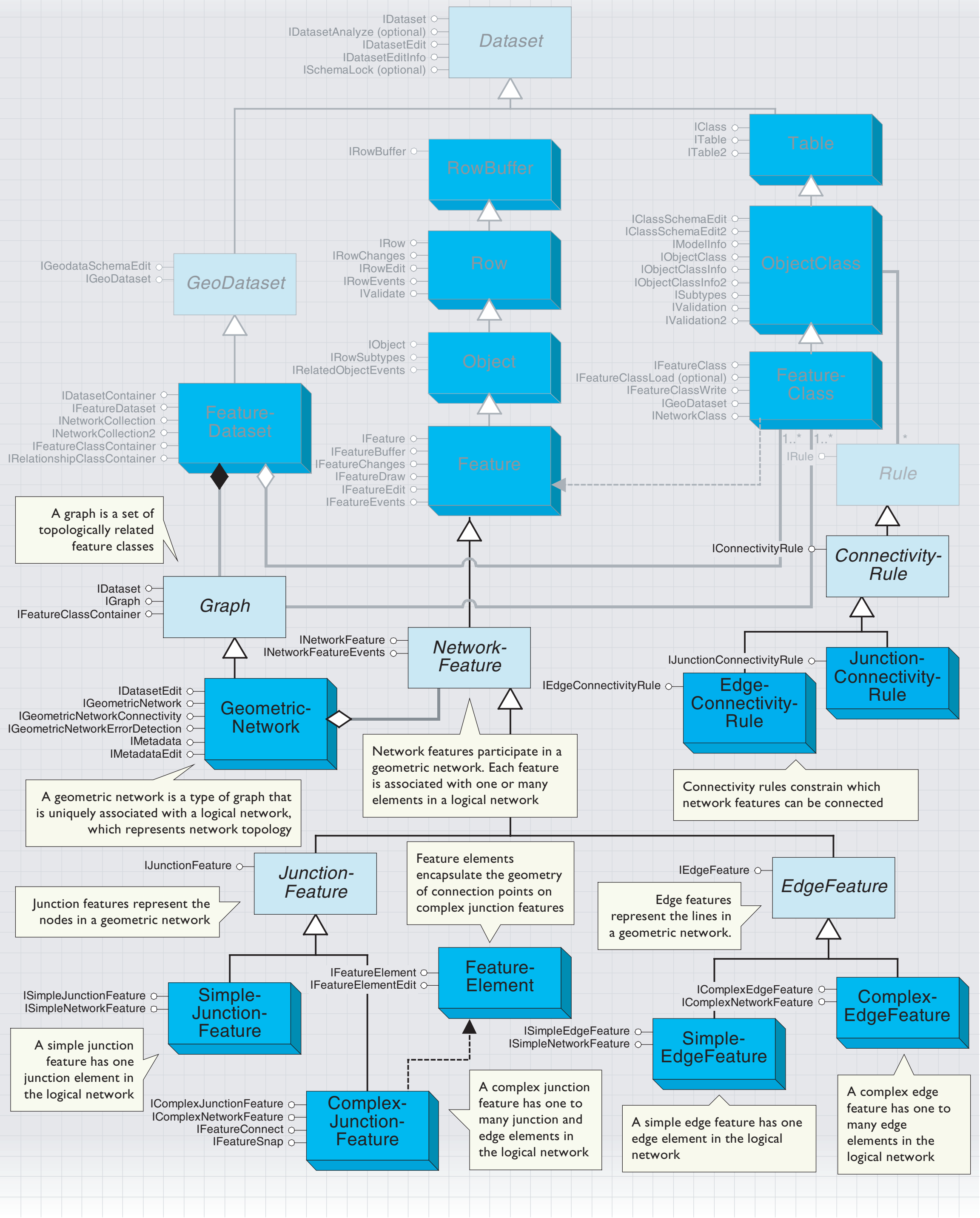
IEdgeConnectivityRule : IConnectivityRule	***Provides access to members that supply information about, modify, and manage edge-edge connectivity rules.***
DefaultJunctionClassID: Long	*The ID of the default junction feature class.*
DefaultJunctionSubtypeCode: Long	*The subtype value of the default junction feature class.*
FromEdgeClassID: Long	*The ID of the source NetworkEdge feature class.*
FromEdgeSubtypeCode: Long	*The subtype value of the source NetworkEdge feature class.*
JunctionClassID (in Index: Long) : Long	*The specified permissible value for the associated attribute.*
JunctionCount: Long	*The number of valid junctions.*
JunctionSubtypeCode (in Index: Long) : Long	*The specified permissible value for the associated attribute.*
ToEdgeClassID: Long	*The ID of the destination NetworkEdge feature class.*
ToEdgeSubtypeCode: Long	*The subtype value of the target NetworkEdge feature class.*
AddJunction (in ClassID: Long, in SubtypeCode: Long)	*The permissible values for the associated attribute.*
ContainsJunction (in ClassID: Long, in SubtypeCode: Long) : Boolean	*Returns whether the specified junction class ID is in the valid junction list.*
GetJunctionInfo (in Index: Long, out ClassID: Long, out SubtypeCode: Long)	*The specified permissible value for the associated attribute.*

The *IEdgeConnectivityRule* interface inherits from *IConnectivityRule*. This interface defines the two types of edges (they can be of the same type) and the valid junctions that can exist between them.

DefaultJunctionClassID and *DefaultJunctionSubtypeCode* define the default junction that will be added at the location where connectivity is established between two edges of the specified type.

The number of junctions associated with the *EdgeConnectivityRule* is unlimited. Junctions are managed through this interface and are accessed on an index basis (the *JunctionCount* property and the *JunctionClassID* and *JunctionSubtypeCode* index-based properties). It is not possible to remove a junction from the rule; if this is required, the rule must be deleted and then re-created, less the junction, to be deleted.

Geometric network objects



A graph is a set of topologically related feature classes

Network features participate in a geometric network. Each feature is associated with one or many elements in a logical network

Connectivity rules constrain which network features can be connected

A geometric network is a type of graph that is uniquely associated with a logical network, which represents network topology

Junction features represent the nodes in a geometric network

Feature elements encapsulate the geometry of connection points on complex junction features

Edge features represent the lines in a geometric network.

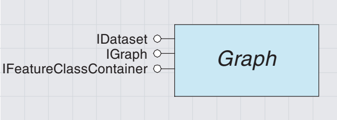
A simple junction feature has one junction element in the logical network

A complex junction feature has one to many junction and edge elements in the logical network

A simple edge feature has one edge element in the logical network

A complex edge feature has one to many edge elements in the logical network

GRAPH ABSTRACT CLASS



A graph is a set of topologically related feature classes.

A *Graph* is an abstract class that factors behavior and attribution common to the different types of topological collections within the geodatabase. (At this release, the geometric network is the only type of graph.)

IGraph : IUnknown	*ESRI graph interface.*
FeatureDataset: IFeatureDataset	*The FeatureDataset associated with the graph.*
VertexBasedStretching: Boolean	*The stretching model to nearest vertex- (True) or junction- (False) based stretching.*
Add (in NewFeature: IFeature)	*Adds the preexisting feature to the graph.*
AddFeatureClass (in FeatureClass: IFeatureClass, in EnabledFieldName: String, in role: esriNetworkClassAncillaryRole, in ancillaryRoleFieldName: String)	*Add the FeatureClass to this graph.*
DeleteSet (in featuresToDelete: ISet)	*Removes the set of feature from the graph.*
GetDisplayFeedback (in Feature: IFeature, in features: ISet, in Point: IPoint) : IDisplayFeedback	*The DisplayFeedback.*
Init (in Dataset: IFeatureDataset, in graphID: Long, in graphName: String, in BuildNormalizedTables: Boolean, in createGraph: Boolean)	*Initializes the graph.*
Merge (in mergingFeatures: IEnumFeature) : IEnumFeature	*Merges the features together, returning the newly created feature.*
Split (in splittingEdge: IEdgeFeature, in Point: IGeometry) : ISet	*Split the feature.*
TransformSet (in features: ISet, in Type: esriTransformType, in tranformation: IAffineTransformation2D)	*Repositions all specified NetworkFeatures and any topologically connected NetworkFeatures.*

In addition to supporting the IGraph *interface, the* Graph *abstract class also supports the* IDataset *and* IFeatureClassContainer *interfaces.These two interfaces are described in this chapter.*

For an explanation of geometric networks and logical networks, see Chapter 12,'Solving linear networks', and Modeling Our World.

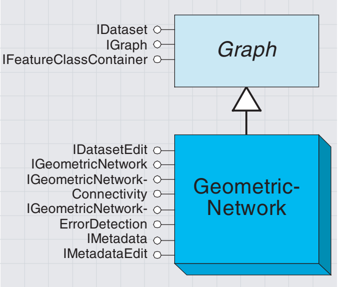
The *IGraph* interface specifies the attributes and properties expected on all the different types of topological collections within the geodatabase. These attributes and methods are not unique to a particular type of topology. It is not expected that third-party client applications will call many of these methods. The primary clients of these methods on this interface are the CASE Tool Schema Generator, ArcMap, ArcCatalog, and the polymorphic implementations of the features managed by the *Graph*.

The *VertexBasedStretching* attribute is directly utilized by ArcMap in order to establish which stretching model is to be used for geometry updates. If *VertexBasedStretching* is *False*, then all updates to topological features containing polyline geometries are proportional stretches to the nearest connected zero-dimensional topological feature (for example, junctions, in the case of geometric networks). If *VertexBasedStretching* is *True*, then the polyline geometry is only proportionally stretched to the nearest vertices on the polyline—only the segment is effectively updated. This directly affects both updating the feature's geometry and the result returned by *GetDisplayFeedback*.

The *Add* method is called whenever a new topological feature is created and added to the collection. This method is typically not called by client applications—it is automatically invoked in the polymorphic implementations of *Store* on the features managed in the topological collection.

The *Merge* operation is not supported at ArcGIS 8.1.

In the *Init* method, the fourth argument (a Boolean named *BuildNormalizedTables*) is ignored.



A geometric network is a type of graph that is uniquely associated with a logical network, which represents network topology.

GeometricNetworks are responsible for detecting and maintaining network connectivity among a set of feature classes that participate in the network. When new network features are created, the *GeometricNetwork* is responsible for detecting endpoint coincidence (in the case of edge features) with other network features, then communicating with the logical network in order to establish network connectivity.

The *GeometricNetwork* is also responsible for managing and validating all connectivity rules.

IGeometricNetwork : IGraph	***ESRI geometric network interface.***
■— ClassesByNetworkAncillaryRole (in role: esriNetworkClassAncillaryRole) : IEnumFeatureClass	*The FeatureClasses with the specified ancillary role.*
■— ClassesByType (in Type: esriFeatureType) : IEnumFeatureClass	*The FeatureClasses containing Features of the specified type.*
■— EdgeElement (in Location: IPoint) : Long	*The EdgeElement EID at the specified location.*
■— GeometryForEdgeEID (in EdgeEID: Long) : IGeometry	*The geometry of the EdgeElement.*
■— GeometryForJunctionEID (in JunctionEID: Long) : IGeometry	*The geometry that corresponds to the JunctionElement (a point).*
■—□ InvalidArea: IInvalidArea	*The area to be drawn.*
■— JunctionElement (in Location: IPoint) : Long	*The JunctionElement EID at the specified location.*
■— Network: INetwork	*The associated logical network.*
■— NetworkFeature (in networkElement: INetElementDescription) : INetworkFeature	*The NetworkFeature that corresponds to the NetworkElement.*
■— NetworkType: esriNetworkType	*The type of associated logical network.*
■— OrphanJunctionFeatureClass: IFeatureClass	*The FeatureClass containing the OrphanJunctionFeatures.*
■— Rules: IEnumRule	*Returns all the connectivity rules associated with the network.*
■— RulesByClassAndSubtype (in ClassID: Long, in SubtypeCode: Long) : IEnumRule	*The connectivity rules associated with the class and subtype.*
■— ValidFlowDirection: Boolean	*Returns whether the current flow directions are valid.*
← AddJunctionWithSubsumption (in pJunction: ISimpleJunctionFeature, in JunctionEID: Long, in pSubsumedJunction: ISimpleJunctionFeature)	
← AddRule (in rule: IConnectivityRule)	*Adds the constraint to the set of connectivity rules.*
← CreateOrphanFeature (in Location: IPoint, out orphanEID: Long) : ISimpleJunctionFeature	*Creates an orphan JunctionFeature.*
← DeleteRule (in rule: IConnectivityRule)	*Removes the rule from the set of rules.*
← EstablishFlowDirection	*Establishes the flow direction in the LogicalNetwork.*
← SearchForNetworkFeature (in Location: IPoint, in Type: esriFeatureType) : IEnumFeature	*The NetworkFeatures found at the point.*
← SpliceSimpleJunction (in junction: ISimpleJunctionFeature, in JunctionEID: Long, in Geometry: IGeometry, in forceConnectivity: Boolean)	

As is the case with the *IGraph* interface on the abstract *Graph* class, this interface, as well as the internal implementations found within the *NetworkFeatures*, will primarily be consumed by ArcMap. The methods related to validation rules should not be used (for example, *AddRule* and *DeleteRule*); client applications should instead use the *IValidation* interface supported by object classes.

The most common type of third-party client applications that will consume the *IGeometricNetwork* interface are custom network solvers. The associated logical network may be accessed through the *Network* property. The direct accessibility of the logical network obviates the need to expose the functionality of the logical network through redundant convenience methods at the geometric network level. Functionality that is related to the mapping between geometry (found at the feature level) and network elements (found at the logical network level) is necessarily supported outside of the logical network. This is because the logical network does not have any understanding of feature geometry, only logical connectivity.

You can determine the network elements associated with a network feature at a given location through the *EdgeElement* and *JunctionElement* properties. If there is more than one network feature of the appropriate type at the location, then the edge or junction element that corresponds to the first one encountered is returned.

An EID is an element ID for an element in a logical network.

Complementary functionality is also provided where, for a given edge or junction element, the associated feature geometry is returned via the *GeometryForEdgeEID* and *GeometryForJunctionEID* properties, respectively.

In contrast to the results returned by the *EdgeElement* and *JunctionElement* methods, the *GeometryForEdgeEID* and *GeometryForJunctionEID* properties return an unambiguous result, as only one piece of geometry corresponds to a given EID.

A final method found on *IGeometricNetwork* that may commonly be called by third-party client applications is *SearchForNetworkFeature*. This method, given a point location and a feature type, will return all the network features that are found within the machine precision of this point. If more than one network feature is coincident with the point, then all are returned. The returned network features may span different feature classes; the only restriction is that all features must be of the same feature type.

Thus, in order to return all network features found at a given location, this routine will be called four times—once for each of the four different network feature types. This is demonstrated in the following VBA code fragment.

```
'Assume we already have a point pPoint and a geometric network pGN pointer
Dim pSimpleJuncs As IEnumFeature, pSimpleEdges As IEnumFeature
Dim pComplexJuncs As IEnumFeature, pComplexEdges As IEnumFeature

'Query for each of the network feature types
Set pSimpleJuncs = pGN.SearchForNetworkFeature(pPoint, _
  esriFTSimpleJunction)
Set pSimpleEdges = pGN.SearchForNetworkFeature(pPoint, esriFTSimpleEdge)
Set pComplexJuncs = pGN.SearchForNetworkFeature(pPoint, _
  esriFTComplexJunction)
Set pComplexEdges = pGN.SearchForNetworkFeature(pPoint, esriFTComplexEdge)
```

IGeometricNetworkErrorDetection : IUnknown	***ESRI geometric network error detection interface.***
■-■ ErrorTable: ITable	
← CreateErrorTable (in Name: String, out ErrorTable: ITable)	*Creates a nonversioned table that can be used to persist error information.*
← CreateSelectionSetFromErrorTable: ISet	
← DeleteNetworkElements (in selectionSets: ISet)	*Deletes the network elements associated with the specified network features.*
← DetectNetworkErrors (in errorType: esriNetworkErrorType, in AreaOfInterest: IEnvelope, in selectionSets: ISet, out problemSelectionSets: ISet)	*The features in the geometric network with connectivity problems.*

The *IGeometricNetworkErrorDetection* interface identifies errors between a geometric network and its logical network.

In order to maintain correct network connectivity in large production environments, it is necessary to have a collection of tools that will enable the user to detect a variety of connectivity problems within a geometric network. In production environments, it is often impractical to drop the network and rebuild when connectivity problems are encountered during general editing of the network. For this reason, it is necessary to provide a set of tools that will enable the end user to detect and repair such problems.

Philosophically, there should not be any need for such tools—the network should always be correct. From this standpoint, the geodatabase will not waver. However, there are certain circumstances where this may be violated:

- The end user attempts to build a geometric network from data that has illegal geometry.
- Logic errors in the software implementation (as the software matures, this will become less and less likely).
- Applications or tools that do not correctly abort edit operations that the geometric network returns as an error.
- Third-party tools that attempt to manipulate the geometric network at a low level (for example, at the logical network level) and have logic errors in their software implementation.

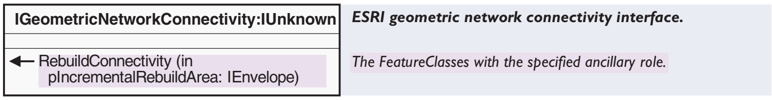
The *CreateErrorTable* method is used to create a table that can be used to persist information related to corrupt network features (using a fixed table schema) with the specified name. Such network error information can only be persisted by the geometric network in a table with this schema. This table is user managed and should remain unversioned.

Once the error table is created, it can be associated with, or retrieved from, a geometric network via the *ErrorTable* property. However, this association will not be persisted—the association is only for the lifetime of the geometric network component instance. Again, the user is responsible for managing this error table.

A set of selection sets may be created from all the entries found in the error table that are currently associated with a geometric network via the *CreateSelectionSetFromErrorTable* method. This is a mechanism that can be used to create instances of the network features that are listed in the error table.

The *DeleteNetworkElements* method takes an *ISet* of *ISelectionSets*. All of the network features contained in the various selection sets will have their network elements deleted from the logical network. The primary reason why one would want to do this is to correct the geometry of an edge feature that was loaded (prior to ArcGIS 8.1) with corrupt polyline geometry.

The *DetectNetworkErrors* method is used to detect the different possible types of network connectivity and geometry problems.



IGeometricNetworkConnectivity:IUnknown

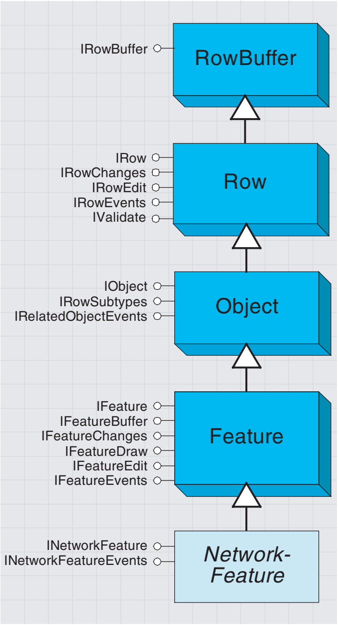
← RebuildConnectivity (in pIncrementalRebuildArea: IEnvelope)

ESRI geometric network connectivity interface.

The FeatureClasses with the specified ancillary role.

If network connectivity errors are found in the geometric network, they can generally be corrected through the use of the *RebuildConnectivity* method on the *IGeometricNetworkConnectivity* interface. This method takes an envelope that should contain all the network features for which connectivity should be rebuilt.

Any network feature that intersects the envelope will have its connectivity rebuilt, regardless of whether or not there are any connectivity problems. This is computationally a very expensive operation and should be used only when necessary. The envelope should also be as small as possible—it is faster to call *RebuildConnectivity* on two small areas rather than one large area that encompasses both smaller areas.



NetworkFeature is an abstract component that supports network connectivity and participates in a geometric network.

A *NetworkFeature* is an abstract class that factors common functionality found in all network features. A *NetworkFeature* cannot be cocreated.

INetworkFeature : IUnknown	*General interface common to all features in a GeometricNetwork.*
Enabled: Boolean	*Returns whether the NetworkFeature is open or not (that is, closed).*
GeometricNetwork: IGeometricNetwork	*The containing GeometricNetwork.*
Connect	*Connect the Feature to the geometrically coincident NetworkFeature.*
CreateNetworkElements: IEnumNetEID	*Create the necessary NetworkElements in the associated Logical Network.*
Disconnect	*Disconnect the Feature from all connected NetworkFeatures.*
OnDisconnect	*Preparation for disconnecting the NetworkFeature.*

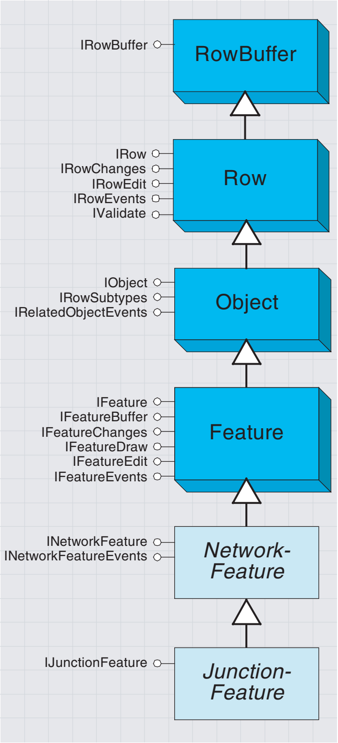
The *INetworkFeature* interface is supported at the *NetworkFeature* level within the geodatabase; all features participating in a *GeometricNetwork* support this interface. Because each *NetworkFeature* may either be enabled (can trace through) or disabled (cannot trace through) within the logical network, the *Enabled* property is read–write. It is important to note that although a complex edge or a complex junction may correspond to one or more network elements, setting the *Enabled* property will either enable or disable all associated network elements. It is not possible to individually set the enabled or disabled status of an individual network element associated with a complex network feature through this interface.

When a *NetworkFeature* is being created and added to a *GeometricNetwork* coclass, the *GeometricNetwork* will call the *CreateNetworkElements* method on the *NetworkFeature*. If a developer is creating a complex junction custom feature, it may be necessary for them to implement this method if the complex junction has an irregular connection topology. Otherwise, it will not be necessary for a custom feature developer to override this method in their implementation.

It is important to note that if network features are being programmatically created (for example, using a sequence similar to *IFeatureClass::CreateFeature*, setting the feature's *Shape*, then calling *Store* on the feature), the network feature's spatial reference must match that of the containing *FeatureClass*. More specifically, if you call *IGeometry::Project* on the geometry prior to it being set as the feature's *Shape*, you must take care to ensure that the *SpatialReference* that is being passed as an argument to *Project* match that of the *FeatureClass*. It is not always the case that the *Map*'s *SpatialReference* is the correct one to use (for example, the *Map* may contain two *FeatureDatasets* with differing *SpatialReferences*).

INetworkFeatureEvents : IUnknown	*NetworkFeature Events.*
OnConnect	*Preparation for connecting a NetworkFeature to another.*
OnDisconnect	*Preparation for disconnecting a NetworkFeature from another.*

The *INetworkFeature* interface contains the two types of events that are common to all four network features. With ArcGIS 8.1, none of these events are triggered by the system, thus their present utility is negligible. It is expected that with future releases of ArcGIS, these events will be triggered by the geodatabase.



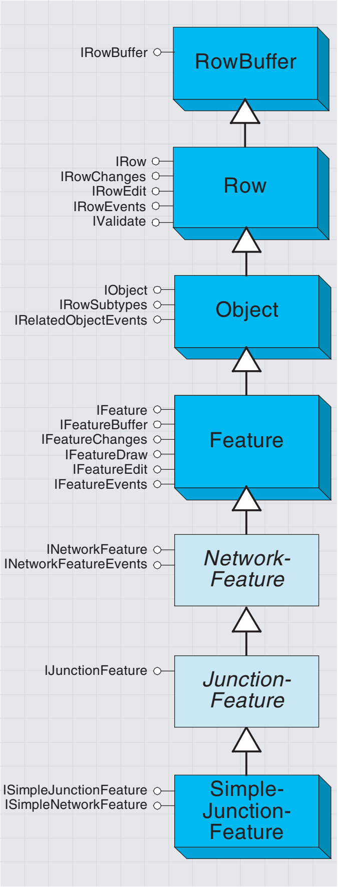
A junction feature is a type of network feature that corresponds to a connection point between two or more edge features in a geometric network.

Junction features are used to maintain network integrity within a geometric network. They are found at the locations that correspond to the endpoints of edge features. They may also be freestanding (unconnected to any edge feature) or connected to complex edges at midspan. *JunctionFeature* is an abstract class.

IJunctionFeature : IUnknown	***General interface common to all features in a GeometricNetwork.***
■— GeometryForJunctionElement (in SubID: Long) : IGeometry	*The geometry (point) corresponding to the junction with the given subID.*
■—■ NetworkAncillaryRole: esriNetworkFeatureAncillaryRole	*Programmatic update of the NetworkFeature.*
■— OriginalGeometryForJunctionElement (in SubID: Long) : IGeometry	*The geometry (point) corresponding to the junction with the given subID.*
← Update (in callingFeature: INetworkFeature, in Transformation: IAffineTransformation2D, in rigidEdges: ISet, in Group: ITransformGroup)	*Programmatic update of the NetworkFeature.*

The *IJunctionFeature* interface contains the properties and methods that are common to both simple and complex junction features. Among the four methods and properties, only two will commonly be implemented by custom feature developers—*GeometryForJunctionElement* and *OriginalGeometryForJunctionElement*. The other two, *NetworkAncillaryRole* and *Update,* are used internally and are not intended for use by application developers; they are consumed by network solvers when displaying the results of a network trace operation.

For simple junctions that commonly have point geometry, *GeometryForJunctionElement* and *OriginalGeometryForJunctionElement* are of little interest. When implementing complex junctions, however, it may be desirable to associate geometry with network elements contained in the complex junction.



A simple junction feature is a junction feature that is associated with a single junction element within the logical network.

The *SimpleJunctionFeature* class represents simple junctions on a network that may be added to *GeometricNetworks*.

The *SimpleJunctionFeature* class can be aggregated, and possibly overridden, by custom feature developers.

Simple junction features have point geometry and may be connected to any number of other edge features.

A simple junction feature may not be directly connected to another junction feature without an intervening edge feature.

ISimpleJunctionFeature : IUnknown	***NetworkFeature representing the junction of two EdgeFeatures.***
EdgeFeature (in Index: Long) : IEdgeFeature	*The EdgeFeature associated with the specified index value.*
EdgeFeatureCount: Long	*The number of EdgeFeatures associated with this junction.*
EID: Long	*The logical network element ID of this junction.*

The *ISimpleJunctionFeature* interface contains three properties that are unique to simple junctions.

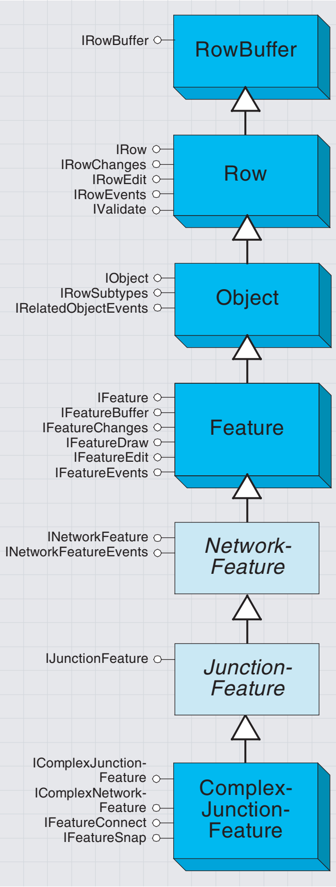
The *EdgeFeatureCount* property and *EdgeFeature* property array are used to specify the connected edge features to the client. The index for *EdgeFeature* is zero-based.

The following VBA code fragment shows how a client might use this information to display the object IDs of the connected edge features.

```
'Assume we already have a pointer to a junction feature.
Dim pSimpleJunction As ISimpleJunctionFeature
Set pSimpleJunction = pJunction
Dim i As Long, pEdgeFeature As IEdgeFeature, pRow as IRow

For i = 0 To (pSimpleJunction.EdgeFeatureCount – 1)
  Set pEdgeFeature = pSimpleJunction.EdgeFeature(i)
  Set pRow = pEdgeFeature
  MsgBox "EdgeFeature [" & i & "]: " & pRow.OID
Next i
```

ISimpleNetworkFeature : IUnknown	***General interface common to all features in a GeometricNetwork.***

The *ISimpleJunctionFeature* interface does not contain any properties or methods; it is an indicator interface used to differentiate simple and complex network features.



A complex junction feature is a junction feature that can contain a subnetwork.

The *ComplexJunctionFeature* class represents network features at junctions that contain internal topology as collections of edge and junction network elements in a logical network.

Objects from the *ComplexJunctionFeature* class cannot be directly added to a *GeometricNetwork*; it is necessary for the application developer to provide a custom implementation of a *ComplexJunctionFeature*. *ComplexJunctionFeature* objects are designed to be aggregated within a custom feature—there are methods and properties that do not have a default implementation. These properties and methods must be implemented within the custom feature.

Complex junction features may have any geometric representation, although polygons are the most common, followed by polylines. Point geometries do not make much sense for complex junction features.

Complex junction features are connected to other edge features via geometric coincidence at their connection points. (These connection points are not to be confused with the *IConnectionPoint* interface found elsewhere in the ArcObjects architecture—this interface is used in the context of event notification.)

It is critical to note that when implementing custom features, such as a complex junction, certain guidelines must be followed in order for the custom feature to behave correctly in the versioned environment. First, during reconciliation, all conflicts are detected on the basis of attributes and geometry found at the feature level. The logical network is not employed as a primary mechanism for detecting network feature differences. Thus, it is critical that any weights that are associated with a network element also be persisted at the network feature level (this is the default system behavior). It is possible (though strongly discouraged) to develop a custom network feature that, as a side effect of another operation, will also update the logical network weights (directly via the logical network interfaces) without also updating the corresponding network feature attribute. This would lead to integrity problems during version reconciliation and posting under certain circumstances.

The easiest way to avoid such problems is to consider the logical network nothing more than a high-performance index on the network features. Being an index, all information in the index must be derivable from the associated network features. Effectively, all states in the logical network must be derivable from a sequence of setting the *Value* and *Shape* attributes, in addition to an *OnChanged* message. If any logical network state cannot be re-created by setting the *Values* and *Shape,* and handling the *OnChanged* message, then the custom feature implementation will be incorrect from the versioning perspective.

IComplexNetworkFeature : IUnknown	*Interface for a Complex Network Feature.*
■— EdgeElementCount: Long	*The number of edge elements associated with this Feature.*
■—■ EnabledByIndex (in edgeIndex: Long) : Boolean	*Returns whether the NetworkFeature is open or not (i.e., closed).*
← FindEdgeEID (in Point: IPoint) : Long	*The EID associated with the EdgeElement at the specified point.*

The *IComplexNetworkFeature* interface is supported on both *ComplexJunctionFeature* objects and *ComplexEdgeFeature* objects. It provides a mechanism to determine the number of edge elements in the logical network that are associated with the complex network feature; it also sets their *Enabled* properties and finds the edge element ID (or EID) that is associated with the portion of the geometry found at the specified location.

The *INetworkFeature* interface (described previously) also has a property for examining and setting the enabled fields of the associated network elements in the logical network. The difference with this index-based property is that with the *ComplexJunctionFeature*, the client has control over the enabled fields on each individual edge element. If the client sets the *Enabled* property at the *INetworkFeature* level, then all edge elements are set. If the client uses the index-based property in this interface, then the edge elements can be individually controlled.

If one or more of the associated network elements is disabled when examining the status of the *Enabled* property via the *INetworkFeature* interface, then *False* is returned. If all of the edge elements are enabled, then *True* is returned.

The *EnabledByIndex* property can be used to set the enabled value for an individual edge element associated with the complex network feature. The index is actually the subID of the edge element. This is appropriate for complex junctions where the set of edge elements generally remains static and ranges from 1 to n with no gaps in the sequence of subIDs. However, this is inappropriate for complex edges as the collection of edge elements (and consequently subIDs) will vary over the lifetime of a complex edge. Additionally, you should not assume that the subIDs associated with a complex edge do not have gaps in the sequence.

The *FindEdgeEID* method does not have a default implementation within the *ComplexJunctionFeature*. This is because, by default, the edge elements do not correspond to a geometry. However, the custom feature developer can associate geometry with an edge element within a *ComplexJunctionFeature*. In order to utilize the *FindEdgeEID* method, the specified point must be within the numerical precision (that is, the reciprocal of the *XYscale* found on the *SpatialReference*) of the portion of the geometry that corresponds to the edge element. This search tolerance is not an absolute rule; it is a suggestion that will allow the search to behave in a manner similar to the rest of the *GeometricNetwork*.

The following VBA code fragment shows how a client might use this information to display the enabled status of all the edge elements associated with the *ComplexJunction*.

```
'Assume we already have a pointer to a junction feature.
Dim pComplexJunction As IComplexJunctionFeature
Set pComplexJunction = pJunction
Dim pComplexNetworkFeature As IComplexNetworkFeature
Set pComplexNetworkFeature = pComplexJunction
Dim i As Long

For i = 0 To (pComplexNetworkFeature.EdgeElementCount - 1)
  MsgBox "Edge element [" & i & "]: " _
 & pComplexNetworkFeature.EnabledByIndex(i)
Next i
```

IComplexJunctionFeature : IUnknown	*Interface for ComplexJunctionFeature.*
■— EdgeFeature (in connectionPointIndex: Long, in Index: Long) : IEdgeFeature	*The EdgeFeature associated with the specified index value and the indexed connection point.*
■— EdgeFeatureCount (in connectionPointIndex: Long) : Long	*The number of EdgeFeatures associated with the indexed connection point.*
■— FieldToEIDMapping (in FieldIndex: Long) : Long	*The EID associated with the specified field index.*
■— GeometryForEdgeElement (in SubID: Long) : IGeometry	*The geometry corresponding to the element with the given subID.*
■—■ JunctionElementCount: Long	*The number of junctions associated with this Feature.*
—■ RotationAngle: Double	*The rotation angle of this Feature.*
■—■ TopologicalConfiguration: esriTopoConfiguration	*The configuration of this Feature.*
◄— FindJunctionEID (in Point: IPoint) : Long	*The EID associated with the JunctionElement at the specified point.*

The *GeometryForEdgeElements* index-based property for the generic *ComplexJunctionFeature* does not have any associated geometric representation. This does not preclude the custom feature developer from implementing the accessor of this index-based property and returning a piece of geometry. This geometry could then be used by the network solvers in order to represent a trace that goes through either all of or a portion of the *ComplexJunctionFeature*. Network solvers are supposed to query for this when displaying the results of the trace operation. If there is no geometric representation for the edge elements in the *ComplexJunctionFeature*, then there is no need to override the default implementation, which will return an E_FAIL.

The *TopologicalConfiguration* property takes an enumeration (*esriTopoConfiguration* Constants) that is used in conjunction with the *JunctionElementCount* property to create the associated network elements (both junctions and edges) in the logical network when the complex junction is initially created and stored. The complex junction supports four such parametrically specifiable configurations: *esriTCChain, esriTCLoop, esriTCStar,* and *esriTCMesh*.

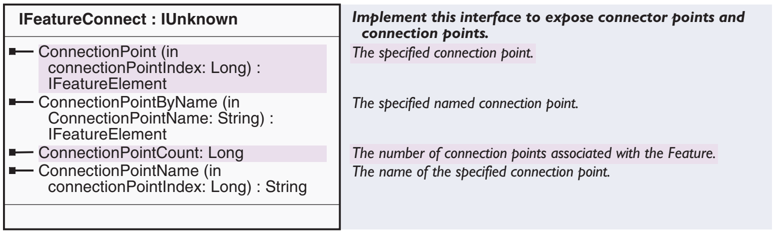
Value	Description
esriTCChain	A chain or linear sequence of n junction and n - 1 edge elements, beginning and ending with a junction with edge elements in between.
esriTCLoop	A loop or ring of n junction and n edge elements, with edge elements positioned between each pair of sequential junction elements in the loop.
esriTCStar	A star or radial configuration of network elements where there is one central junction, n connected edge elements, and n junction elements at the end of each of the connected edge elements (n + 1 junctions and n edges).
esriTCMesh	A complete graph consisting of n junction elements, and (n * (n - 1))/2 edge elements.

Enumeration esriTopoConfiguration	*Topological configuration.*
0 - esriTCChain	*Chain topology.*
1 - esriTCLoop	*Loop topology.*
2 - esriTCStar	*Star [radial] topology.*
3 - esriTCMesh	*Mesh [complete graph] topology.*

Note that the *JunctionElementCount* property corresponds to the *n* value in the table to the left. Additionally, the *JunctionElementCount* property will correspond to the number of connection points that the *ComplexJunctionFeature* will expose (that is, the *ConnectionPointCount* property on the *IFeatureConnect* interface). In the case of the *esriTCStar* configuration, the central junction element will not have an associated connection point (it is in effect and internal, an externally unconnectable junction element).

When developing *ComplexJunctionFeature* objects, you are free to support a topological configuration that is not found in the *esriTopoConfiguration* enumeration. In this case, you would not specify a *TopologicalConfiguration*, but you would be required to implement the *CreateNetworkElements* method on the *INetworkFeature* interface. If you choose to employ a supported topological configuration, then there is no need to implement the *CreateNetworkElements* method.

The *FieldToEIDMapping* property is not currently consumed by any client within the ArcGIS 8.1 architecture; thus, it is unnecessary to implement this property. In addition, the *RotationAngle* property is not currently consumed either.



IFeatureConnect : IUnknown

Implement this interface to expose connector points and connection points.

- ConnectionPoint (in connectionPointIndex: Long) : IFeatureElement — *The specified connection point.*
- ConnectionPointByName (in ConnectionPointName: String) : IFeatureElement — *The specified named connection point.*
- ConnectionPointCount: Long — *The number of connection points associated with the Feature.*
- ConnectionPointName (in connectionPointIndex: Long) : String — *The name of the specified connection point.*

IFeatureConnect contains properties that must be implemented by any *ComplexJunctionFeature* custom feature. The implementation inside the *ComplexJunctionFeature* class merely delegates to the aggregating custom feature. Because there is no general mechanism to completely parametrically specify the internal interconnection topology of a *ComplexJunctionFeature* or the position of all the connection points, it is not possible for the default *ComplexJunctionFeature* to implement these methods.

The purpose of these methods is to serve up connection points (that is, positions where edge features may be connected, thereby establishing network connectivity with the *ComplexJunctionFeature*) to clients. Connection points may be retrieved either in an index basis or by their logical names. Connection points are returned as *FeatureElements*.

The *IFeatureConnect* interface is not currently consumed by any client within ArcGIS 8.1. Third-party clients are free, however, to implement and utilize this interface in their custom features and applications.

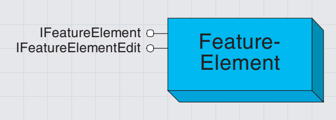
The following VBA code shows how a client might probe for the geometry of all connection points associated with a *ComplexJunctionFeature*.

```
'Assume we already have a pointer to a junction feature.
Dim pFeatureConnect As IFeatureConnect
Set pFeatureConnect = pJunction
Dim i As Long, pFeatureElement as IFeatureElement
Dim pGeometry as IGeometry, pPoint as IPoint

For i = 0 To (pFeatureConnect.ConnectionPointCount - 1)
  Set pFeatureElement = pFeatureConnect.ConnectionPoint(i)
  Set pGeometry = pFeatureElement.Geometry
  Set pPoint = pGeometry
  MsgBox "Connection point (" & i & ") location : (" & pPoint.X & ", " & _
      pPoint.Y & ")"
Next i
```

IFeatureSnap : IUnknown	***Facility for features to do custom snapping.***
← Snap (in Point: IPoint, in Tolerance: Double) : Boolean	*Snap the feature based on the arguments.*

The *Snap* method in the *IFeatureSnap* interface is not implemented by the *ComplexJunctionFeature* class that the custom feature must aggregate. ArcMap will call this method on all complex junctions within snapping distance of the cursor if custom feature snapping is selected in the Snapping dialog box.

The custom feature is responsible for returning a *Boolean* value indicating whether or not the cursor can snap to one of the connection points. If the cursor can snap (the *IPoint* is within the tolerance distance of a connection point), then the inbound *IPoint* is modified to match the location of the connection point.



A feature element is a lightweight class that encapsulates the geometry corresponding to a connection point found on a complex junction feature.

Feature elements are returned by several properties in the *IFeatureConnect* interface (described previously).

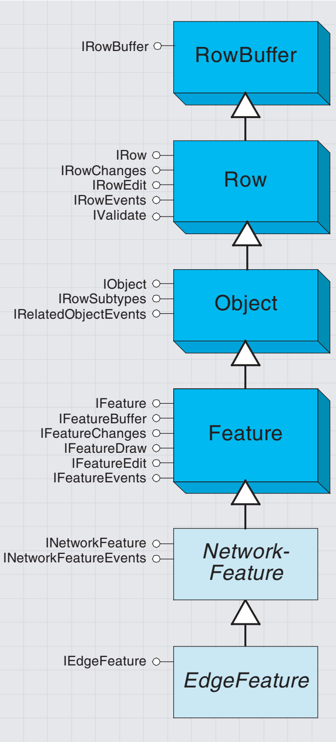
IFeatureElement : IUnknown	***Interface for getting Feature Element properties.***
ElementType: esriFeatureElementType	*The type of feature element.*
Geometry: IGeometry	*The geometry of the feature element.*
Owner: IFeature	*The feature that owns the feature element.*
Parent: IFeatureElement	*The parent of the feature element.*

The *IFeatureElement* interface contains four read-only properties for *FeatureElement* objects. At present, the *Parent* property is not functional.

IFeatureElementEdit : IUnknown	***Interface for setting Feature Element properties.***
ElementType: esriFeatureElementType	*The Type of Feature Element.*
Geometry: IGeometry	*The Geometry of the Feature Element.*
Owner: IFeature	*The Feature that owns the Feature Element.*
Parent: IFeatureElement	*The Parent of the Feature Element.*

The *IFeatureElementEdit* interface enables the custom complex junction feature to set the various properties found on the *FeatureElement*. The *Owner* property should be the *ComplexJunctionFeature*.

EdgeFeature abstract class



An edge feature is a type of network feature that corresponds to a connection (or link) between two or more junction features in a geometric network.

Edge features correspond to features with polyline geometry that are part of the network topology within a geometric network. They have two or more connected junction features—one at each location corresponding to the endpoints of their polyline geometries. Complex edges may also have any number of connected mid-span junction features. An *EdgeFeature* is an abstract class.

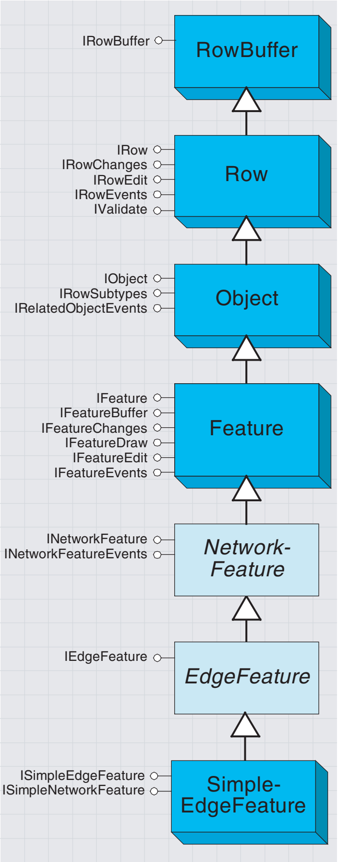
IEdgeFeature : IUnknown	***General interface common to all features in a GeometricNetwork.***
■— FromJunctionEID: Long	*The junction element EID that corresponds to the from endpoint.*
■— FromJunctionFeature: IJunctionFeature	*The junction that corresponds to the from endpoint.*
■— FromToJunctionEIDs: IEnumNetEID	*The FROM and TO junction element EIDs (the first is the FROM, the second is the TO).*
■— GeometryForEdgeElement (in SubID: Long) : IGeometry	*The geometry corresponding to the element with the given subID.*
■— ToJunctionEID: Long	*The junction element EID that corresponds to the to endpoint.*
■— ToJunctionFeature: IJunctionFeature	*The junction that corresponds to the to endpoint.*
← DisconnectAtEndpoint (in EID: Long, in fromEID: Long, in toEID: Long, in disconnectFrom: Boolean, in disconnectTo: Boolean)	*Perform the disconnection at either or both of the endpoints.*
← DisconnectAtJunction (in EID: Long, in JunctionEID: Long)	*Perform the disconnection at the specified junction.*
← Update (in callingFeature: INetworkFeature, in oldJunctionLocation: IPoint, in newJunctionLocation: IPoint, in rigidEdges: ISet, in Group: ITransformGroup)	*Programmatic update of the NetworkFeature.*

The *IEdgeFeature* interface must be supported by both simple and complex edges. This interface is found on the *EdgeFeature* abstract class. The various properties found on this interface are intended to facilitate network feature navigation for client applications.

The *FromToJunctionEIDs* property hands back both the FROM and TO junction EIDs; it is more efficient to access this property than to call *FromJunctionEID* and *ToJunctionEID*. It is important to note that these properties are generally computationally expensive. For certain clients (that is, those that do not require access to the geometry, attributes, or feature class associated with the network feature), it may prove more advantageous to directly utilize the logical network when performing navigation between large numbers of network features. For example, this is the case with network solvers.

The *Update* method is reserved for internal consumption (during the process of updating the shape and storing the result); there is no need for clients to call this method directly.

SimpleEdgeFeature object



A simple edge feature is an edge feature that can connect two junction features.

Simple edge features correspond to features with polyline geometry that are part of the network topology within a geometric network. They have two connected junction features—one at each location corresponding to the endpoints of their polyline geometries. Junction features connected at mid-span are not allowed. If you attempt to connect a junction at mid-span on a *SimpleEdgeFeature*, a split operation occurs (the original *SimpleEdgeFeature* is deleted and replaced by two new *SimpleEdgeFeatures* that are commonly connected at the junction feature that caused the subdivision).

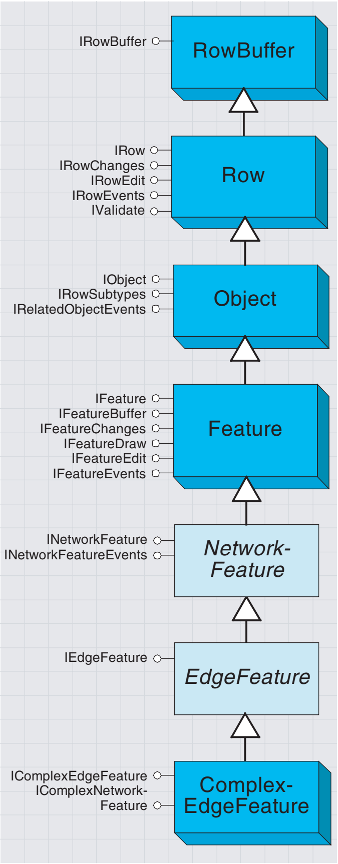
ISimpleEdgeFeature : IUnknown

General interface common to all features in a GeometricNetwork.

■— EID: Long

The logical network element ID of this edge.

The *ISimpleEdgeFeature* interface is supported on a *SimpleEdgeFeature*. The only property, *EID*, simply returns the Element ID associated with the *SimpleEdgeFeature*.



A complex edge feature is an edge feature that can connect a collection of two or more junction features in a linear manner.

Complex edge features correspond to features with polyline geometry that are part of the network topology within a geometric network. They have two or more connected junction features—one at each location corresponding to the endpoints of their polyline geometries. They may also have any number of connected mid-span junction features.

Connecting a junction feature to a *ComplexEdgeFeature* does not result in a physical subdivision of the edge; instead, it results in a logical subdivision (that is, new edge elements in the logical network that are associated with the complex edge).

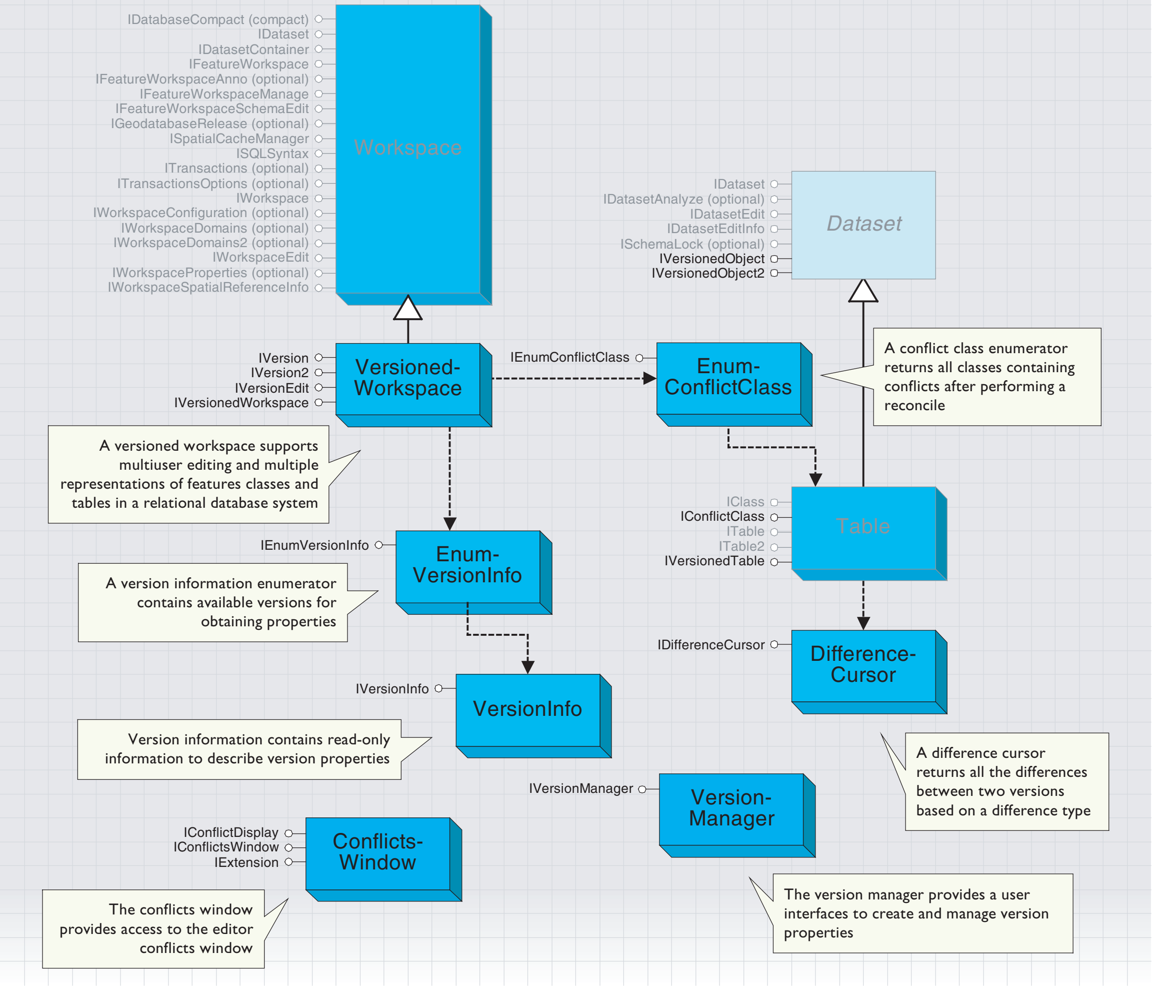
The geometry of *ComplexEdgeFeatures* may not be self-intersecting; there may be discontinuities with the geometry (they may be multipart), and the geometry may not have the same start and stop vertex (that is, a closed loop).

IComplexEdgeFeature : IUnknown	***General interface common to all features in a GeometricNetwork.***
GeometryByPoints (in FromPoint: IPoint, in ToPoint: IPoint) : IGeometry	*The geometry associated with the two points.*
GeometryForEID (in EdgeEID: Long) : IGeometry	*The geometry (point) corresponding to the edge EID.*
JunctionFeature (in Index: Long) : IJunctionFeature	*The JunctionFeature associated with the index.*
JunctionFeatureCount: Long	*The number of connected JunctionFeatures.*
ConnectAtIntermediateVertices	*Attempt to connect at the locations corresponding to intermediate vertices.*
SplitEdgeElement (in Point: IPoint, in newJunctionEID: Long)	*Inserts the specified JunctionElement into an edge at the point.*

The *IComplexEdgeFeature* interface is supported on a *ComplexEdgeFeature*. The *GeometryForEID* property allows clients to obtain the portion of the complex edge's geometry that corresponds to a specified EID. This is useful for network solvers in particular. The *JunctionFeature* property array is a mechanism for clients to obtain all the junction features that are associated with the complex edge.

The *ConnectAtIntermediateVertices* method takes the geometry associated with the complex edge and performs a spatial query at each vertex on the polyline. The spatial query obtains any coincident junction features. If any junction feature is found to be coincident at a vertex, connectivity between the junction and the complex edge is established. This is an expensive method; the cost is linearly related to the number of vertices found in the polyline. Thus, it takes longer on longer complex edges.

Versioning objects



A conflict class enumerator returns all classes containing conflicts after performing a reconcile

A versioned workspace supports multiuser editing and multiple representations of features classes and tables in a relational database system

A version information enumerator contains available versions for obtaining properties

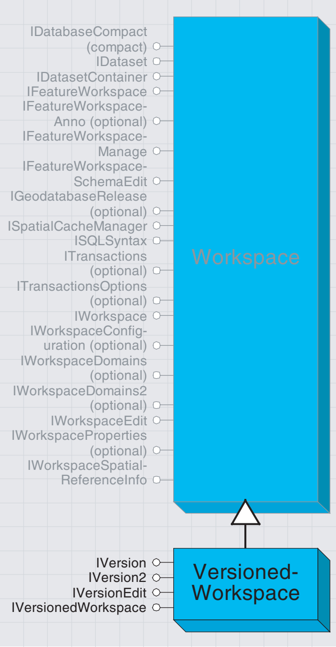
Version information contains read-only information to describe version properties

A difference cursor returns all the differences between two versions based on a difference type

The version manager provides a user interfaces to create and manage version properties

The conflicts window provides access to the editor conflicts window

Versioning allows multiple users to edit spatial and tabular data simultaneously in a long transaction environment. Users can directly modify the database without having to extract data or lock features in advance. The object model provides functionality to create and administer versions, register and unregister classes as versioned, detect differences between versions, and reconcile and post versions.


IDatabaseCompact (compact)
IDataset
IDatasetContainer
IFeatureWorkspace
IFeatureWorkspace-Anno (optional)
IFeatureWorkspace-Manage
IFeatureWorkspace-SchemaEdit
IGeodatabaseRelease (optional)
ISpatialCacheManager
ISQLSyntax
ITransactions (optional)
ITransactionsOptions (optional)
IWorkspace
IWorkspaceConfig-uration (optional)
IWorkspaceDomains (optional)
IWorkspaceDomains2 (optional)
IWorkspaceEdit
IWorkspaceProperties (optional)
IWorkspaceSpatial-ReferenceInfo
Workspace
IVersion
IVersion2
IVersionEdit
IVersionedWorkspace
Versioned-Workspace

A versioned workspace supports multiuser editing and multiple representations of features classes and tables in a relational database system.

A *VersionedWorkspace* is a *Workspace* that supports versioning. It provides the ability to set the version that the workspace will reference.

IVersionedWorkspace : IUnknown	Provides access to members that manage versions.
DefaultVersion: IVersion	Retrieves the default version.
Versions: IEnumVersionInfo	Retrieves all versions the user owns and those which are public or protected.
Compress	Compresses the database by removing states not referenced by a version.
FindVersion (in Name: String) : IVersion	Finds a specific version given its name.

A list of all versions to which the user has permissions can be retrieved using the *Versions* property. The versions returned are either owned by the connected user or have public access.

The *DefaultVersion* property can be used to retrieve the DEFAULT version of the database. There is always a DEFAULT version owned by the ArcSDE user.

Versions returns an enumeration of all public versions and those owned by the connected user.

The *FindVersion* method can be used to retrieve other versions by name. Version names are case-sensitive and limited to 32 characters.

Versioned workspace compression is available using the *Compress* method. Compressing a *VersionedWorkspace* will remove those database states not referenced by a version. Only the ArcSDE administrator user can execute the *Compress* method.

FindVersion finds a specific version provided its name.

The following example demonstrates how to use the *FindVersion* method to set an *IVersion*. The version is fully qualified with the version owner's name.

```
Dim pSdeWs As IVersionedWorkspace
Set pSdeWs = pWorkspace

Dim pVersion As IVersion
Set pVersion = pSdeWs.FindVersion("STEVE.Emily Subdivision Design")
```

IVersion : IUnknown	Provides access to members for managing a version.
Access: esriVersionAccess	The version's access permission.
Description: String	The version's description.
VersionInfo: IVersionInfo	Retrieve this version's information.
VersionLocks: IEnumLockInfo	Retrieves this version's locks.
VersionName: String	The name of the version.
CreateVersion (in newName: String) : IVersion	Creates a new version equivalent to this version.
Delete	Permanently deletes the version from the database.
HasParent: Boolean	True if this version has a parent version.
RefreshVersion	Refreshes the version with the corresponding database state.

The *IVersion* interface is used to manage the properties of a version as well as create new versions. Creating a new version requires an existing version to be the parent of the new version. When the new version is created, the parent and child versions are identical.

Access can only be updated by the owner of the version, so be sure to check the *IsOwner* method on the *IVersionInfo* returned from the *VersionInfo* property.

The *Description* property is a user-defined textual description of the version and is limited to sixty-four characters.

The *VersionInfo* property returns a descriptor object that contains more information about the version.

The *VersionLocks* property returns a list of outstanding locks currently on the version. These locks help determine how a version is currently being used and who is using it.

The *VersionName* property is the name of the version. This name will be qualified appropriately and is case-sensitive. The name of a version can be changed using this property.

CreateVersion creates a new version based on this version.

Delete permanently removes the version from the database.

HasParent returns a Boolean if this version has a parent version.

RefreshVersion refreshes the version to correspond with the database state the version references.

Enumeration esriVersionAccess	*Version Access Permissions.*
0 - esriVersionAccessPrivate	*The version's access permission is private.*
1 - esriVersionAccessPublic	*The version's access permission is public.*
2 - esriVersionAccessProtected	*The version's access permission is protected.*

There are three types of access privileges: private, public, and protected. Private versions are only accessible by the version's owner. All users can view and update public versions, while protected versions can only be viewed.

Here is some sample VBA code for updating the *Access* property of the version associated with the first layer in the map.

```
Dim pDoc As IMxDocument, pMap As IMap, pFLayer As IFeatureLayer
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
If TypeOf pMap.Layer(0) Is IFeatureLayer Then
  Set pFLayer = pMap.Layer(0)
  Dim pDataset As IDataset, pVersion As IVersion
  Set pDataset = pFLayer.FeatureClass
  Set pVersion = pDataset.Workspace
  If pVersion.VersionInfo.IsOwner Then
    pVersion.Access = esriVersionAccessPublic
  End If
End If
```

IVersionEdit : IUnknown	*VersionEdit Interface.*
■— CommonAncestorVersion: IVersion	*The common ancestor of this version and the reconcile version.*
■— ConflictClasses: IEnumConflictClass	*Returns all objects that contain conflicts between the current and reconciled versions.*
■— ModifiedClasses: IEnumBSTR	*Returns all objects modified by the current and reconciled versions.*
■— PreReconcileVersion: IVersion	*The version prior to reconciliation.*
■— ReconcileVersion: IVersion	*The version against which the current version is reconciling.*
■— StartEditingVersion: IVersion	*The version prior to any edits.*
◀— CanPost: Boolean	*Returns a Boolean if the version can be posted to the reconcile version.*
◀— Post (in VersionName: String)	*Posts the current version to the reconciled version.*
◀— Reconcile (in VersionName: String) : Boolean	*Reconciles the current version with a target version.*

The *IVersionEdit* interface is used to reconcile a version with a target version. Once reconciled, the object provides the ability to work with representations of the version prior to start editing, the prereconcile version, the reconcile version, and the common ancestor version. The common ancestor version represents the state of the database when the start editing version was originally created from the reconcile version (at the time when each version was identical).

You can only post a version that has first been reconciled with any of its ancestor versions. You are not limited to simply reconciling a version with its immediate parent version. Once you have performed the reconcile, the *CanPost* method will return *True*. But, if you perform an Undo operation, *CanPost* will become *False*.

CommonAncestorVersion returns the common ancestor version of this version and the reconcile version.

ConflictClasses returns an enumeration of all classes containing conflicts.

ModifiedClasses returns an enumeration of all the classes modified in the version.

PreReconcileVersion returns the version prior to reconciliation.

ReconcileVersion returns the version against which this version is currently reconciling.

StartEditingVersion returns the version before any edits were made.

CanPost returns a Boolean if the version can be posted to the reconcile version.

Post applies the changes in the current version to the reconciled version.

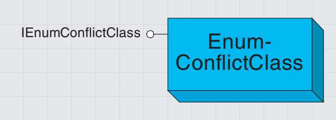
Reconcile merges the current edit version with a target version.

The example below shows how an application can reconcile the current version with the DEFAULT version. If conflicts are detected, the user will have to interactively perform conflict resolution. If not, then the application can verify that it can perform the post operation, and then it can perform the post.

```
Dim pVersionEdit As IVersionEdit
Set pVersionEdit = pCurrentVersion


Dim pconflicts As Boolean
```

```
pconflicts = pVersionEdit.Reconcile("SDE.DEFAULT")

If pconflicts Is True Then
 MsgBox _
   "Conflicts have been detected, review and resolve prior to   posting."
Else
   MsgBox "The version has been successful reconciled with the " & _
          "target version, no conflicts were detected."
End If

' Handle conflicts if necessary
If pVersionEdit.CanPost = True Then
  pVersionEdit.Post "SDE.DEFAULT"
```

EnumConflictClass and EnumVersionInfo classes



A conflict class enumerator returns all classes containing conflicts after performing a reconcile.

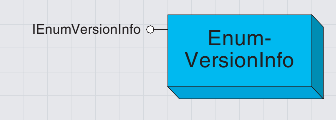
Objects of this type are created through the *IVersionEdit::ConflictClasses* property. The enumeration contains a set of *IConflictClass* objects that specify the conflict classes that were found during the execution of *IVersionEdit::Reconcile*.

IEnumConflictClass : IUnknown	*Conflict Class Enumeration Interface.*
← Next: IConflictClass	*Retrieves the next conflict class in the enumeration sequence.*
← Reset	*Resets the enumeration sequence to the beginning.*

Use the *IEnumConflictClass* interface when you want to do further processing on the conflicts that were found during the execution of *IVersionEdit::Reconcile*.

Next returns an *IConflictClass* object that contains all of the conflicts for a particular object class in the dataset.

Reset resets the enumeration sequence to the beginning.



A version information enumerator contains available versions for obtaining properties.

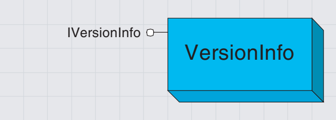
Objects of this type are created through the *IVersionWorkspace::Versions* property. The enumeration contains a set of *IVersionInfo* objects that specify the characteristics of the versions contained in the database.

IEnumVersionInfo : IUnknown	*Provides access to members that enumerate version information.*
← Next: IVersionInfo	*Retrieves the next version info.*
← Reset	*Resets the enumeration sequence to the beginning.*

Use the *IEnumVersionInfo* interface when you need to access the read-only characteristics (such as access setting, children, and parents) of the versions defined on the workspace.

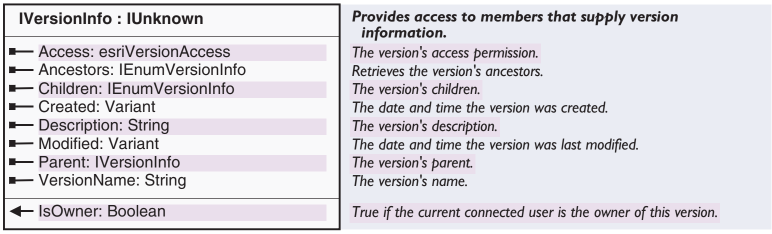
Next retrieves the next version's properties.

Reset resets the enumeration sequence to the beginning.



Version information contains read-only information used to describe version properties.

The *VersionInfo* interface is a read-only collection of methods used to obtain the different properties of a version. If you need to set the properties of a version, use the *IVersion* interface.



IVersionInfo : IUnknown	*Provides access to members that supply version information.*
Access: esriVersionAccess	*The version's access permission.*
Ancestors: IEnumVersionInfo	*Retrieves the version's ancestors.*
Children: IEnumVersionInfo	*The version's children.*
Created: Variant	*The date and time the version was created.*
Description: String	*The version's description.*
Modified: Variant	*The date and time the version was last modified.*
Parent: IVersionInfo	*The version's parent.*
VersionName: String	*The version's name.*
IsOwner: Boolean	*True if the current connected user is the owner of this version.*

The *IVersionInfo* object is created from the *IEnumVersionInfo::Next* property. The properties returned are all read-only; if you need to update a value, use the appropriate *IVersion* method.

Access returns the version access.

Ancestors returns the version's ancestors, for example, its parent version.

Children returns all child versions.

Created returns the date the version was created.

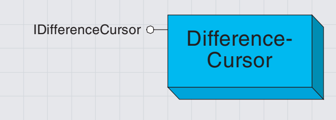
Description returns the version's description.

Modified returns the date the version was last modified.

Parent returns the parent version's properties.

VersionName returns the version's name.

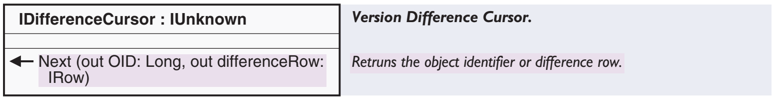
IsOwner returns a Boolean whether or not the connected user is the owner.



A difference cursor returns all the differences between two versions based on a difference type.

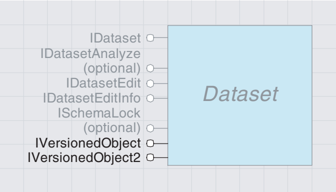
The *DifferenceCursor* returns a cursor of object IDs and *IRows* based on the difference type used with *IVersionedTable*.

The set of object IDs returned is dependent on the difference type category. For example, if the difference type *DeleteNoChange* is applied, the cursor will be empty for the table that has deleted the rows. In this case, the application will have to change the table the version references in the *IVersionedTable* interface.



IDifferenceCursor : IUnknown	*Version Difference Cursor.*
Next (out OID: Long, out differenceRow: IRow)	*Retruns the object identifier or difference row.*

Next returns an object ID of an *IRow*.



The IVersionedObject *interface is used to register and unregister feature datasets and classes as versioned.*

The *IVersionedObject* interface is used to register and unregister feature datasets and classes as versioned. It will also return the current version that a dataset or table references.

Using the *RegisterAsVersioned* method on a feature dataset will register all classes in the dataset as versioned or, alternatively, one could *RegisterAsVersioned* an individual feature class. Only the feature dataset or feature class owner can register an object as versioned. The process will create two additional tables in the database.

IVersionedObject : IUnknown	***Provides access to members that manage a versioned object.***
IsRegisteredAsVersioned: Boolean	*Is the object registered as versioned?*
Version: IVersion	*The object's current version.*
RegisterAsVersioned (in isVersioned: Boolean)	*Register/Unregister the object as versioned.*

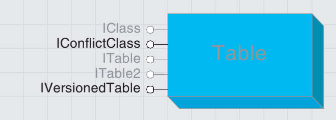
The *IsRegisterAsVersioned* method returns a Boolean if the dataset or class is registered in the database as versioned. When called on a feature dataset, if any class is not registered as versioned, *False* will be returned.

The *Version* method returns the current version the object references. This ensures that the application is working with the correct version of the database.

RegisterAsVersioned provides the ability to register and unregister a feature dataset as versioned. A true value will register the dataset or class as versioned, and a false value will unregister the dataset or class as versioned.

IVersionedObject2 : IVersionedObject	***Provides access to members that manage a versioned object.***
HasUncompressedEdits: Boolean	*Does the object have edits that haven't been compressed yet?*

HasUncompressedEdits returns whether or not there are edits that have not yet been compressed.



IConflictClass *lets you work with conflicting rows after a reconcile.* IVersionedTable *detects conflict categories.*

A table in a versioned workspace implements two additional interfaces.

IConflictClass : IUnknown	*Conflict Class Interface.*
DeleteUpdates: ISelectionSet	*The selection set of all the objects that are delete/update conflicts.*
HasConflicts: Boolean	*True if the conflict class contains conflicts.*
UpdateDeletes: ISelectionSet	*The selection set of all the objects that are update/delete conflicts.*
UpdateUpdates: ISelectionSet	*The selection set of all the objects that are update/update conflicts.*
RestoreRow (in rowID: Long) : IRow	*Restores the row from either the reconcile version or the prereconcile version.*

IConflictClass is obtained from the *IEnumConflictClass* enumeration. It is provided as a mechanism to work with the conflicting rows from each conflict class after performing a reconcile. If *IVersionEdit::Reconcile* has not been called prior to this, the classes will not be available.

The *DeleteUpdates* method returns an *ISelectionSet* of all the object IDs of rows that have been deleted in the edit version and updated in the target reconcile version. If no conflicts were detected, the selection set is null.

HasConflicts returns a Boolean if the reconcile detects conflicts.

The *UpdateDeletes* method returns an *ISelectionSet* of all the object IDs of rows that have been updated in the edit version and deleted in the target reconcile version. If no conflicts were detected, the selection set is null.

The *UpdateUpdate* method returns an *ISelectionSet* of all the object IDs of rows that have been updated in the edit version and updated in the target reconcile version. If no conflicts were detected, the selection set is null.

IVersionedTable : IUnknown	*Versioned Table Interface.*
Differences (in differenceTable: ITable, in differenceType: esriDifferenceType, in QueryFilter: IQueryFilter) : IDifferenceCursor	*Returns an object cursor that can be used to retrieve rows by difference type.*

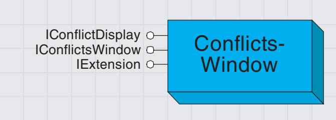
The *IVersionedTable* interface can be used to detect the different conflict categories without first performing an *IVersionEdit::Reconcile*. By specifying the appropriate *esriDifferenceType*, such as *TypeDeleteUpdate* or *TypeInsert*, an *IDifferenceCursor* is returned with a set of *OIDs* and *IRows* for differences.

Differences returns a cursor that can be used to retrieve the rows by the difference type.

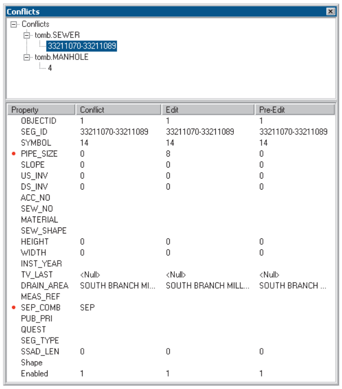
Enumeration esriDifferenceType	*Difference Types.*
0 - esriDifferenceTypeInsert	*Row was inserted in this version.*
1 - esriDifferenceTypeDeleteNoChange	*Row has been deleted in this version and not changed in the difference version.*
2 - esriDifferenceTypeUpdateNoChange	*Row has been updated in this version and not changed in the difference version.*
3 - esriDifferenceTypeUpdateUpdate	*Row has been updated in both versions.*
4 - esriDifferenceTypeUpdateDelete	*Row has been updated in this version but deleted in the difference version.*
5 - esriDifferenceTypeDeleteUpdate	*Row has been deleted in this version but updated in the difference version.*

The *esriDifferenceType* enumeration contains the type of differences possible in a conflict.

ConflictsWindow coclass



The conflicts window provides access to the editor conflicts window.



Property	Conflict	Edit	Pre-Edit
OBJECTID	1	1	1
SEG_ID	33211070-33211089	33211070-33211089	33211070-33211089
SYMBOL	14	14	14
● PIPE_SIZE	0	8	0
SLOPE	0	0	0
US_INV	0	0	0
DS_INV	0	0	0
ACC_NO			
SEW_NO			
MATERIAL			
SEW_SHAPE			
HEIGHT	0	0	0
WIDTH	0	0	0
INST_YEAR			
TV_LAST	<Null>	<Null>	<Null>
DRAIN_AREA	SOUTH BRANCH MI...	SOUTH BRANCH MILL...	SOUTH BRANCH ...
MEAS_REF			
● SEP_COMB	SEP		
PUB_PRI			
QUEST			
SEG_TYPE			
SSAD_LEN	0	0	0
Shape			
Enabled	1	1	1

The Conflicts dialog box contains a list of all feature classes and their features or rows in conflict.

The *ConflictsWindow* class allows you to manage the conflict display environment after performing a reconcile in the *Editor*, if conflicts were detected.

IConflictDisplay : IUnknown	*Provides access to the Conflict display environment.*
FillSymbol (in vers: esriVersion) : IFillSymbol	*Display symbol used to draw polygon features.*
LineSymbol (in vers: esriVersion) : ILineSymbol	*Display symbol used to draw line features.*
MarkerSymbol (in vers: esriVersion) : IMarkerSymbol	*Display symbol used to draw point features.*
VersionVisible (in vers: esriVersion) : Boolean	*The start editing, prereconcile, or reconcile version used for display.*

The *IConflictDisplay* class provides the ability to define the display symbology for the three representations of the conflicting feature, the start editing version, the prereconcile version, and the conflict version. Setting the visible version enables or disables the display for each of the three versions.

FillSymbol sets the fill symbol for displaying polygon conflicts.

LineSymbol sets the line symbol for displaying line conflicts.

MarkerSymbol sets the marker symbol for displaying point conflicts.

VersionVisible enables or disables the display of the start editing, reconcile, and conflict versions.

Enumeration esriVersion	*ESRI Version type.*
0 - esriReconcileVersion	*The version against which the edit session is reconciling.*
1 - esriPreReconcileVersion	*The version prior to reconciliation.*
2 - esriStartEditingVersion	*The version prior to start editing.*

The following diagram shows the three types of versions.

IConflictsWindow : IUnknown	*Provides access to Conflicts Display Window.*
Class (in Index: Long) : IConflictClass	*Class by index.*
ClassCount: Long	*The number of classes with conflicts.*
CurrentClass: IConflictClass	*Class of the selected feature, or 0 if no ConflictClass.*
CurrentRow: Long	*ID of the selected row or feature, or -1 if no current row.*
IDs (in conflictClass: IConflictClass) : IEnumIDs	*Enumerate the feature IDs for a ConflictClass.*
Visible: Boolean	*Indicates if Conflicts window is visible.*
FindTable (in conflictClass: IConflictClass, in vers: esriVersion) : ITable	*Finds a cached table corresponding to the conflict class and version.*
HasConflicts: Boolean	*Indicates if conflicts have been detected.*
Reset	*Resets the conflicts.*

The *IConflictsWindow* contains methods to manage the Conflicts dialog box in the *Editor*. If further postprocessing of conflicts is required, the interface provides the methods to work with the classes that contain conflicts and the individual rows that are conflicts. Removing conflicting rows from the selection sets and resetting the conflicts window allow you to programmatically remove rows from the dialog box.

Class returns the conflict class by its index value.

ClassCount returns the number of classes that contain conflicts.

CurrentClass returns the class of the selected feature, or 0 when nothing is selected.

CurrentRow returns the objected of the selected row, or -1 when no rows are selected.

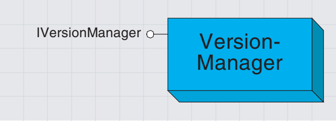
FindTable finds a cached table corresponding to the conflict class and version.

HasConflicts returns *True* if conflicts have been detected for the class.

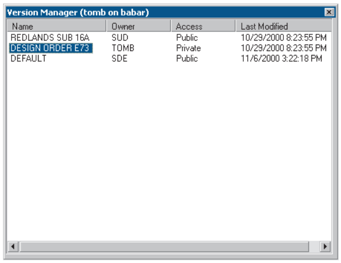
IDs returns an enumeration of feature IDs.

Reset resets the conflict class window.

Visible sets the conflicts window visibility.



The version manager provides a user interface to create and manage version properties.



Version Manager (tomb on babar)

Name	Owner	Access	Last Modified
REDLANDS SUB 16A	SUD	Public	10/29/2000 8:23:55 PM
DESIGN ORDER E73	TOMB	Private	10/29/2000 8:23:55 PM
DEFAULT	SDE	Public	11/6/2000 3:22:18 PM

The VersionManager *command launches the Version Manager dialog box that connects to the database as the user running the process.*

The *VersionManager* coclass provides the ability to create new versions, rename existing versions, delete versions, and modify version properties. The dialog box is the model, and the title bar contains the username and server name in which the version manager is connected. Only versions that the user owns and those that are public or protected are listed.

IVersionManager : IUnknown	***Provides access to members that control the Version Management dialog for a versioned geodatabase.***
← DoModal (in vw: IVersionedWorkspace)	*Displays the dialog box used to manage versions for a versioned geodatabase.*

The following code example shows how to quickly launch the version manager.

```
Dim pSdeWs As IVersionedWorkspace
Set pSdeWs = pWorkspace
Dim pVersion_mngr As IVersionManager
Set pVersion_mngr = New VersionManager
pVersion_mngr.DoModal pSdeWs
```

Enumeration esriVersion	***ESRI Version type.***
0 - esriReconcileVersion	*The version against which the edit session is reconciling.*
1 - esriPreReconcileVersion	*The version prior to reconciliation.*
2 - esriStartEditingVersion	*The version prior to start editing.*

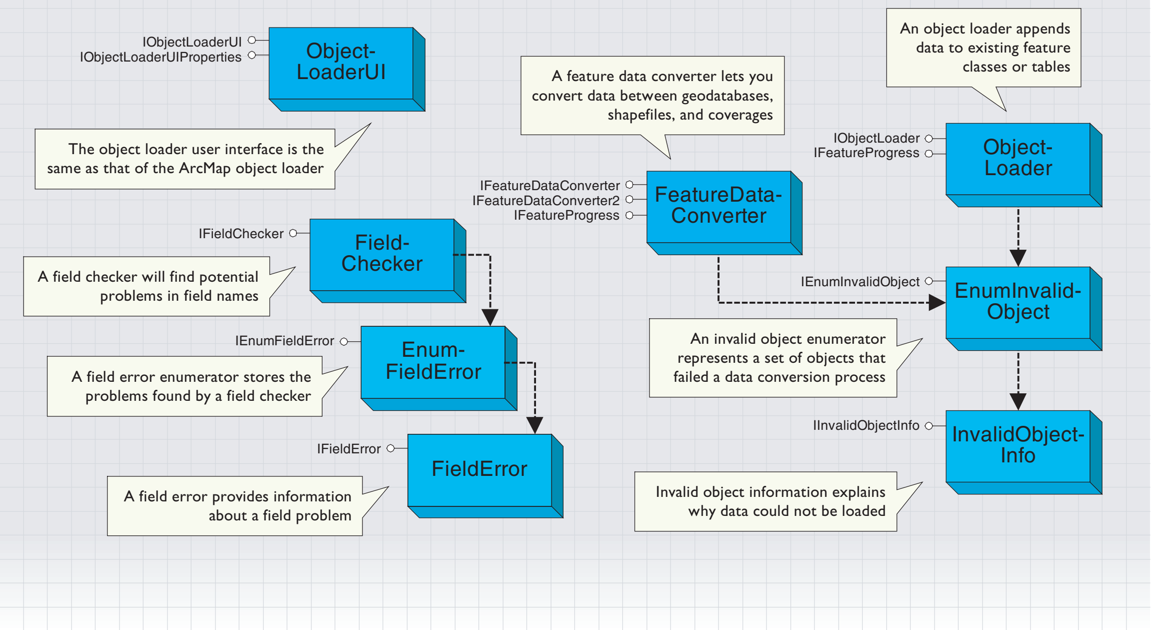
The *esriVersion* Enumeration defines which version's representation should be set as visible in *IConflictDisplay::VersionVisible, FillSymbol, LineSymbol,* and *MarkerSymbol.*

Enumeration esriDifferenceType	***Difference Types.***
0 - esriDifferenceTypeInsert	*Row was inserted in this version.*
1 - esriDifferenceTypeDeleteNoChange	*Row has been deleted in this version and not changed in the difference version.*
2 - esriDifferenceTypeUpdateNoChange	*Row has been updated in this version and not changed in the difference version.*
3 - esriDifferenceTypeUpdateUpdate	*Row has been updated in both versions.*
4 - esriDifferenceTypeUpdateDelete	*Row has been updated in this version but deleted in the difference version.*
5 - esriDifferenceTypeDeleteUpdate	*Row has been deleted in this version but updated in the difference version.*

The *esriDifferenceType* enumeration is used by *IVersionedTable* to define the category of differences to be returned in the cursor.

Each category is self-explanatory. For example, difference type *UpdateNoChange* returns all rows updated in the version but not changed in the target version.

Data converter objects


IObjectLoaderUI
IObjectLoaderUIProperties
Object-LoaderUI
The object loader user interface is the same as that of the ArcMap object loader
A feature data converter lets you convert data between geodatabases, shapefiles, and coverages
An object loader appends data to existing feature classes or tables
IObjectLoader
IFeatureProgress
Object-Loader
IFeatureDataConverter
IFeatureDataConverter2
IFeatureProgress
FeatureData-Converter
IFieldChecker
Field-Checker
A field checker will find potential problems in field names
IEnumInvalidObject
EnumInvalid-Object
IEnumFieldError
Enum-FieldError
A field error enumerator stores the problems found by a field checker
An invalid object enumerator represents a set of objects that failed a data conversion process
IInvalidObjectInfo
InvalidObject-Info
IFieldError
FieldError
A field error provides information about a field problem
Invalid object information explains why data could not be loaded

The two central data converter objects are *FeatureDataConverter* and *ObjectLoader*.

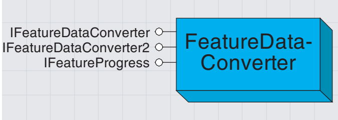
FeatureDataConverter will be familiar to users of ArcCatalog; the import facilities make extensive use of this coclass.

ObjectLoader corresponds to the ArcMap object loader, which can be used in an edit session to import data into an existing feature class.

Some other objects and interfaces are useful in support of *FeatureDataConverter* and *ObjectLoader* and perform the following functions:

- Check for potential problems in your field names with *IFieldChecker*.
- Inspect data that is rejected during the conversion process with *IEnumInvalidObject*.
- Keep the end user informed with *IFeatureProgress*.

FeatureDataConverter coclass



A feature data converter lets you efficiently load data into a geodatabase.

The *FeatureDataConverter* object lets you convert data between geodatabases, shapefiles, and coverages. Most types of feature data are currently supported (except for annotation).

FeatureDataConverter is suitable for loading large amounts of data. When importing to a geodatabase, you can specify an interval for committing data; you can also specify an ArcSDE configuration keyword to control specific storage parameters.

The *ExportOperation* coclass offers similar functionality to the feature data converter but in a simplified form. It corresponds to the export data function available in ArcMap by right-clicking on a layer in the table of contents.

IFeatureDataConverter *can convert data to a new spatial reference.*

IFeatureDataConverter: IUnknown	***Provides access to members that are used to convert from one personal geodatabase/geodatabase dataset to another.***
← ConvertFeatureClass (in InputDatasetName: IFeatureClassName, in InputQueryFilter: IQueryFilter, in outputFDatasetName: IFeatureDatasetName, in outputFClassName: IFeatureClassName, in OutputGeometryDef: IGeometryDef, in OutputFields: IFields, in configKey: String, in FlushInterval: Long, in parantHWnd: Long) : IEnumInvalidObject	*Converts a FeatureClass to a personal geodatabase/geodatabase FeatureClass.*
← ConvertFeatureDataset (in inputFDatasetName: IFeatureDatasetName, in outputFDatasetName: IFeatureDatasetName, in OutputGeometryDef: IGeometryDef, in configKey: String, in FlushInterval: Long, in parentHWnd: Long)	*Converts a FeatureDataset to a personal geodatabase/geodatabase FeatureDataset.*
← ConvertTable (in InputDatasetName: IDatasetName, in InputQueryFilter: IQueryFilter, in OutputDatasetName: IDatasetName, in OutputFields: IFields, in configKey: String, in FlushInterval: Long, in parentHWnd: Long) : IEnumInvalidObject	*Converts a table to a personal geodatabase/geodatabase table.*

ArcCatalog uses FeatureDataConverter *to implement many of its import and export facilities.*

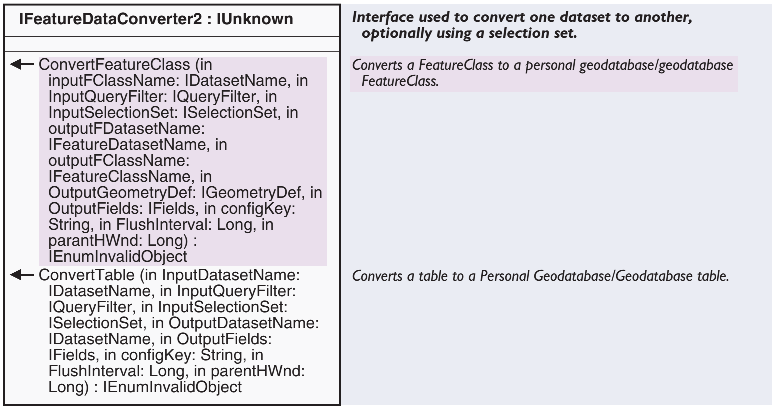
The *IFeatureDataConverter* interface provides methods to convert data between different formats. This example shows conversion of a feature class to a new feature class in a given workspace.

```
Public Sub ConvertFeatureClass(pFeatureClass As IFeatureClass, _
                               pOutWorkspace As IWorkspace)
  ' Get input FeatureClassName and Workspace
  Dim pInFCName As IFeatureClassName
  Dim pDataset As IDataset
  Set pDataset = pFeatureClass
  Set pInFCName = pDataset.FullName
  Dim pInWorkspace As IWorkspace
  Set pInWorkspace = pDataset.Workspace

  ' Set output WorkspaceName
  Set pDataset = pOutWorkspace
  Dim pOutWorkspaceName As IWorkspaceName
  Set pOutWorkspaceName = pDataset.FullName

  ' Set output FeatureClassName
  Dim pOutFCName As IFeatureClassName
  Set pOutFCName = New FeatureClassName
  Dim pDatasetName As IDatasetName
  Set pDatasetName = pOutFCName
  pDatasetName.Name = "NewFeatClass1"
  Set pDatasetName.WorkspaceName = pOutWorkspaceName

  ' Get fields for input feature class and run them through field checker
  Dim pFieldChecker As IFieldChecker
  Dim pFields As IFields
  Set pFields = pFeatureClass.Fields
  Dim pOutFields As IFields
  Set pFieldChecker = New FieldChecker
  pFieldChecker.InputWorkspace = pInWorkspace
  Set pFieldChecker.ValidateWorkspace = pOutWorkspace
  pFieldChecker.Validate pFields, Nothing, pOutFields

  ' Convert the data
  Dim pFeatureDataConverter As IFeatureDataConverter
  Set pFeatureDataConverter = New FeatureDataConverter
  pFeatureDataConverter.ConvertFeatureClass pInFCName, Nothing, _
          Nothing, pOutFCName, Nothing, pOutFields, "", 100, 0
End Sub
```

The *ConvertFeatureDataset* method can import whole feature datasets.

When using *ConvertFeatureClass* and *ConvertFeatureDataset*, if you specify *Nothing* for the *OutputGeometryDef* parameter, then the spatial reference will be taken from the input data or the destination feature dataset, and default spatial index data will be created. The *InputQueryFilter* parameter allows you to just import a subset of the input data.

IFeatureDataConverter2 *lets you specify a selection set on the source data.*


IFeatureDataConverter2 : IUnknown

Interface used to convert one dataset to another, optionally using a selection set.

ConvertFeatureClass (in inputFClassName: IDatasetName, in InputQueryFilter: IQueryFilter, in InputSelectionSet: ISelectionSet, in outputFDatasetName: IFeatureDatasetName, in outputFClassName: IFeatureClassName, in OutputGeometryDef: IGeometryDef, in OutputFields: IFields, in configKey: String, in FlushInterval: Long, in parantHWnd: Long) : IEnumInvalidObject

Converts a FeatureClass to a personal geodatabase/geodatabase FeatureClass.

ConvertTable (in InputDatasetName: IDatasetName, in InputQueryFilter: IQueryFilter, in InputSelectionSet: ISelectionSet, in OutputDatasetName: IDatasetName, in OutputFields: IFields, in configKey: String, in FlushInterval: Long, in parentHWnd: Long) : IEnumInvalidObject

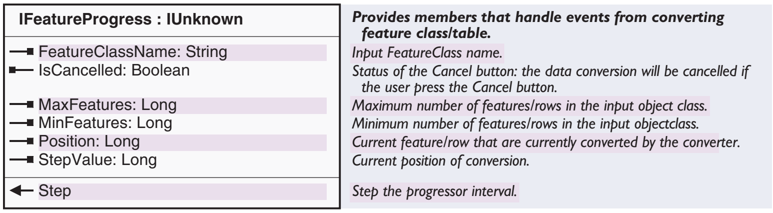
Converts a table to a Personal Geodatabase/Geodatabase table.

The *IFeatureDataConverter2* interface is the same as *IFeatureDataConverter*, except that you can additionally specify a selection set on the input data. This lets you load just those features that might have been selected by a user or any other subset that cannot be defined by a single query.

IFeatureProgress interface

The *IFeatureProgress* interface handles events that are fired by a data-conversion or object-loading process.

Use IFeatureProgress *to keep the user informed about the conversion process.*



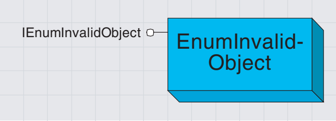
IFeatureProgress : IUnknown	*Provides members that handle events from converting feature class/table.*
FeatureClassName: String	*Input FeatureClass name.*
IsCancelled: Boolean	*Status of the Cancel button: the data conversion will be cancelled if the user press the Cancel button.*
MaxFeatures: Long	*Maximum number of features/rows in the input object class.*
MinFeatures: Long	*Minimum number of features/rows in the input objectclass.*
Position: Long	*Current feature/row that are currently converted by the converter.*
StepValue: Long	*Current position of conversion.*
Step	*Step the progressor interval.*

The various properties, other than *IsCancelled*, are automatically initialized when data conversion starts. You can get these values, but you cannot set them.

The *Step* method is fired automatically for every x number of features, where x is the value of *StepValue*. You can use this event to keep a count of how many features have been converted. The *IsCancelled* property is fetched by the converter after every call to *Step*.

This example shows the code for a form with a command button to cancel the conversion.

```
Private WithEvents m_Converter As FeatureDataConverter
Private m_IsCancel As Boolean

Private Sub Form_Load()
  m_IsCancel = False
End Sub

Private Sub cmdCancel_Click()
  m_IsCancel = True
End Sub

Private Property Get m_Converter_IsCancelled() As Boolean
  m_Converter_IsCancelled = m_IsCancel
  DoEvents
End Property

Public Property Set m_FeatureProgressEvents(ByRef pFDConverter As
IFeatureDataConverter)
  Set m_Converter = pFDConverter
End Property

'The event handling can be initialized in the module containing the data
'converter code before starting the conversion:
  Set frmCancel.m_FeatureProgressEvents = pFeatureDataConverter
  frmCancel.Show vbModeless
  DoEvents
```



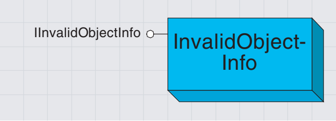
EnumInvalidObject represents a set of objects that failed a data conversion process.

EnumInvalidObject is a standard enumerator like many others in ArcObjects. It represents a set of objects that failed a data-conversion process.

IEnumInvalidObject: IUnknown	*IEnumInvalidFeature interface*
← Next: IInvalidObjectInfo	*Retrieves the next invalid feature/row in the enumeration sequence.*
← Reset	*Resets the enumeration sequence to the beginning.*

The *IEnumInvalidObject* interface lets you step through the objects that failed conversion and gain access to *InvalidObjectInfo*.

InvalidObjectInfo tells you why a particular row or feature could not be loaded.

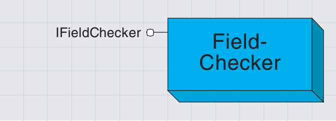


Invalid object information explains why data could not be loaded.

IInvalidObjectInfo: IUnknown	***Return an info about the features that did not convert.***
■— ErrorDescription: String	*Returns the description of the error in converting the feature/row.*
■— InvalidObjectID: Long	*Retrieves the object ID that did not get converted.*

The *IInvalidObjectInfo* interface returns information about an object that could not be loaded. One example of *ErrorDescription* is: “The coordinates or measures are out of bounds.”

The *InvalidObjectID* will be -1 unless the source data is in a geodatabase.



Field checker will find potential problems in field names when converting data between different formats.

A *FieldChecker* object is used to validate a *Fields* collection. It is most often used in conjunction with *FeatureDataConverter*.

FieldChecker is particularly useful when you are creating a new feature class based on an existing feature class and the input and output data are in different formats. For example, a shapefile field name of “UID” would be invalid in an Oracle geodatabase since it is a reserved word in that database.

As well as reporting the problems it finds, *FieldChecker* also generates a new fields collection with standard fixes for the field name problems. In the previous example, a new field name of “UID_” would be generated.

The kinds of errors that the field checker detects are listed by *esriFieldNameErrorType*.

Enumeration esriFieldNameErrorType	***Error enumeration in FieldName.***
0 - esriNoFieldError	*No field error.*
1 - esriSQLReservedWord	*Field name is a SQL Reserved word.*
2 - esriDuplicatedFieldName	*Field name is a duplicate of another field name.*
3 - esriInvalidCharacter	*Field name containes invalid character.*
4 - esriInvalidFieldNameLength	*Field name is too long.*

When converting to a geodatabase, the field checker will also rename geometry fields to “Shape” and object ID fields to “OBJECTID”. No field errors are returned in this situation.

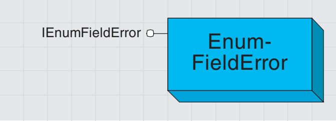
IFieldChecker : IUnknown	***FieldChecker interface***
■—■ InputWorkspace: IWorkspace	*Input workspace of the FieldChecker.*
■—□ ValidateDictionary: ISqlKeywordDictionary	*FieldChecker dictionary.*
■—□ ValidateWorkspace: IWorkspace	*Workspace of the FieldChecker.*
← Validate (in inputField: IFields, out error: IEnumFieldError, out fixedFields: IFields)	*Checks the validity of a list of field names.*
← ValidateField (in FieldIndex: Long, in InputFields: IFields, out error: IEnumFieldError, out fixedFields: IFields)	*Checks the validity of a field.*
← ValidateTableName (in TableName: String, out fixedName: String) : Long	*Checks the validity of a table name.*

The *IFieldChecker* interface validates field names and table names relative to a particular workspace.

If you do not set *ValidateWorkspace* and *InputWorkspace* before validating the fields, then *FieldChecker* assumes a default set of reserved words and invalid characters. This may cause you to rename fields unnecessarily if the problem does not apply to the data format to which you are converting.

An example of the *Validate* method is shown in the *FeatureDataConverter* section in this chapter.

The *ValidateTableName* method will check a proposed table name against reserved words and invalid characters. It will not check to see if that table name is already being used in the workspace.



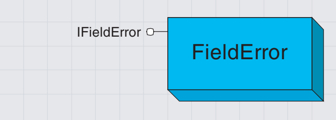
EnumFieldError *stores the problems found by* FieldChecker.

EnumFieldError is a standard enumerator like many others in ArcObjects. It represents a set of field names that would cause problems in a data-conversion process.

IEnumFieldError : IUnknown	*IEnumFieldError interface.*
← Next: IFieldError	*Retrieves the next field error in the enumeration sequence.*
← Reset	*Resets the enumeration sequence to the beginning.*

The *IEnumFieldError* interface lets you step through the field errors found by the field checker. Each element returned is a *FieldError* object.

A *FieldError* object provides information about a problem with a field.

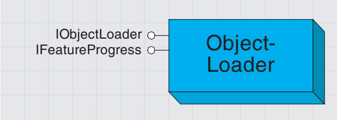


A field error provides information about a field problem.

IFieldError : IUnknown	*IFieldError interface.*
■— FieldError: esriFieldNameErrorType	*Resets the enumeration sequence to the beginning.*
■— FieldIndex: Long	*Field index for the current field error.*

The *IFieldError* interface tells you what kind of error was found and to what field it applies.

ObjectLoader coclass



Use ObjectLoader *to append data to existing feature classes or tables.*

The object loader operates within an edit session.

An *ObjectLoader* is used within an edit session to append features into existing feature classes or to append rows into existing tables. Like the feature data converter, the object loader fires feature progress events, which lets you feed information back to the user. Also, the data that fails to be loaded is referenced by an *EnumInvalidObject* enumerator. The object loader currently supports most types of feature data (except for annotation).

Unlike the feature data converter, the object loader requires an edit session to be in progress. Geodatabase behavior, such as composite relationships, is honored.

The IObjectLoader *interface is used to control the Object Loader.*

IObjectLoader: IUnknown

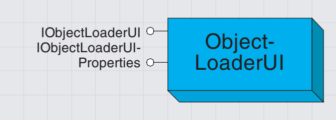
Provides access to members that are used to load an object to an existing feature class or table.

← LoadObjects (in Editor: IEditor, in InputTable: ITable, in InputQueryFilter: IQueryFilter, in OutputTable: ITable, in OutputFields: IFields, in SetSubType: Boolean, in SubtypeCode: Long, in snapToFeatures: Boolean, in applyValidation: Boolean, in FlushInterval: Long, out ppInvalidObjectEnum: IEnumInvalidObject) : ISelectionSet

Loads an object into an existing object class.

LoadObjects returns a selection set of the features that were loaded but failed validation (that is, if the validation flag was specified). This is the same kind of validation as *IValidation* does—don't confuse it with the *EnumInvalidObject*, which identifies the data that could not be loaded.

The most complex part of using *LoadObjects* is specifying the fields to be used. The number of subfields in the input query filter must match the number of fields in the collection specified by the *OutputFields* parameter, and the fields must be in the same order. This gives you the flexibility to map input fields to output fields with different names. The input query filter parameter can be specified as *Nothing*, in which case you must adjust the output fields to match the fields in the source table. Field values are not copied for noneditable fields, such as the object ID.



ObjectLoaderUI *lets you use the same user interface as the object loader in ArcMap.*

The *ObjectLoaderUI* is the same user interface as the object loader in ArcMap. It lets the user pick multiple data sources for loading and also match the input fields to the output fields. Use *ObjectLoaderUI* if you want the user to be able to control what data gets loaded.

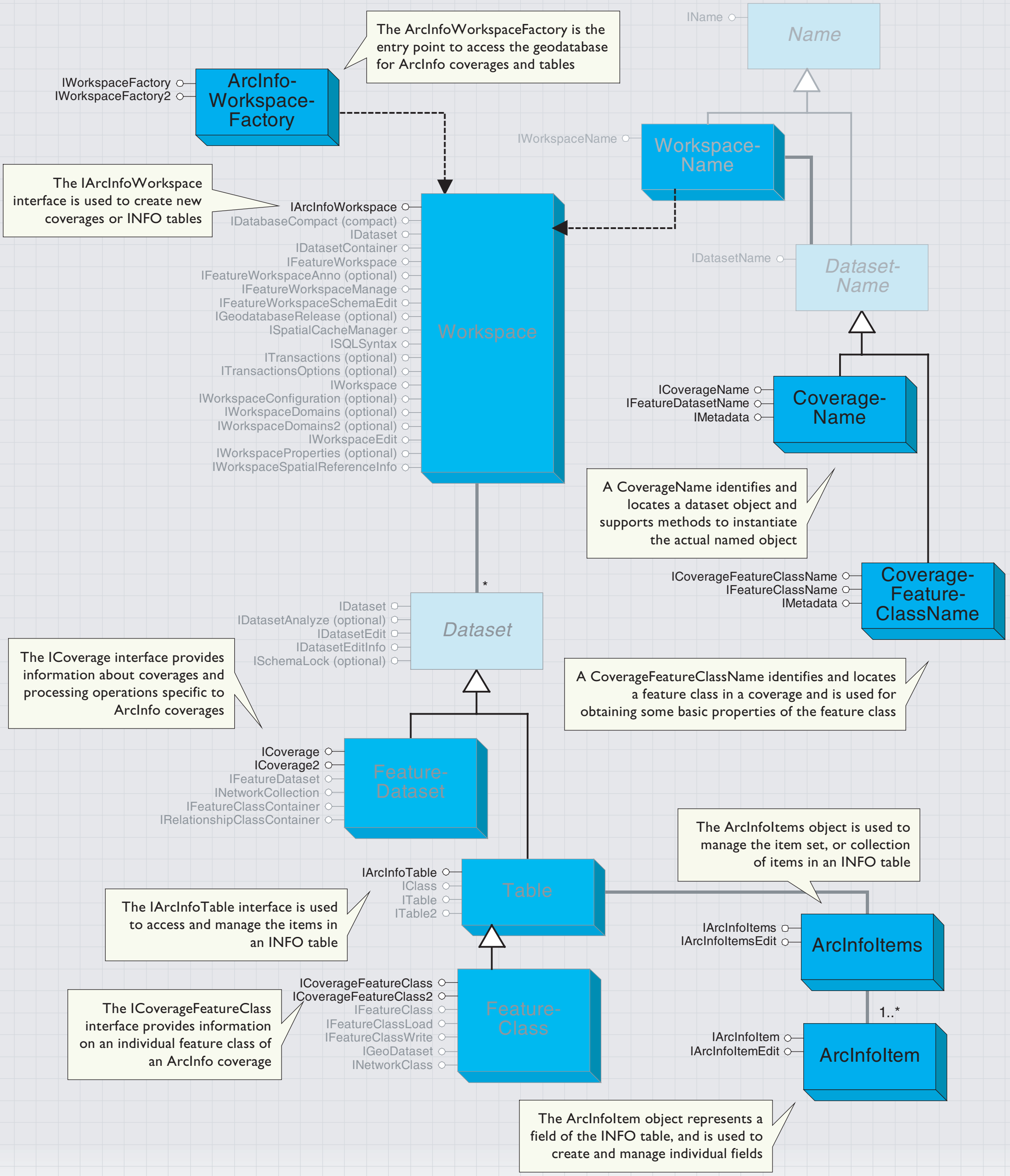
	IObjectLoaderUI : IUnknown	***Provides access to members that control the Object Loader UI.***
■—□	Application: Object	*Application of the Object/Simple data loader.*
■—	Editor (in Editor: IEditor)	*Editor extension.*
◄—	Show (in Show: Boolean, in simpleLoader: Boolean, in parantHWnd: Long)	*Show or hide the object loader window.*

The *IObjectLoaderUI* interface opens the Object Loader dialog box in your application. You can choose between the full user interface and a simplified version.

	IObjectLoaderUIProperties : IUnknown	***Provides access to the members that control the properties of the object loader.***
■—□	InputFields: IFields	*Source fields that will be loaded into the target object class.*
■—■	LoadWithSnap: Boolean	*Snap state of the loader.*
■—■	LoadWithValidation: Boolean	*Validation state of the loader.*
■—□	ObjectLoaderQueryFilter: IQueryFilter	*Query filter to use on the source data.*
■—□	OutputFields: IFields	*Fields in the target object class that will be loaded from the source.*
■—■	SetSubTypeCode: Boolean	*State of the loader subtype code.*
—□	SourceFullName: IName	*Data source to be loaded into the target object class.*
■—■	TargetSubTypeCode: Long	*Target object class subtype code.*
■—□	TargetTable: ITable	*Loader target object class.*
◄—	DataSourceCount: Long	*Data source count that will be loaded into the target object class.*
◄—	DeleteAllSources	*Clear the data sources list.*
◄—	DeleteSourceFullName (in sourceName: IName)	*Delete a data source from the list of sources.*
◄—	GetSourceFullName (in Index: Long) : IName	*Data source at specific index.*

The *IObjectLoaderUIProperties* interface lets you specify the default information that appears in the Object Loader dialog box and then get the settings that the end user decided on.

ArcInfo coverage objects



The ArcInfoWorkspaceFactory is the entry point to access the geodatabase for ArcInfo coverages and tables

The IArcInfoWorkspace interface is used to create new coverages or INFO tables

A CoverageName identifies and locates a dataset object and supports methods to instantiate the actual named object

A CoverageFeatureClassName identifies and locates a feature class in a coverage and is used for obtaining some basic properties of the feature class

The ICoverage interface provides information about coverages and processing operations specific to ArcInfo coverages

The ArcInfoItems object is used to manage the item set, or collection of items in an INFO table

The IArcInfoTable interface is used to access and manage the items in an INFO table

The ICoverageFeatureClass interface provides information on an individual feature class of an ArcInfo coverage

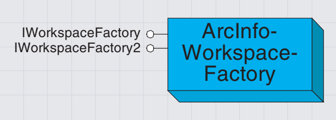
The ArcInfoItem object represents a field of the INFO table, and is used to create and manage individual fields

There are two ways of working with ArcInfo™ coverage objects: using the coverage-specific objects, such as *ArcInfoworkspacefactory*, or using the lightweight name objects, such as *WorkspaceName*. While these objects are used to represent similar things, the name objects are smaller and faster, although they have less functionality.

Since these two groups of objects are similar, which one you decide to use will depend on what functionality, memory usage, and processing speed you require. To retrieve information about a coverage or feature class, such as name, type, or metadata, use the name objects. To retrieve more detailed information, such as the items in a table or the tolerances of a coverage, use the coverage-specific objects. The coverage-specific objects also perform management operations, such as creating, copying, renaming, deleting, or building topology for coverages.

For information on *Name* objects and their appropriate uses, see the 'Workspace and name objects' topic at the beginning of this chapter.

ArcInfoWorkspaceFactory coclass



The ArcInfo workspace factory is the entry point to access the geodatabase classes for ArcInfo coverages and tables. Use ArcInfoWorkspaceFactory *to open a coverage workspace or create a new ArcInfo coverage workspace.*

Workspace factory classes are the entry point for accessing data with the geodatabase objects for any data format. The type of workspace factory you instantiate dictates the type of data that can be handled by the workspace factory object and its derivatives.

To work with ArcInfo coverage or table data, you must create a workspace factory using the *ArcInfoWorkspaceFactory* class. After creating a new instance of the *ArcInfoWorkspaceFactory* object, use the *Open* or *OpenFromFile* method to get a *Workspace* object that is used to actually work with the data.

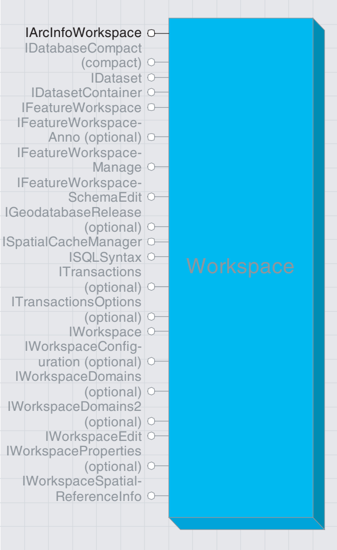
The *IWorkSpaceFactory::Copy* and *IWorkSpaceFactory::Move* methods cannot be used with an *ArcInfoWorkspaceFactory*.

Here are some values specific to *ArcInfoWorkspaceFactory*:

- *IWorkspaceFactory::WorkspaceDescription* returns “ARC/INFO Workspace”.
- *IWorkspaceFactory::WorkspaceType* returns “0” or *esriFileSystemWorkspace*.
- *IWorkspaceFactory::IsWorkspace* returns *True* or *False* depending on whether or not there is an INFO™ subdirectory present.
- *IWorkspaceFactory::ReadconnectionPropertiesFromFile* returns a *PropertySet* object, with the only property being DATABASE, which is set to the pathname.

This code demonstrates the use of the *ArcInfoWorkspaceFactory*.

```
Dim pWorkspaceFact as IWorkSpaceFactory
Dim pWorkspace as IWorkspace
Set pWorkspaceFact = New ArcInfoWorkspaceFactory

'Now assign a workspace folder to the objects
Set pWorkspace = pWorkspaceFact.OpenFromFile("D:\data", 0)
'or
Dim pPropSet As IPropertySet
Set pPropSet = New PropertySet
pPropSet.SetProperty "DATABASE", "D:\canada"
Set pWorkspace = pWorkspaceFact.Open(pPropSet, 0)
```


IArcInfoWorkspace
IDatabaseCompact (compact)
IDataset
IDatasetContainer
IFeatureWorkspace
IFeatureWorkspace-Anno (optional)
IFeatureWorkspace-Manage
IFeatureWorkspace-SchemaEdit
IGeodatabaseRelease (optional)
ISpatialCacheManager
ISQLSyntax
ITransactions (optional)
ITransactionsOptions (optional)
IWorkspace
IWorkspaceConfig-uration (optional)
IWorkspaceDomains (optional)
IWorkspaceDomains2 (optional)
IWorkspaceEdit
IWorkspaceProperties (optional)
IWorkspaceSpatial-ReferenceInfo
Workspace

Like an ArcInfo workspace, the workspace object is a container of datasets.

The *Workspace* object is created by the *ArcInfoWorkspaceFactory* when the *Open* or *OpenFromFile* methods are used. The class has interfaces with methods that include creating new ArcInfo coverages or INFO table data, renaming workspaces, and deleting ArcInfo coverages. This class is cocreatable, but it should only be created by the workspace factory class.

IArcInfoWorkspace : IUnknown	*Provides access to members that create ArcInfo coverages and tables.*
← CreateCoverage (in Name: String, in templateCoverage: String, in Precision: tagesriCoveragePrecisionType) : IFeatureDataset	*Creates a new coverage.*
← CreateInfoTable (in Name: String, in ItemSet: IArcInfoItems) : ITable	*Creates a new INFO table.*

The *IArcInfoWorkspace* interface is used to create new coverages or INFO tables.

```
Dim pWorkSp As IArcInfoWorkspace
Dim pWSfact As IWorkspaceFactory
Dim pPropertyset As IPropertySet
Set pWSfact = New ArcInfoWorkspaceFactory
Set pPropertyset = New PropertySet
'canada is an ArcInfoWorkspace
pPropertyset.SetProperty "DATABASE", "D:\canada"
'pWorkSp is a pointer to the IArcInfoWorkspace
Set pWorkSp = pWSfact.Open(pPropertyset, 0)
'Now use the methods on IArcInfoWorkspace
pWorkSp.CreateCoverage "NewCover", "D:\canada\Water", _
  esriCoveragePrecisionDouble
```

CreateCoverage creates a new ArcInfo coverage in the workspace that is being referenced. The *IFeatureDataset* that is returned can be used to create new feature classes within the coverage.

If a template coverage is not specified or the name is not a valid coverage, the new coverage will only have an empty .tic file. When a template coverage is used, the new coverage will have the same tics: bnd (boundary) and prj (projection).

Enumeration tagesriCoveragePrecisionType	*ArcInfo Coverage Precision Types.*
1 - esriCoveragePrecisionSingle	*Single Precision.*
2 - esriCoveragePrecisionDouble	*Double Precision.*

The precision enumerator is used to specify whether the coverage has single precision (7 significant digits for each coordinate) or double precision (15 significant digits for each coordinate).

The *CreateCoverage* method returns an error if *CoverageName* is a path (such as “D:\data\canada”), if it is longer than 13 characters, or if it exists.

CreateInfoTable creates a new INFO table in the workspace that is being referenced. The *ITable* pointer that is returned can be used to add and delete items in the table.

The name argument for the name of the new table can be up to 32 characters long, inclusive of the extension. The name cannot be an existing INFO table. The table will be created in the workspace used by the *IArcInfoWorkspace*; pathnames are recognized by this method.

The *ItemSet* object must be given, although it does not have to contain any items. If the *ItemSet* contains items, they will be created in the new table. The following example creates a new table named “newtest”.

```
Public Sub testcreateinfo()
  Dim pwfact As IWorkspaceFactory
  Dim pAIWorksp As IArcInfoWorkspace
  Dim pPropertyset As IPropertySet
  'Open the arcinfo workspace
  Set pwfact = New ArcInfoWorkspaceFactory
  Set pPropertyset = New PropertySet
  pPropertyset.SetProperty "DATABASE", "D:\canada2"
  Set pAIWorksp = pwfact.Open(pPropertyset, 0)
  'Create a new info table
  Dim pTableNew As ITable
  Dim pAIItems As IArcInfoItems
  Set pAIItems = New ArcInfoItems
  Set pTableNew = pAIWorksp.CreateInfoTable("newtest", pAIItems)
End Sub
```

The *Workspace* coclass also implements other interfaces, although not all of the properties and methods of each interface are supported. A full discussion of these interfaces along with their properties and methods can be found earlier in this chapter. The following review of each of the interfaces is a highlight of how the properties and methods are applied to ArcInfo workspace data for each interface.

IDataset : IUnknown	***Provides access to members that supply dataset information.***
■–■ BrowseName: String	*The browse name of the dataset.*
■— Category: String	*The category of the dataset.*
■— FullName: IName	*The associated name object.*
■— Name: String	*The name of the dataset.*
■— PropertySet: IPropertySet	*The set of properties for the dataset.*
■— Subsets: IEnumDataset	*Datasets contained within this dataset.*
■— Type: esriDatasetType	*Returns the type of the dataset.*
■— Workspace: IWorkspace	*The workspace containing this dataset.*
◀— CanCopy: Boolean	*True if this dataset can be copied.*
◀— CanDelete: Boolean	*True if this dataset can be deleted.*
◀— CanRename: Boolean	*True if this dataset can be renamed.*
◀— Copy (in copyName: String, in copyWorkspace: IWorkspace) : IDataset	*Copies this dataset to a new dataset with the specified name.*
◀— Delete	*Deletes this dataset.*
◀— Rename (in Name: String)	*Renames this dataset.*

The *IDataset* interface provides information about datasets and high-level management facilities, such as *Copy, Delete,* and *Rename*.

Method	Action in an ArcInfo workspace
BrowseName	Returns the string "ARC/INFO Data"
CanCopy	Returns False, indicating it cannot be copied
CanDelete	Returns True, indicating it can be deleted
CanRename	Returns True, indicating it can be renamed
Category	Returns the string "Coverage Workspace"
Copy	Object doesn't support this action. If you try to use this method, an error will be returned
Delete	Deletes coverages and INFO tables in the workspace. Will not delete other types of data or the workspace
FullName	Returns Name object with NameString property such as "ARCINFO: Workspace = \\Petra\D$\Canada;"
Name	Returns the name of the workspace, such as "Canada"
PropertySet	Object doesn't support this action. If you try to use this method, an error will be returned
Rename	Renames the workspace to the name given
Subsets	Returns an enumerator containing only the coverage and INFO table datasets in the workspace
Type	Returns 2 or *esriDTContainer* indicating the type of dataset
Workspace	This method is not usable

The table above summarizes which properties and methods in *IDataset* are supported and what happens with a coverage workspace.

IFeatureWorkspace : IUnknown	*Feature Workspace Interface.*
← CreateFeatureClass (in Name: String, in Fields: IFields, in CLSID: IUID, in EXTCLSID: IUID, in FeatureType: esriFeatureType, in ShapeFieldName: String, in ConfigKeyword: String) : IFeatureClass	*Creates a new standalone FeatureClass under the workspace.*
← CreateFeatureDataset (in Name: String, in SpatialReference: ISpatialReference) : IFeatureDataset	*Creates a new feature dataset.*
← CreateQueryDef: IQueryDef	*Creates a query definition object.*
← CreateRelationshipClass (in relClassName: String, in OriginClass: IObjectClass, in DestinationClass: IObjectClass, in forwardLabel: String, in backwardLabel: String, in Cardinality: esriRelCardinality, in Notification: esriRelNotification, in IsComposite: Boolean, in IsAttributed: Boolean, in relAttrFields: IFields, in OriginPrimaryKey: String, in destPrimaryKey: String, in OriginForeignKey: String, in destForeignKey: String) : IRelationshipClass	*Creates a new relationship class.*
← CreateTable (in Name: String, in Fields: IFields, in CLSID: IUID, in EXTCLSID: IUID, in ConfigKeyword: String) : ITable	*Creates a new table.*
← OpenFeatureClass (in Name: String) : IFeatureClass	*Opens an existing feature class.*
← OpenFeatureDataset (in Name: String) : IFeatureDataset	*Opens an existing feature dataset.*
← OpenFeatureQuery (in queryName: String, in pQueryDef: IQueryDef) : IFeatureDataset	*Opens a FeatureDataset containing a single FeatureClass defined by the specified query.*
← OpenRelationshipClass (in Name: String) : IRelationshipClass	*Opens an existing relationship class.*
← OpenRelationshipQuery (in pRelClass: IRelationshipClass, in joinForward: Boolean, in pSrcQueryFilter: IQueryFilter, in pSrcSelectionSet: ISelectionSet, in TargetColumns: String, in DoNotPushJoinToDB: Boolean) : ITable	*Table of a relationship join query.*
← OpenTable (in Name: String) : ITable	*Opens an existing table.*

The *IFeatureWorkspace* interface provides information about feature classes and tables along with management facilities such as *Create, Open,* and *Query*. For information about which methods are supported and what happens with a coverage workspace, see the following table.

Method	Action in an ArcInfo workspace
CreateFeatureClass	This method is not applicable
CreateFeatureDataset	Creates a new feature dataset
CreateQueryDef	Not supported with a coverage workspace
CreateRelationshipClass	Creates a new relationship class
CreateTable	Creates a new table
OpenFeatureClass	Opens an existing feature class
OpenFeatureDataset	Opens an existing feature dataset
OpenFeatureQuery	Opens a feature dataset containing a single feature class defined by the specified query
OpenRelationshipClass	Opens an existing relationship class
OpenRelationshipQuery	Table of a relationship join query
OpenTable	Works with INFO table

The table above summarizes which properties and methods in *IFeatureWorkspace* are supported, and what happens with a coverage workspace.

IWorkspace : IUnknown	***Provides access to members that have information about the workspace.***
ConnectionProperties: IPropertySet	*The connection properties of the workspace.*
DatasetNames (in DatasetType: esriDatasetType) : IEnumDatasetName	*The DatasetNames in the workspace.*
Datasets (in DatasetType: esriDatasetType) : IEnumDataset	*The datasets in the workspace.*
PathName: String	*The file system full path of the workspace.*
Type: esriWorkspaceType	*The Type of the Workspace.*
WorkspaceFactory: IWorkspaceFactory	*The factory that created the workspace.*
ExecuteSQL (in sqlStmt: String)	*Executes the specified SQL statement.*
Exists: Boolean	*Checks if the workspace exists.*
IsDirectory: Boolean	*TRUE if the workspace is a file system directory.*

The *IWorkspace* interface provides information about feature classes and tables along with management facilities such as *Create, Open,* and *Query*. For information about which methods are supported and what happens with a coverage workspace, see the following table.

Method	Action in an ArcInfo workspace
ConnectionPropert	Returns the information used with the PropertySet object properties, such as “WORKSPACE” + “D:\canada”.
DatasetNames	Returns an enumation of dataset name objects in the workspace.
Datasets	Returns an enumation of dataset objects in the workspace.
ExecuteSQL	Object doesn’t support this action. If you try to use this method, an error will be returned.
Exists	True, if the workspace exists.
IsDirectory	True, if the workspace is a file system directory.
PathName	Returns the file system full pathname of the workspace.
Type	Returns 0,*esriFilesystemWorkspace*, the type of workspace.
WorkspaceFactor	Returns the workspace factory that created the workspace. The *IArcInfoWorkspaceUtil* interface is used to get an INFO table name.

The table above summarizes which properties and methods in *IWorkspace* are supported, and what happens with a coverage workspace.

IArcInfoWorkspaceUtil : IUnknown	***Provides access to members that retrieves ArcInfo INFO table information.***
GetInfoTableName (in prefix: String) : String	*Maps a prefix to a table name.*

The *IArcInfoWorkspaceUtil* interface is used to get an INFO table name.

Method	Action in an ArcInfo workspace
GetInfoTableName	Maps a prefix to a table name

IDataset : IUnknown	Provides access to members that supply dataset information.
BrowseName: String	The browse name of the dataset.
Category: String	The category of the dataset.
FullName: IName	The associated name object.
Name: String	The name of the dataset.
PropertySet: IPropertySet	The set of properties for the dataset.
Subsets: IEnumDataset	Datasets contained within this dataset.
Type: esriDatasetType	Returns the type of the dataset.
Workspace: IWorkspace	The workspace containing this dataset.
CanCopy: Boolean	True if this dataset can be copied.
CanDelete: Boolean	True if this dataset can be deleted.
CanRename: Boolean	True if this dataset can be renamed.
Copy (in copyName: String, in copyWorkspace: IWorkspace) : IDataset	Copies this dataset to a new dataset with the specified name.
Delete	Deletes this dataset.
Rename (in Name: String)	Renames this dataset.

The *IDataset* interface provides information about datasets and high-level management facilities such as *Copy, Delete,* and *Rename*.

Method	Action on an ArcInfo coverage or INFO table
BrowseName	Returns the coverage name
CanCopy	Returns True
CanDelete	Returns True
CanRename	Returns True
Category	Returns “Coverage” or “INFO TABLE”
Copy	Copies the dataset
Delete	Deletes the coverage
FullName	Returns name object with namestring property, such as “ARCINFO: Workspace = \\PASCHA\D$\canada;Coverage = canada99”
Name	Returns a name such as “canada”
PropertySet	Works
Rename	Renames
Subsets	For coverages, returns INFO tables. For tables, enumeration is nothing
Type	Returns 4 for coverages or 10 for tables
Workspace	Returns the workspace

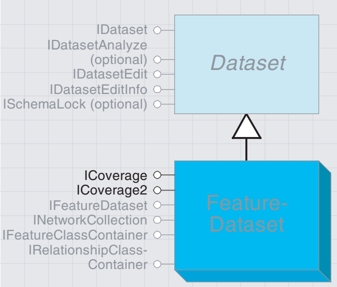
The above table lists which properties and methods in *IDataset* are supported, and what happens with an ArcInfo coverage dataset object.

IDatasetEdit : IUnknown	Provides access to members about the status of datasets being edited.
IsBeingEdited: Boolean	True if the dataset is being edited.

The *IDatasetEdit* interface only has one method, which returns a Boolean indicating whether the dataset ArcInfo coverage is being edited.

Method	Action in an ArcInfo workspace
IsBeingEdited	Indicates if object is being edited

The above table lists which properties and methods in *IDatasetEdit* are supported, and what happens with an ArcInfo coverage dataset object.



Like an ArcInfo coverage, the feature dataset is a container of feature classes.

The *FeatureDataset* is similar to an ArcInfo coverage.

ICoverage : IUnknown	*Provides access to members that modifies ArcInfo coverages.*
Tolerance (in toleranceType: tagesriCoverageToleranceType) : Double	*Value of the specified tolerance.*
ToleranceStatus (in toleranceType: tagesriCoverageToleranceType) : Boolean	*Indicates if the specified tolerance has been verified.*
Build (in FeatureClassType: tagesriCoverageFeatureClassType, subclassName: String)	*Performs a BUILD operation.*
Clean (in dangleTolerance: Double, in fuzzyTolerance: Double, in FeatureClassType: tagesriCoverageFeatureClassType)	*Performs a CLEAN operation.*
CreateFeatureClass (in FeatureClassType: tagesriCoverageFeatureClassType, subclassName: String) : IFeatureClass	*Creates an empty feature class in the coverage.*

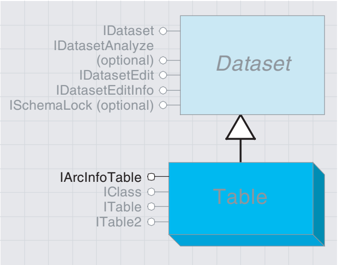
The *ICoverage* interface provides information about coverages and processing operations specific to ArcInfo coverages. This interface can be used to create or update the topology of a coverage and set various tolerances that are used in coverage editing and processing. Tolerance values are considered to be verified if the specified tolerance value has actually been used to process the coverage, with the exception of the ArcEdit™ tolerances. EDIT, NODESNAP, WEED, GRAIN, and SNAP are verified as soon as they have been explicitly set.

Enumeration tagesriCoverageFeatureClassType	*ArcInfo Coverage Feature Class types.*
1 - esriCFCTPoint	*Point Feature Class*
2 - esriCFCTArc	*Arc Feature Class*
3 - esriCFCTPolygon	*Polygon Feature Class*
4 - esriCFCTNode	*Node Feature Class*
5 - esriCFCTTic	*Tic Feature Class*
6 - esriCFCTAnnotation	*Annotation Feature Class*
7 - esriCFCTSection	*Section Feature Class*
8 - esriCFCTRoute	*Route Feature Class*
9 - esriCFCTLink	*Link Feature Class*
11 - esriCFCTRegion	*Region Feature Class*
51 - esriCFCTLabel	*Label Feature Class*
666 - esriCFCTFile	*File Feature Class*

The *esriCoverageFeatureClassType* enumeration contains the possible ArcInfo feature class types.

Enumeration tagesriCoverageToleranceType	*Coverage Tolerance Types*
1 - esriCTTFuzzy	*Fuzzy*
10 - esriCTTSnap	*Snap*
2 - esriCTTGeneralize	*Generalize*
3 - esriCTTNodeMatch	*Node Match*
4 - esriCTTDangle	*Dangle*
5 - esriCTTTicMatch	*Tic Match*
6 - esriCTTEdit	*Edit*
7 - esriCTTNodeSnap	*Node Snap*
8 - esriCTTWeed	*Weed*
9 - esriCTTGrain	*Grain*

The *esriCoverageToleranceType* enumeration contains the possible ArcInfo tolerance class types.

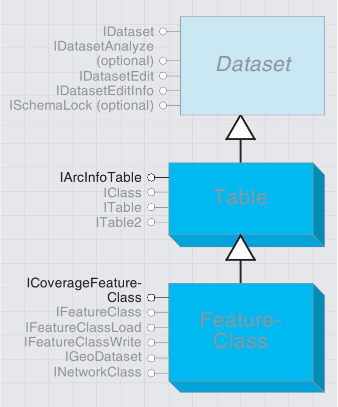


A table is a collection of ArcInfo items (columns) and rows.

The *Table* object is a collection of ArcInfo items (columns) and rows.

IArcInfoTable : IUnknown	Provides access to members that modify ArcInfo tables.
ItemSet: IArcInfoItems	Item collection for this feature class or INFO table.
AddIndex (in itemName: String)	Adds an index for the specified Item.
AddItem (in Item: IArcInfoItem, in startItem: String)	Adds an item to this table.
AlterItem (in itemName: String, in Item: IArcInfoItem)	Changes the properties of the specified Item.
DeleteIndex (in itemName: String)	Deletes an index from the specified item.
DeleteItem (in itemName: String)	Deletes an item from this table.
FindItem (in Name: String) : Long	Index of the item with the specified name.

All types of data use tables to store information about its features, but with ArcInfo the data is stored in an INFO table. The *IArcInfoTable* interface is used to access and modify the items in the INFO table. With this interface, you can add or delete items, add or delete an index for an item, and change the properties of an item (alteritem). This interface is used to get the items collection, with which you can get or set information for individual items.



A feature class is a collection of features that have the same feature type and set of attributes.

A *FeatureClass* object is a collection of features that have the same feature type and set of attributes.

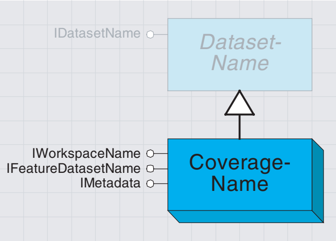
ICoverageFeatureClass : IUnknown	Provides access to members that retrieve ArcInfo coverage feature class information.
FeatureClassType: tagesriCoverageFeatureClassType	Type of the feature class.
HasFAT: Boolean	Indicates if the feature class has a feature attribute table.
Topology: tagesriFeatureClassTopology	Topology of the feature class.

The *ICoverageFeatureClass* interface provides information on an individual feature class of an ArcInfo coverage.

This code checks the properties of a feature class:

```
Public Sub FeatClassType2()
'this will open a featureclass and get info
  Dim pWorksp As IArcInfoWorkspace, pWSfact As IWorkspaceFactory
  Dim pPropertyset As IPropertySet

  Set pWSfact = New ArcInfoWorkspaceFactory
  Set pPropertyset = New PropertySet
  'canada is an arcinfoworkspace
  pPropertyset.SetProperty "DATABASE", "D:\canada"
  'pWorkSp is a pointer to the IArcInfoWorkspace
  Set pWorksp = pWSfact.Open(pPropertyset, 0)
  'open the feature class
  Dim pFeatWS As IFeatureWorkspace
  Dim pFeatClass As IFeatureClass
  Dim pCoverFeatClass As ICoverageFeatureClass

  Set pFeatWS = pWorksp
  Set pFeatClass = pFeatWS.OpenFeatureClass("canada:arc")
  Set pCoverFeatClass = pFeatClass
  MsgBox pCoverFeatClass.HasFAT
 End Sub
```

Enumeration tagesriFeatureClassTopology	*ArcInfo coverage feature class topology types.*
0 - esriFCTNotApplicable	*Topology is not supported by this feature class.*
1 - esriFCTPreliminary	*Topology is preliminary.*
2 - esriFCTExists	*Topology exists.*
3 - esriFCTUnknown	*Topology status is unknown.*



A CoverageName *object can be used to retrieve basic information on an* ArcInfo *coverage.*

A *CoverageName* object identifies and locates a dataset object and supports methods to instantiate the actual named object.

As noted in the section on name objects, a name object can be used as a lightweight surrogate of the actual object until further properties of the object are needed or additional methods on the object need to be called.

Name objects are cocreatable and can be used to specify datasets that are yet to be created, for example, the output dataset to be created by a geoprocessing operation.

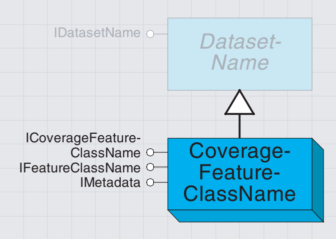
The *CoverageName* object can be used to retrieve information on the type of the coverage, what is contained in the coverage, and the metadata for the coverage.

ICoverageName : IUnknown	***Provides access to members that maintains ArcInfo coverage feature dataset information.***
CoverageType: tagesriCoverageType	*Type of the coverage.*

ICoverageName can be used to find the coverage type, which is based on the highest level of dimension, for the feature classes contained. Levels of dimensions refer to how many dimensions are used to measure the features; in other words, a point has an x- and y-value; a line has length in addition to these values; and polygons, in addition, have area.

Enumeration tagesriCoverageType	***ArcInfo coverage types***
0 - esriEmptyCoverage	*Empty coverage—no feature classes are present*
1 - esriAnnotationCoverage	*Annotation coverage—only annotation features are present*
2 - esriPointCoverage	*Points are the highest dimension feature class*
3 - esriLineCoverage	*Lines are the highest dimension feature class*
4 - esriPolygonCoverage	*Polygons are the highest dimension feature class*
5 - esriPreliminaryPolygonCoverage	*Polygon topology is incomplete*

A *CoverageFeatureClassName* object identifies and locates a feature class in a coverage; it is used for obtaining some basic properties of the feature class without having to open (instantiate) it.

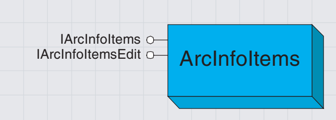


A CoverageFeatureClassName *object can be used to retrieve basic information on an* ArcInfo *coverage's feature classes.*

ICoverageFeatureClassName : IUnknown	***Provides access to members that maintains ArcInfo coverage feature class information.***
FeatureClassType: tagesriCoverageFeatureClassType	*Type of feature class.*
HasFAT: Boolean	*Indicates if the feature class has a feature attribute table.*
Topology: tagesriFeatureClassTopology	*Topology of the feature class.*

The *ICoverageFeatureClassName* has the same properties as the *ICoverageFeatureClass* interface, which is the *FeatureClassType* if there is an attribute table, and the topology status.

ArcInfoItems coclass



The ArcInfoItems *object is a collection of the ArcInfo items (columns) in a table.*

The *ArcInfoItems* coclass represents the item set, or collection of items, in an INFO table. This coclass is similar to the *Fields* object used with tables from other data types. The *ArcInfoItems* object is an ordered collection of items, and the collection behaves like a list, so it is possible to access individual fields by a numbered position (or index) in the list.

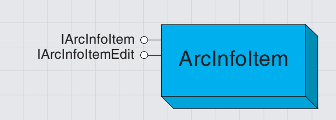
This class contains two interfaces: the *IArcInfoItems* interface, which is used to get information, and the *IArcInfoItemsEdit* interface, which is used to modify the items collection.

IArcInfoItems : IUnknown	***Provides access to members that retrieve ArcInfo items collection information.***
■— Item (in Index: Long) : IArcInfoItem	*Item at the specified index in the items collection.*
■— ItemCount: Long	*Number of items in the items collection.*
← FindItem (in Name: String, out Index: Long)	*Finds the index of the specified item in the items collection.*

The *IArcInfoItems* interface is used to get the number of items, the index of an item, or an item object.

IArcInfoItemsEdit : IArcInfoItems	***Provides access to members that create the ArcInfo Items Collection.***
—■ Item (in Index: Long) : IArcInfoItem	*Item at the specified position.*
—■ ItemCount: Long	*Number of Items in this Item Collection.*
← AddItem (in Item: IArcInfoItem)	*Adds an Item to the Items Collection.*
← DeleteAllItems	*Deletes all the Items from the Items Collection.*
← DeleteItem (in Item: IArcInfoItem)	*Deletes an Item from the Items Collection.*

The *IArcInfoItemsEdit* interface is used when creating or modifing an *ArcInfoItems* collection. For example, you can create a new *ArcInfoItem* object and add items to it, or you can get an item collection from an ArcInfo feature class and add or remove items from it.



An ArcInfo item represents a field of the INFO table that is the coverage attribute table.

Item property	Default value
AlternateName	blank string
IsIndexed	False
IsPseudo	False
IsRedefined	False
Name	blank string
NumberOfDecimals	-1
OutputWidth	0
StartPosition	0
Type	0
Width	0

When a new item is created, the properties in IArcInfoItem *have default values displayed in the table.*

An *ArcInfoItem* has many properties, the most obvious ones being its name and its data type.

IArcInfoItem : IUnknown	*Provides access members that retrieve ArcInfo item information.*
AlternateName: String	*Alternate name of the item.*
IsIndexed: Boolean	*Indicates if the item is indexed.*
IsPseudo: Boolean	*Indicates if the item is a pseudo item.*
IsRedefined: Boolean	*Indicates if the item is a redefined item.*
Name: String	*Name of the item.*
NumberDecimals: Long	*Number of decimals for item values.*
OutputWidth: Long	*Output width, in bytes, for values stored in the Item.*
StartPosition: Long	*Start position of the item.*
Type: tagesriArcInfoItemType	*Type of the item, as an enumeration.*
Width: Long	*Storage width, in bytes, for values stored in the item.*

Use the *IArcInfoItemsEdit* interface to get the properties of an ArcInfo item.

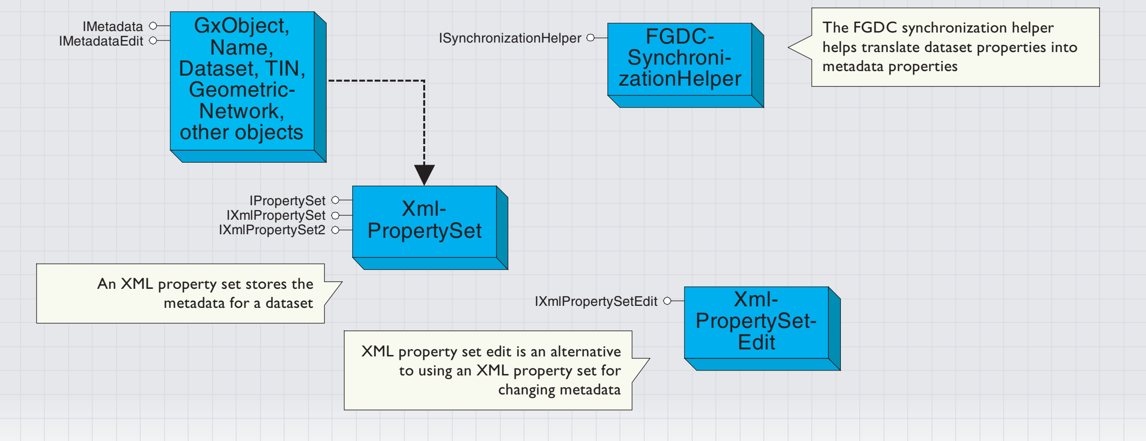
Enumeration tagesriArcInfoItemType	*ArcInfo Item Datatypes*
1 - esriItemTypeDate	*Date*
2 - esriItemTypeCharacter	*Character*
3 - esriItemTypeInteger	*Integer*
4 - esriItemTypeNumber	*Number*
5 - esriItemTypeBinary	*Binary*
6 - esriItemTypeFloat	*Float*
7 - esriItemTypeLeadFill	*LeadFill*
8 - esriItemTypePacked	*Packed*
9 - esriItemTypeZeroFill	*ZeroFill*
10 - esriItemTypeOverpunch	*Overpunch*
11 - esriItemTypeTrailingSign	*TrailingSign*
12 - esriItemTypeOID	*Long Integer representing an object identifier*
13 - esriItemTypeGeometry	*Geometry*
14 - esriItemTypeBlob	*Binary large object*

The *esriItemType* enumeration lists the possible data types for an ArcInfo item.

IArcInfoItemEdit : IArcInfoItem	*Provides access to members that control ArcInfo item editing.*
AlternateName: String	*Alternate name of the item.*
IsIndexed: Boolean	*Indicates if the item is indexed.*
IsPseudo: Boolean	*Indicates if the item is a pseudo item.*
IsRedefined: Boolean	*Indicates if the item is redefined.*
Name: String	*Name of the item.*
NumberDecimals: Long	*Number of decimals for item values.*
OutputWidth: Long	*Output width, in bytes, for values stored in the item.*
StartPosition: Long	*Start position of the item.*
Type: tagesriArcInfoItemType	*Type of the item, as an enumeration.*
Width: Long	*Storage width, in bytes, for values stored in the item.*

Use *IArcInfoItemEdit* to set the properties of an ArcInfo item.

Metadata objects

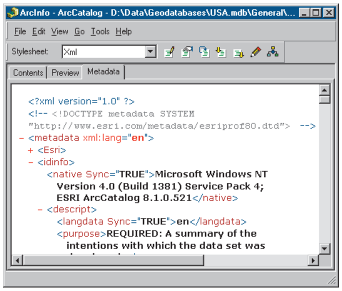


The FGDC synchronization helper helps translate dataset properties into metadata properties

An XML property set stores the metadata for a dataset

XML property set edit is an alternative to using an XML property set for changing metadata

Metadata is stored in XML format. You can use the ArcCatalog XML stylesheet to inspect the structure of the data.


ArcInfo - ArcCatalog - D:\Data\Geodatabases\USA.mdb\General\...
File Edit View Go Tools Help
Stylesheet: Xml
Contents
Preview
Metadata

```
  <?xml version="1.0" ?>
  <!-- <!DOCTYPE metadata SYSTEM
  "http://www.esri.com/metadata/esriprof80.dtd">  -->
- <metadata xml:lang="en">
  + <Esri>
  - <idinfo>
      <native Sync="TRUE">Microsoft Windows NT
        Version 4.0 (Build 1381) Service Pack 4;
        ESRI ArcCatalog 8.1.0.521</native>
    - <descript>
        <langdata Sync="TRUE">en</langdata>
        <purpose>REQUIRED: A summary of the
          intentions with which the data set was
```

Most datasets can have metadata. For datasets accessed using an OLE DB, ArcSDE 3, or an SDE for Coverages database connection, you can neither create metadata nor read metadata that already exists. For all other datasets, ArcCatalog will by default create and update metadata automatically when you view metadata in the Metadata tab (not when the properties or content of the dataset are changed) if you have write permission to the location where the metadata is stored. This process is referred to as synchronization; the Catalog extracts properties from the dataset, calculates values, and then stores the information in the dataset's metadata.

Metadata is stored in an XML document. For file-based datasets, the XML document resides in an appropriately named XML file on the file system. For example, a shapefile's metadata is stored in a file that has the same name as the shapefile such as "myShapefile.shp.xml". A coverage's metadata is stored in a "metadata.xml" file within the coverage directory.

For personal geodatabases, connections to a multiuser geodatabase, and objects stored within any geodatabase, the metadata XML document is stored within a BLOB column in the geodatabase administration table called "GDB_User_Metadata". To manage metadata with ArcObjects you need some basic knowledge of XML, which is assumed for this section.

The key to working with metadata is understanding its structure. By default, when metadata is synchronized it complies with version 2 of the Federal Geographic Data Committee (FGDC) Content Standard for Digital Geospatial Metadata, which will be referred to elsewhere in this document as the FGDC standard.

This means that when the extent of a shapefile's features is recorded within the metadata, the extent coordinates are placed within the appropriate elements as defined by the FGDC standard. The document located at www.fgdc.gov/metadata/contstan.html defines the meaning and organization of the FGDC metadata elements. A workbook with additional explanations and examples is available at www.fgdc.gov/metadata/meta_workbook.html. How to create and update following other metadata standards is discussed later in this section.

ESRI has extended the FGDC standard to describe new ESRI data formats such as geometric networks stored in a multiuser geodatabase. This also allows us to include metadata terminology that ESRI users will be familiar with. The ESRI Profile of the Content Standard for Digital Geospatial Metadata, which describes these extended elements and how they fit into an FGDC metadata document, is located at www.esri.com/metadata/esriprof80.html. This document will be referred to as the ESRI Profile.

Knowing the structure of the metadata is critical for identifying specific metadata elements. Elements in XML documents are organized hierarchically. For example, a metadata document containing the name of a coverage and the names of the coverages from which it was derived might store all names within a "title" element. Each title element can be uniquely identified by its context within the document. Consider a simplified metadata document:

```
<metadata>
<citation>
<title>Proposed site</title>
</citation>
<srccite>
<title>Acceptable soil types</title>
</srccite>
<srccite>
<title>Area excluding 500m buffer zone around sensitive sites</title>
</srccite>
</metadata>
```

In this example, the "citation" element describes the coverage itself. Each "srccite" element describes one of the sources that were used to create the coverage.

To change an element's content in ArcObjects, the name you provide must be an XSL Patterns expression that uniquely identifies the element. The name is constructed similar to the path name for a file on disk; it tells how to find the appropriate element in the XML file starting from the document's root element.

To refer to the title of the coverage, use the element name “citation/title”. To refer to the titles of all of the sources of the coverage, you would use the element name “srccite/title”. To refer to a specific source, the name must select a single element by referring to its index number or value, for example, “srccite[0]/title” or “srccite/title[. = ‘Acceptable soil types’]”. For ArcObjects, the root element is not included in the name. You must include the root element in the name when creating an XSL stylesheet.

In the metadata documents created by ArcCatalog, each XML element corresponds to a metadata element defined in either the FGDC standard or the ESRI Profile. The metadata elements defined in those standards have both a long name and a short name. The short name is used as the XML tag in the metadata document. You can derive the name of the metadata element you want to work with using the standards themselves.

Also, the ESRI Profile Notes document, www.esri.com/metadata/ESRI_Profile_Notes.html, provides a quick reference with the long and short names of all elements in the FGDC standard and the ESRI Profile. You could also inspect the metadata in ArcCatalog using the XML stylesheet, locate the element you want to change, then construct its name by seeing how to navigate the document to that element. All tag names and values in an XML file are case-sensitive.

SYNCHRONIZING METADATA

When synchronization occurs, metadata is created if it doesn’t already exist. A new XML document is created with the root element “metadata”, the “Esri” group of elements is added, then the appropriate metadata elements and their values are immediately added through the synchronization process.

The information in the Esri group is used by ArcGIS software to maintain metadata. Under some circumstances, for example, when you create a thumbnail for a dataset, metadata may be created but synchronization will not occur. You can trigger synchronization manually by clicking the Create/Update Metadata button on the Metadata toolbar in ArcCatalog and programmatically.

The elements added to the metadata by synchronization fall into three categories: documentation hint elements, metadata template elements, and specific elements for each type of dataset. Documentation hints are only added the first time synchronization occurs.

The FGDC standard has several mandatory elements that require documentation, such as a description of the dataset’s contents, to be typed in by a person. If these elements aren’t already present in the metadata, they will be added; their values will be the text “REQUIRED:”, followed by the FGDC standard’s description for that element. These hints are intended to assist people in satisfying the minimum requirements of the FGDC standard; the hints appear red in the metadata editor to make them more visible.

The metadata template elements are added for all objects that support synchronization. This list of elements includes the object's name and type, information about the standards to which the metadata is created, and the date when the metadata was last updated. In addition to these, each type of dataset has its own list of elements that can be derived and added to the metadata. For example, a feature class' metadata would have a count of its features, their extent and coordinate system, its location, and a list of its attributes and their data types. Metadata for raster datasets would include a description of properties such as the number of rows and columns of cells, the size of each cell, and whether or not pyramid layers are present. The ESRI Profile Notes document provides a quick reference for which elements can be maintained using synchronization. If the template and dataset-specific elements are removed from the metadata, they will be added again the next time synchronization occurs.

In ArcCatalog, you can control when synchronization occurs by changing the default options. You might choose not to create metadata automatically, but to update metadata automatically if it already exists. Access to these options is provided using the *IMetadataHelper* interface, which is described in Volume 1, Chapter 7, 'Working with the Catalog'. Similarly, you can choose to turn off synchronization for individual datasets such as when the data and its metadata have been published. This is accomplished by adding a "Sync" element to the Esri group with the value false.

Synchronization can also be managed for individual elements within a metadata document. When synchronization adds elements to the metadata, their XML tag will have a Sync attribute whose value is set to true. When synchronization updates elements, it locates the template and dataset-specific elements, then checks the Sync attribute and its value. If the value is not true, the element's value won't be modified. If you use the metadata editor to manually edit the value of an element that was automatically added to the metadata by the Catalog, the Sync attribute is removed. The software won't overwrite values that were typed by a person.

For example, the Catalog automatically adds a title element to the metadata if it doesn't already exist. Its value will be the object's name, and the Sync attribute is set to true: <title Sync="TRUE">prpsite</title>. Because the Sync attribute's value is true, after renaming the object the next time metadata is synchronized the title element's value will change to reflect the new name. However, if you provide a more descriptive title using the metadata editor the Sync attribute will be removed, and the next time synchronization occurs the Catalog won't overwrite your title: <title>Proposed site</title>.

You can change the value of XML attributes programmatically. Also, each of the methods that can be used to modify an element's value behaves differently with respect to the Sync attribute; they are discussed in detail later in this section.

Metadata can be accessed from most dataset objects, geodatabase name objects, and ArcCatalog GxObjects.

IMetadata : IUnknown	Provides access to members that manage and update metadata.
Metadata: IPropertySet	The PropertySet containing metadata.
Synchronize (in Action: tagesriMetadataSyncAction, in Interval: Long)	Updates metadata with the current properties; may create metadata if it doesn't already exist.

The *IMetadata* interface provides access to an object's metadata. The *Metadata* property returns an XML property set that contains the metadata for the dataset. Any changes you make are only saved when the *Metadata* property is subsequently set.

This example changes the metadata title for the selected object in ArcCatalog (use of *IPropertySet* is discussed later in this section):

```
Dim pGxApp as IGxApplication
Set pGxApp = Application
Dim pGxObj as IGxObject
Set pGxObj = pGxApp.SelectedObject

Dim pMetadata as IMetadata
Set pMetadata = pGxObj

Dim pPropSet as IPropertySet
Set pPropSet = pMetadata.Metadata
pPropSet.SetProperty "idinfo/citation/citeinfo/title", "My New Title"
pMetadata.Metadata = pPropSet
```

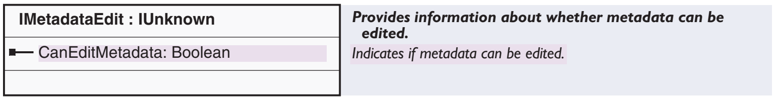
Similarly, the following example gets the selected layer in ArcMap, then gets the metadata associated with its data source using its *Name* object:

```
Dim pMapDoc As IMxDocument
Dim vSelection As Variant
Set pMapDoc = Application.Document
Set vSelection = pMapDoc.CurrentContentsView.SelectedItem

If TypeOf vSelection Is IDataLayer Then
  Dim pDLayer As IDataLayer
  Dim pName As IName
  Set pDLayer = vSelection
  Set pName = pDLayer.DataSourceName

  If TypeOf pName Is IMetadata Then
    Dim pMetadata As IMetadata
    Dim pPS As IPropertySet
    Set pMetadata = pName
    Set pPS = pMetadata.Metadata
  End If

End If
```

The *Synchronize* method initiates synchronization. This is the method used behind the scenes by the Create/Update Metadata button in ArcCatalog and by *IGxDocumentationView::Synchronize*, which is discussed in Volume 1, Chapter 7, 'Working with the Catalog'.

Synchronize uses the options defined in *esriMetadataSyncAction* to specify whether metadata will be created and elements will be modified based on whether or not the metadata already exists. For example, you may not want a new metadata document to be created if one doesn't already exist, but when one does exist you want its contents to be updated.

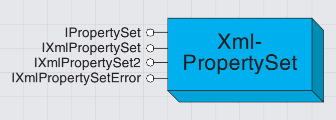
The *Interval* parameter can be used to control how frequently the information in the metadata should be updated in the metadata. Its value is the amount of time in seconds that must have passed since the metadata was last updated before the metadata will be updated again. Use an *Interval* of zero to update the metadata now. With a value of 3600, calling the method will have no effect until the current time is at least one hour past the time recorded in the "Esri/SyncDate" and "Esri/SyncTime" elements.



Provides information about whether metadata can be edited.

Indicates if metadata can be edited.

The *IMetadataEdit* interface lets you know whether or not the metadata can be edited. The *CanEditMetadata* property returns false for file-based objects only if metadata exists and is read-only. For objects in a geodatabase, the *CanEditMetadata* property returns true only if you are the owner of the dataset.



An XML property set stores the metadata for a dataset.

IPropertySet *is a simpler alternative to* IXMLPropertySet, *though its* GetProperty *method is more powerful.*

The *XMLPropertySet* object stores a set of XML elements—in this section we will discuss its use with respect to metadata, though an XML property set could be created and used wholly independently of metadata.

Although it implements *IPropertySet*, the *XMLPropertySet* is a different object to a *PropertySet*. It also provides generalized storage of information but is much more flexible, offering the power of XML.

IPropertySet : IUnknown	***Provides access to members for managing a PropertySet.***
Count: Long	*The number of properties contained in the property set.*
GetAllProperties (out names: Variant, out Values: Variant)	*The name and value of all the properties in the property set.*
GetProperties (in names: Variant, out Values: Variant)	*The values of the specified properties.*
GetProperty (in Name: String) : Variant	*The value of the specified property.*
IsEqual (in PropertySet: IPropertySet) : Boolean	*True if the property set is the same as the input property set.*
RemoveProperty (in Name: String)	*Removes a property from the set.*
SetProperties (in names: Variant, in Values: Variant)	*The values of the specified properties.*
SetProperty (in Name: String, in Value: Variant)	*The value of the specified property.*

The *IPropertySet* interface can be applied to an *XMLPropertySet* as a simple way of accessing and changing metadata.

The following example gets a description of the dataset from the abstract element:

```
Dim vValues as Variant
vValues = pPropSet.GetProperty "idinfo/descript/abstract"
MsgBox vValues(0)
```

GetProperty returns a *Variant* containing an array. If the name string identifies a single element (as above), then there will be just one value in the array. If the name string identifies a group element (that contains other elements), then an array containing the XML tags associated with the child elements is returned. For example, with the name string "idinfo/descript" you would get XML tags associated with elements that describe the dataset, such as "abstract" and "purpose".

Some metadata elements, such as the dataset's attributes, can repeat in the metadata. When the name string identifies several elements in the metadata, *GetProperty* will return an array that contains the value in each element. If the element identified by the name string doesn't exist in the metadata, the *Variant* is set to *Empty*. This example checks to see if any values were returned and then prints the names of the dataset's attributes.

```
vValues = pPropSet.GetProperty "eainfo/detailed/attr/attrlabl"
If Not IsEmpty( vValues ) Then
  For Each v In vValues
    Debug.Print v
  Next
End If
```

If an external file describes the contents of a dataset, you might enclose a copy of the file within the metadata until the metadata document has been completed. The name string "Binary/Enclosure/Data" identifies all

The IXMLPropertySet *interface provides methods to read and write metadata.*

enclosures in the metadata. To identify a specific enclosure, refer to its associated description, such as “Binary/Enclosure[Descript = ‘Data Dictionary’]/Data”. When enclosures are specified with *GetProperty*, a copy of the enclosure is written to a new file in your computer’s Temp directory, and the array returned will contain strings that provide the paths to those files.

Similarly, the name string “Binary/Thumbnail/Data” identifies the dataset’s thumbnail, if one exists. For thumbnails, *GetProperty* returns a standard picture with the *IPicture* interface; it may contain images in Windows® Bitmap, Metafile, GIF, JPEG Icon, or Cursor format. Thumbnails generated in ArcCatalog are in Windows bitmap format. When looping through the array of values returned by *GetProperty*, it may be useful to confirm that the value is not a picture before attempting to display the value in a message box.

SetProperty can only be used to set text values for metadata elements. If an element doesn’t already exist in the metadata, a new one will be added; the new element will not have a *Sync* attribute. *SetProperty* also removes the *Sync* attribute from existing metadata elements if it previously existed. Use *IXMLPropertySet::SetPropertyX* if you want to add enclosures and thumbnails or if you want more control when updating elements.

GetProperties is much like *GetProperty* except that you provide an array of element names for which you want to retrieve values and, instead of returning a single *Variant* containing an array, it contains an array of arrays. The following example will retrieve the dataset’s title, its list of authors, and a description of why the dataset was created:

```
Dim sNames(2) As String
sNames(0) = "idinfo/citation/citeinfo/title"
sNames(1) = "idinfo/citation/citeinfo/origin"
sNames(2) = "idinfo/descript/purpose"

Dim vValues As Variant
Dim v1 As Variant
Dim v2 As Variant
pPropSet.GetProperties sNames, vValues

For Each v1 In vValues
  For Each v2 In v1
    If Not (TypeOf v2 Is Picture) Then Debug.Print v2
  Next
Next
```

SetProperties is similar to *GetProperties*. You provide a *String* array with the names of elements whose values you want to change and a *Variant* containing an array with one value for each element name. The example below shows a method for adding two authors to the metadata. The FGDC standard specifies that the *Originator* element, origin, may be repeating; each origin element would contain a different author’s name. Here, index numbers are used to clearly identify which origin element is assigned which author's name. If index numbers weren't specified as part of the element's name string, the value of all existing origin elements would be overwritten by the first author and then the second author.

```
Dim pMetadata As IMetadata
Set pMetadata = pGxObj

Dim pPropSet As IPropertySet
Set pPropSet = pMetadata.Metadata

Dim sNames(1) As String
sNames(0) = "idinfo/citation/citeinfo/origin[0]"
sNames(1) = "idinfo/citation/citeinfo/origin[1]"

Dim vValues As Variant
vValues = Array("Author1", "Author2")

pPropSet.SetProperties sNames, vValues
pMetadata.Metadata = pPropSet
```

GetAllProperties provides a list of all metadata elements that contain values in the order in which they appear in the metadata document. Group elements are not included in the list. *GetAllProperties* returns two *Variants*, each of which contains an array. One contains the element names, and the other contains the element values. For repeating elements, there will be one entry in both arrays for each occurrence of the element.

The *RemoveProperty* method will delete all metadata elements identified by the name string. This might be useful for removing information that is no longer appropriate, for example, you might delete the entire existing contact information section before adding in new contact information elements. A previous list of contact numbers by region may be replaced by one new toll-free phone number, or different addresses may be used for different types of orders. When the name string identifies a group element such as the distributor's contact information section, which is identified in the example below, the group element and all of the elements it contains are deleted.

```
pPropSet.RemoveProperty "distinfo/distrib/cntinfo"
```

The *Count* property and *IsEqual* method should not be used to analyze and compare XML property sets. *Count* always returns the number 1, and *IsEqual* always returns *False*.

IXmlPropertySet : IUnknown	Provides access to members that manage metadata.
■— CountX (in Name: String) : Long	Number of occurrances of an element in the metadata.
■— IsNew: Boolean	Indicates if a new XmlPropertySet was created on retrieving the metadata.
← DeleteProperty (in Name: String)	Deletes the specified elements.
← DeletePropertyByAttribute (in Attribute: String, in Value: String, in deleteParent: Boolean)	Deletes the elements which have the specified attribute value.
← GetPropertiesByAttribute (in Attribute: String, in Value: String, in noValues: Boolean, out pTags: Variant, out pValues: Variant)	Returns the set of names and values for elements which have the specified attribute value.
← InitExisting	Initializes an XmlPropertySet and adds the ESRI group of elements.
← SaveAsFile (in xslPath: String, in header: String, in outputANSI: Boolean, outPath: String)	Transforms the metadata using an XSL stylesheet if specified, writes out the header if specified, and saves it in a file.
← SetAttribute (in Name: String, in Attribute: String, in Value: Variant, in Action: tagesriXmlSetPropertyAction)	Sets the attribute of the specified element.
← SetPropertyX (in Name: String, in Value: Variant, in propType: tagesriXmlPropertyType, in Action: tagesriXmlSetPropertyAction, syncing: Boolean)	Sets the value of the specified element.
← SimpleGetProperty (in Name: String) : String	The values of the specified property.
← TransformImages (in Path: String, out pFileNames: Variant)	Transforms encoded thumbnail and image enclosures to files and links them into the metadata.

The *CountX* property returns the number of elements matching the name string. The line of code below counts the number of theme keywords that have been entered. If the name string identifies a group element instead, *CountX* returns the number of elements it contains.

```
pXMLPropSet.CountX "idinfo/keywords/theme/themekey"
```

SetPropertyX gives you greater control than *IPropertySet::SetProperty*. The *propType* parameter uses the *esriXmlPropertyType* enumeration to define the type of value that is being assigned. The *Action* parameter uses the *esriXmlSetPropertyAction* enumeration to define how the element should be added to the metadata document.

In the example below, a theme keyword is added, and its value is the *String* “county”.

```
pXMLPropSet.SetPropertyX "idinfo/keywords/theme/themekey", "county", _
  esriXPTText, esriXSPAAddDuplicate, False
```

There are two choices for adding a dataset’s thumbnail to the metadata programmatically. One is to use *SetPropertyX*, providing a picture object and specifying the picture property type. The other alternative is to provide the picture to the *IGxThumbnail.Thumbnail* property. To add an enclosure you would provide a path to the appropriate file and specify the property type for either a regular (binary) or an image enclosure. When adding a new enclosure, it should be contained within a new, empty “Enclosure” element. The following example illustrates how to use *SetPropertyX* to add a thumbnail and a new enclosure to the metadata.

```
pXMLPropSet.SetPropertyX "Binary/Thumbnail/Data", _
  LoadPicture("C:\stuff\myImage.jpg"), _
  esriXPTImage,    esriXSPAAddOrReplace, False
```

```
dim i as Integer
```

```
i = pXMLPropSet.CountX "Binary/Enclosure"
pXMLPropSet.SetPropertyX "Binary/Enclosure[" & i & "]/Description", _
  "New!", esriXPTText, esriXSPAAddIfNotExists, False
  pXMLPropSet.SetPropertyX "Binary/Enclosure[" & i & "]/Data", _
  "c:\stuff\myFile.txt", esriXPTBinaryEnclosure, _
  esriXSPAAddIfNotExists, False
```

In addition to providing more control over how elements are added, *SetPropertyX* lets you set an element's value with respect to the *Sync* attribute. When the syncing parameter is *False*, new elements are added without a *Sync* attribute (the same behavior as *IPropertySet::SetProperty*), and the *Sync* attribute is removed from existing elements. When the syncing parameter is *True*, new elements will get the *Sync* attribute with the value *True*.

For existing elements, their values are modified if the value of their *Sync* attribute is true, but that value will change again the next time synchronization occurs; otherwise, the element's value won't be changed, and the *Sync* attribute won't be added. The behavior of *SetPropertyX* can be changed using the *IXmlPropertySet2::OverwriteSyncAttribute* property.

The *DeleteProperty* method works exactly the same as the *IPropertySet::RemoveProperty* method.

The *SetAttribute, GetPropertiesByAttribute,* and *DeletePropertiesByAttribute* methods all perform actions based on an element's XML attributes. *SetAttribute* will most often be used to set the *Sync* property for a specific element to *True*. For example, when importing an existing metadata document you may want only the bounding coordinate and coordinate system information to be synchronized with the dataset. The example below shows how to set the *Sync* attribute for these elements. The first name string selects all elements contained within the Bounding Coordinates group element; they contain the west, east, north, and south bounding coordinates, respectively. The second name string selects all elements contained anywhere within the Spatial Reference group that have a value and sets their *Sync* attribute to *True*. After setting the *Sync* attribute, the changes are saved and then the metadata is synchronized. The existing values in those elements will be updated with current information derived from the dataset.

```
pXMLPropSet.SetAttribute "idinfo/spdom/bounding/*", _
  "Sync", "TRUE", esriXSPAAddOrReplace
pXMLPropSet.SetAttribute "spref//*[text()]", _
  "Sync", "TRUE", esriXSPAAddOrReplace
  pMetadata.Metadata = pXMLPropSet
  pMetadata.Synchronize esriMSAAccessed, 0
```

ArcGIS software maintains a few XML attributes in addition to *Sync*. The elements that contain thumbnails and enclosures have the XML attribute “EsriPropertyType”. For thumbnails, its value is “Picture”; for enclosures that contain images (samples of those images can be viewed in the ESRI stylesheet in ArcCatalog), its value is “Image”; and for all other enclosures, its value is “Base64”. When using *GetPropertiesByAttribute* with enclosures, the *noValues* parameter must be set to false for the files to be decoded and then written to the locations identified. When using *DeletePropertiesByAttribute* with thumbnails or enclosures, the *deleteParent* parameter should be true so that the entire group of elements associated with the thumbnail or enclosure is removed, as shown below.

```
pXMLPropSet.DeletePropertiesByAttribute "EsriPropertyType", "Base64", True
```

TransformImages is used to display thumbnails and samples of image enclosures in ArcCatalog. As discussed above, they are contained in elements with the *EsriPropertyType* attribute. When you access metadata programmatically, these elements are intact. *TransformImages* decodes the data for all of these elements, saves their contents to files in the folder you have specified, and returns a *Variant* that contains an array of file names representing the files that were created. Also, each original element is replaced with an HTML IMG element whose source attribute is set to the appropriate output file path. If you save the metadata after running this method, this change will be permanent. *TransformImages* is always used before showing metadata in the Metadata tab.

The *SaveAsFile* method lets you apply an XSL stylesheet to the metadata and export the results. A stylesheet might generate a text, XML, or HTML file. With *SaveAsFile* you can place a header at the top of a file, for example, placing the text "<?xml version='1.0'?>" above the root element in an XML file. *TransformImages* is not automatically used before the stylesheet is applied; if the ESRI stylesheet is specified but you don't transform the metadata first, the thumbnail and bitmaps of enclosed images won't appear in the resulting HTML file.

When you retrieve a dataset's metadata using the *IMetadata::Metadata* property, metadata will be created if it did not previously exist. If this has happened, the *IsNew* property will return *True*. When metadata is created it is initialized, then *InitExisting* is called to add the ESRI group of elements. In addition to when the metadata was created, they record when the metadata was last synchronized and modified manually, and provide a unique identifier to the document. Another element, "SyncOnce", is also added; it is the element that indicates metadata has not yet been synchronized and is removed when synchronization occurs. Typically, you would not use the *InitExisting* method unless you wanted to add the ESRI group of elements to an existing XML metadata document; the next time synchronization occurs after doing so, the appropriate documentation hint elements will be added to the metadata.

IXmlPropertySet2 : IUnknown	***Provides access to members that manage metadata.***
■— CountX (in Name: String) : Long	*Number of occurrances of an element in the metadata.*
■— IsNew: Boolean	*Indicates if a new XmlPropertySet was created on retrieving the metadata.*
■—■ OverwriteSyncAttribute: Boolean	*Indicates if the Sync attribute will be ignored when setting an element's value.*
← DeleteProperty (in Name: String)	*Deletes the specified elements.*
← DeletePropertyByAttribute (in Attribute: String, in Value: String, in deleteParent: Boolean)	*Deletes the elements which have the specified attribute value.*
← DeletePropertyByNameAndAttribute (in Name: String, in Attribute: String, in Value: String, in deleteParent: Boolean)	*Deletes the specified elements which have the specified attribute value.*
← GetAttribute (in Name: String, in Attribute: String, out pValue: Variant)	*Returns the set of values for the specified attribute from the specified elements.*
← GetPropertiesByAttribute (in Attribute: String, in Value: String, in noValues: Boolean, out pTags: Variant, out pValues: Variant)	*Returns the set of names and values for elements which have the specified attribute value.*
← GetXml (in Name: String) : String	*Returns the XML corresponding to the specified element as a string.*
← InitExisting	*Initializes an XmlPropertySet and adds the ESRI group of elements.*
← InitGeneric (in rootName: String)	*Initializes an XmlPropertySet without adding the ESRI group of elements.*
← SaveAsFile (in xslPath: String, in header: String, in outputANSI: Boolean, outPath: String)	*Transforms the metadata using an XSL stylesheet if specified, writes out the header if specified, and saves it in a file.*
← SetAttribute (in Name: String, in Attribute: String, in Value: Variant, in Action: tagesriXmlSetPropertyAction)	*Sets the attribute of the specified element.*
← SetPropertyX (in Name: String, in Value: Variant, in propType: tagesriXmlPropertyType, in Action: tagesriXmlSetPropertyAction, syncing: Boolean)	*Sets the value of the specified element.*
← SetXml (in xml: String)	*Replaces existing metadata with the content defined in the XML.*
← SimpleGetProperty (in Name: String) : String	*The values of the specified property.*
← TransformImages (in Path: String, out pFileNames: Variant)	*Transforms encoded thumbnail and image enclosures to files and links them into the metadata.*

The *IXMLPropertySet2* interface extends the functionality available in *IXMLPropertySet*. It provides access to all the methods defined in the *IXMLPropertySet* interface in addition to a few new methods.

The *OverwriteSyncAttribute* property lets you modify the behavior of the *IXmlPropertySet::SetPropertyX* method. By default, this property's value is false. If you set it to *True* before using *IXmlPropertySet::SetPropertyX* and if its syncing parameter is *True*, the value of existing elements will always be modified, and if the *Sync* attribute doesn't exist, it will be added with the value *True*.

The *GetXML* and *SetXML* methods deal with entire chunks of XML, which can be a powerful way of manipulating the metadata. This code excerpt shows the XML containing the contact information describing who to contact to find out more about the dataset. That information is contained within the point of contact group element, "idinfo/ptcontac".

```
Dim pXPS2 as IXMLPropertySet2
Set pXPS2 as pMetadata.Metadata
pXPS2.GetXML "idinfo/ptcontac/cntinfo"
```

SetXML replaces the entire metadata document with the specified XML.

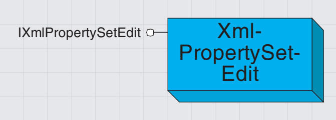
GetAttribute returns a *Variant* that contains an array value for the specified attribute for all elements identified by the name string. The example below will return a list of all feature classes whose attributes are described in a coverage's metadata document. The metadata should contain one Detailed Description group of elements for each feature class that has attributes. When the metadata is synchronized, the XML attribute *Name* is added to each Detailed Description group element; its value is the name of the feature attribute table that associated with the feature class it described.

```
Dim vValues As Variant
pXPS2.GetAttribute "eainfo/detailed", "Name", vValues
```

The *DeletePropertyByNameAndAttribute* method removes specific elements that have specific attribute values from the metadata. For example, you might use this to remove the attribute information associated with a coverage's feature class. In the example below, the Detailed Description group that describes the route feature class named "roads" will be deleted from the metadata. You might do this after deleting the feature class from the coverage. Here the *deleteParent* parameter is false because you don't want to remove all attribute information from the metadata, only the information describing one feature class.

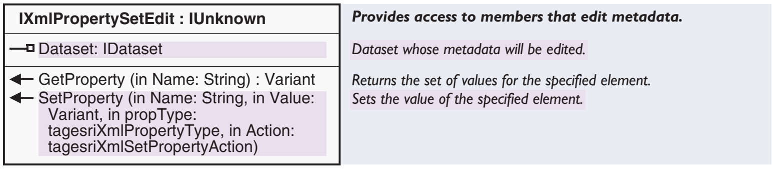
```
pXPS2.DeletePropertyByNameAndAttribute "eainfo/detailed", _
"Name", "myCoverage.ratroads", False
```

When metadata is created in Visual Basic, *IXmlPropertySet::InitExisting* runs automatically to initialize metadata by adding the ESRI group of elements. *InitGeneric* allows more control for C++ programmers to initialize a new XML property set without having to add the ESRI group of elements.



The XMLPropertySetEdit *object provides access to members that edit metadata.*

The *XMLPropertySetEdit* object provides a simple, convenient interface for editing metadata.



IXmlPropertySetEdit : IUnknown — ***Provides access to members that edit metadata.***

Dataset: IDataset — *Dataset whose metadata will be edited.*

GetProperty (in Name: String) : Variant — *Returns the set of values for the specified element.*

SetProperty (in Name: String, in Value: Variant, in propType: tagesriXmlPropertyType, in Action: tagesriXmlSetPropertyAction) — *Sets the value of the specified element.*

The *IXMLPropertySetEdit* interface is used for setting up an *XMLPropertySetEdit* object and using it to read and write metadata. This example changes the metadata title for the selected dataset in ArcCatalog:

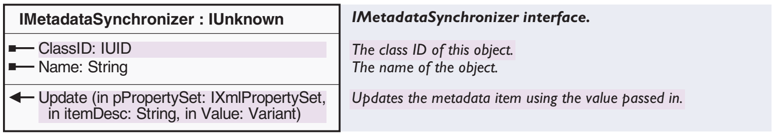
```
Dim pGxApp As IGxApplication
Dim pGxObj As IGxObject
Dim pName As IName
Dim pDataset As IDataset
Dim pXPSE As IXmlPropertySetEdit

Set pGxApp = Application
Set pGxObj = pGxApp.SelectedObject
Set pName = pGxObj.InternalObjectName
Set pDataset = pName.Open
Set pXPSE = New XmlPropertySetEdit
Set pXPSE.Dataset = pDataset

pXPSE.SetProperty "idinfo/citation/citeinfo/title", "My New Title", _
  esriXPTText, esriXSPAddOrReplace
```

SetProperty is similar to *IXmlPropertySet::SetPropertyX* in that it lets you add thumbnails and enclosures to the metadata in addition to text values, and it offers excellent control over exactly how and when new elements are added to the metadata document. Note that unlike *XMLPropertySet* there is no need to save the changes back to the metadata after using *SetProperty*; the changes are applied when the XML property set edit object is destroyed.

However, like *IPropertySet::SetProperty*, there is no ability to control new and existing elements with respect to the *Sync* attribute. New elements added with this method will not have a *Sync* attribute, and for existing elements the *Sync* attribute will be removed from the element. After changing a dataset's title using the example above, it will not automatically be updated by the synchronization process to reflect the current name of the dataset. ArcGIS software will not overwrite documentation that was typed by a user using a metadata editor.

You can build your own custom metadata synchronizer by creating a class that implements *IMetadataSynchronizer* and registering it with the Component Categories Manager utility. It is possible to create and use many metadata synchronizers. The effect of doing this is that when synchronization occurs, metadata for the same dataset property may be written in many different ways. You might want to do this to support multiple metadata standards, although this will make the metadata documents large. One metadata synchronizer object is currently supplied with ArcCatalog: the *FGDCSynchronizer*.

The *MetadataSynchronizer* coclass manages the entire synchronization process. It has two interfaces: *IMetadataSynchronizer* and *IMetadataSynchronizerManager*. The *IMetadataSynchronizerManager* interface is used to manage the metadata synchronizer objects that have been registered with the ESRI Metadata Synchronizers component category.



IMetadataSynchronizer : IUnknown

ClassID: IUID — *The class ID of this object.*
Name: String — *The name of the object.*

Update (in pPropertySet: IXmlPropertySet, in itemDesc: String, in Value: Variant) — *Updates the metadata item using the value passed in.*

IMetadataSynchronizer interface.

The *IMetadataSynchronizer* interface controls what happens when synchronization occurs.

When using a metadata synchronizer, the properties *ClassID* and *Name* are read-only. They identify the synchronizer by its UID and name. These properties are defined when the *IMetadataSynchronizer* interface is implemented.

The *Update* method is called many times by the *MetadataSynchronizer* during the synchronization process. When the interface is implemented, it defines exactly what is recorded in the metadata document when synchronization occurs. Each time the *Update* method is called, three parameters are passed in: an XML property set containing the metadata that is being updated, an item description, and an object that is derived from the dataset. The item description is a *String* that identifies the type of object being passed in.

The following table summarizes the item descriptions and associated objects that may be passed to the *Update* method.

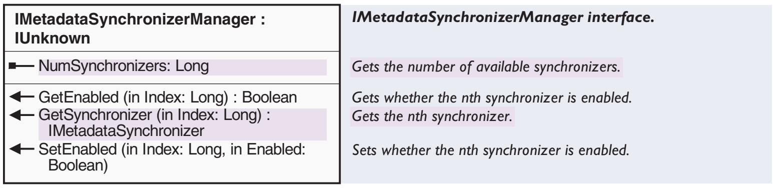
itemDesc	Value	Description
Boilerplate	Nothing	A special case which is called when the SyncOnce element is present in the Esri group of metadata elements; generally, this happens only the first time synchronization occurs. This may be used to add boilerplate text such as documentation hints or fixed contact information for your organization that should not be changed again by synchronization.
CoverageEntity[i]	IArcInfoTable	Provides access to INFO tables and a coverage feature class's feature attribute table. Used to record attribute information and to count the number of records or features.
CoverageFeatureClass[i]	ICoverageFeature-Class	Provides information about the coverage feature class, including the type of feature class, and whether it has an attribute table or topology. Used to record feature information.
DatasetLocation	String	Location of dataset on disk, or the connection information for accessing an ArcSDE geodatabase.
DatasetName	String	Name of the dataset: either derived from the filename or the table name.
DatasetSize	String	Size of the dataset on disk. Not used for objects stored within a geodatabase.
DDExtent	IEnvelope	Envelope containing the dataset's geographic data. Used to record its extent in decimal degrees.
Entity[i]	IClass	Provides access to an object class such as a table or feature class. Used to record full attribute information.
EntityBrief[i]	IClass	Provides access to an object class such as a table or feature class. Used to record brief entity information for the feature classes contained in a feature dataset.
Environment	String	Operating system and software name and version of the computer.
FeatureClass[i]	IFeatureClass	Provides access to a feature class. Used to record feature information such as feature and geometry type.
GeoForm	String	One of: "raster digital data", "remote-sensing image", "tabular digital data", "vector digital data" Mode in which the spatial data is represented.
GeometryType	String, either "Vector" or "Raster"	Type of dataset.
Language	String	Language of the data and the metadata. Derived from the operating system's default input locale.
MetadataDate	String	The current date. Used to record when the metadata was last updated.
MetadataStandard	String	The name of the metadata standard supported by ArcCatalog: version 2 of the CSDGM. Used to record information about the standard to which the metadata was created.
NativeExtent	IEnvelope	Envelope containing the dataset's geographic data. Used to record its actual extent, either in projected or decimal degrees coordinates.
NativeForm	String	Type of dataset such as "Shapefile", "Personal Geodatabase Table", or "Raster Dataset". ArcCatalog's Search tool expects to find this information in "idinfo/natvform" when searching for specific objects.
NetworkRule[i]	IRule	Provides information about the connectivity rules in a geometric network.
NetworkSchema	INetSchema	Provides information about the schema of a geometric network such as element classes, ancillary roles, and weights.
OperatingSystem	String	The name of the operating system on the computer used to create or update the metadata (duplicated in Environment).
RasterBand	IRasterBand	Provides access to information about a raster band, including its attribute table and colormap.
RasterDataset	IRasterDataset (may also support IRasterBandCollection)	Provides information about a raster dataset such as its format and compression type.
Relationship[i]	IRelationshipClass	Provides information about a relationship such as its origin, destination, and cardinality. Used to record detailed information about a relationship.
RelationshipBrief[i]	IRelationshipClass	Provides information about a relationship. Used to record brief relationship information for objects that participate in a relationship.
Software	String	The name and version of the software used to create or update the metadata (duplicated in Environment).
SpatialReference	ISpatialReference	Provides access to the dataset's spatial reference.
Tin	ITin	Provides access to information about a TIN dataset.

Each type of dataset is associated with a specific list of items that will be passed to the *Update* method. For example, if the dataset is a dBASE® table, the following list of item descriptions will be passed: *Boilerplate, DatasetLocation, DatasetName, DatasetSize, Entity[i], Environment, GeoForm, Language, MetadataDate, MetadataStandard, NativeForm, OperatingSystem,* and *Software*. For a shapefile, the *DDExtent, FeatureClass[i], GeometryType, NativeExtent,* and *SpatialReference* objects would also be passed.

Note that for item descriptions that are shown in the table with an index number such as *itemDesc[i]*, several different objects may be sent to the metadata synchronizer. For example, a coverage has several feature classes. To record the coverage's attributes, *Update* will be called once for each feature class that has a feature attribute table. Each time, the *itemDesc* parameter will be *CoverageEntity[i]*, and the *Value* parameter will be the *IArcInfoTable* object. If the coverage has one polygon and two region feature classes, *Update* will be called, with the *itemDesc* values *CoverageEntity[0], CoverageEntity[1],* and *CoverageEntity[2]*, the appropriate different *IArcInfoTable* objects.

When the *IMetadataSynchronizer* interface is implemented, you specify which properties will be retrieved from each object and any calculations that must occur. For example, the *Update* method might query the *IArcInfoTable* object for column names in the table, but it might ignore properties indicating whether those columns have indexed values. Then the appropriate metadata element must be added or updated in the XML property set with the derived value.

The *FGDCSynchronizer* adds and updates metadata elements following the metadata structure described by the FGDC standard. This is the metadata synchronizer that will be used when ArcGIS software is installed. The stylesheets used in ArcCatalog are based on queries that rely on the presence of FGDC metadata elements. If you create a custom metadata synchronizer following a different standard, you must create custom stylesheets as well for ArcCatalog.



IMetadataSynchronizerManager : IUnknown

IMetadataSynchronizerManager interface.

■— NumSynchronizers: Long	*Gets the number of available synchronizers.*
◀— GetEnabled (in Index: Long) : Boolean	*Gets whether the nth synchronizer is enabled.*
◀— GetSynchronizer (in Index: Long) : IMetadataSynchronizer	*Gets the nth synchronizer.*
◀— SetEnabled (in Index: Long, in Enabled: Boolean)	*Sets whether the nth synchronizer is enabled.*

The *IMetadataSynchronizerManager* interface is used to manage all of the available metadata synchronizer objects.

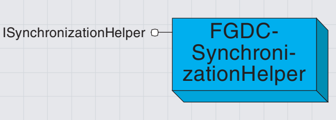
The *NumSynchronizers* property returns the number of registered metadata synchronizers. Each of these can be enabled or disabled using the *SetEnabled* method; when disabled, the synchronizer will not write any information to the metadata document. You can test the status of a synchronizer with *GetEnabled*. Finally, *GetSynchronizer* will return a metadata synchronizer object such as the *FGDCSynchronizer*.

When synchronization occurs, ArcGIS software sends the appropriate parameters to the *Update* method of the *MetadataSynchronizer* coclass. The *MetadataSynchronizer* iterates through all of the metadata synchronizers such as the *FGDCSynchronizer*, which are registered in the component category. For each metadata synchronizer that is enabled, the *MetadataSynchronizer* coclass calls its *Update* method.

If you create your own custom metadata synchronizer following a different metadata standard, you may wish to disable the *FGDCSynchronizer* coclass so that the metadata document will only contain elements according to your standard; this is illustrated in the example below.

```
Dim pMDSync As IMetadataSynchronizer
Set pMDSync = New esriCore.MetadataSynchronizer
Dim pSyncManager As IMetadataSynchronizerManager
Set pSyncManager = pMDSync

Dim i As Long
For i = 0 To pSyncManager.NumSynchronizers - 1
  If (pSyncManager.GetSynchronizer(i).Name = "FGDC CSDGM") And _
    (pSyncManager.GetEnabled(i)) Then
      pSyncManager.SetEnabled i, False
  End If
Next i
```

You can find more details about creating your own metadata synchronizer in the white paper “Creating a Custom Metadata Synchronizer” at http://arconline.esri.com.



The FGDCSynchronizationHelper *helps translate dataset properties into metadata properties.*

The *FGDCSynchronizationHelper* coclass was created at version 8 to retrieve properties from a dataset, calculate values, and then record that information in the metadata. This class always records information in metadata elements that are defined in the FGDC standard; it could not be adapted to support other metadata standards. This coclass was rendered obsolete by the introduction of the *MetadataSynchronizer* and *FGDCSynchronizer* coclasses. However, for ArcGIS 8.1, the *FGDCSynchronizationHelper* is still used to record some information in the metadata; therefore, even if the *FGDCSynchronizer* is disabled, some FGDC metadata tags will still appear in the metadata as a result of the synchronization process.

FGDCSynchronizationHelper *is an advanced object that you would not normally use.*

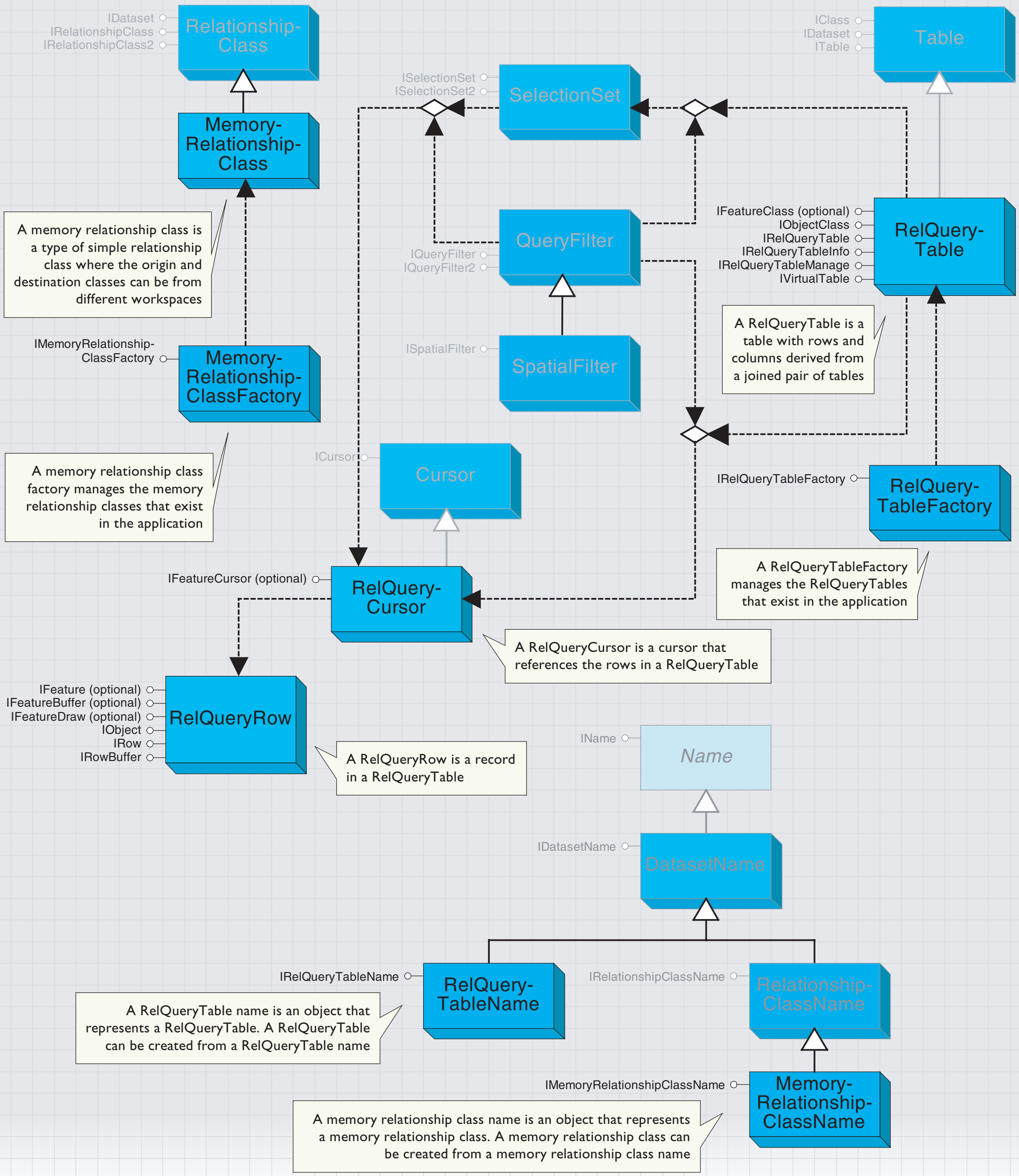
ISynchronizationHelper : IUnknown	***Provides helper functions for metadata synchronization.***
← ExtractBriefEntityAttrProperties (in pGeoDataset: IClass, in Index: Long, in pProperties: IPropertySet)	*Extracts brief entity attribute properties from a FeatureClass.*
← ExtractBriefRelationshipProperties (in pRelationship: IRelationshipClass, in Index: Long, in pProperties: IPropertySet)	*Extracts brief entity attribute properties from a RelationshipClass.*
← ExtractEntityAttrProperties (in pGeoDataset: IClass, in Index: Long, in pProperties: IPropertySet)	*Extracts entity attribute properties from a FeatureClass.*
← ExtractFeatureClassProperties (in pGeoDataset: IFeatureClass, in Index: Long, in pProperties: IPropertySet)	*Extracts properties from a FeatureClass.*
← ExtractRelationshipProperties (in pRelationship: IRelationshipClass, in Index: Long, in pProperties: IPropertySet)	*Extracts entity attribute properties from a RelationshipClass.*
← ExtractSpatialProperties (in pGeoDataset: IGeoDataset, in pProperties: IPropertySet)	*Extracts spatial properties from a GeoDataset.*
← FinishSynchronization (in pProperties: IPropertySet)	*Call this after synchronizing.*
← PopulateDistributionProperties (in FileName: String, in fileType: String, in pProperties: IPropertySet)	*Populates distribution properties given a file name.*
← PopulateDistributionPropertiesForDatabase (in pDataset: IDataset, in pProperties: IPropertySet)	*Populates distribution properties given a file name.*
← PopulateStaticProperties (in pProperties: IPropertySet)	*Fills in required properties.*
← StartSynchronization (in pProperties: IPropertySet, in Action: tagesriMetadataSyncAction, in Interval: Long, out pOK: Boolean)	*Call this before synchronizing.*

ISynchronizationHelper may still be used to write FGDC format metadata, if desired. You may use any of the *Populate* or *Extract* methods to force specific aspects of the metadata to be synchronized. The methods whose names begin *Populate…* write information into the metadata that relates to the processing environment, such as the version of ArcGIS software that is being used. The *Extract…* methods take an input object such as *IRelationshipClass* and write properties of this object into the metadata. Calls to the *Extract* or *Populate* methods should be preceded by *StartSynchronization* and proceeded by *FinishSynchronization*.

As with the *IMetadata::Synchronize* method, *StartSynchronization* uses the options defined in *esriMetadataSyncAction* to specify whether metadata will be created and elements will be modified based on whether or not the metadata already exists. Set the *Interval* parameter to zero to ensure that the metadata is updated when synchronization occurs. Check the value of the *pOK* parameter before proceeding to modify the metadata; *StartSynchronization* sets this parameter after checking several criteria that define whether metadata can be created or updated.

FinishSynchronization indicates that the synchronization process is complete. Changes to the XML property set that occurred during synchronization are saved in the metadata document.

On-the-fly table join objects



A memory relationship class is a type of simple relationship class where the origin and destination classes can be from different workspaces

A memory relationship class factory manages the memory relationship classes that exist in the application

A RelQueryTable is a table with rows and columns derived from a joined pair of tables

A RelQueryTableFactory manages the RelQueryTables that exist in the application

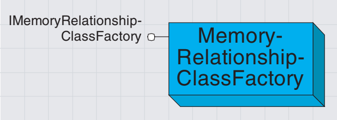
A RelQueryCursor is a cursor that references the rows in a RelQueryTable

A RelQueryRow is a record in a RelQueryTable

A RelQueryTable name is an object that represents a RelQueryTable. A RelQueryTable can be created from a RelQueryTable name

A memory relationship class name is an object that represents a memory relationship class. A memory relationship class can be created from a memory relationship class name

MemoryRelationshipClassFactory coclass


IMemoryRelationship-ClassFactory
Memory-Relationship-ClassFactory

A memory relationship class factory manages the memory relationship classes that exist in the application.

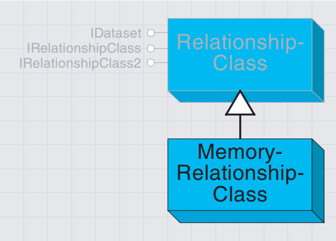
A *MemoryRelationshipClassFactory* is an object that manages the memory relationship classes that exist in an application. You must use either a *MemoryRelationshipClassFactory* or a *MemoryRelationshipClassName* object to create new memory relationship classes.

Like workspace factory objects, a *MemoryRelationshipClassFactory* is a singleton object. This means that you can have only one instance of this object in a process.

IMemoryRelationshipClassFactory : IUnknown	***Provides access to members that open a memory relationship class.***
← Open (in Name: String, in originPrimaryClass: IObjectClass, in originPrimaryKeyField: String, in originForeignClass: IObjectClass, in originForeignKeyField: String, in ForwardPathLabel: String, in BackwardPathLabel: String, in Cardinality: esriRelCardinality) : IRelationshipClass	*Opens the memory relationship class specified by the given properties.*

The *IMemoryRelationshipClassFactory* interface provides an *Open* method that creates a new *MemoryRelationshipClass*.

When creating a *MemoryRelationshipClass*, much of the same information that is required for a *RelationshipClass* in the geodatabase is needed. However, memory relationship classes are always simple and nonattributed, so only two tables and two fields need to be specified. The *originPrimaryKeyField* refers to the field in the *originPrimaryClass*, while the *originForeignKeyField* refers to the field in the *originForeignClass*.



A MemoryRelationshipClass *is a type of* RelationshipClass *in which the origin and destination classes can be from different workspaces and do not need to persist in a geodatabase. For example, the origin class can represent a shapefile, while the destination class can represent a table in a personal geodatabase. It is stored in memory instead of within a geodatabase like other* RelationshipClasses.*You can use the* MemoryRelationshipClassName *object to save and restore a* Memory-RelationshipClass.

For more information on relationship classes in general, see the RelationshipClass *topic in this chapter.*

A *MemoryRelationshipClass* is a simple (noncomposite), nonattributed *RelationshipClass* that does not support relationship rules.

A *MemoryRelationshipClass* inherits from a *RelationshipClass* and, although it implements the same interfaces, not all properties and methods are supported. The following section reviews each of these interfaces and describes which properties and methods behave differently or are not supported with memory relationship classes.

To create a *Relate* in ArcMap, a *MemoryRelationshipClass* must first be created and then assigned to a *Layer* or *StandaloneTable* using the *IRelationshipClassCollectionEdit* interface.

IRelationshipClass : IUnknown	***Provides access to members that return information about the relationship class, create relationships, relationship rules, and get related objects.***
■— BackwardPathLabel: String	*The backward path label for the relationship class.*
■— Cardinality: esriRelCardinality	*The cardinality for the relationship class.*
■— DestinationClass: IObjectClass	*The destination object olass.*
■— DestinationForeignKey: String	*The relationship destination foreign key.*
■— DestinationPrimaryKey: String	*The relationship destination primary key.*
■— FeatureDataset: IFeatureDataset	*The feature dataset, if any, to which this relationship class belongs.*
■— ForwardPathLabel: String	*The forward path label for the relationship class.*
■— IsAttributed: Boolean	*True if the relationships in this relationship class have attributes.*
■— IsComposite: Boolean	*True if the relationship class represents a composite relationship in which the origin object class represents the composite object.*
■— Notification: esriRelNotification	*The notification direction for the relationship class.*
■— OriginClass: IObjectClass	*The origin object class.*
■— OriginForeignKey: String	*The relationship origin foreign key.*
■— OriginPrimaryKey: String	*The relationship origin primary key.*
■— RelationshipClassID: Long	*The relationship class ID.*
■— RelationshipRules: IEnumRule	*Gets the relationship rules that apply to this relationship class.*
◄— AddRelationshipRule (in rule: IRule)	*Adds a relationship rule to this relationship class.*
◄— CreateRelationship (in OriginObject: IObject, in DestinationObject: IObject) : IRelationship	*Creates a new relationship between the two specified objects.*
◄— DeleteRelationship (in OriginObject: IObject, in DestinationObject: IObject)	*Deletes the relationship that associates the two specified objects.*
◄— DeleteRelationshipRule (in rule: IRule)	*Deletes a relationship rule from this relationship class.*
◄— DeleteRelationshipsForObject (in anObject: IObject)	*Deletes all relationships that apply to a specified object.*
◄— DeleteRelationshipsForObjectSet (in anObjectSet: ISet)	*Deletes all relationships that apply to the specified origin or destination object set.*
◄— GetObjectsMatchingObjectSet (in pSrcObjectSet: ISet) : IRelClassEnumRowPairs	*Gets rows pairs of objects that are related to the specified origin or destination object set.*
◄— GetObjectsRelatedToObject (in anObject: IObject) : ISet	*Gets the objects that are related to the specified object.*
◄— GetObjectsRelatedToObjectSet (in anObjectSet: ISet) : ISet	*Gets the objects that are related to the specified origin or destination object set.*
◄— GetRelationship (in OriginObject: IObject, in DestinationObject: IObject) : IRelationship	*Gets the relationship that associates the two specified objects.*
◄— GetRelationshipsForObject (in anObject: IObject) : IEnumRelationship	*Gets all relationships that apply to a specified object.*
◄— GetRelationshipsForObjectSet (in anObjectSet: ISet) : IEnumRelationship	*Gets all relationships that apply to the specified origin or destination object set.*

The *IRelationshipClass* interface provides information on how the relationship class was defined, functionality to create and delete individual relationships, and methods to find related objects.

For more information on *RelationshipClasses* in general, see the *RelationshipClass* topic.

The properties and methods of IRelationshipClass *not listed in the table behave the same way with memory relationship classes as they do with other relationship classes.*

Member	Behavior with a MemoryRelationshipClass
DestinationClass	Returns the *OriginForeignClass* object specified in the *IMemoryRelationshipClassFactory::Open* method.
OriginClass	Returns the *OriginPrimaryClass* object specified in the *IMemoryRelationshipClassFactory::Open* method.
DestinationForeignKey	Returns an empty string since a *MemoryRelationshipClass* is not attributed.
DestinationPrimaryKey	Returns an empty string since a *MemoryRelationshipClass* is not attributed.
FeatureDataSet	Property is not supported. An error will be returned if you try to use this property.
IsAttributed	Returns False since it can't be attributed.
IsComposite	Returns False since it can't be composite.
Notification	Returns esriRelNotificationNone.
RelationshipClassID	Returns -1. This does not need to be set to a meaningful value since a *MemoryRelationshipClass* is not stored in a geodatabase.
RelationshipRules	Property is not supported. An error will be returned if you try to use this property.
AddRelationshipRule	Method is not supported. An error will be returned if you try to use this method.
CreateRelationship	Method is not supported. An error will be returned if you try to use this method.
DeleteRelationship	Method is not supported. An error will be returned if you try to use this method.
DeleteRelationshipRule	Method is not supported. An error will be returned if you try to use this method.
DeleteRelationshipsforObject	Method is not supported. An error will be returned if you try to use this method.
DeleteRelationshipsforObjectSet	Method is not supported. An error will be returned if you try to use this method.
GetRelationship	Method is not supported. An error will be returned if you try to use this method.
GetRelationshipForObject	Method is not supported. An error will be returned if you try to use this method.
GetRelationshipForObjectSet	Method is not supported. An error will be returned if you try to use this method.

Since the origin and destination classes may belong to different workspaces, the methods in *IRelationshipClass* that involve editing are not available.

The following code example creates a *MemoryRelationshipClass* between the us_states feature class and the us_counties feature class. It then uses the *MemoryRelationshipClass* to print the counties that appear in the State of California.

```
Dim pRelationshipClass As IRelationshipClass
Dim pMemRelationshipClassFact As IMemoryRelationshipClassFactory
Set pMemRelationshipClassFact = New MemoryRelationshipClassFactory
Set pRelationshipClass = pMemRelationshipClassFact.Open("test", _
  pFOBClass, "state_fips", pFOBClass2, "state_fips", "forward", _
  "backward", esriRelCardinalityOneToMany)

Dim pQFilter As IQueryFilter
Set pQFilter = New QueryFilter
pQFilter.WhereClause = """STATE_NAME"" = 'California'"

Dim pFeatureClass As IFeatureClass
Dim pFCursor As IFeatureCursor
Dim pFeature As IFeature
Set pFeatureClass = pFOBClass
Set pFCursor = pFeatureClass.Search(pQFilter, True)
Set pFeature = pFCursor.NextFeature

Dim pRelateSet As ISet
Dim pRowBuff As IRowBuffer
Set pRelateSet = pRelationshipClass.GetObjectsRelatedToObject(pFeature)
Set pRowBuff = pRelateSet.Next
Do While Not pRowBuff Is Nothing
  Debug.Print pRowBuff.Value(2)
  Set pRowBuff = pRelateSet.Next
Loop
```

IDataset : IUnknown	***Provides access to members that supply dataset information.***
■━■ BrowseName: String	*The browse name of the dataset.*
■— Category: String	*The category of the dataset.*
■— FullName: IName	*The associated name object.*
■— Name: String	*The name of the dataset.*
■— PropertySet: IPropertySet	*The set of properties for the dataset.*
■— Subsets: IEnumDataset	*Datasets contained within this dataset.*
■— Type: esriDatasetType	*Returns the type of the dataset.*
■— Workspace: IWorkspace	*The workspace containing this dataset.*
◀— CanCopy: Boolean	*True if this dataset can be copied.*
◀— CanDelete: Boolean	*True if this dataset can be deleted.*
◀— CanRename: Boolean	*True if this dataset can be renamed.*
◀— Copy (in copyName: String, in copyWorkspace: IWorkspace) : IDataset	*Copies this dataset to a new dataset with the specified name.*
◀— Delete	*Deletes this dataset.*
◀— Rename (in Name: String)	*Renames this dataset.*

The *IDataset* interface provides information about datasets and some management facilities, such as *Copy, Delete,* and *Rename.*

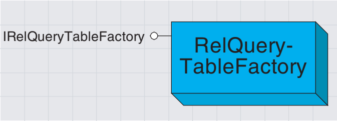
Member	Behavior with a MemoryRelationshipClass
BrowseName	You can get but not set the *BrowseName*. The *BrowseName* will be the name given the *MemoryRelationshipClass* when initialized. If you try to set it, an error is returned.
Category	Returns the string "Memory relationship class"
FullName	Returns a *MemoryRelationshipClassName* object.
Name	Like *BrowseName*, returns the name given the *MemoryRelationshipClass* when initialized
PropertySet	Property is not supported. An error will be returned if you try to use this property.
Subsets	Returns a *Null* or a *Nothing* object in Visual Basic.
Type	Returns *esriDTRelationshipClass.*
Workspace	Returns a *Null* or a *Nothing* object in Visual Basic.
CanCopy	Returns *False*, indicating that it can't be copied.
CanDelete	Returns *False*, indicating that it can't be deleted.
CanRename	Returns *True*, indicating that it can be renamed.
Copy	Method is not supported. An error will be returned if you try to use this method.
Delete	Method is not supported. An error will be returned if you try to use this method.
Rename	Renames the *MemoryRelationshipClass* to the name given.

The table above describes how the methods and properties from *IDataset* are implemented by a memory relationship class.

IRelationshipClass2 : IUnknown	***Provides access to members that get related object row pairs within a query filter specification.***
◀— GetObjectsMatchingObjectArray (in pSrcObjectArray: IArray, in pQueryFilterAppliedToMatchingObjects: IQueryFilter) : IRelClassEnumRowPairs	*Gets row pairs of objects that are related to the specified origin or destination object array that also meet the query filter expression.*
◀— GetObjectsMatchingObjectSetEx (in pSrcObjectSet: ISet, in pQueryFilterAppliedToMatchingObjects: IQueryFilter) : IRelClassEnumRowPairs	*Gets row pairs of objects that are related to the specified origin or destination object set that also meet the query filter expression.*

The *IRelationshipClass2* interface provides methods that allow a *QueryFilter* to be applied to the group of rows that match a specified group of rows in the related table. For example, if a method from this interface had been used in the example above, a *QueryFilter* could have been used to limit the California counties returned to those with a population of over 1 million.

RelQueryTableFactory coclass



A RelQueryTableFactory *manages the* RelQueryTables *that exist in the application.*

A *RelQueryTableFactory* is an object that manages the *RelQueryTables* in the application. You must use either a *RelQueryTableFactory* or a *RelQueryTableName* object to create new *RelQueryTables*.

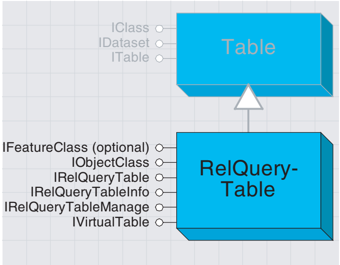
Like the workspace factory objects, a *RelQueryTableFactory* is a singleton object. This means that you can only have one instance of this object in a process.

IRelQueryTableFactory : IUnknown — ***Provides access to members that open a join table.***

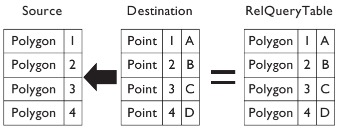
← Open (in pRelClass: IRelationshipClass, in joinForward: Boolean, in pQueryFilter: IQueryFilter, in pSrcSelectionSet: ISelectionSet, in target_Columns: String, in DoNotPushJoinToDB: Boolean, in openAsLeftOuterJoin: Boolean) : IRelQueryTable — *Opens a join table specified by the given properties.*

The *IRelQueryTableFactory* interface provides an *Open* method to define the data a *RelQueryTable* represents and how that data is accessed. The following table describes in more detail the meaning of each of the input parameters.

Parameter	Meaning
pRelClass	This is the *RelationshipClass* used to define the join tables and join fields as well as the cardinality.
JoinForward	If *joinForward* is *True*, the origin table from *pRelClass* is the source in the *RelQueryTable*, otherwise the destination table in *pRelClass* becomes the source. If the cardinality is many-to-one, you can define your relationship as one-to-many and set this parameter to false in order to make the many side the source. You will need to do this since you can't set the cardinality to many-to-one for a *RelationshipClass*.
PQueryFilter	You can further define the data that will be returned by a *RelQueryTable* by applying a *QueryFilter*. The *WhereClause* of *pQueryFilter* is added to the *WhereClause* of the *QueryFilter* specified when you use the *ITable::Search* method using the *And* operator. The *SubFields* of *pQueryFilter* define which fields will include data when a cursor is opened. The other fields are included but will be empty.
pSrcSelectionSet	This parameter is not exposed and should always be set to *Nothing*.
target_Columns	This is a comma-delimited string that defines the fields returned from the destination table. This is different from the *SubFields* of *pQueryFilter* since in this case, fields not included in *target_columns* are not included at all in a cursor.
DoNotPushJoinToDB	If this is *True*, the join is always processed on the client; otherwise it is processed on the server if possible. If all datasets involved are stored on the same ArcSDE or personal geodatabase server, the processing can be performed by the server, which is normally faster. The *openAsLeftOuterJoin* parameter must also be set to *False* in order for processing to occur on the server. In any other case, processing occurs on the client regardless of how this parameter is set.
openAsLeftOuterJoin	A left outer join is performed if this is *True*, otherwise a left inner join is performed. For more information, see *IRelQueryTableInfo::JoinType* below.



A RelQueryTable *is a class that represents a joined pair of tables or feature classes.*



Source	
Polygon	1
Polygon	2
Polygon	3
Polygon	4

Destination		
Point	1	A
Point	2	B
Point	3	C
Point	4	D

RelQueryTable		
Polygon	1	A
Polygon	2	B
Polygon	3	C
Polygon	4	D

This diagram shows the results of joining two feature classes.

A *RelationshipClass* is used when creating a *RelQueryTable* to specify the tables involved and the fields on which the join is based. The *RelationshipClass* can be stored in a geodatabase or created in memory. Memory relationship classes can include tables that belong to different data sources. Therefore, a *RelQueryTable* can join tables from different data sources.

A *RelQueryTable* includes a source table or feature class and a destination table or feature class. If you step through a cursor opened from a *RelQueryTable*, each row includes the columns from both input tables. The fields from the source appear on the left, while the fields from the destination appear on the right. Each row from the table is composed of the primary and foreign keys from *IRelationshipClass* to produce a single row.

Shapes can only be retrieved from the source table. If the destination table has a geometry field, it will not be included in the *RelQueryTable*.

When you perform a join in ArcMap, a *RelQueryTable* object is created and used as the table or layer's data source for all display purposes. In ArcMap, you can use the *IDisplayTable::DisplayTable* property to get a joined table or layer's *RelQueryTable*.

Since a *RelQueryTable* implements *IObjectClass* and *IFeatureClass* and inherits from *Table*, it can be treated like any other *Table* or *FeatureClass*. The *IFeatureClass* interface is implemented only when the source is a *FeatureClass*. A *RelQueryTable* cursor is read-only, so you must edit the source and destination to change the data.

A *RelQueryTable* is designed to work with relationships that have one-to-one or many-to-one cardinality. If the cardinality is one-to-many, a row from the source will be associated with the first matching row in the destination—any other matching rows are ignored. A *RelationshipClass* with a many-to-many cardinality is not supported and will cause an error. If the relationship has a cardinality of one-to-many or many-to-many, use *RelationshipClass* objects to access the data. If the cardinality is really one-to-one but the *Relationship* is defined as one-to-many, the *RelQueryTable* will still process correctly.

A *RelQueryTable* will have an *ObjectID* if the source has an *ObjectID*. When initialized, the *RelQueryTable* uses the values from the source's *ObjectID* field to define its *ObjectIDs*. If the source is a non*ObjectID* object class, the *RelQueryTable* can still access the data, but there will be limitations, such as an inability to select rows.

By definition, *ObjectIDs* must be unique. The reason relationships with one-to-many cardinalities match one row from the source to only one row in the destination is to prevent repeating *ObjectIDs* in the *RelQueryTable*. Repeating *ObjectIDs* will cause many objects, such as *SelectionSets* and table windows, to behave incorrectly.

IRelQueryTableManage : IUnknown	Provides access to members that manage the query tables.
← Init (in pRelClass: IRelationshipClass, in joinForward: Boolean, in pQueryFilter: IQueryFilter, in pSrcSelectionSet: ISelectionSet, in target_Columns: String, in DoNotPushJoinToDB: Boolean, in openAsLeftOuterJoin: Boolean)	*Initializes the RelQueryTable instance*
← VersionChanged (in pSelectedWorkspace: IVersion, in pTargetVersion: IVersion, in pTablesRequiringMapEventFiring: IEnumTableVersionChanges)	*Updates all children tables to use new version of the workspace.*

The *IRelQueryTableManage* interface provides an *Init* method to define what data a *RelQueryTable* represents and how that data is accessed. The following table describes in more detail the meaning of each of the input parameters.

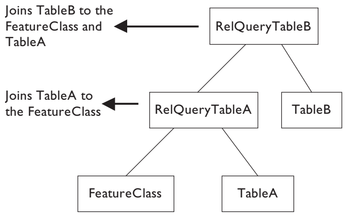
The following example uses a *MemoryRelationshipClass* and a *RelQueryTable* to join country demographic data to a countries feature class. The field names are then printed:

```
Dim pMemRelClassFact As IMemoryRelationshipClassFactory
Set pMemRelClassFact = New MemoryRelationshipClassFactory
Dim pRelClass As IRelationshipClass
Set pRelClass = pMemRelClassFact.Open("Country_Demog", _
  FeatureObjectClass, "fips_code", pTableObjectClass, "fips_code", _
  "forward", "backward", esriRelCardinalityOneToMany)

Dim pRelQueryTableFact As IRelQueryTableFactory
Dim pRelQueryTab As ITable
Set pRelQueryTableFact = New RelQueryTableFactory
Set pRelQueryTab = pRelQueryTableFact.Open(pRelClass, True, Nothing, _
 Nothing, "", True, True)

Dim pCursor As ICursor
Set pCursor = pRelQueryTab.Search(Nothing, True)

Dim pField As IField
Dim pFields As IFields
Dim intI As Integer, intJ As Integer

Set pFields = pCursor.Fields
intI = pFields.FieldCount - 1
For intJ = 0 To intI
  Set pField = pFields.Field(intJ)
  Debug.Print pField.Name
Next intJ
```

The *VersionChanged* method is called internally when the database version is changed. This method allows a *RelQueryTable* to update the internal workspaces of the underlying data sources.

IRelQueryTable : IUnknown	*Provides access to members that define the datasets and relationship used in a join.*
DestinationTable: ITable	*The fields that appear on the right side of the join belong to the destination table.*
RelationshipClass: IRelationshipClass	*Relationship class used in the table join.*
SourceTable: ITable	*The fields that appear on the left side of the join belong to the source table.*

The *IRelQueryTable* interface allows you to get the source and destination as well as the *RelationshipClass* or *MemoryRelationshipClass* used to define the *RelQueryTable*. The source and destination can be tables, feature classes, or even other *RelQueryTables*.


Joins TableB to the FeatureClass and TableA
RelQueryTableB
Joins TableA to the FeatureClass
RelQueryTableA
TableB
FeatureClass
TableA

The source is on the left and the destination is on the right.

For example, if you wanted to join two tables to a feature class, you would first create a *RelQueryTableA* to join one of the tables to the feature class. You would then create a *RelQueryTableB* to join the second table to *RelQueryTableA*. *RelQueryTableA* would be the source for *RelQueryTableB*. The diagram to the left illustrates how this works.

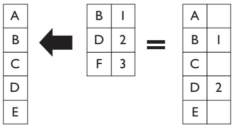
The following code example shows how to step through a *RelQueryTable*'s source and destination and prints the names of the joined tables and feature classes. This list is similar to the list of joined tables and feature classes that you see in the Joins and Relates tab in the Layer or Table Properties dialog boxes in ArcMap.

```
Dim pFeatureLayer As IFeatureLayer
Set pFeatureLayer = GetLayer(0)

Dim pTable As ITable, pDisplayTable As IDisplayTable
Set pDisplayTable = pFeatureLayer
Set pTable = pDisplayTable.DisplayTable

Dim pRelQueryTable As IRelQueryTable, pDestTable As ITable
Dim pDataset As IDataset, sOut As String

Do While TypeOf pTable Is IRelQueryTable
  Set pRelQueryTable = pTable
  Set pDestTable = pRelQueryTable.DestinationTable
  Set pDataset = pDestTable
  sOut = sOut & pDataset.Name & vbNewLine
  Set pTable = pRelQueryTable.SourceTable
Loop
MsgBox "The joined tables include:" & vbNewLine & sOut
```

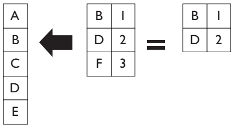
The first four lines of the code example show how to use the *IDisplayTable* interface to get the *RelQueryTable* from a feature layer in ArcMap. The *FeatureLayer* class in ArcMap implements *ITable*, but changing to this returns the *FeatureLayer* object's implementation of *ITable*, not a *RelQueryTable* object. You must use the *IDisplayTable* interface to get a layer or standalone table object's *RelQueryTable* in ArcMap.

IRelQueryTableInfo : IUnknown	Provides access to members that provide information about joins.
■— HasDirectAccessLookup (pDirectAccess: Boolean)	Indicates if direct access lookup is used by a RelQueryTable to match records between the source and destination tables.
■— JoinType: esriJoinType	Type of table join.
■— QueryDef: IQueryDef	QueryDef used to create the join. This property will be null if the join is done on the client.
← GetBaseTableOfField (in dbColumn: String) : ITable	Returns the base table for a particular field.

Left outer join



Left inner join



The *IRelQueryTableInfo* interface returns the join type, which can be either *esriLeftInnerJoin* or *esriLeftOuterJoin*. A left outer join ensures that all records in the source are returned. A left inner join only returns rows that have matching key field values. The diagram to the left illustrates the difference.

The *QueryDef* property returns the query that is used to retrieve the joined data when processing is done on the server. If the join is processed on the client as opposed to a server, the *QueryDef* property returns a *Null* or a *Nothing* object in Visual Basic.

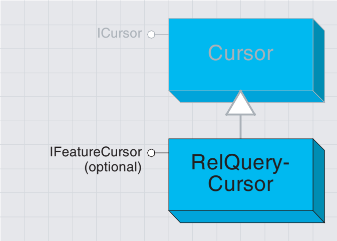
If all tables involved are stored on the same ArcSDE server of the personal geodatabase, the processing can be performed by the server, which is normally faster. The *JoinType* property must also be *esriLeftInnerJoin* in order for processing to occur on the server. In any other case, processing occurs on the client.

The *GetBaseTableOfField* method returns the underlying table object that is associated with a field in a *RelQueryTable*. To ensure that the column will be found, provide a fully qualified field name when executing this method.

HasDirectAccessLookup returns *True* if the destination table supports the *IRandomAccessCursor* interface and the source table has an ObjectID field. This interface allows for faster data access and therefore better join performance. Tables from shapefile and ArcInfo Workspace factories support this interface.

IVirtualTable : IUnknown	Identity interface for temporary memory tables.

A class that implements *IVirtualTable* represents an abstract representation of data. The data returned by this class is modified or enhanced in some way. *RelQueryTables* are virtual because they return rows that are a join of two other rows. Event layers are also virtual, as they return a feature class from a simple table. The *IVirtualTable* interface does not have any properties or methods. The pure presence of the interface tells you that it's a virtual table.



A RelQueryCursor *is a tool that references the rows in a* RelQueryTable.

Each row returned by the cursor includes fields from both the source and destination tables with the source fields on the left. Each row from the source and destination tables is matched according to the join fields to create a single row.

For more information on cursors in general, see the Cursor *and* FeatureCursor *objects topic.*

A *RelQueryCursor* is created when you open a cursor on a *RelQueryTable*. You can use methods such as *Search* from *ITable* and *IFeatureClass* to open the cursor. Since it inherits from cursor, it implements *ICursor* and will implement *IFeatureCursor* if the *RelQueryTable* has geometry.

A *RelQueryCursor* is read-only; therefore, performing edits using the *IRow::Delete* and *IRow::Store* methods is not supported. Also, trying to open an insert or update cursor will result in an error since there is no insert or update *RelQueryCursor*.

ICursor : IUnknown	***Cursor Interface.***
Fields: IFields	*Return the Fields collection for this cursor.*
DeleteRow	*Delete the existing row in the database corresponding to the current position of the cursor*
FindField (in Name: String) : Long	*The index of the field with the specified name.*
Flush	*Flush any outstanding buffered writes to the database.*
InsertRow (in Buffer: IRowBuffer) : Variant	*Insert a new row into the database using the property values in the input buffer. The object ID of the new row, if there is one, is returned*
NextRow: IRow	*Advance the position of the cursor by one and return the Row object at that position.*
UpdateRow (in Row: IRow)	*Update the existing row in the database corresponding to the current position of the cursor*

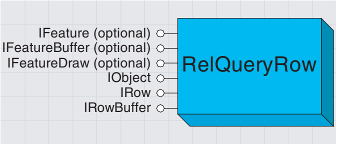
The *ICursor* interface provides access to a set of rows.

Member	Behavior with a MemoryRelationshipClass
Fields	Returns the fields of *RelQueryTable*.
DeleteRow	Method is not supported since update cursors are not supported. An error will be returned if you try to use this method.
FindField	Returns the index of field with the given name. If the field does not exist, -1 is returned. It is good practice to provide a fully qualified field name (tablename.fieldname) with this method. If it is not fully qualified, it may not be found in the *RelQueryTable*.
Flush	Method is not supported since update and insert cursors are not supported. An error will be returned if you try to use this method.
InsertRow	Method is not supported since update cursors are not supported. An error will be returned if you try to use this method.
NextRow	Moves the cursor to the next row and returns the *Row* object at that position.
UpdateRow	Method is not supported since update cursors are not supported. An error will be returned if you try to use this method.

The table above outlines how the properties and methods of *ICursor* behave when used on a *RelQueryCursor*.

IFeatureCursor : IUnknown	***Feature Cursor Interface.***
Fields: IFields	*Return the Fields collection for this cursor.*
DeleteFeature	*Delete the existing Feature in the database corresponding to the current position of the cursor*
FindField (in Name: String) : Long	*The index of the field with the specified name.*
Flush	*Flush any outstanding buffered writes to the database.*
InsertFeature (in Buffer: IFeatureBuffer) : Variant	*Insert a new Feature into the database using the property values in the input buffer. The ID of the new Feature is returned*
NextFeature: IFeature	*Advance the position of the cursor by one and return the Feature object at that position.*
UpdateFeature (in Object: IFeature)	*Update the existing Feature in the database corresponding to the current position of the cursor*

The *IFeatureCursor* interface provides access to a set of features in a *RelQueryTable* and operates the same way as *ICursor*. The information provided in the above text for *ICursor* can also be applied to *IFeatureCursor* interface. As with *ICursor*, the *InsertFeature, UpdateFeature, DeleteFeature,* and *Flush* methods are not supported by *RelQueryTable*.



A RelQueryRow *represents a row of data in a* RelQueryTable.

A *RelQueryRow* can be obtained from a cursor (*ICursor::NextRow*) or methods, such as *ITable::GetRow*. The *ITable::CreateRow* method is not supported and will return an error if used.

IRow : IRowBuffer	**Row Interface.**
■— HasOID: Boolean	*True if the row has an OID.*
■— OID: Long	*The OID for the row.*
■— Table: ITable	*The table for the row.*
← Delete	*Deletes the row.*
← Store	*Stores the row.*

IRowBuffer : IUnknown	**Row Buffer Interface.**
■— Fields: IFields	*The Fields collection for this row buffer.*
■—■ Value (in Index: Long) : Variant	*Return the value of the field with the specified index.*

The *IRow* and *IRowBuffer* interfaces are always implemented by a *RelQueryRow*. The *IFeature, IFeatureBuffer,* and *IFeatureDraw* interfaces are only implemented if the *RelQueryTable* has a geometry field. A *RelQueryRow* is read-only; therefore, some of the properties and methods may not be supported.

For more information on rows in general, see the *RowBuffer* and *Row* objects topic as well as the *Object* and *Feature* object topics. The interfaces implemented by *RelQueryRow* are documented with those objects.

The *IRowBuffer* interface can be used to retrieve values from the *RelQueryRow*; the same can be done with *IRow* since *IRow* inherits this interface. The *IRowBuffer::Value* set method is not supported and will return an error if used with a *RelQueryRow*.

The *IRow* interface provides methods and properties to read and write data as well as delete rows. A *RelQueryRow* does not support the members that allow the data to be changed. An error is returned if the set value property or the store and delete methods are used. The *hasOID, OID,* and *Table* properties return valid results.

IObject : IRow	**Object Interface.**
■— Class: IObjectClass	*The object class for the row.*

The *IObject* interface inherits from *IRow* and *IRowBuffer*. It also includes a class property that returns an *IObjectClass* reference to the *RelQueryTable*.

IFeature : IObject	*Feature Interface.*
■— Extent: IEnvelope	*The extent of the feature.*
■— FeatureType: esriFeatureType	*The type of the feature.*
■—□ Shape: IGeometry	*Returns a reference to the default shape for the feature.*
■— ShapeCopy: IGeometry	*Returns a cloned copy of the default shape for the feature.*

The *IFeature* interface inherits from *IObject* and *IRow*, plus has additional properties that apply to a shape in a *RelQueryRow*. All properties are valid except for the *IFeature::Shape* set method, which will return an error.

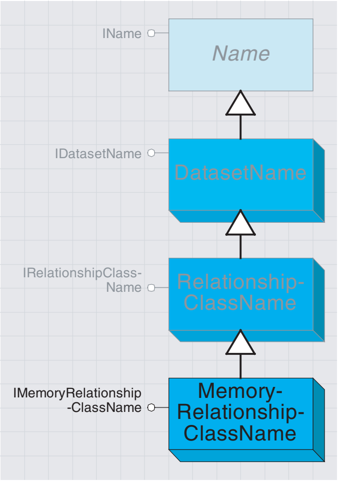
IFeatureBuffer : IRowBuffer	*Feature Buffer Interface.*
■—□ Shape: IGeometry	*The default shape in the feature buffer.*

The *IFeatureBuffer* interface inherits from and performs the same operations as the *IRowBuffer,* plus it allows the shape to be retrieved independently from a *RelQueryRow*. All properties are valid except the *IFeatureBuffer::Shape* set method, which returns an error.

IFeatureDraw : IUnknown	*Interface for custom drawing by a feature.*
■—□ InvalidArea: IInvalidArea	*The area to be drawn.*
← Draw (in drawPhase: tagesriDrawPhase, in Display: IDisplay, in Symbol: ISymbol, in symbolInstalled: Boolean, in Geometry: IGeometry, in DrawStyle: esriDrawStyle)	*Draws the feature on the display.*

For more information on *IFeatureDraw*, see the *Feature* object topic.

MemoryRelationshipClassName coclass



A memory relationship class name can be used to create new, or work with existing, memory relationship classes.

A *MemoryRelationshipClassName* object is a representation of a *MemoryRelationshipClass* object. A *MemoryRelationshipClassName* can be used to create new, work with existing, or persist *MemoryRelationshipClasses*.

IMemoryRelationshipClass : IUnknown	*Provides access to members that initialize a memory relationship class.*
← Init (Name: String, pOriginPrimaryClass: IObjectClass, originPrimaryKeyField: String, pOriginForeignClass: IObjectClass, originForeignKeyField: String, ForwardPathLabel: String, BackwardPathLabel: String, Cardinality: esriRelCardinality)	*Initializes an in-memory relationship class*

The *IMemoryRelationshipClassName* interface contains properties that correspond to the parameters used with the *IMemoryRelationshipClassFactory::Open* method. These include the *Origin* and *Destination* tables, the fields, and the forward and backward pathnames.

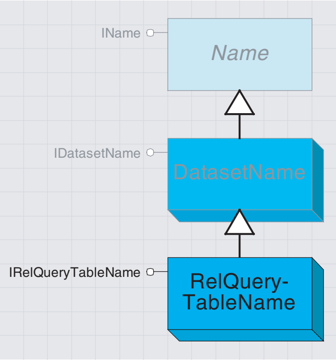
The only parameters from the *IMemoryRelationshipClassFactory::Open* method that don't have a corresponding property in *IMemoryRelationshipClassName* are the name and the cardinality. The name can be set using the *IDatasetName* interface, and the cardinality can be set using the *IRelationshipClassName* interface. Both of these interfaces are inherited by *MemoryRelationshipClassName*.

When creating a new *MemoryRelationshipClass* using a *MemoryRelationshipClassName* object, only the properties described above need to be set. The example below creates a new *MemoryRelationshipClass* from a *MemoryRelationshipClassName*.

For more information on Name *objects in general, see the* Name *objects topics.*

```
Dim pMemoryRelationshipClassName As IMemoryRelationshipClassName
Set pMemoryRelationshipClassName = New MemoryRelationshipClassName
With pMemoryRelationshipClassName
  Set .OriginName = pOriginName
  Set .DestinationName = pDestinationName
  .OriginPrimaryKey = "STATE_FIPS"
  .OriginForeignKey = "STATE_FIPS"
  .ForwardPathLabel = "forward"
  .BackwardPathLabel = "backward"
End With

Dim pRelationshipClassName As IRelationshipClassName
Set pRelationshipClassName = pMemoryRelationshipClassName
pRelationshipClassName.Cardinality = esriRelCardinalityOneToOne
Dim pDatasetName As IDatasetName
Set pDatasetName = pRelationshipClassName
pDatasetName.Name = "New_MemRC"

Dim pName As IName
Set pName = pRelationshipClassName
Dim pMemoryRelationshipClass As IMemoryRelationshipClass
Set pMemoryRelationshipClass = pName.Open
Dim pRelationshipClassCollectionEdit as IRelationshipClassCollectionEdit
Dim pRelationshipClassCollectionEdit = pFeatureLayer
pRelationshipClassCollectionEdit.AddRelationshipClass _
  pMemoryRelationshipClass
```

Since a MemoryRelationshipClass *implements* IDataset, *you can use the* IDataset::FullName *property to get a* MemoryRelationshipClassName *object that corresponds to an existing* MemoryRelationshipClass.



A RelQueryTable *name can be used to create new, and work with existing,* RelQueryTables *and memory relationship classes.*

A *RelQueryTableName* is a representation of a *RelQueryTable*. A *RelQueryTableName* can be used to create new, work with existing, or persist *RelQueryTables*.

For more information on name objects in general, see the *Name* objects topics.

IRelQueryTableName : IUnknown	*Provides access to members that define a relationship query table name.*
■━■ DoNotPushJoinToDB: Boolean	*Indicates if the join is processed on the client.*
■━■ ForwardDirection: Boolean	*Indicates if the originPrimaryClass of the RelationshipClass is the SourceTable.*
■━■ LeftOuterJoin: Boolean	*Indicates if the type of join will be a left outer join.*
■━□ RelationshipClassName: IName	*The name object for the RelationshipClass that defines the RelQueryTable.*
■━□ SrcQueryFilter: IQueryFilter	*A QueryFilter applied to a cursor opened from the RelQueryTable.*
■━□ SrcSelectionSet: ISelectionSet	*A SelectionSet applied to a cursor opened from the RelQueryTable.*
■━■ TargetColumns: String	*The destination dataset columns available in a cursor opened from the RelTableTable.*

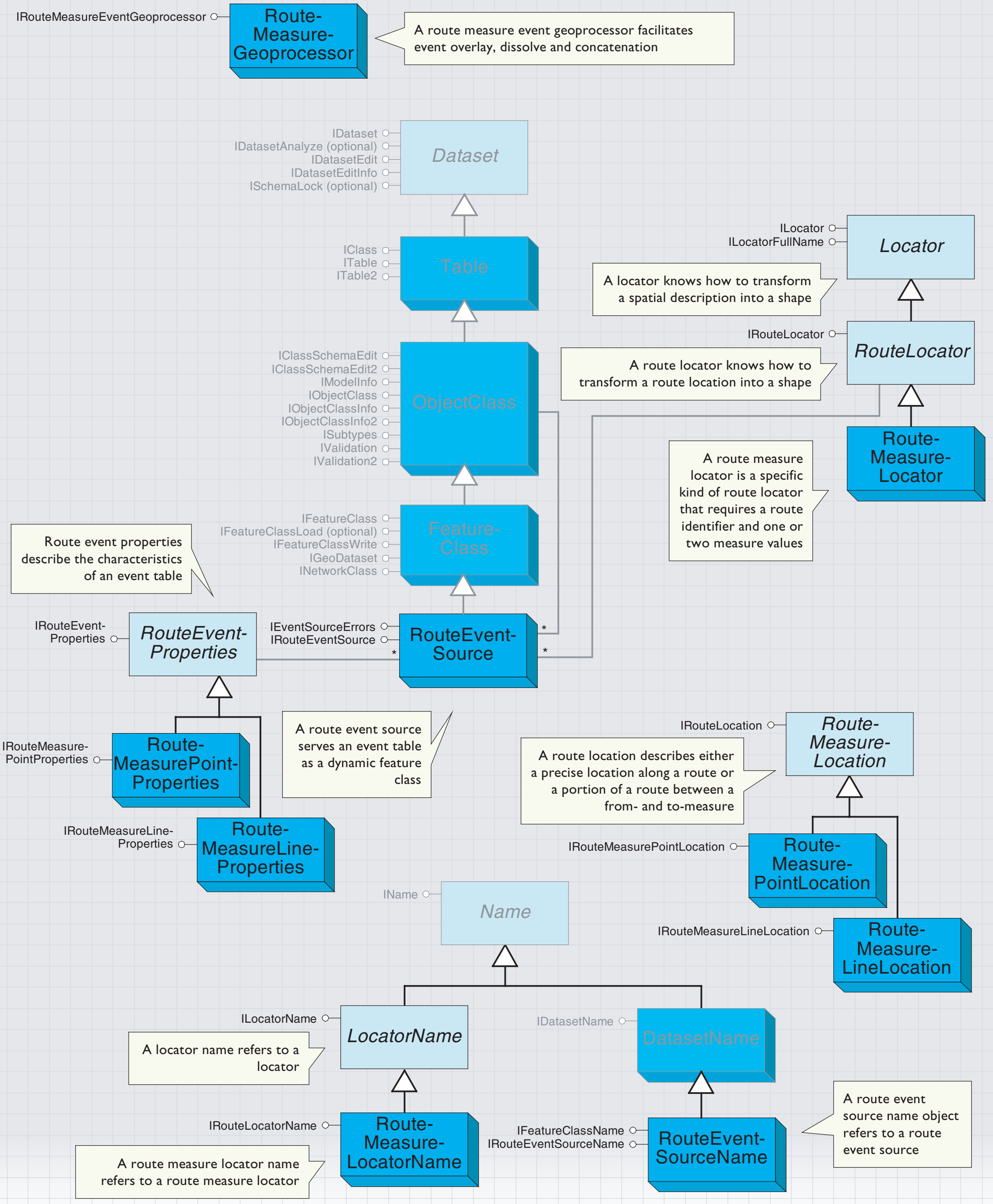
The *IRelQueryTableName* interface contains properties that correspond to the parameters used with the *IRelQueryTableFactory::Open* method described above.

The following code shows how to create a new *RelQueryTable* from a *RelQueryTableName* object. In this example, the *MemoryRelationshipClassName* has already been created.

```
Dim pRelQueryTableName As IRelQueryTableName
Set pRelQueryTableName = New RelQueryTableName

With pRelQueryTableName
  Set .RelationshipClassName = pMemoryRelationshipClassName
  .ForwardDirection = True
  .DoNotPushJoinToDB = True
  .TargetColumns = ""
  .LeftOuterJoin = True
  Set .SrcQueryFilter = Nothing
  Set .SrcSelectionSet = Nothing
End With

Dim pName As IName
Set pName = pRelQueryTableName

Dim pRelQueryTable As IRelQueryTable
Set pRelQueryTable = pName.Open
```

The *IDataset::FullName* method can be used on an existing *RelQueryTable* object to get a corresponding *RelQueryTableName* object.

Dynamic segmentation objects



A route measure event geoprocessor facilitates event overlay, dissolve and concatenation

A locator knows how to transform a spatial description into a shape

A route locator knows how to transform a route location into a shape

A route measure locator is a specific kind of route locator that requires a route identifier and one or two measure values

Route event properties describe the characteristics of an event table

A route event source serves an event table as a dynamic feature class

A route location describes either a precise location along a route or a portion of a route between a from- and to-measure

A locator name refers to a locator

A route event source name object refers to a route event source

A route measure locator name refers to a route measure locator

Dynamic segmentation concepts

Dynamic segmentation is the process of computing the shape of route locations along calibrated linear features at runtime based on event tables for which distance measures are available.

A calibrated linear feature, or route, is simply a polyline feature that has m- (measure) values and an identifier.

Route locations can be organized into tables based on a common theme. These are called event tables. For example, five event tables containing information on speed limits, year of resurfacing, present condition, signs, and accidents can reference a route feature class representing highways.

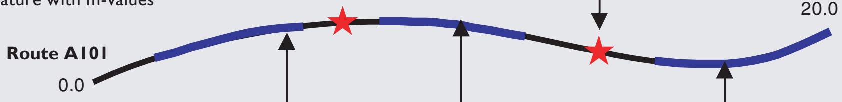
An event table is any table that contains a route identifier field and at least one measure field. Tables containing point route locations have one measure field while tables containing line route locations have two. The route identifier field matches the route identifier in the route feature class (does not have to have the same name).

A point event table contains many point events. Each point event has a route location.

OID	RID	Mile
1	A101	12
2	A101	7.5

An event is a row in an event table. An event has a route location (either point or line).

A route is a polyline feature with m-values



The identifier for each route is stored in any numeric or text field.

OID	RID	From_M	To_M
1	A101	1	5
2	A101	7	9
3	A101	15	20

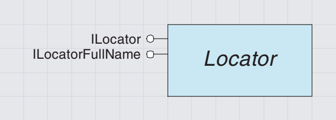
A line event table contains many line events. Each line event has a route location.

A route event source serves an event table as a "dynamic" feature class. Every row in the table is served as a feature whose shape is calculated on the fly every time it is asked for. This is dynamic segmentation.

In a route event source, there is one feature for every row of the original event table. Sometimes, however, the features have empty shapes. This is because there was some reason the event could not be properly located. Other times, an event can only be partially located (this happens for line events only). These are some sample errors codes.

OID	RID	From_M	To_M	Error
1	A101	1	5	LOCATING_OK
2	A101	-5	9	LOCATING_E_FROM_PARTIAL_MATCH
3	A101	15	25	LOCATING_E_TO_PARTIAL_MATCH
3	A101	35	45	LOCATING_E_CANT_FIND_EXTENT

OID	RID	Mile	Error
1	A101	1	LOCATING_OK
2	A101	-5	LOCATING_E_CANT_FIND_LOCATION



Locators know how to transform a spatial description into a shape that can be placed on a map.

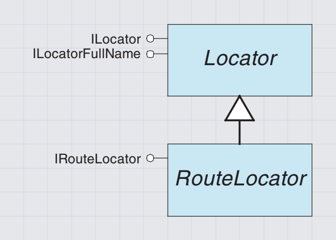
Locator is an abstract class that specifies the interfaces common to all types of locator objects. Types of locators include addresses, x,y coordinates, routes, and place names. Locators combine reference data and a location method.

ILocator : IUnknown	*Provides access to members that describe general locator properties.*
Category: String	*Category of the locator.*
Description: String	*Description of the locator.*
Name: String	*Name of the locator.*
UserInterface: ILocatorUI	*User interface for the locator.*

The *ILocator* interface provides access to the properties of a locator.

ILocatorFullName : IUnknown	*Provides access to the Name object for the locator.*
FullName: ILocatorName	*The Name object for the locator.*

The *ILocatorFullName* interface provides access to the name property of a *Locator* so that it may be persisted.



A route locator knows how to transform a route location into a shape.

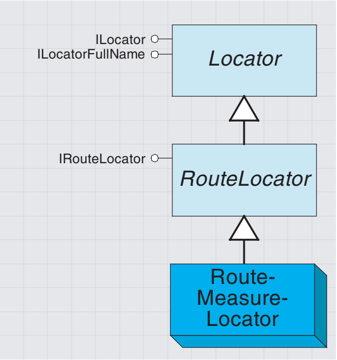
RouteLocator is an abstract class. A *RouteLocator* knows how to transform a route location into a shape that can be displayed on a map.

Route locations describe either a precise location along a route or a portion of a route between a from- and to-measure (see the discussion on *RouteMeasureLocator* on the next page).

IRouteLocator : IUnknown	*Provides access to properties and methods of a route locator.*
Extent: IEnvelope	*The route locator's extent (same as a route feature class' extent).*
HasSpatialIndex: Boolean	*Indicates if the route feature class has a spatial index.*
MeasureUnit: esriUnits	*The unit of the route measures.*
RouteFeatureClass: IFeatureClass	*The route feature class (Polyline with m feature class).*
RouteIDFieldIndex: Long	*The field index of the route identifier.*
RouteIDFieldName: String	*The route identifier field from the route feature class.*
RouteIDFieldNameDelimited: String	*The delimited route identifier field of the route feature class.*
RouteIDIsString: Boolean	*Indicates if the route identifier field type is string.*
RouteIDIsUnique: Boolean	*Indicates the uniqueness of each route identifer in the route feature class.*
RouteWhereClause: String	*The where clause that limits the routes on which events can be located.*
SpatialReference: ISpatialReference	*The route locator's spatial reference (same as route feature class' spatial reference).*
GetRouteGeometry (in routeLocation: IRouteLocation, out routeGeometry: IGeometry, out locatingError: tagesriLocatingError)	*The routes corresponding to the route location.*
Locate (in routeLocation: IRouteLocation, out result: IGeometry, out locatingError: tagesriLocatingError)	*Locates a point or line route location.*
LocateRow (in EventProperties: IRouteEventProperties, in Row: IRow, out result: IGeometry, out locatingError: tagesriLocatingError)	*Locates an event table row containing a point or line route location.*

The *IRouteLocator* interface is useful for retrieving the properties of a *RouteLocator* object and for determining the shape of route locations and events (see example following the discussion on route locations).

For route locators, the *RouteFeatureClass* class can be a coverage route system, a PolyLineM shapefile, or a PolyLine feature class (with m-values) in a geodatabase (Access or ArcSDE). This means routes are stored in a feature class where *IGeometryDef::GeometryType* = *esriGeometryPolyLine* and *IGeometryDef::HasM* = *True.*

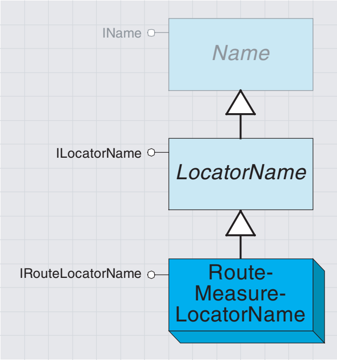


A route measure locator is a type of route locator that determines that a route location's position is by the measure values along a route.

A *RouteMeasureLocator* is one type of *RouteLocator*. It determines the shape of a route location by matching the route location's measure values to those stored in a route feature. A *RouteMeasureLocator* is created via its *Name* object counterpart, *RouteMeasureLocatorName*.

The *IRouteLocatorName* interface is used to retrieve the properties of a *RouteLocator* object.

LocatorName and RouteMeasureLocatorName



A locator name refers to a locator object.

A route measure locator name refers to a route measure locator object.

LocatorName is an abstract class that can be used to refer to a *Locator* object.

RouteLocatorName is an abstract class that can be used to refer to a *RouteLocator* object.

RouteMeasureLocatorName is a class that can be used to refer to a *RouteMeasureLocator* object. It is a specific implementation of *LocatorName* and *RouteLocatorName*.

IRouteLocatorName : IUnknown	**Provides access to route locator name properties.**
RouteFeatureClassName: IName	*The route feature class name (Polyline with m feature class name).*
RouteIDFieldName: String	*The route identifier field of the route feature class.*
RouteIDIsUnique: Boolean	*Indicates the uniqueness of each route identifer in the route feature class.*
RouteMeasureUnit: esriUnits	*The route measure unit.*
RouteWhereClause: String	*The where clause that limits the routes on which events can be located.*

All route locator name classes implement the *IRouteLocatorName* interface. This interface is used for setting and retrieving the properties of a *RouteLocatorName* object. Some things to note about this interface:

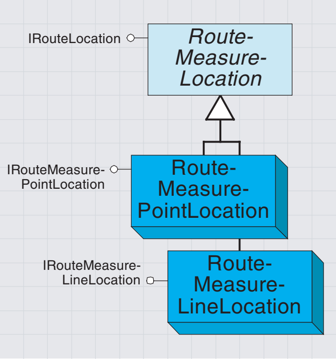
- *RouteFeatureClassName* is a polyline feature class with m-values.
- *RouteIDFieldName* is any numeric or text field containing the route identifiers. This field relates to a similar field in an event table
- *RouteIDIsUnique* is set to *True* if every route feature has a unique ID. Dynamic segmentation runs faster when this is *True*.
- *RouteMeasureUnits* are the units of the m-values stored in the routes. The default is *esriUnknownUnits*.
- *RouteWhereClause* is a string that limits the number of routes on which route locations can be found.

The *RouteIDIsUnique* property is particularly important. If you set this to *False* and the route IDs are unique, then the dynamic segmentation process will produce the correct results (but will be slower). However, if you set this to *True* and the route IDs are not unique, the dynamic segmentation process will only look for one occurrence of a particular RouteID and could produce erroneous results. The default is *False*. This setting is only applicable to route feature classes in a geodatabase (personal or ArcSDE).

The following example shows how to create a *RouteMeasureLocator* via a *RouteMeasureLocatorName*.

```
Dim pName As IName
Dim pDS As IDataset
Dim pRtLocatorName As IRouteLocatorName
Dim pRtLocator As IRouteLocator

Set pDS = pRouteFC   ' A PolyLineM feature class
Set pName = pDS.FullName
Set pRtLocatorName = New RouteMeasureLocatorName
```

```
With pRtLocatorName
  Set .RouteFeatureClassName = pName
  .RouteIDFieldName = "rKey"
  .RouteIDIsUnique = True
  .RouteMeasureUnit = esriMeters
End With
Set pName = pRtLocatorName
Set pRtLocator = pName.Open
```


IRouteLocation
Route-Measure-Location
IRouteMeasure-PointLocation
Route-Measure-PointLocation
IRouteMeasure-LineLocation
Route-Measure-LineLocation

A route measure location describes a portion of a route or a single position along a route.

A route measure line location uses from and to measure values to describe a portion of a route.

A route measure point location uses a single measure value to describe a single position along a route.

A *RouteMeasureLocation* describes a portion of a route or a single position along a route.

IRouteLocation : IUnknown	***Provides access to route location properites.***
LateralOffset: Double	*The route location's lateral offset (default 0.0).*
MeasureUnit: esriUnits	*The route location's measure units.*
RouteID: Variant	*The route identifier (string, integer, or double).*

The *IRouteLocation* interface lets you define the properties of a route location. For example, route locations occur along a single route, so you set that value here. Additionally, you identify the units in which the route location was collected and specify whether you want the route location's shape offset from its route when it is located.

Offsets are in the spatial reference units of the route feature class (and not necessarily the same units as the route feature class' measures). Therefore, an offset on route data stored in geographic units might produce inconsistent results. Offsets are used for rendering purposes only.

Setting the *IRouteLocation::MeasureUnit* property enables you to do on-the-fly measure conversion. This property corresponds to *IRouteLocator::RouteMeasureUnit*. For example, you may know the position of a route location in miles, but your route feature class has its measures stored in meters. By setting these values accordingly, you can achieve measure conversion.

RouteMeasureLineLocation is a class that describes portions of a route using from and to measure locations.

IRouteMeasureLineLocation : IUnknown	***Provides access to point specific route-measure location properties.***
FromMeasure: Double	*The from measure value.*
ToMeasure: Double	*The to measure value.*

The *IRouteMeasureLineLocation* interface is where you set the route location's from- and to-measure values. For example, say you wanted to find a location from 2,500 meters to 3,500 meters along route 10. Furthermore, you want this location to be offset 25 meters from the route. Your code would look like this:

```
Dim pRouteLoc As IRouteLocation
Dim pRMLineLoc As IRouteMeasureLineLocation
Set pRouteLoc = New RouteMeasureLineLocation
With pRouteLoc
  .MeasureUnit = esriMeters
  .RouteID = 10
  .LateralOffset = 25
End With
Set pRMLineLoc = pRouteLoc
pRMLineLoc.FromMeasure = 2500
pRMLineLoc.ToMeasure = 3500
```

A *RouteMeasurePointLocation* is a class that uses a single m-value to describe a single position along a route.

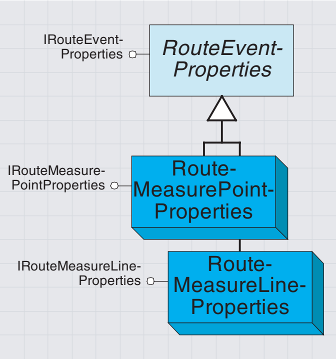
IRouteMeasurePointLocation : IUnknown	***Provides access to point specific route-measure location properties.***
▪━▪ Measure: Double	*The measure value.*

The *IRouteMeasurePointLocation* interface is where you set the route location's m-value. For example, if you wanted to find a location 565.5 meters along route 10, your code would look like this:

```
Dim pRouteLocation As IRouteLocation
Dim pRMPointLoc As IRouteMeasurePointLocation
Set pRouteLocation = New RouteMeasurePointLocation
With pRouteLocation
  .MeasureUnit = esriMeters
  .RouteID = 10
  .LateralOffset = 0
End With
Set pRMPointLoc = pRouteLocation
pRMPointLoc.Measure = 565.5
```

Once you have created a route location, determine its geometry by calling the *IRouteLocator::Locate* method (refer to the examples above to see how the *RouteLocator* object was created).

```
Dim pGeom As IGeometry
Dim LocError As esriLocatingError
pRtLocator.Locate pRMPointLoc, pGeom, LocError
```


IRouteEvent-Properties
RouteEvent-Properties
IRouteMeasure-PointProperties
Route-MeasurePoint-Properties
IRouteMeasureLine-Properties
Route-MeasureLine-Properties

Route event properties are used to identify the characteristics of an event table.

Route-measure line properties are used to specify the characteristics of a line event table.

Route-measure point properties are used to specify the characteristics of a point event table.

An event table is a table that stores route locations and associated attributes. An event, therefore, is a row from an event table. For example, an event may be a speed limit of 110 km/h on route 50 from km 92 to 138. In this case, the route location information of route 50 between km 92 and 138 is used to reference an attribute to a particular portion of a route in a route feature class.

You need to create *RouteEventProperties* in order to identify certain characteristics of the table so that it can be recognized as an event table. *RouteEventProperties* are helper objects for a *RouteEventSource*.

IRouteEventProperties : IUnknown	***Provides access to the properties of an event table.***
■—■ EventMeasureUnit: esriUnits	*The units of the event measures.*
■—■ EventRouteIDFieldName: String	*The route identifier field name.*
■— IsALineEvent: Boolean	*Is a line event.*
■—■ LateralOffsetFieldName: String	*The lateral offset field name.*
← GetSettingError	*The state of the object (see if all the required field names have been set).*

The *IRouteEventProperties* interface establishes the route key field, the measure units the events were collected in, and (optionally) the lateral offset field.

Note that the route key (*EventRouteIDFieldName*) defined on this interface is related to the *RouteIDFieldName* property on both *IRouteLocator* and *IRouteLocatorName*. This is how events are located along their respective routes.

The *EventRouteIDFieldName* does not have to have the same name as the *RouteIDFieldName*, but it must store similar data.

RouteMeasureLineProperties is a class used to specify the characteristics of a line event table.

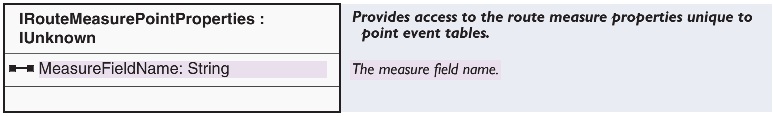
IRouteMeasureLineProperties : IUnknown	***Provides access to the route measure properties unique to line event tables.***
■—■ FromMeasureFieldName: String	*The from-measure field name.*
■—■ ToMeasureFieldName: String	*The to-measure field name.*

The *IRouteMeasureLineProperties* interface is where you identify the line event table's from- and to-measure fields. Each line event's measures reflect the distance from the lowest measure along its route. To set up line event properties where your table has an offset field, your code would look like this:

```
Dim pRtProp As IRouteEventProperties
Dim pRMLineProp As IRouteMeasureLineProperties
Set pRtProp = New RouteMeasureLineProperties
With pRtProp
  .EventMeasureUnit = esriMeters
  .EventRouteIDFieldName = "rKey"
  .LateralOffsetFieldName = "Offset"
End With
Set pRMLineProp = pRtProp
```

```
pRMLineProp.FromMeasureFieldName = "fmp"
pRMLineProp.ToMeasureFieldName = "tmp"
```

RouteMeasurePointProperties is a class used to specify the characteristics of a point event table.



IRouteMeasurePointProperties : IUnknown

MeasureFieldName: String

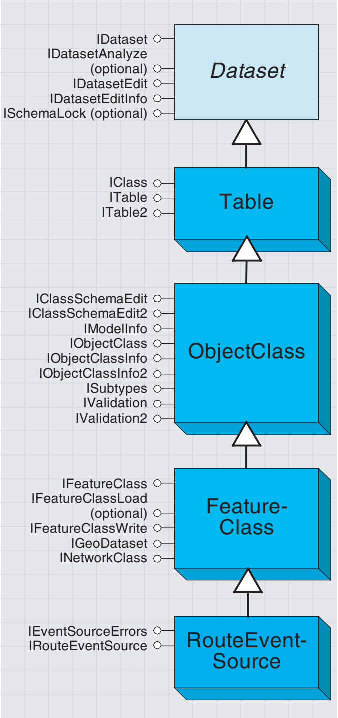
Provides access to the route measure properties unique to point event tables.

The measure field name.

The *IRouteMeasurePointProperties* interface is where you identify the point event table's measure field. Each point event's measure reflects the distance from the lowest measure along its route. To set up point event properties on a table where you have no offset field, your code would look like this:

```
Dim pRtProp As IRouteEventProperties
Dim pRMPointProp As IRouteMeasurePointProperties
Set pRtProp = New RouteMeasurePointProperties
With pRtProp
  .EventMeasureUnit = esriMeters
  .EventRouteIDFieldName = "rKey"
End With
Set pRMPointProp = pRtProp
pRMPointProp.MeasureFieldName = "mile"
```

RouteEventSource coclass



A route event source serves an event table as a "dynamic" feature class.

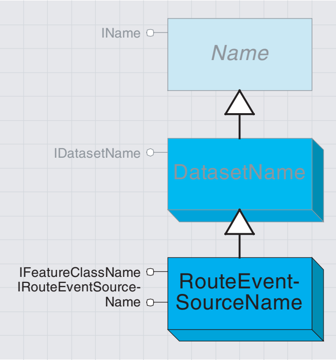
A *RouteEventSource* serves an event table as a "dynamic" feature class. Every row in the table is served as a feature whose shape is calculated on the fly every time it is asked for. This is dynamic segmentation.

IRouteEventSource : IUnknown	***Provides access to the route event source properties.***
EventProperties: IRouteEventProperties	*The route event properties.*
EventTable: ITable	*The table of containing route events.*
ExpandDistance: Double	*The distance used to expand spatial searches for laterally offset events.*
RouteLocator: IRouteLocator	*The route locator.*

In order to serve an event table as a feature class, a *RouteEventSource* needs to know things such as the event table, the *RouteEventProperties*, and the *RouteLocator*. The *IRouteEventSource* interface retrieves this information.

Just like the locator objects outlined earlier, a *RouteEventSource* is created via its name object counterpart, *RouteEventSourceName*.

ROUTEEVENTSOURCENAME COCLASS



A route event source name specifies a route event source object and can be used to instantiate it.

A *RouteEventSourceName* specifies a *RouteEventSource* object and can be used to instantiate it.

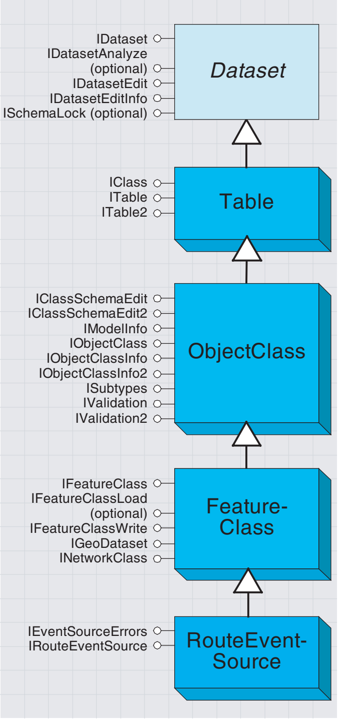
IRouteEventSourceName : IUnknown	Provides access to the route event source name properties.
EventProperties: IRouteEventProperties	The route event properties.
EventTableName: IName	The name object for the table containing route events.
RouteLocatorName: IRouteLocatorName	The name object of the route locator.

The *IRouteEventSourceName* interface sets the event table, the *RouteEventProperties*, and the *RouteLocator*. The following example shows how to create a *RouteEventSource* via a *RouteEventSourceName*. Here, the *RouteMeasurePointProperties* and the *RouteLocatorName* are already created. These values are set using *IRouteEventSourceName*.

```
Dim pDS As IDataset
Dim pName As IName
Set pDS = pEventTable
Set pName = pDS.FullName

Dim pRESN As IRouteEventSourceName
Set pRESN = New RouteEventSourceName
Set pRESN.EventTableName = pName
Set pRESN.EventProperties = pRMPtProp
Set pRESN.RouteLocatorName = pRtLocatorName

Dim pRES As IRouteEventSource
Set pName = pRESN
Set pRES = pName.Open
```

The esriRouteEventError *enumeration represents the errors you can get when trying to open a route event source object.*

Enumeration tagesriRouteEventError	Error codes used by route event classes.
-2147220968 - ROUTEEVENT_E_ROUTEFEATURECLASS_TOO_LARGE	The route feature class is too large.
-2147220969 - ROUTEEVENT_E_CANT_CREATE_ROUTECURSOR	Cannot open a cursor on the route feature class.
-2147220970 - ROUTEEVENT_E_CANT_SELECT	The RouteEventSource doesn't have an OID column.
-2147220971 - ROUTEEVENT_E_EVENTPROPERTY_NOT_CORRECTLY_SETUP	One or more missing event properties.
-2147220972 - ROUTEEVENT_E_NOT_DATASETNAME	The Name must be a dataset name object.
-2147220973 - ROUTEEVENT_E_SOURCENAME_NOT_CORRECTLY_SETUP	The RouteSourceName object has not been correctly setup.
-2147220974 - ROUTEEVENT_E_CANT_CONVERT_RID_STRING	The route identifier value could not be converted to a string.
-2147220975 - ROUTEEVENT_E_INVALID_EVT_LOFIELD	Invalid lateral offset field type.
-2147220976 - ROUTEEVENT_E_CANT_FIND_EVT_LOFIELD	The lateral offset field does not exist in the source table.
-2147220977 - ROUTEEVENT_E_INVALID_EVT_TMFIELD	Invalid to-measure field type.
-2147220978 - ROUTEEVENT_E_CANT_FIND_EVT_TMFIELD	The to-measure field does not exist in the source table.
-2147220979 - ROUTEEVENT_E_INVALID_EVT_FMFIELD	Invalid from-measure field type.
-2147220980 - ROUTEEVENT_E_INVALID_EVT_MFIELD	Invalid measure field type.
-2147220981 - ROUTEEVENT_E_CANT_FIND_EVT_FMFIELD	The from-measure field does not exist in the source table.
-2147220982 - ROUTEEVENT_E_CANT_FIND_EVT_MFIELD	The measure field does not exist in the source table.
-2147220983 - ROUTEEVENT_E_INVALID_EVT_RIDFIELD	Invalid event route identifier field type.
-2147220984 - ROUTEEVENT_E_CANT_FIND_EVT_RIDFIELD	The event route identifier field does not exist in the source table.
-2147220985 - ROUTEEVENT_E_INVALID_EVENTPROPERTY_OBJECT	The route event property object is invalid.
-2147220986 - ROUTEEVENT_E_NOT_POLYLINEM_FEATURECLASS	The route feature class is not a Polyline with m's feature class.
-2147220987 - ROUTEEVENT_E_INVALID_RIDFIELD	Invalid route identifier field type.
-2147220988 - ROUTEEVENT_E_CANT_FIND_RIDFIELD	The route identifer field does not exist in the route feature class.
-2147220989 - ROUTEEVENT_E_NOT_POLYLINE_FEATURECLASS	The route feature class is not a Polyline feature class.
-2147220990 - ROUTEEVENT_E_LOCATORNAME_NOT_CORRECTLY_SETUP	The RouteLocatorName object has not been correctly setup. Can't create the RouteLocator object.
-2147220991 - ROUTEEVENT_E_NOT_FEATURECLASSNAME	The name must be a feature class name object.



A route event source serves an event table as a dynamic feature class.

Because a *RouteEventSource* is a subclass of a feature class, it can be used anywhere a feature class can be. For example, a *RouteEventSource* can act as the basis of a feature layer in ArcMap, and its attributes can be edited directly with the editing tools in ArcMap.

There may be some limitations imposed by the event table, however. For example, you will not be able to directly edit a feature class created from a delimited text file table since the Editor does not allow text files to be edited directly.

In a *RouteEventSource*, there is one feature for every row of the original event table. In some cases, however, the features have empty shapes. This is because there was some reason the event could not be properly located. Other times, an event can only be partially located (this happens for line events only).

IEventSourceErrors : IUnknown	***Provides access to members that deal with event source errors.***
← GetErrorCursor (in Filter: IQueryFilter) : ICursor	*The cursor of the events with locating errors.*
← GetErrors: IEnumEventError	*The enumerator of the event source errors.*
← GetLocatingErrorOID (in OID: Long) : tagesriLocatingError	*The locating error associated with an event's OID.*
← GetLocatingErrorRow (in Row: IRow) : tagesriLocatingError	*The locating error associated with a row.*

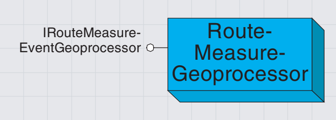
The *IEventSourceErrors* interface exposes some methods that allow you to determine the locating errors of events.

The following example uses *IEventSourceErrors::GetErrors* to create an enumeration of the event rows that did not locate properly.

```
Sub TestGetErrors(pRES As IRouteEventSource)
  Dim pESErrors As IEventSourceErrors
  Dim pEnum As IEnumEventError
  Dim pRow As IRow
  Dim LocError As esriLocatingError
  Set pESErrors = pRES
  Set pEnum = pESErrors.GetErrors
  pEnum.Next pRow, LocError
  Do While Not pRow Is Nothing
    Select Case LocError
      Case 0
       Debug.Print pRow.OID & ": LOCATING_OK"
      Case 1
       Debug.Print pRow.OID & ": LOCATING_E_INVALIDRID"
      Case 2
       Debug.Print pRow.OID & ": LOCATING_E_INVALIDMEASURE"
      Case 3
       Debug.Print pRow.OID & ": LOCATING_E_CANT_FIND_ROUTE"
      Case 4
       Debug.Print pRow.OID & ": LOCATING_E_ROUTE_SHAPE_EMPTY"
      Case 5
       Debug.Print pRow.OID & ": LOCATING_E_CANT_FIND_LOCATION"
      Case 6
```

```
          Debug.Print pRow.OID & ": LOCATING_E_CANT_FIND_EXTENT"
        Case 7
          Debug.Print pRow.OID & ": LOCATING_E_FROM_PARTIAL_MATCH"
        Case 8
          Debug.Print pRow.OID & ": LOCATING_E_TO_PARTIAL_MATCH"
        Case 9
          Debug.Print pRow.OID & ": LOCATING_E_ROUTE_MS_NULL"
        Case 10
          Debug.Print pRow.OID & ": LOCATING_E_ROUTE_NOT_MAWARE"
        Case 11
          Debug.Print pRow.OID & ": LOCATING_E_ROUTE_FROM_TO_PARTIAL_MATCH"
        Case Else
          Debug.Print pRow.OID & ": INVALID_LOCATING_ERROR"
        End Select
      pEnum.Next pRow, LocError
  Loop
End Sub
```

Enumeration tagesriLocatingError	*Locating error codes.*
0 - LOCATING_OK	*Locating was successful.*
1 - LOCATING_E_INVALIDRID	*The route location's route ID is invalid (null, empty or invalid value).*
10 - LOCATING_E_ROUTE_NOT_MAWARE	*The route is not a polyline m aware.*
2 - LOCATING_E_INVALIDMEASURE	*At least one of the route location's measure values is invalid.*
3 - LOCATING_E_CANT_FIND_ROUTE	*The route does not exist.*
4 - LOCATING_E_ROUTE_SHAPE_EMPTY	*The route does not have a shape or the shape is empty.*
5 - LOCATING_E_CANT_FIND_LOCATION	*Could not find route location's shape (the route has no m values or the route location's measures don't exist on the route).*
6 - LOCATING_E_CANT_FIND_EXTENT	*Could not find route location's shape, the from-measure and the to-measure are outside of the route measures.*
7 - LOCATING_E_FROM_PARTIAL_MATCH	*Could not find the entire route location's shape, the from-measure was outside of the route measure range.*
8 - LOCATING_E_TO_PARTIAL_MATCH	*Could not find the entire route location's shape, the to-measure was outside of the route measure range.*
9 - LOCATING_E_ROUTE_MS_NULL	*The route does not have m values or m values are null.*



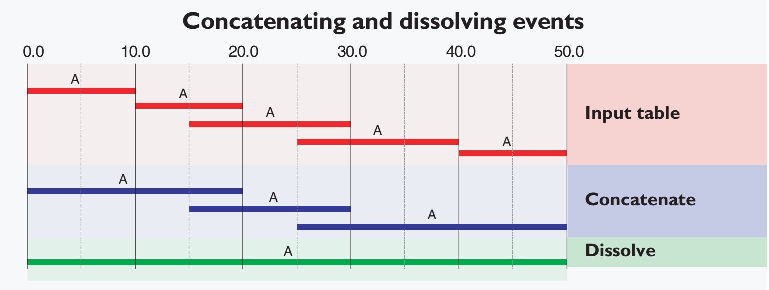
A route measure event geoprocessor provides access to geoprocessing operations on route measure events.

As mentioned previously, a *RouteEventSource* behaves like any other feature class. As such, you can do things like apply spatial queries and perform spatial analysis. Other types of event processing operations include dissolving events, concatenating events, and event overlay (line on line and point on line).

IRouteMeasureEventGeoprocessor : IUnknown	*Provides access to the route measure event geoprocessor properties and methods.*
■—■ BuildOutputIndex: Boolean	*Indicates whether an index is going to be built on the route ID field on the output result.*
■—□ InputEventProperties: IRouteEventProperties	*The input table's route event properties.*
■—□ InputSelection: ISelectionSet	*The input table's selection set.*
■—□ InputTable: ITable	*The input table.*
■—■ KeepZeroLengthLineEvents: Boolean	*Indicates whether zero length events should be included in the overlay result (line-on-line overlays only).*
■—□ OverlayEventProperties: IRouteEventProperties	*The overlay table's route event properties.*
■—□ OverlaySelection: ISelectionSet	*The overlay table's selection set.*
■—□ overlayTable: ITable	*The table to overlay with the input table.*
← Concatenate (in concatenateFields: Variant, in OutputName: IDatasetName, in trackCancel: ITrackCancel, in ConfigKeyword: String) : ITable	*Concatenate events.*
← Dissolve (in dissolveFields: Variant, in OutputName: IDatasetName, in trackCancel: ITrackCancel, in ConfigKeyword: String) : ITable	*Dissolve events.*
← Intersect (in outputProperties: IRouteEventProperties, in OutputName: IDatasetName, in trackCancel: ITrackCancel, in ConfigKeyword: String) : ITable	*Intersect events.*
← Union (in outputProperties: IRouteEventProperties, in OutputName: IDatasetName, in trackCancel: ITrackCancel, in ConfigKeyword: String) : ITable	*Union events.*

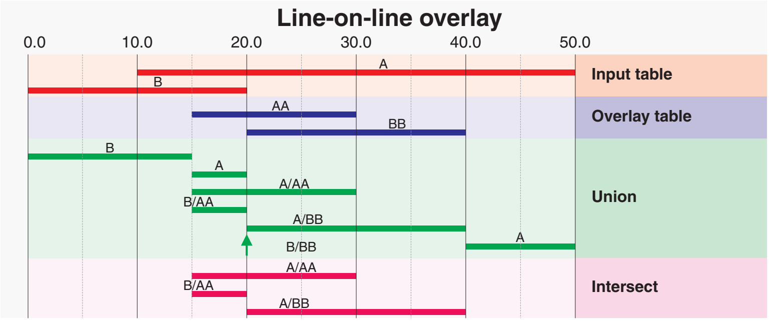
The *IRouteMeasureEventGeoprocessor* interface provides access to the event geoprocessing operations.

Concatenating and dissolving events both combine adjacent records in linear event tables if they are on the same route and have the same value for the dissolve fields.This is useful for breaking up one large (many fields) event table into many skinny tables.



Event dissolving and event concatenating both involve combining records in line event tables if they are on the same route and have the same value for specified fields. The results are written to a new line event table. The difference between dissolving and concatenating is that concatenating only combines events in situations where the to-measure of one event matches the from-measure of the next event. Dissolving events will combine events when there is measure overlap.

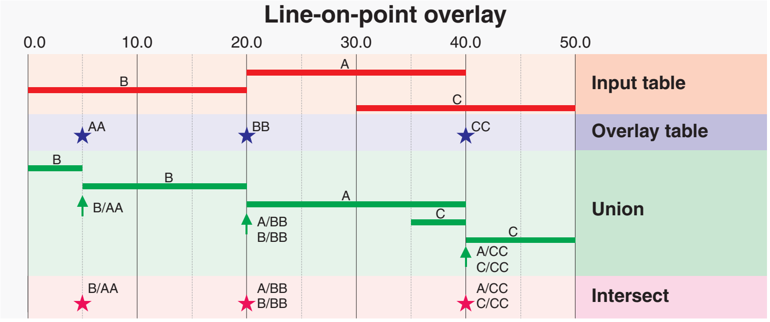
A line-on-line overlay involves the overlay of two linear event tables to produce a single linear event table.



A line-on-line overlay involves the overlay of two line event tables to produce a line event table. For example, you might want to take an event table that describes pavement cracking and overlay it with pavement resurfacing dates. The results of such an overlay could be used to find the characteristics of the oldest paved sections.

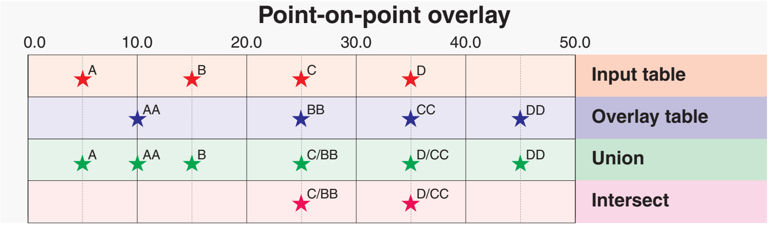
When performing a line-on-line overlay, the results may contain events that have no length (for example, the from- and to-measure values are the same). The *IRouteMeasureEventGeoprocessor::KeepZeroLengthLineEvents* property can be used to indicate whether you want such events in your result set.

A line-on-point overlay involves the overlay of a point event table with a linear event table to produce a single point event table.



A line-on-point overlay involves the overlay of a point event table with a line event table to produce either a point or line event table. The intersection of a point and a line event table produces a point event table. The union of a point and a line event table produces a line event table.

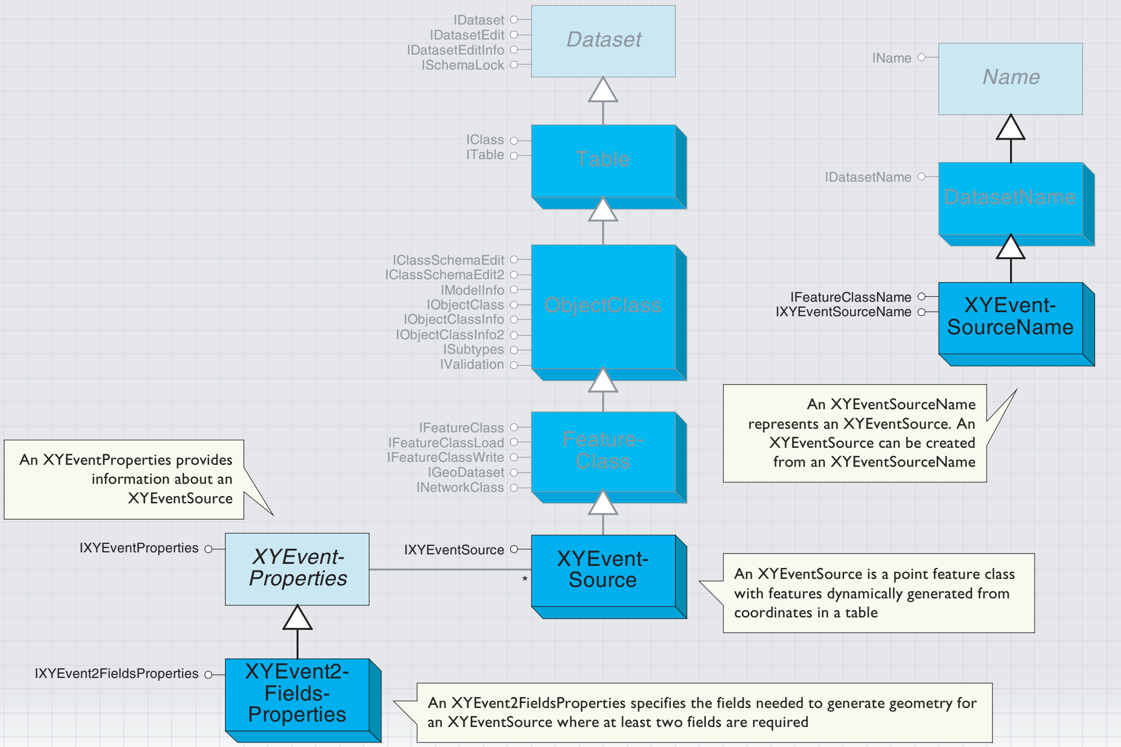
A point-on-point overlay involves the overlay of two point event tables to produce a single point event table.



The following code shows the intersection of a point event table containing highway accident data and a linear event table containing pavement cracking information. The results of such an overlay could be used to analyze the pavement characteristics of accident locations.

```
Public Sub OE_PointOnLineIntersect()

  ' The input table and properties
  Dim pFact As IWorkspaceFactory
  Dim pFeatWS As IFeatureWorkspace
  Dim pPointTable As ITable
  Set pFact = New AccessWorkspaceFactory
  Set pFeatWS = pFact.OpenFromFile("\\rockytop\data\dyndata\oe.mdb", 0)
  Set pPointTable = pFeatWS.OpenTable("accidents")

  Dim pPointProp As IRouteEventProperties
  Dim pPointRMProp As IRouteMeasurePointProperties
  Set pPointProp = New RouteMeasurePointProperties
  With pPointProp
    .EventMeasureUnit = esriUnknownUnits
    .EventRouteIDFieldName = "RKEY"
  End With
  Set pPointRMProp = pPointProp
  pPointRMProp.MeasureFieldName = "location"

  ' The overlay table and properties
  Dim pLineTable As ITable
  Set pLineTable = pFeatWS.OpenTable("pavement")

  Dim pLineProp As IRouteEventProperties
  Dim pLineRMProp As IRouteMeasureLineProperties
  Set pLineProp = New RouteMeasureLineProperties
  With pLineProp
    .EventMeasureUnit = esriUnknownUnits
    .EventRouteIDFieldName = "RKEY"
  End With
  Set pLineRMProp = pLineProp
  With pLineRMProp
    .FromMeasureFieldName = "fmp"
    .ToMeasureFieldName = "tmp"
  End With
  ' Create some output event properties. They must be point because we
  ' are doing an Intersect. They would be line if we were doing a Union.
  Dim pOutputProp As IRouteEventProperties
  Dim pOutputRMProp As IRouteMeasurePointProperties
  Set pOutputProp = New RouteMeasurePointProperties
  With pOutputProp
    .EventMeasureUnit = esriUnknownUnits
    .EventRouteIDFieldName = "RKEY"
  End With
  Set pOutputRMProp = pOutputProp
  pOutputRMProp.MeasureFieldName = "location"

  ' Create a new table name for the output. We'll write the results out to
  ' the same workspace as the input event table
  Dim pTempDS As IDataset
  Dim pTempWs As IWorkspace
  Dim pOutDSN As IDatasetName
  Dim pOutWSN As IWorkspaceName

  Set pTempDS = pPointTable
  Set pTempWs = pTempDS.Workspace
  Set pOutWSN = New WorkspaceName
  pOutWSN.ConnectionProperties = pTempWs.ConnectionProperties
  If pTempWs.Type = esriRemoteDatabaseWorkspace Then
    pOutWSN.WorkspaceFactoryProgID = "esriCore.SdeWorkspaceFactory.1"
  ElseIf pTempWs.Type = esriLocalDatabaseWorkspace Then
    pOutWSN.WorkspaceFactoryProgID = "esriCore.AccessWorkspaceFactory.1"
  Else
    pOutWSN.WorkspaceFactoryProgID = "esriCore.ShapefileWorkspaceFactory.1"
  End If
  Set pOutDSN = New TableName
  Set pOutDSN.WorkspaceName = pOutWSN
  pOutDSN.Name = "Accident_Cracking2"

  ' Set up a RouteMeasureGeoprocessor
  Dim pRMEvtProc As IRouteMeasureEventGeoprocessor
  Set pRMEvtProc = New RouteMeasureGeoprocessor
  With pRMEvtProc
    Set .InputEventProperties = pPointProp
    Set .InputTable = pPointTable
    Set .OverlayEventProperties = pLineProp
    Set .OverlayTable = pLineTable
  End With

  ' Perform the overlay
  Dim pOutTable As ITable
  Set pOutTable = pRMEvtProc.Intersect(pOutputRMProp, pOutDSN, Nothing, "")

End Sub
```

XY Event objects



An XYEventSourceName represents an XYEventSource. An XYEventSource can be created from an XYEventSourceName

An XYEventProperties provides information about an XYEventSource

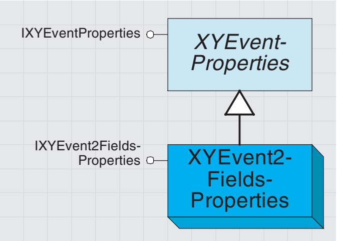
An XYEventSource is a point feature class with features dynamically generated from coordinates in a table

An XYEvent2FieldsProperties specifies the fields needed to generate geometry for an XYEventSource where at least two fields are required

A table that contains a field with x-coordinates and a field with y-coordinates can be used to dynamically create a point feature class using the classes described below.

The feature class is dynamic in that the shapes are generated as needed from data in a source table, rather than accessed from a physical data source.

The source table that contains the coordinates is called the XY event table.



XY event properties provide information about an XY event table.

XYEventProperties is an abstract class that provides information about an XY event table. This information is needed in order to transform the x,y coordinates to point features.

IXYEventProperties : IUnknown	***Provides access to members that define the XY event properties (x,y) of an event table.***
□	

The *IXYEventProperties* interface is implemented by *XYEventProperties* but provides no properties or methods. To access or set this information, you must use the *XYEvent2FieldsProperties* class, which inherits from *XYEventProperties*.

The *XYEvent2FieldsProperties* class provides information for an x,y event table that has fields with x,y (and optionally z) coordinates.

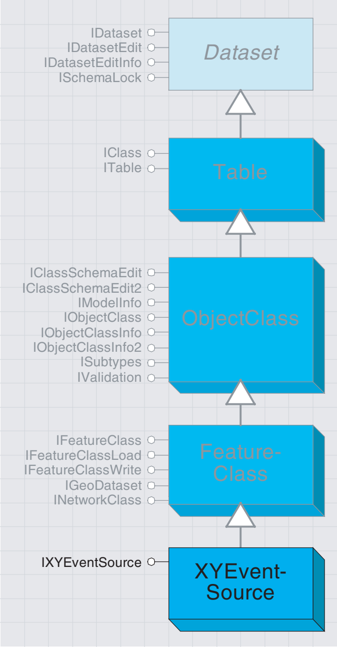
IXYEvent2FieldsProperties : IXYEventProperties	***Provides access to members that define the fields needed to create an XY event layer. A minimum of two fields (x and y) are required.***
XFieldName: String	*The name of the x field.*
YFieldName: String	*The name of the y field.*
ZFieldName: String	*The name of the z field (optional).*

The *IXYEvent2FieldsProperties* interface has properties for specifying the x field name, the y field name, and the z field name. The x and y field name properties are required and must always return valid field names, but the z field name is optional. The number “2” appears in both the class name and the interface name because two of the three fields are required.

This information is used when creating a new feature class and can be returned from an existing dynamic XY feature class.

The fields must have numeric data types. For example, if your coordinates are stored in degrees, minutes, and seconds, you need to convert them to decimal degrees and store them in numeric fields. These numeric fields can then be used to create an XY feature class.

XYEventSource class



An XYEventSource *generates a dynamic feature class from an XY event table.*

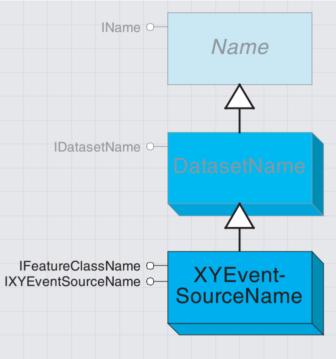
The *XYEventSource* class generates a dynamic feature class from an XY event table. A point, based on the coordinates in the fields specified by *XYEvent2FieldsProperties*, is created for each row in the XY event table.

IXYEventSource : IUnknown	***Provides access to members that allow interaction with an existing XY Event Layer.***
EventProperties: IXYEventProperties	*Property object used to define the x, y, and z location fields.*
EventTable: ITable	*Table used to initialize the XYEventSource.*
RefreshExtent	*Resets the extent of the XYEventSource layer.*

In order to create an *XYEventSource*, you must first create an *XYEventSourceName* object (see the example with *XYEventSourceName*).

Since *XYEventSource* inherits from *FeatureClass*, an *XYEventSource* object can be treated like any other point feature class. It can be added to ArcMap as a point feature layer and even edited directly with the editing tools in ArcMap.

There are some limitations imposed by the XY event table, however. For example, you will not be able to directly edit a feature class created from a delimited text file table since the editing tools don't allow text files to be edited directly. Also, you cannot add or move points using the editing tools. To add or move points, you must edit the coordinates or add new records to the table.



An XYEventSourceName *is used to persist and create new* XYEventSource *objects.*

The *XYEventSourceName* class is used to persist and create new *XYEventSource* objects.

IXYEventSourceName : IUnknown	***Provides access to the XY event source name properties.***
EventProperties: IXYEventProperties	*The XY event properties.*
EventTableName: IName	*The name object for the XY event table.*
SpatialReference: ISpatialReference	*The spatial reference of the XYEventSource.*

When creating a new *XYEventSource*, you must specify the XY event table name and the field names. If the spatial reference is not set and the coordinates are within range, the coordinate system will be assumed to be geographic. Otherwise, it will be unknown. The field names are specified using the *XYEvents2FieldsProperties* object.

The following code shows how to create a new *XYEventSource* from an *XYEventSourceName*.

```
Dim pXYEvent2FieldsProperties As IXYEvent2FieldsProperties
Set pXYEvent2FieldsProperties = New XYEvent2FieldsProperties
With pXYEvent2FieldsProperties
  .XFieldName = "longitude"
  .YFieldName = "latitude"
  .ZFieldName = ""
End With

Dim pSpatialReferenceFactory As ISpatialReferenceFactory
Dim pProjectedCoordinateSystem As IProjectedCoordinateSystem

Set pSpatialReferenceFactory = New SpatialReferenceEnvironment
Set pProjectedCoordinateSystem = pSpatialReferenceFactory._
    CreateProjectedCoordinateSystem (esriSRProjCS_NAD1983UTM_11N)

Dim pXYEventSourceName As IXYEventSourceName
Set pXYEventSourceName = New XYEventSourceName

With pXYEventSourceName
  Set .EventProperties = pXYEvent2FieldsProperties
  Set .SpatialReference = pProjectedCoordinateSystem
  Set .EventTableName = pTableName
End With

Dim pname As IName
Dim pXYEventSource As IXYEventSource
Set pname = pXYEventSourceName
Set pXYEventSource = pname.Open
```

9

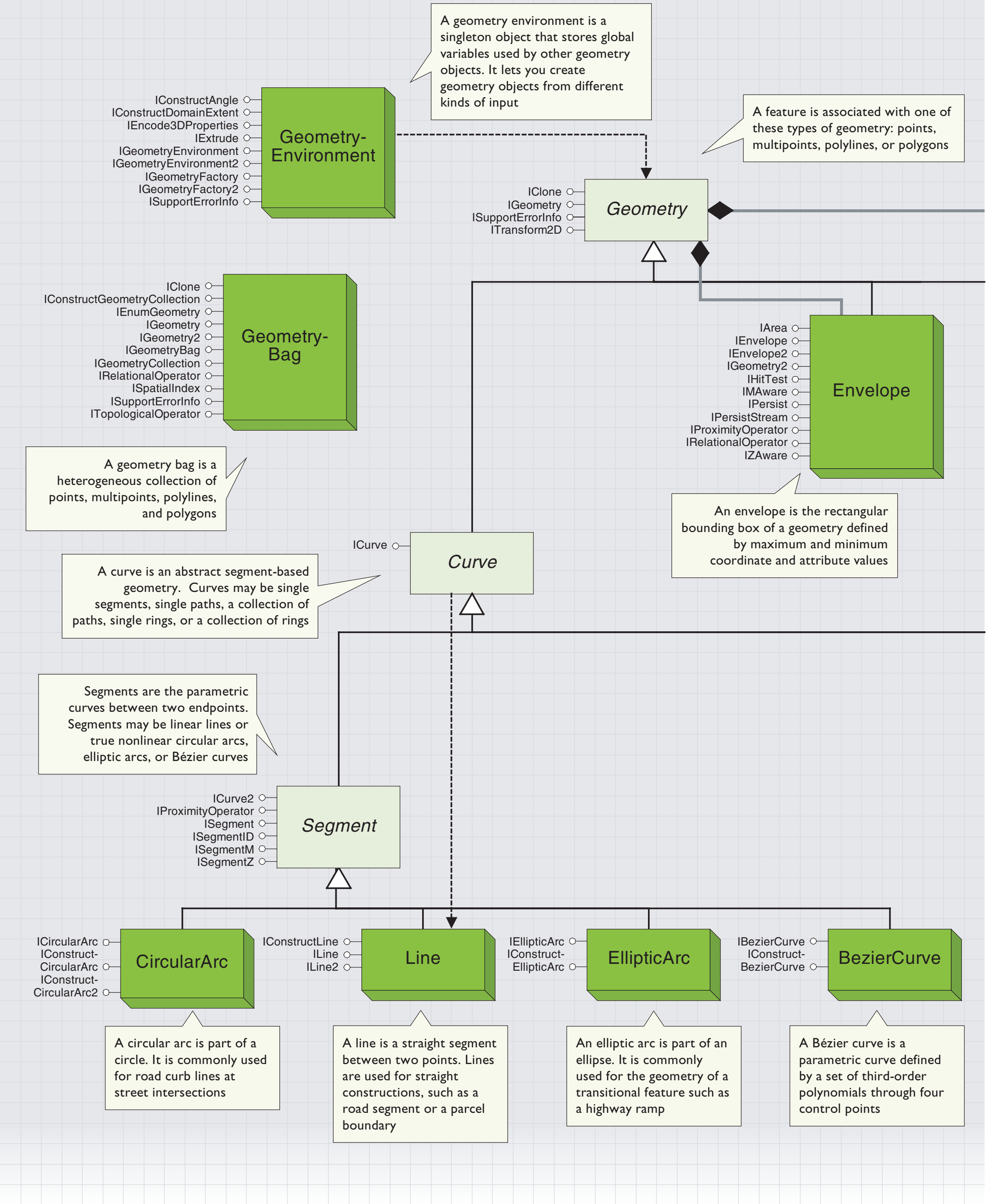
Shaping features with geometry

Shelly Gill

One of the primary data representation models of geography is the vector data model. Discrete features are stored in a geodatabase with a geometry field that contains a precise and compact description of the shape. You can use the geometry object model to manipulate and create features and map elements.

The topics covered in this chapter include: defining shapes with lines, circular arcs, elliptic arcs, and Bézier curves • constructing simple and multipart polylines and polygons with paths and rings • creating points and multipoints • spanning features and sets of features with envelopes • managing the geometry environment and handling collections • adding elevation and measure attributes on geometries • applying spatial and topological operators • using 3D geometry objects

Geometry



A geometry environment is a singleton object that stores global variables used by other geometry objects. It lets you create geometry objects from different kinds of input

A feature is associated with one of these types of geometry: points, multipoints, polylines, or polygons

A geometry bag is a heterogeneous collection of points, multipoints, polylines, and polygons

An envelope is the rectangular bounding box of a geometry defined by maximum and minimum coordinate and attribute values

A curve is an abstract segment-based geometry. Curves may be single segments, single paths, a collection of paths, single rings, or a collection of rings

Segments are the parametric curves between two endpoints. Segments may be linear lines or true nonlinear circular arcs, elliptic arcs, or Bézier curves

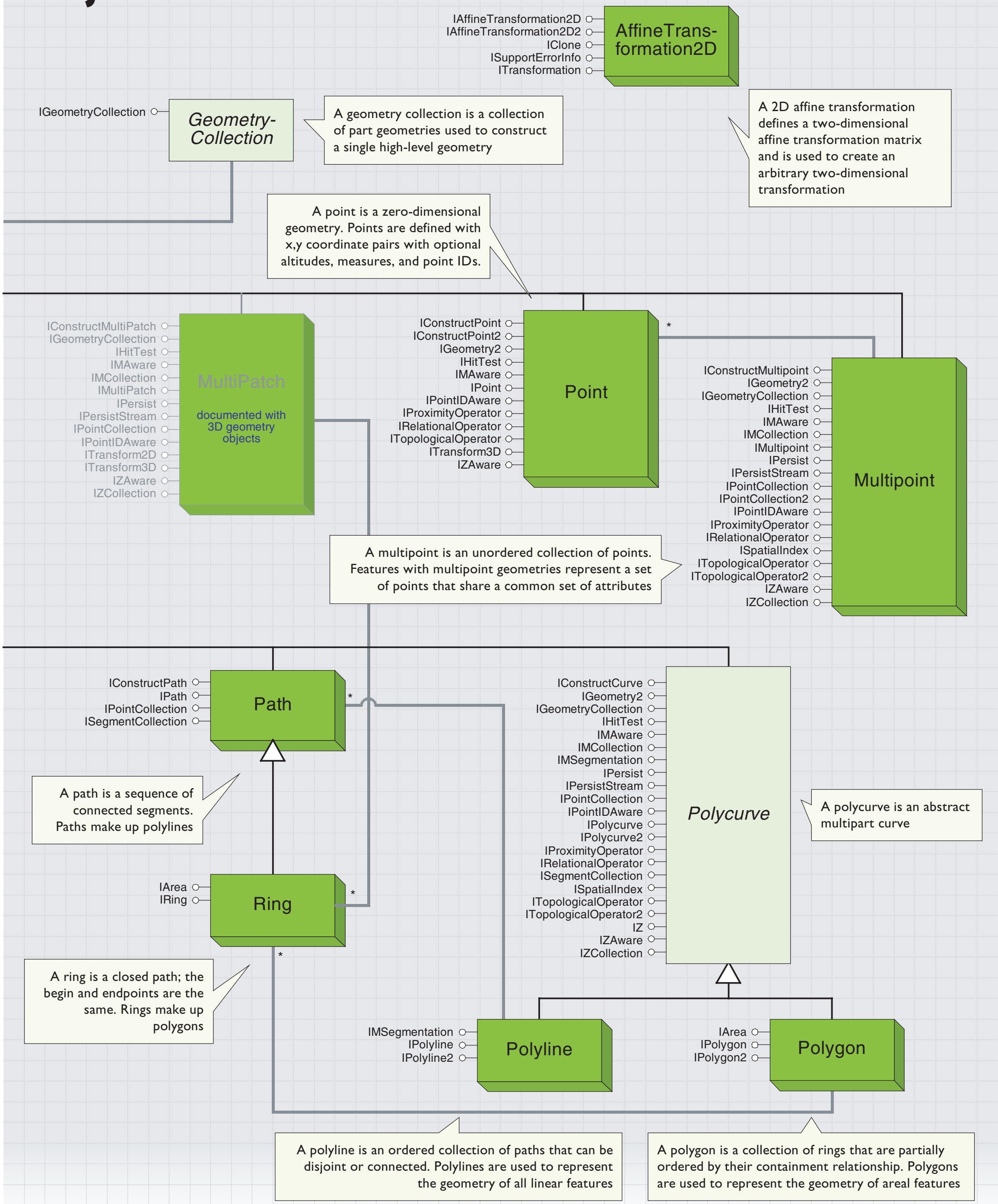
A circular arc is part of a circle. It is commonly used for road curb lines at street intersections

A line is a straight segment between two points. Lines are used for straight constructions, such as a road segment or a parcel boundary

An elliptic arc is part of an ellipse. It is commonly used for the geometry of a transitional feature such as a highway ramp

A Bézier curve is a parametric curve defined by a set of third-order polynomials through four control points

object model



A geometry collection is a collection of part geometries used to construct a single high-level geometry

A 2D affine transformation defines a two-dimensional affine transformation matrix and is used to create an arbitrary two-dimensional transformation

A point is a zero-dimensional geometry. Points are defined with x,y coordinate pairs with optional altitudes, measures, and point IDs.

A multipoint is an unordered collection of points. Features with multipoint geometries represent a set of points that share a common set of attributes

A path is a sequence of connected segments. Paths make up polylines

A polycurve is an abstract multipart curve

A ring is a closed path; the begin and endpoints are the same. Rings make up polygons

A polyline is an ordered collection of paths that can be disjoint or connected. Polylines are used to represent the geometry of all linear features

A polygon is a collection of rings that are partially ordered by their containment relationship. Polygons are used to represent the geometry of areal features

Geometry in ArcObjects is essential when you create, draw, edit, select, and analyze your vector-based geographic data.

These tasks rely on concepts from plane geometry. Those concepts such as "point" and "line" are represented as a set of classes known collectively as geometries. Concepts such as "intersect" and "distance to" are represented as methods and properties on those classes.

Geometries are used throughout other areas of the ArcObjects model, notably geodatabase, spatial reference, symbology, and the editor. Familiarity with these areas will aid the effective use of geometry within ArcObjects.

The following sections will introduce you to the classes that comprise the geometry model. You will be introduced to some common concepts, such as geometric attributes and geometric simplicity, that apply to all geometries. Each topic is covered in more depth later in this chapter.

THE GEOMETRY COCLASSES

Certain geometry coclasses, representing elements of Cartesian geometry, are considered to be "top-level" geometries. These coclasses can be persisted to a *FeatureClass* and may be composed of other geometries. The top-level geometries are:

- A *Point* is a single location in the x,y plane.
- A *Multipoint* is a finite set of locations in the x,y plane.
- An *Envelope* is a rectangle with sides orthogonal to the axes of the x,y plane. It is used to provide a rough but useful approximation of the spatial extent of another geometry. Any given point in the x,y plane is either "in" the *Envelope* or "out" of the *Envelope*.
- A *Polyline* is a sequence of *Points*, called vertices, connected pairwise using *Segments*. A *Segment* is a function that describes a curve from one vertex to the next. For example, a *Line* is a linear *Segment* between two endpoints, and a *CircularArc* is a different kind of *Segment*, as are *EllipticArc*s and *BezierCurve*s. The *Segments* of a single *Polyline* do not have to be all of the same kind. A *Polyline* can have multiple parts, that is, there may be gaps between some of its *Segments*. Any given point in the x,y plane is either "on" or "off" the *Polyline*.
- A *Polygon* is a part of the x,y plane cut off from the rest of the plane by a distinguished *Polyline* called its boundary. Any given point in the x,y plane can always be classified as being "inside" the *Polygon*, "outside" the *Polygon*, or "on the boundary" of the *Polygon*. The boundary of a *Polygon* does not have to be contiguous. For example, a multipart *Polygon* representing a "donut" with a hole has a multipart *Polyline* defining its boundary. As with *Polylines*, *Segments* define the boundary of a *Polygon*.

The *GeometryBag* coclass is not considered to be a top-level geometry; it is a collection of any kind of object that supports the *IGeometry* interface, which is just about every object in the geometry object model including other *GeometryBags*. Geometry bags are used for various operations within ArcObjects, but some operations assume that only certain classes of *Geometry* objects are in the bag. You might find a *GeometryBag* useful as a place to hold a group of shapes during the execution of your code.

Although the geometries discussed above are plane geometries, ArcObjects also implements other geometries that can be classified as 2.5D or spaghetti 3D geometries—these geometries are discussed later in this chapter.

CREATING, CONSTRUCTING, AND USING GEOMETRIES

The geodatabase object model organizes vector-based geographic data as a set of *Features*. A *Feature* is a geographic phenomenon that has a location. The location is represented as an instance of a *Point, Multipoint, Polyline,* or *Polygon*. Note that *Envelopes, Segments, Rings,* and *Paths* cannot represent the location of a *Feature*. When you create a *Feature*, you also need to create a *Geometry* object and associate it with that *Feature*.

Geometry objects are also essential for purposes other than representing GIS data. They are used in spatial selections (the selection rectangle is an *Envelope*), sophisticated cartographic rendering (a thick dashed offset neatline may be defined by a *Polygon* or *Polyline*), annotation editing (the path of splined text is defined by a Polyline containing Bézier curve segments), and many other procedures.

When a geometry is first created, it is empty (*IGeometry::IsEmpty* = *True*)—the object has been instantiated in memory and is of the specified coclass but as yet has no location in the x,y plane. Empty geometries may also be returned from certain functions. For example, an empty *Polygon* returned by performing an intersection on two *Polygons* indicates that the shapes do not overlap. Once created, a *Geometry* may have its location defined and redefined repeatedly and may also become empty.

Throughout this chapter, to “define” a *Geometry* means to give it a location in the x,y plane. For each geometrical coclass, working with existing shapes and creating and defining new shapes is described.

DRAWING GEOMETRIES

All top-level *Geometry* objects can be drawn and printed, either within the ArcObjects framework or outside it. The ArcObjects framework uses *Symbol* objects to draw geometries to a display. You can use a *Symbol* directly whenever you need to redraw the *Geometry*.

Alternatively, you may wish to create a *GraphicElement* to display the *Geometry*, which is persistable and will automatically redraw when the display is refreshed. For more details, refer to Volume 1, Chapter 5, ‘Displaying graphics’.

You may wish to use a *Geometry* outside the context of ArcObjects and draw it directly to a Win32 device context. All geometries provide support for this by implementing the *IWin32Shape* interface, which can be used to produce a list of drawing instructions that can be efficiently turned into Win32 GDI method calls; however, this interface is not available to VB or VBA users. Therefore, the *GeometryDraw* coclass (part of the symbology object model) provides an alternative method.

SELECTIONS, GEODATABASE CURSORS, AND GEOMETRIES

Geometry is an essential component of a *FeatureClass*, telling each *Feature* where it is located. You can perform a spatial query on a *FeatureClass* using a *Geometry* as the spatial criteria and indicating the type of spatial relationship the query *Geometry* and the returned *Feature Geometry* should have. For example, you can specify that all returned *Features* intersect the query *Geometry*. Selecting features is discussed further in Chapter 8, 'Accessing the geodatabase'.

In addition to a query *Geometry*, a *SpatialFilter* also has an *OutputSpatialReference* property. Features resulting from a *SpatialFilter* will have their geometries projected into this specified *OutputSpatialReference*. Furthermore, the query *Geometry* can be defined relative to a third *SpatialReference*. In this case, a projected version of the *Geometry* will be used in order to process the query. Effectively, if you are a client of the geodatabase, you will rarely need to project your data into another *SpatialReference* in order to perform a task.

SPATIAL OPERATIONS

Spatial operations, such as buffer, intersect, union, difference, distance-to, contains, touches, snapping, and so on, should be familiar concepts to any GIS user. Spatial operations such as these can be performed using the topological, relational, proximity, and hit-test functions provided by the Geometry object model. These operations are generally performed by comparing or combining two *Geometry* objects, although a spatial operation on many geometries can be performed using special methods such as *ITopologicalOperator::ConstructUnion*, which constructs a union of numerous *Geometry* objects at once.

THE SPATIAL REFERENCE

ArcObjects Geometry uses a Cartesian planar model. Each *Geometry* object is associated with another COM object, called a *SpatialReference*, which anchors it to a location on the earth and may describe how the geometry has been distorted in order to represent it in a flat Cartesian plane.

The *SpatialReference* has another important responsibility. The location of a geometry cannot be known perfectly on the earth—the coordinates of each vertex contain some imprecision. A simple model for managing this imprecision is to say that all vertices must snap to a finite set of locations, arranged in a grid on a section of the earth's surface (mapped to a plane). A *SpatialReference* describes this grid, and the *IGeometry* interface provides a method (*SnapToSpatialReference*) to move or snap vertices to their closest *SpatialReference* grid locations.

When attempting to perform a spatial operation using two or more geometries—for example, an intersection—the map projection portions of the two associated *SpatialReferences* must be equal. Currently, the precision of the left operand geometry is used in the comparison or operation.

GEOMETRY PARTS

Some geometries are defined as collections of references to other geometries. For example, a *Polyline* is a collection of references to *Path* objects, each of which is a part of the *Polyline*. In turn, *Paths* are composed of references to *Segment* objects. The table below summarizes this collection/part relationship and also indicates which interface should primarily be used to access the items of a collection or geometry.

Coclass	Each part of this shape is a ...	Use this interface to create and edit the shape
Path	Segment	ISegmentCollection
Ring	Segment	ISegmentCollection
Multipoint	Point	IPointCollection or IGeometryCollection
Polyline	Path	IGeometryCollection
Polygon	Ring	IGeometryCollection
TriangleFan	Point	IPointCollection or IGeometryCollection
TriangleStrip	Point	IPointCollection or IGeometryCollection
MultiPatch	TriangleFan, TriangleStrip, or Ring	IGeometryCollection

ATTRIBUTES

Geometries may have z-, m-, and/or ID attributes, each of which is a numerical value. M-attributes are used mainly by *Polyline* geometries to define relative positions along a line and are used in dynamic segmentation routines. Z-attributes can be interpreted as height coordinates for three-dimensional display. The use of the ID attribute is up to the ArcObjects developer, but it can be used to store a foreign key, linking the vertices of geometries to further attribution information in a database.

Topological operations, such as union or intersection, use the following rules to define attributes on the result of the operation. For topological operation C = A.Operation(B), the result geometry C will have the same attributes defined for it that are defined for geometry A. The values of those attributes are determined by linear interpolation from A, where possible. Vertices in C that came strictly from geometry B will have B’s attribute values. For example, consider the operation:

```
pMultipoint = pPolyline1.Intersect(pPolyline2)
```

If *pPolyline1* has m-attributes defined, and *pPolyline2* has m- and ID attributes defined, then *pMultipoint* will have m-attributes defined. Each *Point* in the *Multipoint* will have an m-value assigned to it that represents an m-value linearly interpolated from m-attributes on *pPolyline1*.

SIMPLICITY

Points, Multipoints, Polylines, and *Polygons* can be either simple or nonsimple. A simple geometry is one that meets its definition unambiguously. *Geometry* objects used in topological operations must be simple.

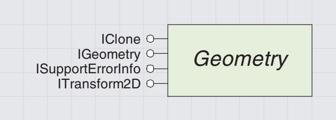
The rules of simplicity are:

- A *Point* is always simple.
- A *Multipoint* is simple if no two of its points have the same x-, y-, z-, m-, and ID values.
- A *Polyline* is simple if each of its *Paths* is not self-intersecting and only touches other *Paths* at *Path* endpoints.

  A coverage with constructed arc topology and no pseudonodes is an example of a simple, multipart *Polyline*. It is not always useful for *Polylines* to meet this definition of simplicity. A bus-route, for example, can have multiple self-intersecting and overlapping parts. Thus, instead of planar simplicity, a *Polyline* can also have “network” simplicity. Such a *Polyline* has no zero length *Segments*, no empty parts, and the *ToPoint* of the i^{th} *Segment* in a part shares the same location as the *FromPoint* of the $i+1^{th}$ *Segment* in the same part. In addition, if only two parts share a common endpoint, those parts are merged into one part. However, all manner of intersections within and between parts is permitted.
- A *Polygon* is simple if each of its *Rings* forms a closed, nonself-intersecting loop and is disjoint from other *Rings*.

ANGLES

Angular properties of geometries are set and returned as radians. Following the standard for Cartesian and polar coordinates, angles are measured from the positive horizontal axis toward the arc. Angles are therefore positive if they define a counterclockwise direction. For example, a horizontal line with a *ToPoint* to the right of the *FromPoint* will have an *Angle* of 0 degrees.



A geometry defines a shape and its spatial location.

A *Geometry* is an abstraction of all the ArcObjects geometrical classes; it defines properties and behavior common to all geometries. The *IGeometry* interface is inherited by all the shape coclasses in ArcObjects.

IGeometry : IUnknown	***Provides access to members that describe properties and behavior of all geometric objects.***
Dimension: tagesriGeometryDimension	*Returns the dimension of this geometry.*
Envelope: IEnvelope	*Creates a copy of this geometry's envelope and returns it.*
GeometryType: tagesriGeometryType	*Returns the type of this geometry.*
IsEmpty: Boolean	*Indicates when this geometry defines an empty point set.*
SpatialReference: ISpatialReference	*The spatial reference associated with this geometry.*
GeoNormalize	*Shift longitudes, if need be, into a continuous range of 360 degrees.*
GeoNormalizeFromLongitude (Longitude: Double)	*Normalize longitudes into a continuous range containing the longitude.*
Project (newReferenceSystem: ISpatialReference)	*Projects this geometry into a new spatial reference.*
QueryEnvelope (outEnvelope: IEnvelope)	*Copies this geometry's envelope properties into the specified envelope.*
SetEmpty	*Makes this geometry equivalent to an empty point set.*
SnapToSpatialReference	*Moves points of this geometry so that they can be represented in the precision of the geometries associated spatial reference system..*

IGeometry is used to provide general information about what kind of shape you have. It is not used to create or define geometries.

In ArcObjects, geometries are most commonly passed in and out of functions by the *IGeometry* interface, allowing the methods and properties to function with any type of shape. For an unknown *IGeometry* object, you might first check to see if the *Geometry* is empty, indicating it is an object that has been created but holds no actual shape yet.

```
If Not pGeometry Is Nothing Then
  If Not pGeometry.IsEmpty Then
    ' Use the Geometry here.
  End If
End If
```

A *Geometry* is empty when first created; its shape has not yet been set. You can delete an existing *Geometry* object's spatial properties by calling *SetEmpty*, which removes the geometric shape of an object but retains the *SpatialReference* (if this has been previously set).

After checking if your *Geometry* has a shape, you might check the *Dimension* to see what class of shape you have.

Dimension gives a higher-level view of the type of Geometry you hold. For example, both a Point and a Multipoint can be symbolized by a MarkerSymbol and have a Dimension of esriGeometry0Dimension. Instead of checking for each case individually, you can use the Dimension property to check for both cases together.

Enumeration tagesriGeometryDimension	***The topological dimension of a geometry.***
1 - esriGeometry0Dimension	*A zero dimensional geometry (such as a point or multipoint).*
-1 - esriGeometryNoDimension	*The dimension is unknown or unspecified.*
2 - esriGeometry1Dimension	*A one dimensional geometry (such as a polyline).*
4 - esriGeometry2Dimension	*A two dimensional geometry (such as a polygon).*
5 - esriGeometry25Dimension	*A 2.5D geometry (such as a surface mesh).*
6 - esriGeometry3Dimension	*A 3D geometry (such as a multipatch).*

Alternatively, you could check the *GeometryType*.

Alternatively, you can also try a QueryInterface to check for a particular geometry interface. For example, a successful QI for IPolycurve indicates you have a Polyline or Polygon. The GeometryType property provides a more exact check, telling you exactly what coclass you have.

Enumeration tagesriGeometryType	*The available kinds of geometry objects*
0 - esriGeometryNull	*A geometry of unknown type.*
1 - esriGeometryPoint	*A single zero dimensional geometry.*
2 - esriGeometryMultipoint	*An ordered collection of points.*
3 - esriGeometryPolyline	*An ordered collection of paths.*
4 - esriGeometryPolygon	*A collection of rings ordered by their containment relationship.*
5 - esriGeometryEnvelope	*A rectangle indicating the spatial extent of another geometry.*
6 - esriGeometryPath	*A connected sequence of segments.*
7 - esriGeometryAny	*Any of the geometry coclass types.*
9 - esriGeometryMultiPatch	*A collection of surface patches.*
11 - esriGeometryRing	*An area bounded by one closed path.*
13 - esriGeometryLine	*A straight line segment between two points.*
14 - esriGeometryCircularArc	*A portion of the boundary of a circle.*
15 - esriGeometryBezier3Curve	*A third degree bezier curve (four control points).*
16 - esriGeometryEllipticArc	*A portion of the boundary of an ellipse.*
17 - esriGeometryBag	*A collection of geometries of arbitrary type.*
18 - esriGeometryTriangleStrip	*A surface patch of triangles defined by three consecutive points.*
19 - esriGeometryTriangleFan	*A surface patch of triangles defined by the first point and two consecutive points.*
20 - esriGeometryRay	*An infinite, one-directional line extending from an origin point.*
21 - esriGeometrySphere	*A complete 3 dimensional sphere.*

All spatial coordinates have a SpatialReference *as their frame of reference that tells you what those coordinates mean. If a* Geometry *object is part of a* Feature*, the* SpatialReference *property will already hold a reference to the* SpatialReference *of the* FeatureClass *(if set).*

When creating a Geometry *from scratch, you can create an appropriate* SpatialReference *object and set the* SpatialReference *property.*

For more information on coordinate systems, see Chapter 10, 'Managing the spatial reference'.

The *Envelope* property returns the spatial extent of a shape, which is its minimum bounding box. For a single *Point* object, the *Envelope* property has zero area.

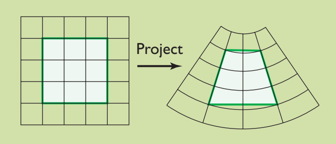
The *SpatialReference* property of a *Geometry* holds a reference to an *ISpatialReference* object, which acts as metadata for the *Geometry*, indicating the coordinate system used by the coordinates of the *Geometry*. Changing the *SpatialReference* property will not change the coordinates of the *Geometry*.

Your spatial data may involve geometries with different coordinate systems, in which case you may wish to actually convert the coordinates of a *Geometry* from one coordinate system to another. Use the *Project* method, which changes the spatial coordinates of your *Geometry* to the new system and sets the *SpatialReference* property to the new system.

To use the *Project* method, first ensure the *SpatialReference* of your *Geometry* is set. Next, create a new *SpatialReference* object indicating the destination coordinate system or use an appropriate existing *SpatialReference*. Then, simply call the *Project* method, and your shape is changed. The code below projects the shape, *pGeometry*, into the *Mercator* projection.

Try using the code on the right to convert a simple Point *geometry from one coordinate system to another. You will see how its coordinates have changed after the* Project *method is called.*

```
Dim pGeometry As IGeometry
' Set pGeometry's shape and SpatialReference here.
Dim pFactory As ISpatialReferenceFactory2
Set pFactory = New SpatialReferenceEnvironment
Dim pNewSR As ISpatialReference
Set pNewSR = _
   pFactory.CreateProjectedCoordinateSystem(esriSRProjCS_World_Mercator)
pGeometry.Project pNewSR
```



This simple polygon retains its number of vertices and straight line segments after projection.

Note that a projected *Geometry* retains its characteristics. For example, an *Envelope* remains rectangular, a *Line* remains linear, a *CircularArc* remains circular, and so on. You may wish to create a different shape

Before projecting a shape, you may wish to densify it. Densification is a process that adds additional vertices to a shape, without changing the characteristics of the shape.You may find that projecting the densified shape gives the effect you require.

after a projection, for example, turn an *Envelope* into a *Polygon* by creating a *Polygon* that has the same shape as the *Envelope* and then using the *Polygon* to perform the projection.

The *SpatialReference* model used by ArcObjects includes a precision value. You can correct a geometry's coordinates to account for this precision by calling *SnapToSpatialReference*. This method can only be called if the *Geometry* has a *SpatialReference* that has a precision set (see the *HasXYPrecision* property and *SetDomain* method in Chapter 10, 'Managing the spatial reference').

Geonormalize and *GeonormalizeFromLongitude* are methods used internally by the *Project* method for horizon-line clipping on geometries in a geographical coordinate system.

IGeometry2 : IGeometry	***Provides access to members that extend the IGeometry interface.***
← ProjectWithGeoTransformation (newReferenceSystem: ISpatialReference, Direction: tagesriTransformDirection, pGeoTransformation: IGeoTransformation)	*Project geometry and apply a GeoTransformation.*

The *IGeometry2* interface provides a more powerful version of the *IGeometry::Project* method. *ProjectWithGeoTransformation* projects a geometry by using a geographic transformation, also known as a datum shift. If the current and destination spatial references involved in a *Project* method are based on different geographic coordinate systems, you can use this method to incorporate a datum shift into the projection operation. This datum shift will increase the accuracy of the operation.

This method is still applicable if the *SpatialReference* is a projected coordinate system, as each projected coordinate system is based on an underlying geographic coordinate system.

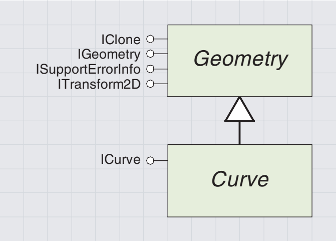
Note that geometry errors are returned as a Long *integer, where the lowest bits indicate the geometry error number and the highest bits indicate a COM error constant.*

Invalid property and method calls may raise the following errors. Constants beginning with S indicate that although the function succeeded in producing a result, that result is invalid or unexpected in some way. Constants beginning with E indicate that the operation could not be performed at all.

Enumeration tagesriGeometryError	***Describes why a parameter to a method is incorrect, or why a method could not be completed.***
0 - S_GEOMETRY_OK	
513 - S_GEOMETRY_DEGENERATE	*A geometric construction succeeded but the resulting geometry is degenerate in some way.*
514 - E_GEOMETRY_EMPTYGEOMETRY	*An operation on an empty geometry was attempted.*
515 - E_GEOMETRY_INCONSISTANT_PARAMS	*The operation could not be completed with the information furnished.*
516 - E_GEOMETRY_INVALID_RADIUS	*An arc construction operation was given an invalid radius.*
517 - E_GEOMETRY_INVALID_CHORD	*An arc construction operation was given an invalid chord distance.*
518 - E_GEOMETRY_NONENVELOPE	*The method expected to receive an Envelope object.*
519 - E_GEOMETRY_NONPART	*Something other than a geometry part (point, path, ring) was added to a multipart geometry.*
520 - E_GEOMETRY_ROTATEENVELOPE	*Envelopes cannot be rotated.*
521 - E_GEOMETRY_TRANSFORMENVELOPE	*Envelopes cannot have arbitrary transformations applied to them.*
522 - E_GEOMETRY_WRONGTYPE	*The geometry parameter was of the wrong type for the method.*
523 - E_GEOMETRY_UNKNOWNTYPE	*An unrecognized geometry or segment type was encountered.*
524 - E_GEOMETRY_UNDERCONSTRAINED	*The parameters to a geometric construction did not provide enough information to complete.*
525 - E_GEOMETRY_INVALID_ANGLE	*An arc construction operation was given an invalid angle.*
526 - E_GEOMETRY_NONPATH	*Something other than a path or ring was added to the parts collection of a polygon or polyline.*
527 - E_GEOMETRY_NONSEGMENT	*Something other than a segment (line, circular arc, bezier curve, etc) was added to the segments collection of a path or ring.*
528 - E_GEOMETRY_NONPOINT	*Something other than a point was added to the points collection of a multipoint.*
533 - E_GEOMETRY_INCONSISTANT_SPATIAL_REFERENCE	*Input geometries do not have same spatial reference.*
535 - E_GEOMETRY_PARTNOTFOUND	*The part could not be found in the geometry.*
536 - E_GEOMETRY_NOTSIMPLE	*The operation cannot be performed on a non-simple geometry.*
537 - E_GEOMETRY_INTERIORPART	*An exterior part must be specified.*
540 - E_GEOMETRY_BAD_SPLIT_DISTANCE	*The specified splitting distance is not included in the curve to be split.*
541 - E_GEOMETRY_NULL	*A null geometry does not correspond to any ESRI geometry type.*
542 - E_GEOMETRY_CANT_RESHAPE	*The geometry cannot be reshaped using the specified polyline.*
543 - E_GEOMETRY_NONPOLYGON	*Something other than a polygon was encountered.*
544 - E_GEOMETRY_NONPOLYLINE	*Something other than a polyline was encountered.*
545 - E_GEOMETRY_NONGEOMETRY	*Something other than a geometry was encountered.*
547 - E_GEOMETRY_EQUAL_VERTEX_ATTRIBUTES	*The From and To attributes of the segment are equal.*
549 - E_GEOMETRY_CANT_QUERY_ON_VERTEX_ATTRIBUTES	*Can't query based on the given attribute values.*
550 - E_GEOMETRY_NO_VALID_VERTEX_ATTRIBUTES	*No vertex attributes of the specified type or attribute is NaN.*
551 - E_GEOMETRY_UNDEFINED_SPATIAL_REFERENCE	*Both spatial references must exist.*
553 - E_GEOMETRY_INCONSISTANT_DIMENSIONS	*Input geometries do not have same spatial reference.*
556 - E_GEOMETRY_SIMPLIFYFAILED	*Something went wrong in Polygon/Polyline simplification.*
558 - E_GEOMETRY_PROJECTDATUM	*The project method cannot do a datum transformation.*
559 - E_GEOMETRY_FILLET_FAILED	*The fillet could not be constructed according to specs.*
560 - E_GEOMETRY_INVALID_AXES	*An elliptic arc construction operation was given invalid axes.*
561 - E_GEOMETRY_CANT_CUT_POLYGON	*A cut operation could not classify all parts of the polygon as being left or right of the cutting polyline.*
562 - E_GEOMETRY_BADRELATION	*The Relate operator couldn't evalute the specified relation expression.*
563 - S_GEOMETRY_HAS_NL_SEGMENTS	*Non linear segments were detected while exporting this geometry to an ESRI shapefile buffer.*
564 - E_GEOMETRY_NOT_Z_AWARE	*The geometry is not Z-aware.*
565 - E_GEOMETRY_NOT_M_AWARE	*The geometry is not M-aware.*
566 - E_GEOMETRY_SEGMENTGRAPH_CANTLOAD	*A SegmentGraph can only organize polyline and polygon objects.*
567 - E_GEOMETRY_SEGMENTGRAPH_CONSTRUCTERROR	*The geometries could not be topologically structured.*
568 - E_GEOMETRY_OUT_OF_BOUNDS	*The coordinates of this geometry are out of bounds.*
569 - E_GEOMETRY_INTERNALERROR	*An internal error has occurred in the geometry system.*
570 - E_GEOMETRY_TOOMANYPOINTS	*This operation produced too many points.*
571 - E_GEOMETRY_BUFFEROUTOFBOUNDS	*The buffer coordinates are out of bounds.*
572 - E_GEOMETRY_OUTOFMEMORY	*There is not enough memory.*
573 - E_GEOMETRY_RELATIONSYNTAXERROR	*The relation expression string has a syntax error.*
574 - E_GEOMETRY_UNKNOWNERROR	*An unknown error has occurred in the geometry system.*
575 - E_GEOMETRY_NOPENDINGMOVETO	*The SegmentGraphCursor has no unfinished MoveTo operation.*
576 - E_GEOMETRY_NOT_ID_AWARE	*The geometry is not ID-aware.*
577 - E_GEOMETRY_ILLEGALWIN32EXPORT	*get_Win32ShapeSize was not called first on this geometry.*
578 - E_GEOMETRY_CONSTRUCTPOINTUNION	*Can't use ConstructUnion on a point.*
579 - E_GEOMETRY_BEZIER_EXTEND_EMBEDDED	*ExtendEmbedded not implemented for Bezier curves.*
580 - E_GEOMETRY_NOT_Z_SIMPLE	*The geometry has some Z values that are empty (NaN).*
581 - E_GEOMETRY_NOT_M_SIMPLE	*The geometry has some M values that are empty (NaN).*
582 - E_GEOMETRY_INVALIDCONSTRUCTION	*The same segment or part has been added to this geometry more than once.*
583 - S_GEOMETRY_DATUMCONVERSIONATTEMPTED	*The source and destination coordinate systems of a Project were different geographic systems.*
584 - S_GEOMETRY_EMPTY_GEOMETRY	*A (successful) operation on an empty geometry was performed.*
585 - E_GEOMETRY_NONMULTIPATCH	*Something other than a multipatch was encountered.*
586 - E_GEOMETRY_UNDEFINEDRING	*The multipatch contains a ring that is invalid or has an undefined type.*
587 - E_GEOMETRY_INVALIDRINGTYPE	*The given ring is not of the required type within the multipatch. (For example an inner ring may be used where an outer ring is required.)*
588 - E_GEOMETRY_AMBIGUOUSPARTTYPE	*The operation would result in the creation of a new part, but the type of part was ambiguous.*
589 - E_GEOMETRY_INVALIDRINGORDER	*The ordering of rings and types is invalid. (For example, an inner ring may not have an outer ring.)*
590 - E_GEOMETRY_INVALIDCOUNT	*The number of items specified is too high or too low in the given context.*
591 - E_GEOMETRY_EXTERIORPART	*An interior part must be specified.*
592 - E_GEOMETRY_NONTRIANGLESTRIP	*The input interface does not belong to a triangle strip object.*
593 - E_GEOMETRY_NONTRIANGLEFAN	*The input interface does not belong to a triangle fan object.*
594 - E_GEOMETRY_NONVECTOR3D	*The input interface does not belong to a 3-dimensional vector.*
595 - E_GEOMETRY_DEGENERATEGEOMETRY	*The operation could not be performed because the object was geometrically degenerate.*
596 - S_GEOMETRY_GEOMETRY_NOT_PROJECTED	*The geometry could not be projected, it has been set empty.*

You can use the following function to return the geometry error constant number from a Long integer error number (reported by the VB Err object)

```
Function ErrorNo(lErrorNumber) _
    as Long
  ErrorNo = (lErrorNumber Mod _
    &H10000) - &HFFFF0000
End Function
```



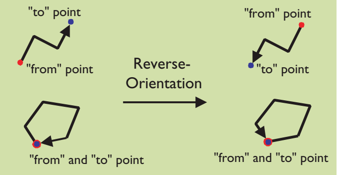
A curve returns information about an ArcObjects one-dimensional shape or the boundary of a two-dimensional shape.

A *Curve* abstract class represents a high-level view of a one-dimensional, or boundary of a two-dimensional, geometry. The *Polygon, Polyline, Ring, Path, Line, BezierCurve, EllipticArc,* and *CircularArc* coclasses can all be represented by curves and therefore implement the *ICurve* interface.

ICurve : IGeometry	***Provides access to members that control properties of curves which describe how to get from a 'from' point to a 'to' point.***
FromPoint: IPoint	*The 'from' point of the curve.*
IsClosed: Boolean	*Indicates when 'from' and 'to' points (of each part) are identical.*
Length: Double	*The length of the curve.*
ToPoint: IPoint	*The 'to' point of the curve.*
GetSubcurve (fromDistance: Double, toDistance: Double, asRatio: Boolean, out outSubcurve: ICurve)	*Extracts a portion of this curve into a new curve.*
QueryFromPoint (from: IPoint)	*Copies this curve's 'from' point to the input parameter.*
QueryNormal (Extension: tagesriSegmentExtension, distanceAlongCurve: Double, asRatio: Boolean, Length: Double, Normal: ILine)	*Constructs a line normal to a curve from a point at a specified distance along the curve.*
QueryPoint (Extension: tagesriSegmentExtension, distanceAlongCurve: Double, asRatio: Boolean, outPoint: IPoint)	*Copies to outPoint the properties of a point on the curve at a specified distance from the beginning of the curve.*
QueryPointAndDistance (Extension: tagesriSegmentExtension, inPoint: IPoint, asRatio: Boolean, outPoint: IPoint, distanceAlongCurve: Double, distanceFromCurve: Double, bRightSide: Boolean)	*Finds the point on the curve closest to inPoint, then copies that point to outPoint; optionally calculates related items.*
QueryTangent (Extension: tagesriSegmentExtension, distanceAlongCurve: Double, asRatio: Boolean, Length: Double, tangent: ILine)	*Constructs a line tangent to a curve from a point at a specified distance along the curve.*
QueryToPoint (to: IPoint)	*Copies the curve's 'to' point into the input parameter.*
ReverseOrientation	*Reverses the parameterization of the curve ('from' point becomes 'to' point, etc).*

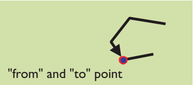
The *ICurve* interface provides information and functionality common to any one-dimensional shape or boundary of a two-dimensional shape. It is not used to create a new *Curve*.

The full *Length* of the constituent parts of the *Curve* can be read. The end vertices of the whole geometry can be found from the *FromPoint* and *ToPoint* properties or from the *QueryFromPoint* or *QueryToPoint* methods. To avoid potential problems with *Polygons* or *Rings*, it is recommended that the *FromPoint* and *ToPoint* properties are used for read-only access for these coclasses.



ReverseOrientation *changes the direction of polylines and rings.*

Use the *ReverseOrientation* method to change the order of vertices in a *Curve*. The *IsClosed* property indicates if the *FromPoint* and *ToPoint* share an identical location and applies to all types of geometries, not just *Polygons*. *Polygons* may have disjoints in their constituent geometries, for example, a gap between two segments in a *Ring*. *IsClosed* does not check for cases like this. To ensure a *Polygon* or *Ring* has no disjoints throughout its entire length, you must ensure it is simple (see the *ITopologicalOperator* interface).



It is possible to construct a polygon or ring that may be closed but not simple. In this case, two segments have "from" and "to" points that join correctly, but there remains a gap. When you construct a geometry like this, test for both IsClosed *and* IsSimple.

When working with the methods of *ICurve*, note the methods that contain an *esriSegmentExtension* parameter. These parameters allow the methods to act on a *Curve* as if it was extended according to the segment extension parameter, without actually changing the geometry.

The *QueryPoint* method allows you to retrieve the location of a *Point* at any specified distance or ratio along a *Curve* or along the extension to the curve if the distance specified is longer than the curve. To return the *Point* at two units along the curve, write code like this:

```
Dim pOutPoint As IPoint
Set pOutPoint = New Point
pCurve.QueryPoint esriNoExtension, 2, False, pOutPoint
```

If you call *QueryPoint* using a distance or ratio longer than the curve using the *esriExtendTangentAtTo* constant, you are returned a *Point* location along the *Tangent* at the *ToPoint* of the *Curve*.

```
pCurve.QueryPoint esriExtendTangentAtTo, 1.2, True, pOutPoint
```

You can also call *QueryPoint* using a negative distance or ratio and an extension that extends the *Curve* from its *FromPoint*, like this code shows:

```
pCurve.QueryPoint esriExtendTangentAtFrom, -0.2, True, pOutPoint
```

The embedded extensions extend a *CircularArc* or *EllipticArc* along the circle or ellipse defined by the *Segment*.

```
pCurve.QueryPoint esriExtendEmbedded, 1.2, True, pOutPoint
```

Enumeration tagesriSegmentExtension	*Describes if, how, and where to extend segments.*
1 - esriExtendTangentAtFrom	*The segment is extended infinitely far along the line tangent to its 'from' point.*
2 - esriExtendEmbeddedAtFrom	*The segment is extended by producing its embedding geometry at its 'from' point (an arc segment's embedding geometry is a complete circle; a line segment's embedding geometry is an infinite line.).*
3 - esriExtendAtFrom	*The segment is extended at its 'from' point, either by tangent or by its embedding geometry).*
4 - esriExtendTangentAtTo	*The segment is extended infinitely far along the line tangent to its 'to' point.*
5 - esriExtendTangents	*The segment is extended infinitely far along lines tangent to both endpoints.*
8 - esriExtendEmbeddedAtTo	*The segment is extended by producing its embedding geometry at its 'to' point (an arc segment's embedding geometry is a complete circle; a line segment's embedding geometry is an infinite line.).*
0 - esriNoExtension	*The segment is not extended.*
10 - esriExtendEmbedded	*The segment is extended by producing its embedding geometry at both endpoints (an arc segment's embedding geometry is a complete circle; a line segment's embedding geometry is an infinite line.).*
12 - esriExtendAtTo	*The segment is extended at its 'to' point, either by tangent or by its embedding geometry).*

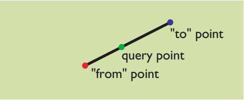
Extension constants *esriExtendAtFrom* and *esriExtendAtTo* are only used to check the extension type internally and are not valid input extension methods, although you can use these constants as bit masks if required.

Extension parameters are also used in methods on *ICurve, IConstructLine, IConstructPoint,* and *IProximityOperator*.

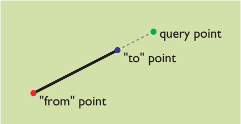
Use the *GetSubcurve* method to duplicate a particular section of any curve based on distance along the curve. For example, for a *Curve* representing a road ten miles long, you can get a second *Curve*, representing that road from five to eight miles, as the following code shows:

```
Dim pNewCurve as ICurve
Set pNewCurve = New Polyline
pCurve.GetSubcurve 5, 8, True, pNewCurve
```

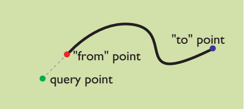
The esriSegmentExtension *constants can be used with the* QueryPoint *method to return points lying on a* Curve *or on an imaginary extension of the* Curve. *Some examples are shown below.*



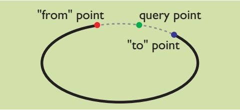
When you use QueryPoint *with* esriNoExtension, *the returned point is forced to lie on the actual* Curve *shape, nearest to the specified distance.*



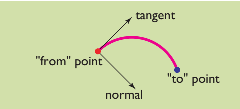
When you use QueryPoint *with* esriExtendTangentAtTo, *the returned point can lie on the tangent of the* ToPoint.



When you use QueryPoint *with* esriExtendTangentAtFrom *and a negative distance, the returned point can lie on the tangent of the* FromPoint.



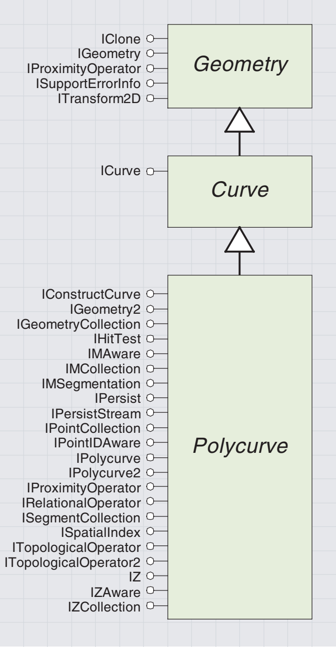
When you use QueryPoint *with* esriExtendEmbedded *on an* EllipticArc *or* CircularArc, *the point can lie along the embedded ellipse or circle.*



The tangent and normal to a curve

A tangent line touches a curve at one single point and has the same slope as the curve at that point. A normal line is perpendicular to a tangent at that point. Tangents and normals at any location on a curve can be identified. The code below sets the shape of a new *Line* object to the tangent and then to the normal of a *Curve* at its start, or *FromPoint*.

```
Dim pGeometry() As IGeometry
GetAllSelectedGeometries pGeometry 'Function in Util.bas

If UBound(pGeometry) > -1 Then
  Dim i As Integer
  Dim pCurve As ICurve
  For i = 0 To UBound(pGeometry)
    Set pCurve = pGeometry(i)
  Next i
End If

Dim pLine as ILine
Set pLine = New Line
pCurve.QueryTangent esriNoExtension, 0, True, 1, pLine
pCurve.QueryNormal esriNoExtension, 0, True, 1, pLine
```



A Polycurve *represents a* Polyline *or the outline of a* Polygon.

SplitPoint *does not need to lie exactly on the* Polycurve *if the second parameter,* projectOnto*, is* True.

The third parameter determines if a new part is created in the Polycurve *at the split point. Note that* CreatePart *should not be* True *for a* Polygon*, as this would result in two open* Rings.

The *Polycurve* abstract class represents the common functionality of a *Polygon* and *Polyline* and is inherited by both coclasses, which have much in common conceptually. Both a *Polygon* and *Polyline* reference a collection of parts, each part being a collection of *Segments*. In the case of a *Polyline*, each part is a valid *Path*, and in the case of the *Polygon*, each part is a *Ring*.

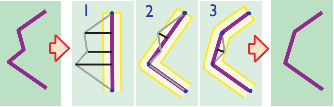
IPolycurve : ICurve	***Provides access to members that define operations common to the polylines and the boundaries of polygons.***
← Densify (maxSegmentLength: Double, maxDeviation: Double)	*Converts this polycurve into a piecewise linear approximation of itself.*
← Generalize (maxAllowableOffset: Double)	*Generalizes this polycurve using the Douglas-Poiker algorithm.*
← Smooth (maxAllowableOffset: Double)	*Converts this curve into a smooth curve containing only Bezier curve segments.*
← SplitAtDistance (Distance: Double, asRatio: Boolean, createPart: Boolean, out SplitHappened: Boolean, out newPartIndex: Long, out newSegmentIndex: Long)	*Introduces a new vertex into this polyline at a specified distance from the beginning of the polyline.*
← SplitAtPoint (splitPoint: IPoint, projectOnto: Boolean, createPart: Boolean, out SplitHappened: Boolean, out newPartIndex: Long, out newSegmentIndex: Long)	*Introduces a new vertex into this polyline at the location on it closest to the input point.*
← Weed (maxAllowableOffsetFactor: Double)	*Generalizes using a small tolerance based upon either the system units of the geometry's spatial reference, or the shape's bounding box.*

The *IPolycurve* interface provides generic shape editing and correction functionality. The *SplitAtDistance* and *SplitAtPoint* methods add a new vertex into a *Polycurve* at the specified distance or *Point*, as shown below. These methods alter the object's shape (unlike the more primitive *SplitAtDistance* and *SplitDivideLength* methods on *ISegment*).

```
Dim bSplit As Boolean, lPart As Long, lSeg As Long
If pPolycurve.GeometryType = esriGeometryPolygon Then
  pPolycurve.SplitAtPoint pSplitPoint, False, False, bSplit, lPart, lSeg
Else
  pPolycurve.SplitAtPoint pSplitPoint, False, True, bSplit, lngPart, lSeg
End If
If bSplit Then
  MsgBox "Split at " & lPart & "(" & lSeg & ")"
Else
  MsgBox "Polycurve not split"
End If
```

Generalization has a general aim of retaining as much information as possible while reducing the amount of raw data needed to convey that information; this improves data access time.

Generalization with the Douglas-Poiker Algorithm



1. A temporary line is constructed joining the "from" point and "to" point of the original line. The distance from each vertex to the temporary line is measured.

2. The vertex farthest away from the original line is added to the temporary line. The distance of each vertex to the temporary line is recalculated.

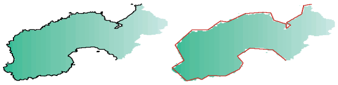
3. This process is repeated until the distance to the vertex farthest away is smaller than the offset parameter. At this point, the original line is set to equal the temporary line.

The *Generalize* method removes vertices from a *Polycurve* according to the Douglas–Peucker generalization algorithm. It is appropriate for thinning those vertices that contribute least to the shape of the line while retaining the characteristics of the shape and is based on a maximum offset value. A generalized line contains only linear segments.

The offset value should be chosen with care, as too large a value can change the shape significantly. Choosing an offset value depends on the characteristics of the line, the "wiggliness", length, shape, and so on, and may be a matter of trial and error. The examples below show a

Polycurve generalized, using as an offset a factor of the Polycurves Length:

```
pPolycurve.Generalize pPolycurve.Length / dblOffset
```

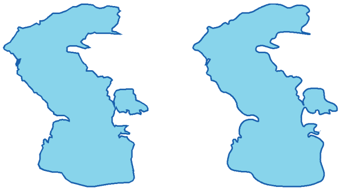


The Generalize *method reduced the number of vertices in this shape from 427 to 29.*

You can find details on the algorithm behind the Generalize *method at Douglas, D.H., and Peucker, T.K. (1973):* Algorithms for the Reduction of the Number of Points Required to Represent a Line or Its Character, The American Cartographer, *10(2), pp. 112–123.*

If all the *Segments* are linear and the offset is equal to zero, the *Polycurve* is unchanged. For a *Polycurve* containing nonlinear *Segments*, the *Generalize* method can be used to produce a linear approximation of the *Polycurve*. In this case, *Generalize* may actually increase the amount of vertices in the line, especially for small offset values—which may be the opposite of your aim.

The *Weed* method is similar to the *Generalize* method. However, the offset you specify is multiplied by a "zero-equivalence" tolerance value based on the geometry's *SpatialReference* units; effectively, this method removes virtually collinear points from a *Polycurve*. It is inappropriate for use on nonlinear *Segments*, as the number of *Segments* may greatly increase.



Smoothing is often used to produce a more aesthetically pleasing shape for a line but will necessarily warp the original shape. Used appropriately, it is a useful method. For example, a lake feature consisting of lines may offer a more realistic shape if smoothed since the actual geographic feature has a curved shape.

The *Smooth* method converts each *Segment* in a *Polycurve* into a *BezierCurve* coclass, retaining the original number of *Segments*. If the offset parameter is zero, the *FromPoints* and *ToPoints* of each *Segment* will also be preserved. The control points of each curve will be complementary to those of the neighboring *Segments*, which produces a smooth flowing shape. In the graphic to the left, a lake feature is smoothed, reducing the number of *Segments,* retaining the shape characteristics, and gaining a smooth appearance. The code used is below.

```
pPolycurve.Smooth pPolycurve.Length / dblOffset
```

Note that if you're using the offset parameter at a constant value, you only need to call one of the following methods: Weed, Generalize, *or* Smooth. *For example, there is no need to call* Weed *before calling* Generalize *with the same offset value, as* Generalize *will remove all the vertices that a preceding call to* Weed *would have removed.*

The *Smooth* method has a maximum offset parameter, which is used in the same way as the offset parameter in *Weed* and *Generalize*. An offset of zero produces a *Polycurve* that has exactly one *BezierCurve* segment for every *Segment* in the original *Polycurve*; greater offset values may change the number of *Segments* in the smoothed *Polycurve*.

If calling *Smooth* on a *Polycurve* that contains nonlinear *Segments*, using a small offset parameter may greatly increase the number of *Segments* in the *Polycurve*.

IPolycurve2 : IPolycurve	***Provides access to members that extend operations common the polylines and the boundaries of polygons.***
← SplitAtDistances (distanceCount: Long, distances: Double, asRatios: Boolean, createParts: Boolean) : IEnumSplitPoint	*Introduces new vertices into this polyline at specified distances from the beginning of the polyline.*
← SplitAtPoints (splitPoints: IEnumVertex, projectOnto: Boolean, createParts: Boolean) : IEnumSplitPoint	*Introduces new vertices into this polyline at the locations on it closest to the input points.*

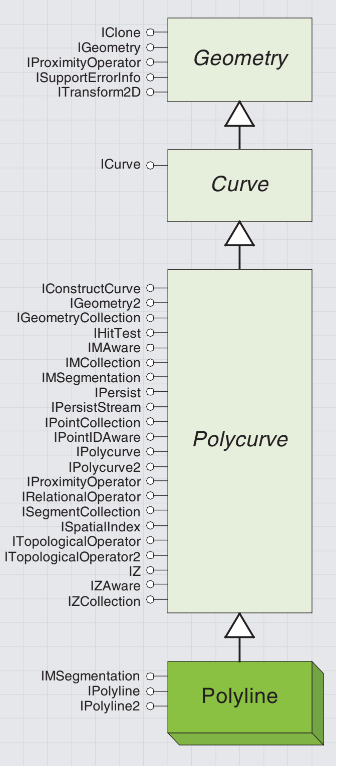
The *IPolycurve2* interface provides *SplitAtDistances* and *SplitAtPoints* methods, which allow you to add multiple vertices to a *Polycurve* in one method call.

For more information on using the IGeometryCollection, ISegmentCollection, *and* IPointCollection *interfaces, see the geometry collection interfaces section in this chapter.*

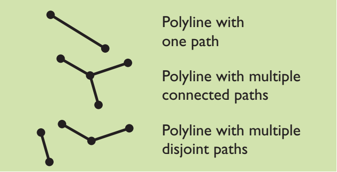
The *Polygon* and *Polyline* coclasses both implement the *IGeometryCollection* interface, which lets you add, change, or remove parts of a *Polyline* or *Polygon*. This interface is the primary interface for defining the shape of a *Polycurve*.

IGeometryCollection allows multipart shapes to be correctly constructed. Each *Geometry* in the *IGeometryCollection* corresponds to a single part of the shape and is referenced in a particular order. The order of parts may affect the result of methods such as *QueryPoint*, which traverses each part in turn to find the point at a specified distance along the *Polycurve*.

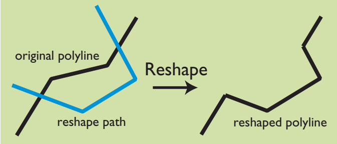
The *ISegmentCollection* interface is implemented by the *Path, Ring, Polyline*, and *Polygon* coclasses and allows access to each *Segment* of any *Polycurve*. The *IPointCollection* interface is also implemented by these coclasses and allows access to each individual vertex of any *Polycurve*. However, neither interface has a concept of multipart shapes, which is an essential concept of *Polygons* and *Polylines*. Therefore, it is recommended that you generally make use of the *ISegmentCollection* or *IPointCollection* interface of a *Polycurve* to query *Segments* or vertices and not add new ones or remove or edit existing ones. The most efficient way to iterate through the constituent parts of a multipart *Polycurve* is to use one of the enumerator classes. A *Segment* enumerator can be obtained from the *ISegmentCollection* interface using the *EnumSegments* method. A vertex enumerator can be obtained from the *IPointCollection* interface using the *EnumVertices* method.



A polyline is a collection of path objects. Polylines are used for feature shapes in networks and routes and for graphic element shapes.


Polyline with one path
Polyline with multiple connected paths
Polyline with multiple disjoint paths

A polyline may consist of many different combinations of connected and disjoint paths.



The Reshape *method modifies a simple, valid polyline to remove intersections with an input path.*

A *Polyline* holds an ordered collection of references to *Path* objects, each *Path* constituting a part of the *Polyline*. A *Polyline* may contain a single *Path*, multiple disjoint *Paths*, or multiple connected *Paths*.

A topologically correct *Polyline* (*IsSimple* = *True*) satisfies the following criteria:

- Each *Path* is valid.
- *Paths* do not overlap, cross themselves, or cross each other.
- Multiple *Paths* may result in a continuous or a disjoint *Polyline* shape.
- *Paths* may contain both curved and linear *Segments*.
- Zero-length *Paths* are not permitted.

For information on network simplicity, see also the *SimplifyNetwork* method.

IPolyline : IPolycurve

Provides access to members that identify a polyline object.

← Reshape (reshapeSource: IPath) : Boolean — *Modifies this polyline by replacing some of its segments with some segments from reshapeSource.*

← SimplifyNetwork — *Performs a simplification that preserves network properties and creates a consistent network geometry.*

The *SimplifyNetwork* method provides a polyline-specific routine, similar to the *ITopologicalOperator::Simplify* method, which implements rules for simplicity more suitable for network applications. Unlike *Simplify*, *SimplifyNetwork* allows *Paths* to intersect and overlap each other and themselves, but will:

- Remove empty or zero-length *Segments* and empty *Paths*.
- Ensure *Segment* orientation is consistent with order (the *ToPoint* of a segment is equal to the *FromPoint* of the succeeding *Segment*).
- Create a new path for discontiguous *Segments* or *Segments* with different attributes, ensuring each *Path* is contiguous.
- Merge parts where exactly two *Paths* share an endpoint.
- For two contiguous *Segments* in a *Path* with a common endpoint (*FromPoint* or *ToPoint*), if one endpoint has nonNaN (“not a number”) z-, m-, or ID attributes, and the other has NaN attributes, these values will be copied to the attributes of the other endpoint. If the endpoints have unequal nonNaN values, the path will be split into two paths at this point.

A *Polyline* can be constructed from scratch by creating a *Path* and adding a reference to this *Path* to the *Polyline* coclass using the *IGeometryCollection* interface. This sequence is repeated until the *Polyline* is complete. When adding *Paths* to a *Polyline* using *IGeometryCollection*, remember these facts:

- Each *Path* must be valid or be made valid by a later call to *Simplify*—for information on creating a valid *Path*, see the *Path* coclass.

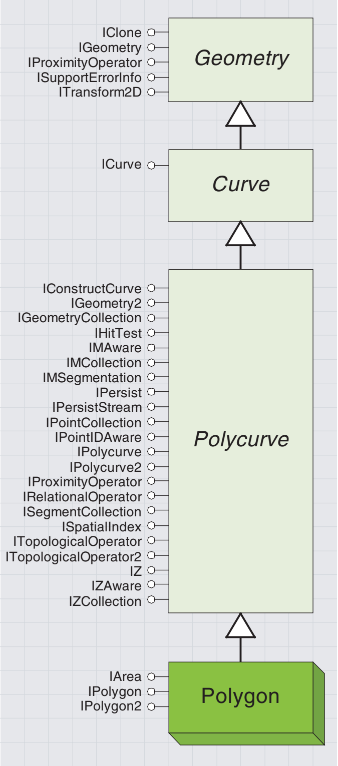
- A *Polyline* is an ordered collection of *Paths*—think about the order in which you add your *Paths* and the direction they travel.
- To ensure the *Polyline* is topologically valid as a whole, call *Simplify* after creating the shape; for a network application, a call to *SimplifyNetwork* would be more appropriate.

For example, if you have four points and want to build up a *Polyline* shape with two parts, you could write code like this:

Note that if you're creating a Polyline *with numerous parts and/or vertices, the array based methods (for example,* AddSegments, AddPoints*) are much more efficient than repeated calls to* AddSegment.

```
Dim pPoint1 As iPoint, pPoint2 As iPoint
Dim pPoint3 As iPoint, pPoint4 As iPoint

Set pPoint1 = New Point
pPoint1.PutCoords 1, 2
Set pPoint2 = New Point
pPoint2.PutCoords 2, 3
Set pPoint3 = New Point
pPoint3.PutCoords 4, 5
Set pPoint4 = New Point
pPoint4.PutCoords 5, 6

Dim pGeometryColl As IGeometryCollection
Set pGeometryColl = New Polyline

Dim pSegmentColl As ISegmentCollection
Set pSegmentColl = New Path

Dim pLine As ILine
Set pLine = New Line
pLine.PutCoords pPoint1, pPoint2
pSegmentColl.AddSegment pLine
pGeometryColl.AddGeometry pSegmentColl

Dim pPathSegments As ISegmentCollection
Set pPathSegments = New Path
Set pLine = New Line
pLine.PutCoords pPoint3, pPoint4
pSegmentColl.AddSegment pLine
pGeometryColl.AddGeometry pPathSegments
```

If you are holding references to any members of the *Polyline*, note the use of the *IGeometryCollection::GeometriesChanged* method, discussed in the geometry collection interfaces section later in this chapter.



A polygon defines a shape that has an area. It may be composed of a single ring or several separate rings.

In ArcObjects, a *Polygon* is an ordered series of *Rings*. A topologically correct *Polygon* (*IsSimple* = *True*) satisfies the following criteria:

- Each *Ring* is valid.
- *Ring* boundaries do not overlap.
- Exterior *Rings* (those defining the outside of a region) are oriented in a clockwise direction. Traveling from the *FromPoint* to the *ToPoint* of the *Ring*, the interior of the *Polygon* is always on the right-hand side.
- Interior *Rings*, which define a hole in a *Polygon*, are oriented in a counterclockwise direction. Traveling from the *FromPoint* to the *ToPoint* of the *Ring*, the interior of the *Polygon* is always on the left-hand side.
- *Rings* with zero area are not permitted.
- Dangling *Segments* or *Paths* are not permitted.

A *Polygon* can be constructed with incorrect topology, and that shape may be used in many circumstances, but not in others. For example, a self-overlapping *Polygon* may be drawn as a graphic element and can also be added as a feature to a shapefile. However, it cannot be added as a feature to a geodatabase because ArcSDE specifies strict rules about *Feature* geometry. Also, it cannot be used in a topological method, as these methods require a simple shape.

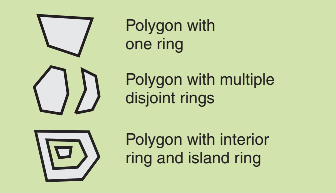
IPolygon : IPolycurve	***Provides access to members that identify a polygon and permit controlled access to its inner and outer rings.***
■— ExteriorRingCount: Long	*Returns the number of exterior rings.*
■— InteriorRingCount (exteriorRing: IRing) : Long	*Returns the number of rings interior to the specified exterior ring.*
←— Close	*Closes all rings in this polygon. The resulting polygon may not be simple.*
←— FindExteriorRing (interiorRing: IRing) : IRing	*Returns the exterior ring containing the specified interior ring.*
←— QueryExteriorRings (exteriorRings: IRing)	*Returns an array of references to all exterior rings.*
←— QueryInteriorRings (exteriorRing: IRing, interiorRings: IRing)	*Returns an array of references to rings that are interior to the specified exterior ring.*
←— SimplifyPreserveFromTo	*Simplify polygon and preserve the 'from' and 'to' points of each ring.*

The *IPolygon* interface presents methods and properties that permit controlled access to a *Polygon*'s *Rings*.

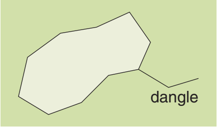
IPolygon2 : IPolygon	***Provides access to members that extend the IPolygon interface.***
←— GetConnectedComponents (numComponentsRequested: Long, out components: IPolygon)	*Returns an array of polygons that represent contiguous components of the original. The rings of the output polygons are references to rings in the original.*
←— GetOutermostComponents (numComponentsRequested: Long, out numComponentsReturned: Long, out components: IPolygon, out moreComponentsExist: Boolean)	*Returns an array of polygons, each of which represents a component of the original and all components within. The rings of the outputs are references to rings in the caller. The number of polygons returned is at most the number of exterior rings.*
←— QueryExteriorRingsEx (numExteriorRingsRequested: Long, out exteriorRings: IRing)	*Returns an array of references to all exterior rings, along with a count of the number of rings returned.*
←— QueryInteriorRingsEx (exteriorRing: IRing, numInteriorRingsRequested: Long, out interiorRings: IRing)	*Returns an array of references to rings that are interior to the specified exterior ring, along with a count of the number of rings returned.*

The *IPolygon2* interface inherits from the *IPolygon* interface, providing improved implementations of some *IPolygon* methods as well as addi-

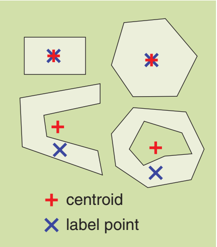
A polygon may be a donut, having an interior ring that defines a hole in the polygon. Interior rings are said to be "embedded" in the exterior ring. A donut polygon may have an island ring, or many islands, within a hole. This "nested" ring relationship may be repeated as required and is referred to as the containment relationship.


Polygon with one ring
Polygon with multiple disjoint rings
Polygon with interior ring and island ring

When constructing shapes to add as features to a feature class, bear in mind that each separate island could be a separate polygon. If you are in doubt as to whether to construct a donut polygon with an island, or two separate polygons, look at their attribution. If the two parts must have the same attributes, they can be constructed as one single polygon feature; if not, construct them as two separate polygon features.



Dangling segments are those that form a dead-end within a shape and are often produced from processes such as digitizing. Dangling segments are not permitted in simplified polygons since adjacency for the segment cannot be calculated correctly.



The Centroid *and* LabelPoint *of a polygon may be identical or different, depending on the exact shape.*

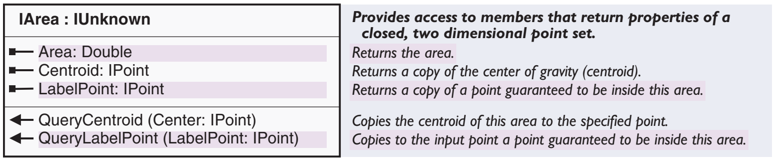
tional methods. The *QueryExteriorRingsEx* and *QueryInteriorRingsEx* should be used in preference to the inherited *QueryExteriorRings* and *QueryInteriorRings* methods.

The *ExteriorRingCount* provides a total count of the exterior *Rings*, while *InteriorRingCount* provides a total of the number of *Rings* that are interior to a particular exterior *Ring*. Below, this method is used with the *QueryExteriorRings* method to find out how many interior *Rings* exist for each exterior *Ring* of a *Polygon* (*pGeom*).

```
Dim pPoly As IPolygon2
Set pPoly = pGeometry

Dim pExtRings() As IRing
ReDim pExtRings(pPoly.ExteriorRingCount - 1) As IRing

Dim lNumRings As Long
lNumRings = pPoly.ExteriorRingCount
pPoly.QueryExteriorRingsEx lNumRings, pExtRings(0)

Dim i As Long
Dim lCount As Long
For i = 0 To UBound(pExtRings)
  lCount = pPoly.InteriorRingCount(pExtRings(i))
  Debug.Print "ExteriorRing " & i & " has " & lCount & " InteriorRings."
Next i
```

QueryInteriorRings can be used to find the actual interior *Rings* inside each exterior *Ring*; conversely, *FindExteriorRing* returns the exterior *Ring* enclosing the specified interior *Ring*.

The *Close* method calls *IRing::Close* for each part of the *Polygon*. The *SimplifyPreserveFromTo* method provides a polygon-specific implementation similar to *ITopologicalOperator::Simplify* (it applies exactly the same topological rules as *Simplify*) but preserves existing *FromPoint* and *ToPoint* locations on each *Ring* in the *Polygon*.



IArea : IUnknown

Provides access to members that return properties of a closed, two dimensional point set.

- Area: Double — *Returns the area.*
- Centroid: IPoint — *Returns a copy of the center of gravity (centroid).*
- LabelPoint: IPoint — *Returns a copy of a point guaranteed to be inside this area.*
- QueryCentroid (Center: IPoint) — *Copies the centroid of this area to the specified point.*
- QueryLabelPoint (LabelPoint: IPoint) — *Copies to the input point a point guaranteed to be inside this area.*

The *IArea* interface provides information relating to two-dimensional shapes. The area property gives the total area of all the parts of the shape. The *Centroid* and *LabelPoint* properties both return weighted center points. *Centroid* gives the true centroid of a single or multipart *Polygon*, which may lie outside of the actual shape. The *LabelPoint* gives an approximate center point that is guaranteed to always lie within the boundary of the shape. It is based on only the first outer *Ring* (and any enclosed inner *Rings*) in a multipart *Polygon*.

A *Polygon* can be constructed by creating a valid *Ring* and adding a reference to this *Ring* to the *Polygon* coclass using the *IGeometryCollection* interface. This sequence is repeated until the *Polygon* is complete.

When constructing a *Polygon* from *Rings*, you could consider the following:

- Each *Ring* must be valid or be made valid by a later call to *Simplify*. For information on creating valid *Rings*, see the *Ring* coclass.
- After completing a *Polygon*, call *Simplify* or *SimplifyPreserveToFrom* to ensure interior and exterior *Rings* are oriented correctly, *Rings* do not overlap, and *Rings* are closed.
- If you expect a call to *Simplify* to have preserved the number of *Rings* and vertices, check these by using the *IPolygon* and *IPointCollection* interfaces.

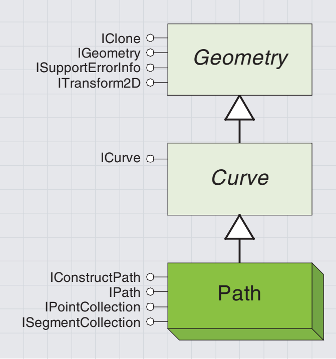
The code below demonstrates one possible way of building a *Polygon* by taking all the *Polygon* or *Path* geometries from an existing geometry enumeration, *pEnumGeom*.

In this code structure, there are references to the same Geometry *objects from both the* pEnumGeom *and the new* Polygon, pPolygon. *If it is necessary for these variables to hold references to entirely separate objects, you should clone the enumeration and then iterate the clone.*

If you decide that you need to preserve the locations of the FromPoint *and* ToPoint *of the parts of a simplified* Polygon, *you can use the* SimplifyPreserveToFrom *method instead of* Simplify. *Note, however, that this method may take longer to complete than the* Simplify *method.*

```
pEnumGeom.Reset

Dim pPolyGeomColl As IGeometryCollection
Set pPolyGeomColl = New Polygon

Dim pGeometry As IGeometry
Set pGeometry = pEnumGeom.Next
Do While Not pGeometry Is Nothing
  If pGeometry.GeometryType = esriGeometryRing Then
    pPolyGeomColl.AddGeometry pGeometry
  ElseIf pGeometry.GeometryType = esriGeometryPolygon Then
    pPolyGeomColl.AddGeometryCollection pGeometry
   End If
  Set pGeometry = pEnumGeom.Next
Loop


Dim pPolygon As IPolygon
Set pPolygon = pPolyGeomColl

pPolygon.SimplifyPreserveFromTo
```

If you are holding references to any members of the *Polygon*, note the use of the *IGeometryCollection::GeometriesChanged* method, discussed in the geometry collection interfaces section later in this chapter.



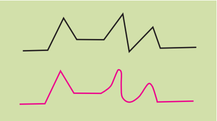
A Path *is a collection of continuous* Segments. Path *objects are the building blocks of* Polylines.

A *Path* holds an ordered collection of references to *Segment* objects. A valid *Path* should have *Segments* that form a continuous shape (the *ToPoint* of the first *Segment* should equal the *FromPoint* of the following *Segment*) and may be a combination of any or all of the *ISegment* objects: *Line, EllipticArc, CircularArc,* and *BezierCurve*.

IPath : ICurve	***Provides access to members that define the properties and specific behavior of a path; a piecewise continuous one dimensional curve.***
← Generalize (maxAllowableOffset: Double)	*Generalizes this path using the Douglas-Poiker algorithm.*
← QueryChordLengthTangents (pointIndex: Long, pPrevTangent: IPoint, pbPrevSetByUser: Boolean, pNextTangent: IPoint, pbNextSetByUser: Boolean)	*Returns tangent vectors (relative to corresponding endpoint) at both sides of a Bezier end point; and whether they have been set by user or by smoothing process.*
← SetChordLengthTangents (pointIndex: Long, pPrevTangent: IPoint, pNextTangent: IPoint)	*Sets tangent vectors (relative to corresponding endpoint) at both sides of a Bezier end point; if either is Nothing, they will be set by smoothing process.*
← Smooth (maxAllowableOffset: Double)	*Converts this path into a smooth approximation of itself that contains only Bezier curve segments.*
← SmoothLocal (pointIndex: Long)	*Converts this path near pointIndex into a smooth path of Bezier curve segments.*

Although invalid Paths *may be created, you will have problems using other* ArcObjects *methods and properties if you are working with an invalid* Path.

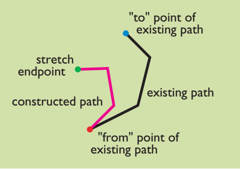
The *IPath* interface has *Generalize* and *Smooth* methods that function similarly to those methods on the *Polycurve* interface but are implemented for a *Path* instead of an entire *Polycurve*. The *IPath* interface also offers the *SmoothLocal* method, which smoothes a *Path* around a certain vertex, changing the existing *Segments* to *BezierCurves* with complementary control points. Below, *SmoothLocal* is applied to a vertex in the center of a *Path*, *pPath*.



Smoothing a certain section of a path is achieved using SmoothLocal. *Up to two* Segments *on either side of the indicated vertex may be changed.*

```
Dim pPointColl As IPointCollection
Set pPointColl = pPath

Dim iPoint As Integer
iPoint = CInt(pPointColl.PointCount / 2)

Dim dPoint As Double
dPoint = 1.2
pPath.SmoothLocal CInt(dPoint)
```

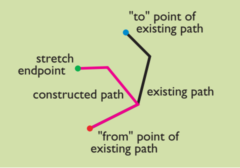
The shape of a *Path* can be defined by adding *Segment* objects to a *Path* object, using the *ISegmentCollection* interface. For more information on this interface, see the section on geometry collection interfaces in this chapter.



Scale and rotate a path using ConstructRigidStretch.

IConstructPath : IUnknown	***Provides access to members that construct a path using other geometries and measures.***
← ConstructRigidStretch (srcPath: IPath, stretchStartIndex: Long, startAnchor: Long, endAnchor: Long, stretchEnd: IPoint)	*Constructs a version of the input path that has been rotated and scaled. The point at stretchStartIndex will end up at stretchEnd.*

For an existing *Path*, the *ConstructRigidStretch* method can be used to rotate and scale the shape of a *Path*, or just a section of the *Path*, to a certain point. This method is ideal for use in interactive rubber-sheeting operations. ArcMap, for example, makes use of this method in the 'Stretch geometry proportionally when moving a vertex' option.



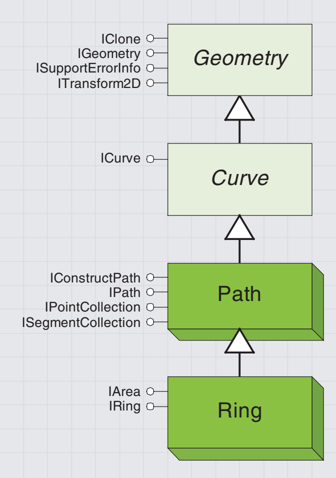
ConstructRigidStretch *can also be used on only part of the path.*

This example scales and rotates an entire path to *pPoint*, *pExistingPath*.

```
Dim pConstructPath As IConstructPath
Set pConstructPath = New Path

Dim pPointColl As IPointCollection
Set pPointColl = pExistingPath

pConstructPath.ConstructRigidStretch pExistingPath, _
  pPointColl.PointCount - 1, 0, 0, pPoint
```

To create a *Path* where the first *Segment* is unchanged, the code could be modified like this:

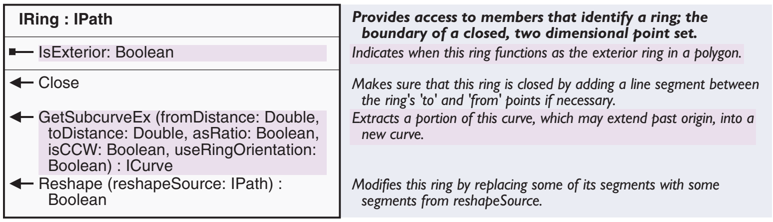
```
pConstructPath.ConstructRigidStretch pExistingPath, _
  pPointColl.PointCount - 1, 0, 1, pPoint
```



A ring is a collection of contiguous segments but, unlike a path, its "from" point and "to" point must share an identical location, creating a closed loop. Ring objects are the building blocks of polygons.

A *Ring* holds an ordered collection of references to *Segment* objects and inherits from *IPath*. However, a *Ring* is only valid if the *FromPoint* and *ToPoint* of the *Ring* share an identical location, creating a closed-loop shape. Invalid *Rings* may be created, particularly while a Ring is being constructed. However, you may find problems working with other methods and properties if you leave a *Ring* in an invalid state permanently. A valid *Ring* satisfies the following criteria:

- It consists of a series of connected segments that are all oriented in the same direction (the *FromPoint* of one *Segment* is the same as the *ToPoint* of the *Segment* before it).
- It is closed (its *FromPoint* and *ToPoint* are identical).
- It does not intersect itself.



IRing : IPath — ***Provides access to members that identify a ring; the boundary of a closed, two dimensional point set.***

IsExterior: Boolean — *Indicates when this ring functions as the exterior ring in a polygon.*

Close — *Makes sure that this ring is closed by adding a line segment between the ring's 'to' and 'from' points if necessary.*

GetSubcurveEx (fromDistance: Double, toDistance: Double, asRatio: Boolean, isCCW: Boolean, useRingOrientation: Boolean) : ICurve — *Extracts a portion of this curve, which may extend past origin, into a new curve.*

Reshape (reshapeSource: IPath) : Boolean — *Modifies this ring by replacing some of its segments with some segments from reshapeSource.*

The segments in a *Ring* can be oriented either clockwise or counterclockwise. The *IsExterior* property, generally used in conjunction with multipart *Polygons*, returns *True* if the *Ring* is oriented clockwise. The *Close* method adds a new *Line* object to an open *Ring*, connecting the first and last points in the *Ring*.

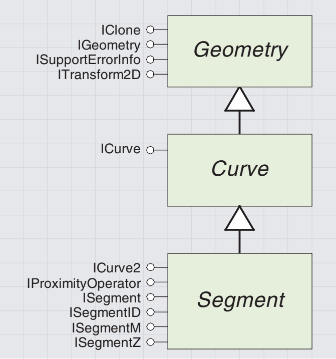
The shape of a *Ring* can be defined by adding *Segment* objects to a *Ring* object using the *ISegmentCollection* interface, as shown in this code.

The ISegmentCollection *interface is discussed further in the geometry collection interfaces section in this chapter.*

```
Dim pSegments As ISegmentCollection, pLine As ILine, pRing as IRing
Set pSegments = New Ring

Set pLine = New Line
pLine.PutCoords pPoint1, pPoint2
pSegments.AddSegment pLine
Set pLine = New Line
pLine.PutCoords pPoint2, pPoint3
pSegments.AddSegment pLine

Set pRing = pSegments
pRing.Close
```

The *GetSubcurveEx* method provides a path-specific method similar to the inherited *GetSubcurve* but that allows the orientation of the resultant *Curve* to be specified. This may mean that the resultant *Curve* straddles the *FromPoint* and *ToPoint* of the *Ring*.

The *Reshape* method provides a similar method to the *IPolyline::Reshape* method, allowing you to reshape a *Polygon* one *Ring* at a time.



A Segment *is a one-dimensional shape consisting of a single parameterized line joining a start and endpoint. It can exist by itself but is more commonly used as a part of a* Polyline *or* Polygon*. For example, a* Feature *in a line* FeatureClass *contains* Polylines*, and each* Polyline *may have one or more* Segments*.*

The Segment *abstract class also provides primitive line splitting and densification methods, although it is most likely that the line splitting and densification functionality available on the high-level geometry classes may be more suitable for the average user.*

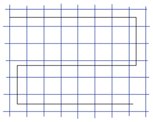
A *Segment* represents a single-part primitive line shape joining two vertices. It is defined by a start point, endpoint, and a formula describing the line between the two points.

The *Segment* may be linear, based on a *Line* coclass, or nonlinear (curved), based on a *BezierCurve, CircularArc,* or *EllipticArc* coclass. Each of the *Segment* coclasses can exist as a standalone object. They can also be used as building blocks to create a *Path, Ring,* or *Polycurve.*

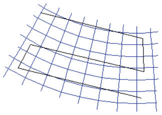
A *Segment* may have z-coordinates, measures, or IDs, which are discussed throughout this section and in the geometry attributes section of this chapter.

ISegment : ICurve	***Provides access to members that identify a segment; a non-piecewise function which defines how to travel from a 'from' point to a 'to' point.***
■— VertexAttributeAware (attributeType: esriGeometryAttributes) : Boolean	*Indicates the segment's awareness of the specified attribute type.*
← ConvertDistanceMeasureToRatio (in distanceMeasure: Double, pRatio: Double)	*Converts the distance measure to a ratio of the total distance.*
← Densify (cNewSegments: Long, maxDeviation: Double, cOutSegments: Long, ppSegments: ILine)	*Densify segment into the specified number of smaller segments.*
← EnvelopeIntersection (pEnvelope: IEnvelope, boundaryOverlap: Boolean, segmentParams: Double, envelopeDistances: Double, pcIntersection: Long, out pOutcode: Long)	*Finds intersections with clipping envelope; boundaryOverlap is ignored for non-linear segments.*
← GeographicShift (splitLongitude: Double)	*Shift longitudes to the right of splitLongitude.*
← GetDistanceAtVertexAttribute (attributeType: esriGeometryAttributes, attributeValue: Double, asRatio: Boolean) : Double	*Gets the distance corresponding to the attribute value along the segment.*
← GetPointsAtVertexAttribute (attributeType: esriGeometryAttributes, attributeValue: Double, LateralOffset: Double, outPoints: IPointCollection)	*Gets the point at the location corresponding to the attribute value.*
← GetSubSegmentBetweenVertexAttributes (attributeType: esriGeometryAttributes, fromAttribute: Double, toAttribute: Double, out outSegment: ISegment)	*Gets the segment corresponding to the extent along the segment between the 'from' and 'to' attribute values.*
← GetVertexAttributeAtDistance (attributeType: esriGeometryAttributes, Distance: Double, asRatio: Boolean) : Double	*Gets the attribute value corresponding to the distance along the segment.*
← HasVertexAttributes (attributeType: esriGeometryAttributes, out hasFromAttribute: Boolean, out hasToAttribute: Boolean)	*Returns two booleans telling if the segment as from attribute and to attribute values.*
← HorizontalIntersectionCount (p: _WKSPoint, out pointOnLine: Boolean) : Long	*Returns the number of horizontal intersections.*
← InterpolateVertexAttributes (distanceAlongSegment: Double, asRatio: Boolean, atPoint: IPoint)	*Interpolates Z and M values at distanceAlongSegment and stores the results at point.*
← MaxDistanceFromLine (pBaseFrom: _WKSPoint, pBaseTo: _WKSPoint, minOffset: Double, fromArcDistance: Double, toArcDistance: Double, pMaxOffset: Double, pAtArcDistance: Double, pFarPoint: _WKSPoint)	*Returns the maximum distance from the line.*
← PutAttributes (PutAttributes: Boolean, putAwareness: Boolean, from: _esriPointAttributes, to: _esriPointAttributes)	*Sets some attributes from this point and copies them to another point. Awareness is not considered.*
← PutVertexAttributes (attributeType: esriGeometryAttributes, fromAttribute: Double, toAttribute: Double)	*Sets the 'from' and the 'to' attribute values.*
← QueryAreaCorrection (out areaCorrection: Double)	*Queries the area correction value.*

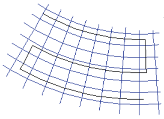
ISegment : ICurve, continued	
← QueryAttributes (getAttributes: Boolean, getAwareness: Boolean, from: _esriPointAttributes, to: _esriPointAttributes)	Gets some attributes from this point and copies them to another point. Awareness is not considered.
← QueryCentroidCorrection (pWeightedCentroidx: Double, pWeightedCentroidy: Double, pAreaCorrection: Double)	Queries the centroid correction value.
← QueryCurvature (distanceAlongCurve: Double, asRatio: Boolean, pCurvature: Double, pUnitVector: ILine)	Finds curvature and unit vector starting at point on segment and directed to embedded circle center.
← QueryVertexAttributes (attributeType: esriGeometryAttributes, out fromAttribute: Double, out toAttribute: Double)	Gets the 'from' and the 'to' attribute values.
← QueryWKSEnvelope (Envelope: _WKSEnvelope)	Queries the WKS Envelope.
← QueryWKSFromPoint (p: _WKSPoint)	Query the WKSPoint at the 'from' point.
← QueryWKSToPoint (p: _WKSPoint)	Query the WKSPoint at the 'to' point.
← ReturnTurnDirection (otherSegment: ISegment) : Long	Finds turn direction between two connected segments.
← SplitAtDistance (distances: Double, asRatio: Boolean, ppFromSegment: ISegment, ppToSegment: ISegment)	Split segment at specified distance.
← SplitAtVertexAttribute (attributeType: esriGeometryAttributes, attributeValue: Double, out fromSegment: ISegment, out toSegment: ISegment)	Splits the segment in two segments at the location corresponding to the attribute value.
← SplitDivideLength (Offset: Double, Length: Double, asRatio: Boolean, cSplitSegments: Long, ppSegments: ISegment)	Divide segment into smaller segments of the specified length.
← SynchronizeEmptyAttributes (pToSegment: ISegment)	Synchronize Empty Attributes.
← VertexAttributeOn (attributeType: esriGeometryAttributes, attributeValue: Double) : Long	Indicates if attributeValue is located on this segment.



1. For an existing Polyline*, you can choose to perform densification before a projection, depending on the effect you require.*



2. Here, the Polyline *is projected.*



3. Here, you densify the Polyline *before projecting it.*

You can use IPolycurve::Densify *as an alternative method—this densifies the actual input* Geometry.

You can set the size of the array of returned segments at runtime. By making use of the ReDim *keyword in* VB*, you can set the size of the array according to the number of new segments requested, although the entire array may not be filled by the* Densify *operation.*

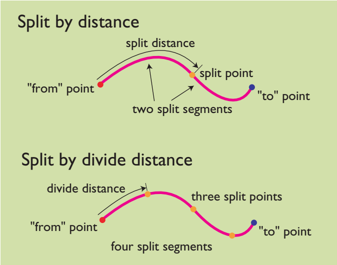
You can use the *Densify* method to split any curve into an approximation of itself, consisting of a series of connected lines. Densification is an important topic if you intend to project a shape (using the *IGeometry::Project* method) to a different *SpatialReference*. Projecting a geometry from one coordinate system to another may distort its shape, for example, a projected line may become curved in shape.

An ArcObjects *Line* coclass must remain linear in shape; therefore, project the *Line* results in a linear shape, where the *FromPoint* and *ToPoint* have been projected. Depending on the effect you wish to achieve, you may wish to project a densification of that shape instead.

The number of resultant lines from a *Densify* method call will be, at most, the number of segments specified in the *cNewSegments* parameter. If the *maxDev* parameter is greater than zero, the number of segments that results will be the minimum number that can satisfy the maximum-deviation criteria. Therefore, if the maximum deviation specified is greater than the maximum possible deviation, the method will return only one line. The code below creates a new *Polyline* from the result of a *Densify* (where the *pInSegment* is an existing *Segment*).

```
Dim lNewSegments As Long, lOutSegments As Long
lNewSegments = 4
Dim pLine() As ILine
ReDim pLine(lNewSegments - 1) As ILine
pInSegment.Densify lNewSegments, 0, lOutSegments, pLine(0)
Dim pNewLine As ISegmentCollection
```

```
Set pNewLine = New Polyline
Dim i As Long
For i = 0 To lOutSegments - 1
  If not pLine(i) is Nothing then
    pNewLine.AddSegment pLine(i)
  End If
Next i
```



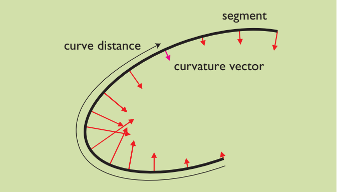
The SplitAtDistance *method splits a segment into two segments at the curve length.*

The SplitDivideDistance *method splits a segment into multiple segments by the divide distance. Typically, the last segment is shorter than the rest because it has the remainder length.*

The *ISegment* interface provides two methods to split a segment into two or more new segments, leaving the original segment unaffected. In contrast to the *Densify* method, the coclass of the resultant segments is the same as the original geometry. The *SplitAtDistance* method splits a curve into two at a specified distance or a ratio along the line's length. The *SplitDivideDistance* splits a curve into an unspecified number of curves of a specified length. This method returns a pointer to the first *Segment* in an array—for more information on dealing with returned arrays, see Volume 1, Chapter 2, 'Developing with ArcObjects'.

The code below creates five equal *Segments* by calling *SplitDivideLength*. There are five segments because the distance is split as a ratio, using a split length of 0.2. Therefore, the result array is declared as *pSegments(4)*, as the array is zero-based.

```
Dim pSegments(4) As ISegment
Dim lNumSegs As Long
pInSegment.SplitDivideLength 0, 0.2, True, lNumSegs, pSegments(0)
Dim i As Long
For i = 0 To (lNumSegs - 1)
  pNewLine.AddSegment pSegments(i)
Next i
```



Given a segment and curve distance, QueryCurvature *returns a curvature vector, which is calculated by deriving the equation of the line and solving the derived equation at a specific point.*

The *QueryCurvature* method returns the direction and magnitude of curvature at any specified point along a segment. Curvature is the rate of change of the line slope. The direction of the curvature vector is always either normal or opposite normal to the segment.

The *ReturnTurnDirection* method calculates the turn direction between two connected segments. For example, the *ToPoint* of the first *Segment* equals the *FromPoint* of the second *Segment*. At ArcGIS 8.1, only *Line* and *CircularArc* coclasses support the *ReturnTurnDirection* method. *ReturnTurnDirection* is ideal for producing driving directions from a map.

ISegmentM : IUnknown	***Provides access to members that allow simple manipulations of Ms at the segment level.***
← GetMs (out fromM: Double, out toM: Double)	*Get the Ms on the segment's endpoints.*
← SetMs (fromM: Double, toM: Double)	*Set the Ms on the segment's endpoints.*

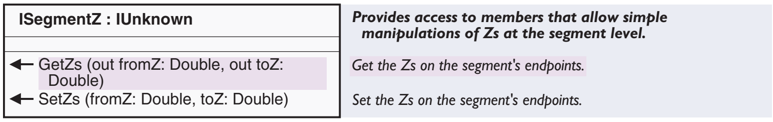
Measure values are stored as the *Measure* property of a *Point* object and can be any number in the M domain of the geometry's *SpatialReference* or in the range of a *Double* if the geometry has no *SpatialReference*. For a measured segment, that is, a segment that has measure values set at its *FromPoint* and *ToPoint*, these values are interpolated on the fly as required for locations along the *Segment*.

A Segment *may be part of a* Polyline *or* Polygon*, in which case the measure values may be more conveniently set onto the* Polyline *or* Polygon *as a whole. For more information, see the Geometry Attributes section later in the chapter.*

Note that z-, m-, and ID values can only be returned and set depending on the object's attribute awareness, which can be determined via the IZAware, IMAware, *or* IPointIDAware *interfaces.*

In the code below, you set *pSegmentM* to have measure values from 0 to 100.

```
pSegmentM.SetMs 0,100
```



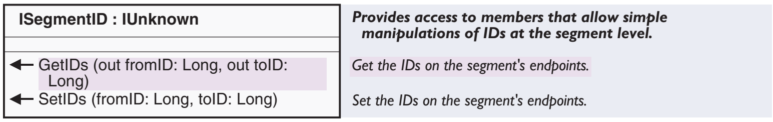
ISegmentZ : IUnknown | ***Provides access to members that allow simple manipulations of Zs at the segment level.***

← GetZs (out fromZ: Double, out toZ: Double) | *Get the Zs on the segment's endpoints.*

← SetZs (fromZ: Double, toZ: Double) | *Set the Zs on the segment's endpoints.*

Z-values are another attribute of a *Point*. In some ArcObjects methods, z-values are used as a vertical height coordinate with units the same as the *Point*'s x,y coordinates. Other methods work regardless of the z-attribute. In the code below, you set *pSegmentZ* to have z-values from 10.2 to 12.3.

```
pSegmentZ.SetZs -10.2,12.3
```



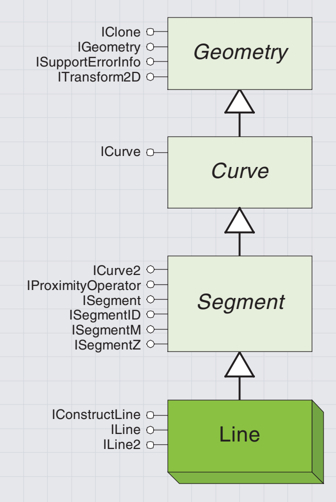
ISegmentID : IUnknown | ***Provides access to members that allow simple manipulations of IDs at the segment level.***

← GetIDs (out fromID: Long, out toID: Long) | *Get the IDs on the segment's endpoints.*

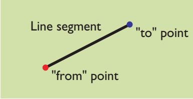
← SetIDs (fromID: Long, toID: Long) | *Set the IDs on the segment's endpoints.*

ID values are an attribute of a *Point* geometry. Where points are used programmatically, it may be useful to "track" them using an ID. For example, the input from a roving GPS unit could be encoded with IDs to keep track of each point it reports. The IDs could correspond to a time or to an entry in a database. In this way, a *Polyline* object in a *Feature-Class* could have its own attributes, and each of its vertices could have their own separate attributes. In the code below, *pSegmentID* is set to have a *FromPoint::ID* of 23987 and a *ToPoint::ID* of 23988.

```
pSegmentID.SetIDs 23987,23988
```



A Line *is a one-dimensional shape that links two points by a direct route. It may represent a geographical feature too narrow to depict as an area, or it may define the shape of a graphic element.*



A Line *is the simplest type of* Segment.

The *Line* coclass defines a direct route between two vertices, either by specifying the vertices or by other constructor methods. It is the simplest and most common kind of segment and can be the building block of *Polylines, Polygons, Rings,* and *Paths*.

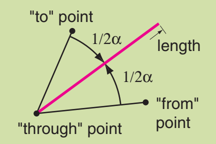
ILine : ICurve	*Provides access to members that identify a straight line segment and defines its properties.*
Angle: Double	*The angle between this line and the positive x-axis.*
PutCoords (from: IPoint, to: IPoint)	*Sets this line's endpoints to be 'from' and 'to'.*
QueryCoords (from: IPoint, to: IPoint)	*Copies the endpoints of this line to 'from' and 'to'.*

Use the *ILine* interface to find out line-specific properties of a *Line* segment. The *QueryCoords* property will return any existing coordinates by populating two valid *Point* objects (make sure both points are declared as *New* objects before passing them to *QueryCoords*). If the *Line* is an empty geometry, error 514 is raised. The *Angle* property will indicate the angle between the positive x-axis and the line in radians.

The *ILine* interface also provides the simple *PutCoords* method, which allows you to construct a line. Below, the code constructs a line and then checks its coordinates.

```
Dim pLine As ILine, pFromPoint As IPoint, pToPoint As IPoint

Set pFromPoint = New Point
pFromPoint.PutCoords 0, 0
Set pToPoint = New Point
pToPoint.PutCoords 10, 10

Set pLine = New esriCore.Line
pLine.PutCoords pFromPoint, pToPoint
MsgBox "From: " & pLine.FromPoint.X & ", " & pLine.FromPoint.Y & _
  vbNewLine & "To: " & pLine.ToPoint.X & ", " & pLine.ToPoint.Y & _
  vbNewLine & "Angle: " & pLine.Angle
```

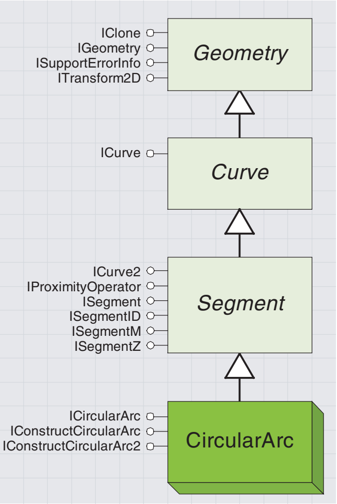
IConstructLine : IUnknown	*Provides access to members that construct a line segment using other geometries and measures.*
ConstructAngleBisector (from: IPoint, through: IPoint, to: IPoint, Length: Double, bUseAcuteAngle: Boolean)	*Constructs a line segment being the bisector through the angle defined by the three input points.*
ConstructExtended (InLine: ILine, extendHow: tagesriSegmentExtension)	*Extends a line segment in either or both of its 'to' or 'from' direction.*



ConstructAngleBisector *can be used to create a new* Line *from three existing* Points.

The *IConstructLine* interface provides more complex ways to define a *Line*. Given a “from” point, a “through” point, and a “to” point, the *ConstructAngleBisector* method bisects the angle defined by the three points and creates a line of the specified length. The line is constructed through the right-hand-side angle but can be forced to go through the left-hand-side angle if it is the smaller angle and the last parameter is set to *True*.

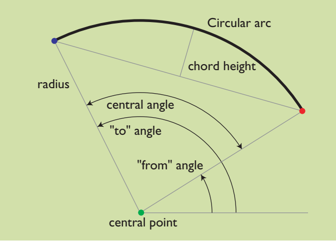
The third way to construct a *Line* is with the *ConstructExtended* method, where an existing *Line* is extended to the limit of the *SpatialReference*; therefore, the *SpatialReference* of both lines must be set and have Domain information (*HasXYPrecision* = *True*). For more information, see the *esriSegmentExtension* list documented with the *ICurve* interface.



A CircularArc *is a* Segment *that describes a portion of a circle. A* CircularArc *that describes an entire circle will have a* CentralAngle *of 2π radians, and its* FromPoint *and* ToPoint *will be equal.*

A *CircularArc* is an object that describes a portion of a circle or a complete circle. In geometric terms, a *CircularArc* is a special case of an *EllipticArc*, where the major and minor axes are equal. Consequently, every point on the arc is equidistant from the *CenterPoint*, this distance being the *Radius*.

ICircularArc : ICurve	***Provides access to members that control properties of circular arcs.***
CenterPoint: IPoint	*A copy of the center point of this circular arc.*
CentralAngle: Double	*The included (or central) angle.*
ChordHeight: Double	*The chord height (assigning preserves endpoints, and orientation unless chord height is < 0).*
FromAngle: Double	*The angle, measured from a horizontal line through this circular arc's center point, that defines where this arc starts.*
IsCounterClockwise: Boolean	*Indicates when this circular is oriented counter-clockwise from its 'from' point to its 'to' point.*
IsLine: Boolean	*Indicates when the arc has degenerated to a line (radius is infinite).*
IsMinor: Boolean	*Indicates whether this circular arc is a minor arc or a major arc.*
IsPoint: Boolean	*Indicates when the arc has degenerated to a point (radius is 0).*
Radius: Double	*The uniform distance, the radius, from the center point to the arc.*
ToAngle: Double	*The angle, measured from a horizontal line through this circular arc's center point, that defines where this arc ends.*
Complement	*Produces circle complement of arc; 'from' and 'to' points are unchanged.*
PutCoords (cp: IPoint, sp: IPoint, ep: IPoint, arcOrientation: tagesriArcOrientation)	*Defines this circular by a center point, 'from' and 'to' points, and orientation.*
PutCoordsByAngle (cp: IPoint, FromAngle: Double, CentralAngle: Double, arcRadius: Double)	*Defines this circular arc by a center point, 'from' angle, signed central angle, and radius.*
PutRadiusByPoint (pInP: IPoint)	*Defines the radius of this circular arc to be the distance from the arc's center point to the input point; other properties remain unchanged.*
QueryCenterPoint (Center: IPoint)	*Copies the center point of this circular arc to the input point.*
QueryCoords (cp: IPoint, sp: IPoint, ep: IPoint, isCCW: Boolean, IsMinor: Boolean)	*Copies the center, 'from' and 'to' points, orientation and major/minor property into the input parameters.*
QueryCoordsByAngle (cp: IPoint, FromAngle: Double, centerAngle: Double, arcRadius: Double)	*Returns the center point, 'from' angle, signed central angle, and radius.*



These are the main properties of a circular arc set and returned in ICircularArc*.*

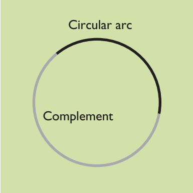
A CircularArc *is defined by its* FromPoint*,* ToPoint*,* CenterPoint*, and* Orientation*. The* Radius *and* CentralAngle *provide information and can also be used to adjust the shape of an arc.*

The defining properties of an existing *CircularArc*, as shown to the left, can be obtained individually from the *FromAngle, ToAngle, CentralAngle, CenterPoint, ChordHeight,* and *Radius* properties. The *QueryCoord* and *QueryCoords* methods can also be used to retrieve parameters from an existing *CircularArc*.

The *FromAngle* and *ToAngle* of an arc can be changed directly by writing to the *FromAngle* and *ToAngle* properties. You can also write to the *CentralAngle* property of a *CircularArc*, which will alter the *ToAngle* as necessary, preserving the *FromAngle* of the arc. The *ChordHeight* property can be used to return this property of an arc, and its maximum value is twice the radius (the diameter). It is also possible to alter the shape of a *CircularArc* by changing the *ChordHeight* of an existing *CircularArc*, which will retain the *FromPoint* and *ToPoint* but adjust the *CenterPoint, CentralAngle,* and *Radius*, accordingly.

Some properties that provide checks for certain special cases are:

- *IsLine*—if *True*, the *Radius* is infinite.
- *IsPoint*—if *True*, the *Radius* is zero.
- *IsCounterClockwise*—if *True*, the *CentralAngle* is positive.
- *IsMinor*—if *True*, the arc is less than a semicircle (*CentralAngle* < π radians).



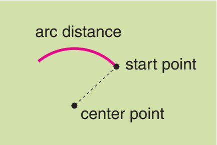
A circular arc and its complement combine to form a full circle.

An existing *CircularArc* can be altered by calling the *Complement* method, changing the *CircularArc* to its “other” part. The *Complement* method defines a *CircularArc* as the arc that creates a full circle when combined with the original geometry; the *FromPoint* and *ToPoint* of the arc are preserved. Setting either the *IsCounterClockwise* or the *IsMinor* property to their alternate value also changes the arc to the complement of the original shape.

Both the *ICircularArc* and *IConstructCircularArc* interfaces offer ways of defining a new *CircularArc*. The method by which you create a *CircularArc* should be chosen according to which parameters of the arc you can define in advance.

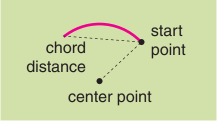
You should generally define a new *CircularArc* using one of the described all-in-one methods, rather than setting the *FromAngle, ToAngle, Radius,* and *IsCounterClockwise* properties separately.

The *PutCoords* method requires the *CenterPoint, FromPoint,* and *ToPoint* to be known in advance, in addition to specifying the orientation of the arc—an empty geometry may be created if the *FromPoint* and *ToPoint* are not equal distances from the *CenterPoint*. The *PutCoordsByAngle* method, which requires the *CenterPoint, FromAngle, CentralAngle,* and *Radius*, is strongly recommended in preference to the *PutCoords* method (if such parameters are known), as using *PutCoords* requires the *exact* location of the *FromPoint* and *ToPoint* to be known in advance.

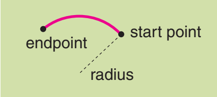


ConstructArcDistance

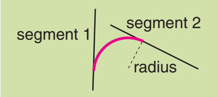
IConstructCircularArc : IUnknown	***Provides access to members that construct a circular arc using other geometries and measures.***
← ConstructArcDistance (Center: IPoint, from: IPoint, isCCW: Boolean, arcDistance: Double)	*Constructs an arc from a center point, a starting point, and an arc length.*
← ConstructBearingAngleArc (from: IPoint, inAngle:Double, isCCW: Boolean, CentralAngle: Double, arcDistance: Double)	*Constructs an arc with the given chord bearing, central angle and arc distance).*
← ConstructBearingAngleChord (from: IPoint, inAngle: Double, isCCW: Boolean, CentralAngle: Double, chordDistance: Double)	*Constructs an arc with the given chord bearing, central angle and chord distance).*
← ConstructBearingAngleTangent (from: IPoint, inAngle: Double, isCCW: Boolean, CentralAngle: Double, tangentDistance: Double)	*Constructs an arc with the given chord bearing, central angle and tangent distance).*
← ConstructBearingArcTangent (from: IPoint, inAngle: Double, isCCW: Boolean, arcDistance: Double, tangentDistance: Double)	*Constructs an arc with the given chord bearing, arc distance and tangent distance).*
← ConstructBearingChordArc (from: IPoint, inAngle: Double, isCCW: Boolean, chordDistance: Double, arcDistance: Double)	*Constructs an arc with the given chord bearing, chord distance and arc distance (negative for clockwise orientation)).*
← ConstructBearingChordTangent (from: IPoint, inAngle: Double, isCCW: Boolean, chordDistance: Double, tangentDistance: Double)	*Constructs an arc with the given chord bearing, chord distance and tangent distance).*
← ConstructBearingRadiusAngle (pStart: IPoint, inAngle: Double, isCCW: Boolean, inRadius: Double, CentralAngle: Double)	*Constructs an arc with the given chord bearing, radius and central angle).*
← ConstructBearingRadiusArc (from: IPoint, inAngle: Double, isCCW: Boolean, inRadius: Double, arcDistance: Double)	*Constructs an arc with the given chord bearing, radius and arc distance).*
← ConstructBearingRadiusChord (from: IPoint, inAngle: Double, isCCW: Boolean, inRadius: Double, chordDistance: Double, IsMinor: Boolean)	*Constructs an arc with the given chord bearing, radius and chord distance).*



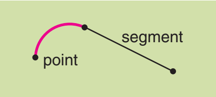
ConstructChordDistance



ConstructEndPointsRadius



ConstructFilletRadius

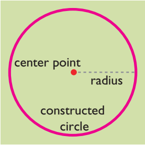


ConstructTangentAndPoint

IConstructCircularArc : IUnknown, continued	
← ConstructBearingRadiusTangent (from: IPoint, inAngle: Double, isCCW: Boolean, inRadius: Double, tangentDistance: Double)	*Constructs an arc with the given chord bearing, radius and tangent distance).*
← ConstructChordDistance (Center: IPoint, from: IPoint, isCCW: Boolean, chordDistance: Double)	*Constructs an arc from a center point, a starting point, and a chord length.*
← ConstructCircle (pCenter: IPoint, Radius: Double, isCCW: Boolean)	*Constructs a circle of a given radius and orientation.*
← ConstructEndPointsAngle (from: IPoint, to: IPoint, isCCW: Boolean, CentralAngle: Double)	*Constructs an arc from the given endpoints and central angle.*
← ConstructEndPointsArc (from: IPoint, to: IPoint, isCCW: Boolean, arcDistance: Double)	*Constructs an arc from the given endpoints and arc distance.*
← ConstructEndPointsChordHeight (from: IPoint, to: IPoint, isCCW: Boolean, ChordHeight: Double)	*Constructs an arc from a starting point, endpoint and the height of circle segment.*
← ConstructEndPointsRadius (from: IPoint, to: IPoint, isCCW: Boolean, inRadius: Double, IsMinor: Boolean)	*Constructs an arc from the given endpoints and radius.*
← ConstructEndPointsTangent (from: IPoint, to: IPoint, isCCW: Boolean, tangentDistance: Double)	*Constructs an arc from the given endpoints and tangent distance.*
← ConstructFilletPoint (s1: ISegment, s2: ISegment, from: IPoint, hintPoint: IPoint)	*Constructs an arc of given start point near first segment and tangent to two segments.*
← ConstructFilletRadius (s1: ISegment, s2: ISegment, inRadius: Double, hintPoint: IPoint)	*Constructs an arc of given radius and tangent to two segments.*
← ConstructTangentAndPoint (s: ISegment, AtStart: Boolean, p: IPoint)	*Constructs an arc tangent to a given segment.*
← ConstructTangentAngleArc (Segment: ISegment, AtStart: Boolean, isCCW: Boolean, CentralAngle: Double, arcDistance: Double)	*Constructs an arc with a common tangent to the input segment, a given central angle and an arc length).*
← ConstructTangentAngleChord (Segment: ISegment, AtStart: Boolean, isCCW: Boolean, CentralAngle: Double, chordDistance: Double)	*Constructs an arc with a common tangent to the input segment, a given central angle and a chord length).*
← ConstructTangentAngleTangent (Segment: ISegment, AtStart: Boolean, isCCW: Boolean, CentralAngle: Double, tangentDistance: Double)	*Constructs an arc with a common tangent to the input segment, a given central angle and a tangent length).*
← ConstructTangentArcTangent (Segment: ISegment, AtStart: Boolean, isCCW: Boolean, arcDistance: Double, tangentDistance: Double)	*Constructs an arc with a common tangent to the input segment, a given arc length and a tangent length).*
← ConstructTangentChordArc (Segment: ISegment, AtStart: Boolean, isCCW: Boolean, chordDistance: Double, arcDistance: Double)	*Constructs an arc with a common tangent to the input segment, a given chord length and an arc length).*
← ConstructTangentChordTangent (Segment: ISegment, AtStart: Boolean, isCCW: Boolean, chordDistance: Double, tangentDistance: Double)	*Constructs an arc with a common tangent to input segment, a given chord length and a tangent length).*
← ConstructTangentDistance (Center: IPoint, from: IPoint, isCCW: Boolean, tangentDistance: Double)	*Constructs an arc from a center point, a starting point, and an tangent length.*
← ConstructTangentRadiusAngle (Segment: ISegment, AtStart: Boolean, isCCW: Boolean, inRadius: Double, CentralAngle: Double)	*Constructs an arc with a common tangent to the input segment, a given radius and a central angle).*
← ConstructTangentRadiusArc (Segment: ISegment, AtStart: Boolean, isCCW: Boolean, inRadius: Double, arcDistance: Double)	*Constructs an arc having a common tangent to the input segment, a given radius and an arc length).*
← ConstructTangentRadiusChord (Segment: ISegment, AtStart: Boolean, isCCW: Boolean, inRadius: Double, chordDistance: Double)	*Constructs an arc with a common tangent to the input segment, a given radius and a chord length).*
← ConstructTangentRadiusTangent (Segment: ISegment, AtStart: Boolean, isCCW: Boolean, inRadius: Double, tangentDistance: Double)	*Constructs an arc with a common tangent to the input segment, a given radius and a tangent length).*
← ConstructThreePoints (from: IPoint, middle: IPoint, to: IPoint, bUseExistingCenter: Boolean)	*Constructs an arc from three points.*
← QueryFilletRadiusRange (s1: ISegment, s2: ISegment, hintPoint: IPoint, minRadius: Double, maxRadius: Double)	*Returns minimum and maximum radius for fillet to touch both input segments.*

When constructing an arc using a FromAngle *and* ToAngle, *the* FromPoint *and* ToPoint *calculated may be slightly different from the exact point you may expect due to the limits of accuracy in floating-point numbers and the methods by which arcs are calculated. Remember this when creating connected* Segments *for a* Polyline *or* Polygon, *and always get the* FromPoint *and* ToPoint *from the arc.*

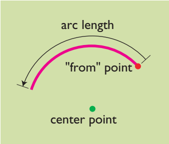
The *IConstructCircularArc* interface contains numerous alternative methods for constructing a *CircularArc*, often based on other existing geometries. Selecting the most appropriate method should provide a convenient way to define a *CircularArc* no matter what factors you know. Below, the most common methods of construction are discussed in more detail.



ConstructCircle

The *ConstructCircle* method is the simplest way to define a complete *CircularArc* coclass, using a *CenterPoint* and a *Radius*. The code below uses an existing *Segment* (for example, a *Line*) with the *ConstructCircle* method, as if the *Line* was the span of a compass that draws a circle. Its *FromPoint* becomes the *CenterPoint* of the circle, its *Length* defines the *Radius*, and its *ToPoint* inscribes the circumference.

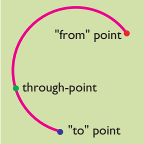
```
Dim pCircularArc As IConstructCircularArc
Set pCircularArc = New CircularArc
pCircularArc.ConstructCircle pSegment.FromPoint, pSegment.Length, True
```



ConstructArcDistance

The *ConstructArcDistance* method constructs a *CircularArc* based on a *FromPoint*, a *CenterPoint*, and the desired length along the arc, which must be less than 2π. You must also specify the orientation of the arc.

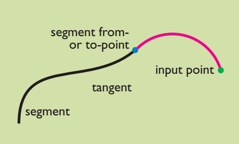
```
pCircularArc.ConstructCircle pSegment.FromPoint, pSegment.Length, True
```



ConstructThreePoints

The *ConstructThreePoints* method makes use of the fact that there is only one single possible circle for any given three points. You must define the *FromPoint* and *ToPoint* of the arc along with a through point, which will lie somewhere between the *FromPoint* and *ToPoint* on the constructed arc. The *useExistingCenter* parameter is applicable only to existing arcs. If *True*, the *CircularArc* will be constructed using the previous center. For example, this method can be used where an existing *CircularArc* is edited and the *FromPoint* and *ToPoint* approach each other.

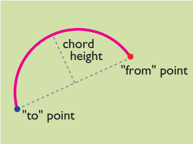
```
pCircularArc.ConstructThreePoints pFrom, pMiddle, pTo, bUseExistingCenter
```



ConstructTangentAndPoint

The *ConstructTangentAndPoint* method may be useful if you have an existing *Segment* and require a smooth, connecting *CircularArc* to be constructed to a known point. Specifically, the *CircularArc* is constructed so that the tangent at its *FromPoint* is the same as the tangent of the *Segment*. If the *AtStart* parameter is *True*, the arc is constructed from the specified point to the *FromPoint* of the *Segment* to the specified point; if *False*, the arc goes from the *ToPoint* of the segment to the specified point.

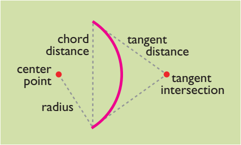
Other *ConstructTangent* methods construct a *CircularArc* based on tangent segments in conjunction with other parameters.



ConstructEndPointsChordHeight

The *ConstructEndPointsChordHeight* is ideal for connecting two known geometries with a circular arc that is not necessarily tangential to those geometries. Specifically, the *FromPoint* and *ToPoint* of the arc are specified, along with the *ChordHeight*. Specify the *ChordHeight* according to how “curvy” you wish the segment to be—a *ChordHeight* of half the distance between the *FromPoint* and *ToPoint* creates a semicircle, while a value less than this would create a less curved arc.

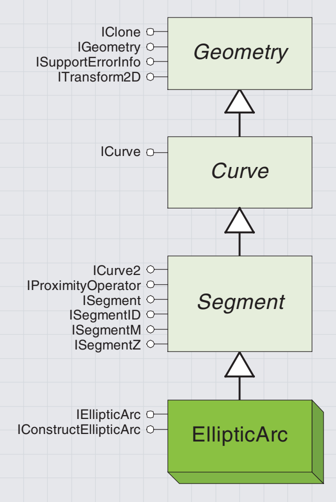
Other *ConstructEndPoints* methods construct a *CircularArc* based on the *FromPoint* and *ToPoint* in conjunction with other circular parameters.



ConstructBearingChordArc

The *ConstructBearingChordArc* method is suitable for constructing an arc where the *FromPoint* is known, the *ToPoint* must be at a certain angle from that *FromPoint*, and the arc must be a certain length. Specifically, the arc is constructed in terms of its *FromPoint*, bearing, chord distance, and arc distance. In addition, the direction of the arc is specified as clockwise or counterclockwise.

Other *ConstructBearing* methods construct a *CircularArc* based on the bearing along the chord, in conjunction with other circular parameters.



An elliptic arc is a segment that describes a portion of an ellipse.

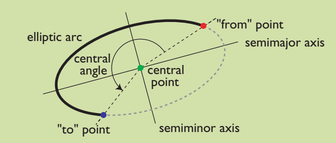
An elliptic arc that describes an entire ellipse will have a central angle of 2π radians, and its "from" point and "to" point will be equal.

An *EllipticArc* is an object that describes any portion of an ellipse or a complete ellipse. An ellipse is defined by its *Semimajor* and *Semiminor* axes, *CenterPoint*, and a *Rotation* value. An *EllipticArc* is defined by these parameters as well as a *FromAngle* and *ToAngle*, as shown below.

Although the *EllipticArc* and *CircularArc* coclasses share some similar geometrical concepts, properties, and methods, the underlying coclasses are different, and the shapes are constructed in different ways.

The positive horizontal axis is defined as an angle of 0 radians, and the *CenterPoint, ToPoint,* and *FromPoint* are all defined from this vector. When working with an *EllipticArc*, if you are using a method that requires an *ellipseStd* parameter, you have the opportunity to change the position defined as 0 radians. If *ellipseStd* is *False*, the standard Cartesian coordinates apply. If *ellipseStd* is *True*, two things are different. First, all angles are specified relative to the embedded ellipse that the arc is based on, and you can specify by how much the ellipse is rotated. An angle of 0 becomes the semimajor axis of the ellipse. Also, coordinates of the *FromPoint* and *ToPoint* are specified relative to the *CenterPoint*.

Setting this parameter to *True* may make it easier for you to calculate the parameters required by the construction methods. Using the *ellipseStd* parameter only affects angles and coordinates in that same method call.



An axis traverses from one side of an ellipse, through the center point, to the opposite side of the ellipse. The major axis is the longest axis of an ellipse. The semimajor axis is half this distance.

The minor axis is the shortest axis of an ellipse. It is perpendicular to the major axis. The semiminor axis is half this distance.

If you require an embedded ellipse that is rotated, look for methods that have the ellipseStd parameter.

IEllipticArc : ICurve	***Provides access to members that control properties of elliptic arc segments.***
CenterPoint: IPoint	*A copy of the center point of the arc.*
CentralAngle: Double	*The included (or central) angle.*
FromAngle (ellipseStd: Boolean) : Double	*The start angle (measured from a horizontal line through the center point) defining where the arc starts.*
IsCircular: Boolean	*Indicates when the embedded ellipse is a circle.*
IsCounterClockwise: Boolean	*Indicates when this elliptic arc is oriented counter-clockwise from its 'from' point to its 'to' point.*
IsLine: Boolean	*Indicates when the arc is degenerated to a line.*
IsMinor: Boolean	*Indicates whether the arc is a minor arc or a major arc.*
IsPoint: Boolean	*Indicates when the arc is degenerated to a point.*
ToAngle (ellipseStd: Boolean) : Double	*The end angle (measured from a horizontal line through the center point) defining where the arc ends.*
Complement	*Produces ellipse complement of arc; 'from' and 'to' points are unchanged.*
GetAxes (semiMajor: Double, semiMinor: Double, minorMajorRatio: Double)	*Gets the semi-major and semi-minor axes.*
PutAxes (semiMajor: Double, minorMajorRatio: Double)	*Sets the semi-major and semi-minor axes.*
PutCoords (ellipseStd: Boolean, Center: IPoint, from: IPoint, to: IPoint, RotationAngle: Double, minorMajorRatio: Double, Orientation: tagesriArcOrientation)	*Sets the center point, starting point, endpoint, angle of rotation, focal distance, and orientation.*
PutCoordsByAngle (ellipseStd: Boolean, Center: IPoint, FromAngle: Double, CentralAngle: Double, RotationAngle: Double, semiMajor: Double, minorMajorRatio: Double)	*Sets the center point, starting angle, signed central angle, angle of rotation, ratio of the minor axis to the major axis, and axes.*
QueryCenterPoint (Center: IPoint)	*Copies the center of this arc to the input point.*
QueryCoords (ellipseStd: Boolean, Center: IPoint, from: IPoint, to: IPoint, RotationAngle: Double, minorMajorRatio: Double, isCCW: Boolean, minor: Boolean)	*Copies coordinates of the center, starting and endpoints, angle of rotation, focal distance, orientation and major/minor property.*
QueryCoordsByAngle (ellipseStd: Boolean, Center: IPoint, FromAngle: Double, CentralAngle: Double, RotationAngle: Double, semiMajor: Double, minorMajorRatio: Double)	*Returns the center point, starting angle, signed central angle, angle of rotation, ratio of the minor axis to the major axis, and axes.*

The defining properties of an existing *EllipticArc* can be obtained from the *FromAngle, CentralAngle,* and *ToAngle* properties and the *GetAxes* method (for details of the *ellipseStd* parameter, see previous section).

```
dblFromAngle = pEllipticArc.FromAngle (bEllipseStd)
dblToAngle = pEllipticArc.ToAngle (bEllipseStd)
pEllipticArc.GetAxes(dblSemiMajor, dblSemiMinor, dblMinorMajorRatio)
```

The *PutAxes* method can be used to scale an existing *EllipticArc* by changing the length of the axis while retaining all other properties. The *FromAngle, CenterPoint,* and *ToAngle* propeties of the arc will be preserved, although the *FromPoint* and *ToPoint* will be altered as necessary.

Other properties of the *IEllipticArc* allow you to check certain special cases:

- *IsCircular*—major axis = minor axis
- *IsLine*—if *True*, minor axis/major axis = 0 (or minor axis = 0)
- *IsPoint*—if *True*, major axis = minor axis = 0
- *IsCounterClockwise*—if *True*, the *CentralAngle* is positive
- *IsMinor*—if *True*, arc is less than half and ellipse (*CentralAngle* < 2 pi radians)

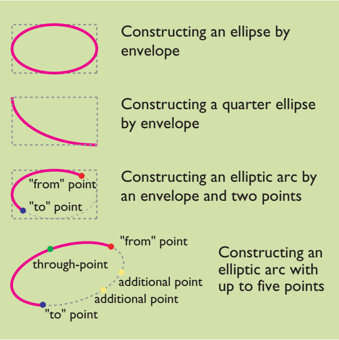
An EllipticArc *with a rotation other than zero or pi/2 can only be defined by using the* PutCoords, PutCoordsByAngle, *or* ConstructUpToFivePoints *methods, but it is not recommended to use the* PutAxes *method on a rotated ellipse.*

The *IEllipticArc* interface also has *Complement, PutCoord, PutCoords, QueryCoords, QueryCoordsByAngle,* and *QueryCenterPoint* methods, with definitions similar to those methods on *ICircularArc*, except that they return appropriate properties for the ellipse.

The *PutCoords* and *PutCoordsByAngle* methods are similar to their counterpoints on the *ICircularArc* interface but use different parameters. *PutCoordsByAngle* is recommended over the *PutCoords* method.

The *IEllipticArc* and *IConstructEllipticArc* interfaces both offer ways of defining a new *EllipticArc* and, like a *CircularArc,* the method used should be chosen according to which parameters of the ellipse you can define in advance. Again, it is recommended that you create an *EllipticArc* from one of the described all-in-one methods, rather than by setting separate properties.

IConstructEllipticArc : IUnknown	***Provides access to members that construct an elliptic segment using other geometries and measures.***
← ConstructEnvelope (boundingEnvelope: IEnvelope)	*Constructs the inscribed ellipse of the given envelope. The ellipse is oriented counterclockwise.*
← ConstructQuarterEllipse (FromPoint: IPoint, ToPoint: IPoint, CCW: Boolean)	*Construct an elliptic arc that starts at fromPoint, goes to toPoint, and spans an angle of pi/2. The rotation of the ellipse will be either 0 or pi/2.*
← ConstructTwoPointsEnvelope (FromPoint: IPoint, ToPoint: IPoint, suggestedEnvelope: IEnvelope, Orientation: tagesriArcOrientation)	*Construct an elliptic arc that starts at fromPoint, goes to toPoint, and tries to have the embedded ellipse inscribed in the suggestedEnvelope. The result will have rotation of 0 or pi/2.*
← ConstructUpToFivePoints (from: IPoint, to: IPoint, thru: IPoint, point4: IPoint, point5: IPoint)	*Given up to 5 points, construct an elliptic arc such that the embedded ellipse passes through as many as possible. The arc will start at the first point and end at the second, passing through the third.*

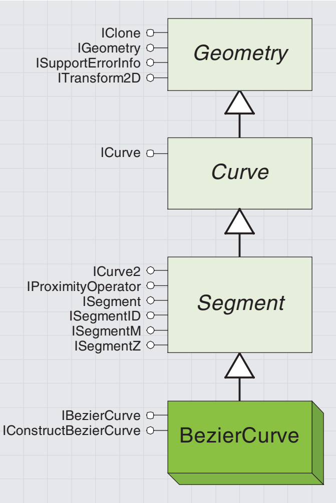

Constructing an ellipse by envelope
Constructing a quarter ellipse by envelope
"from" point
"to" point
Constructing an elliptic arc by an envelope and two points
"from" point
through-point
additional point
additional point
"to" point
Constructing an elliptic arc with up to five points

Construct your arc by selecting the most appropriate construction method.

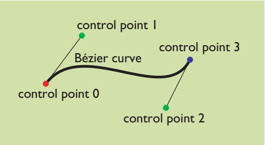
The *IConstructEllipticArc* interface offers alternative ways to define a new *EllipticArc* using other geometries. The *ConstructEnvelope* method generates a full counterclockwise ellipse to precisely fit a known *Envelope*.

ConstructQuarterEllipse defines an ellipse where the *FromPoint* and *ToPoint* are known, and the arc returned has a *CentralAngle* of pi/2 radians. If *ConstructEnvelope* does not give the result you require, try the *ConstructTwoPointsEnvelope* method, where a *FromPoint* and *ToPoint*, along with a suggested envelope, are precisely specified. The result is an unrotated ellipse that has the nearest envelope to the envelope suggested but has the specified orientation and can still retain the *FromPoint* and *ToPoint* specified. The *CentralAngle* will be determined by these factors.

The *ConstructUpToFivePoints* method uses a similar principle to the *IConstructCircularArc::ConstructThreePoints* method; it constructs an arc only from a *FromPoint,* a *ToPoint,* and any other known points on the arc. It can be used to construct an ellipse from up to five known points, as there is only one possible ellipse for five points. It is recommended that you use at least three known points, the *FromPoint, ToPoint,* and a "through" point, as only providing one or two points will create an ellipse for which *IsPoint* or *IsLine* is *True*. The additional two point parameters can be specified to identify the shape of the ellipse. Pass an empty point *Geometry*, or *Nothing*, for any points you do not know. If the fourth or fifth parameters do not lie on a convex hull identified by the first three points, then the parameter will not be used.



A Bézier curve links two points by a curve.The curve is defined by a start point, an endpoint, and two additional control points.



A Bézier curve produces a smooth, flowing curve and may be preferable to a series of numerous straight lines approximating a curve.

Bézier curves generally have zero or one inflection point. It is unlikely, however, that the average ArcObjects developer will require a knowledge of inflection points, as they are accounted for internally in relevant ArcObjects functions.

The *BezierCurve* coclass defines a curved line between two vertices (the *FromPoint* and *ToPoint*). A further two points define the tangents at the start and end of the curve.

These four points are known as control points, and together they characterize the equation used to define a *BezierCurve*. The curve starts at control point zero, the *FromPoint*, and ends at control point three, the *ToPoint*. Control points zero and one define the tangent at the *FromPoint*, and control points two and three define the tangent at the *ToPoint*.

IBezierCurve : ICurve	***Provides access to members that identify third degree bezier curve segments and defines their properties.***
■— Degree: Long	*The degree of the Bezier curve. For third degree Beziers, this is always 3.*
← PutCoord (Index: Long, controlPoint: IPoint)	*Sets the specified (0 <= index < 4) control point of this Bezier curve.*
← PutCoords (cPoints: Long, in controlPoints: IPoint)	*Sets this Bezier curve's control points from an array of cPoints input points.*
← PutWKSCoords (in controlPoints: _WKSPoint)	*Sets this Bezier curve's control points from the array of 4 input point structures.*
← QueryChordLengthTangentAtFrom (pTangent: IPoint, pbSetByUser: Boolean)	*Returns tangent vector at 'from' point, based on chord length parametrization; and whether it has been set by user or by smoothing process.*
← QueryChordLengthTangentAtTo (pTangent: IPoint, pbSetByUser: Boolean)	*Returns tangent vector at 'to' point, based on chord length parametrization; and whether it has been set by user or by smoothing process.*
← QueryCoord (Index: Long, controlPoint: IPoint)	*Copies the specified control point of this Bezier curve into the input point.*
← QueryCoords (controlPoints: IPoint)	*Copies this Bezier curve's control points into the array of 4 existing points.*
← QueryInflectionPoint (pInflectionPoint: IPoint)	*Finds inflection point; sets it empty if none exists.*
← QueryWKSCoords (out controlPoints: _WKSPoint)	*Copies this Bezier curve's control points into the array of 4 existing point structures.*
← SetChordLengthTangentAtFrom (pTangent: IPoint, bSetByUser: Boolean)	*Establishes tangent vector at 'from' point, based on chord length parametrization; and sets flag whether it has been set by user or by smoothing process.*
← SetChordLengthTangentAtTo (pTangent: IPoint, bSetByUser: Boolean)	*Establishes tangent vector at 'to' point, based on chord length parametrization; and sets flag whether it has been set by user or by smoothing process.*

The *IBezierCurve* interface allows you to define and query the properties of the curve. The *PutCoord* method can be used to alter an existing *BezierCurve* by changing one point at a time; for example, the code below updates the tangent point of the *ToPoint* of the *BezierCurve, pBezier*:

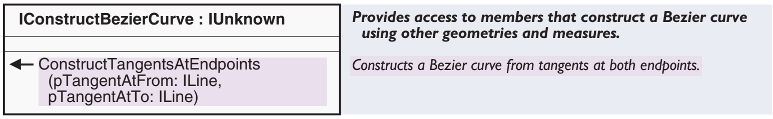
```
Dim pBezier As IBezierCurve
Set pBezier = New BezierCurve

Dim pPoint as IPoint
Set pPoint = New Point
pPoint.PutCoords 20, 30

pBezier.PutCoord 2, pPoint
```

Use the *QueryCoord* and *QueryCoords* methods to retrieve control points from an existing *BezierCurve*. The *QueryInflectionPoint* returns an inflection point of a *BezierCurve* (which is defined mathematically as the point at which the rate of change of the curvature is zero).

If the four control points of a potential *BezierCurve* are known, the *PutCoords* method may be used to define the curve, as shown below.

```
Dim pPoints(3) as IPoint
' Set the coordinates of each member of the pPoints array here.
pBezier.PutCoords 4, pPoints(0)
```

For example, the control points could be the result of mouse clicks or be based on an existing *Line* or *Multipoint*. The *PutCoords* method should be used in preference to setting each control point separately with four calls to *PutCoord*, as the order in which the control points are specified may affect the outcome of the shape of the *BezierCurve,* possibly resulting in an invalid arc.

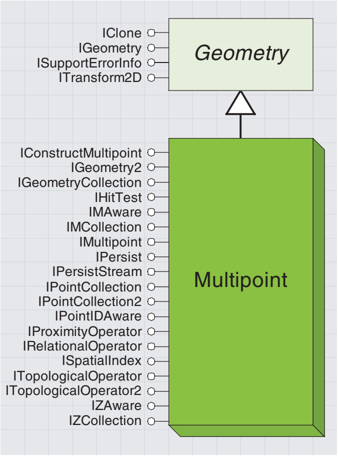


IConstructBezierCurve : IUnknown

Provides access to members that construct a Bezier curve using other geometries and measures.

ConstructTangentsAtEndpoints (pTangentAtFrom: ILine, pTangentAtTo: ILine) — *Constructs a Bezier curve from tangents at both endpoints.*

The *IConstructBezierCurve* interface provides an alternative method to constructing a *BezierCurve* using Bézier tangents. However, the recommended way to define a *BezierCurve* is to use *IBezierCurve::PutCoords*.



A multipoint is a collection of points. It is commonly found in feature classes or as the result of a relational or topological operation.

A *Multipoint* coclass holds a collection of references to *Point* objects. A *Multipoint* is often returned from operations where the result may be one or many *Points*. A *Multipoint* object can also be used as the *Geometry* of a *Feature*.

IMultipoint : IGeometry	***Provides access to members that identify a multipoint object.***

The *IMultipoint* interface has no methods and exists so that you can identify a *Multipoint Geometry* object. This line of code shows its use.

```
If TypeOf pGeometry Is IMultipoint Then ...
  ' You have a Multipoint object
End If
```

The shape of a *Multipoint* object can be defined by adding *Point* objects to a *Multipoint* object using the *IPointCollection* interface, as shown in the following code. Remember you are adding the point *pPoint* by reference, not by value.

```
Dim pPointCollection As IPointCollection
Set pPointCollection = New Multipoint
pPointCollection.AddPoint pPoint
```

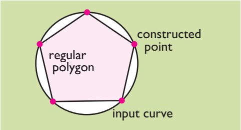
For more information about the *IPointCollection* interface, see the collection interfaces section later in this chapter.

The *IConstructMultipoint* interface offers ways to construct multipoints based on other existing geometries.

IConstructMultipoint : IUnknown	***Provides access to members that construct multiple points using other geometries and measures.***
← ConstructArcPoints (a: ICircularArc)	*Constructs the four arc points (Point of Tangency, Point of Curvature, Center point, Point of Intersection, in that order) for the specified circular arc.*
← ConstructDivideEqual (inCurve: ICurve, numInnerPoints: Long)	*Constructs cPoints points evenly distributed along the input curve.*
← ConstructDivideLength (inCurve: ICurve, separationDistance: Double)	*Places points along the input curve each seperate by the specified distance.*
← ConstructIntersection (segment1: ISegment, extension1: tagesriSegmentExtension, segment2: ISegment, extension2: tagesriSegmentExtension, pParams1: Variant, pParams2: Variant, isTangentPoint: Variant)	*Constructs the point(s) of intersection/tangency between two segments. Different ways of producing the segments in order to locate additional points can be specified.*
← ConstructIntersectionEx (segment1: ISegment, extension1: tagesriSegmentExtension, segment2: ISegment, extension2: tagesriSegmentExtension, pParams1: Double, pParams2: Double, pTangentBits: Long)	*Constructs the point(s) of intersection/tangency between two segments. Different ways of producing the segments in order to locate additional points can be specified.*
← ConstructTangent (inCurve: ICurve, p: IPoint)	*Constructs all points of tangency to a curve from a point.*

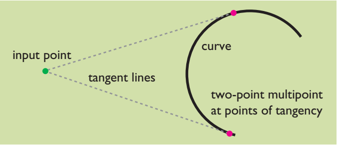
The *ConstructDivideEqual* method creates *Point* objects at equal distances along an *ICurve* object.

The following code uses this method to create a regular *Polygon*. This example is similar to the function shown with *IConstructPoint* but, instead of the length of one edge, this function allows you to define the overall size of the *Polygon*.



ConstructDivideEqual *is used in this code to help construct a regular polygon, as shown above.*

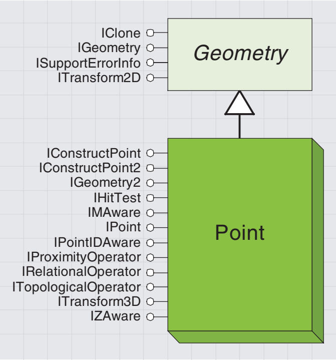
```
Private Function fnMakePolygon2(pArc As ICircularArc, intSides As Integer) _
    As ISegmentCollection
  If Not pArc Is Nothing Then
    If pArc.IsClosed Then
      Set fnMakePolygon2 = New Ring
      Dim pMulti As IConstructMultipoint
      Set pMulti = New Multipoint
      ' ConstructDivideEqual always returns the FromPoint and ToPoint of
      ' the curve, therefore divide the curve into the number of sides
      ' required minus one
      pMulti.ConstructDivideEqual pArc, intSides - 1

      Dim pPointColl As IPointCollection
      Set pPointColl = pMulti

      Dim i As Integer
      Dim pLine As ILine
      For i = 0 To intSides - 1
        Set pLine = New Line
        pLine.PutCoords pPointColl.Point(i), pPointColl.Point(i + 1)
        fnMakePolygon2.AddSegment pLine
      Next i
    End If
  End If
End Function
```



Using ConstructTangent, *you can find a tangent line from any curve to a particular point.*

Similarly, the *ConstructDivideLength* method divides a curve into sections, adding a *Point* to the new *Multipoint* at each division.

The *ConstructTangent* method adds a new *Point* to the *Multipoint* for each point of tangency of a *Curve* to a particular *Point*.



A point represents a single location. It is commonly used in a point feature class but can be found in many areas of ArcObjects, such as locators, symbology, spatial references, and networks. It is also used to help define the shape of other geometry objects.

An instance of the *Point* coclass represents a set of x,y coordinates, which together define a single, zero-dimensional location in space.

IPoint : IGeometry	***Provides access to members that define two dimensional points.***
ID: Long	*The Point ID attribute.*
M: Double	*The measure attribute.*
VertexAttribute (attributeType: esriGeometryAttributes) : Double	*Any attribute (coordinate), except X or Y.*
X: Double	*The X coordinate.*
Y: Double	*The Y coordinate.*
Z: Double	*The Z attribute.*
Compare (pOtherPoint: IPoint) : Long	*Compares X, Y, M, Z, ID of this point with that of the other point. Returns -1 if this point's value is less, 1 if greater, and 0 otherwise.*
ConstrainAngle (constraintAngle: Double, Anchor: IPoint, allowOpposite: Boolean)	*Moves this point to the closest point on the infinite line defined by anchor and angle (in radians). If allowOpposite is true, then the point can also snap to angle + pi radians.*
ConstrainDistance (constraintRadius: Double, Anchor: IPoint)	*Project this point to the perimeter of the circle defined by radius and anchor.*
PutCoords (X: Double, Y: Double)	*Sets the X and Y coordinates.*
QueryCoords (out X: Double, out Y: Double)	*Copies the X and Y coordinates.*

The *IPoint::X* and *IPoint::Y* properties return or set the *Point*'s spatial coordinates. The properties cannot be read from an empty *Geometry* (one that has not had its shape defined), and *esriGeometryError* 514 ("Empty Geometry") will be raised if this is attempted. The *PutCoords* and *QueryCoords* methods get and set the x,y coordinates in a single method call.

A *Point* may also have a z-attribute, stored in the *Z* property. This attribute can be used as a z or height coordinate to help construct 3D geometries, such as *MultiPatch*. The *M* property stores a measure value, which is a numeric value used by dynamic segmentation routines. For more information on dynamic segmentation, see Chapter 8, 'Accessing the geodatabase'. The *Z* and *M* properties both have a default value that is not a number (NaN).

For more information about working with z-, m- and ID values, see the geometry attributes section in this chapter.

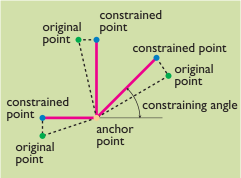
A *Point* has a third attribute, a *Long* integer value stored in the ID property, which has a default value of zero. This value is not used by any other ArcObjects objects and can therefore be used programmatically as you decide.

You can set the appropriate awareness for a *Point* object as shown in the code below.

```
Dim pZAware As IZAware
Set pZAware = pPoint1
pZAware.ZAware = True
pPoint1.Z = 11.1
```

The *ConstrainAngle* and *ConstrainDistance* methods are ideal for exact correction of existing point locations. Relative to an anchor point, *ConstrainAngle* corrects a point's location to the specified angle, and *ConstrainDistance* corrects to a specified distance. The code below corrects the angle of a line to lie on the nearest of eight compass points (0, 45, 90, 135, 180, -135, -90, or -45 degrees).

```
Dim dblSize As Double
'This formula calculates the angle in-between compass points, in Radians
dblSize = 45 / 180 * 3.14159265358979
```



ConstrainAngle and ConstrainDistance can be used to "tidy up" the location of points. For example, the code shown will restrict points to lie exactly North, North East, East, and so on, from a central point.

```
Dim pPoint As IPoint
Set pPoint = pLine.ToPoint
' You cannot directly set a Line Angle, so ConstrainAngle is used instead
pPoint.ConstrainAngle dblSize * Round(pLine.Angle / dblSize), _
  pLine.FromPoint, False
pLine.ToPoint = pPoint
```

Compare is a method used internally by ArcObjects to compare x-, y-, z-, m-, and ID values and can be used to sort *Points* into lexicographical order. If you wish to compare the spatial location of two points, you may wish to use the *IRelationalOperator::Equals* instead, which compares x, y, and *SpatialReference*. Alternatively, use the *IClone::IsEqual* method to check if the coordinate and attribute properties are equal (depending on their attribute awareness).

A *Point* is the simplest shape to define. Its x,y coordinates can be set directly.

```
Dim pPoint As IPoint
Set pPoint = New Point
pPoint.X = 10
pPoint.Y = 20
```

Alternatively, the *PutCoords* method can be used to set both coordinates in a single call.

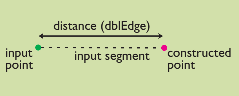
```
pPoint.PutCoords 10, 20
```

IConstructPoint : IUnknown	***Provides access to members that construct a point using other geometries and measures.***
← ConstructAlong (curve: ICurve, Extension: tagesriSegmentExtension, Distance: Double, asRatio: Boolean)	*Constructs a point distance units along the input curve.*
← ConstructAngleBisector (from: IPoint, through: IPoint, to: IPoint, Distance: Double, bUseAcuteAngle: Boolean)	*Constructs a point lying along the bisector of the angle defined by three points.*
← ConstructAngleDistance (p: IPoint, inAngle: Double, Distance: Double)	*Constructs a point at a specified angle (in radians) from the horizontal axis and a specified distance away from the input point.*
← ConstructAngleIntersection (p1: IPoint, angle1: Double, p2: IPoint, angle2: Double)	*Constructs the point of intersection between two lines defined by the input points and angles (in radians).*
← ConstructDeflection (baseLine: ILine, Distance: Double, inAngle: Double)	*Constructs a point in the polar coordinate system defined by baseLine and its 'from' point. The angle is in radians.*
← ConstructDeflectionIntersection (baseLine: ILine, StartAngle: Double, EndAngle: Double, bRightSide: Boolean)	*Constructs the point of intersection of two rays with origins at the endpoints of the base line and the specified angles (in radians).*
← ConstructOffset (curve: ICurve, Extension: tagesriSegmentExtension, Distance: Double, asRatio: Boolean, Offset: Double)	*Constructs a point distance units along the input curve and offset units perpendicularly away from it.*
← ConstructParallel (Segment: ISegment, Extension: tagesriSegmentExtension, Start: IPoint, Distance: Double)	*Constructs a point distance units from start, parallel to the tangent at the nearest point on the (extended) segment.*
← ConstructPerpendicular (base: ISegment, Extension: tagesriSegmentExtension, from: IPoint, Distance: Double, bUseLineOrientation: Boolean)	*Constructs a point along the line normal to base and passing through from.*
← ConstructThreePointResection (pPoint1: IPoint, angleP1P2: Double, pPoint2: IPoint, angleP2P3: Double, pPoint3: IPoint, out arcAngle: Double)	*Constructs the point of observation from which two signed angles between three points were measured; returns an angle which can help establish the confidence of the observation location: A small angle indicates greater uncertainty in the location.*

The *IConstructPoint* interface offers numerous other ways to define a *Point*'s location based on other existing geometries.

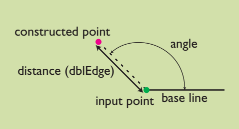
The *ConstructAngleDistance* method defines a point to be a specified distance from an existing *Point* at a specified angle.

The *ConstructDeflection* is a similar method, but it allows you to construct the *Point* at a specified angle from an existing *Line*, at a specified distance. These methods are used together in the function below, which constructs and returns a regular polygonal *Ring* where *pStart* is the first vertex of the shape, *dblEdge* is the length of an edge, and *intSides* is the number of sides required on the polygon.



ConstructAngleDistance *is used in this code to create a point at a known distance from an existing point.*

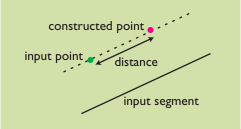
Segments are added by reference to a SegmentCollection*. You want to use the original orientation of the* Line *as the baseline, but the opposite orientation to add to the* Ring*, so you should clone the* Line *before adding the* Line *to the* Ring*. The* CloneMe *function returns a clone of the input object.*



ConstructDeflection *is used in this code to create a new point at a particular angle from the existing line.*

```
Private Function fnMakeRing(pStart As iPoint, dEdge As Double, iSides As _
Integer) As ISegmentCollection

  Set fnMakeRing = New Ring

  Dim dAngle As Double
  ' This formula calculates internal angle of the regular polygon in Radians
  dAngle = 3.14159265358979 - (6.28318530717958 / iSides)

  Dim pEnd As IConstructPoint
  Set pEnd = New Point
  ' Use ConstructAngleDistance to make the first Line
  pEnd.ConstructAngleDistance pStart, 0, dEdge
  Dim pLine As ILine
  Set pLine = New Line
  pLine.PutCoords pStart, pEnd

  Dim pSwitchLine As ILine
  Set pSwitchLine = CloneMe(pLine)
  pLine.ReverseOrientation
  fnMakeRing.AddSegment pLine

  ' Here, ensure the last Point and first Point of the Ring are identical
  Dim i As Long
  For i = 0 To iSides - 2
    If i = iSides - 2 Then
      Set pEnd = fnMakeRing.Segment(0).FromPoint
    Else
      ' Create a point at a constant angle from the last Line constructed.
      Set pEnd = New Point
      pEnd.ConstructDeflection pSwitchLine, dEdge, dAngle
    End If

    ' Here, add a reference to the new Line to the SegmentCollection
    Set pLine = New Line
    pLine.PutCoords pStart, pEnd
    fnMakeRing.AddSegment pLine

    ' These Lines set up the objects for the next iteration
    Set pStart = pEnd
    Set pSwitchLine = CloneMe(pLine)
    pSwitchLine.ReverseOrientation
  Next i
End Function
```

The *ConstructParallel* method can be used to define a *Point* parallel to an existing *Segment*. The *ConstructOffset* method returns a *Point* offset by a certain distance from an existing *Line*. These methods are demonstrated in the code below, where they are combined to make a function that constructs a *Line* parallel to an existing *Line*, *pLine*, at a distance of *dblDist* units.

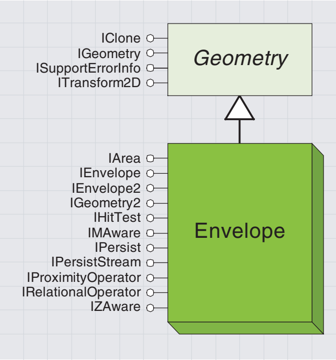


ConstructParallel *is used in this code to help create parallel lines.*

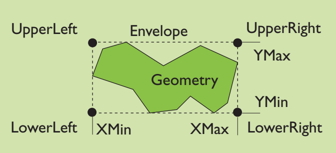
The ConstructOffset *method also has a distance parameter.This function could be rewritten using two calls to* ConstructOffset *instead.*

```
Function fnMakeParallel(pLine As ILine, dDist As Double) As ILine
  If Not pLine Is Nothing Then
    Dim pFromPoint As IConstructPoint
    Set pFromPoint = New Point
    pFromPoint.ConstructOffset pLine, esriNoExtension, 0, False, dDist

    Dim pToPoint As IConstructPoint
    Set pToPoint = New Point
    pToPoint.ConstructParallel pLine, esriNoExtension, pFromPoint, _
      pLine.Length

    Set fnMakeParallel = New Line
    fnMakeParallel.PutCoords pFromPoint, pToPoint
  End If
End Function
```

As you have seen above, the *IConstructPoint* methods, along with other construction methods, can be combined in numerous ways to help you construct even very complex geometrical shapes.



An Envelope *is a rectangular shape. It is generally used in the geometry model as the minimum bounding box of any geometry shape.* Envelopes *are also used throughout ArcObjects, for example, as the extent of a view or geodataset or as the result of a feedback operation.*



An Envelope *is defined by the minimum and maximum x,y coordinates. It also defines the coordinates of each of its corners.*

The *Envelope* coclass defines a rectangular shape by its minimum and maximum x,y coordinates. Therefore, an *Envelope* is always orthogonal to its *SpatialReference*. An *Envelope* may also define minimum and maximum z- and m-values, depending on the implemented *IZAware* and *IMAware* interfaces.

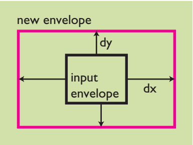
IEnvelope : IGeometry	***Provides access to members that set and return properties of envelopes.***
Depth: Double	*The depth of the envelope.*
Height: Double	*The height of the envelope.*
LowerLeft: IPoint	*The lower left corner.*
LowerRight: IPoint	*The lower right corner.*
MinMaxAttributes: _esriPointAttributes	*A reference to the attribute structures for this envelope.*
MMax: Double	*The maximum measure value in the area of the envelope.*
MMin: Double	*The minimum measure value in the area of the envelope.*
UpperLeft: IPoint	*The upper left corner.*
UpperRight: IPoint	*The upper right corner.*
Width: Double	*The width of the envelope.*
XMax: Double	*The position of the right side.*
XMin: Double	*The position of the left side.*
YMax: Double	*The position of the top.*
YMin: Double	*The position of the bottom.*
ZMax: Double	*The maximum Z value in the area of the envelope.*
ZMin: Double	*The minimum Z value in the area of the envelope.*
CenterAt (p: IPoint)	*Moves this envelope so it is centered at p.*
DefineFromPoints (Count: Long, in Points: IPoint)	*Defines the envelope to cover all the points.*
DefineFromWKSPoints (Count: Long, in Points: _WKSPoint)	*Defines the envelope to cover all the points.*
Expand (dx: Double, dy: Double, asRatio: Boolean)	*Moves the X and Y coordinates of the sides toward or away from each other.*
ExpandM (dm: Double, asRatio: Boolean)	*Moves the measure of the sides toward or away from each other.*
ExpandZ (dz: Double, asRatio: Boolean)	*Moves the Z attribute of the sides toward or away from each other.*
Intersect (inEnvelope: IEnvelope)	*Adjusts to include only the area also included by inEnvelope.*
Offset (X: Double, Y: Double)	*Moves the sides x units horizontally and y units vertically.*
OffsetM (M: Double)	*Moves the sides m units.*
OffsetZ (Z: Double)	*Moves the sides z units.*
PutCoords (XMin: Double, YMin: Double, XMax: Double, YMax: Double)	*Constructs an envelope from the coordinate values of lower, left and upper, right corners.*
PutWKSCoords (e: _WKSEnvelope)	*Copies e's dimensions into this envelope.*
QueryCoords (out XMin: Double, out YMin: Double, out XMax: Double, out YMax: Double)	*Returns the coordinates of lower, left and upper, right corners.*
QueryWKSCoords (out e: _WKSEnvelope)	*Copies the left, bottom, right and top sides into e.*
Union (inEnvelope: IEnvelope)	*Adjusts to overlap inEnvelope.*

The *IEnvelope* interface provides the *XMax, XMin, YMax, YMin, Height,* and *Width* properties, allowing you to return and set the spatial coordinates of an existing *Envelope*. Setting *Width* or *Height* changes the *XMax* or *YMax* property, respectively. For example, the code:

```
pEnv.XMax = pEnv.XMax + 10
```

has exactly the same effect on the *Envelope* as:

```
pEnv.Width = pEnv.Width  + 10
```



Expand *will stretch an envelope on all sides.*

The *Expand* method can be used to stretch an *Envelope* by equal amounts (either units or ratio) on both the *XMin* and *XMax* or *YMin* and *YMax* properties. The example above shows the *Envelope* being stretched by 10 units to the right (*XMax*). The code below also stretches the envelope by 10 units by adding 5 units to the *XMax* and subtracting 5 units from the *XMin*.

```
pEnvelope.Expand 5, 0, False
```

The *Offset* method adds a value (either positive or negative) to the *XMin, XMax, YMin,* and *YMax* properties, moving it by the specified amount but retaining the same area. The *CenterAt* method also retains the area, centering the *Envelope* around the specified *Point*.

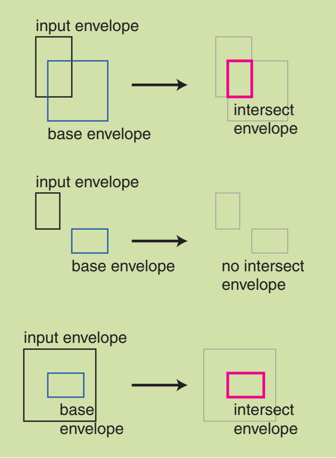
The corners of an *Envelope* can be returned directly from the *UpperLeft, UpperRight, LowerLeft,* and *LowerRight* properties. For example, you can create a *Ring* that traverses the boundary of an *Envelope* using the code below, where *CreateLine* is a function that returns a new *Line* with *FromPoint* and *ToPoint* as specified.

```
Dim pEnv As IEnvelope

Set pMxDocument = Application.Document
Set pActiveView = pMxDocument.FocusMap

Set pEnvelope = pActiveView.Extent

Dim pSegmentColl As ISegmentCollection
Set pSegmentColl = New Ring
pSegmentColl.AddSegment CreateLine(pEnv.UpperLeft, pEnv.UpperRight)
pSegmentColl.AddSegment CreateLine(pEnv.UpperRight, pEnv.LowerRight)
pSegmentColl.AddSegment CreateLine(pEnv.LowerRight, pEnv.LowerLeft)
pSegmentColl.AddSegment CreateLine(pEnv.LowerLeft, pEnv.UpperLeft)
```

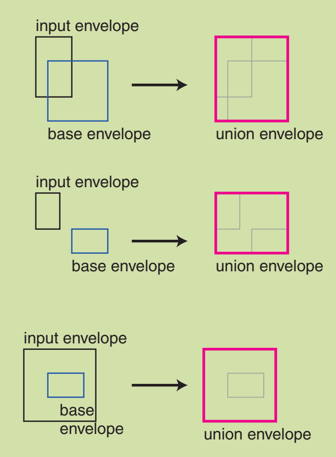
If the *Envelope* is *ZAware*, the *ZMin* and *ZMax* and *Depth* properties can be read and set. Changing the *Depth* property affects the *ZMax* property, reflecting the behavior of *Width* and *Height*.

The *ZMin* and *ZMax* properties of a new *Envelope* default to NaN ("not a number"). If either *ZMin* or *ZMax* has a NaN value, the *Depth* property cannot be read and *esriGeometryError* 564 is raised, indicating the *Geometry* is not z-aware; if both values are NaN, error 580 is raised, indicating that the *Geometry* is not z-simple. *ExpandZ* and *OffsetZ* function similarly to *Expand* and *Offset* but change only the *ZMin* and *ZMax* of a z-aware *Envelope*.

MMin, MMax, ExpandM, and *OffsetM* function in a similar way to the z-properties and methods mentioned above and work in conjunction with the *IMAware* interface.



Intersect *finds the rectangular overlap of two* Envelopes*.*



Union *finds the rectangular union of the bounding box of two* Envelopes*.*

IEnvelope provides two envelope-specific topological methods, *Intersect* and *Union*. *Intersect* changes the input *Envelope* to the area of intersection between itself and the input *Envelope*. The *Union* method operates somewhat differently to the similar method on *ITopologicalOperator*, indicating the minimum bounding box of two *Envelopes*.

The *IEnvelope* interface inherits from *IGeometry* and therefore inherits its own *Envelope* property. This property is present for consistency within the geometry model and simply returns a copy of the original *Envelope*.

For a valid Envelope, *XMin, YMin, ZMin,* and *MMin* must be respectively less than or equal to *XMax, YMax, ZMax,* and *MMax*.

An *Envelope* automatically corrects the x,y coordinates and z- and m-attributes if they are set incorrectly. For example, if *XMin* = 5 and *XMax* = 10, and *XMax* is set to 3, the *Envelope* will switch the new *XMin* and *XMax* values to ensure a valid shape, meaning *XMin* becomes 3 and *XMax* becomes 5.

IEnvelope2 : IEnvelope	***Provides access to members that extend the IEnvelope interface.***
← PutMCoords (MMin: Double, MMax: Double)	*Sets the minimum and maximum M values simultaneously.*
← PutZCoords (ZMin: Double, ZMax: Double)	*Sets the minimum and maximum Z values simultaneously.*
← QueryMCoords (MMin: Double, MMax: Double)	*Queries the minimum and maximum M values simultaneously.*
← QueryZCoords (ZMin: Double, ZMax: Double)	*Queries the minimum and maximum Z values simultaneously.*

The *IEnvelope2* interface provides methods to set both z- or m-attributes simultaneously to avoid problems with the automatic correction mentioned above.

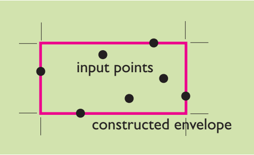
There are a number of different ways to define a new *Envelope*. When working with ArcObjects, you will often find an *Envelope* returned by value as the extent of another spatial object, for example, a *GeoDataset*, *ActiveView*, or another *Geometry*. You can often exploit this to define an *Envelope*, as shown below.

```
Dim pEnvelope as IEnvelope
Set pEnvelope = pGeometry.Envelope
```

You can also define a new *Envelope* from scratch by defining its coordinates. When a new *Envelope* is created, it has no default values of *XMin, XMax, YMin,* and *YMax*—the *Geometry* is empty. Using the *PutCoords* method, you can set all four values at once.

```
Dim pEnvelope As IEnvelope
Set pEnvelope = New Envelope
pEnvelope.PutCoords 0, 0, 10, 10
```

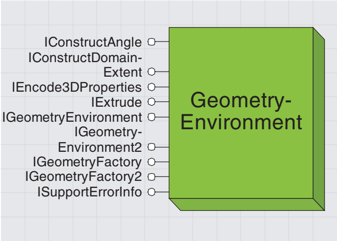
You can define an *Envelope* by setting the *XMin, XMax, YMin,* and *YMax* separately or by setting the corner properties, but watch out for the automatic correction of these properties described previously. Consider using *PutCoords* instead to define the *Envelope* in a single method call.



DefineFromPoints *sets an* Envelope *as the minimum bounding box of an array of* Points.

Alternatively, you can use the *DefineFromPoints* method, which will set the *Envelope* to the minimum bounding box of an array of *Points*. The code below demonstrates this, where *pPoints* is a predefined array of *Point* objects.

```
Dim pEnvelope As IEnvelope
Set pEnvelope = New Envelope
pEnvelope.DefineFromPoints UBound(pPoints) + 1, pPoints(0)
```



A GeometryEnvironment *controls certain aspects of the Geometry system in ArcObjects. It is suitable for use by the more advanced programmer and is not generally required for creating new* Geometries.

The *GeometryEnvironment* is a singleton object that controls certain factors, such as on-the-fly densification limits, and provides methods to allow ArcObjects to create and populate geometries from persistent sources.

To get a reference to the *GeometryEnvironment* singleton object, simply create the object as you would any other coclass.

```
Dim pGeometryEnv as IGeometryEnvironment2
Set pGeometryEnv = New GeometryEnvironment
```

IGeometryEnvironment : IUnknown	*Provides access to members that control the environment for certain geometric operations*
AutoDensifyTolerance: Double	*The tolerance used for on-the-fly densification. If the value is less than or equal to zero, the system will try to pick a reasonable tolerance at the time of densification.*
NoDiceLimit: Long	*The number of vertices for a polygon before the geometry can be exported to a format that can be directly used by the Win32 drawing api (GDI).*

By default, the NoDiceLimit *value is 20,000 vertices, which is suitable for most cases.*

NoDiceLimit controls how geometries are passed to the Win32 drawing API. Windows may have performance issues when drawing *Polygons* with particularly high vertex counts. Therefore, if a *Polygon* has a vertex count greater than this limit, the *Polygon* will be diced into separate trapezoids. These trapezoids are then passed to Windows for drawing.

Users may wish to experiment with increasing this value if they are experiencing problems with drawing complex *Polygons* or *Polylines*, specifically when outputting to a printer device.

IGeometryEnvironment2 : IGeometryEnvironment	*Provides access to members that extend the IGeometryEnvironment interface.*
Pre81Compatibility: Boolean	*Indicates compatibility for some geometric operations with releases previous to 8.1. When set to false, return errors for some illegal relational operations (default is true).*

If *Pre81Compatibility* is *True*, the *GeometryEnvironment* uses the ArcInfo 8.0.2 implementations of *IRelationalOperator*. At ArcGIS 8.1 and later, the relational operators have improved to offer increased error checking, raising errors when the relationship specified is illogical according to the framework for spatial relationships, as defined by Clementini.

You can find details of the framework used for relational operations at Clementini, E., and Di Felice, P. (1993): An Object Calculus for Geographic Databases, *ACM Symposium on Applied Computing, Indianapolis, IN, pp. 302–8.*

This property is *True* by default, indicating that the extra error checking is not used, to ensure existing ArcObjects code is not broken. To ensure that *IRelationalOperator* is used fully, it is recommended that you set *Pre81Compatibility* to *False* if this will not prevent backwards compatibility within your code.

IGeometryFactory : IUnknown	Provides access to members that create geometries in different formats.
← CreateEmptyGeometryByESRIType (ShapeType: tagesriShapeType, out outGeometry: IGeometry)	Create an empty geometry of the specified ESRI shape file type.
← CreateEmptyGeometryByType (GeometryType: tagesriGeometryType, out ppOutGeometry: IGeometry)	Creates an empty geometry of the specified type.
← CreateGeometry (byteCountInOut: Long, in geometryInfo: Unsigned Char, out outGeometry: IGeometry)	Create a point, polyline, polygon, or multipoint from the specified shapefile format buffer.
← CreateGeometryFromEnumerator (geometries: IEnumGeometry) : IGeometry	Creates geometries from geometry enumerator.
← CreateGeometryFromWkb (byteCountInOut: Long, in geometryInfo: Unsigned Char, out outGeometry: IGeometry)	Create a point, polyline, polygon, or multipoint from the specified OGIS WKB format buffer.
← CreateGeometryFromWkbVariant (wkb: Variant, out outGeometry: IGeometry, out cBytesRead: Long)	Create a point, polyline, polygon, or multipoint from the specified OGIS WKB format buffer.

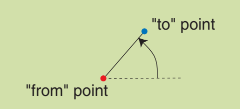
The CreateEmptyGeometry *and* CreateGeometryFromEnumerator *methods are suitable for use from Visual Basic.*

The *IGeometryFactory* interface is used internally in ArcObjects to create and populate *Geometries* in the formats used internally by ArcObjects. Generally, its methods are not suitable for use from Visual Basic®, as they require information not generally available in the Visual Basic environment. However, the *CreateGeometryFromEnumerator* method may be used to create a *GeometryBag* from an enumeration of *Geometries*.

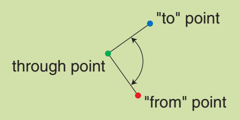
For example, the code below takes an *ISelectionSet* and creates a *GeometryBag* coclass. You could extend the code to create a *GeometryBag* from an entire *FeatureClass* by creating a *SelectionSet* from an entire *FeatureClass*.

```
Dim pEnumGeom As IEnumGeometry
Set pEnumGeom = New EnumFeatureGeometry

Dim pEnumGeometryBind As IEnumGeometryBind
Set pEnumGeometryBind = pEnumGeom
pEnumGeometryBind.BindGeometrySource Nothing, pSelectionSet

Dim pGeomFactory As IGeometryFactory
Set pGeomFactory = New GeometryEnvironment
Dim pGeom As IGeometry
Set pGeom = pGeomFactory.CreateGeometryFromEnumerator(pEnumGeom)
```

C++ programmers or advanced Visual Basic programmers may wish to use the *CreateGeometry* method if they already hold a reference to an *ESRIShape*, for example, from a shapefile buffer, or use *CreateGeometryFromWkb* or *CreateGeometryFromWkbVariant* if they already hold a reference to a *WKB* or *WKBVariant* shape.



ConstructLine *returns the angle of a known* Line.



ConstructThreePoints *returns the angle between three known* Points.

IConstructAngle : IUnknown	**_Provides access to members that construct an angle using other geometries and measures._**
← ConstructLine (InLine: ILine) : Double	*Constructs the angle between the infinite line containing the input line segment and the positive x-axis.*
← ConstructThreePoint (from: IPoint, through: IPoint, to: IPoint) : Double	*Constructs the angle included in three points.*

The *IConstructAngle* interface aids in the calculation of angles, which may then be used in other geometry constructors. Values are returned in radians.

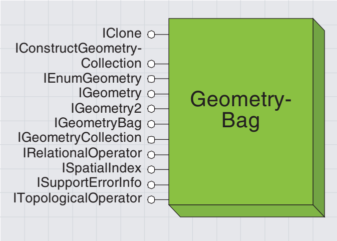
Extrusion is a process generally used (via the *IConstructMultiPatch* interface) to extrude *Polylines, Polygons,* or *Envelopes* to create 3D *MultiPatch* geometries. However, the *IExtrude* interface also allows the extrusion of *Points* or *Multipoints* to create *Polylines*. For more information on the use of the extrusion methods, see the 3D geometry section later in this chapter.

IExtrude : IUnknown	**_Provides access to members that can be used to take a geometry and connect it to a translated version of itself to generate a higher-dimensional geometry._**
← Extrude (OffsetZ: Double, baseGeom: IGeometry) : IGeometry	*Extrude using an input geometry as one base and offsetting the Zs already set on the input geometry to get the second base.*
← ExtrudeAbsolute (toZ: Double, baseGeom: IGeometry) : IGeometry	*Extrude a geometry using its initial Zs for one base, and a uniform input Z for the other.*
← ExtrudeAlongLine (extrusionLine: ILine, baseGeom: IGeometry) : IGeometry	*Extrude a geometry along a specified line, using the Zs on the two ends of the line to set Zs on the top and bottom.*
← ExtrudeBetween (fromSurface: IFunctionalSurface, toSurface: IFunctionalSurface, baseGeom: IGeometry) : IGeometry	*Extrude a geometry between two functional surfaces.*
← ExtrudeFromTo (fromZ: Double, toZ: Double, baseGeom: IGeometry) : IGeometry	*Extrude a geometry between two specified Z values.*
← ExtrudeRelative (extrusionVector: IVector3D, baseGeom: IGeometry) : IGeometry	*Extrude a geometry along a specified vector, using Zs already set on the input geometry.*

The *IExtrude* interface provides methods to create new geometries from existing geometries by a process of extrusion, where the new geometry has one more dimension than the input. For example, a *Point* may be extruded to a *Line*, or a *Polygon* may be extruded to a *MultiPatch*.

IEncode3DProperties : IUnknown	**_Provides access to members that encode and decode normals and 2D texture coordinates into a single double value._**
← PackNormal (normalVector: IVector3D, packedNormal: Double)	*Encodes a normal into part of a double. A normal and texture information can both be packed in a single double without conflict.*
← PackTexture2D (textureS: Double, textureT: Double, packedTexture: Double)	*Encodes texture coordinates into part of a double. A normal and texture information can both be packed in a single double without conflict.*
← UnPackNormal (packedNormal: Double, normalVector: IVector3D, wasProductive: Boolean)	*Decodes a normal from a double.*
← UnPackTexture2D (packedTextureST: Double, textureS: Double, textureT: Double, wasProductive: Boolean)	*Decodes texture coordinates.*

The *IEncode3DProperties* interface allows the storage of normal and texture attributes on a *Geometry*. This interface provides a temporary solution to storing these values for use by 3D applications.



A geometry bag is a convenient place to keep assorted geometry objects. You can add any IGeometry *object to the bag.*

A *GeometryBag* can be thought of as a convenient programmatic place to keep *Geometries*. Unlike a standard collection or array, the *GeometryBag* itself implements *IGeometry*, which allows you to use the inherited properties and methods on the *GeometryBag* as a whole. A *GeometryBag* preserves the order of its members.

A *GeometryBag* with no *Geometries* has a *Dimension* of *esriGeometryNoDimension*. If the *SpatialReference* of a *GeometryBag* is set, each contained *Geometry* will reference this property in its *SpatialReference*—so ensure that all your *Geometries* share the same *SpatialReference* if you intend to do this. If you do not set the *SpatialReference* of the *GeometryBag* coclass, each *Geometry* will maintain any existing reference to an existing *SpatialReference*.

IGeometryBag : IGeometry	***Provides access to members that identify a geometry bag***
LosslessExport: Boolean	*Indicates when this geometry bag exported itself to a shapefile buffer with no loss of information.*

The *IGeometryBag* interface has only one property, which is used in conjunction with the restricted *IESRIShape* interface.

GeometryBag supports a number of other interfaces, such as *IClone, IRelationalOperator, ISpatialIndex,* and *ITopologicalOperator*. To use these interfaces, ensure that all contained geometries also support the required interface. These interfaces have limited use for a *GeometryBag*—you can use *Simplify* and *Buffer* operations on *ITopologicalOperator, Assign* and *Clone* on *IClone*, and all methods on *IRelationalOperator* except *Equal*, although the relational operations may be uninformative if used on geometries with varied dimensions.

The Multipoint, Polygon, *and* Polyline *coclasses also support* ISpatialIndex.

ISpatialIndex : IUnknown	***Provides access to members that create a temporary spatial index to select by location***
AllowIndexing: Boolean	*Indicates permission for creation of a spatial index for the geometry.*
Invalidate	*Invalidate the spatial index.*

ArcObjects uses spatial indices on *FeatureClasses* to improve access times on spatial queries. Separate temporary indices can also be created for individual *Geometries* using the *ISpatialIndex* interface. You could create an individual index on a *GeometryBag* like this:

```
Dim pSpatialIndex As ISpatialIndex
Set pSpatialIndex = pBag
pSpatialIndex.AllowIndexing = True
```

This line of code updates the index and should be used if the members of the bag change.

```
pSpatialIndex.Invalidate
```

Individual geometry indices may help to speed up spatial operations on particularly large shapes, for example, *Point* in *Polygon* type operations, *Polygon* or *Polyline* intersection operations, *GeometryBag* relation operations, or operations that identify individual *Segments* within a *Geometry*. You may wish to use indices if the *Geometry* is particularly large, but do not use an index if the *Geometry* changes often, as the index must be rebuilt each time the shape changes.

To add geometries to a *GeometryBag*, use the *IGeometryCollection* interface.

```
Dim pGeomColl as IGeometryCollection
Set pGeomColl = New GeometryBag
pGeomColl.AddGeometry pPolygon
pGeomColl.AddGeometry pPoint   ' And so on
```

IConstructGeometryCollection : IUnknown	***Provides access to members that construct a collection of geometries***
← ConstructDivideEqual (divideSource: IPolyline, cDivisions: Long, divideHow: tagesriConstructDivideEnum)	*Locate additional points equally spaced along the input polyline, and create either new segments, parts or polylines depending on the value of divideHow.*
← ConstructDivideLength (divideSource: IPolyline, Length: Double, asRatio: Boolean, divideHow: tagesriConstructDivideEnum)	*Locate additional points along the input polyline, spaced at a specified interval, and create either new segments, parts, or polylines depending on the value of divideHow.*

Alternatively, the *IConstructGeometryCollection* interface provides methods to define the shapes in a *GeometryBag* using other existing *Geometries*.

Both methods create a *GeometryBag* containing *Polylines*, defined by splitting an existing *Polyline* into many separate *Polylines*.

Certain geometries define their shape by holding a collection of references to other geometries. For example, a *Polygon* holds a collection of references to *Rings*. The *IGeometryCollection, ISegmentCollection,* and *IPointCollection* interfaces provide functionality to access the individual constituents of a *Geometry* to add new references, rearrange references, and remove references. Understanding these interfaces is an essential part of working with the ArcObjects geometry model.

IGeometryCollection *is implemented by all geometries that reference a collection of other geometries—*Polygons, Polylines, Multipoints, MultiPatches, TriangleStrips, TriangleFans, *and* GeometryBags.

IGeometryCollection : IUnknown	***Provides access to members that can be used for accessing, adding and removing individual geometries of a multi-part geometry (Multipoint, Polyline, Polygon, MultiPatch, and GeometryBag).***
▪— Geometry (Index: Long) : IGeometry	*Returns a reference to the ith geometry.*
▪— GeometryCount: Long	*Returns the number of geometries in this collection.*
← AddGeometries (Count: Long, in newGeometries: IGeometry)	*Adds references to geometries in the input array.*
← AddGeometry (inGeometry: IGeometry, before: Variant, after: Variant)	*Adds a reference to the input geometry either at the end, or before, or after the specified index.*
← AddGeometryCollection (newGeometries: IGeometryCollection)	*Adds references to geometries in the input collection.*
← GeometriesChanged	*Tells this geometry collection that some of its geometries have been altered.*
← InsertGeometries (Index: Long, Count: Long, in newGeometries: IGeometry)	*Insert references to geometries in the input array.*
← InsertGeometryCollection (Index: Long, newGeometries: IGeometryCollection)	*Inserts reference to geometries in the input collection.*
← QueryGeometries (Index: Long, Count: Long, out geometries: IGeometry)	*Returns references to a sub-sequence of geometries.*
← RemoveGeometries (Index: Long, Count: Long)	*Removes references to some geometries.*
← SetGeometries (Count: Long, in newGeometries: IGeometry)	*Replaces all current geometries with references to those in the input array.*
← SetGeometryCollection (newParts: IGeometryCollection)	*Replacess all current geometries with references to geometries from the input collection.*

The *IGeometryCollection* interface holds a collection of references to the parts of a multipart geometry and allows you to add, change, and remove those parts (note the use of the *GeometriesChanged* method, discussed later in this section, if you are editing a geometry).

- For the *GeometryBag* coclass, each part *Geometry* can be any type of *Geometry*.

If the coclass is a Polygon*, add a* Ring *using* AddGeometry*, an array of* Rings *using* AddGeometries*, or another* Polygon *using* AddGeometryCollection*. If, however, the coclass is a* MultiPatch*, add a surface patch (a* TriangeFan, TriangleStrip*, or* Ring*) using* AddGeometry*, an array of surface patches using* AddGeometries*, or another* MultiPatch *using* AddGeometryCollection.

- For the *Polygon* coclass, each part *Geometry* is a *Ring*.
- For the *Polyline* coclass, each part *Geometry* is a *Path*.
- For the *Multipoint* coclass, each part *Geometry* is a *Point*.
- For the *MultiPatch* coclass, each part *Geometry* is a *TriangleFan, TriangleStrip,* or a *Ring*.
- For the *TriangleFan* coclass, each part *Geometry* is a *Point* or *Multipoint*.
- For the *TriangleStrip* coclass, each part *Geometry* is a *Point* or *Multipoint*.

The *Geometry* property holds a read-only array of the parts of a shape, with *GeometryCount* providing a count of those parts. This code uses these properties to iterate a *MultiPatch* shape and find out what constituent geometries it has.

```
Dim pGeomColl As IGeometryCollection, i As Integer
Set pGeomColl = pMultipatch
For i = 0 To pGeomColl.GeometryCount - 1
  If pGeomColl.Geometry(i).GeometryType = esriGeometryRing Then
```

```
    Debug.Print i & ": Ring"
  ElseIf pGeomColl.Geometry(i).GeometryType = esriGeometryTriangleFan Then
    Debug.Print i & ": TriangleFan"
  ElseIf pGeomColl.Geometry(i).GeometryType = _
                                   esriGeometryTriangleStrip Then
    Debug.Print i & ": TriangleStrip"
  End If
Next i
```

If you have numerous geometries to add to a collection, using the array-based AddGeometries *method will be more efficient than calling* AddGeometry *repeatedly. The* InsertGeometries *method is also array based.*

Geometries can be added singly using *AddGeometry* or as an array of geometries using *AddGeometries*. The two methods have one important difference—the *AddGeometry* method allows you to specify where to add the *Geometry* to the collection using an index. The *AddGeometries* method adds the geometries to the end of the collection, making them the last parts in the shape.

Below, the *AddGeometry* method is used to add the *Geometry* of one single-part *Polygon* to a second single-part *Polygon*, creating a *Polygon* with two parts. If the parts overlap, are not closed, or have a containment relationship, the *Polygon* will not be simple. Therefore, *Simplify* is called to ensure the *Polygon* has a valid geometry.

```
Dim pGeomColl1 As IGeometryCollection
Dim pGeomColl2 As IGeometryCollection
Set pGeomColl1 = pExistingPolygon1
Set pGeomColl2 = pExistingPolygon2
pGeomColl1.AddGeometry pGeomColl2.Geometry(0)
Dim pTopological As ITopologicalOperator
Set pTopological = pGeomColl1
pTopological.Simplify
```

The *AddGeometryCollection* method adds a reference to every *Part* in a *Polygon* to the base *Polygon*. You may wish to use this method to combine *Polygons* with more than one part (although you can also use it regardless of the part count of a geometry):

```
pGeomColl1.AddGeometryCollection pGeomColl2
```

If the incorrect coclass is passed to these methods, this is indicated by error 522.

Using the *InsertGeometries* or *InsertGeometryCollection* methods, you can insert parts into an existing *GeometryCollection* at a certain index. Parts are removed using the *RemoveGeometries* method. The *SetGeometries* and *SetGeometryCollection* methods replace all existing parts of a shape with the specified parts.

The code below removes all parts of a *Polyline* that are closed *Paths*, where *pPolyline* is an existing multipart *Polyline Geometry*.

```
Dim pGeomColl As IGeometryCollection
Set pGeomColl = pPolyline
If Not pPolyline.IsEmpty Then
  Dim i As Integer
  Dim pPath As IPath
  Do While i < pGeomColl.GeometryCount
    Set pPath = pGeomColl.Geometry(i)
    If pPath.IsClosed Then
```

```
      pGeomColl.RemoveGeometries i, 1
        i = i - 1
      End If
      i = i + 1
    Loop
  End If
```

Calling the *GeometriesChanged* method indicates to a *Geometry* that its parts have been altered. It should be called in a situation where you are holding a variable that has also been added to an *IGeometryCollection* interface, and you then make changes to the original variable. There is no need to call this method after using the *IGeometryCollection* methods to alter the *Geometry*.

The ISegmentCollection *interface provides access to individual* Segments *of geometries that are composed of* Segments. *It is implemented by the* Path, Ring, Polygon, *and* Polyline *coclasses.*

Generally when working with multipart geometries, that is, the Polygon *or* Polyline *coclasses,* IGeometryCollection *should be used in preference to* ISegmentCollection *if* Segments *are to be removed or added, to avoid potential problems with the parts of the shape, or in performance-critical situations.*

ISegmentCollection : IUnknown	***Provides access to members that manipulate the segments of a path, ring, polyline, or polygon***
■— EnumCurve: IEnumCurve	*Returns a new curve enumerator for this segment collection.*
■— EnumSegments: IEnumSegment	*Returns a new enumerator for this segment collection.*
■— IndexedEnumSegments (pQuery: IGeometry) : IEnumSegment	*Returns a new indexed curve enumerator for this segment collection.*
■— Segment (i: Long) : ISegment	*Returns a reference to the ith segment.*
■— SegmentCount: Long	*Returns the number of segments.*
← AddSegment (inSegment: ISegment, before: Variant, after: Variant)	*Adds a reference to the input segment at the end, or before or after a specified index.*
← AddSegmentCollection (segments: ISegmentCollection)	*Adds references to the segments from the specified segment collection.*
← AddSegments (Count: Long, in newSegments: ISegment)	*Adds references to segments.*
← HasNonLinearSegments (pbNonLinearSegments: Boolean)	*Indicates when this segment collection contains segments other than lines.*
← InsertSegmentCollection (Index: Long, newSegments: ISegmentCollection)	*Inserts references to the segments in the input collectoin.*
← InsertSegmentCollectionEx (Index: Long, Start: Long, Count: Long, newSegments: ISegmentCollection)	*Inserts references to some of the segments from the input collection.*
← InsertSegments (Index: Long, Count: Long, in newSegments: ISegment)	*Inserts references to the input segments.*
← QuerySegments (Index: Long, Count: Long, out segments: ISegment)	*Returns references to some of the input segments.*
← RemoveSegments (Index: Long, Count: Long, closeGap: Boolean)	*Removes references to some segments. If closeGap is TRUE, then any remaining internal gap in the path, ring, polyline or polygon is connected with a single line segment.*
← ReplaceSegmentCollection (Index: Long, goingAway: Long, newSegments: ISegmentCollection)	*Remove and inserts some segments.*
← ReplaceSegments (Index: Long, comingIn: Long, goingAway: Long, newSegments: ISegment)	*Removes and inserts from segments.*
← SegmentsChanged	*Informs the segmentcollection that any cached values that it may be maintaining (envelope, length, etc.) are invalid.*
← SetCircle (cp: IPoint, circleRadius: Double)	*Defines this path, ring, polyline or polygon to contain a single circular arc segment that is closed.*
← SetRectangle (inEnvelope: IEnvelope)	*Defines this path, ring, polyline or polygon to have four line segments in the same positions as the sides of the input envelope.*
← SetSegmentCollection (newSegments: ISegmentCollection)	*Replaces all segments with references to segments from the input collection.*
← SetSegments (Count: Long, in newSegments: ISegment)	*Replaces all segments with references to the input segments.*
← SynchronizeEmptyAttributes	*If, at end point shared by two segments, one segment has an empty value for an attribute and the other has a non-empty value, use the non-empty value for both.*

AddSegment is used to add references to single *Segments* to a *SegmentCollection*. The following code creates a new *Line* and uses the *AddSegment* method to add a reference to this *Line* to a new *Path*.

Note here that Segments *are added to* ISegmentCollection *by reference, but* Points *are added to a* Line *by value.*

```
Dim pLine As ILine
Set pLine = New Line
pLine.PutCoords pPoint1, pPoint2

Dim pSegments As ISegmentCollection
Set pSegments = New Path
pSegments.AddSegment pLine
```

Alternatively, *AddSegments* can be used to add references to an array of *Segments*, or *AddSegmentCollection* can be used to add references to all the *Segments* from another *ISegmentCollection*. Be careful when sharing references to Segments—you are only copying references to the same underlying objects.

The *InsertSegments, InsertSegmentCollection, RemoveSegments, ReplaceSegments, ReplaceSegmentCollection, SetSegmentCollection,* and *SetSegments* methods can be used to change and rearrange *Segments* in the collection.

The *SegmentsChanged* method is similar to the *IGeometryCollection::GeometriesChanged* method and should be called in a situation where you are holding a reference to a *Segment* of a *SegmentCollection* as well as to the *SegmentCollection* itself, and you change the properties of the *Segment* object directly.

HasNonLinearSegments is a useful check on a *SegmentCollection*; it indicates the presence of a *CircularArc, EllipticArc,* or *BezierCurve* within the collection. These *Segment* types may not be supported by all data formats. For example, a shapefile cannot store a nonlinear feature—it will be converted to a linear approximation if you attempt this.

The *SetCircle* and *SetRectangle* methods provide a simple way to construct an entire *Path, Ring, Polyline,* or *Polygon* without adding separate *Segments* to the *ISegmentCollection*. The *SetCircle* method works similarly to the *ICircularArc::ConstructCircle* method—it takes a center *Point* and radius and produces a single *CircularArc* representing a full circle. The *SetRectangle* method creates four *Line Segments* that equal the sides of the input *Envelope*.

The MultiPoint, TriangleFan, *and* TriangleStrip *coclasses base their geometry on* Point *objects. These coclasses implement* IPointCollection, *providing methods and properties to investigate, add, rearrange, and replace the individual* Points *of these geometries. For these coclasses, the methods and properties use references to the original* Point *objects.*

A second type of geometry also implements IPointCollection. *The* Path, Ring, Polygon, Polyline, *and* MultiPatch *geometries are not based on* Point *objects but can be represented by collections of* Points. *In these cases, the* Point *objects are passed by value. For these coclasses, new* Point *objects are created in memory as required. Ensure that your code takes account of this difference.*

The MultiPatch *coclass is based on both these types of geometries and will return* Points *either by reference (for* TriangleFans *or* TriangleStrips*) or by value (for* Rings*).*

If you are using the IPointCollection *interface of a multipart shape, for example, a* Polygon *or* Polyline *coclass, care should be taken if adding or removing* Points. *To avoid potential problems with the parts of the multipart shape, you may prefer to use the* IGeometryCollection *interface instead.*

IPointCollection : IUnknown	***Provides access to members that manipulate the points of a Multipoint, Path, Ring, Polyline, Polygon, TriangleFan, TriangleStrip, or MultiPatch.***
■— EnumVertices: IEnumVertex	*Returns a new enumerator for this point collection.*
■— Point (i: Long) : IPoint	*Returns a copy of the ith vertex of a Path, Ring, Polyline, or Polygon; or a reference to the ith point of a Multipoint, TriangleFan, or TriangleStrip.*
■— PointCount: Long	*Returns the number of points in the collection.*
← AddPoint (inPoint: IPoint, before: Variant, after: Variant)	*Adds a vertex to a Path, Ring, Polyline, or Polygon; or adds a reference to the input point to a Multipoint, TriangleFan, or TriangleStrip.*
← AddPointCollection (newPoints: IPointCollection)	*Adds copies of points in the input point collection to this Path, Ring, Polyline, or Polygon; or adds references to the points in the collection to this Multipoint, TriangleFan, or TriangleStrip.*
← AddPoints (Count: Long, in newPoints: IPoint)	*Adds copies of the input points as vertices to this Path, Ring, Polyline, or Polygon; or references to the input points to this Multipoint, TriangleFan, or TriangleStrip.*
← AddWKSPoints (Count: Long, in pointStructures: _WKSPoint)	*Adds vertices to this Path, Ring, Polyline, or Polygon, or adds new points to this Multipoint, TriangleFan, or TriangleStrip.*
← InsertPointCollection (Index: Long, newPoints: IPointCollection)	*Inserts copies of points, from the input point collection, as vertices into this Path, Ring, Polyline, or Polygon; or references to points in the input point collection into this Multipoint, TriangleFan, or TriangleStrip.*
← InsertPoints (Index: Long, Count: Long, in newPoints: IPoint)	*Inserts copies of the input points as vertices into a Path, Ring, Polyline, or Polygon; or references to the input points into a Multipoint, TriangleFan, or TriangleStrip.*
← InsertWKSPoints (Index: Long, Count: Long, in newPoints: _WKSPoint)	*Inserts new vertices/points into this Path, Ring, Polyline, Polygon, Multipoint, TriangleFan, TriangleStrip, or MultiPatch.*
← QueryPoint (Index: Long, pPoint: IPoint)	*Queries for a point in the PointCollection at given index.*
← QueryPoints (Index: Long, Count: Long, Points: IPoint)	*Copies some points to an existing array of points.*
← QueryWKSPoints (Index: Long, Count: Long, out pointStructures: _WKSPoint)	*Copies vertices'/points' coordinates to the array of point structures.*
← RemovePoints (Index: Long, Count: Long)	*Removes vertices from a Path, Ring, Polyline, or Polygon, or references to points from a Multipoint, TriangleFan, or TriangleStrip.*
← ReplacePointCollection (Index: Long, goingAway: Long, newPoints: IPointCollection)	*Replaces vertices/points within a PointCollection.*
← ReplacePoints (Index: Long, comingIn: Long, goingAway: Long, in newPoints: IPoint)	*Replaces vertices/points within a PointCollection.*
← SetPointCollection (newPoints: IPointCollection)	*Replaces all vertices of this Path, Ring, Polyline, or Polygon with copies of the points in the input collection; or all points of this Multipoint, TriangleFan, or TriangleStrip with references to points from the input collection.*
← SetPoints (Count: Long, in newPoints: IPoint)	*Replaces all existing vertices of this Path, Ring, Polyline, or Polygon with copies of the input points; or all existing points of this Multipoint, TriangleFan, or TriangleStrip with references to the input points.*
← SetWKSPoints (Count: Long, in pointStructures: _WKSPoint)	*Replaces all vertices of this Path, Ring, Polyline, or Polygon with new ones, or replaces all points of this Multipoint, TriangleFan, or TriangleStrip with new ones.*
← UpdatePoint (i: Long, p: IPoint)	*Changes the ith vertex or point to be a copy of the input point.*

IPointCollection allows you to interact with the *Point* objects that embody the shape of a *Multipoint, TriangleFan,* or *TriangleStrip*. It is analogous to *ISegmentCollection* on a *Path* or *IGeometryCollection* on a *Polyline*. A reference to a *Point* object can be added to a *Multipoint* by using the *AddPoint* method.

The code below uses a *UIToolControl* in a VBA ArcMap session to add a new *Point* to a *Multipoint* (using *AddPoint*) each time the user clicks on the map. Each *Point* in the *Multipoint* gives map coordinates at the location the user clicked.

```
Private pPointColl As IPointCollection
Private pTransformation As IDisplayTransformation

Private Sub UIToolControl1_MouseDown(ByVal button As Long, _
  ByVal shift As Long, ByVal x As Long, ByVal y As Long)
  Dim pPoint As IPoint
  Set pPoint = New Point
  Set pPoint = pTransformation.ToMapPoint(x, y)
  pPointColl.AddPoint pPoint
End Sub

Private Sub UIToolControl1_Select()
  Set pPointColl = New Multipoint
  Dim pMxDoc As IMxDocument
  Set pMxDoc = ThisDocument
  Set pTransformation = _
     pMxDoc.ActiveView.ScreenDisplay.DisplayTransformation
End Sub
```

The *Polygon, Polyline, Path,* and *Ring* coclasses also implement the *IPointCollection* interface. You can take advantage of this to copy the vertices from an existing *Polygon* to a *Multipoint* object by using the *AddPointCollection* method.

```
  If TypeOf pGeometry Is IPointCollection Then
    Dim pPolyPointColl As IPointCollection
    Set pPolyPointColl = pGeometry

    Dim pMultiPointColl As IPointCollection
    Set pMultiPointColl = New Multipoint
    pMultiPointColl.AddPointCollection pPolyPointColl
  End If
```

Alternatively, you can replace all the *Points* in an existing *Multipoint* with references to the *Points* in the *Polygon* by using the *SetPointCollection* instead.

```
  pMultiPointColl.SetPointCollection pPolyPointColl
```

An existing *Point* in the point collection can be changed using the *UpdatePoint* method. For example, the code changes any *Point* in a *Multipoint* that has a y-coordinate greater than zero to zero. The code also uses the read-only *Point* property to query each *Point* and the *PointCount* property to find out how many *Points* are in the *Multipoint, pMulti*.

```
  Dim pTemp As IPoint
  For i = 0 To pMulti.PointCount - 1
    If pMulti.Point(i).y <> 0 Then
      Set pTemp = pMulti.Point(i)
      pTemp.y = 0
      pMulti.UpdatePoint i, pTemp
    End If
  Next i
```

The other methods of *IPointCollection* can be used to add, insert, replace, remove, and query *Points*, arrays of *Points*, and *Points* collections.

The *EnumVertices* property returns an enumerator of the *Points* in the *IPointCollection* interface.

EnumVertex is a lightweight object that you can use to pass around between routines.

You may wish to use this enumerator in preference to the Points array returned by the IPointCollection::Points property, as it allows you to directly change the x-, y-, z-, m-, and ID properties of each Point, although Points cannot be removed or replaced using this interface.

The IEnumVertex has knowledge of parts within multipart shapes and may therefore be convenient for use on a multipart shape, such as a Polygon or Polyline.

IEnumVertex : IUnknown	***Provides access to members that iterate over the vertices of a path, ring, polyline or polygon.***
← Clone: IEnumVertex	*Returns a copy of this enumerator positioned at the same vertex.*
← IsLastInPart: Boolean	*Indicates when the current vertex is last in the current part.*
← Next (out outVertex: IPoint, out outPartIndex: Long, out vertexIndex: Long)	*Returns the next vertex and its location within the geometry.*
← NextInPart (out outVertex: IPoint, out OutVertexIndex: Long)	*Returns the next vertex in current part, or goes back to first vertex after last vertex in part is encountered.*
← Previous (out outVertex: IPoint, out outPartIndex: Long, out vertexIndex: Long)	*Returns the previous vertex and its location in the geometry.*
← put_Attribute (attributeType: esriGeometryAttributes, Value: Double)	*Sets attribute values at the current vertex.*
← put_ID (pointID: Long)	*Sets ID at the current vertex.*
← put_M (M: Double)	*Sets M at the current vertex.*
← put_X (X: Double)	*Sets X at the current vertex.*
← put_Y (Y: Double)	*Sets Y at the current vertex.*
← put_Z (Z: Double)	*Sets Z at the current vertex.*
← QueryNext (Vertex: IPoint, out outPartIndex: Long, out vertexIndex: Long)	*Copies the next vertex to the input parameter and returns its location in the geometry.*
← QueryNextInPart (Vertex: IPoint, out OutVertexIndex: Long)	*Copies the next vertex in current part to the input parameter and returns the next vertex index in current part, or goes back to first vertex after last vertex in part is encountered.*
← QueryPrevious (Vertex: IPoint, out outPartIndex: Long, out vertexIndex: Long)	*Copies the previous vertex to the input parameter and returns the previous vertex in the geometry.*
← Reset	*Starts from the beginning of the geometry the next time Next is called.*
← ResetToEnd	*Starts from the end of the geometry the next time Previous is called.*
← SetAt (iPart: Long, iVertex: Long)	*Resets enumerator to specific location.*
← Skip (cVertices: Long)	*Skips forward or backward over a specified number of vertices.*

The *Next* method populates a *Point* with the next *Point* in the enumerator. It also indicates the current position in the collection by part and vertex number. Calling *Reset* ensures the enumerator is positioned at the beginning of the collection.

```
Dim pEnum As IEnumVertex
Set pEnum = pPointCollection.EnumVertices

pEnum.Reset
Dim pPoint As IPoint, lPart As Long, lVertex As Long

pEnum.Next pPoint, lPart, lVertex
Do While Not pPoint Is Nothing
  Debug.Print pPoint.X, pPoint.Y
  pEnum.Next pPoint, lPart, lVertex
Loop
```

By using the *ResetToEnd* and *Previous* methods, you can iterate backwards through the enumeration.

```
pEnum.ResetToEnd
pEnum.Previous pPoint, lPart, lVertex
Do While Not pPoint Is Nothing
  Debug.Print pPoint.X, pPoint.Y
  pEnum.Previous pPoint, lPart, lVertex
Loop
```

The *Skip* method positions the enumeration cursor by skipping a certain number of *Points*. The *NextInPart* method allows you to loop around a particular part of a multipart shape—remember that *Multipoint* objects only have one single part conceptually, but a *Polygon* or *Polyline* may have many. The code below uses these methods to check the z- and m-values of the first and last point in a part.

```
Dim pEnum As IEnumVertex
Set pEnum = pPolygonPointCollection.EnumVertices
pEnum.Reset

Dim pPoint As IPoint, lPart As Long, lVertex As Long
pEnum.Next pPoint, lPart, lVertex

Do While Not pPoint Is Nothing
  If pEnum.IsLastInPart Then
    Dim pPointFirst As IPoint, lFirstVertex As Long
    pEnum.NextInPart pPointFirst, lFirstVertex
    Debug.Print pPoint.M, pPointFirst.M
    If Not pPoint.M = pPointFirst.M Then
      Debug.Print "Unequal M"
     End If

    pEnum.Skip lVertIndex
    pEnum.Next pPoint, lPart, lVertex

   Else
    pEnum.Next pPoint, lPart, lVertex
   End If
Loop
```

The *Clone* method provides a convenient way to copy an enumeration of *Points*, as the enumeration does not support *IClone*. Additionally, it positions the cloned enumeration at the same point as the original enumeration.

*Geometries can have z-, m-, and/or ID attributes at the point level. If a geometry has attribute awareness (*ZAware*,* MAware*, or* IDAware *= True), it will use the attributes in any appropriate operations.*

If a geometry has its attribute awareness removed (set to False), those attributes will not be used in operations. However, any existing attribute values will remain in memory; therefore, if awareness is removed and then reinstated, the geometry will maintain its set of attributes.The awareness concept provides a level of dynamic type safety and efficiency for geometries and operations that work with attributes.

It may not be possible to perform some attribute operations if the Geometry *is not* MSimple, ZSimple, *or* PointIDSimple.

Geometries may have z-, m-, or ID attributes, which can be used for a variety of purposes. Attributes of geometries can be stored in feature classes of many formats, as long as the feature class has the appropriate awareness (to find out more, check the *HasZ* and *HasM* properties on the *FeatureClass*).

Z-attributes define a value that may be used as a height coordinate by 3D objects and operations. In this case, the units of the z-coordinate are defined by the *SpatialReference* of the *Geometry*.

An m-attribute defines a measure value that represents a relative position along a geometry. Measures are most commonly used to represent distances but can also represent times, costs, or other events that may occur that are not necessarily relative to the spatial coordinates. Features with associated measure information are often termed “measured features”. M-attributes are principally used by dynamic segmentation routines.

ID or Point ID attributes define a value that is not used by other ArcObjects functions and can therefore be used programmatically as you require, perhaps to uniquely tag *Point* objects or to relate vertices of a *Polygon* to rows in a database.

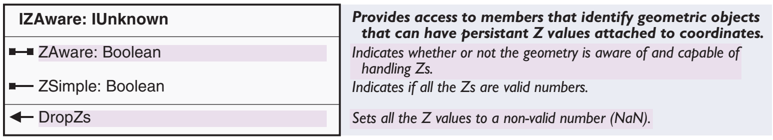
Z-, m-, and ID attributes are stored at a low level on the constituent objects that comprise the *Geometry*; on the *Point* objects that comprise a *Multipoint*, *TriangleFan*, or *TriangleStrip*; or on the *Segment* endpoints of *Polygons* or *Polylines*. For a *MultiPatch* geometry, both cases apply.

A geometry’s attribution awareness, however, is controlled at its highest level. For example, if *ZAware* is set to *True* on a *Multipoint*, *ZAware* will also equal *True* for each of the *Point* objects in the *Multipoint*.

A Segment *has a* FromPoint *and* ToPoint, *and* Points *have z-, m-, and ID attributes. The* ISegmentZ, ISegmentM, *and* ISegmentID *interfaces provide direct access from the* Segment *to these attributes, without having to replace the* FromPoint *and* ToPoint *properties with new* Point *objects.*

Instead of accessing the attributes separately via each *Point* or *Segment* in a *Geometry*, interfaces are provided to deal with attributes via the higher level *Geometry*. Generally, you can read z-, m-, and ID attribute values regardless of the awareness of the *Geometry*, although a good practice would be to set awareness to *True* if you intend to store and use those attributes. Operations that can make use of attributes will only use those attributes if the geometry is aware of them.

The IZAware *interface determines whether or not the* Geometry *object is aware that it may have z-attributes.*



IZAware: IUnknown	***Provides access to members that identify geometric objects that can have persistant Z values attached to coordinates.***
■—■ ZAware: Boolean	*Indicates whether or not the geometry is aware of and capable of handling Zs.*
■— ZSimple: Boolean	*Indicates if all the Zs are valid numbers.*
← DropZs	*Sets all the Z values to a non-valid number (NaN).*

For example, to use a Point *as a three-dimensional object, set the* IZAware *property to* True *and set the* IPoint::Z *property. If you intend to store the* Geometry *in a* FeatureClass, *the* FeatureClass *must support z-values. For more information, see* IGeometry-Def *and* IGeometryDefEdit *in Chapter 8, ‘Accessing the geodatabase’.*

To make a *Geometry* z-aware, simply set the *ZAware* property to *True*. By default, the z-values of a shape will be NaN (“not a number”)—the *ZSimple* property returns *True* if any NaN values remain. To reset all z-values of a *Geometry* to NaN, call *DropZs*.

```
If Not pZaware.ZSimple Then
  pZAware.DropZs
End If
```

Logically, either a shape has no z-values or a complete set of z-values, depending on whether or not you intend to use a *Geometry* as a two- or three-dimensional shape—a non-z-simple shape may not display correctly in ArcScene™ software, for example. If your shape is not z-simple, consider why some z-attributes are missing and what you could do to fill in missing values.

The IZ *interface is used to calculate and set z-attributes on the* Point *objects that represent the vertices (*IPointCollection*) of a* Polyline *or* Polygon *object.You might use* IZ *methods to ensure that a shape does not have inappropriate z- values.*

IZ: IZCollection	***Provides access to members that identify geometric objects that can have 3D coordinates and defines operations on such objects.***
■— ZVertical: Boolean	*Indicates when at least two consecutive vertices of this polyline or polygon have the same x and y values, but distinct z values.*
← CalculateNonSimpleZs	*Calculates the non-simple Z values by extrapolation/interpolation.*
← InterpolateFromSurface (pFunctionalSurface: IFunctionalSurface)	*Use the specified functional surface to generate Z values for the vertices of this object.*
← InterpolateZsBetween (startPart: Long, StartPoint: Long, endPart: Long, EndPoint: Long)	*Generate Z values by linear interpolation for all vertices in the range [start+1, end-1].*
← SetConstantZ (zLevel: Double)	*Sets Z coordinates at all locations on this object equal to a single value.*

If some z-values are missing for a shape, three methods provide ways to fill in the missing values. *CalculateNonSimpleZs* interpolates the existing z-values to fill in the NaN values, and *InterpolateZsBetween* replaces every z-attribute with a value based on the distance along the *Polyline* or boundary of the *Polygon*.

Finally, the *InterpolateFromSurface* method sets z-attributes from a specified *FunctionalSurface*, which indicates that the z-attributes will have a valid value if the vertex lies within the *Domain* of the *FunctionalSurface*. Alternatively, the *SetConstantZ* method will set all z-attributes to a constant value—this method has no *Domain* limit—which is much more efficient than setting the z-attribute of each constituent *Point* individually.

Elsewhere in this chapter, the *Simplify* method is discussed, which ensures topological simplicity for a *Geometry*. A z-aware *Geometry* follows the same rules of simplicity as non-z-aware *Geometry*—that is, the z-attribute is always ignored. The *ZVertical* read-only property indicates the presence of two consecutive vertices that are only differentiated by a differing z-attribute. Such cases will be removed by a call to *Simplify*.

The IZCollection *interface is used to change existing z-attributes on the* Point *objects that represent the vertices (*IPointCollection*) of a* Polyline, Polygon, MultiPatch, *or* Multipoint *object.*

IZCollection: IUnknown	***Provides access to members that identify geometric collection objects that can have Z values attached to coordinates and defines operations on such objects.***
■— ZMax: Double	*Returns the maximum Z value.*
■— ZMin: Double	*Returns the minimum Z value.*
← MultiplyZs (factor: Double)	*Multiplies all the Z values by a factor.*
← OffsetZs (Offset: Double)	*Offsets all the Z values by an offset value.*

The *MultiplyZs* and *OffsetZs* methods update all the z-attributes for a *Geometry* and can only be used if every z-attribute has previously been set. Check *IZAware::ZSimple* or consider using the *IZ* interface methods to fill in z-attributes that are NaN.

The IMAware *interface determines whether or not the* Geometry *object is aware that it may have m-attributes.*

IMAware : IUnknown	***Provides access to members that identify geometric objects that can have persistant M values attached to coordinates.***
MAware: Boolean	*Indicates whether or not the geometry is aware of and capable of handling Ms.*
MSimple: Boolean	*Indicates if all the Ms are valid numbers.*
DropMs	*Sets all the M values to a non-valid number (NaN).*

To make a *Geometry MAware*, simply set the *MAware* property to *True*. By default, the m-values of a shape are NaN—the *MSimple* property returns *True* if any NaN values remain. To reset all m-values of a *Geometry* to NaN, call *DropMs*.

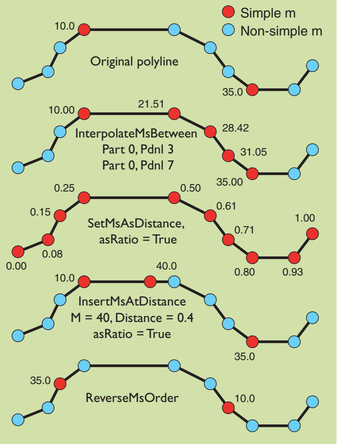
The IMCollection *interface is used to change existing m-attributes on the* Point *objects that represent the vertices of a* Polyline, Polygon, MultiPatch, *or* Multipoint *object.*

IMCollection : IUnknown	***Provides access to members that identify geometric collection objects that can have M values attached to coordinates and defines operations on such objects.***
MMax: Double	*Returns the maximum M value.*
MMin: Double	*Returns the minimum M value.*
MultiplyMs (factor: Double)	*Multiplies all the M values by a factor.*
OffsetMs (Offset: Double)	*Offsets all the M values by an offset value.*

The *MultiplyMs* and *OffsetMs* methods update all the m-attributes for a *Geometry* and can only be used if every m-attribute has been set. Check the *IMAware::MSimple* property or consider using the *IMSegmentation* methods to fill in missing m-attributes.

Although m-attributes can be set on any Point *object, measure values were first introduced to work in association with dynamic segmentation routines, which are specific to* Polyline *shapes. The* IMSegmentation *interface, implemented only on the* Polyline *coclass, provides methods designed to work with the dynamic segmentation functionality in ArcObjects.*

IMSegmentation : IMCollection	***Provides access to members that identify polycurve geometric objects that can have M as a linear coordinate system.***
MMonotonic: esriMMonotonicEnum	*Returns a value indicating whether Ms are monotonic, and if so, whether they are ascending or descending.*
CalculateNonSimpleMs	*Calculates the non-simple M values by extrapolation/interpolation.*
ExtrapolateMs (extrapolationStyle: esriExtrapolationEnum, startPart: Long, startPointIndex: Long, endPart: Long, endPointIndex: Long)	*Extrapolates the M values at the beginning of the geometry up to the fromIndex based on the M value interval between the fromIndex and the toIndex.*
GetDistancesAtM (asRatio: Boolean, M: Double) : Variant	*Returns an array of distances corrsponding to the M value along the line. If the M's are monotonic along the geometry then returns only one value.*
GetMsAtDistance (Distance: Double, asRatio: Boolean) : Variant	*Returns any M values at the distance along the geometry.*
GetPointsAtM (M: Double, LateralOffset: Double) : IGeometryCollection	*Returns a multipoint geometry corresponding to the location along the geometry at the M value.*
GetSubcurveBetweenMs (fromM: Double, toM: Double) : IGeometryCollection	*Returns a polyline geometry corresponding to the extent along the geometry between the fromM and the toM values.*
InsertMAtDistance (M: Double, Distance: Double, asRatio: Boolean, createPart: Boolean, out SplitHappened: Boolean, out newPartIndex: Long, out newSegmentIndex: Long)	*Sets the M value at the given distance along the geometry. If no point exists at this distance then creates a new one.*
InterpolateMsBetween (fromPart: Long, FromPoint: Long, toPart: Long, ToPoint: Long)	*Generate M values by linear interpolation for all vertices in the range [start+1, end-1].*
ReverseMsOrder	*Reverse the order of the M values along the geometry.*
SetAndInterpolateMsBetween (fromM: Double, toM: Double)	*Sets the M values at the beginning and the end of the geometry and interpolates the M values between these values.*
SetMsAsDistance (asRatio: Boolean)	*Sets the M values to the cumulative length from the origin of the geometry.*

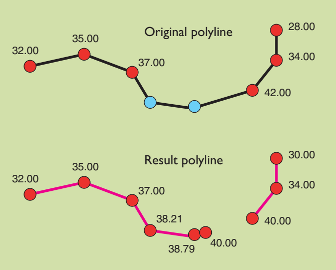


Starting with the original Polyline *(shown top), you can fill in nonsimple m-attributes using the methods on* IMSegmentation.

The *CalculateNonSimpleMs* method interpolates or extrapolates missing (NaN) measure values based on the existing values. Use the *ExtrapolateMs* or *InterpolateMsBetween* methods to set m-attributes for only the specified vertices of a *Polyline*. *InsertMAtDistance* will update a single vertex's m-attribute or, if the specified distance does not fall on a vertex, a new vertex will be inserted into the *Polyline* at that location.

The CalculateNonSimpleMs, SetAndInterpolateMsBetween, and SetMsAsDistance methods all ensure a Polyline is MSimple.

IMSegmentation also provides methods to query a measured *Polyline* based on its m-attributes. The code below first ensures that the *Polyline* is *MSimple* by interpolating missing m-attributes before using *GetSubcurveBetweenMs* to return a new *Polyline*, whose parts indicate the sections of the original *Polyline* between the specified m-attributes.



The code opposite takes the top Polyline*, interpolates the nonsimple m-attributes, and then returns only the parts of the* Polyline *that now have m-attributes between 30 and 40.*

```
Dim pMAware As IMAware
Set pMAware = pPolyline
If pMAware.MAware Then
  Dim pMSeg As IMSegmentation2
  Set pMSeg = pPolyline
  If Not pMAware.MSimple Then
    pMSeg.CalculateNonSimpleMs
  End If
  Dim pNewGeom As IGeometry
  Set pNewGeom = pMSeg.GetSubcurveBetweenMs(30, 40)
End If
```

If the m-attributes do not monotonically increase along the line (check the *MMonotonic* property), the result of *GetSubcurveBetweenMs* may have more than one part.

The IMSegmentation2 *interface extends the functionality available in* IMSegmentation*, which it inherits.*

IMSegmentation2: IMSegmentation	***Provides access to members that provide additional linear referencing operations on polylines.***
← CalibrateByDistance (Points: IEnumVertex, updateHow: Long, ignoreGaps: Boolean) : IEnumSplitPoint	*Calibrates M values based on distances from a fixed set of input points and a given update method.*
← CalibrateByMs (Points: IEnumVertex, updateHow: Long) : IEnumSplitPoint	*Calibrates M values based on Ms from a fixed set of input points and a given update method.*
← GetSubcurveBetweenMsEx (fromM: Double, toM: Double, fromMDetails: Long, toMDetails: Long) : IGeometryCollection	*Returns a polyline geometry corresponding to the extent along the geometry between the fromM and the toM values. The 'details' arguments are composed of esriMCurveRelationEnum values.*
← SetMsAsDistance2 (pOrigin: IPoint, Scale: Double, Offset: Double, ignoreGaps: Boolean)	*Sets Ms as a scalable distance relative to an origin point along the curve with an initial offset. May treat gaps as continuations of the curve or add the gap distance to the calculation.*
← UpdateMsByDistance (fromPart: Long, FromPoint: Long, toPart: Long, ToPoint: Long, fromM: Double, toM: Double, updateHow: Long, ignoreGaps: Boolean)	*Update Ms based on distance for points in a given range. The update method is given as a combination of esriGeometryUpdateMEnum values.*
← UpdateMsByMs (fromPart: Long, FromPoint: Long, toPart: Long, ToPoint: Long, fromM: Double, toM: Double, updateHow: Long)	*Update Ms based on input M values for points in a given range. The update method is given as a combination of esriGeometryUpdateMEnum values.*

The methods of *IMSegmentation2* offer extended ways to interpolate and update the m-attributes on a *Polyline* by cumulative distance and also by existing m-values.

The IPointIDAware *interface determines whether or not the* Geometry *object is aware that it may have ID attributes.*

The IPointID *interface is implemented by all shapes that are based on* Point *objects (*Point, MultiPoint, TriangleFan*, or* TriangleStrip*) or that implement* IPointCollection *(*Polygon, Path, Polyline, Ring*, and* MultiPatch*), all of which may have an ID attribute for each of the constituent* Points.

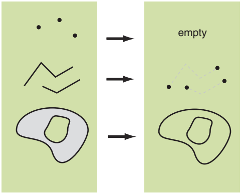
IPointIDAware: IUnknown	***Provides access to members that identify geometric objects that can have persistant point ID values attached to coordinates.***
■—■ PointIDAware: Boolean	*Indicates whether or not the geometry is aware of and capable of handling PointIDs.*
■— PointIDSimple: Boolean	*Indicates when all PointID values for this object are well-defined. Only works if object is aware of PointIDs.*
← DropPointIDs	*Unsets all PointID values without changing awareness. Only works if object is aware of PointIDs.*

To make a *Geometry* point ID aware, simply set the *PointIDAware* property to *True*. By default, the ID values of a shape will be zero—the *PointIDSimple* property returns *True* if any zero values remain. To reset all ID values of a *Geometry* to zero, call *DropPointIDs*.

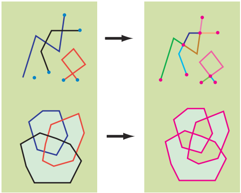
Topology refers to the spatial connectivity of a shape.

A Geometry's topology does not change if data is deformed continuously and elastically, for example, if it is uniformly stretched. A topologically simple shape is one that is able to apply topological operations.

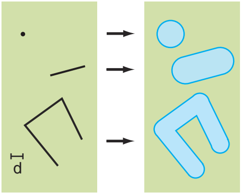
The ITopologicalOperator provides various topological operations, such as Intersect and Union. It also provides simplification functionality—to be used in another topological operation, a Geometry must be simple.



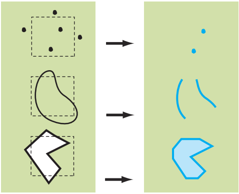
Boundaries have a lower dimension than the original shape.



Simplified shapes can be used in other topological operations.



Buffering creates areal shapes.



Use Clip to trim existing shapes.

Spatial operations comprise an essential part of most GIS systems, allowing spatial querying and modification of spatial entities. The interfaces described below, implemented by many of the geometry coclasses, provide a wide range of spatial operations, including topological, relational, and proximity operations.

Geometries used in spatial operations should share the same coordinate system (*SpatialReference*), or the result of the operation may be meaningless. Some spatial operations may raise geometry error 553 (inconsistent spatial references) if comparing two geometries with different spatial references. *IGeometry::Project* can be used to convert a *Geometry* from one coordinate system to another, prior to attempting a spatial operation.

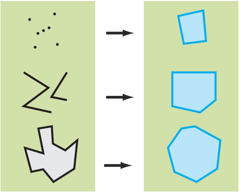
ITopologicalOperator : IUnknown	***Provides access to members that define methods for constructing new geometries based upon topological relationships between existing geometries.***
Boundary: IGeometry	*Returns the boundary of this geometry.*
IsKnownSimple: Boolean	*Indicates when this geometry is known to be simple and FALSE if its state is unknown.*
IsSimple: Boolean	*Indicates when the topological state of this geometry is definitely not simple and TRUE when it is.*
TopologyCache (out pTopologyCacheHandle: Long)	*Provides a handle to the TopologyCache.*
Buffer (Distance: Double) : IGeometry	*Constructs a polygon that is the locus of points at a distance less than or equal to a specified distance from this geometry.*
Clip (clipperEnvelope: IEnvelope)	*Constructs the intersection of this geometry and the specified envelope.*
ClipDense (clipperEnvelope: IEnvelope, denseDistance: Double)	*Constructs the intersection of this geometry and the specified envelope; densifies lines on window.*
ConstructUnion (geometries: IEnumGeometry)	*Defines this geometry to be the union of the inputs.*
ConvexHull: IGeometry	*Constructs the convex hull of this geometry.*
Cut (cutter: IPolyline, out leftGeom: IGeometry, out rightGeom: IGeometry)	*Splits this geometry into a part left of the specified polyline, and a part right of it.*
Difference (other: IGeometry) : IGeometry	*Constructs the geometry containing points from this geometry but not the other geometry.*
Intersect (other: IGeometry, resultDimension: tagesriGeometryDimension) : IGeometry	*Constructs the geometry that is locus of points common to this geometry and the other geometry.*
QueryClipped (clipperEnvelope: IEnvelope, clippedGeometry: IGeometry)	*Redefines clippedGeometry to be the intersection of this geometry and the clipping envelope.*
QueryClippedDense (clipperEnvelope: IEnvelope, denseDistance: Double, clippedGeometry: IGeometry)	*Redefines clippedGeometry to be the intersection of this geometry and the clipping envelope; densifies lines on window.*
Simplify	*Makes this geometry topologically consistent.*
SymmetricDifference (other: IGeometry) : IGeometry	*Constructs the geometry that contains points from either but not both input geometries.*
Union (other: IGeometry) : IGeometry	*Constructs the geometry that is the locus of points in one or the other input geometries.*

Topological operations can be performed on *Polyline, Polygon, Point, Multipoint,* and *GeometryBag* coclasses using the *ITopologicalOperator* interface.

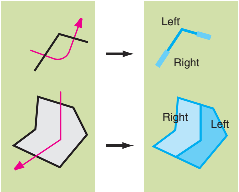
To be used in a topological operation, a geometry must be topologically simple, or *esriGeometryError* 536 is raised.

The *IsKnownSimple* property returns *True* if the *Geometry* has not been changed since simplicity was last confirmed, whereas *IsSimple* actually checks the *Geometry* for topological simplicity. It may be more efficient, therefore, to check *IsKnownSimple* before using *IsSimple*, especially inside a code loop, as shown in this code:

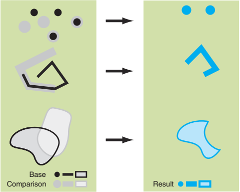
```
Dim pEnumGeom As IEnumGeometry
Set pEnumGeom = pGeometryBag
```



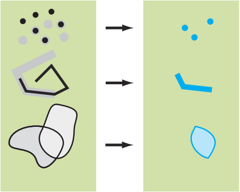
A ConvexHull *encloses an entire shape.*



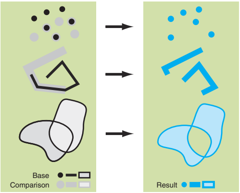
You can cut a shape using a Polyline.



Difference *returns the difference between two shapes.*



Intersect *returns the overlap of two shapes.*



SymmetricDifference *returns a different result to* Difference.

```
Dim pTopoOp As ITopologicalOperator
Set pTopoOp = pEnumGeom.Next

Do While Not pTopoOp Is Nothing
  If Not pTopoOp.IsKnownSimple Then  ‘ You check IsKnownSimple first here
    If Not pTopoOp.IsSimple Then     ‘ because its quicker than IsSimple.
      pTopoOp.Simplify              ‘ This could save time if the enum
     End If                         ‘ is particularly large.
  End If
  Set pTopoOp = pEnumGeom.Next
Loop
```

The *Simplify* method modifies a *Geometry*'s shape to ensure it obeys all the rules of geometric simplicity for the particular coclass. For a *Polygon, Polyline, Multipoint,* or *Point* coclass, these rules are discussed previously with each coclass. For a *GeometryBag* coclass, each object in the bag must implement the *ITopologicalOperator* interface and must then apply the appropriate rules of simplicity for that coclass.

The *Boundary* property returns the boundary of a *Geometry*, which is always one dimension less than the input *Geometry—Points* and *Multipoints*, therefore, have an empty boundary. *Polylines* return a *Multipoint* as their boundary, where each point corresponds to the end of a part of the *Polyline*. For example, using the *Boundary* property of a *Polyline* (*pPolyline*), you could create a *Multipoint* geometry like this:

```
Dim pPointColl as IPointCollection
Set pPointColl = pPolyline.Boundary
```

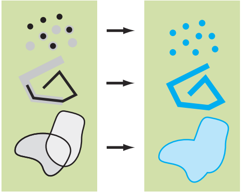
The *ConvexHull* of a *Geometry* is the smallest possible convex *Polygon* that contains the entire shape—the exception being that a *Point* has a *ConvexHull* that equals the original *Point*.

The *Boundary, Buffer, Difference, Intersect, SymmetricDifference,* and *Union* methods all derive from set theory and should be familiar to any GIS user. The *ConstructUnion, SymmetricDifference,* and *Union* methods all require the base *Geometry* and input *Geometry* to have the same dimension. The *Difference* method requires that the base *Geometry* has a dimension less than or equal to the dimension of the input *Geometry*. *Intersect* may be used with any combination of dimensions.

If you wish to construct a *Union* of numerous geometries, instead of using *Union* in a loop, you may find *ConstructUnion* to be more efficient. Use *ConstructUnion* by passing in an enumerator of geometries.

```
Dim pEnum as IEnumGeometry
Set pEnum = GeometryBag
Dim pNewGeomTopo as ITopologicalOperator
Set pNewGeomTopo = pEnum.Next
pNewGeomTopo.ConstructUnion pEnum
```

ClipDense provides an alternative to *Clip*, suitable for use on *Polygons*, which densifies the clipped *Geometry* along its clipped edges, adding new vertices at the specified separation. Use this if you wish to project the *Geometry* after clipping it.



The Union *of two shapes includes all the points that were in either of the input shapes.*

Note that the *Clip, ClipDense,* and *Simplify* methods all operate by changing the shape of the original *Geometry* to the result of the topological operation—ensure that you do not need to use the original *Geometry* object again, or use a clone to perform the operation instead.

QueryClipped and *QueryClippedDense* populate a new Geometry with the operations result instead of changing the base object.

ITopologicalOperator2 : ITopologicalOperator	***Provides access to members that extend the ITopologicalOperator interface.***
IsKnownSimple: Boolean	*Sets the state of being known simple for this geometry to true or false.*
ClipToDomain	*Clips the geometry to the domain of the spatial reference.*
ConstructBuffers (cBuffers: Long, in distances: Double) : IEnumGeometry	*Constructs enumerated polygons of various distances that are the locus of points at a distance less than or equal to specified distances from this geometry.*

After performing a buffer, a shape may exceed the *Domain* of its *SpatialReference*. If you intend to persist the result to an ArcSDE or personal geodatabase *FeatureClass* coclass, you may wish to use the *ClipToDomain* method to ensure your *Geometry* remains inside its *Domain*.

The IHitTest *interface can be used to return the nearest point or vertex on a* Geometry*, find the nearest endpoint or centroid of a shape, or find the midpoint of a* Segment *of a shape.*

IHitTest : IUnknown	***Provides access to members that locate a part of a geometry closest to a point.***
HitTest (QueryPoint: IPoint, searchRadius: Double, geometryPart: tagesriGeometryHitPartType, hitPoint: IPoint, hitDistance: Double, hitPartIndex: Long, hitSegmentIndex: Long, bRightSide: Boolean) : Boolean	*Locates a part of a geometry closest to a point.*

The *IHitTest* interface provides a flexible search method, locating the point on a *Polygon, Polyline, Point, Multipoint, MultiPatch,* or *Envelope* closest to a specified search *Point*. This method is used internally by other ArcObjects search methods that may be more appropriate for your use than *HitTest*, for example, *IProximityOperator::QueryPoint* or *ICurve::QueryPointAndDistance*.

The *HitTest* method has a number of parameters. *QueryPoint, searchRadius,* and *geometryPart* are all passed by value and indicate the location you wish to search for. The *hitPoint, hitDistance, hitPartIndex, hitSegmentIndex,* and *bRightSide* parameters are passed by reference and are used to return the results of the hit test operation.

If *HitTest* is successful, the *hitPoint* parameter indicates the found *Point*, and the *hitDistance* indicates the distance between the *hitPoint* and the *QueryPoint*.

If *bRightSide* is *True*, this indicates that the *QueryPoint* lies on the right-hand side of the search *Geometry*; for a two-dimensional geometry, this indicates the *QueryPoint* lies inside the boundary of the shape. The *partIndex* and *SegmentIndex* indicate on which part and segment in a multipart shape (*Polygon, Polyline, Multipoint,* or *MultiPatch*) the *QueryPoint* was found. For an *Envelope*, the *SegmentIndex* indicates a corner of the *Envelope* using one of the following *esriEnvelopeVertex* constants:

Enumeration tagesriEnvelopeVertex	*The corners of an envelope. This enumeration can be used to interpret the hitSegmentIndex parameter of the IHitTest::HitTest method when hit testing against an envelope.*
0 - esriEnvelopeVertexLL	*The lower left envelope vertex.*
1 - esriEnvelopeVertexUL	*The upper left envelope vertex.*
2 - esriEnvelopeVertexUR	*The upper right envelope vertex.*
3 - esriEnvelopeVertexLR	*The lower right envelope vertex.*

To specify which type of point you wish to find, use one of the following *esriGeometryHitPartType* constants.

Enumeration tagesriGeometryHitPartType	*Describes the parts of a geometry that can be located by their proximity to a query point.*
0 - esriGeometryPartNone	*No part was located by the hit test.*
1 - esriGeometryPartVertex	*Locate the vertex of a geometry closest to the query point.*
4 - esriGeometryPartBoundary	*Locate the closest point on the boundary of a polygon, or the closest point on a polyline, to the query point.*
8 - esriGeometryPartMidpoint	*Locate the segment midpoint that is closest to the query point.*
16 - esriGeometryPartEndpoint	*Locate the 'from' or 'to' point of the polyline closest to the query point.*
32 - esriGeometryPartCentroid	*Locate the ring centroid closest to the query point.*

Not every constant is suitable for use on every *GeometryType*—*esriGeometryPartCentroid* is suitable only for geometries with two or more dimensions (*Polygons, Envelopes,* and *MultiPatches*), while *esriGeometryPartEndpoint* can only be used on *Polyline* geometries.

The example code below demonstrates how to use *HitTest* in the *MouseDown* event of a *UIToolControl*. The *ActiveView* variable should be set at an appropriate point, and the search *Geometry* should also be set as required.

```
Private m_pAV As IActiveView

Private Sub UIToolControl1_MouseDown(ByVal button As Long, _
   ByVal shift As Long, ByVal x As Long, ByVal y As Long)
```

Set a maximum radius in which to search, relative to ActiveView's *width.*

```
  Dim dSrchDis As Double
  dSrchDis = m_pAV.Extent.Width / 20
```

To make the QueryPoint, *use the* MouseDown *coordinates.*

```
  Dim pPnt As IPoint
  Set pPnt = m_pAV.ScreenDisplay.DisplayTransformation.ToMapPoint(x, y)
```

Set the pHitTest *variable to the* Geometry *on which you wish to search, for example, the selected feature in a layer or a graphic element.*

```
  Dim pHitTest As IHitTest
  Set pHitTest = GetSomeGeometryFunction
```

Specifies to search for the closest point on the shape, regardless of whether it is a vertex, or somewhere on a segment.

```
  If Not pHitTest Is Nothing Then
    Dim lPartVert As esriGeometryHitPartType
    lPartVert = esriGeometryPartBoundary
```

Creates a new Point *before using this variable as the* HitPoint *parameter; otherwise, the* Point *is not populated by the* HitTest *method.*

```
    Dim pHitPoint As IPoint
    Set pHitPoint = New Point
```

Checks the return value of HitTest *to see whether or not a point was found. If successful, you can check some of the return values here.*

```
    Dim lPart As Long, lSeg As Long, bHitRt As Boolean, dHitDis As Double
    If pHitTest.HitTest(pPnt, dSrchDis, lPartVert, pHitPoint, dHitDis, _
          lPart, lSeg, bHitRt) Then
    Debug.Print "Successful Hit"
    Debug.Print "Distance from QueryPoint: " & dHitDis
    Debug.Print "Part Index: " & lPart & "Segment Index: " & lSeg
    If Not pHitPoint Is Nothing Then
      'Use the found point as required.
     End If
   End If
  End If
End Sub
```

Relational operators assess the spatial relationships between two geometries.

IRelationalOperator provides a number of methods that assess the spatial relationships between two geometries.

When using *IRelationalOperator* interface, it is important to note the use of the *Pre81Compatibility* property of the *IGeometryEnvironment2* interface. If you wish to use the full implementation of the methods, it is important to create your *Geometry* using *Pre81Compatibility* equal to *True* (the default is *False*). For more information, see the *GeometryEnvironment* coclass in this chapter.

Only IGeometry *objects that also support* IRelationalOperator *may be used as the other parameter.*

IRelationalOperator : IUnknown	***Provides access to members that determine if a certain relationship exists between two geometries.***
← Contains (other: IGeometry) : Boolean	*Indicates when this geometry properly contains the other geometry.*
← Crosses (other: IGeometry) : Boolean	*Indicates when the two geometries intersect in a geometry of lesser dimension.*
← Disjoint (other: IGeometry) : Boolean	*Indicates when the two geometries share no points in common.*
← Equals (other: IGeometry) : Boolean	*Indicates when the two geometries are structurally equivalent.*
← Overlaps (other: IGeometry) : Boolean	*Indicates when the intersection of the two geometries intersect has the same dimension as one of the input geometries.*
← Relation (other: IGeometry, relationDescription: String) : Boolean	*Indicates if the defined relationship exists.*
← Touches (other: IGeometry) : Boolean	*Indicates when strictly the boundaries of two geometries intersect.*
← Within (other: IGeometry) : Boolean	*Indicates when this geometry is a proper subset of the other geometry.*

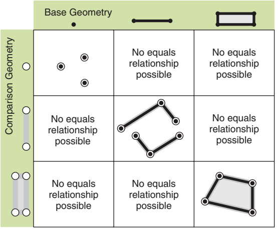
For each *IRelationalOperator* method, the return Boolean value indicates whether or not the particular spatial relationship exists. These diagrams indicate the valid types of relationship. Using a relational operator with incompatible geometries will raise errors, which may vary according to the relationship attempted.

The *Relation* method is a flexible way to check highly specific spatial relationships—it allows you to define your own type of spatial relationship using the Shape Comparison Language. This language is based on the Calculus-Based Method (CBM), as described and defined by Clementini and Felice, but has some extensions specific to working with vertex-based geometries and is fully described in the Technical Documents section of the ArcObjects Developer Help system. Note that at the current release, Relation only operates with straight lines.

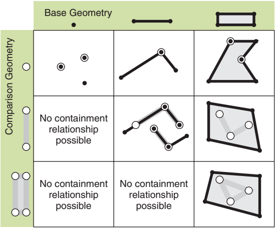
Briefly, the method uses the boundary or Interior of each shape to calculate the relationship. It can be used as shown below, where G1 and G2 refer to the base and other *Geometry* object, respectively:

```
If pRelational.Relation (pOther, "G1 IDENTICAL G2") Then
  MsgBox "Geometries are identical"
End If
```

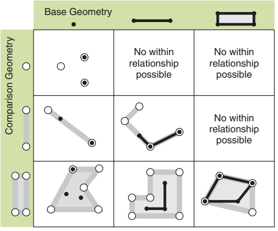
Does the current geometry **equal** the other geometry?


Base Geometry
Comparison Geometry
No equals relationship possible
No equals relationship possible
No equals relationship possible
No equals relationship possible
No equals relationship possible
No equals relationship possible

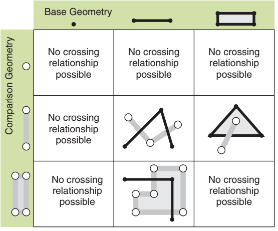
Does the current geometry **contain** the other geometry?


Base Geometry
Comparison Geometry
No containment relationship possible
No containment relationship possible
No containment relationship possible

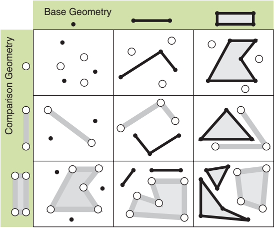
Is the current geometry **within** the other geometry?


Base Geometry
Comparison Geometry
No within relationship possible
No within relationship possible
No within relationship possible

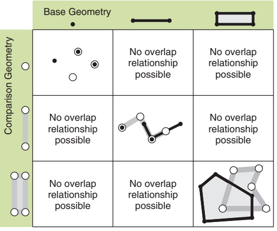
Does the current geometry **cross** the other geometry?


Base Geometry
Comparison Geometry
No crossing relationship possible
No crossing relationship possible
No crossing relationship possible
No crossing relationship possible
No crossing relationship possible
No crossing relationship possible

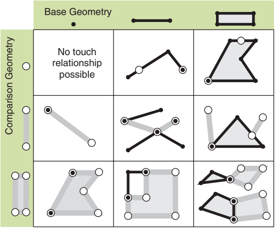
Is the current geometry **disjoint** from the other geometry?



Does the current geometry **overlap** the other geometry?


Base Geometry
Comparison Geometry
No overlap relationship possible
No overlap relationship possible
No overlap relationship possible
No overlap relationship possible
No overlap relationship possible
No overlap relationship possible

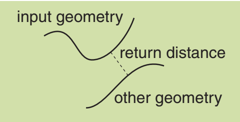
Does the current geometry **touch** the other geometry?



Use IProximityOperator *to find the nearest* Point *on a* Geometry, *or to calculate the distance between two existing plane geometries.*

IProximityOperator is implemented by the plane geometries *Polygon, Polyline, Point, Multipoint,* and *Envelope* and also by the *Segment* coclasses *BezierCurve, EllipticArc, CircularArc,* and *Line*.

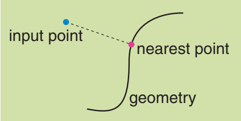
IProximityOperator : IUnknown	***Provides access to members that find the distance between two geometries.***
← QueryNearestPoint (p: IPoint, Extension: tagesriSegmentExtension, nearest: IPoint)	*Sets the location of the 'nearest' parameter to be a point on this geometry nearest to the input point.*
← ReturnDistance (other: IGeometry) : Double	*Returns the minimum distance between two geometries.*
← ReturnNearestPoint (p: IPoint, Extension: tagesriSegmentExtension) : IPoint	*Creates and Returns a point on this geometry nearest to the input point.*



ReturnDistance *calculates the minimum possible distance between two geometries. The minimum distance does not have to be measured between two vertices—it may occur along a* Segment.

The code below uses the *ReturnDistance* method to find out which *Geometry* in a *GeometryBag* (*pBag*) is closest to the query *GeometrypQueryGeom*.

```
If TypeOf pQueryGeom Is IProximityOperator Then
  Dim pProximity As IProximityOperator
  Set pProximity = pQueryGeom

  ' Here, set the initial distance to be the Map's Full Extent.
  ' Use this variable to keep track of the smallest ReturnDistance value
  Dim i As Long, lClosest As Long, dDist As Double, dCurr As Double
  dDist = pAV.FullExtent.Width
  For i = 0 To pGeomColl.GeometryCount - 1
    If Typeof pGeomColl.Geometry(i) Is IProximityOperator Then
     'We can only use this on geometries that support IProximityOperator
      dCurr = pProximity.ReturnDistance(pGeomColl.Geometry(i))
      If dCurr < dDist Then
        lClosest = i
        dDist = dCurr
      End If
    End If
  Next i
End If
```



ReturnNearestPoint *calculates the minimum possible distance between an input point and an existing* Geometry. *The minimum distance may occur along a* Segment *of the* Geometry.

ReturnNearestPoint or *QueryNearestPoint* can both be used to return the *Point* on a given *Geometry* closest to the specified *QueryPoint*. Using the *esriNoExtension* constant as the *Extension* parameter, the *Point* returned is restricted to lie on a *Segment* of a *Polygon* or *Polyline* or on the boundary of an *Envelope*. Other parameters can be used to return a *Point* that lies on an extension of the existing *Geometry*.

ITransform2D interface

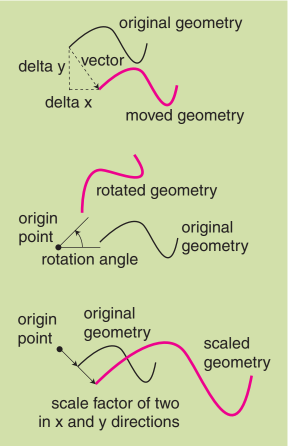
Geometries can be scaled, rotated, or moved by using the ITransform2D *methods.*

ITransform2D is implemented by plane geometries and by many graphic elements, providing simple Euclidean transformation methods.

ITransform2D : IUnknown	*Provides access to members that supply an object with Euclidean 2D transformation capabilities.*
← Move (dx: Double, dy: Double)	*Moves the object dx units horizontally and dy units vertically.*
← MoveVector (v: ILine)	*Moves the object defined by a 2D displacement vector.*
← Rotate (Origin: IPoint, RotationAngle: Double)	*Rotates the object about the specified origin point through rotationAngle radians.*
← Scale (Origin: IPoint, sx: Double, sy: Double)	*Scales the object about the specified origin point a factor of sx horizontally and sy vertically.*
← Transform (Direction: tagesriTransformDirection, Transformation: ITransformation)	*Applies an arbitrary transformation.*

The *Move* method translates a *Geometry* by specified amounts along the x- and y-axes—the *dx* and *dy* values are in the units of the *Geometry*.

The *MoveVector* method translates the *Geometry* according to the height and width of an input *Line*.



ITransform2D *provides a variety of simple spatial transformations that alter the location and/or the size and shape of a* Geometry.

Rotate a *Geometry* around a given origin using the *Rotate* method. As with other *Geometry* methods, the *Rotation* angle must be in radians.

Rotate and *Scale* allow you to specify a point of origin around which to perform the transformation—this origin may lie inside or outside the *Geometry*. Below, the code rotates a *Polygon* (*pPolygon*) around its *Centroid* by one radian (about 57 degrees).

```
Dim pArea As IArea
Set pArea = pPolygon
Dim pTrans As ITransform2D
Set pTrans = pPolygon
pTrans.Rotate pArea.Centroid, 1
```

When using any transformation method, the characteristics of the original *Geometry* may be changed. For example, a *CircularArc* when scaled must remain circular, whether or not the *dx* and *dy* values are identical—you may wish to convert a *CircularArc* to an *EllipticArc* before performing a transformation. Also, an *Envelope* cannot be rotated (geometry error 520 is raised), as conceptually a rectangle rotated by, for example, 45 degrees would no longer be rectangular in shape—its sides would no longer be orthogonal to the coordinate system. However, you could convert the *Envelope* to a *Polygon* first if this is the effect you require.

The *Transform* method is used internally by the *IGeometry::Project* method but can also be effectively used by an ArcObjects developer to apply a specific, highly customizable type of transformation to a *Geometry*. For more information, see the *IAffineTransformation2D* interface in this chapter.

ITransform3D is implemented by *MultiPatch* and *Point*. *ITransform3D* should only be used on z-aware *Point* objects; otherwise, *esriGeometryError* 564 is raised.

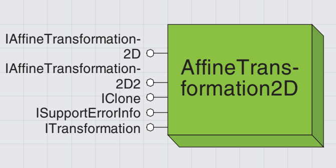
```
Dim pZAware as IZAware
Set pZAware = pMyPoint
pZAware.ZAware = True
Dim pTransform3D as ITransform3D
Set pTransform3D = pMyPoint
```

Like the ITransform2D *interface, geometries can be scaled, rotated, or moved by using the* ITransform3D *methods. However, this interface is used to transform three-dimensional* Geometries *in three-dimensional space. This interface is not fully implemented at ArcGIS 8.1 and is therefore discussed only briefly.*

ITransform3D : IUnknown	***Provides access to members that supplies an object with 3D transformation capabilities.***
← Move3D (dx: Double, dy: Double, dz: Double)	*Moves the object by dx, dy and dz along the x, y, and z axes respectively.*
← MoveVector3D (v: IVector3D)	*Moves the object by an offset defined by a 3D vector.*
← ProjectToPlane (planarOrigin: IPoint, planarPositiveX: IVector3D, planarNorm: IVector3D) : IGeometry	*Generates a polygon footprint for the object in an arbitrary plane. The footprint may have multiple parts.*
← RotateVector3D (axis: IVector3D, RotationAngle: Double)	*Rotates the object about axis defined by the specified vector through an angle measured in radians.*
← Scale3D (Origin: IPoint, sx: Double, sy: Double, sz: Double)	*Scales the object about the specified origin point. sx, sy, and sz are the scaling factors for the x, y, and z dimensions repectively.*
← Transform3D (Direction: tagesriTransformDirection, Transformation: ITransformation3D)	*Applies an arbitrary 3D transformation.*

The *ProjectToPlane* method can be used to create a *Polygon* from a *MultiPatch* shape—it has no analogous two-dimensional equivalent. This method produces a planar *Polygon* in three dimensions by projecting a *MultiPatch* shape onto a specified plane. Imagine a *MultiPatch* shape as a solid that is held up to a light source over a sheet of paper—the resultant *Polygon* is the shadow cast on the paper. The plane is specified by an origin and two three-dimensional vectors that together define a unique plane; the projection is orthogonal to the plane.

For a *Point* coclass, only the *Move3D* and *MoveVector3D* methods are implemented at ArcGIS 8.1.



Affine transformations are operations that change some aspect of a geometry, such as its size or position, while retaining colinearity (that is, all the points on a line remain on the line) and distance ratios (that is, the midpoint of a line remains the midpoint). These transformations are two-dimensional.

In addition to offering alternative transformations, the affine transformation offers the ability to specify other transformations that are performed before or after the specified transformation.

The *AffineTransformation2D* coclass offers the ability to construct custom transformations for geometrical shapes. It is useful for creating particular transformations that are not supported by *ITransform2D* and also for performing numerous transformations in one go.

Transformations can be done in two different ways. Firstly, and most commonly within the geometry model, the *AffineTransformation2D* object can be used in the *ITransform2D::Transform* method to transform an existing *Geometry*. Alternatively, the methods of *ITransform* can be used to transform points or values individually.

ITransformation : IUnknown	***Applies a function (or its inverse) to a set of points or measures. The suffix of each method indicates the type of parameters operated on.***
← TransformMeasuresFF (Direction: tagesriTransformDirection, cMeasures: Long, inMeasures: Double, outMeasures: Double)	*Transforms floating point measures to floating point measures (or do the inverse).*
← TransformMeasuresFI (Direction: tagesriTransformDirection, cMeasures: Long, inMeasures: Double, outMeasures: Long)	*Transforms floating point measures to integer measures (or do the inverse).*
← TransformMeasuresIF (Direction: tagesriTransformDirection, cMeasures: Long, inMeasures: Long, outMeasures: Double)	*Transforms integer measures to floating point measures (or do the inverse).*
← TransformMeasuresII (Direction: tagesriTransformDirection, cMeasures: Long, inMeasures: Long, outMeasures: Long)	*Transforms integer measures to integer measures (or do the inverse).*
← TransformPointsFF (Direction: tagesriTransformDirection, cPoints: Long, inPoints: Double, outPoints: Double)	*Transforms floating point points to floating point points (or do the inverse).*
← TransformPointsFI (Direction: tagesriTransformDirection, cPoints: Long, in inPoints: Double, outPoints: Long)	*Transforms floating point points to integer points (or do the inverse).*
← TransformPointsIF (Direction: tagesriTransformDirection, cPoints: Long, inPoints: Long, outPoints: Double)	*Transforms integer points to floating point points (or do the inverse).*
← TransformPointsII (Direction: tagesriTransformDirection, cPoints: Long, inPoints: Long, outPoints: Long)	*Transforms integer points to integer points (or do the inverse).*

The methods of the *ITransformation* interface provide functions that convert arrays of *Points* or values according to the defined transformation.

These methods are more commonly used in other areas of the ArcObjects model, such as *Display* and *SpatialReference*—only the *TransformPointsFF* and *TransformPointsFI* are implemented by the *AffineTransformation2D* coclass.

IAffineTransformation2D : ITransformation	Provides access to members that define and manipulate affine transformations.
■— IsReflective: Boolean	Indicates if the transformation contains a reflection (determinant is negative).
—■ MoveOrigin: IPoint	Move origin.
■— Rotation: Double	Returns the rotation angle.
■—□ SpatialReference: ISpatialReference	The spatial reference in which this transformation is meaningful.
■— XScale: Double	Returns the scale along the X axis.
■— XTranslation: Double	Returns the translation along the X axis.
■— YScale: Double	Returns the scale along the Y axis.
■— YTranslation: Double	Returns the translation along the Y axis.
◀— DefineFromControlPoints (cPoints: Long, in FromPoints: IPoint, in ToPoints: IPoint)	Define transformation that maps from control points.
◀— DefineFromControlPointsEx (cPoints: Long, in FromPoints: _WKSPoint, in ToPoints: _WKSPoint)	Define transformation that maps from control points.
◀— DefineFromEnvelopes (from: IEnvelope, to: IEnvelope)	Defines a transformation that maps a point relative to one envelope to a similar position relative to another envelope.
◀— DefineFromEnvelopesEx (from: IEnvelope, to: IEnvelope, outFrom: IEnvelope, assumeFalseOrigin: Boolean, keepAspect: Boolean, flipIt: Boolean)	Defines a transformation that maps a point relative to one envelope to a similar position relative to another envelope.
◀— DefineReflection (l: ILine)	Defines a transformation that can perform a reflection about the line l.
◀— GetControlPointError (i: Long, out fromError: Double, out toError: Double)	Returns the errors involved in moving control point i from the 'from' to 'to' system.
◀— GetRMSError (out fromError: Double, out toError: Double)	RMS error expressed relative to the 'from' and 'to' points defining the transformation.
◀— Move (dx: Double, dy: Double)	Incorporates a translation factor into the transformation.
◀— MoveVector (pVector: ILine)	Performs an X and Y translation defined by a 2D vector.
◀— PostMultiply (postTransform: IAffineTransformation2D)	Post-multiplies the transformation by another transformation.
◀— PreMultiply (preTransform: IAffineTransformation2D)	Pre-multiplies the transformation by another transformation.
◀— Project (pNewSpatialReference: ISpatialReference)	Moves this transformation into another spatial reference.
◀— Reset	Reset the tranformation.
◀— Rotate (da: Double)	Incorporates a rotation (in radians) into the transformation.
◀— Scale (dx: Double, dy: Double)	Incorporates scale factors into the transformation.

The *IAffineTransformation2D* interface defines the function of a transformation, that is, how the coordinates of a *Geometry* are altered by the transformation. Use the *DefineFromControlPoints, DefineFromEnvelopes, DefineFromEnvelopesEx, DefineReflection, Move, MoveVector, Project, Rotate,* or *Scale* methods to define transformation functions for the *AffineTransformation2D*.

For example, the code below reflects the geometry *pGeom* in the y-axis (where the function *CreatePoint* returns a new *Point* as specified).

```
Dim pLine As ILine
Set pLine = New Line
pLine.PutCoords fnCreatePoint(0, 0), CreatePoint(10, 0)

Dim pAffine as IAffineTransformation2D, pTrans2D as ITransform2D
Set pAffine = New AffineTransformation2D
pAffine.DefineReflection pLine

Set pTrans2D = pGeom
pTrans2D.Transform esriTransformForward, pAffine
```

An AffineTransformation2D *defines a transformation as a matrix. Using the* esriTransformDirection *constant,* esriTransformReverse, *applies the inverse of the transformation matrix.*

The *Move, Scale,* and *Rotate* transformations are cumulative—they add the transformation specified to any existing transformation in an *AffineTransformation2D* object. The following code creates a transformation that moves a *Geometry* 20 units in the x direction before rotating it 90 degrees (~1.57 radians).

```
Dim pAffine as IAffineTransformation2D
Set pAffine = New AffineTransformation2D
pAffine.Move 20, 0
pAffine.Rotate 1.57
```

To remove all current transformations from an *AffineTransformation2D* object, simply call the *Reset* method.

If set, *MoveOrigin* is used only by the *Project* method—it does not affect the transformation.

The *Rotation, IsReflective, XScale, YScale, XTranslation,* and *YTranslation* properties all report calculated parameters of the currently set transformation.

To perform chained transformation, where one transformation is performed after another, use the *PreMultiply* or *PostMultiply* methods to connected transformations. For example, if you have two *AffineTransformation2D* objects, you can apply both in turn to your *Geometry*. To specify that *pAffineOne* should be applied before *pAffineTwo*, set the *PreMultiply* property like so:

```
pAffineTwo.PreMultiply pAffineOne
```

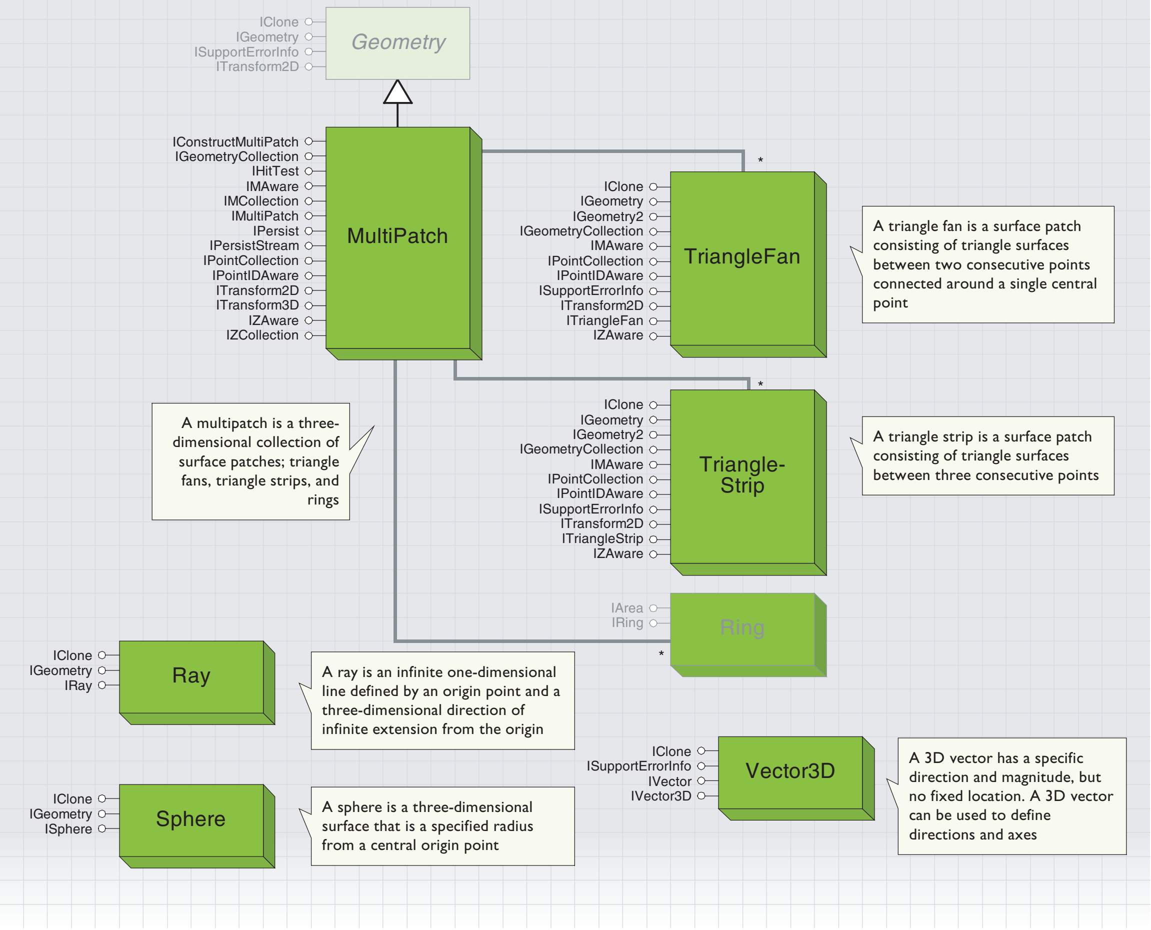
Now, when you call *Transform* on your *Geometry* (*pTransform2D*), pass in *pAffineTwo* as the transformation, which will apply the *PreMultiply* transformation before applying its own transformation functions.

```
pTransform2D.Transform pAffineTwo
```

You can achieve the same effect by specifying *pAffineTwo* as the *PostMultiply* transformation of *pAffineOne*, then passing *pAffineOne* to the *Transform* method.

The *DefineFromControlPoints* method may be particularly useful if you wish to register a set of control points from a digitizer to existing known control points. This method calculates a 'best fit' affine transformation to map one set of control points onto another.

3D geometry objects



A triangle fan is a surface patch consisting of triangle surfaces between two consecutive points connected around a single central point

A multipatch is a three-dimensional collection of surface patches; triangle fans, triangle strips, and rings

A triangle strip is a surface patch consisting of triangle surfaces between three consecutive points

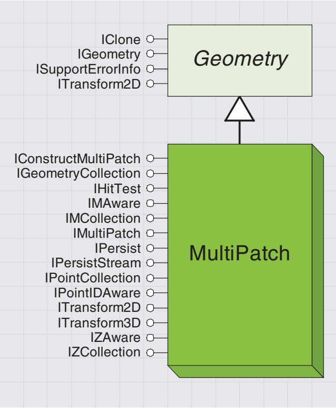
A ray is an infinite one-dimensional line defined by an origin point and a three-dimensional direction of infinite extension from the origin

A 3D vector has a specific direction and magnitude, but no fixed location. A 3D vector can be used to define directions and axes

A sphere is a three-dimensional surface that is a specified radius from a central origin point

In previous versions of ArcGIS, geometry was based on two-dimensional shapes. With the introduction of three-dimensional geometries and such software as the ArcGIS 3D Analyst™ extension and the ArcScene application, the geometry object model has been extended. In 2D geometry, z-values are attributes, but in 3D geometry, z-values are height coordinates.

MultiPatch, TriangleFan, and *TriangleStrip* shapes are stored internally as collections of vertices; they have no concept of actual edges and faces, and the 3D geometry is only constructed in the drawing process. Therefore, 3D geometry does not have topology, and 3D topological analysis functionality is not currently available. The relational, proximity, and hit test operators are not available for 3D geometries.



A MultiPatch *is a three-dimensional shape defined by a collection of surface patches. Surface patches can be* Rings, TriangleFans, *or* TriangleStrips, *each of which defines a three-dimensional surface.*

A MultiPatch *can be used as a* Feature *in a* FeatureClass *and displayed as a solid three-dimensional shape in* ArcScene. *It is also used as the* Geometry *for a* MultiPatchElement *graphic.*

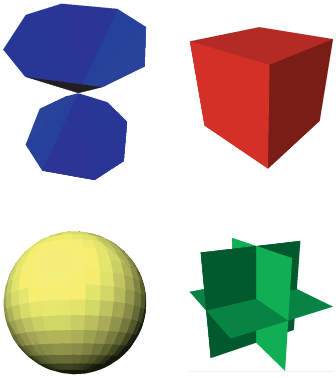
The *MultiPatch* coclass is a high-level three-dimensional *Geometry* shape with linear edges. The shape of a *MultiPatch* is defined as a collection of surface patches. Surface patches are geometries which, when added to a *MultiPatch*, define a three-dimensional surface. *TriangleFan, TriangleStrip,* or *Ring* objects can all be surface patches. A *MultiPatch* can consist of one or more objects, using any combination of the named surface patch coclasses.

The *MultiPatch, TriangleStrip,* and *TriangleFan* all support the *IZAware* interface—for these coclasses, *ZAware* always equals *True*. Each object must also be *ZSimple* to be a valid 3D *Geometry*.

The individual surface patches in a *MultiPatch* are accessed via the *IGeometryCollection* interface—for more information on this interface, see the section on geometry collections in this chapter.

The *IMultiPatch* interface provides methods and properties that return information about existing *MultiPatches*; it is also essential to defining and maintaining a valid *MultiPatch* shape.

IMultiPatch : IGeometry	***Provides access to members that identify a MultiPatch and permit controlled access to its parts.***
▪— BeginningRingCount (ringTypesDesired: Long) : Long	*Returns the number of beginning rings, counting only those of the desired types.*
▪— FollowingRingCount (beginningRing: IRing) : Long	*Returns the number of following rings in the ring group that starts with the specified beginning ring.*
▪— XYFootprint: IGeometry	*Returns a reference to a cached copy of the multipatch's footprint in the x-y plane. If the footprint is modified, InvalXYFootprint should be called.*
← FindBeginningRing (followingRing: IRing) : IRing	*Returns the beginning ring of the ring group containing the specified following ring.*
← GetRingType (queryRing: IRing, isBeginningRing: Boolean) : tagesriMultiPatchRingType	*Gets the esriMultiPatchRingType of the input Ring and returns a boolean indicating if that ring is a beginning ring.*
← InvalXYFootprint	*Notifies the multipatch that its cached footprint has been modified by an outside agent. The footprint will be recalculated the next time it is requested.*
← PutRingType (queryRing: IRing, ringType: tagesriMultiPatchRingType)	*Defines the type of the input Ring.*
← QueryBeginningRings (ringTypesDesired: Long, numBeginningRingsRequested: Long, out beginningRings: IRing)	*Returns an array of references to all beginning rings of the specified types.*
← QueryFollowingRings (beginningRing: IRing, numFollowingRingsRequested: Long, out followingRings: IRing)	*Returns an array of references to following rings that are in the ring group that starts with the specified beginning ring.*



These are some MultiPatches *created and displayed in* ArcScene.

The *XYFootprint* property returns a *Geometry* that is a copy of the footprint of the *MultiPatch* in the x,y plane. If the shape of a *MultiPatch* is changed, the *InvalXYFootprint* method should be called to update this property, as the footprint is cached, not regenerated for each property call.

A *MultiPatch* imposes some order on any *Rings* it contains. When added to a *MultiPatch* shape, *Rings* must always be planar—that is, all the vertices must lie on the same 3D plane. The plane can have any 3D orientation; it does not have to be horizontal or vertical.

MultiPatch *feature classes cannot be edited using the* ArcMap *user interface as* ArcMap *is 2D and only displays the* XYFootprint *of a* MultiPatch.

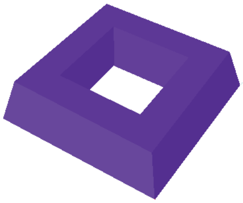
Within a *MultiPatch* shape, any adjacent *Rings* (those with consecutive indices in the *IGeometryCollection* interface) define a *Ring* sequence. A sequence consists of a beginning *Ring* followed by one or more other *Rings*. A sequence may be a first *Ring* followed by one or more generic

Rings or an outer *Ring* followed by one or more inner *Rings*. These inner, outer, first, and generic *Ring* objects are not different when they are created but, when added to the *MultiPatch*, they are tagged internally—whenever you add a *Ring* to a *MultiPatch* or edit an existing *Ring* so that the type may be changed, call the *PutRingType* method to create the internal tag.

Enumeration tagesriMultiPatchRingType	*MultiPatch Ring Types.*
1 - esriMultiPatchInvalidRing	*Invalid Ring.*
2 - esriMultiPatchUndefinedRing	*Ring type has not been defined.*
3 - esriMultiPatchProblemCaseRingMask	*A mask of problematic rings (UndefinedRings and InvalidRings).*
4 - esriMultiPatchFirstRing	*The beginning FirstRing in a FirstRing/Ring sequence.*
8 - esriMultiPatchRing	*A following Ring in a FirstRing/Ring sequence or a beginning Ring in a solo Ring group.*
16 - esriMultiPatchOuterRing	*The beginning OuterRing in an OuterRing/InnerRing sequence.*
28 - esriMultiPatchBeginningRingMask	*A mask of valid beginning rings (OuterRings, FirstRings, and solo Rings).*
32 - esriMultiPatchInnerRing	*A following InnerRing in an OuterRing/InnerRing sequence.*
40 - esriMultiPatchFollowingRingMask	*A mask of valid following rings (InnerRings and Rings).*

In the code below, a *Ring* is added to a *MultiPatch*, and it is indicated as a beginning *Ring*, specifically an *OuterRing*.

```
pGeoColl.AddGeometry pSegmentCollection
Dim pPatch as IMultiPatch
Set pPatch = pGeomColl ' an existing MultiPatch
pPatch.PutRingType pSegColl, esriMultiPatchOuterRing
```



The picture above shows a MultiPatch *containing an outer-*Ring*, inner-*Ring *sequence, which forms the top face of the shape.*

ExteriorRings with the following *InteriorRings* indicate a *Ring* with a hole, where the hole is defined by the inner *Ring*. An outer *Ring* may have many inner *Rings*. Outer and inner *Rings* do not need to have the specific orientation that exterior and interior *Polygons* require—that is, both an outer and inner *Ring* can be oriented either clockwise or counterclockwise. If you do not know in advance the relationship of your ring sequence, you may specify a first *Ring* followed by one or more generic *Rings*.

The *BeginningRingCount* property reports the number of *Ring* sequences present in a *MultiPatch* of the specified type. The *FollowingRingCount* property and *FindBeginningRing* method also provide ways to help you navigate your *MultiPatch*'s *Ring* sequences.

To create a new *MultiPatch* shape, create *TriangleFan, TriangleStrip,* or *Ring* objects and use the *IGeometryCollection* interface to add these surface patches to the *MultiPatch*. The code below demonstrates how you might create a *MultiPatch* that is pyramid shaped with one missing face.

Create a new MultiPatch *object and get both the* IGeometryCollection *and* IMultiPatch *interfaces.*

```
Dim pSegColl As ISegmentCollection, pPointColl As IPointCollection
Dim pGeoColl as IGeometryCollection, pPatch As IMultiPatch
Set pGeoColl = New MultiPatch
Set pPatch = pGeoColl
```

Create a new TriangleFan *object.*

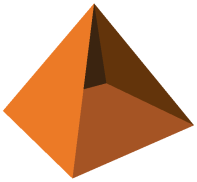
CreatePointZ *is a function that creates and returns a new* Point *object from x,y,z coordinates. There is no need to ensure the* Point *is* ZAware*, as it will have* ZAwareness *automatically set when it is added to the* TriangleFan.

```
Set pPointColl = New TriangleFan
With pPointColl
  .AddPoint CreatePointZ(5, 5, 20)
  .AddPoint CreatePointZ(0, 0, 0)
```

CreatePointZ *is a function that creates and returns a new* Line *object from two endpoints. There is no need to ensure the* Line *is* ZAware*, as it will have* ZAwareness *automatically set when it is added to the* MultiPatch.

```
  .AddPoint CreatePointZ(0, 10, 0)
  .AddPoint CreatePointZ(10, 10, 0)
  .AddPoint CreatePointZ(10, 0, 0)
End With
pGeoColl.AddGeometry pPointColl

Set pSegColl = New Ring
With pSegColl
  .AddSegment CreateLine(CreatePointZ(0, 0, 2), CreatePointZ(10, 0, 2))
  .AddSegment CreateLine(CreatePointZ(10, 0, 2), CreatePointZ(10, 10, 2))
  .AddSegment CreateLine(CreatePointZ(10, 10, 2), CreatePointZ(0, 10, 2))
  .AddSegment CreateLine(CreatePointZ(0, 10, 2), CreatePointZ(0, 0, 2))
End With
pGeoColl.AddGeometry pSegColl
pPatch.PutRingType pSegColl, esriMultiPatchFirstRing
pPatch.InvalXYFootprint 'Update the cached XY footprint
```

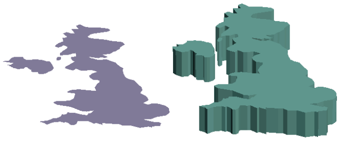
Always set the RingType *of any* Ring *you add to a* MultiPatch.



The shape created by the code above is pyramidal. The Ring *forms the base of the pyramid, and the* TriangleFan *creates the faces.*

Earlier it was stated that the orientation, clockwise or counterclockwise, of the vertices of surface patches in a *MultiPatch* is unimportant when it comes to constructing the geometrical shape. When rendering 3D geometries, however, orientation is important. If a *Ring*, or the first triangle in a *TriangleFan* or *TriangleStrip*, is oriented in a clockwise direction, ArcScene will render the surface patch as if it forms an outer face of the *MultiPatch*. If counterclockwise, the surface patch will be rendered as if it forms an inner face of the *MultiPatch*.

IConstructMultiPatch : IUnknown	***Provides access to members that can be used to construct MultiPatches.***
← ConstructExtrude (OffsetZ: Double, baseGeom: IGeometry)	*Construct a MultiPatch by using an input (non-point) geometry as one base and offsetting the Zs already set on the input geometry to get the second base.*
← ConstructExtrudeAbsolute (toZ: Double, baseGeom: IGeometry)	*Construct a MultiPatch by extruding a (non-point) geometry using its initial Zs for one base, and a uniform input Z for the other.*
← ConstructExtrudeAlongLine (extrusionLine: ILine, baseGeom: IGeometry)	*Construct a MultiPatch by extruding a (non-point) geometry along a specified line, using the Zs on the two ends of the line to set Zs on the top and bottom.*
← ConstructExtrudeBetween (fromSurface: IFunctionalSurface, toSurface: IFunctionalSurface, baseGeom: IGeometry)	*Construct a MultiPatch by extruding a (non-point) geometry between two functional surfaces.*
← ConstructExtrudeFromTo (fromZ: Double, toZ: Double, baseGeom: IGeometry)	*Construct a MultiPatch by extruding a (non-point) geometry between two specified Z values.*
← ConstructExtrudeRelative (extrusionVector: IVector3D, baseGeom: IGeometry)	*Construct a MultiPatch by extruding a (non-point) geometry along a specified vector, using Zs already set on the input geometry.*



A shape being extruded in ArcScene

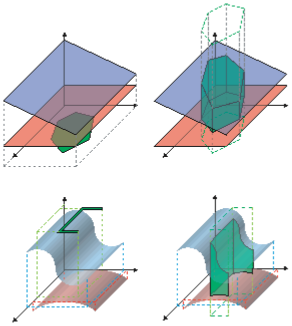
The *IConstructMultiPatch* interface offers alternative ways to create the shape of a new *MultiPatch*; it lets you extrude an existing Geometry—create a new shape by extending a *Geometry* into more dimensions than the original shape.

More information on 3D vectors can be found later in this section.

Polygons, Polylines, and *Envelopes* can be extruded using the *ConstructExtrude* method. For example, the code below extrudes the first selected *Polygon Feature* in an ArcScene document from the existing plane to the plane z=5.

```
Dim pDoc As ISxDocument
Set pDoc = ThisDocument
```

```
Dim pEnumFeat As IEnumFeature
Set pEnumFeat = pDoc.Scene.FeatureSelection

If Not pEnumFeat Is Nothing Then
  Dim pFeat As IFeature, pGeom as IGeometry, pZAware as IZAware
  Set pFeat = pEnumFeat.Next
  Set pGeom = pFeat.Shape
  If TypeOf pGeom Is IPolygon Then
    Set pZAware = pGeom
    If pZAware.ZAware Then
      Dim pConstruct As IConstructMultiPatch
      Set pConstruct = New MultiPatch
      pConstruct.ConstructExtrude 2, pGeom
    End If
  End If
End If
```

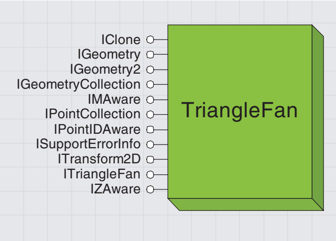


ExtrudeBetween *creates a* MultiPatch *shape from two* FunctionalSurface *objects.*

The *ConstructExtrude, ConstructExtrudeAbsolute,* and *ConstructExtrudeRelative* methods all generate *MultiPatch* shapes using z-values from the original geometry and an offset value. The *ConstructExtrudeAlongLine* and *ConstructExtrudeFromTo* methods use z-values specified in a vector or as constants. Any extrusion methods that use the z-attributes of the existing *Geometry* to generate the new shape require the input *Geometry* to be *ZAware* and *ZSimple*.

The *ConstructExtrudeBetween* method extrudes geometries between two *FunctionalSurfaces*. A *FunctionalSurface* defines a plane in three dimensions by specifying two *3DVectors* and a planar point of origin. When defined, a *FunctionalSurface* can return a z-value for every pair of x,y coordinates in its domain. A *FunctionalSurface* can be defined from a TIN or raster layer.

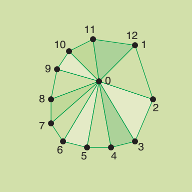
TriangleFan coclass



A TriangleFan *is a collection of* Points *that define a surface made of triangles in a fan arrangement.*

A *TriangleFan* is a continuous fan of triangles, where every triangle in the fan shares at least one vertex, which together define a surface. *TriangleFans* are mainly used as surface patches in *MultiPoint* geometries.

The *TriangleFan* coclass is based on an ordered collection of *Points*, where the first *Point* in the collection defines the vertex that is shared by all triangles. Each triangle in a fan with n *Points* has the vertices *Point(0), Point(i),* and *Point(i + 1)*, up to n = -2. The number of triangles in a *TriangleFan* equals *IPointCollection.PointCount - 2*.



All the surfaces in a single TriangleFan *share a common vertex.*

TriangleFans *are based on two-dimensional shapes, with additional knowledge of height coordinates, and are therefore sometimes known as 2.5D objects.*

ITriangleFan : IGeometry	***Provides access to members that identify a triangle fan.***

The *ITriangleFan* interface has no methods or properties, but a *QueryInterface* for *ITriangleFan* can be used as a simple check for the *TriangleFan* coclass.

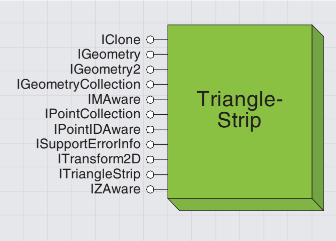
To add, change, move, or remove *Points* in a *TriangleFan*, use the *IPointCollection* interface as shown below.

```
  Dim pPointColl As IPointCollection
  Set pPointColl = New TriangleFan

  With pPointColl
    .AddPoint CreatePointZ(5, 5, 20)
    .AddPoint CreatePointZ(0, 0, 0)
    .AddPoint CreatePointZ(0, 10, 0)
    .AddPoint CreatePointZ(10, 10, 0)  'You can use values like these to
    .AddPoint CreatePointZ(10, 0, 0)   'create a pyramid shaped TriangleFan
  End With
```

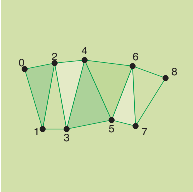
Where *CreatePointZ* is the function:

```
Private Function CreatePointZ(dblX As Double, dblY As Double, _
    dblZ As Double) As IPoint
  Set CreatePointZ = New Point
  CreatePointZ.PutCoords dblX, dblY
  CreatePointZ.Z = dblZ
End Function
```

You do not need to ensure that each Point *is* ZAware*; when a* Point *is added to a z-aware* TriangleFan*, the* Point *will automatically be set to have z-awareness. For more information on z-attributes, see the section on geometry attributes in this chapter.*



A TriangleStrip *is a collection of* Points *that define a surface of triangles, where consecutive triangles in the strip share an edge.*



A TriangleStrip *is also known as a 2.5D object, as it is based on two-dimensional shapes with height coordinates.*

A *TriangleStrip* is a continuous strip of triangles, where every triangle shares two vertices and an edge with the preceding triangle. *TriangleStrips* are mainly used as surface patches in *MultiPoint* geometries.

The *TriangleStrip* coclass is based on an ordered collection of *Points*, where each triangle in a strip with n points has the vertices *Point(i), Point(i +1),* and *Point(i + 2),* up to n = -2. The number of *Triangles* can be found by *IPointCollection.PointCount* - 2.

ITriangleStrip : IGeometry

Provides access to members that identify a triangle strip.

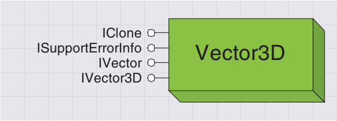
The *ITriangleStrip* interface has no methods or properties but can be used as a check for the *TriangleStrip* coclass.

```
If Typeof pGeometry Is ITriangleStrip Then ...
```

To add, change, move, or remove *Points* in a *TriangleStrip*, use the *IPointCollection* interface. The code used would be similar to that shown previously for *TriangleFan*.

To identify the vertices of the ith triangle in the strip, for example, use the code below:

```
Dim pPointColl As IPointCollection
Set pPointColl = pTriangleStrip

Dim pPoint1 As IPoint, pPoint2 As IPoint, pPoint3 As IPoint
Dim i As Integer
i = 3
If Not (i > pPointColl.PointCount - 2) Then
  Set pPoint1 = pPointColl.Point(i - 1)
  Set pPoint2 = pPointColl.Point(i)
  Set pPoint3 = pPointColl.Point(i + 1)
Else
  MsgBox "There are only " & pPointColl.PointCount - 2 & _
    " triangles in the strip."
End If
```



A Vector3D *defines a shape that has a direction in three dimensions.*

A *Vector3D* defines a direction in terms of magnitude along the x-, y-, and z-axes. Its direction can also be thought of in terms of spherical coordinates, as an angle of rotation (azimuth) from the y,z plane; angle of displacement (inclination) from the x,y plane; or length (magnitude).

A *Vector3D* is not a geometrical shape and as such does not inherit the *IGeometry* interface—it does not have a spatial location and is mainly used in the construction of other 3D geometries.

IVector : IUnknown	*Provides access to members that define general vector properties and operations.*
■—■ ComponentByIndex (componentIndex: Long) : Double	*The component corresponding to a given index.*
■— Dimension: Long	*The dimension of this vector.*
■— IsEmpty: Boolean	*Indicates if the vector is empty (unset).*
■—■ Magnitude: Double	*The length of the vector.*
◀— AddVector (otherVector: IVector) : IVector	*Construct a new vector by adding a different vector to this vector.*
◀— ConstructAddVector (vector1: IVector, vector2: IVector)	*Set this vector by adding two input vectors.*
◀— ConstructCrossProduct (vector1: IVector, vector2: IVector)	*Set this vector equal to the cross product of the two input vectors.*
◀— ConstructSubtractVector (vector1: IVector, vector2: IVector)	*Set this vector by subtracting the second input vector from the first one.*
◀— CrossProduct (otherVector: IVector) : IVector	*Returns the cross product of this vector and another vector.*
◀— DotProduct (otherVector: IVector) : Double	*Returns the dot product of this vector and another vector.*
◀— Normalize	*Normalize the vector (scale it to magnitude = 1).*
◀— Scale (ScaleFactor: Double)	*Scale the vector by the given factor.*
◀— SetEmpty	*Makes the vector empty (unset).*
◀— SubtractVector (otherVector: IVector) : IVector	*Construct a new vector by subtracting a different vector from this vector.*

The *IVector* interface applies to vectors of any dimension. This interface allows you to change existing vectors using vector mathematics using the *AddVector, CrossProduct, DotProduct, Normalize, Scale,* or *SubtractVector* methods. Use *ConstructAddVector, ConstructCrossProduct,* or *ConstructSubtractVector* to set the components of a new vector by using existing vectors.

IVector3D *contains particular properties and methods that apply to three-dimensional vectors.*

IVector3D : IVector	*Provides access to members that define 3D vector properties and operations.*
■—■ Azimuth: Double	*The vector's azimuth angle in radians.*
■—■ Inclination: Double	*The vector's inclination in radians.*
■—■ XComponent: Double	*The vector's X component.*
■—■ YComponent: Double	*The vector's Y component.*
■—■ ZComponent: Double	*The vector's Z component.*
◀— ConstructDifference (point1: IPoint, point2: IPoint)	*Set the vector by taking the difference of point1 and point2 (so the vector would go from point2 to point1).*
◀— Move (dx: Double, dy: Double, dz: Double)	*Move the vector by adding a shift value to each component.*
◀— PolarMove (dAzimuth: Double, dInclination: Double, dRadius: Double)	*Modify the vector by adding to its polar components. Angles are in radians.*
◀— PolarQuery (out Azimuth: Double, out Inclination: Double, out radiusLength: Double)	*Get the vector's polar components. Angles are in radians.*
◀— PolarSet (Azimuth: Double, Inclination: Double, radiusLength: Double)	*Set the vector using polar components. Angles are in radians.*
◀— QueryComponents (out dx: Double, out dy: Double, out dz: Double)	*Get the values of the vector's components.*
◀— Rotate (Angle: Double, axis: IVector3D)	*Rotate the vector around an axis defined by another vector. The angle is in radians.*
◀— SetComponents (dx: Double, dy: Double, dz: Double)	*Set the values of the vector's components.*

Use the *IVector3D* interface to define a *3DVector* in two different ways, either by Euclidean or polar coordinates. To define the vector using

Euclidean coordinates, set the *XComponent, YComponent,* and *ZComponent* properties. You can either use the individual properties or use *SetComponents*.

```
Dim pVector3D as IVector3D
Set pVector3D = New 3DVector
pVector3D .SetComponents 10, 5, 2
```

Alternatively, use polar coordinates—either set the *Azimuth, Inclination,* and *Magnitude* properties, or use *PolarSet*.

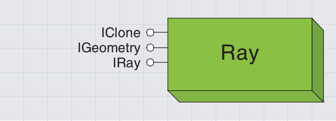
```
p3DVector.PolarSet 1, 1, 10
```

The *Azimuth* and *Inclination* properties both use radians as units.

The *IVector3D* interface also provides methods to construct a vector. For example, the *ConstructDifference* method sets a *Vector3D* to be the line between two z-aware *Points*.

The points must have z-attributes set in order to correctly generate the vector.

```
Dim pPointOne As IPoint, pPointTwo As IPoint
Dim pZAware As IZAware

Set pPointOne = New Point
pPointOne.PutCoords -10, -10
Set pZAware = pPointOne
pZAware.ZAware = True
pPointOne.Z = -10

Set pPointTwo = New Point
pPointTwo.PutCoords 15, 15
Set pZAware = pPointTwo
pZAware.ZAware = True
pPointTwo.Z = 15

pVector3D.ConstructDifference pPointOne, pPointTwo
```



A Ray *is a three-dimensional linear shape, beginning at a* Point *and continuing infinitely in one direction.*

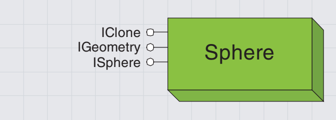
A *Ray* is a linear 3D *Geometry* that inherits the *IGeometry* interface. Its location is defined by its origin (a *Point* object), and its direction is defined by a vector (a *Vector3D* object).

IRay : IGeometry	***Provides access to members that define properties and functionality specific to 3D rays.***
■━■ Origin: IPoint	*The origin point of the ray.*
■━■ Vector: IVector3D	*The direction vector of the ray.*
← GetEnumIntersect (targetGeometry: IGeometry) : IEnumIntersection	*Constructs an enumerator that can provide information about intersections with the target geometry.*
← GetPointAtDistance (Distance: Double) : IPoint	*Constructs a point at a distance along the ray.*
← Intersect (targetGeometry: IGeometry, intersectionPoints: IPointCollection)	*Returns a point collection containing all points of intersection, in order along the ray.*
← Intersects (targetGeometry: IGeometry) : Boolean	*Indicates if the ray intersects the target geometry.*
← QueryFirstIntersection (targetGeometry: IGeometry, intersectionPoint: IPoint)	*Returns the first point of intersection between the ray and the target geometry. The point is set empty if there is no intersection.*
← QueryOrigin (vectorOrigin: IPoint)	*Sets a point equal to the ray's origin.*
← QueryPointAtDistance (Distance: Double, Point: IPoint)	*Queries a point at a distance along the ray.*
← QueryVector (directionVector: IVector3D)	*Sets a vector equal to a unit vector with the same direction as the ray.*

The *IRay* interface provides information about existing *Rays* and also allows you to construct a new *Ray*.

```
Dim pRay As IRay
Set pRay = New Ray
pRay.Origin = CreatePointZ(0, 0, 0)
pRay.Vector = pVector3D
```

Basic *Ray* intersection is available using the *Intersects* and *Intersect* methods, passing in an existing *MultiPatch* object or a *ZSimple Polygon*, *Polyline Envelope*, or *Point* as the target *Geometry*. However, note that *Ray* intersection is not fully implemented at ArcGIS 8.1. The methods indicate if the *Ray* intersects the bounding *Envelope* of the *Geometry*, not the shape itself—returned intersect *Points* lie within the bounding *Envelope*, not on the edges or surfaces of the input *Geometry*.



A Sphere *is a spherical 3D geometry.*

A *Sphere* coclass defines a spherical 3D geometry. A sphere's shape is defined by a center *Point* and a *Radius* distance.

ISphere : IGeometry	***Provides access to members that define a sphere.***
■━■ Center: IPoint	*The center of the sphere.*
■━■ Radius: Double	*The radius of the sphere.*
← QueryCenter (CenterPoint: IPoint)	*Sets a point equal to the center of the sphere.*

The *ISphere* interface provides information about existing *Spheres* and also allows you to construct a new *Sphere* by setting the *Radius* and *Center* properties:

```
Dim pPoint As IPoint, pSphere as ISphere
Set pPoint = New Point
pPoint.PutCoords 10, 10
pPoint.Z = 10

Set pSphere = New Sphere
pSphere.Center = pPoint
pSphere.Radius = 50
```

10 Managing the spatial reference

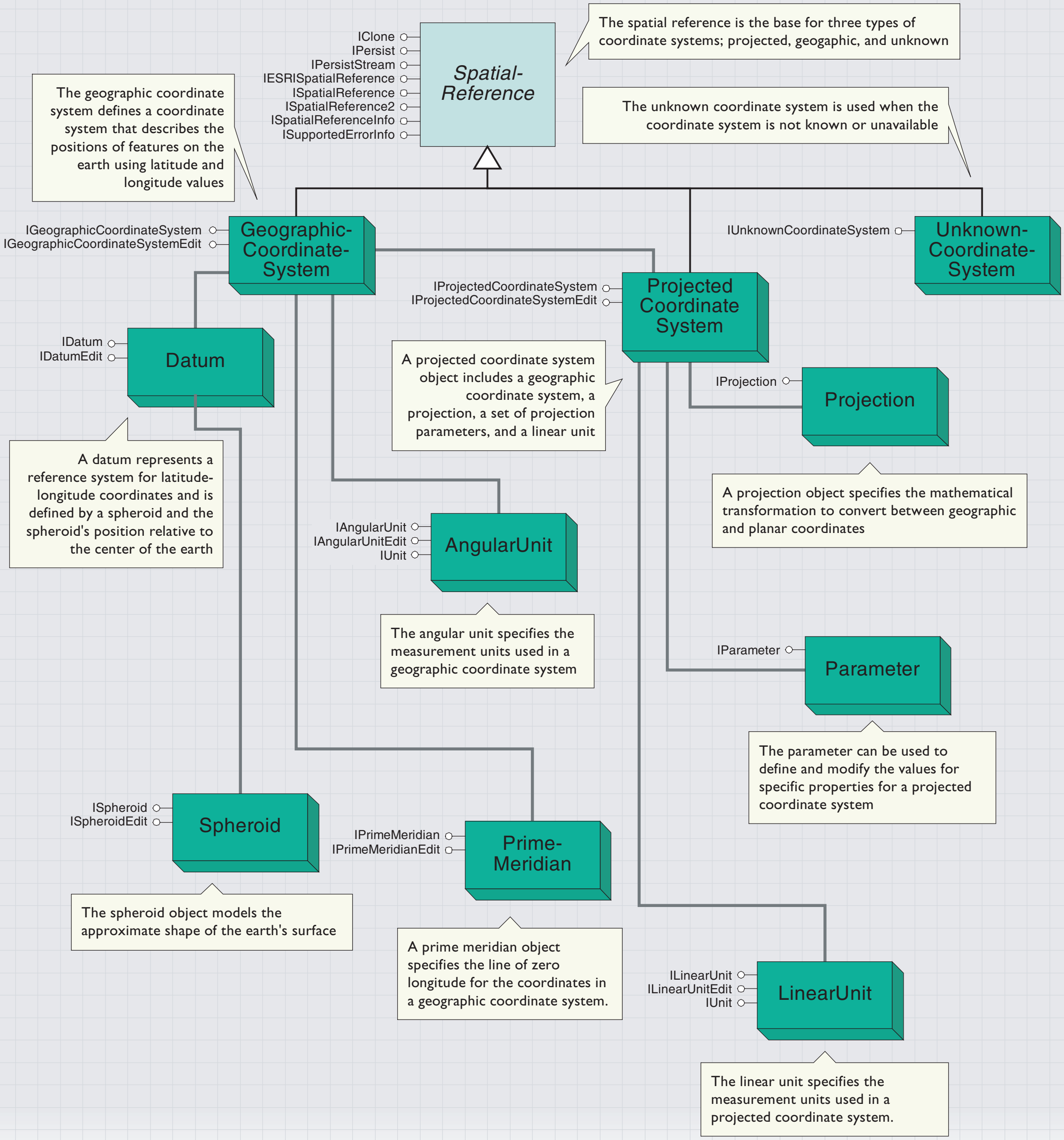
Steve Wheatley, Melita Kennedy

The features in a dataset represent objects in the real world. Each feature's relative location within the dataset reflects the location of that feature within the real world. The location of each feature is defined by a coordinate system.

Geographic coordinate systems, measured in degrees of latitude and longitude, are based on a spheroidal approximation of the shape of the earth. To facilitate the two-dimensional display of features on a map or computer screen, spatial data is transformed from the three-dimensional geographic coordinate system onto a two-dimensional coordinate system by means of a map projection.

Many different coordinate systems are used for data collection and storage. If the data you are using came from a variety of sources, it's likely that the different datasets may be based on different coordinate systems. You can use the spatial reference objects in ArcObjects to view your data in a common coordinate system.

Spatial reference



The spatial reference is the base for three types of coordinate systems; projected, geopaphic, and unknown

The unknown coordinate system is used when the coordinate system is not known or unavailable

The geographic coordinate system defines a coordinate system that describes the positions of features on the earth using latitude and longitude values

A projected coordinate system object includes a geographic coordinate system, a projection, a set of projection parameters, and a linear unit

A datum represents a reference system for latitude-longitude coordinates and is defined by a spheroid and the spheroid's position relative to the center of the earth

A projection object specifies the mathematical transformation to convert between geographic and planar coordinates

The angular unit specifies the measurement units used in a geographic coordinate system

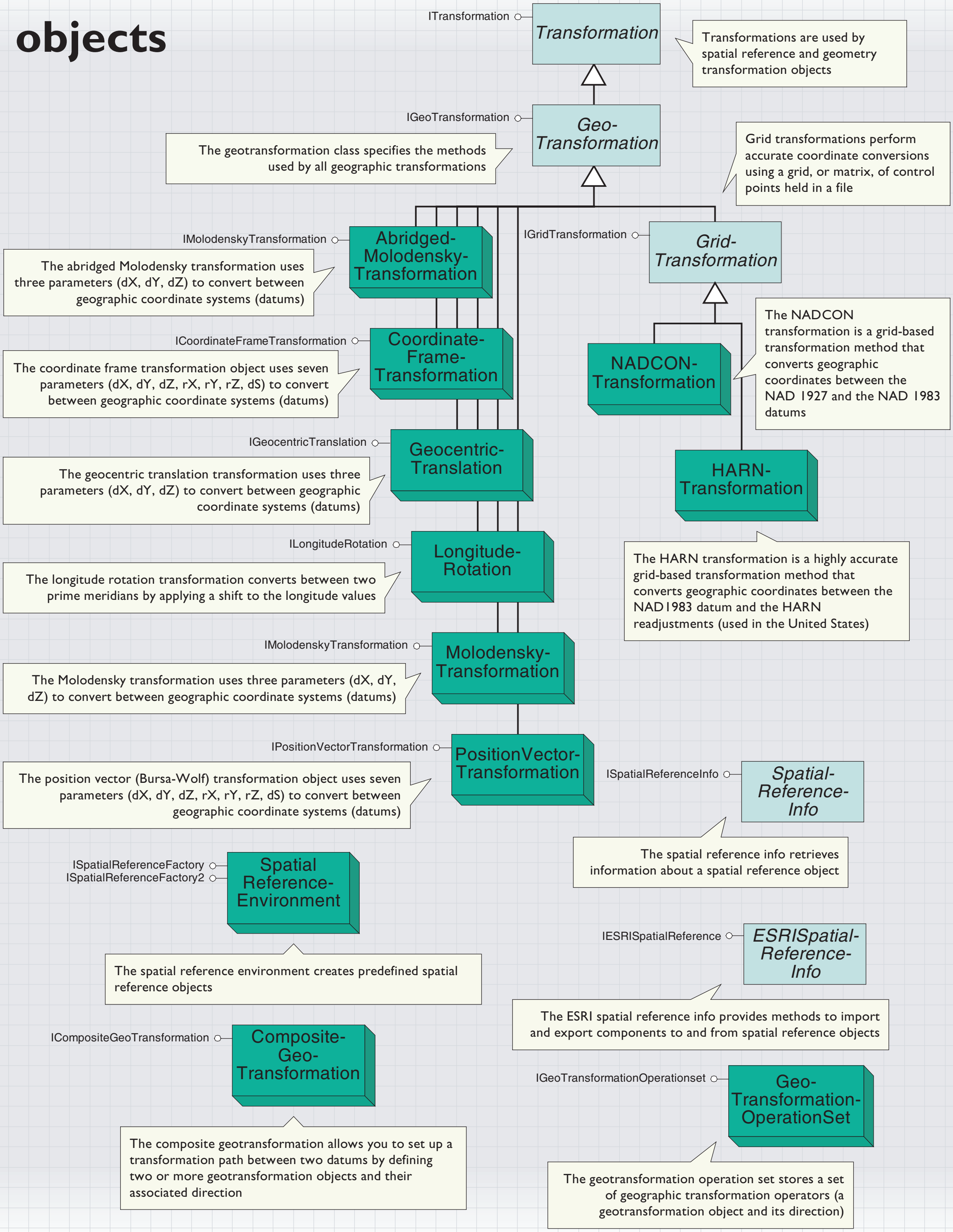
The parameter can be used to define and modify the values for specific properties for a projected coordinate system

The spheroid object models the approximate shape of the earth's surface

A prime meridian object specifies the line of zero longitude for the coordinates in a geographic coordinate system.

The linear unit specifies the measurement units used in a projected coordinate system.

objects


ITransformation
Transformation
IGeoTransformation
Geo-Transformation
IMolodenskyTransformation
Abridged-Molodensky-Transformation
IGridTransformation
Grid-Transformation
ICoordinateFrameTransformation
Coordinate-Frame-Transformation
NADCON-Transformation
IGeocentricTranslation
Geocentric-Translation
HARN-Transformation
ILongitudeRotation
Longitude-Rotation
IMolodenskyTransformation
Molodensky-Transformation
IPositionVectorTransformation
PositionVector-Transformation
ISpatialReferenceInfo
Spatial-Reference-Info
ISpatialReferenceFactory
ISpatialReferenceFactory2
Spatial-Reference-Environment
IESRISpatialReference
ESRISpatial-Reference-Info
ICompositeGeoTransformation
Composite-Geo-Transformation
IGeoTransformationOperationset
Geo-Transformation-OperationSet

Transformations are used by spatial reference and geometry transformation objects

The geotransformation class specifies the methods used by all geographic transformations

Grid transformations perform accurate coordinate conversions using a grid, or matrix, of control points held in a file

The abridged Molodensky transformation uses three parameters (dX, dY, dZ) to convert between geographic coordinate systems (datums)

The coordinate frame transformation object uses seven parameters (dX, dY, dZ, rX, rY, rZ, dS) to convert between geographic coordinate systems (datums)

The NADCON transformation is a grid-based transformation method that converts geographic coordinates between the NAD 1927 and the NAD 1983 datums

The geocentric translation transformation uses three parameters (dX, dY, dZ) to convert between geographic coordinate systems (datums)

The HARN transformation is a highly accurate grid-based transformation method that converts geographic coordinates between the NAD1983 datum and the HARN readjustments (used in the United States)

The longitude rotation transformation converts between two prime meridians by applying a shift to the longitude values

The Molodensky transformation uses three parameters (dX, dY, dZ) to convert between geographic coordinate systems (datums)

The position vector (Bursa-Wolf) transformation object uses seven parameters (dX, dY, dZ, rX, rY, rZ, dS) to convert between geographic coordinate systems (datums)

The spatial reference info retrieves information about a spatial reference object

The spatial reference environment creates predefined spatial reference objects

The ESRI spatial reference info provides methods to import and export components to and from spatial reference objects

The composite geotransformation allows you to set up a transformation path between two datums by defining two or more geotransformation objects and their associated direction

The geotransformation operation set stores a set of geographic transformation operators (a geotransformation object and its direction)

Part of what defines a feature dataset is its spatial reference, or coordinate system. A coordinate system includes such information as the unit of measure, the earth model used and, sometimes, how the data was projected.

A geographic coordinate system is defined by a datum, an angular unit of measure (usually either degrees or grads), and a prime meridian.

A projected coordinate system consists of a linear unit of measure (usually meters or feet), a map projection, the specific parameters used by the map projection, and a geographic coordinate system.

Many analysis techniques and data are designed for two-dimensional or planar coordinates. Three-dimensional geographic data is converted to planar coordinates via a map projection. A map projection is a set of mathematical equations to convert from a 3D earth represented by longitude and latitude to planar coordinates (x,y).

Converting from three to two dimensions causes distortions—either the shape, area, distance, or direction can be affected. A map projection is designed to minimize distortions caused by flattening the earth's surface. However, a projection that minimizes distortion of shape may be at the cost of increased distortion in distance. Therefore, ensure that the projection chosen for your data is fit for your purpose, as different projections are useful for different applications.

STRUCTURE OF SPATIAL REFERENCE OBJECT MODEL

The spatial reference model is based on a model developed by Petrotechnical Open Software Corporation (POSC), a consortium of oil and gas companies that simplifies the various pieces that compose a coordinate system.A related organization, European Petroleum Survey Group (EPSG), has compiled a large set of coordinate systems and the objects needed to define them. Each object has a unique integer code or ID. For example, the code for international meters is 9001, while the WGS 1984 datum is 6326, and so on.A coordinate system has a single ID.

Within the spatial reference model, the integer code is known as a FactoryCode.

To ensure that the most recent version of the EPSG files is always available, the EPSG has requested that only one Web site carry the files. The files are available in three different formats at www.epsg.org.

ArcObjects provides a set of classes designed to allow the user to control and manipulate when coordinate systems of data are displayed and how they are stored. For the majority of developers, there are three main ArcObjects components to help manage coordinate systems: *ProjectedCoordinateSystem, GeographicCoordinateSystem,* and *SpatialReferenceEnvironment.*

For advanced developers who need additional flexibility to create user-defined or even custom coordinate systems, the following classes are available: *Projection, Datum, AngularUnit, LinearUnit, Spheroid, PrimeMeridian,* and the *GeoTransformation* classes.

The relationships between the *SpatialReference* objects are shown in the object model diagram. The objects can be placed in three groups: utility, core, and transformation.

The utility group of classes and interfaces are those that are used to either create *SpatialReference* objects or provide information about them. These include *SpatialReferenceEnvironment, ESRISpatialReferenceInfo,* and *SpatialReferenceInfo.*

The core group consists of objects that are used to represent the component parts of a coordinate system. These are *ProjectedCoordinateSystem, Projection, GeographicCoordinateSystem, AngularUnit, LinearUnit, Datum, Spheroid, Parameter,* and *PrimeMeridian.*

The object model diagram also illustrates the relationships between the core spatial reference objects. For example, a *Datum* object has a *Spheroid* property, while a *GeographicCoordinateSystem* object has both a *Datum* property and a *PrimeMeridian* property.

The geographic transformation objects are all those objects that handle coordinate conversions between geographic systems, also known as datum conversions or datum shifts. This chapter starts with a discussion on the utility objects, followed by the core objects, and finally the transformation objects.

METADATA

If your feature class is contained within a feature dataset, then all feature classes within that dataset must share a common spatial reference. Depending on your data source, ArcObjects will read and honor any accompanying metadata containing information on the coordinate system of that data and will set the *SpatialReference* property of that feature dataset or feature class appropriately.

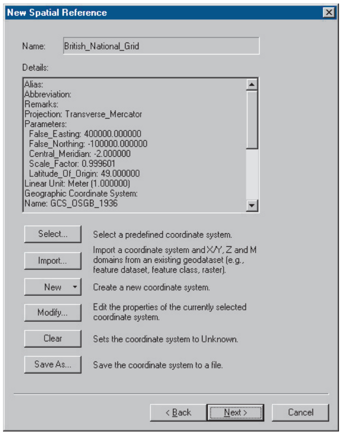
- A shapefile may have an accompanying coordinate system metadata file (.prj).
- An ArcInfo coverage contains coordinate system information in a PRJ (prj.adf) file within the coverage workspace.
- ArcSDE layers store coordinate system metadata in a field in the ArcSDE layers table.
- VPF should have its projection information already built in its database. ArcGIS will honor that metadata, and the VPF data will be projected. Since VPF is currently a read-only data source, it's not possible to set the coordinate system.
- It is possible to assign a spatial reference to CAD data, but this can only be done at the CAD feature dataset (not feature class) or CAD drawing level. A projection (.prj) file must be saved to disk. As long as this file shares the same name as the CAD file and resides in the same folder, ArcGIS will recognize it.
- Feature classes in a personal geodatabase always have an explicit *SpatialReference,* which may be an *UnknownCoordinateSystem.*
- For raster datasets based on a grid and a TIN, the associated PRJ file will also be read.

If the metadata is not present or is incorrect, then ArcObjects will inspect the coordinate range and magnitude of the data. If it appears that the coordinates of the data are in units of degrees and within the range of standard geographic coordinates, then it will associate the feature class with an “Assumed Geographic Coordinate System”. This also means that no information is known about the datum on which these geographic coordinates are based. In fact, ArcObjects will set the datum to be NAD 1927, which is generally fine for data based in North America.

If the coordinates of the data appear to be in units other than degrees, such as meters or feet, then ArcObjects will set the *SpatialReference* property of the feature class to be an "UnknownCoordinateSystem". This maintains precision information for the coordinates so that geometry operations have a consistent tolerance.

Defining the spatial reference metadata for a layer is a data management task best achieved within ArcCatalog. Within the ArcMap application, it is not possible to select an individual layer and set its spatial reference property. However, it is possible to do it programmatically. There is an ArcObjects component that provides a dialog box to allow for the browsing of all the available projected and geographic coordinate systems that ArcObjects supports.

ISpatialReferenceDialog : IUnknown	***Provides access to members that control the Spatial Reference Dialog.***
← DoModalCreate (in hasXY: Boolean, in HasZ: Boolean, in HasM: Boolean, in hParent: Long) : ISpatialReference	*Prompts the user to define a new spatial reference.*
← DoModalEdit (in inputSpatialReference: ISpatialReference, in hasXY: Boolean, in HasZ: Boolean, in HasM: Boolean, in coordPageReadOnly: Boolean, in domainPageReadOnly: Boolean, in hParent: Long) : ISpatialReference	*Displays/edits the properties of the given spatial reference.*



Name: British_National_Grid

Details:

```
Alias:
Abbreviation:
Remarks:
Projection: Transverse_Mercator
Parameters:
  False_Easting: 400000.000000
  False_Northing: -100000.000000
  Central_Meridian: -2.000000
  Scale_Factor: 0.999601
  Latitude_Of_Origin: 49.000000
Linear Unit: Meter (1.000000)
Geographic Coordinate System:
Name: GCS_OSGB_1936
```

Select... Select a predefined coordinate system.

Import... Import a coordinate system and X/Y, Z and M domains from an existing geodataset (e.g., feature dataset, feature class, raster).

New Create a new coordinate system.

Modify... Edit the properties of the currently selected coordinate system.

Clear Sets the coordinate system to Unknown.

Save As... Save the coordinate system to a file.

The New Spatial Reference dialog box in ArcCatalog

The following code illustrates how to programmatically call up the dialog box and use it to instantiate a *SpatialReference* object.

```
  Dim pDialog As ISpatialReferenceDialog
  Set pDialog = New SpatialReferenceDialog
  Dim pSpatialReference As ISpatialReference
  'Once the dialog box pops up you can browse for the PRJ file that you
want.
  Set pSpatialReference = pDialog.DoModalCreate(True, False, False, 0)
```

While it appears possible to set the *SpatialReference* property of a *FeatureLayer* coclass, this will not have any effect on the drawing of the layer within the *Map*. This property is used to carry the *Map*'s knowledge of the current on-the-fly projection back to the feature layer and is really intended for internal ArcObjects use.

If you want to reset or override the *SpatialReference* of your *FeatureLayer*, you need to use the *IGeoDatasetSchemaEdit* interface. This interface has two methods: *CanAlterSpatialReference* and *AlterSpatialReference*.

The following code illustrates how to obtain a handle on the *IGeoDatasetSchemaEdit* interface.

```
  ' This code sample takes a layer and resets its SpatialReference
  ' to be the OSGB1936 Geographic Coordinate System.
  Dim pMxDoc As IMxDocument
  Set pMxDoc = ThisDocument

  Dim pMap As IMap
  Set pMap = pMxDoc.FocusMap

  Dim pLayer As IFeatureLayer
```

```
Set pLayer = pMap.Layer(0)

Dim pFeatureClass As IFeatureClass
Set pFeatureClass = pLayer.FeatureClass

'QI for the geodataset for the layers featureclass
Dim pGeoDataset As IGeoDataset
Set pGeoDataset = pFeatureClass

'QI for the GeoDatasetSchemaEdit from the geodataset
Dim pGeoDatasetEdit As IGeoDatasetSchemaEdit
Set pGeoDatasetEdit = pGeoDataset

'Test if you can alter the spatialreference, if you can, the you
'create a factory and use it to create a geographic coordinate system.
If (pGeoDatasetEdit.CanAlterSpatialReference = True) Then
  Dim pSpatRefFact As ISpatialReferenceFactory2
  Set pSpatRefFact = New SpatialReferenceEnvironment

  Dim pGeoCoordSys As IGeographicCoordinateSystem
  Set pGeoCoordSys = _
   pSpatRefFact.CreateGeographicCoordinateSystem(esriSRGeoCS_OSGB1936)

  'Now alter the layers SR
  pGeoDatasetEdit.AlterSpatialReference pgeocoorsys
End If

'and force a refresh
pMxDoc.ActiveView.Refresh
```

To get the *SpatialReference* information on a *Layer*, you will need to *QI* for the *IGeoDataset* interface and obtain the *SpatialReference* object from there.

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument

Dim pMap As IMap
Set pMap = pMxDoc.FocusMap

Dim pLayer As IFeatureLayer
Set pLayer = pMap.Layer(0)

Dim pGeoDataset As IGeoDataset
Dim pSpatialReference As ISpatialReference
Set pGeoDataset = pLayer 'QI for the geodataset from the layer
Set pSpatialReference = pGeoDataset.SpatialReference
MsgBox pSpatialReference.Name
```

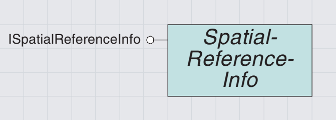
The *SpatialReference* property on the *IMap* interface defines the way in which the layers are displayed onscreen. This is known as your target coordinate system, while each layer's coordinate system is known as the source coordinate system.

Setting or changing the target coordinate system on the *Map* will change how your layers are displayed, as each *Layer* is transformed from the source to the target coordinate system. The coordinates of all features within the visible extent are read and transformed for each display refresh.

Here is an example of how to set the *SpatialReference* property on a *Map*.

```
Dim pSpatialReference As IProjectedCoordinateSystem
Dim pDialog As ISpatialReferenceDialog
Set pDialog = New SpatialReferenceDialog
Set pSpatialReference = pDialog.DoModalCreate(True, False, False, 0)

Dim pMap As IMap
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Set pMap = pMxDoc.FocusMap

Set pMap.SpatialReference = pSpatialReference
pMxDoc.ActiveView.Refresh
```

SpatialReferenceInfo abstract class



The spatial reference info provides information about any spatial reference object.

The three *SpatialReference* classes that could be considered utility classes are *SpatialReferenceInfo, ESRISpatialReferenceInfo,* and *SpatialReferenceEnvironment.* As their names and their supported interfaces suggest, they are concerned with the creation of *SpatialReference* objects and also with providing information about those objects.

The *SpatialReferenceInfo* abstract class supports *ISpatialReferenceInfo,* which defines properties common to all components of the spatial reference object model. For example, the *Datum* coclass, *GeographicCoordinateSystem,* and *Projection* coclasses all implement this interface. This is achieved through type inheritance—the *ISpatialReference* interface inherits from *ISpatialReferenceInfo.*

As mentioned earlier, the SpatialReference model is based on the POSC model and uses EPSG integer codes to uniquely identify coordinate systems and their component parts. In ArcObjects, this code number is referred to as the FactoryCode. It is primarily used to create predefined coordinate systems with the methods available in the ISpatialReferenceFactory interface.The value of the FactoryCode can be obtained from the ISpatialReferenceInfo interface.

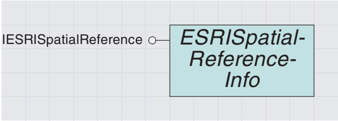
ISpatialReferenceInfo : IUnknown	***ISpatialReferenceInfo interface defines properties common to all components of a spatial reference system.***
Abbreviation: String	*The abbreviated name of this spatial reference component.*
Alias: String	*The alias of this spatial reference component.*
FactoryCode: Long	*Returns the factory code of the spatial reference*
Name: String	*The name of this spatial reference component.*
Remarks: String	*The comment string of this spatial reference component.*

The *ISpatialReferenceInfo* interface provides properties such as the *FactoryCode, Name,* and *Alias* of the *SpatialReference* object. For example, this type of information might be provided from a *Projection* object.

```
FactoryCode: 43033
Name: "Lambert Azimuthal Equal Area"
Alias: "Zenithal Equal Area"
Usage: "Maintains small area, good for up to a hemisphere, often used for
  polar data.
Classification: Azimuthal/Planar, Equal Area"
Remarks: "Supports both spheres and spheroids (datums). Projection
  parameters are central meridian and latitude of origin"
```

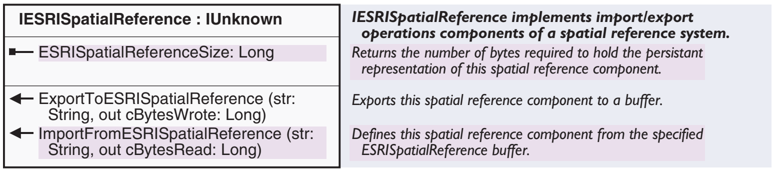
This code shows the display of spatial reference information. Note that because *IProjection* inherits from *ISpatialReferenceInfo,* no *QI* is needed.

```
Dim pSpatRefFact As ISpatialReferenceFactory
Set pSpatRefFact = New SpatialReferenceEnvironment
Dim pProjection As IProjection
Set pProjection = _
pSpatRefFact.CreateProjection(esriSRProjection_LambertAzimuthal) '43033

Debug.Print pProjection.Abbreviation
Debug.Print pProjection.Alias
Debug.Print pProjection.FactoryCode
Debug.Print pProjection.Name
Debug.Print pProjection.Remarks
```



The ESRI spatial reference info provides methods to import and export spatial reference objects.

The *ESRISpatialReferenceInfo* abstract class defines the *IESRISpatialReference* interface, which is implemented by all spatial reference objects except the *SpatialReferenceEnvironment* singleton object. This interface provides import and export capability for *SpatialReference* objects or their components.



IESRISpatialReference : IUnknown

IESRISpatialReference implements import/export operations components of a spatial reference system.

ESRISpatialReferenceSize: Long	*Returns the number of bytes required to hold the persistant representation of this spatial reference component.*
ExportToESRISpatialReference (str: String, out cBytesWrote: Long)	*Exports this spatial reference component to a buffer.*
ImportFromESRISpatialReference (str: String, out cBytesRead: Long)	*Defines this spatial reference component from the specified ESRISpatialReference buffer.*

The *IESRISpatialReference* interface was designed primarily for internal ArcObjects use but can be utilized by experienced developers who are also familiar with the Projection Engine API.

The counts passed out of the methods on this interface are byte counts, not character counts.

The *ESRISpatialReferenceSize* property returns the number of bytes required to hold the string representation of the *SpatialReference* object. This number is guaranteed to be large enough but may be larger than needed. The number returned from *ExportToESRISpatialReference* is the exact number of bytes used in the buffer to hold the string.

The *ExportToESRISpatialReference* method is straightforward, as it provides a string representation of the definition of the *SpatialReference* object.

The following code, which demonstrates how to use this method, expects that a valid *SpatialReference* object has already been created. In this case, you can assume that a *ProjectedCoordinateSystem* object can be obtained from the *FocusMap*.

```
Dim pMxDoc As IMxDocument
Dim pBytes As Long
Dim pBuffer As String * 2048
Dim pParameterExport As IESRISpatialReference
Dim pProjectedCoordinateSystem As ISpatialReference
'Here it is essential that the buffer is intialized and allocated memory.
Set pMxDoc = Application.Document
'get the SpatialReference object from the FocusMap
Set pProjectedCoordinateSystem = pMxDoc.FocusMap.SpatialReference
Set pParameterExport = pProjectedCoordinateSystem 'QI
'make the call
pParameterExport.ExportToESRISpatialReference pBuffer, pBytes
MsgBox pBuffer
```

The *ImportFromESRISpatialReference* method is slightly more complicated. To correctly create a *SpatialReference* object requires that the string buffer is formatted in a way that is defined by the ESRI Projection Engine (which is the POSC/GeoTIFF format for spatial reference representation). The required format is exactly the same as the format of the new PRJ file structure.

```
PROJCS["Test",
GEOGCS["GCS_WGS_1984",
DATUM["D_WGS_1984",
SPHEROID["WGS_1984",6378137,298.257223]],
PRIMEM["Greenwich",0],
UNIT["Degree",0.0174532925199433]],
PROJECTION["Mercator"],
PARAMETER["false_easting",1000000],
UNIT["Foot",0.3048] ]
```

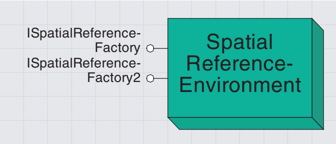
If you open up a PRJ file in Notepad that contains the string description of a *ProjectedCoordinateSystem*, you will see something like the text to the left. The important fact to realize is that subcomponents of the PROJCS are defined with a pair of square brackets "[ ]". Therefore, the *Datum* component, which is composed of a name and a spheroid, can be seen highlighted in red.

With this in mind, the following code shows the *ImportFromESRISpatialReference* method to create a *Parameter* object from a string description. What you should do with the *Parameter* object is explained later in this chapter.

```
Dim pBuffer As String
Dim pBytes As Long
Dim pParameterImport As IESRISpatialReference
Dim pParameter As IParameter
'Note the PARAMETER keyword
'Note also the double quotation marks around an embedded string.
pBuffer = "PARAMETER[""false_easting"", 1000000]"
'Create an ESRISpatialReference using the parameter coclass
Set pParameterImport = New Parameter
'make the call
pParameterImport.ImportFromESRISpatialReference pBuffer, pBytes
'QI to get your new Parameter
Set pParameter = pParameterImport
MsgBox pParameter.Name
MsgBox pParameter.Value
```

Finally, the following similar example also shows how to use the *ImportFromESRISpatialReference* method, this time to create a *Datum* object from a string.

```
Dim pBuffer As String
Dim pBytes As Long
Dim pDatumImport As IESRISpatialReference
Dim pDatum As IDatum

' Note the DATUM and SPHEROID keywords.
' Note also the double quotation marks around embedded strings.
pBuffer = "DATUM[""D_WGS_1984"", _
   SPHEROID[""WGS_1984"",6378137,298.257223]]"
' Create an ESRISpatialReference using the Datum coclass
Set pDatumImport = New Datum
' make the call
pDatumImport.ImportFromESRISpatialReference pBuffer, pBytes
' QI to get your new Datum
Set pDatum = pDatumImport

MsgBox pDatum.Name
MsgBox pDatum.Spheroid.Name
MsgBox pDatum.Spheroid.Flattening
MsgBox pDatum.Spheroid.SemiMajorAxis
MsgBox pDatum.Spheroid.SemiMinorAxis
```



The spatial reference environment is used to create predefined spatial reference objects.

The *SpatialReferenceEnvironment* coclass is another primary component of the spatial reference object model. It is a singleton object that implements the *ISpatialReferenceFactory* interface, which provides the developer with methods that can be used to create predefined "factory" instances of all types of spatial reference objects.

ISpatialReferenceFactory : IUnknown	***ISpatialReferenceFactory creates different kinds of spatial reference components.***
← CreateDatum (datumType: Long) : IDatum	*Creates a predefined datum.*
← CreateESRISpatialReference (spatRefInfo: String, out SpatialReference: ISpatialReference, out cBytesRead: Long)	*Creates a spatial reference system and defines it from the specified ESRISpatialReference buffer.*
← CreateESRISpatialReferenceFromPRJ (prj: String) : ISpatialReference	*Creates a spatial reference from a PRJ string*
← CreateESRISpatialReferenceFromPRJFile (prjFile: String) : ISpatialReference	*Creates a spatial reference from a PRJ file*
← CreateGeographicCoordinateSystem (gcsType: Long) : IGeographicCoordinateSystem	*Creates a predefined geographic coordinate system.*
← CreateGeoTransformation (gTransformationType: Long) : ITransformation	*Creates a predefined transformation between geographic coordinate systems.*
← CreateParameter (parameterType: Long) : IParameter	*Creates a predefined parameter.*
← CreatePredefinedAngularUnits: ISet	*Creates a list of predefined angular units.*
← CreatePredefinedDatums: ISet	*Creates a list of a list of predefined datums.*
← CreatePredefinedLinearUnits: ISet	*Creates a list of predefined linear units.*
← CreatePredefinedPrimeMeridians: ISet	*Creates a list of predefined prime meridians.*
← CreatePredefinedProjections: ISet	*Creates a list of predefined projections.*
← CreatePredefinedSpheroids: ISet	*Creates a list of predefined spheroids.*
← CreatePrimeMeridian (primeMeridianType: Long) : IPrimeMeridian	*Creates a predefined prime meridian.*
← CreateProjectedCoordinateSystem (pcsType: Long) : IProjectedCoordinateSystem	*Creates a predefined projected coordinate system.*
← CreateProjection (projectionType: Long) : IProjection	*Creates a predefined projection.*
← CreateSpheroid (spheroidType: Long) : ISpheroid	*Creates a predefined spheroid.*
← CreateUnit (unitType: Long) : IUnit	*Creates a predefined unit of measure.*
← ExportESRISpatialReferenceToPRJFile (prjFile: String, SpatialReference: ISpatialReference)	*Exports a spatial reference to a PRJ file*

The *ISpatialReferenceFactory* interface, whose coclass is *SpatialReferenceEnvironment*, provides methods that use the *FactoryCode* to generate predefined "factory" spatial reference objects.

There are three types of functions on this interface: those that return single objects, those that return a set of objects of the same type, and those that are used to import and export *SpatialReference* objects to and from a PRJ file or a PRJ string representation.

For example, the *CreateDatum* function takes as its only parameter an integer that represents the *FactoryCode* of a predefined datum. The function returns a fully instantiated *Datum* object that can then be queried for its name and *Spheroid* coclass. The following code shows how to create a *Datum* object that represents the WGS 1984 datum.

```
Dim pDatum As IDatum
Dim pSpatialRefFact As ISpatialReferenceFactory
Set pSpatialRefFact = New SpatialReferenceEnvironment
'esriSRDatum_WGS1984 = 6326
Set pDatum = pSpatialRefFact.CreateDatum(esriSRDatum_WGS1984)
```

```
Debug.Print pDatum.Name
Debug.Print pDatum.FactoryCode
Debug.Print pDatum.Spheroid.Name
Debug.Print pDatum.Spheroid.FactoryCode
Debug.Print pDatum.Spheroid.Flattening
Debug.Print pDatum.Spheroid.SemiMajorAxis
Debug.Print pDatum.Spheroid.SemiMinorAxis
```

The *CreateDatum* function takes an enumerated *esriSRDatumType* as the integer code. In the example *esriSRDatum_WGS1984* = 6326, 6326 is the POSC integer code for the WGS 1984 datum.

Other functions on the *ISpatialReferenceFactory* take similar enumerated types. The full listing of available types and their values can be seen in the Object Browser.

These are the enumerations relevant to spatial reference in esriCore.olb.

esriSRGeoCSType	Geographic coordinate systems
esriSRDatumType	Available predefined datums
esriSRSpheroidType	The available spheroids and spheres
esriSRPrimeMType	The available prime meridians
esriSRUnitType	The available units of measure
esriSRProjCSType	Projected coordinate systems
esriSRProjectionType	Map projections
esriSRParameterType	Predefined parameters
esriSRGeoTransformationType	The available equation-based datum transformations
esriSRGeoTransformation2Type	More datum transformations; longitude rotation, NADCON and HARN methods

Similarly, the following code demonstrates the *CreateProjectedCoordinateSystem*, which returns a fully instantiated projection system that represents the British National Grid.

```
 Dim pBritishNatGrid As IProjectedCoordinateSystem
 Dim pSpatialRefFact As ISpatialReferenceFactory
 Set pSpatialRefFact = New SpatialReferenceEnvironment
 ' esriSRProjCS_BritishNationalGrid = 27700
 Set pBritishNatGrid = _
pSpatialRefFact.CreateProjectedCoordinateSystem(esriSRProjCS_BritishNationalGrid)
 ' now show the component parts for the projected coordinate system
 Debug.Print pBritishNatGrid.Name
 Debug.Print pBritishNatGrid.GeographicCoordinateSystem.Name
 Debug.Print pBritishNatGrid.GeographicCoordinateSystem.Datum.Name
 Debug.Print pBritishNatGrid.GeographicCoordinateSystem.Datum.Spheroid.Name
 Debug.Print pBritishNatGrid.Projection.Name
 Debug.Print pBritishNatGrid.FalseEasting
 Debug.Print pBritishNatGrid.FalseNorthing
```

The next type of function on the *ISpatialReferenceFactory* interface returns a complete *Set* of objects. For example, the following code shows how the *CreatePredefinedProjections* function returns a set that contains all the available *Projection* objects supported by ArcObjects. The set is iterated through, and the name of each *Projection* with the set is obtained. These type of functions are useful for developers who may wish to populate a pulldown selection list of available *SpatialReference* objects.

```
Dim pProjection As IProjection
Dim pProjectionSet As ISet
Dim pSpatialRefFact As ISpatialReferenceFactory
Set pSpatialRefFact = New SpatialReferenceEnvironment
Set pProjectionSet = pSpatialRefFact.CreatePredefinedProjections
Debug.Print pProjectionSet.Count
Dim i As Integer
pProjectionSet.Reset
For i = 0 To pProjectionSet.Count - 1
  Set pProjection = pProjectionSet.Next
  Debug.Print pProjection.Name
Next i
```

The third type of function supported by *ISpatialReferenceFactory* deals with PRJ files and strings.

CreateESRISpatialReferenceFromPRJFile takes an old or new style PRJ file and creates either a geographic or projected coordinate system from it, depending on the file contents. *CreateESRISpatialReferenceFromPRJ* is used to create a *SpatialReference* based on the string buffer of an old style PRJ file. While *CreateESRISpatialReference* is similar, the string buffer must be in the format of a new PRJ file.

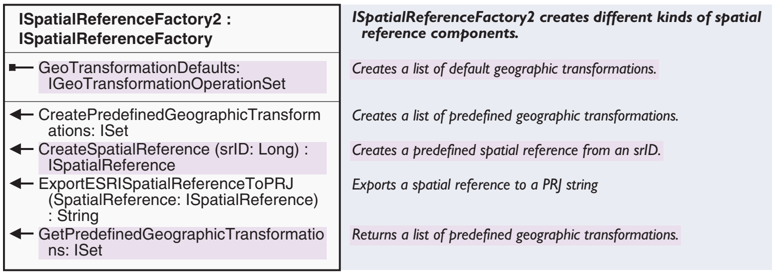
This code sample shows how to create a *SpatialReference* coordinate system directly from a PRJ file (both old and new style files are supported):

```
Dim pSpatialRefFact As ISpatialReferenceFactory
Set pSpatialRefFact = New SpatialReferenceEnvironment
Dim pProjCoordSys As IProjectedCoordinateSystem

Set pProjCoordSys = _
pSpatialRefFact.CreateESRISpatialReferenceFromPRJFile("C:\Data\UKData\county.prj")

Debug.Print pProjCoordSys.Name
Debug.Print pProjCoordSys.GeographicCoordinateSystem.Name
Debug.Print pProjCoordSys.GeographicCoordinateSystem.Datum.Name
Debug.Print pProjCoordSys.GeographicCoordinateSystem.Datum.Spheroid.Name
Debug.Print pProjCoordSys.Projection.Name
Debug.Print pProjCoordSys.FalseEasting
Debug.Print pProjCoordSys.FalseNorthing
```

Conversely, the *ExportESRISpatialReferenceToPRJFile* function provides a mechanism to take a *SpatialReference* object and create a new style PRJ file from it. These four functions provide you with a way to take advantage of existing routines that involve the use of PRJ files. They also provide an easy and effective way to exchange spatial reference information through the use of text files.

This piece of code demonstrates the *CreateESRISpatialReference* method, which takes a string buffer representing the contents of a new style PRJ file and creates a Spatial *Reference* coordinate system from it. If you have an old style PRJ file, then you should use the *CreateESRISpatialReferenceFromPRJ* method instead.

```
 Dim pSpatialRefFact As ISpatialReferenceFactory
 Set pSpatialRefFact = New SpatialReferenceEnvironment

 Dim pSpatialReference As ISpatialReference
 Dim pProjCoordSys As IProjectedCoordinateSystem

 ' create a coordsys using the factory
 Set pSpatialReference = _
pSpatialRefFact.CreateProjectedCoordinateSystem(esriSRProjCS_BritishNationalGrid)

 Dim pESRISpatialReference As IESRISpatialReference
 Set pESRISpatialReference = pSpatialReference
 Dim pBuffer As String * 2048
 Dim pBytes As Long

 ' Export the coord sys description to a string buffer
 pESRISpatialReference.ExportToESRISpatialReference pBuffer, pBytes
 ' Read that string buffer and create a new coord sys from it
 pSpatialRefFact.CreateESRISpatialReference pBuffer, pProjCoordSys, pBytes
 Debug.Print pProjCoordSys.Name
 Debug.Print pProjCoordSys.GeographicCoordinateSystem.Name
 Debug.Print pProjCoordSys.GeographicCoordinateSystem.Datum.Name
 Debug.Print pProjCoordSys.GeographicCoordinateSystem.Datum.Spheroid.Name
 Debug.Print pProjCoordSys.Projection.Name
 Debug.Print pProjCoordSys.FalseEasting
 Debug.Print pProjCoordSys.FalseNorthing
```



ISpatialReferenceFactory2 : ISpatialReferenceFactory	*ISpatialReferenceFactory2 creates different kinds of spatial reference components.*
GeoTransformationDefaults: IGeoTransformationOperationSet	*Creates a list of default geographic transformations.*
CreatePredefinedGeographicTransformations: ISet	*Creates a list of predefined geographic transformations.*
CreateSpatialReference (srID: Long) : ISpatialReference	*Creates a predefined spatial reference from an srID.*
ExportESRISpatialReferenceToPRJ (SpatialReference: ISpatialReference) : String	*Exports a spatial reference to a PRJ string*
GetPredefinedGeographicTransformations: ISet	*Returns a list of predefined geographic transformations.*

The *ISpatialReferenceFactory2* interface implements all the methods inherited from *ISpatialReferenceFactory*; it also provides additional methods.

The *GeoTransformationDefaults* method returns an *IGeoTransformationOperationSet* that contains a default set of geotransformations that ArcObjects calculates are required, depending on the feature classes loaded into the *Map*.

If your application has a reference to a *Map* object, then you should be working with this *Map*'s *GeoTransformationOperationSet*. You only need to work directly with the *ISpatialReferenceFactory2::Geotransformation-Defaults* when creating an application that does not use the *Map* object. For example, you may be using the geodatabase API directly and would still like to have automatic datum conversions.

The *Map* object is currently preloaded with two geotransformation operations (NAD27 to NAD83 via NADCON and NAD83 to NAD27 via NADCON). In other cases, ArcObjects does not try to automatically pick a geotransformation operation based on a pair of geographic coordinate systems. By default, the *IGeoTransformationOperationSet* returned by the *ISpatialReferenceFactory2* interface is empty and is not populated until after a redraw has been performed.

Geographic transformations are covered later in this chapter.

The *CreatePredefinedGeographicTransformations* and the *GetPredefinedGeographicTransformations* methods both return an *ISet* of all the possible geotransformations that ArcObjects can create. The difference between the two is that the *Set* object (and its contents) returned by *GetPredefinedGeographicTransformations* should be considered "read-only"; the *Set* object (and its contents) returned by *CreatePredefinedGeographicTransformations* can be modified in any way.

The following code shows how to create a set of predefined geographic transformations and iterate through them, printing out their names.

```
Dim pGeotrans As IGeoTransformation
Dim pGeotransSet As ISet
Dim pSpatialRefFact As ISpatialReferenceFactory2
Set pSpatialRefFact = New SpatialReferenceEnvironment
Set pGeotransSet = _
  pSpatialRefFact.CreatePredefinedGeographicTransformations
Debug.Print pGeotransSet.Count
Dim i As Integer
pGeotransSet.Reset

For i = 0 To pGeotransSet.Count - 1
  Set pGeotrans = pGeotransSet.Next
  Debug.Print pGeotrans.Name
Next i
```

The *CreateSpatialReference* method creates a valid *SpatialReference*—either a projected or geographic coordinate system, depending on the supplied *FactoryCode* (here called an srID). The method returns an *ISpatialReference*. The following code illustrates how to test for what type of *SpatialReference* has been created. This method will raise an error (*E_INVALIDARG*) if the FactoryCode number supplied is not valid.

```
Dim pSpatialRefFact As ISpatialReferenceFactory2
Set pSpatialRefFact = New SpatialReferenceEnvironment
Dim pSpatialReference As ISpatialReference
'esriSRProjCS_ColombiaBogota = 21892
'esriSRGeoCS_Australian = 4003
Set pSpatialReference = pSpatialRefFact.CreateSpatialReference(4003)
If TypeOf pSpatialReference Is IProjectedCoordinateSystem Then
  MsgBox "You have a Projected Coordinate System"
ElseIf TypeOf pSpatialReference Is IGeographicCoordinateSystem Then
  MsgBox "You have a Geographic Coordinate System"
End If
```

Feature classes derived from ArcSDE layers, an ArcSDE geodatabase, or a personal geodatabase have additional requirements for a coordinate transformation: conversion from floating point real-world units to positive integer system units for storage in the database. All coordinates must be 32-bit positive integers between 0 and 2147483647 in ArcSDE. This format provides better data accuracy, data integrity, and processing speed than real numbers.

This ArcSDE conversion requires the following false origin and scale information:

- *falsex*, a false origin for x-values
- *falsey*, a false origin for y-values
- *falsez*, a false origin for z-values
- *falsem*, a false origin for measure values
- *xyunits*, a scale factor to convert from world units to integer x,y-system units
- *zunits*, a scale factor to convert from elevation units to integer z- system units
- *munits*, a scale factor to convert from measure units to integer m-system units

Because coordinates are often neither positive nor integer, ArcSDE requires an offset distance (a false origin) to ensure numbers are positive and a minimum resolution multiplier (called the scale factor) to convert real numbers to integers. The conversion algorithm is:

```
ArcSDE X = truncate ((( X coordinate - false X ) * xyunits ) + 0.5 )
ArcSDE Y = truncate ((( Y coordinate - false Y ) * xyunits ) + 0.5 )
ArcSDE Z = truncate ((( Z coordinate - false Z ) * zunits ) + 0.5 )
ArcSDE M = truncate ((( M coordinate - false M ) * munits ) + 0.5 )
```

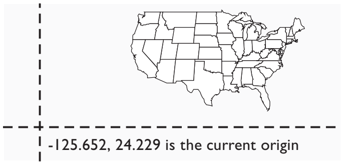
0.5 is added to round off numbers. ArcSDE coordinates are converted back to plane coordinates with the following formula:

```
X coordinate = (( ArcSDE X / xyunits ) + false X)
Y coordinate = (( ArcSDE Y / xyunits ) + false Y)
Z coordinate = (( ArcSDE Z / zunits ) + false Z)
M coordinate = (( ArcSDE M / munits ) + false M)
```

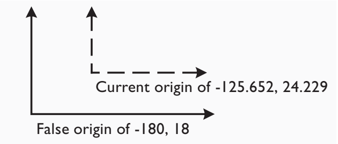
The false origin (false x, false y, false z) translates the origin of the layer in either a positive or negative direction along any of the three axes. As a rule, the false origin of a layer should be set to its minimum x,y,z plane coordinate. The z-origin should be set to 0 for two-dimensional layers.

A false origin is mandatory for layers that have negative world coordinates. The false origin is moved so that the minimum x-coordinate will be positive. The y-values are all positive, but you can extend the false y origin in case other data is added to the database.

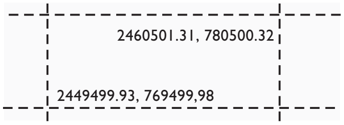
A false origin can also improve coordinate precision, especially for maps that cover a very small area. For example, the extent of the layer to the side has more than 10 digits, so ArcSDE will not keep all of them.



All coordinates must be positive, so the false origin is set to at least the minimum x-value (-125.652), but probably even further to move all features into positive space. Be sure you allow for more features to be added in all directions. If Hawaii and Alaska are added to the layer, you'll need to shift the false origin to about -180,18.



Setting the false origin to -180, 18



You can offset the origin in the positive direction because all coordinates are the same for the first two digits in the x-direction (2400000), and one digit in the y-direction. The false origin can be set to 2400000, 700000, 0. This preserves the precision of the numbers when they are converted to integers.

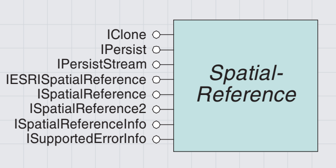
For this layer, all x- and y-values are greater than 2.4 million and 700000 meters, respectively.

The minimum resolution below which the precision of a plane coordinate is truncated is called the scale in ArcSDE. For instance, for a layer with units of meters and a precision of no less than half a centimeter, the x,y scale would be set to 200. Remember that digital data is only as accurate as its source and that z-coordinates and measures can also have scales.

You can translate the precision of real numbers to the scale. In the example above, the coordinates are stored to three decimal places. A scale of 1000 converts the numbers to integers and preserves the same resolution. Double-precision coordinates may have up to six decimal places. ArcSDE integers can have up to ten digits (about two billion), so you need to consider the number of digits to the left of the decimal place plus the number to the right when deciding the system unit.

A quick look at the coordinate values of your data will show you the number of decimal places you can use to determine the system unit.

SpatialReference abstract class



The spatial reference is the top-level class in the spatial reference model.

The previous discussion about the utility classes made references to some of the core *SpatialReference* classes. This part of the chapter documents these classes and their interfaces.

One of the primary components of the spatial reference object model is the *SpatialReference* abstract class. This abstract class supports the *ISpatialReference* interface, which provides you with access to fundamental spatial reference properties of a dataset, such as the domain extents and coordinate precision.

The *SpatialReference* class specifies the *ISpatialReference* interface. This interface is implemented by all three types of coordinate systems (projected, geographic, and unknown) and therefore provides the basis for polymorphic substitution within the spatial reference model.

ISpatialReference : ISpatialReferenceInfo	***ISpatialReference interface***
PrecisionExImpl: Long	*Return an opaque reference to the precision information (including z/m awareness) implementation for this spatial reference.*
PrecisionImpl: Long	*Return an opaque reference to the precision information implementation for this spatial reference.*
SpatialReferenceImpl: Long	*SpatialReferenceImpl*
ZCoordinateUnit: ILinearUnit	*Returns the unit for the Z coordinate*
Changed	*Notify this object that some of its parts have changed (parameter values, z unit, etc.)*
GetDomain (out XMin: Double, out XMax: Double, out YMin: Double, out YMax: Double)	*Get the domain extent.*
GetFalseOriginAndUnits (falseX: Double, falseY: Double, xyUnits: Double)	*Get the false origin and units.*
GetMDomain (out outMMin: Double, out outMMax: Double)	*Get the measure domain extent.*
GetMFalseOriginAndUnits (falseM: Double, mUnits: Double)	*Get the measure false origin and units.*
GetZDomain (out outZMin: Double, out outZMax: Double)	*Get the Z domain extent.*
GetZFalseOriginAndUnits (falseZ: Double, zUnits: Double)	*Get the Z false origin and units.*
HasMPrecision: Boolean	*Returns true when m-value precision information has been defined.*
HasXYPrecision: Boolean	*Returns true when (x,y) precision information has been defined.*
HasZPrecision: Boolean	*Returns true when z-value precision information has been defined.*
IsPrecisionEqual (in otherSR: ISpatialReference, out IsPrecisionEqual: Boolean)	*Returns TRUE when the precision information for the two spatial references is the same.*
SetDomain (in XMin: Double, in XMax: Double, in YMin: Double, in YMax: Double)	*Set the xy domain extent*
SetFalseOriginAndUnits (falseX: Double, falseY: Double, xyUnits: Double)	*Set the false origin and units.*
SetMDomain (in inMMin: Double, in inMMax: Double)	*Set the measure domain extent*
SetMFalseOriginAndUnits (falseM: Double, mUnits: Double)	*Set the measure false origin and units.*
SetZDomain (in inZMin: Double, in inZMax: Double)	*Set the z domain extent*
SetZFalseOriginAndUnits (falseZ: Double, zUnits: Double)	*Set the Z false origin and units.*

This interface provides methods to get and set various properties of a coordinate system. The properties and methods refer to the domain, precision, and the false origin and units of the coordinate system. Generally, most developers have no need to set or use these properties.

The most important method on this interface is the *Changed* method. This is used to indicate when a *Parameter* of a *ProjectedCoordinate-*

System has changed. For detailed information on when to use this method, see the section on the *Parameter* class in this chapter.

For a detailed explanation of the Project Engine API, be sure to consult the ESRI ArcSDE documentation.

The *SpatialReferenceImpl* property is a pointer to the underlying ESRI Projection Engine structure, which implements the coordinate system. For example, if your *SpatialReference* was *ProjectedCoordinateSystem,* then *SpatialReferenceImpl* would refer to a PE_PROJCS structure; if your *SpatialReference* was a *GeographicCoordinateSystem,* then it would refer to a PE_GEOGCS.

PrecisionExImpl and *PrecisionImpl* are both pointers to underlying data structures used to retrieve precision information implementation for the coordinate system. Precision, for ArcGIS, is the number of significant digits used to store a coordinate. Since there can only be a finite number of bits in the computer representation of a coordinate, if you need more significant digits, this will be at the cost of the extent.

Likewise, the *GetDomain* and *SetDomain* methods are used to set and get the domain extents of a coordinate system. The domain extent is different than the valid area of a projection. The domain extent is an arbitrary rectangle used to determine the precision of coordinates within that rectangle. It is possible that the domain extent is larger than the usable area of a projection (a UTM zone, for example). Developers can define a domain extent to control the precision of coordinates. A small domain extent gives you more precise coordinates over a smaller area.

A larger domain extent lets you represent features over a larger geographic area but with less precision; so, if you are happy with less significant digits, you can get a larger extent.

ISpatialReference2 : ISpatialReference	***ISpatialReference extension interface***
← ApplyPrecision (cPoints: Long, Points: _WKSPoint, ms: Double, zs: Double)	*Applies the measure and z value precisions.*
← ApplyXYPrecision (cPoints: Long, Points: _WKSPoint)	*Applies the XY precision.*
← IsMPrecisionEqual (in otherSR: ISpatialReference) : Boolean	*Returns true if the measure precisions of the two spatial references are the same.*
← IsXYPrecisionEqual (in otherSR: ISpatialReference) : Boolean	*Returns true if the XY precisions of the two spatial references are the same.*
← IsZPrecisionEqual (in otherSR: ISpatialReference) : Boolean	*Returns true if the Z precisions of the two spatial references are the same.*

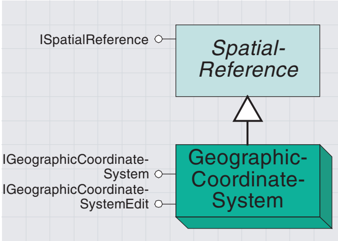
ISpatialReference2 is an extension to the *ISpatialReference* interface. It provides additional methods for comparing the precision information of coordinate systems. In addition, it "snaps" points to that precision.

Precision does not snap coordinates of existing or new geometries added to coverages or shapefiles, but it is used when converting to a personal geodatabase or ArcSDE, and it is also used as the "fuzzy tolerance" when doing topological operations.

The geometry system uses the *ApplyXYPrecision* and the *ApplyPrecision* methods to snap geometries to the grid defined by the geometry's *SpatialReference*. This happens whenever a geometry is associated with a feature. It is needed so that features coming from an ArcSDE database, and features on the client side destined for that database, can be accurately compared before the latter feature makes a round-trip through the database.

A developer who has an array of point structures (*WKSPoints*) might have some application-specific reason to use this method; otherwise, it is very unlikely that a developer will need to use this method.

GeographicCoordinateSystem coclass



ISpatialReference
Spatial-Reference
IGeographicCoordinate-System
IGeographicCoordinate-SystemEdit
Geographic-Coordinate-System

A geographic coordinate system (GCS) defines locations on the earth using a three-dimensional spherical surface.

The *GeographicCoordinateSystem* (GCS) coclass serves as the underlying spatial reference component for both geographic and projected coordinate system objects. This coclass implements two interfaces: *IGeographicCoordinateSystem* and *IGeographicCoordinateSystemEdit*.

A GCS is often incorrectly called a datum, but a datum is only one part of a GCS, along with an angular unit of measure and a prime meridian.

IGeographicCoordinateSystem : ISpatialReference	***IGeographicCoordinateSystem permits access to all properties of geographic coordinate systems.***
CoordinateUnit: IAngularUnit	*The angular unit of this geographic coordinate system.*
Datum: IDatum	*The horizontal datum of this geographic coordinate system.*
PrimeMeridian: IPrimeMeridian	*The prime meridian of this geographic coordinate system.*
Usage: String	*The usage notes of this geographic coordinate system.*

The *IGeographicCoordinateSystem* interface has properties that will return a reference to the *PrimeMeridian*, *Datum,* and *CoordinateUnit* objects that make up a GCS. These properties are useful in determining the characteristics of a geographic coordinate system.

The following code shows how to retrieve information about the component parts of a geographic coordinate system.

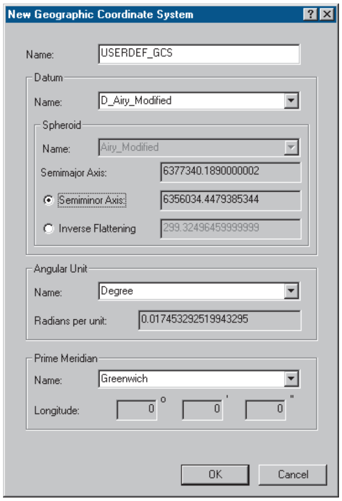
```
Dim pGeographicCoordinateSystem As IGeographicCoordinateSystem
Dim pSpatRefFact As ISpatialReferenceFactory
Set pSpatRefFact = New SpatialReferenceEnvironment
Set pGeographicCoordinateSystem = _
  pSpatRefFact.CreateGeographicCoordinateSystem(esriSRGeoCS_OSGB1936)
Dim pDatum As IDatum
Set pDatum = pGeographicCoordinateSystem.Datum
Debug.Print pDatum.Name
Dim pSpheroid As ISpheroid
Set pSpheroid = pDatum.Spheroid
Debug.Print pSpheroid.Name
Debug.Print pSpheroid.Flattening
Debug.Print pSpheroid.SemiMajorAxis
Debug.Print pSpheroid.SemiMinorAxis
Dim pPrimeMeridian As IPrimeMeridian
Set pPrimeMeridian = pGeographicCoordinateSystem.PrimeMeridian
Debug.Print pPrimeMeridian.Name
Debug.Print pPrimeMeridian.Longitude
Dim pUnit As IUnit
Set pUnit = pGeographicCoordinateSystem.CoordinateUnit
Debug.Print pUnit.Name
```

IGeographicCoordinateSystemEdit : IUnknown	***Defines the properties for a geographic coordinate system.***
← Define (Name: Variant, Alias: Variant, Abbreviation: Variant, Remarks: Variant, useage: Variant, Datum: Variant, PrimeMeridian: Variant, geographicUnit: Variant)	*Defines the properties for a geographic coordinate system.*
← DefineEx (Name: String, Alias: String, Abbreviation: String, Remarks: String, useage: String, Datum: IDatum, PrimeMeridian: IPrimeMeridian, geographicUnit: IAngularUnit)	*Defines the properties for a geographic coordinate system.*

The *IGeographicCoordinateSystemEdit* interface allows you to establish a geographic coordinate system based on properties such as *Name*, *Datum* coclass, *PrimeMeridian*, and *CoordinateUnit*. This is accomplished with *IGeographicCoordinateSystemEdit::Define*.

The following code demonstrates how to use the *Define* method to create a user-defined geographic coordinate system. The *ISpatialReferenceFactory* allows you to create the *Datum, PrimeMeridian,* and *AngularUnit* component parts. These components can also be created using a similar *Define* method available on their classes.

```
Dim pUserDefinedGeogCS As IGeographicCoordinateSystem
Dim pSpatRefFact As ISpatialReferenceFactory
Set pSpatRefFact = New SpatialReferenceEnvironment
Dim pDatum As IDatum
Set pDatum = pSpatRefFact.CreateDatum(esriSRDatum_OSGB1936)

Dim pPrimeMeridian As IPrimeMeridian
Set pPrimeMeridian = _
  pSpatRefFact.CreatePrimeMeridian(esriSRPrimeM_Greenwich)

Dim pUnit As IUnit
Set pUnit = pSpatRefFact.CreateUnit(esriSRUnit_Degree)

Dim pGCSEdit As IGeographicCoordinateSystemEdit
Set pGCSEdit = New GeographicCoordinateSystem

pGCSEdit.Define "UserDefined Geographic Coordinate System", _
  "UserDefined GCS", _
  "UserDefined", _
  "User Defined Geographic Coordinate System based on OSGB1936", _
  "Suitable for the UK", _
  pDatum, _
  pPrimeMeridian, _
  pUnit
' QI for the result
Set pUserDefinedGeogCS = pGCSEdit
Debug.Print pUserDefinedGeogCS.Name
```



New Geographic Coordinate System

Name: USERDEF_GCS

Datum
Name: D_Airy_Modified

Spheroid
Name: Airy_Modified
Semimajor Axis: 6377340.1890000002
● Semiminor Axis: 6356034.4479385344
○ Inverse Flattening 299.32496459999999

Angular Unit
Name: Degree
Radians per unit: 0.017453292519943295

Prime Meridian
Name: Greenwich
Longitude: 0 ° 0 ' 0 "

Dialog box for a new geographic coordinate system

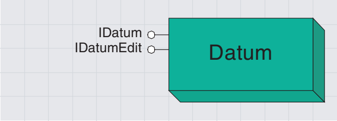
DefineEx *is a C++-friendly method that can be used to create a user-defined geographic coordinate system. It does exactly the same job as the* Define *method.The difference between the two is that the parameters in the* Define *method are all defined as optional and are passed in as* Variants.*This can make for cumbersome programming within a C++ environment, so the* DefineEx *method is provided and the C++ programmer does not need to create* Variants.*VB programmers will not see the* DefineEx *appear in the IntelliSense list, while C++ programmers will see both methods.*

Alternatively, it is possible to make use of the *IGeographicCoordinateSystemDialog* to provide an intuitive user interface with which to create a new geographic coordinate system.

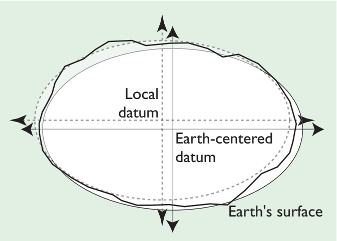
```
Dim pGeographicCoordinateSystem As IGeographicCoordinateSystem
Dim pGCSDialog As IGeographicCoordinateSystemDialog
Set pGCSDialog = New GeographicCoordinateSystemDialog
Set pGeographicCoordinateSystem = pGCSDialog.DoModalCreate(0)
Debug.Print pGeographicCoordinateSystem.Name
```

The following C++ code shows how the *DefineEx* method can be used. It uses a *SpatialReferenceFactory* to create the *Datum, PrimeMeridian,* and *Unit* components.

```
// Smart pointer variables used
IDatumPtr ipDatum;
IPrimeMeridianPtr ipPrimeMeridian;
IUnitPtr ipUnit;
IAngularUnitPtr ipAngularUnit;

// Create the factory and the component parts
ISpatialReferenceFactoryPtr ipFactory(CLSID_SpatialReferenceEnvironment);
ipFactory->CreateDatum(esriSRDatum_OSGB1936,&ipDatum);
ipFactory->CreatePrimeMeridian(esriSRPrimeM_Greenwich,&ipPrimeMeridian);
ipFactory->CreateUnit(esriSRUnit_Degree,&ipUnit);
IGeographicCoordinateSystemEditPtr ipGeoCSEdit(CLSID_GeographicCoordinateSystem);
IGeographicCoordinateSystemPtr ipGCS;

// QI for the AngularUnit from the Unit
// - this is achieved by the SmartPointers
ipAngularUnit = ipUnit;

// Make the string descriptions
CComBSTR name(_T("User Defined Geographic Coordinate System"));
CComBSTR alias(_T("UserDefined"));
CComBSTR abbreviation(_T("User"));
CComBSTR remarks(_T("User Define GCS based on OSGB1936"));
CComBSTR useage(_T("Suitable for the UK"));

// Make the call
HRESULT hr;
hr = ipGeoCSEdit->DefineEx(name,
                           alias,
                           abbreviation,
                           remarks,
                           useage,
                           ipDatum,
                           ipPrimeMeridian,
                           ipAngularUnit);
// QI for the result
ipGCS = ipGeoCSEdit;
```



While a spheroid approximates the shape of the earth, a datum defines the position of the spheroid relative to the center of the earth. A datum provides a frame of reference for measuring locations on the surface of the earth.



The relationship between an earth-based datum and a local datum

A *Datum* object represents a reference system for latitude–longitude coordinates. It is defined by a spheroid and the spheroid's position relative to the center of the earth.

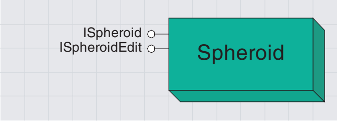
The *Datum* coclass creates a datum. A *Datum* object in ArcObjects contains a reference to its *Spheroid*.

IDatum : ISpatialReferenceInfo	*IDatum defines properties of all horizontal datums.*
■— Spheroid: ISpheroid	*The spheroid of this horizontal datum.*

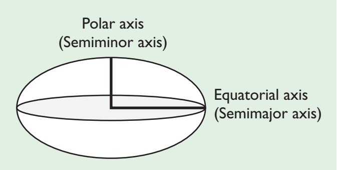
The *IDatum* interface has one property, its *Spheroid*. The *IDatumEdit* interface has two methods, *Define* and *DefineEx*. Both perform the same function, except that *DefineEx* is geared toward the C++ developer.

IDatumEdit : IUnknown	*Defines the properties of a horizontal datum.*
← Define (Name: Variant, Alias: Variant, Abbreviation: Variant, Remarks: Variant, Spheroid: Variant)	*Defines the properties of a horizontal datum*
← DefineEx (Name: String, Alias: String, Abbreviation: String, Remarks: String, Spheroid: ISpheroid)	*Defines the properties of a horizontal datum.*

The *IDatumEdit* interface creates a user-defined *Datum* object. Please refer to the code example following the *ISpheroid* interface of the *Spheroid* object.



The shape and size of a geographic coordinate system's surface is defined by a sphere or spheroid. Although the earth is best represented by a spheroid, the earth is sometimes treated as a sphere to make mathematical calculations easier. However, to maintain accuracy for large-scale maps (scales of 1:1,000,000 or larger), a spheroid is necessary to represent the shape of the earth.



The semimajor and semiminor axes of a spheroid

The *Spheroid* object models the approximate shape of the earth's surface. A spheroid that best fits one region is not necessarily the most ideal for another region.

ISpheroidEdit : IUnknown	*Defines the properties of a spheroid.*
← Define (Name: Variant, Alias: Variant, Abbreviation: Variant, Remarks: Variant, majorAxis: Variant, Flattening: Variant)	*Defines the properties of a spheroid.*
← DefineEx (Name: String, Alias: String, Abbreviation: String, Remarks: String, majorAxis: Double, Flattening: Double)	*Defines the properties of a spheroid.*

To see how the *DefineEx* method could be used with C++, please refer to the *IGeographicCoordinateSystemEdit::DefineEx* method.

ISpheroid : ISpatialReferenceInfo	*ISpheroid defines properties of all spheroids.*
■— Flattening: Double	*The flattening ratio of this spheroid.*
■— SemiMajorAxis: Double	*The semi-major axis length of this spheroid.*
■— SemiMinorAxis: Double	*The semi-minor axis length of this spheroid.*

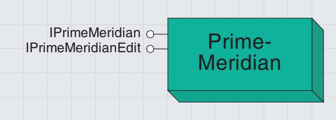
The *ISpheroid* interface returns the properties that make up a spheroid: its flattening and its semimajor and semiminor axes.

The following piece of code illustrates how to define a *Datum* using a *Spheroid* that has been created using the *ISpheroidEdit::Define* method.

The last two *Define* parameters are the semimajor axis and the flattening. The semimajor axis is the equatorial radius of the new spheroid, while the flattening is represented as one minus the ratio of polar radius to equatorial radius.

Prior to using the *Spheroid* created by the *Define* method (as a parameter in the *IDatumEdit::Define method*), you must *QI* for it from *SpheroidEdit*.

```
Dim pSpheroidEdit As ISpheroidEdit
Dim pSpheroid As ISpheroid
Set pSpheroidEdit = New Spheroid
pSpheroidEdit.Define "UserDefined Spheroid", _
  "UserDefined", _
  "UserDefined", _
  "Canada Spheroid", _
  6378135, _
  1 / 298.257223563

'Note - to use the spheroid in DatumEdit::Define
'we must QI from the SpheroidEdit first.
Set pSpheroid = pSpheroidEdit

Dim pDatumEdit As IDatumEdit
Dim pDatum As IDatum
Set pDatumEdit = New Datum
pDatumEdit.Define "CAN2000", _
  "TRANSCAN", _
  "CAN", _
  "New Datum for Canada", _
  pSpheroid
Set pDatum = pDatumEdit
'Get the spheroid name
Debug.Print pDatum.Name
Debug.Print pSpheroid.Name
Debug.Print pSpheroid.Abbreviation
Debug.Print pSpheroid.Alias
Debug.Print pSpheroid.Remarks
Debug.Print pSpheroid.Flattening
Debug.Print pSpheroid.SemiMajorAxis
Debug.Print pSpheroid.SemiMinorAxis
```



A meridian is a reference line on the earth's surface formed by the intersection of the surface with a plane passing through both poles. This line is identified by its longitude. Meridians run north–south between the poles. A prime meridian defines the origin of the longitude values for a geographic coordinate system.

The *PrimeMeridian* coclass implements *IPrimeMeridian* and *IPrimeMeridianEdit*.

IPrimeMeridian : ISpatialReferenceInfo	*IPrimeMeridian defines properties of all prime meridians.*
Longitude: Double	*The longitude value of this prime meridian.*

Longitude is the value of the location of the *PrimeMeridian* that is used to define a geographic coordinate system. In this example, Paris is set as the prime meridian at 2° 20' 14".025 east of Greenwich.

```
Dim pSpatRefFact As ISpatialReferenceFactory
Set pSpatRefFact = New SpatialReferenceEnvironment
Dim pPrimeMeridian As IPrimeMeridian
Set pPrimeMeridian = pSpatRefFact.CreatePrimeMeridian(esriSRPrimeM_Paris)
Debug.Print pPrimeMeridian.Name
Debug.Print pPrimeMeridian.Longitude
```

IPrimeMeridianEdit : IUnknown	*Defines the properties of the prime meridian.*
Define (Name: Variant, Alias: Variant, Abbreviation: Variant, Remarks: Variant, Longitude: Variant)	*Defines the properties of the prime meridian.*
DefineEx (Name: String, Alias: String, Abbreviation: String, Remarks: String, Longitude: Double)	*Defines the properties of the prime meridian.*

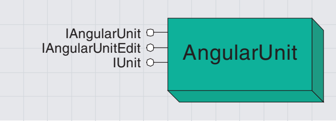
Most geographic coordinate systems use Greenwich, England, as their prime meridian. Other prime meridians defined in the POSC/EPSG model, such as Paris, Rome, and Oslo, are available in ArcObjects. These are defined in relation to Greenwich.

When using the *Define* or *DefineEx* methods on *IPrimeMeridianEdit*, the value given for the *Longitude* should be decimal degrees. The next example defines a new prime meridian for Timbuktu, in Mali, West Africa. It is 2° 59' west of Greenwich:

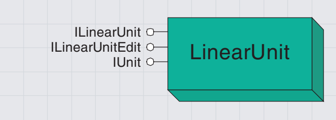
```
Dim pPrimeMeridian As IPrimeMeridian
Dim pPrimeMeridianEdit As IPrimeMeridianEdit
Set pPrimeMeridianEdit = New PrimeMeridian
pPrimeMeridianEdit.Define "Timbuktu Prime Meridian", _
  "Timbuktu", "TBKU", "All the way to Timbuktu", 2.983
Set pPrimeMeridian = pPrimeMeridianEdit
Debug.Print pPrimeMeridian.Longitude
Debug.Print pPrimeMeridian.Remarks
```

To list all predefined *PrimeMeridians* and their *Longitude* values supported by ArcObjects, do the following:

```
Dim pPrimeMeridian As IPrimeMeridian
Dim pPrimeMeridianSet As ISet
Dim pSpatialRefFact As ISpatialReferenceFactory2
Set pSpatialRefFact = New SpatialReferenceEnvironment
Set pPrimeMeridianSet = pSpatialRefFact.CreatePredefinedPrimeMeridians
Debug.Print pPrimeMeridianSet.Count
Dim i As Integer
pPrimeMeridianSet.Reset
For i = 0 To pPrimeMeridianSet.Count - 1
  Set pPrimeMeridian = pPrimeMeridianSet.Next
  Debug.Print pPrimeMeridian.Name & " " & pPrimeMeridian.Longitude
Next i
```



An angular unit is used by geographic coordinate systems and can be degrees or grads.



A linear unit is used by projected coordinate systems and can be feet, meters, or inches.

A unit is defined by its name and the conversion factor between meters and the unit, if linear, or radians and the unit, if angular. The *ConversionFactor* property on the *IUnit* interface represents this.

Linear units, such as meters and feet, are used by *ProjectedCoordinateSystems,* and angular units, such as degrees, are used by *GeographicCoordinateSystems*.

To view all the predefined units available in ArcObjects, run the following code. You will notice that the *ConversionFactor* is the same as the *RadiansPerUnit* or *MetersPerUnit* property.

```
Dim pAngularUnit As IAngularUnit
Dim pLinearUnit As ILinearUnit
Dim pUnitSet As ISet
Dim pSpatialRefFact As ISpatialReferenceFactory2
Set pSpatialRefFact = New SpatialReferenceEnvironment
Dim i As Integer
Set pUnitSet = pSpatialRefFact.CreatePredefinedAngularUnits
Debug.Print pUnitSet.Count
pUnitSet.Reset
For i = 0 To pUnitSet.Count - 1
  Set pAngularUnit = pUnitSet.Next
  Debug.Print pAngularUnit.Name & " " & pAngularUnit.ConversionFactor & _
     " " & pAngularUnit.RadiansPerUnit
Next i

Set pUnitSet = pSpatialRefFact.CreatePredefinedLinearUnits
Debug.Print pUnitSet.Count
pUnitSet.Reset
For i = 0 To pUnitSet.Count - 1
  Set pLinearUnit = pUnitSet.Next
  Debug.Print pLinearUnit.Name & " " & pLinearUnit.ConversionFactor & _
    " " & pLinearUnit.MetersPerUnit
Next i
```

Sometimes, especially when dealing with North American data on a State Plane Coordinate System, you may find that different datasets do not appear to align correctly with each other when projected; the misalignment can be significant. In some cases, this may be due to the wrong *Unit* being used within the *ProjectedCoordinateSystem*. For example, the data may be in U.S. feet while a *LinearUnit* of meters is being used. The following code shows how to check what units are being used by a *ProjectedCoordinateSystem*.

```
Dim pUnit As ILinearUnit
Dim pGeoDataset As IGeoDataset
Dim pLayer As IFeatureLayer
Dim pProjCoordSys As IProjectedCoordinateSystem
Dim pMxDoc As IMxDocument
Dim pMap As IMap

Set pMxDoc = Application.Document
```

Predefined angular units in ArcObjects

Name	RadiansPerUnit
Second_Centesimal	1.5707963267949E-06
Grad	0.015707963267949
Mil_6400	9.8174770424681E-04
Gon	0.015707963267949
Degree	1.74532925199433E-02
Microradian	0.000001
Minute	2.90888208665722E-04
Radian	1
Minute_Centesimal	1.5707963267949E-04
Second	4.84813681109536E-06

Predefined linear units in ArcObjects

Name	MetersPerUnit
Chain_Benoit_1895_B	20.1167824943759
Link_Sears	0.201167651215526
Meter_German	1.00000135965
Foot_Indian	0.304799510248147
Link_Benoit_1895_B	0.201167824943759
Yard_Benoit_1895_A	0.9143992
Chain_US	20.1168402336805
Foot_Indian_1937	0.30479841
Foot_Benoit_1895_A	0.304799733333333
Link_US	0.201168402336805
Foot_Indian_1962	0.3047996
Meter	1
Chain_Benoit_1895_A	20.1167824
Mile_US	1609.34721869444
Foot_Indian_1975	0.3047995
Foot	0.3048
Kilometer	1000
Yard_Indian	0.914398530744441
Link_Clarke	0.2011661949
Foot_US	0.304800609601219
Link_Benoit_1895_A	0.201167824
Yard_Clarke	0.914391795
Yard_Indian_1937	0.91439523
Yard_Sears	0.914398414616029
Foot_Clarke	0.304797265
Foot_1865	0.304800833333333
Yard_Benoit_1895_B	0.914399204289812
Chain_Clarke	20.11661949
Yard_Indian_1962	0.9143988
Foot_Sears	0.304799471538676
Fathom	1.8288
Foot_Benoit_1895_B	0.304799734763271
Yard_Indian_1975	0.9143985
Chain_Sears	20.1167651215526
Nautical_Mile	1852

```
Set pMap = pMxDoc.FocusMap
Set pLayer = pMap.Layer(0)
Set pGeoDataset = pLayer

Set pProjCoordSys = pGeoDataset.SpatialReference
Set pUnit = pProjCoordSys.CoordinateUnit
Debug.Print pUnit.Name
Debug.Print pUnit.ConversionFactor
```

IUnit : ISpatialReferenceInfo	***IUnit identifies a linear or angular unit of measure within a spatial reference system.***
■— ConversionFactor: Double	*Returns the conversion factor of the unit.*

IAngularUnit : IUnit	***Properties of angular unit.***
■— RadiansPerUnit: Double	*Returns radians per angular unit.*

Parameters are defined in the same units as the coordinate system.That is, linear parameters, such as false easting and false northing, are defined in the same linear units as the projected coordinate system.

Angular parameters, such as central meridian and standard parallels, are the same angular units as the geographic coordinate system.

IAngularUnitEdit : IUnknown	***Defines the properties of an angular unit.***
← Define (Name: Variant, Alias: Variant, Abbreviation: Variant, Remarks: Variant, RadiansPerUnit: Variant)	*Defines the properties of an angular unit.*
← DefineEx (Name: String, Alias: String, Abbreviation: String, Remarks: String, RadiansPerUnit: Double)	*Defines the properties of an angular unit.*

ILinearUnit : IUnit	***Properties of the linear unit.***
■— MetersPerUnit: Double	*Returns the meters per unit for a coordinate system.*

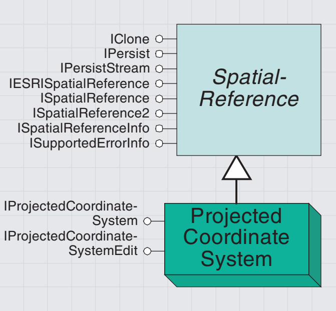
ILinearUnitEdit : IUnknown	***Defines the properties of the linear unit.***
← Define (Name: Variant, Alias: Variant, Abbreviation: Variant, Remarks: Variant, MetersPerUnit: Variant)	*Defines the properties of the linear unit.*
← DefineEx (Name: String, Alias: String, Abbreviation: String, Remarks: String, MetersPerUnit: Double)	*Defines the properties of the linear unit.*

The *IAngularUnit* interface has one property, *RadiansPerUnit*.

If you used the *Define* method to create your own angular unit object, you would have to know how many radians equate to one of your units. Likewise, the *ILinearUnit* has a similar property, *MetersPerUnit*.

If you wanted to define your own linear unit, you would have to know how many meters equate to one of your units. For the vast majority of developers, the predefined units provided by ArcObjects are sufficient for their requirements.

The only real purpose for using the *Define* methods comes when working with data that has been captured in an undefined unit of measurement. The *DefineEx* methods on these interfaces perform the same functions as the *Define* methods, except that they are C++ friendly.



A PCS is defined on a flat, two-dimensional surface. Unlike a geographic coordinate system, a PCS has the advantage that lengths, angles, and areas are constant across the two dimensions.

The *ProjectedCoordinateSystem* coclass creates a *ProjectedCoordinateSystem* (PCS).

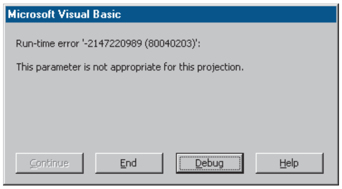
A PCS is composed of a *GeographicCoordinateSystem*, a *Projection*, a *Linear Unit*, and a set of *Parameters*—these are shown as properties on the interface.

Two interfaces are supported by this coclass: *IProjectedCoordinateSystem* and *IProjectedCoordinateSystemEdit*.

IProjectedCoordinateSystem : ISpatialReference	***IProjectedCoordinateSystem defines properties and methods for all projected coordinate systems.***
Azimuth: Double	*The azimuth of a projected coordinate system.*
CentralMeridian (in inDegrees: Boolean) : Double	*The central meridian (Lambda0) of a projected coordinate system.*
CentralParallel: Double	*The central parallel (Phi 0) of a projected coordinate system.*
CoordinateUnit: ILinearUnit	*The linear unit of a projected coordinate system.*
FalseEasting: Double	*The false easting (X0) of a projected coordinate system.*
FalseNorthing: Double	*The false northing (Y0) of a projected coordinate system.*
GeographicCoordinateSystem: IGeographicCoordinateSystem	*The geographic coordinate system of a projected coordinate system.*
Horizon (in horizonIndex: Long) : esriSRHorizon	*The mathematical limits of a projected coordinate system.*
HorizonCount: Long	*The number of shapes that describe the limits of a ProjCS.*
LatitudeOf1st: Double	*The latitude of the first point (Phi 1) of a projected coordinate system.*
LatitudeOf2nd: Double	*The latitude of the second point (Phi 2) of a projected coordinate system.*
LatitudeOfOrigin: Double	*The latitude of the origin (Phi 0) of a projected coordinate system.*
LongitudeOf1st: Double	*The longitude of the first point (Lambda 1) of a projected coordinate system.*
LongitudeOf2nd: Double	*The longitude of the second point (Lambda 2) of a projected coordinate system.*
LongitudeOfOrigin: Double	*The longitude of origin (Lambda0) of a projected coordinate system.*
Projection: IProjection	*The map projection of a projected coordinate system.*
ScaleFactor: Double	*The scale factor (K0) of a projected coordinate system.*
StandardParallel1: Double	*The first parallel (Phi 1) of a projected coordinate system.*
StandardParallel2: Double	*The second parallel (Phi 2) of a projected coordinate system.*
Usage: String	*The usage notes of a projected coordinate system.*
Forward (in Count: Long, Points: _WKSPoint)	*Projects points from geographic to planar coordinates.*
GetParameters (out parameters: IParameter)	*Gets the map projection parameters of a projected coordinate system.*
Inverse (in Count: Long, Points: _WKSPoint)	*Projects points from planar to geographic coordinates.*

IProjectedCoordinateSystem allows you to obtain and set properties of the PCS and also provides you with methods that are inherited from the *ISpatialReference* interface.

The following code illustrates how to retrieve properties of a projected coordinate system. This example retrieves a parameter (*Azimuth*) that is not appropriate for the projected coordinate system. The dialog box to the left is displayed.


Microsoft Visual Basic

Run-time error '-2147220989 (80040203)':

This parameter is not appropriate for this projection.

```
Dim pSpatRefFact As ISpatialReferenceFactory2
Set pSpatRefFact = New SpatialReferenceEnvironment

Dim pProjCoordSys As IProjectedCoordinateSystem
Set pProjCoordSys = _
pSpatRefFact.CreateProjectedCoordinateSystem(esriSRProjCS_Argentina_1)

Debug.Print pProjCoordSys.Azimuth
```

IProjectedCoordinateSystemEdit : IUnknown	*Defines the properties of a projected coordinate system.*
← Define (Name: Variant, Alias: Variant, Abbreviation: Variant, Remarks: Variant, useage: Variant, gcs: Variant, projectedUnit: Variant, Projection: Variant, parameters: Variant)	*Defines the properties of a projected coordinate system.*
← DefineEx (Name: String, Alias: String, Abbreviation: String, Remarks: String, useage: String, gcs: IGeographicCoordinateSystem, projectedXYUnit: ILinearUnit, Projection: IProjection, parameters: IParameter)	*Defines the properties of a projected coordinate system.*

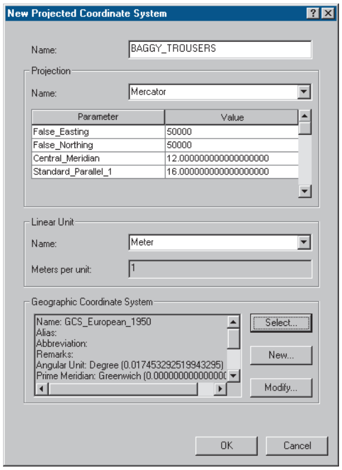
For a used-defined PCS, ESRI recommends creating a predefined or factory PCS that is "close" to what is required—essentially the same projection. Then, either use the parameter setting methods on IProjectedCoordinateSystem *to change parameter values or use the* Define *method to plug in only those new components that are different (probably only a different GCS).*

The *IProjectedCoordinateSystemEdit* interface provides you with the *Define* method to create your own PCS object based on parameters such as *Name*, *GeographicCoordinateSystem*, *projectedUnit*, *Projection* and, if necessary, projection *Parameters*.

```
'Create a factory
Dim pSpatRefFact As ISpatialReferenceFactory2
Set pSpatRefFact = New SpatialReferenceEnvironment

'Create a projection, gcs and unit using the factory
Dim pProjection As IProjection
Dim pGCS As IGeographicCoordinateSystem
Dim pUnit As IUnit
Dim pLinearUnit As ILinearUnit
Set pProjection = _
  pSpatRefFact.CreateProjection(esriSRProjection_Sinusoidal)
Set pGCS = _
  pSpatRefFact.CreateGeographicCoordinateSystem(esriSRGeoCS_WGS1984)
Set pUnit = pSpatRefFact.CreateUnit(esriSRUnit_Meter)
Set pLinearUnit = pUnit

'get the default parameters from the Projection
Dim pParams(16) As IParameter
pProjection.GetDefaultParameters pParams(0)

'create a projected coordinate system using the Define method
Dim pProjCoordSysEdit As IProjectedCoordinateSystemEdit
Dim pProjCoordSys As IProjectedCoordinateSystem
Set pProjCoordSysEdit = New ProjectedCoordinateSystem
pProjCoordSysEdit.Define "Newfoundland", _
  "NF_LAB", "NF", "Most Eastern Province in Canada", _
  "When making maps of Newfoundland", pGCS, _
  pLinearUnit, pProjection, pParams
```

It is also possible to use the *IProjectedCoordinateSystemDialog* to provide an intuitive user interface to create a projected coordinate system.

```
Dim pProjCoordSysDialog As IProjectedCoordinateSystemDialog
Set pProjCoordSysDialog = New ProjectedCoordinateSystemDialog
Dim pProjCoordSys As IProjectedCoordinateSystem
Set pProjCoordSys = pProjCoordSysDialog.DoModalCreate(0)
```



Name: BAGGY_TROUSERS

Projection

Name: Mercator

Parameter	Value
False_Easting	50000
False_Northing	50000
Central_Meridian	12.000000000000000000
Standard_Parallel_1	16.000000000000000000

Linear Unit

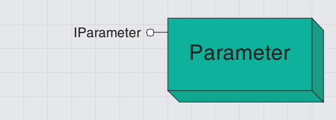
Name: Meter

Meters per unit: 1

Geographic Coordinate System

Name: GCS_European_1950
Alias:
Abbreviation:
Remarks:
Angular Unit: Degree (0.0174532925199433295)
Prime Meridian: Greenwich (0.00000000000000(

Dialog box for a projected coordinate system



A parameter defines and modifies the properties of a projected coordinate system.

As a matter of style, ESRI discourages developers from using the Parameter *object approach with a script to change the values of a projected coordinate system or geographic transformation. They can be difficult to use and are really only useful when writing user interfaces that need to generically manipulate projection parameters. Instead, it is recommended that the developer calls the appropriate method on the* IProjectedCoordinateSystem *interface to modify a parameter directly.*

ESRI also recommends using the SpatialReferenceEnvironment *to create* Parameter *objects.*

The following is a list of all ArcObjects enumerations for parameters that are appropriate for projected coordinate systems:

esriSRParameter_Azimuth
esriSRParameter_CentralMeridian
esriSRParameter_CentralParallel
esriSRParameter_FalseEasting
esriSRParameter_FalseNorthing
esriSRParameter_LatitudeOf1st
esriSRParameter_LatitudeOf2nd
esriSRParameter_LatitudeOfCenter
esriSRParameter_LatitudeOfOrigin
esriSRParameter_LongitudeOf1st
esriSRParameter_LongitudeOf2nd
esriSRParameter_LongitudeOfCenter
esriSRParameter_LongitudeOfOrigin
esriSRParameter_StandardParallel1
esriSRParameter_StandardParallel2

The following is a list of the ArcObjects enumerations for parameters appropriate for geographic transformations:

esriSRParameter_NameDataset
esriSRParameter_ScaleDifference
esriSRParameter_ScaleFactor
esriSRParameter_XAxisRotation
esriSRParameter_XAxisTranslation
esriSRParameter_YAxisRotation
esriSRParameter_YAxisTranslation
esriSRParameter_ZAxisRotation
esriSRParameter_ZAxisTranslation

Parameters are required by both projected coordinate systems and geographic transformations. For example, to define a Lambert Azimuthal Equal Area projected coordinate system, only the central meridian and latitude of origin parameters are required by the mathematic algorithm that actually performs the projection.

IParameter : ISpatialReferenceInfo	*Get properties of projection parameters.*
Index: Long	*Returns the index of a particular projection parameter.*
Value: Double	*The numerical value of a projection parameter.*

The *IParameter* interface has an *Index* and a *Value*. The value is self-explanatory and refers to the internal array that holds the parameters for a projected coordinate system or a geographic transformation.

The *ISpatialReferenceFactory* can be used to create new parameters. Here is an example of how to use the *CreateParameter* method and the *esriSR_ParameterType* enumeration. The *SpatialReferenceFactory* provides default values for each type of parameter. The values can easily be changed.

```
Dim pSpatRefFact As ISpatialReferenceFactory2
Set pSpatRefFact = New SpatialReferenceEnvironment

Dim pParameter As IParameter
Set pParameter = _
  pSpatRefFact.CreateParameter(esriSRParameter_LatitudeOfOrigin)
Debug.Print pParameter.Name
Debug.Print pParameter.Index
Debug.Print pParameter.Value
pParameter.Value = 45
Debug.Print pParameter.Value
```

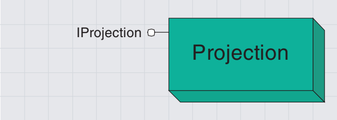
The following code demonstrates how to get the parameters from a map's projected coordinate system. These parameters are passed to the client by reference; it is then possible to modify the value of the parameters directly. If this is done, then the *Changed* method on the *ProjectedCoordinateSystem* must be called. The following code illustrates getting the *Parameters* from a map's projected coordinate system.

```
Dim pMxDoc As IMxDocument
Dim pMap As IMap
Set pMxDoc = Application.Document
Set pMap = pMxDoc.FocusMap

'Get the projected coordinate system from the IMap
Dim pPcs As IProjectedCoordinateSystem
Set pPcs = pMap.SpatialReference
'Create an array of IParameters with 16 elements
Dim pParams(16) As IParameter

'Pass the address of the first element of the array and get the parameters
```

```
pPcs.GetParameters pParams(0)
Dim pParam As IParameter
' iterate through the array of Parameters
Dim i As Integer
For i = 0 To 15
  Set pParam = pParams(i)
  If Not (pParam Is Nothing) Then
    Debug.Print pParam.Name, pParam.Index, pParam.Value
  End If
Next i
```

The following code shows how to change a *Parameter* using the same variables.

```
'Pass the address of the first element of the array and get the parameters
pPcs.GetParameters pParams(0)
Dim pParam As IParameter
' Get the Central Meridian Parameter
Set pParam = pParams(2)
'set the new value
pParam.Value = 123
'tell the projected coordinate system that it has changed
pPcs.Changed
```



A projection specifies the mathematical transformation to convert between geographic and planar coordinates.

The *Projection* coclass creates a projection. A projection uses mathematical formulas to relate spherical 3D coordinates on the globe to flat, 2D planar coordinates. Along with a GCS, *Projection* is one of the components that is used to create a *ProjectedCoordinateSystem*.

IProjection : ISpatialReferenceInfo	*IProjection defines properties of all map projections.*
Classification: String	*The classification of a map projection.*
Usage: String	*The usage notes of a map projection.*
GetDefaultParameters (parameters: IParameter)	*Returns the set of default parameters needed for this projection.*

The *Classification* of a projection typically refers to the type of projection. For example, if the projection is a Lambert Azimuthal Equal Area, then the classification is Azimuthal/Planar, Equal Area.

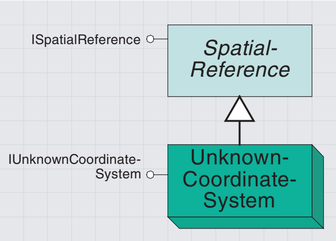
Likewise, using the same example projection above, the *Usage* can have a comment such as, “Maintains small area, good for up to a hemisphere, often used for polar data”.

Not all ArcObjects predefined projection objects return *Classification* and *Usage* with descriptive strings.

GetDefaultParameters returns the set of parameters, with default values, needed for this projection. This method can be used to obain a list of valid parameters for a projection to pass to *IProjectedCoordinateSystemEdit::Define*. Therefore, before using the parameters, their correct values should be set.

The following example uses the *GetDefaultParameters* method to retrieve a set of the required parameters for a projection. Next, set some values and create a new projected coordinate system using these parameters, then make a call to *IProjectedCoordinateSystem::GetParameters* to verify that the parameters have been set.

```
'Create a factory
Dim pSpatRefFact As ISpatialReferenceFactory2
Set pSpatRefFact = New SpatialReferenceEnvironment

'Create a projection, gcs and unit using the factory
Dim pProjection As IProjection
Dim pGCS As IGeographicCoordinateSystem
Dim pUnit As IUnit
Dim pLinearUnit As ILinearUnit
Set pProjection = _
  pSpatRefFact.CreateProjection(esriSRProjection_Sinusoidal)
Set pGCS = _
  pSpatRefFact.CreateGeographicCoordinateSystem(esriSRGeoCS_WGS1984)
Set pUnit = pSpatRefFact.CreateUnit(esriSRUnit_Meter)
Set pLinearUnit = pUnit

'get the default parameters from the Projection
Dim i As Integer
Dim pParameter As IParameter
Dim pParams(16) As IParameter
pProjection.GetDefaultParameters pParams(0)

'Iterate through the Parameters and print out their name and value
For i = 0 To 15
  Set pParameter = pParams(i)
  If Not (pParameter Is Nothing) Then
    Debug.Print pParameter.Name, pParameter.Index, pParameter.Value
  End If
Next i

'reset one of the parameter values
Set pParameter = pParams(2)
pParameter.Value = 45

'create a projected coordinate system using the Define method
Dim pProjCoordSysEdit As IProjectedCoordinateSystemEdit
Dim pProjCoordSys As IProjectedCoordinateSystem
Set pProjCoordSysEdit = New ProjectedCoordinateSystem
pProjCoordSysEdit.Define "Newfoundland", _
  "NF_LAB", _
  "NF", _
  "Most eastern Province in Canada", _
  "When making maps of Newfoundland", _
  pGCS, _
  pLinearUnit, _
  pprojeciont, _
  pParams

'QI to get out projected coordinate system
Set pProjCoordSys = pProjCoordSysEdit
'Get the parameters from your new projected coordinate system and verify
'that the parameter value was changed.
pProjCoordSys.GetParameters pParams(0)

'Iterate through the Parameters and print their name and value
For i = 0 To 15
  Set pParameter = pParams(i)
  If Not (pParameter Is Nothing) Then
    Debug.Print pParameter.Name, pParameter.Index, pParameter.Value
  End If
Next i
```



The unknown coordinate system is used when the coordinate system is not known or is unavailable. This object is used to maintain precision information for coordinates, so geometry operations will have a consistent tolerance with which to work.

The *UnknownCoordinateSystem* coclass provides you with a way to create a spatial reference for a dataset without defining a geographic or projected coordinate system.

This is accomplished using the *IUnknownCoordinateSystem* interface. This functionality is helpful when you possess spatial reference information about a dataset, such as domain extents and false origin and units, but do not need to assign a geographic or projected coordinate system at the time of data creation.

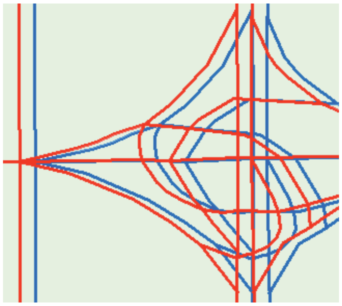
IUnknownCoordinateSystem : ISpatialReference	***Unknown coordinate system***

Likewise, when a *FeatureClass* is loaded into a *Map*, if there is no associated projection information (such as a PRJ file), then ArcObjects will inspect the coordinate values of the dataset and try to determine whether or not the *FeatureClass* is in projected or geographic coordinates.

If the range and magnitude of the coordinate values indicate that the data is projected, then an *UnknownCoordinateSystem* is assigned. This is because it is impossible to infer the projection and type of units used from the raw coordinate values. This approach still allows for precision information to be maintained.

Moving your data between projected coordinate systems may also involve transforming between geographic coordinate systems. Because the geographic coordinate systems contain datums that are based on spheroids, a geographic transformation also changes the underlying spheroid. Other frequently used terms for a geographic transformation include "datum shift" and "geodetic transformation".

A geographic transformation is a mathematical operation that takes the coordinates of a point in one geographic coordinate system and returns the coordinates of the same point in another geographic coordinate system. There is also an inverse transformation to allow coordinates to be put back to the first coordinate system from the second. There are many different types of mathematical operations used to achieve this task.

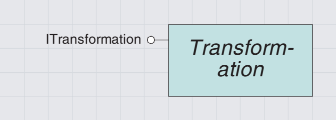


This diagram illustrates the difference in Eastings between two road feature classes, one (red) based on NAD1983, and the other (blue) based on NAD1927.

To illustrate the above, consider the following scenario. You have a known geographic position in the State of Kansas: 97.32° W, 37.68° N. This same location, when displayed with UTM Grid Zone 14N for Kansas (based on the NAD 1927 geographic coordinate system), will have planar coordinates of 648147.22m E, 4171434.25m N. The exact same geographic location when using the UTM Grid Zone 14N (based on the NAD 1983 geographic coordinate system) will have planar coordinates of 648115.09m E, 4171640.19m N. This is a difference of -12.13 meters in the Eastings and 204.86 meters in the Northings.

Thus, if you have two datasets that are projected, they may be on different projected coordinate systems, and their respective coordinate systems may be based on different geographic coordinate systems. It might not be enough to simply change the parameters of the projected coordinate system. You may experience a misalignment between the two datasets even when both are displayed using a common projected coordinate system. The magnitude of the error will vary depending on the geographic coordinate systems used and the relative accuracy of the data. A geographic transformation should minimize these inaccuracies.

ArcObjects provides a number of classes that represent different mathematical methods for applying the geographic transformation. There are several standard mathematical methods for transforming between datums, and each has a different level of accuracy and range. These include the geocentric translation, position vector, and coordinate frame, as well as grid-based methods. ArcObjects also provides you with the capability to define your own geographic transformation. The following discussion introduces the ArcObjects geographic transformation components and how to create them. Afterwards, you will learn how to use them.



The transformation class is the top-level class used by both the spatial reference and geometry models.

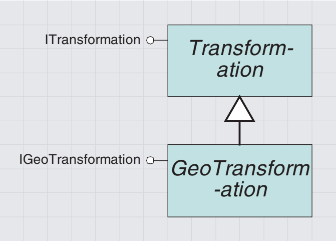
Transformation is an abstract class used by both the spatial reference and geometry models. It defines the methods on the *ITransformation* interface.

ITransformation : IUnknown	***Applies a function (or its inverse) to a set of points or measures. The suffix of each method indicates the type of parameters operated on.***
← TransformMeasuresFF (Direction: tagesriTransformDirection, cMeasures: Long, inMeasures: Double, outMeasures: Double)	*Transforms floating point measures to floating point measures (or do the inverse).*
← TransformMeasuresFI (Direction: tagesriTransformDirection, cMeasures: Long, inMeasures: Double, outMeasures: Long)	*Transforms floating point measures to integer measures (or do the inverse).*
← TransformMeasuresIF (Direction: tagesriTransformDirection, cMeasures: Long, inMeasures: Long, outMeasures: Double)	*Transforms integer measures to floating point measures (or do the inverse).*
← TransformMeasuresII (Direction: tagesriTransformDirection, cMeasures: Long, inMeasures: Long, outMeasures: Long)	*Transforms integer measures to integer measures (or do the inverse).*
← TransformPointsFF (Direction: tagesriTransformDirection, cPoints: Long, inPoints: Double, outPoints: Double)	*Transforms floating point points to floating point points (or do the inverse).*
← TransformPointsFI (Direction: tagesriTransformDirection, cPoints: Long, in inPoints: Double, outPoints: Long)	*Transforms floating point points to integer points (or do the inverse).*
← TransformPointsIF (Direction: tagesriTransformDirection, cPoints: Long, inPoints: Long, outPoints: Double)	*Transforms integer points to floating point points (or do the inverse).*
← TransformPointsII (Direction: tagesriTransformDirection, cPoints: Long, inPoints: Long, outPoints: Long)	*Transforms integer points to integer points (or do the inverse).*

These methods in *ITransformation* are implemented by the transformation subclasses in both models. In the case of the spatial reference model, the subclasses are those that provide the geographic transformations.

Enumeration tagesriTransformDirection	***Specifies whether to apply a forward or reverse (inverse) transformation.***
0 - esriTransformForward	*Specifies a forward transformation.*
1 - esriTransformReverse	*Specifies a reverse (inverse) transformation.*

The direction enumerations dictate the direction of the transformation—forward or reverse (inverse). A geographic transformation is always defined as converting "from" one geographic coordinate system "to" another one. Using the reverse flag allows you to convert in the other direction.



These transformations are used when data that is held on one datum needs to be transformed onto another datum. This is also known as a datum transformation.

The *GeoTransformation* abstract class defines the *IGeoTransformation* interface.

IGeoTransformation : ITransformation	***Defines a geographic (datum) transformation.***
■—■ Name: String	*Returns the name of the geographic transformation.*
← GetSpatialReferences (out from: ISpatialReference, out to: ISpatialReference)	*Returns the from and to spatial references for the transformation.*
← PutSpatialReferences (from: ISpatialReference, to: ISpatialReference)	*Sets the from and to spatial references for the transformation.*

The *IGeoTransformation* interface is used as a basis for all the transformation interfaces, such as *IPositionVectorTransformation, IGeocentricTransformation,* and the grid-based transformations.

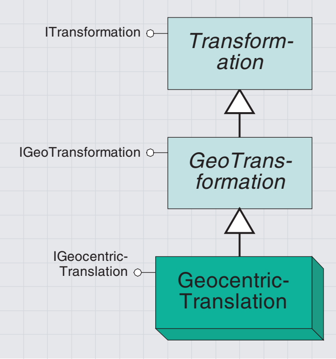
The *IGeoTransformation* interface provides two methods, *GetSpatialReferences* and *PutSpatialReferences,* which are used by all transformations.

When performing a geographic transformation, all methods need to know where the source points are coming from (the source geographic coordinate system) and where they are going to (the target coordinate system).

Consider a geographic transformation from NAD 1927 to NAD 1983. With these, there are two spatial references. These are what the *PutSpatialReferences* and *GetSpatialReferences* methods are referring to. Either projected or geographic coordinate systems can be passed as parameters. If a projected coordinate system is passed, the transformation object will automatically obtain its inherent geographic coordinate system. The transformations get required parameters from the spatial references (spheroid parameters) so they can perform the mathematics.

The following code illustrates creating a geotransformation using the spatial reference factory and the *GetSpatialReferences* methods.

```
  Dim pSpatRefFact As ISpatialReferenceFactory2
  Set pSpatRefFact = New SpatialReferenceEnvironment
  Dim pGeotrans As IGeoTransformation
  Dim pFromSR As ISpatialReference
  Dim pToSR As ISpatialReference
  'mean for Great Britain
  Set pGeotrans = _
pSpatRefFact.CreateGeoTransformation(esriSRGeoTransformation_OSGB1936_To_WGS1984_1)
  pGeotrans.GetSpatialReferences pFromSR, pToSR
  Debug.Print pGeotrans.Name
  Debug.Print pFromSR.Name, pToSR.Name
```

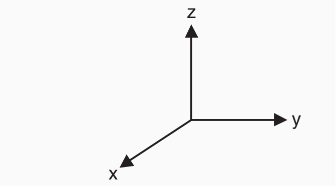


The geocentric translation transformation uses three parameters to convert between two geographic coordinate systems.

One of the simplest datum transformation methods is a geocentric, or three-parameter, translation. The geocentric translation transformation models the differences between the two datums in the x,y,z coordinate system. One datum is defined to be centered at (0, 0, 0). The center of the other datum is defined to be at some distance dx, dy, and dz meters away. Usually, the transformation parameters are defined as going “from” a local datum “to” WGS 1984 or to another geocentric datum.

IGeocentricTranslation : IGeoTransformation	3D vector transformation with 3 translation values.
← GetParameters (dx: Double, dy: Double, dz: Double)	Returns the translation values in meters for the X, Y and Z axis
← PutParameters (dx: Double, dy: Double, dz: Double)	Sets the translation values in meters for the X, Y and Z axis

The *GeocentricTranslation* coclass defines the *IGeocentricTranslation* interface, which has two methods: *GetParameters* and *SetParameters*. These allow the developer to set or retrieve the values for the geocentric translation transformation. The parameters are delta x, delta y, and delta z and are always specified in meters.



The geocentric (x,y,z) coordinate system

The code below shows how to use the spatial reference factory to create a predefined geocentric translation transformation and then display its default parameter values.

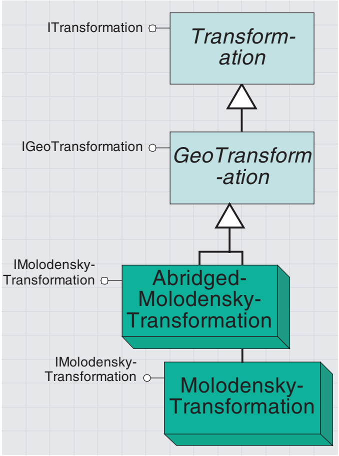
First, use the *esriSRGeoTransformationType* of *esriSRGeoTransformation_OSGB1936_To_WGS1984_1*. This creates a geocentric translation transformation object that converts geographic coordinates from the OSGB1936 geographic coordinate system to the WGS 1984 geographic coordinate system. This particular transformation uses parameters that are mean values for Great Britain (England, Scotland, Wales, and Isle of Man).

ArcObjects provides the ability to generate predefined geotransformation objects.These predefined “factory” geotransformations are all geometric translations apart from the Grid Based Geotransformations, such as HARN and NADCON, which will be covered shortly. ArcObjects also allows you to define Position Vector and Coordinate Frame geotransformation objects.

Next, use *esriSRGeoTransformation_OSGB1936_To_WGS1984_5*; this provides parameter values that are more specific to Wales. These parameter values are all taken from the POSC/EPSG database. To see the different enumerations available within ArcObjects, use the online Help system or the browser.

```
Dim pSpatRefFact As ISpatialReferenceFactory2
Set pSpatRefFact = New SpatialReferenceEnvironment
Dim pGeocentric As IGeocentricTranslation
Dim dx As Double
Dim dy As Double
Dim dz As Double

'mean for Great Britain
Set pGeocentric = _
 pSpatRefFact.CreateGeoTransformation(esriSRGeoTransformation_OSGB1936_To_WGS1984_1)
pGeocentric.GetParameters dx, dy, dz
Debug.Print dx, dy, dz
```

```
'specific for Wales
Set pGeocentric = _
pSpatRefFact.CreateGeoTransformation(esriSRGeoTransformation_OSGB1936_To_WGS1984_5)
pGeocentric.GetParameters dx, dy, dz
Debug.Print dx, dy, dz
```


ITransformation
Transform-ation
IGeoTransformation
GeoTransform-ation
IMolodensky-Transformation
Abridged-Molodensky-Transformation
IMolodensky-Transformation
Molodensky-Transformation

The Molodensky and Abridged Molodensky transformations, like the Geocentric Translation, use three parameters to convert between two geographic coordinate systems.

The *MolodenskyTransformation* and *AbridgedMolodenskyTransformation* coclasses both implement the *IMolodensky* interface.

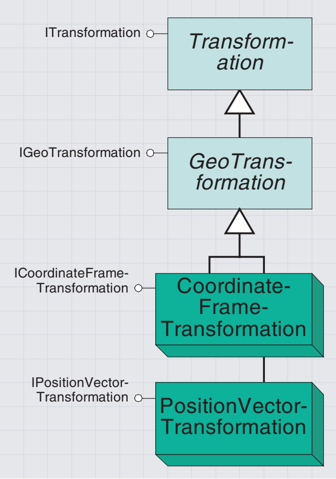
IMolodenskyTransformation : IGeoTransformation	***Specify/retrieve parameters of a Molodensky transformation.***
← GetParameters (dx: Double, dy: Double, dz: Double)	*Returns the dx, dy and dz parameters.*
← PutParameters (dx: Double, dy: Double, dz: Double)	*Sets the dx, dy and dz parameters.*

These transformation methods also take three parameters (like *GeocentricTranslation*): delta x, delta y, and delta z. The parameters are always specified in meters.

These two transformations (and the *GeocentricTranslation* transformation) differ in the underlying mathematical formula, but the interfaces are very similar. For more information on the mathematics, see *Understanding Map Projections*.

The following code creates an *AbridgedMolodenskyTransformation* object.

```
Dim pSpatRefFact As ISpatialReferenceFactory2
Set pSpatRefFact = New SpatialReferenceEnvironment
Dim pFromSR As ISpatialReference
Dim pToSR As ISpatialReference
Set pFromSR = _
  pSpatRefFact.CreateGeographicCoordinateSystem(esriSRGeoCS_OSGB1936)
Set pToSR = _
  pSpatRefFact.CreateGeographicCoordinateSystem(esriSRGeoCS_WGS1984)
Dim pGeotrans As IMolodenskyTransformation
Set pGeotrans = New AbridgedMolodenskyTransformation
pGeotrans.PutParameters 375, -111, 431
pGeotrans.PutSpatialReferences pFromSR, pToSR
```


ITransformation
Transformation
IGeoTransformation
GeoTransformation
ICoordinateFrame-Transformation
Coordinate-Frame-Transformation
IPositionVector-Transformation
PositionVector-Transformation

These transformations use a seven-parameter similarity equation to convert between two geographic coordinate systems.

The *CoordinateFrameTransformation* coclass implements the interface of the same name.

ICoordinateFrameTransformation : IGeoTransformation	***3D frame transformation with rotation, translation and scaling.***
← GetParameters (dx: Double, dy: Double, dz: Double, rx: Double, ry: Double, rz: Double, s: Double)	*Returns translation, rotation and scale values of the transformation.*
← PutParameters (dx: Double, dy: Double, dz: Double, rx: Double, ry: Double, rz: Double, s: Double)	*Sets translation, rotation and scale values for the transformation.*

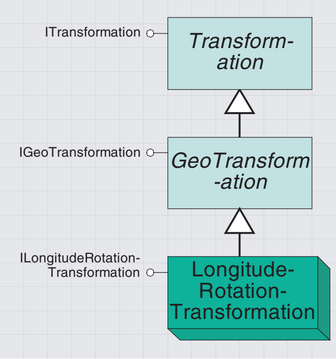
The coordinate frame geographic transformation uses seven parameters to convert between geographic coordinate systems and is therefore more accurate than the simpler three-parameter transformations.

The *PositionVectorTransformation* is similar to the *CoordinateFrameTransformation;* this transformation also uses seven parameters, the values of which should be supplied by the developer depending on the specific requirements of the transformation.

IPositionVectorTransformation : IGeoTransformation	***3D vector transformation with rotation, translation and scaling.***
← GetParameters (dx: Double, dy: Double, dz: Double, rx: Double, ry: Double, rz: Double, s: Double)	*Returns translation, rotation and scale values of the transformation.*
← PutParameters (dx: Double, dy: Double, dz: Double, rx: Double, ry: Double, rz: Double, s: Double)	*Sets translation, rotation and scale values for the transformation.*

The parameters for methods are delta x, delta y, delta z, rotation x, rotation y, rotation z, and scale difference. In both cases, the translations (delta x,y,z) are always specified in meters, while the rotations are in decimal seconds. The scale difference is in parts per million. The following code shows how to create a *CoordinateFrameTransformation*.

```
Dim pSpatRefFact As ISpatialReferenceFactory2
Set pSpatRefFact = New SpatialReferenceEnvironment
Dim pFromSR As ISpatialReference
Dim pToSR As ISpatialReference

Set pFromSR = _
  pSpatRefFact.CreateGeographicCoordinateSystem(esriSRGeoCS_OSGB1936)
Set pToSR = _
  pSpatRefFact.CreateGeographicCoordinateSystem(esriSRGeoCS_WGS1984)

Dim pGeotrans As ICoordinateFrameTransformation
Set pGeotrans = New CoordinateFrameTransformation
pGeotrans.PutParameters -9.2, 158.7, 183.1, 0.382, -1.451, -0.72, 2.482
pGeotrans.PutSpatialReferences pFromSR, pToSR
Dim dx As Double, dy As Double, dz As Double
Dim rx As Double, ry As Double, rz As Double
Dim dscale As Double
pGeotrans.GetParameters dx, dy, dz, rx, ry, rz, dscale
Debug.Print dx, dy, dz, rx, ry, rz, dscale
```


ITransformation
Transform-ation
IGeoTransformation
GeoTransform-ation
ILongitudeRotation-Transformation
Longitude-Rotation-Transformation

The longitude-rotation transformation converts between two prime meridians.

The *LongitudeRotationTransformation* coclass implements the *ILongitudeRotationTransformation* interface.

ILongitudeRotationTransformation : IGeoTransformation

Get parameters of a longitude-rotation transformation.

- Rotation: Double — *Counterclockwise (looking down on North Pole) positive rotation about Earth's rotational axis.*

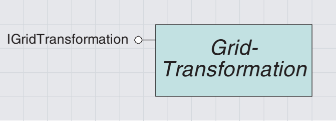
This transformation performs a shift between two prime meridians. Not all geographic coordinate systems use Greenwich as their prime meridian; the *Rotation* value refers to the difference in degrees between Greenwich and the prime meridian for the target geographic coordinate system.

Use the *CreateGeotransformation* method on the *ISpatialReferenceFactory* to create geotransformations of this type; the *esriSRGeoTransformation2Type* enumeration gives you valid factory codes for this geotransformation, as the following code demonstrates.

```
Dim pSpatRefFact As ISpatialReferenceFactory2
Set pSpatRefFact = New SpatialReferenceEnvironment
Dim pFromSR As ISpatialReference
Dim pToSR As ISpatialReference
Dim pLongitudeRotation As ILongitudeRotationTransformation
Set pLongitudeRotation = _
 pSpatRefFact.CreateGeoTransformation(esriSRGeoTransformation_Bogota_Bogota_To_Bogota)

Dim pRot As Double
pRot = pLongitudeRotation.Rotation
pLongitudeRotation.GetSpatialReferences pFromSR, pToSR
Debug.Print pRot
Debug.Print pFromSR.Name, pToSR.Name
```

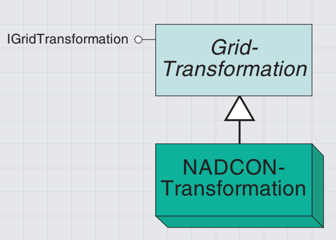
These are the *esriSRGeoTransformation2Type* enumeration values that apply to *LongitudeRotationTransformation*:

- esriSRGeoTransformation_Batavia_Jakarta_To_Batavia
- esriSRGeoTransformation_Belge_1950_Brussels_To_Belge_1950
- esriSRGeoTransformation_Bern_1898_Bern_To_Bern_1898
- esriSRGeoTransformation_Bogota_Bogota_To_Bogota
- esriSRGeoTransformation_Greek_Athens_To_Greek
- esriSRGeoTransformation_Lisbon_Lisbon_To_Lisbon
- esriSRGeoTransformation_Makassar_Jakarta_To_Makassar
- esriSRGeoTransformation_MGI_Ferro_TO_MGI
- esriSRGeoTransformation_Monte_Mario_Rome_To_Monte_Mario
- esriSRGeoTransformation_NGO_1948_Oslo_To_NGO_1948
- esriSRGeoTransformation_NTF_Paris_To_NTF
- esriSRGeoTransformation_Padang_1884_Jakarta_To_Padang_1884
- esriSRGeoTransformation_RT38_Stockholm_TO_RT38
- esriSRGeoTransformation_Tananarive_1925_Paris_To_Tananarive_1925
- esriSRGeoTransformation_Voirol_1875_Paris_To_Voirol_1875
- esriSRGeoTransformation_Voirol_Unifie_1960_Paris_To_Voirol_Unifie_1960

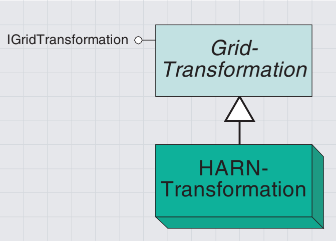


Grid-based geographic transformations, such as NADCON and NTv2, are often the most accurate way to convert between two geographic coordinate systems.

All NGS grids are available for download at ftp://ftp.ngs.noaa.gov/pub/pcsoft/nadcon/.



The NADCON transformation is a grid-based transformation method that converts geographic coordinates between the NAD 1927 and NAD 1983 datums.



The HARN transformation is a highly accurate grid-based transformation method that converts geographic coordinates between the NAD 1983 datum and the HARN readjustments (used in the United States).

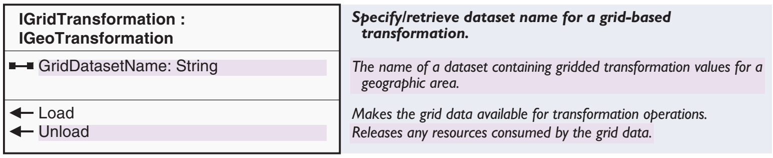
Some countries, like the United States and Canada, use a grid-based geographic (datum) transformation method. A grid contains the differences (often in seconds) between two geographic coordinate systems. Grid-based methods can be very accurate because a grid can model small changes in the fit between the two geographic coordinate systems. The grids are held in files and can be found in the PEDATA directory of your ArcInfo 8.1 installation.

Currently, ArcObjects supports one grid type and method—the United States National Geodetic Survey (NGS) format.

NGS has grids that convert from NAD 1927 and other old datums to NAD 1983. The grid files can be found in the Nadcon subdirectory. A NADCON transformation actually needs two grids, one for latitude shifts and one for longitude shifts. Each has an .las or an .los extension. The NADCON files are:

- *alaska*—NAD27–NAD83 shifts for Alaska
- *conus*—NAD27–NAD83 shifts for the contiguous U.S. (lower 48)
- *hawaii*—Old Hawaiian–NAD83 shifts
- *prvi*—NAD27–NAD83 shift for Puerto Rico and Virgin Islands
- *stgeorge*—Alaskan island datum–NAD83 shifts for St. George Island
- *stlrnc*—Alaskan island datum–NAD83 shifts for St. Lawrence Island
- *stpaul*—Alaskan island datum–NAD83 shifts for St. Paul Island

NGS also provides High Accuracy Regional Network (HARN) or High Precision Geodetic Network (HPGN) grids. These are a more accurate redefinition of the NAD 1983 datum. The grid files for these are stored in the Harn subdirectory in PEDATA.



IGridTransformation : IGeoTransformation

Specify/retrieve dataset name for a grid-based transformation.

GridDatasetName: String — *The name of a dataset containing gridded transformation values for a geographic area.*

Load — *Makes the grid data available for transformation operations.*

Unload — *Releases any resources consumed by the grid data.*

The *GridTransformation* coclass defines the *IGridTransformation* interface. Due to polymorphic substitution, a *GridTransformation* is also a *GeoTransformation,* as the *IGridTransformation* interface inherits from the *IGeoTransformation* interface. One property and two methods are defined.

The *GridDatasetName* is a read–write property that represents the grid file on disk. The *Load* method caches the contents of the grid file into memory, thus improving the performance of this transformation. The *Unload* method recovers memory.

The *NADCONTransformation* coclass implements the *IGridTransformation* interface and is used to perform geographic transformations from NAD 1927 to NAD 1983 using the NGS grid files found in the Nadcon subdirectory.

The *HARNTransformation* coclass implements the *IGridTransformation* interface and performs geographic transformations from NAD 1983 to the HARN or HPGN grids.

To create both *NADCONTransformation* and *HARNTransformation* geotransformation objects, use the *CreateGeoTransformation* method on the *ISpatialReferenceFactory2* interface. Use the *esriSRGeoTransformation2Type* enumerations for *GridTransformations*.

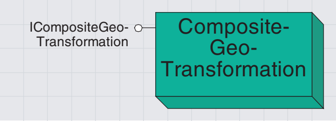
The following piece of code shows how to create a geographic transformation that transforms NAD 1927 to NAD 1983 for the contiguous United States (CONUS). The *GridDatasetName* is automatically set, but the *Load* method still needs to be called.

```
Dim pSpatRefFact As ISpatialReferenceFactory2
Set pSpatRefFact = New SpatialReferenceEnvironment
Dim pGeotransNAD27toNAD83 As IGridTransformation
Set pGeotransNAD27toNAD83 = _
 pSpatRefFact.CreateGeoTransformation(esriSRGeoTransformation_NAD_1927_TO_NAD_1983_NADCON)
pGeotransNAD27toNAD83.Load
```

Alternatively, you can use the *NADCONTransformation* coclass. Note how the NADCON grid file is specified. No directory path or file extensions are required.

```
Dim pGeotransNAD27toNAD83 As IGridTransformation
Set pGeotransNAD27toNAD83 = New NADCONTransformation
pGeotransNAD27toNAD83.GridDatasetName = "CONUS"
pGeotransNAD27toNAD83.Load
```

Please refer to the ArcObjects Developer Help system for a complete listing of the current *esriSRGeoTransformation2Type* enumerations that apply to NAD27 and NAD83 grid-based geotransformations.



The composite geotransformation is used to build up a transformation that goes from one datum to another via a third common datum.

A *CompositeGeoTransformation* is a geotransformation.

ICompositeGeoTransformation : IGeoTransformation	***Contains a set of geographic transformations.***
■— Count: Long	*Returns the number of geographic transformations in the list.*
■— GeoTransformation (i: Long) : IGeoTransformation	*Returns a geographic transformation from the list.*
■— TransformationDirection (i: Long) : esriTransformDirection	*Returns the direction (forward/reverse) of a geographic transformation.*
← Add (Direction: esriTransformDirection, pXForm: IGeoTransformation)	*Adds a geographic transformation to the list.*
← SetEmpty	*Clears the list of geographic transformations from the object.*

Use the *ICompositeGeoTransformation* interface when you need to define a geographic transformation operation that requires the use of an interim datum. For example, there is no direct path from one geographic coordinate system to another, so you can use a third geographic coordinate system to get from one to another.

For example, Cameroon uses both the Adindan and Minna geographic coordinate systems. While it is not possible to convert directly between Adindan and Minna, you can convert both to WGS 1984. So, you can go from Adindan to WGS 1984, and then from WGS 1984 to Minna. The transformation method actually goes from Minna to WGS 1984, so you need to state that you want to go in the reverse direction (WGS 1984 to Minna).

To specify the direction of a transformation, use the *esriTransformDirection* enumerations (*esriTransformForward* and *esriTransformReverse*).

Once you create a *CompositeGeoTransformation*, add it to the *GeographicOperationSet* for the *Map*. When you do this, specify the transformation direction.

In the *CompositeGeotransformation* example above, you define whether you want to do Adindan to WGS 1984 followed by WGS 1984 to Minna, or Minna to WGS 1984 followed by WGS 1984 to Adindan.

The "forward" direction through this composite geotransformation takes you from Adindan to Minna. The "reverse" direction through this geotransformation takes you from Minna to Adindan. This composite geotransformation has two components. That is, it has two (direction, geotransformation) pairs:

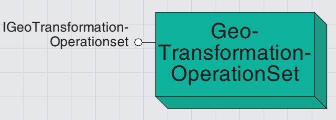
- Adindan to WGS 1984 (forward)
- Minna to WGS 1984 (reverse)

Going "forward" through the composite geotransformation is the same as going forward through the first component geotransformation and backward through the second component geotransformation. Going "reverse" through the composite geotransformation is the same as going forward through the second geotransformation and backward through the first geotransformation.

In other words, you need the component directions and component ordering to define what forward and reverse mean at the composite level. The order is important. Once you build the composite transformation, it acts just like a regular transformation.

The following code applies the example just discussed.

```
Dim pActiveView As IActiveView
Dim pMxDoc As IMxDocument

Set pMxDoc = ThisDocument
Set pMap = pMxDoc.FocusMap
Set pActiveView = pMxDoc.ActiveView

'1)Create your factory
Dim pSpatRefFact As ISpatialReferenceFactory2
Set pSpatRefFact = New SpatialReferenceEnvironment
Dim pGeoTrans_A As IGeoTransformation
Dim pGeoTrans_B As IGeoTransformation

'2)Use the factory to create your geotransformation objects
Set pGeoTrans_A = _
 pSpatRefFact.CreateGeoTransformation(esriSRGeoTransformation_Adindan_To_WGS1984_1)
Set pGeoTrans_B = _
 pSpatRefFact.CreateGeoTransformation(esriSRGeoTransformation_Minna_To_WGS1984_1)

'3)Create a composite geotransformation object
Dim pGeoTransComposite As ICompositeGeoTransformation
Set pGeoTransComposite = New CompositeGeoTransformation

'4)Add the two seperate geotransformations to the composite
pGeoTransComposite.Add esriTransformForward, pGeoTrans_A
pGeoTransComposite.Add esriTransformReverse, pGeoTrans_B

'5)QI for the IMapGeographicTransformations
Dim pMapGeotrans As IMapGeographicTransformations
Set pMapGeotrans = pMap

'6)And get the IGeoTransformationOperationSet
Dim pGeoTransOperationSet As IGeoTransformationOperationSet
Set pGeoTransOperationSet = pMapGeotrans.GeographicTransformations

'7)Add your composite to the set
pGeoTransOperationSet.Set esriTransformForward, pGeoTransComposite
pActiveView.Refresh
```



The geotransformation operation set manages the collection of transformations needed to transform all the currently loaded datasets onto one common datum.

The *GeotransformationOperationSet* coclass is used by the *Map* to store all the required geotransformation objects. During the refresh cycle, ArcObjects uses the geotransformation objects stored in this set to achieve any geographic transformations required by the feature classes loaded into the *Map*.

IMapGeographicTransformations : IUnknown	***Provides access to members that control the map's set of geographic transformations and the directions in which they are applied.***
■— GeographicTransformations: IGeoTransformationOperationSet	*on-the-fly geographic transformations.*

The *IMapGeographicTransformations* interface returns by reference the geographic operations set from the *Map*. An *IMapGeographicTransformations* is obtained by a *QI* from the *IMap*.

```
' Get the IMapGeographicTransformations by QI from the IMap.
Dim pMapGeotrans As IMapGeographicTransformations
Set pMapGeotrans = pActiveView.FocusMap
```

IGeoTransformationOperationSet : IUnknown	***Stores a set of geographic transformation operators (GT + direction).***
■— Count: Long	*Returns the number of geographic transformations in the set.*
◄— Find (Direction: tagesriTransformDirection, GT: IGeoTransformation) : Boolean	*Check a geographic transformation and a direction to see if it exists in the set.*
◄— Get (pFromGCS: IGeographicCoordinateSystem, pToGCS: IGeographicCoordinateSystem, out Direction: tagesriTransformDirection, out Transformation: IGeoTransformation)	*Returns a default geographic transformation.*
◄— Next (out Direction: tagesriTransformDirection, out GT: IGeoTransformation)	*Retrieves the next geographic transformation in the set.*
◄— Remove (Direction: tagesriTransformDirection, Transformation: IGeoTransformation)	*Deletes a particular geographic transformation.*
◄— RemoveAll	*Deletes all geographic transformations in the set.*
◄— RemoveByKey (pFromGCS: IGeographicCoordinateSystem, pToGCS: IGeographicCoordinateSystem)	*Deletes a particular geographic transformation by its from and to GeoCS.*
◄— Reset	*Reinitializes the geographic transformation set.*
◄— Set (Direction: tagesriTransformDirection, Transformation: IGeoTransformation)	*Sets a default geographic transformation.*

The *IGeoTransformationOperationSet* interface stores an ordered collection of geographic transformations and associated direction pairs.

The *GeoTransformationOperationSet* property on the *IMapGeographicTransformations* returns a reference to the map's *IGeographicOperationsSet*. You are then free to modify it directly.

The following code shows how to get the *GeoTransformationsOperationSet* and find a matching geotransformation object given the feature dataset's spatial reference and the map's current spatial reference.

```
Dim pMxDoc As IMxDocument
Dim pMap As IMap
Set pMxDoc = ThisDocument
Set pMap = pMxDoc.FocusMap

'Get the IMapGeographicTransformations by QI from the IMap
Dim pMapGeoTrans As IMapGeographicTransformations
Set pMapGeoTrans = pMap

' Get the set of geotransformations from the IMapGeographicTransformations
Dim pGeoTransSet As IGeoTransformationOperationSet
Set pGeoTransSet = pMapGeotrans.GeographicTransformations

pGeoTransSet.Reset 'put the set to its beginning
' set up the geotran to receive the direction/transformation pairs
Dim pGT As IGeoTransformation
Dim pDirection As esriTransformDirection

' Get the GCSs from the source featureclass and from the target projection:
' Assuming source is Geographic and get the GCS from the featureclass
Dim pGCSfrom As IGeographicCoordinateSystem
Dim pGeoDataset As IGeoDataset
Set pGeoDataset = pMap.Layer(0)
Set pGCSfrom = pGeoDataset.SpatialReference

' Assuming the IMap has a ProjectedCoordinateSystem
Dim pGCSto As IGeographicCoordinateSystem
Dim pPCS As IProjectedCoordinateSystem
Set pPCS = pMap.SpatialReference
Set pGCSto = pPCS.GeographicCoordinateSystem

' From the IGeographicOperationSet, Get the geotransformation/direction
' associated with this pair of GCSs
pGeoTransSet.Get pGCSfrom, pGCSto, pDirection, pGT

' print out the names
Debug.Print pGCSfrom.Name
Debug.Print pGCSto.Name
Debug.Print Str(pDirection)
Debug.Print pGT.Name
```

The following code extract shows how to set geographic transformations into the *IGeographicOperationSet*.

```
' Reset the IGeographicOperationSet to the beginning, and if the set
' doesn't contain your required geographic transformation, then,
' if you don't need them, remove all the current contents of the set
' and add to it your specific geotransformation/direction pair

pGeoTransSet.Reset
If (not pGeoTransSet.Find esriTransformForward, pGeotrans) Then
  pGeoTransSet.RemoveAll
  pGeoTransSet.Set esriTransformForward, pGeotrans
EndIf
```

This section focuses on how to actually use geotransformation objects to perform an on-the-fly geotransformation.

This scenario has two feature classes for data in the United States. Both sets of data are in geographic latitude and longitude. However, one set of geographicals is based on the NAD1927 geographic coordinate system, and the other is based on the NAD1983 geographic coordinate system. The aim is to assign a projected coordinate system to the map and project both feature classes. The target projected coordinate system uses a Mercator projection and a geographic coordinate system based on the WGS 1984 datum.

Not only do the feature classes need to go from geographic latitude and longitude coordinates to projected x,y coordinates, but a geographic transformation also needs to take place to ensure the best accuracy in alignment between the features. However, ArcObjects does most of the work for you.

When the feature classes were loaded as feature layers into the map, if there were associated PRJ files or other projection metadata, then the spatial reference for each feature layer was automatically created. Here is how to get the name of the spatial reference associated with the feature layer.

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument

Dim pMap As IMap
Set pMap = pMxDoc.FocusMap

Dim pLayer As IFeatureLayer
Set pLayer = pMap.Layer(0)

Dim pGeoDataset As IGeoDataset
Dim pSpatialReference As ISpatialReference
Set pGeoDataset = pLayer 'QI for the geodataset from the layer
Set pSpatialReference = pGeoDataset.SpatialReference
MsgBox pSpatialReference.Name
```

When you create a *ProjectedCoordinateSystem* and set the *IMap* to use it, the ArcObjects drawing pipeline checks to see if the *Map* has a target *SpatialReference* set; if so, it will automatically reproject on the fly as necessary.

The *Map* keeps a *Set* of *GeoTransformations* called an *IGeoTransformationsOperationSet*. It is possible to add and remove objects from this set. When a projection operation occurs and the source and target *GeographicCoordinateSystems* involved are different, then the *Set* is automatically searched for a *GeoTransformation* appropriate for the *GeographicCoordinateSystems* involved. This geographic transformation is then applied to every feature layer that is based on the same geographic coordinate system.

All you need to do is to create the appropriate *GeoTransformation* objects and add them to the *IGeoTransformationsOperationSet*. The above scenario, which has feature classes on NAD1927 and NAD1983, will project both onto the SPCS for Kansas North, then use a *NADCONTransformation* to enable both feature layers to be correctly aligned.

```
Dim pMap As IMap
Dim pActiveView As IActiveView
Dim pMxDoc As IMxDocument

Set pMxDoc = Application.Document
Set pMap = pMxDoc.FocusMap
Set pActiveView = pMxDoc.ActiveView

Dim pSpatRefFact As ISpatialReferenceFactory2
Set pSpatRefFact = New SpatialReferenceEnvironment

'1)Create a NADCON transformation
Dim pGeotransNAD27toNAD83 As IGridTransformation
Set pGeotransNAD27toNAD83 = New NADCONTransformation

'2)Specify which grid file to use.
pGeotransNAD27toNAD83.GridDatasetName = "CONUS"

'3)Load the grid file into memory
pGeotransNAD27toNAD83.Load

'4)Get the IMapGeographicTransformations
Dim pMapGeotrans As esriCore.IMapGeographicTransformations
Set pMapGeotrans = pMap

'5)Now get set of geotransformations from IMapGeographicTransformations
Dim pGeoTransSet As IGeoTransformationOperationSet
Set pGeoTransSet = pMapGeotrans.GeographicTransformations

'6)RemoveAll the default geotransformations as they are unneccessary
pGeoTransSet.RemoveAll

'7)And add your NADCON transformation to it
pGeoTransSet.Set esriTransformForward, pGeotransNAD27toNAD83

'8)Create a pcs for State Plane Coordinate System for Kansas
Dim pPCS As IProjectedCoordinateSystem
Set pPCS = _
 pSpatRefFact.CreateProjectedCoordinateSystem(esriSRProjCS_NAD1983SPCS_KSNorth)

'9)Assign it to the map
Dim pEnv As IEnvelope
Set pEnv = pActiveView.Extent
pActiveView.PartialRefresh esriViewGeography, Nothing, pEnv
```

The next example illustrates how to project a *FeatureLayer* that is in geographical coordinates based on WGS 1984 onto the British National Grid, a projected coordinate system based on the OSGB 1936 geographic coordinate system.

This could be a common scenario when adding GPS-derived points to an application. Likewise, although you are using the British National Grid as your target projection, the same approach would be required for a target coordinate system using, for example, a State Plane Coordinate System.

The code example that follows uses the *GeocentricTranslation* coclass to create the *GeoTransformation*. If what you want to do is a common operation (such as this example), then you can use the *SpatialReferenceFactory* to create a predefined *GeoTransformation*. If you need a *GeoTransformation* that is not supported by ArcObjects, then you can create your own using the following approach. However, you will still need to obtain the correct geodetic information for the parameter values yourself.

In this example, your "from" coordinate system is OSGB 1936, and your "to" coordinate system is WGS 1984. You actually want to do the inverse operation, that is, go from WGS 1984 to OSGB 1936. To enable this you can either swap the *pFromSR* and *pToSR* variables around and modify the *Parameter* values or, as is done here, specify that the inverse operation should be performed. To specify the direction of a transformation, use the *esriTransformDirection* enumerations *(esriTransformForward* and *esriTransformReverse*).

```
Dim pMap As IMap
Dim pActiveView As IActiveView
Dim pMxDoc As IMxDocument

Set pMxDoc = Application.Document
Set pMap = pMxDoc.FocusMap
Set pActiveView = pMxDoc.ActiveView

Dim pSpatRefFact As ISpatialReferenceFactory2
Set pSpatRefFact = New SpatialReferenceEnvironment

Dim pFromSR As ISpatialReference
Dim pToSR As ISpatialReference

'1) Create your from and to Spatial References
Set pFromSR = _
pSpatRefFact.CreateGeographicCoordinateSystem(esriSRGeoCS_OSGB1936)
Set pToSR = _
pSpatRefFact.CreateGeographicCoordinateSystem(esriSRGeoCS_WGS1984)

'2) Create your geocentric transformation
```

```
Dim pGeotrans As IGeocentricTranslation
Set pGeotrans = New GeocentricTranslation

'3) Put its SpatialReferences and Parameters using values provided by a
'third party
pGeotrans.PutSpatialReferences pFromSR, pToSR
pGeotrans.PutParameters 375, -111, 431

'4) Get the IMapGeographicTransformations from the Map.
Dim pMapGeotrans As esriCore.IMapGeographicTransformations
Set pMapGeotrans = pMap

'5) Now get set of geotransformations from IMapGeographicTransformations
Dim pGeoTransSet As IGeoTransformationOperationSet
Set pGeoTransSet = pMapGeotrans.GeographicTransformations

'6) RemoveAll the default geotransformations as they are unneccessary
pGeoTransSet.RemoveAll

'7) And add your geotrans to it - NOTE THE DIRECTION
pGeoTransSet.Set esriTransformReverse, pGeotrans

'8) Finally, refresh current extent of the map. it's already projected.
Dim pEnv As IEnvelope
Set pEnv = pActiveView.Extent
pActiveView.PartialRefresh esriViewGeography, Nothing, pEnv
```

ArcObjects allows you to integrate your own custom projection server. To do so, write a COM component that implements two spatial reference interfaces, *IProjection* and *ISpatialReferenceInfo*.

The definitions of the methods you need to implement are defined in the esriCore object type library (esriCore.olb). This file can be found in the bin directory of your ArcGIS installation.

One of the easiest ways to build a COM component object that implements these interfaces is to use the ATL and VC++. ATL is the Active Template Library, a set of template-based VC++ classes with which you can easily create small, fast (COM) objects. For a detailed description of what this involves, please see Volume 1, Chapter 2, 'Developing with ArcObjects'.

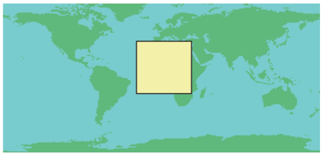
Likewise, refer to the Custom Projection Sample topic under Spatial Reference in the Developer Samples section of the ArcObjects Developer Help System. This sample covers the implementation in greater detail than is appropriate here. However, as an outline, to create a custom projection you need to:

1. Use the Projection Engine (PE) API to define a custom PE_PROJECTION object and its forward and inverse methods. These methods are the actual mathematical transformations that define how your projection behaves.
2. Use the standard COM techniques described in Chapter 2 to create a COM projection object that implements the two interfaces above and knows about your custom PE_PROJECTION object.
3. Within your client application, use the *Define* method on *IProjectedCoordinateSystemEdit* to create a user-defined *ProjectedCoordinateSystem* that uses your custom COM projection and its parameters.
4. Assign your user-defined projected coordinate system to your map; you should see your projection at work.

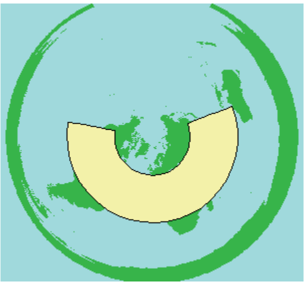
Within the geometry object model, a number of interfaces have a *SpatialReference* as a property or use one within a method. For example, calling the *Project* method on an individual geometry will change the coordinates of the geometry from one coordinate system to another.

In most cases, developers will not need to manage the *SpatialReferences* of individual geometries, and in some cases it would not make sense to do so. For example, if a geometry is projected using a *SpatialReference* different to that of the *Map*, the geometry will be projected, but it will not be drawn in the same display space that the *Map* is currently using.

However, it makes sense to draw the same geometry onto a different *Map* that uses a different *SpatialReference*.



Rectangle in WGS 1984 geographicals



Rectangle densified and then projected to the Equidistant Conic projection

From the screen image you can see what happens to a rectangle drawn in an unprojected geographic coordinate system when it is densified (adding a vertex every 10 degrees) and then projected to Equidistant Conic projection. If the Densify *method is not used, the result would be a simple trapezoid drawn in the projected display.*

As an illustration, consider a VB project that uses two *MapControls*. Each *MapControl* has been loaded with the same *FeatureClass* using the *PropertyPage*, and each has been assigned a different *SpatialReference* in the *Form_Load* method.

The following code shows what is required to track a polygon on the first *MapControl* and draw it onto the second *MapControl*.

```
Option Explicit

Private g_pPolygon As IPolygon

Private Sub Form_Load()
  Dim pSpatialRefFact As ISpatialReferenceFactory2
  Set pSpatialRefFact = New SpatialReferenceEnvironment
  Dim pGeographic As IGeographicCoordinateSystem
  Dim pProjected As IProjectedCoordinateSystem
  Set pGeographic = _
pSpatialRefFact.CreateGeographicCoordinateSystem(esriSRGeoCS_WGS1984)
  Set pProjected = _
pSpatialRefFact.CreateProjectedCoordinateSystem(esriSRProjCS_World_EquidistantConic)
  Set MapControl1.SpatialReference = pGeographic
  Set MapControl2.SpatialReference = pProjected
End Sub

Private Sub MapControl1_OnAfterDraw(ByVal display As esriCore.IDisplay, _
 ByVal phase As esriCore.esriViewDrawPhase)

  If (Not g_pPolygon Is Nothing) Then
    g_pPolygon.Project MapControl1.SpatialReference
    MapControl1.DrawShape g_pPolygon
  End If

  If (Not g_pPolygon Is Nothing) Then
    g_pPolygon.Project MapControl2.SpatialReference
    MapControl2.DrawShape g_pPolygon
  End If
End Sub
```

```
Private Sub MapControl1_OnMouseDown(ByVal button As Long, _
 ByVal shift As Long, ByVal x As Long, ByVal y As Long, _
 ByVal mapX As Double, ByVal mapY As Double)

  Set g_pPolygon = MapControl1.TrackPolygon
  Set g_pPolygon.SpatialReference = MapControl1.SpatialReference
  MapControl1.Refresh esriViewForeground
  MapControl2.Refresh esriViewForeground
End Sub
```

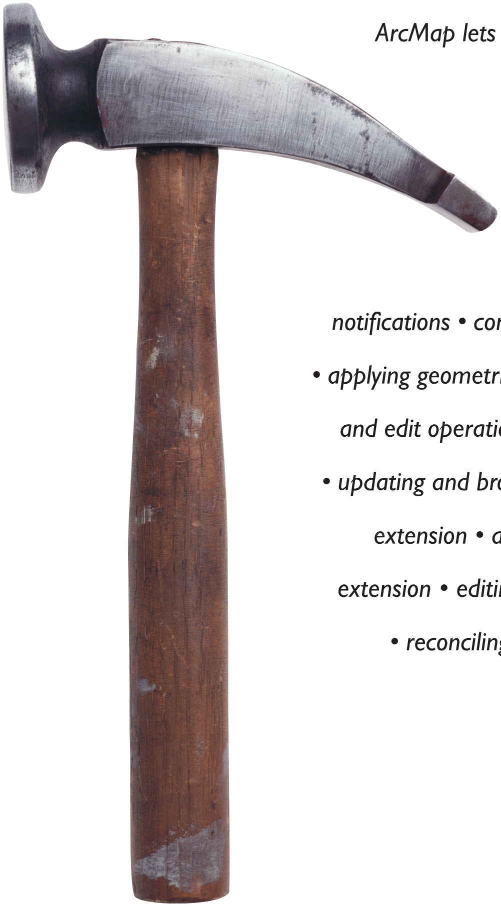
These are some summary points to help ensure your success with the spatial reference object model:

- Check that your feature classes have correct coordinate system metadata. If necessary, use ArcCatalog to prepare your data.
- Whenever you are repeatedly doing the same on-the-fly projections, consider permanently projecting your feature class into the target coordinate system.
- Obtain a working understanding of projection concepts—you do not necessarily need to concern yourself with the mathematics.
- Use geographic transformations as necessary when collating feature classes from different coordinate systems to ensure as much accuracy is obtained as possible; enough is already lost due to generalization, data capture methods, and other causes.
- If you change a *ProjectedCoordinateSystem* parameter by reference (and not by using one of the available methods), remember to call the *Changed* method afterwards.
- Once your application has finished, if you have used the *IGridTransformation::Load method*, you should call the *Unload* method.
- When a *Map*'s *SpatialReference* is changed, all elements contained within its *GraphicLayers* or *GraphicContainer* will automatically be projected, too.

11

Editing features

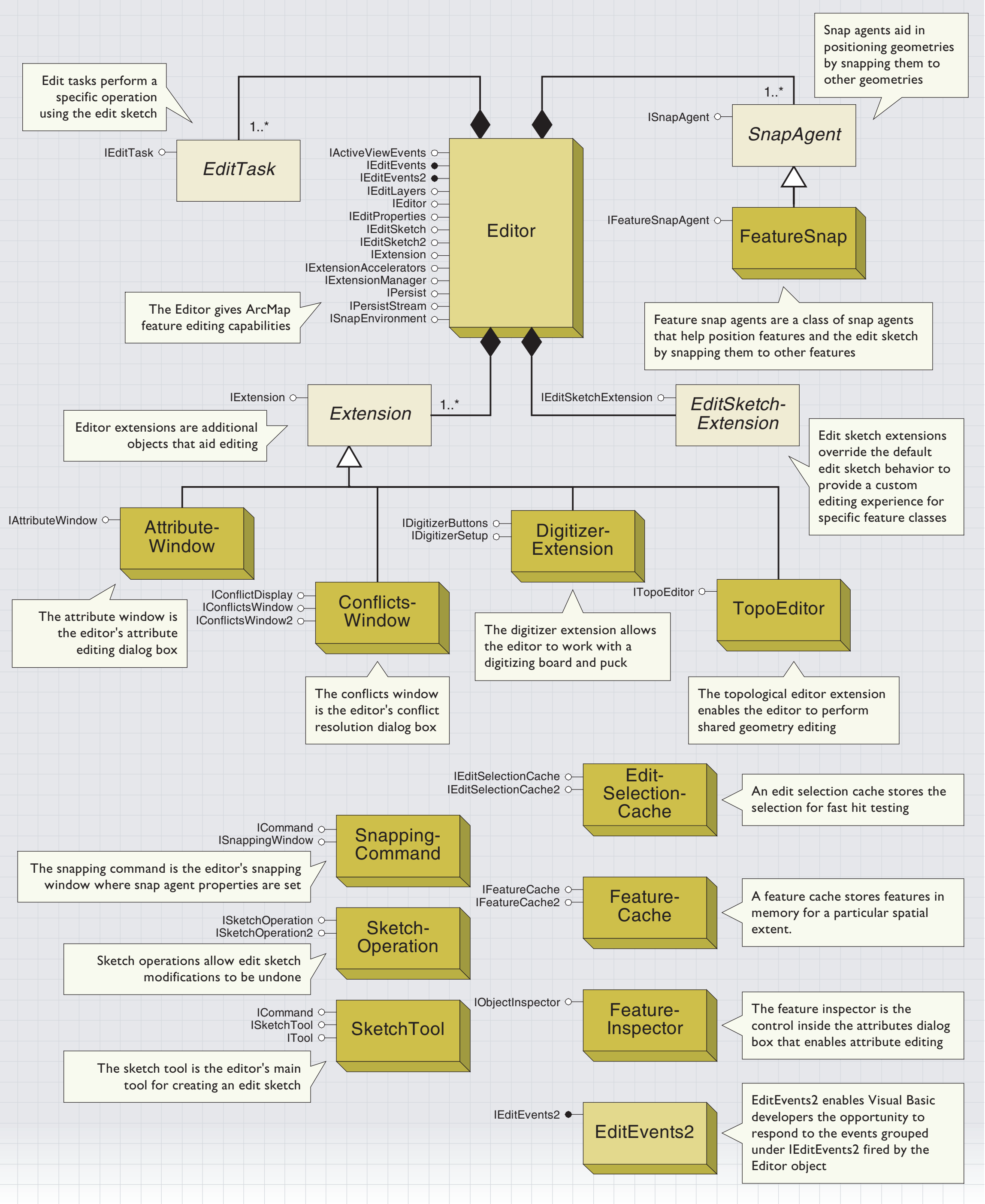
Steve Van Esch



ArcMap lets the user create, modify, and remove vector-shaped features in a geodatabase, coverage, or shapefile.

The topics covered in this chapter include: implementing edit operations through commands, tools, tasks, and edit event notifications • controlling the scope of updates within an edit session • applying geometric updates through edit sketches, sketch operations, and edit operations • joining features precisely through snap agents • updating and browsing feature attributes with the Attribute Window extension • adding features from manuscripts with the Digitizer extension • editing shared edges with the Topology Editor extension • reconciling versions through the Conflict Resolution extension

ArcMap editing objects



Edit tasks perform a specific operation using the edit sketch

Snap agents aid in positioning geometries by snapping them to other geometries

The Editor gives ArcMap feature editing capabilities

Feature snap agents are a class of snap agents that help position features and the edit sketch by snapping them to other features

Editor extensions are additional objects that aid editing

Edit sketch extensions override the default edit sketch behavior to provide a custom editing experience for specific feature classes

The attribute window is the editor's attribute editing dialog box

The digitizer extension allows the editor to work with a digitizing board and puck

The conflicts window is the editor's conflict resolution dialog box

The topological editor extension enables the editor to perform shared geometry editing

An edit selection cache stores the selection for fast hit testing

The snapping command is the editor's snapping window where snap agent properties are set

A feature cache stores features in memory for a particular spatial extent.

Sketch operations allow edit sketch modifications to be undone

The feature inspector is the control inside the attributes dialog box that enables attribute editing

The sketch tool is the editor's main tool for creating an edit sketch

EditEvents2 enables Visual Basic developers the opportunity to respond to the events grouped under IEditEvents2 fired by the Editor object

The ArcMap editing toolbar is an extension to the ArcMap application that provides a unified editing and mapping environment for features stored in all types of vector geographic datasets: geodatabases, coverages, and shapefiles.

The ArcMap editing toolbar consists of tools for editing and maintaining GIS databases. These are some important functions of these tools:

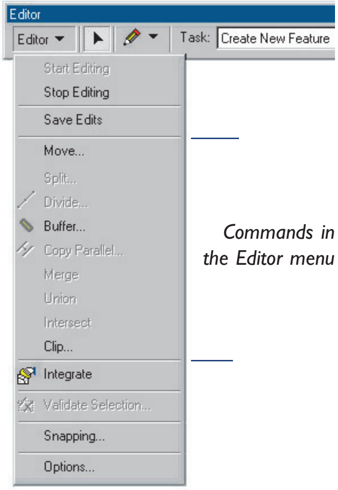
- CAD-like tools for feature construction and editing
- Rule-based feature validation
- Multilayer feature snapping
- Undo/Redo capabilities
- Multiuser editing and versioning

The ArcMap editing toolbar is built on an underlying framework or object model composed of COM components that you can program to customize the user's editing environment. Developers can use these objects to create new custom tools, constrain or remove existing tools, or enforce application-specific behavior using custom tasks or edit event notifications implemented using custom extensions.

The primary object in the editor framework is the *Editor* object. The *Editor* object exposes many interfaces, including: *IEditor, IEditLayers, IEditEvents, IEditProperties, IEditSketch,* and *ISnapEnvironment*. Each interface manages a logical grouping of editing functionality. Before discussing the editing components in more detail, this chapter first reviews the model for extending the editing environment.

IMPLEMENTING EDIT OPERATIONS

Edit operations typically occur through one of four methods: commands, tools, tasks, and edit event notifications.



Commands in the Editor menu

- Commands perform edits—the user doesn't need to click on the map. For example, the Buffer command creates new features by buffering the selected features.
- Tools require user interaction. For example, the Split tool requires the user to locate the point where the split will occur.
- Edit tasks require an input geometry to perform their edits. For example, the Reshape task uses a sketch geometry to modify a selected feature's shape.
- Edit events are notifications that occur during an edit session, and edit event listeners are any objects that respond to the events. For example, the target layer control on the Editor toolbar responds to the *IEditEvents::OnCurrentLayerChanged* event so that it can update itself when the target layer is set programmatically.

Editor commands

ArcMap uses commands for all operations that do not require the user to click on the map. Examples of editor commands include the Buffer, Intersect, and Union commands. Commands may prompt the user for input using a dialog box, but none of them require the user to interact with the display. Most editor commands reside on the Editor menu.

All commands implement the *ICommand* interface. For more details on creating custom commands, read Volume 1, Chapter 3, 'Customizing the user interface'.

An example of a custom editor command that a developer can create is a Difference command. Such a command creates new features based on the overlapping regions of two selected features. The code samples provided in your ArcGIS software installation contain examples of how to create custom editor commands.

Editor tools

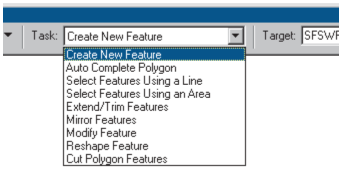
Tools in the Editor toolbar

All operations that require the user to interact with the display are called tools. The Sketch tool, the Rotate tool, and the Split tool are all examples of editing tools. Tools require that the user click on the map to complete the desired operation. Tools generally reside directly on the Editor toolbar.

All tools implement the *ITool* and *ICommand* interfaces. For more details on creating custom tools, read Volume 1, Chapter 3, 'Customizing the user interface'.

An example of a custom tool that can be created and added to the Editor toolbar is a Fillet tool. A Fillet tool asks the user to select two segments and then create a fillet line between them based on a radius value. The code samples on your ArcGIS installation contain many examples of how to create a custom edit tool.

Edit tasks



Task dropdown list in the Editor toolbar

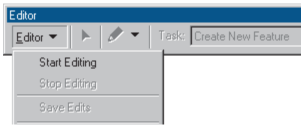
For edit operations that require an input geometry, ArcMap uses edit tasks. Edit tasks are components that acquire the geometry stored in an edit sketch and perform a specific operation with it. For example, the Reshape task uses the sketch geometry to alter the shape of a selected feature. Edit tasks are managed by the *Editor* object, and one is always active. The current task is set using the *IEditor::CurrentTask* property.

All edit tasks implement the *IEditTask* interface and are registered in the ESRI Edit Tasks component category. An example of a custom edit task might be a Measure task that reports the length of a line created in the edit sketch. The benefit of such a task is that the user can digitize an accurate line using sketch tools and snapping, instead of just clicking on the map. All edit tasks appear in the Current Task dropdown list on the Editor toolbar.

Edit events

Edit events are specific notifications that occur during editing. Edit event listeners are objects, such as commands, that listen for and respond to edit events. For example, a specific edit event is fired each time a new feature is created, and a custom object can perform automatic feature validation after receiving this notification.

EDIT SESSION



Starting an edit session in the Editor menu

All editing takes place during an edit session. Only layers belonging to one workspace can be edited at a time; all the layers that have been added to a map and belong to the same workspace can be edited simultaneously.

To specify a workspace to edit, use *IEditor::StartEditing*. You can get a reference to the current edit workspace with *IEditor::EditWorkspace*.

The following sample determines the workspace that the first feature layer in the map belongs to and starts an edit session on it. This sample and all the following samples in this chapter must have a reference to the Editor extension passed in. The first subroutine below shows how to obtain this reference.

```
Public Sub GetEditorReference()
  Dim pEditor As IEditor
  Dim pID As esriCore.UID
  Set pID = New esriCore.UID
  pID = "esriCore.Editor"
  Set pEditor = Application.FindExtensionByCLSID(pID)
  'Call the StartEditing routine
  StartEditing pEditor
End Sub
```

The following sample code determines the edit workspace the first feature layer belongs to and starts an edit session on it.

```
Public Sub StartEditing(pEditor As IEditor)
  Dim pMxDoc As IMxDocument
  Dim pMap As IMap
  Dim pFeatureLayer As IFeatureLayer
  Dim pDataset As IDataset
  Dim iLayerCount As Integer

  Set pMxDoc = Application.Document
  Set pMap = pMxDoc.FocusMap

  'If an edit session has already been started exit
  If Not pEditor.EditState = esriStateNotEditing Then Exit Sub

  'Start editing the workspace of the first featurelayer you find
  For iLayerCount = 0 To pMap.LayerCount - 1
    If TypeOf pMap.Layer(iLayerCount) Is IFeatureLayer Then
      Set pFeatureLayer = pMap.Layer(iLayerCount)
      Set pDataset = pFeatureLayer.FeatureClass
      pEditor.StartEditing pDataset.Workspace
       Exit For
     End If
  Next iLayerCount
End Sub
```

The Start Editing command on the Editor menu performs similarly.

Edit sketch

The editor facilitates geometric construction and modification by managing a temporary staging area, called the edit sketch, *for coordinates.*

The edit sketch contains a geometry that is used as input for completion of the current edit task. The type of sketch geometry may be a multipoint, a polyline, or a polygon. The current edit task sets the type of sketch geometry. The edit sketch is owned by the *Editor* object and accessed via the *IEditSketch* interface. Access to the edit sketch geometry is through the *IEditSketch::Geometry* property.

When the edit sketch is finished, the current editing task takes the geometry stored in the edit sketch and performs a specific operation with it. For example, completing the sketch of a building outline when the current task is set to Create New Feature and the target layer is set to the Buildings feature class creates a new Building feature.

Tools that add points to the sketch are called sketch tools. Any sketch tool or combination of sketch tools can be used to create a sketch geometry. For example, the Intersection tool and the Distance-Distance tool can be used interchangeably to add points to an edit sketch. A custom sketch tool is another example of a custom editing tool that can be created and added to the Editor toolbar.

The edit sketch has a context menu that aids in manipulating the edit sketch geometry. Commands that appear on this menu include Move, Move To, Insert, and Delete. Right-clicking any part of the edit sketch invokes the edit sketch context menu, no matter what the active tool is. Custom commands can be added to the edit sketch context menu through the Customize dialog box.

To automatically add new commands to the edit sketch context menu, register commands in the 'ESRI Sketch Menu Commands' component category. Customize the sketch tool context menu in the same fashion, except in this case register commands in the 'ESRI SketchTool Menu Commands' component category. Commands registered in these categories will appear at the top of their related menus. An interesting alternative when adding several commands to either category is to add a single pullright menu that in turn lists the custom commands. For more information, see *IMenuDef*. A pullright menu makes ordering and managing the custom commands easier.

The following sample adds a new point to the end of an edit sketch and then completes the sketch. In this example, the new point is calculated at a delta x,y of 50 map units from the last point in the edit sketch. Once *IEditSketch::FinishSketch* is called, the geometry the edit sketch manages is sent to the current task.

```
Public Sub AddPoint(pEditor As IEditor)
  Dim pEditSketch As IEditSketch
  Dim pPoint As IPoint

  Set pEditSketch = pEditor 'QI
  Set pPoint = pEditSketch.LastPoint
  If pPoint Is Nothing Then Exit Sub
  pPoint.PutCoords pPoint.x + 50, pPoint.y + 50
  pEditSketch.AddPoint pPoint, True
  pEditSketch.FinishSketch
End Sub
```

Edit sketch extensions

Edit sketch extensions provide developers with a mechanism for managing the behavior of edit tasks to ensure application-specific feature construction and modification.

Edit sketch extensions let programmers alter the edit sketch geometry and edit sketch display feedback mechanism. For example, a custom edit sketch extension may be written for a layer that contains two-point polylines. Such an extension can ensure that new features are restricted to two points when created and modified.

When constructing a new feature of this type, the edit sketch extension automatically finishes the sketch when a second point is added. When modifying the feature, inserting new vertices into the edit sketch is prevented unless the user has deleted a vertex and the point count is less than two.

The creation or modification of a dimension feature in a geodatabase uses edit sketch extensions; dimension features store complex geometry, and the edit sketch extension is used to help the user create and modify complex dimension shapes in an intuitive manner.

Edit sketch extensions are created by implementing *IExtension* and *IEditSketchExtension*, then registering the class in the ESRI Editor Extensions component category.

Sketch operations

All editing tools and commands that create or modify the geometry of an edit sketch use sketch operations to provide undo/redo capabilities.

Sketch operations are a type of operation that can be put on the document's operation stack, *IMxDocument::OperationStack*. Any change to the edit sketch should happen within the context of a sketch operation.

For example, the Edit tool is able to move edit sketch vertices using sketch operations so that each action is undoable. Code that modifies the edit sketch should be placed between calls to *ISketchOperation::Start* and *ISketchOperation::Finish*.

IEditSketch::AddPoint adds a new vertex to the end of the edit sketch, and it automatically creates a sketch operation. This case is an exception; there is no need to create an edit operation when using *AddPoint*.

The sample below deletes a vertex from the edit sketch. The sample relies on the *IEditSketch::Vertex* property to identify which vertex to delete. This property is set whenever you right-click a vertex in the edit sketch. This is also the case for *IEditSketch::Part* and *IEditSketch::Segment*. If nothing has been right-clicked, a value of -1 is returned. Right-clicking any part of the edit sketch opens the edit sketch context menu.

The best place for commands and macros that work with the edit sketch is on the edit sketch context menu, so they can be easily executed after right-clicking the edit sketch.

```
Public Sub DeleteEditSketchVertex(pEditor As IEditor)
```

```
 Dim pEditSketch As IEditSketch
  Dim pPointColl As IPointCollection
  Dim lIndex As Long
  Dim pSketchOp As ISketchOperation

  Set pEditSketch = pEditor 'QI
  lIndex = pEditSketch.Vertex 'Get the vertex that was last right-
clicked

  If lIndex = -1 Then Exit Sub 'Exit if I don't have a vertex

  'Create a sketch operation to get undo/redo capabilities
  Set pSketchOp = New SketchOperation
  pSketchOp.MenuString = "Delete Vertex"  'Give the operation a name
  pSketchOp.start pEditor 'Start the operation

  'Delete the point from the edit sketch and refresh
  Set pPointColl = pEditSketch.Geometry
  pPointColl.RemovePoints lIndex, 1
  pEditSketch.RefreshSketch

  'Finish the operation to add it to the operation stack
  pSketchOp.Finish pEditSketch.Geometry.Envelope
End Sub
```

Edit operations

All editing commands, tools, and tasks use edit operations to provide undo/redo capabilities.

Edit operations are very similar to sketch operations except that these are typically operations on features instead of the edit sketch. For example, if a feature is moved with the Edit tool, the operation can be undone and redone.

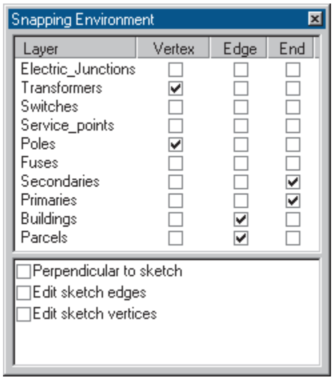
Edit operations are created using the *IEditor* interface by placing the code between calls to *IEditor::StartOperation* and *IEditor::StopOperation*.

The following sample deletes all of the selected features that are editable and does so within the confines of an edit operation so the delete can be undone.

```
Public Sub DeleteFeatures(pEditor As IEditor)
 On Error GoTo ErrorHandler:

  Dim pEnumFeature As IEnumFeature
  Dim pFeature As IFeature
  Dim pActiveView As IActiveView

  'Check the editor's selection
  If pEditor.SelectionCount = 0 Then Exit Sub

  'Start an edit operation
  pEditor.StartOperation

 'Delete each selected feature
```

```
  Set pEnumFeature = pEditor.EditSelection
  pEnumFeature.Reset
  Set pFeature = pEnumFeature.Next
  Do While Not pFeature Is Nothing
    pFeature.Delete
    Set pFeature = pEnumFeature.Next
  Loop

  'Complete the edit operation
  pEditor.StopOperation "Delete Features"

  'Refresh the display
  pEditor.Map.ClearSelection
  Set pActiveView = pEditor.Map
  pActiveView.PartialRefresh esriViewGeography + _
    esriViewGeoSelection, Nothing, Nothing

  Exit Sub 'Exit sub to avoid error handler

ErrorHandler:
    'Abort the edit operation if any error occurs
    pEditor.AbortOperation
End Sub
```

Snap agents



Snapping Environment

Layer	Vertex	Edge	End
Electric_Junctions	□	□	□
Transformers	☑	□	□
Switches	□	□	□
Service_points	□	□	□
Poles	☑	□	□
Fuses	□	□	□
Secondaries	□	□	☑
Primaries	□	□	☑
Buildings	□	☑	□
Parcels	□	☑	□

□ Perpendicular to sketch
□ Edit sketch edges
□ Edit sketch vertices

Snap agents help position features and edit sketch vertices.

ArcMap also maintains a snapping environment that contains several snapping agents useful for placing points. For example, *FeatureSnapAgent* can be configured to snap input points to the vertices of existing features.

All snap agents implement the *ISnapAgent* interface and are registered in the Editor Snap Agents component category. A specific class of snap agent is the feature snap agent.

The sketch tools and other editing tools use feature snap agents to find features to which to snap. A feature snap agent is automatically instantiated for each editable feature class the first time the snapping window is opened. The other snap agents, such as Snap Perpendicular, are also instantiated when the snapping window is first opened.

The snapping properties, such as snap tolerance, snap tolerance units (map or pixel), and hit-type, are managed by the *ISnapEnvironment* interface on the *Editor* object.

Snapping is performed by calling the *ISnapEnvironment::SnapPoint* method and passing it an *IPoint*. For example, the sketch tools get the current mouse location (*IEditor::Location*) and pass it to *SnapPoint*. *SnapPoint* in turn calls each snap agent's *ISnapAgent::Snap* method until one of them returns *True*, which indicates that the snap agent has found a new point that meets its unique snapping criteria. The coordinates of the point are modified to reflect that of the new point location.

Feature snap agents use feature caches to create a small selected set of features in memory. The feature snap agents track the current mouse location and continually reinitialize a feature cache and fill it with the features that reside near this point. The snap agents then cycle through all of the features in the cache and check to see if any of them are within the ArcMap snap tolerance.

Editor extensions

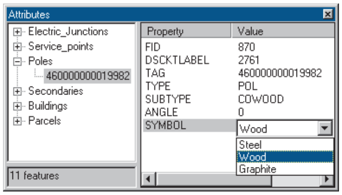
Just as the editor is an extension to the ArcMap application, it also manages its own extensions.

ArcMap has several extensions including the Attributes Window extension, the Digitizer extension, the Topology Editor extension, and the Conflict Resolution extension. All editor extensions must implement the *IExtension* interface and be registered in the ESRI Edit Extensions component category. When an edit session begins, each editor extension is activated; when editing is complete, each editor extension is deactivated.

Custom editor extensions can be created and added to the editor. For example, a developer may choose to create a custom extension that controls feature validation throughout an edit session. Such an extension might listen for the edit events *OnCreateFeature* and *OnChangeFeature* and perform validation whenever these events are fired.

Feature inspectors

Feature inspectors let you analyze features in greater detail.



Property	Value
FID	870
DSCKTLABEL	2761
TAG	460000000019982
TYPE	POL
SUBTYPE	COWOOD
ANGLE	0
SYMBOL	Wood

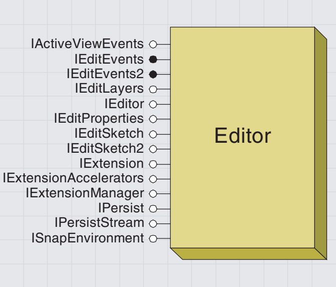
The ArcMap feature inspector enables attribute editing.

The ArcMap Attribute dialog box contains two panels. The left panel lists the features from the map that have been selected and are editable. The features are listed under the feature class they belong to. Any related features are also listed in this panel underneath the selected feature they are related to. The right panel houses a feature inspector.

ArcMap ships with a standard feature inspector, which enables attribute editing. For any feature class in a geodatabase, you can replace the default feature inspector with a custom feature inspector. For example, you may want to create a custom feature inspector that displays a bitmap whenever a feature belonging to a specific feature class is selected.

Create custom inspectors by implementing the *IObjectInspector* interface and registering the class as a feature class's feature class extension. Again, custom feature inspectors can only be assigned to feature classes in a geodatabase.

Only one feature inspector can be active for each feature class. When you create a custom feature inspector, you specify the specific feature classes that will use it. Selecting a feature in the left panel of the Attributes dialog box activates the associated feature inspector in the right panel.



The Editor *object represents the* Editor *extension to ArcMap; it is the main editing component and the focal point for all other objects in the* Editor *object model. Because the* Editor *object is implemented as an extension, this object is instantiated when ArcMap is launched.*

The *Editor* object manages the edit sketch, the current task, the current target layer, the edit workspace, the edit selection, the edit session properties, and the snap environment.

You can get a reference to one of the *Editor* object's interfaces by using *IApplication::FindExtensionByCLSID* or *IApplication::FindExtensionByName*.

This VBA code shows how to get the reference by class ID.

```
Dim pEditor As IEditor
Dim pID As New esriCore.UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
```

This VBA code shows how to get the reference by name.

```
Dim pEditor as IEditor
Set pEditor = Application.FindExtensionByName ("ESRI Object Editor")
```

IEditor : IUnknown	***Controls the behavior of the editor.***
CurrentTask: IEditTask	*Controls the current edit task.*
Display: IScreenDisplay	*Reference to the current display.*
EditSelection: IEnumFeature	*Gets the selected features which are editable.*
EditState: esriEditState	*Returns the editor's current edit state.*
EditWorkspace: IWorkspace	*Reference to the workspace being edited.*
Location: IPoint	*The last known location of the mouse.*
Map: IMap	*Reference to the map being edited.*
Parent: IApplication	*Reference to the parent application.*
ScratchWorkspace: IWorkspace	*Reference to the editor's scratch workspace.*
SelectionAnchor: IAnchorPoint	*The selection anchor point.*
SelectionCount: Long	*Gets the number of selected features which are editable.*
Task (in Index: Long) : IEditTask	*Returns an edit task by index.*
TaskCount: Long	*The number of edit tasks.*
AbortOperation	*Aborts an edit operation.*
CreateSearchShape (in Point: IPoint) : IGeometry	*Creates a geometry using the point and the current search tolerance.*
DelayEvents (in delay: Boolean)	*Used to batch operations together and minimize notifications.*
EnableUndoRedo (in Enabled: Boolean)	*Enable/disable the undo/redo capabilities.*
FindExtension (in extensionID: IUID) : IExtension	*Finds the extension given an id.*
HasEdits: Boolean	*Returns true if edits have been made.*
InvertAgent (in loc: IPoint, in hDC: Long)	*Draws the editor's snapping agent.*
RedoOperation	*Redo an edit operation.*
SearchSelection (in Point: IPoint) : IEnumFeature	*Searches the edit selection using the given location.*
StartEditing (Workspace: IWorkspace)	*Starts an edit session.*
StartOperation	*Starts an edit operation.*
StopEditing (in saveChanges: Boolean)	*Stops an edit session.*
StopOperation (in menuText: String)	*Stops an edit operation.*
UndoOperation	*Undo an edit operation.*

The *IEditor* interface is the main interface used to control all editing actions. Use the members in this interface to start and stop an edit session, create and manage edit operations, and set the editor's current task.

This sample routine uses the *IEditor* interface to change the current task based on input passed to the routine.

```
Public Sub ChangeTask(pEditor As IEditor, sTaskName As String)
  Dim pEditTask As IEditTask
   Dim lTaskCount As Long

   'Loop through all the available edit tasks
  For lTaskCount = 0 To pEditor.TaskCount - 1
```

```
   Set pEditTask = pEditor.Task(lTaskCount)
     If pEditTask.Name = sTaskName Then
       Set pEditor.CurrentTask = pEditTask
       Exit For
     End If
  Next lTaskCount
End Sub
```

IEditEvents : IUnknown	*IEditEvents is an outbound interface on the editor. Implement it to listen for specific events that occur during an edit session.*
AfterDrawSketch (in pDpy: IDisplay)	Called after the edit sketch is drawn.
OnChangeFeature (obj: IObject)	Called when features are modified.
OnConflictsDetected	Called when editing conflicts are detected during save.
OnCreateFeature (obj: IObject)	Called when new features are created.
OnCurrentLayerChanged	Called when the current layer changes.
OnCurrentTaskChanged	Called when the current task changes.
OnDeleteFeature (obj: IObject)	Called when features are deleted.
OnRedo	Called when RedoOperation is called.
OnSelectionChanged	Called when the selection changes.
OnSketchFinished	Called when the edit sketch is finished.
OnSketchModified	Called when the edit sketch is modified.
OnStartEditing	Called when editing begins.
OnStopEditing (in Save: Boolean)	Called when editing ends.
OnUndo	Called when UndoOperation is called.

IEditEvents is an outbound interface on the *Editor*. Use this interface to trap specific events that occur inside an edit session. For example, you may wish to execute custom validation code whenever a user completes an edit sketch.

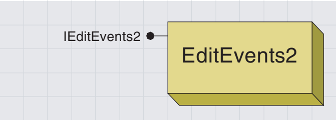
To respond to events using Visual Basic, declare a modular-level object variable of type *Editor* using the *WithEvents* keyword in a class module.

```
  Private WithEvents EditorEvents as Editor
```

Although the object variable has been declared, it points to nothing. Initialize the object variable using the *Set* statement to link it to the existing *Editor* object. If implementing *ICommand*, do so in *ICommand_OnCreate* or *Class_Initialize*. Editor extensions typically initialize event object variables in *IExtension_Startup*.

Always set the event object variable to *Nothing* when the class is destructed to avoid circular reference problems.

IEditEvents2 : IUnknown	*Provides access to more editor events. Implement it to listen for specific events that occur during an edit session.*
BeforeStopEditing (in Save: Boolean)	Fired before StopEditing happens.
BeforeStopOperation	Called before StopOperation is called.
OnAbort	Called when AbortOperation is called.
OnCurrentZChanged	Called when the CurrentZ changes.
OnSaveEdits	Called when edits are saved.
OnStartOperation	Called when StartOperation is called.
OnStopOperation	Called when StopOperation is called.
OnVertexAdded (in Point: IPoint)	Called after a point/vertex is added to the sketch.
OnVertexDeleted (in Point: IPoint)	Called after a point is added to the sketch.
OnVertexMoved (in Point: IPoint)	Called after a vertex/point has been moved in the sketch.



The EditEvents2 coclass allows the Visual Basic programmer to respond to additional editor events.

With ArcGIS 8.1, additional editor events have been added and grouped under the *IEditEvents2* interface. Because Visual Basic only supports one outbound interface per object, the *EditEvents2* coclass has been created to allow Visual Basic developers the opportunity to respond to these events. To respond to events under *IEditEvents2*, declare a modular-level object variable of type *EditEvents2,* as shown below.

```
  Private WithEvents EditorEvents2 as EditEvents2
```

As with *IEditEvents*, set the event object variable to reference the *Editor* object.

```
  Set EditorEvents2 = m_pEditor
```

Again, as with *IEditEvents*, always set the event object variable to *Nothing* when the class is destroyed to avoid circular reference problems.

```
Private WithEvents EditorEvents As Editor
Private WithEvents EditorEvents2 As EditEvents2

Private m_pEditor As IEditor
Private m_pEditLayers As IEditLayers

Public Sub InitEvents()
   Dim pUID As New UID

   pUID = "esriCore.Editor"
   Set m_pEditor = Application.FindExtensionByCLSID(pUID)
   If m_pEditor Is Nothing Then Exit Sub
   Set m_pEditLayers = m_pEditor
   Set EditorEvents = m_pEditor
   Set EditorEvents2 = m_pEditor
End Sub

Private Sub EditorEvents_OnCurrentLayerChanged()
  MsgBox m_pEditLayers.CurrentLayer.Name
End Sub

Private Sub EditorEvents_OnSelectionChanged()
  MsgBox m_pEditor.SelectionCount
End Sub

Private Sub EditorEvents_OnStopEditing(ByVal bSave As Boolean)
  Set EditorEvents = Nothing
End Sub

Private Sub EditorEvents2_OnVertexMoved(ByVal Point As IPoint)
  MsgBox Point.X &amp; " " &amp; Point.Y
End Sub
```

IEditLayers : IUnknown	Access information about layers in the edit session.
▪— CurrentLayer: IFeatureLayer	*Indicates the editor's target layer which new features are added to.*
▪— CurrentSubtype: Long	*The sub type for new features in the CurrentLayer.*
◀— IsEditable (in Layer: IFeatureLayer) : Boolean	*Determines if a specific feature layer is editable.*
◀— SetCurrentLayer (in Layer: IFeatureLayer, in SubType: Long)	*The editor's target layer and subtype for new features.*

The *IEditLayers* interface is used to access information about layers involved in an edit session. For example, use *IEditLayers* to determine if a particular layer involved in an edit session is editable or not; in addition, use *IEditLayers* to check or set the editor's current layer and current subtype.

The current layer (or target layer) determines which layer will receive newly created features. For instance, if you set the current layer to Buildings, all new features created will be added to this layer. Edit tasks and commands that create new features use this property to determine to which layer to write out the new features.

The following subroutine sets the current layer based on a name and subtype index.

```
Public Sub SetCurrentLayer(pEditor As IEditor, sLayerName As String,
lSubType As Long)
  Dim pEditLayers As IEditLayers
  Dim pFeatLayer As IFeatureLayer
  Dim pMap As IMap
  Dim lLayerCount As Long

  Set pEditLayers = pEditor 'QI
  Set pMap = pEditor.Map
  'Loop through all of the maps layers to find the desired one
  For lLayerCount = 0 To pMap.LayerCount - 1
    If pMap.Layer(lLayerCount).Name = sLayerName Then
      'Make sure the layer is editable
     If pEditLayers.IsEditable(pMap.Layer(lLayerCount)) Then
       Set pFeatLayer = pMap.Layer(lLayerCount)
       pEditLayers.SetCurrentLayer pFeatLayer, lSubType
        Exit For
     End If
   End If
  Next lLayerCount
End Sub
```

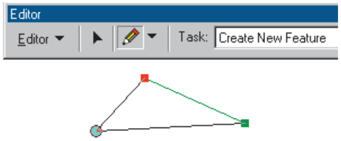
IEditProperties : IUnknown	Controls the properties of an edit session.
■—■ AutoSaveOnVersionRedefined: Boolean	Enabling autosave informs the stop editing process that it should automatically reconcile an edit session and save the version without notification.
■—■ ReportPrecision: Long	Controls the number of decimal places the editor reports numbers with.
■—□ SelectedVertexSymbol: IMarkerSymbol	Symbol used to draw the active vertex of the edit sketch.
■—□ SketchSymbol: ILineSymbol	Symbol used to draw the lines of the edit sketch.
■—□ SketchVertexSymbol: IMarkerSymbol	Symbol used to draw the vertices of the edit sketch.
■—□ SnapSymbol: IMarkerSymbol	Symbol used to draw the snap location.
■—■ StreamGroupingCount: Long	Controls the number of points to group together when streaming.
■—■ StreamTolerance: Double	Controls the streaming tolerance, measured in map units.
■—■ StretchGeometry: Boolean	If True, the edit sketch is stretched when one of its vertices is moved.

The *IEditProperties* interface manages all of the properties an edit session has. This sample changes the color of edit sketch segments from green to red.

```
Public Sub ChangeSketchSymbol(pEditor As IEditor)
  Dim pEditProperties As IEditProperties
  Dim pLineSymbol As ILineSymbol
  Dim pRGBColor As IRgbColor

  Set pEditProperties = pEditor 'QI
  Set pLineSymbol = New SimpleLineSymbol
  Set pRGBColor = New RgbColor
  pRGBColor.Red = 255
  pLineSymbol.Color = pRGBColor
  Set pEditProperties.SketchSymbol = pLineSymbol
End Sub
```

Here is a more complete sample that changes the Sketch tool's default snap symbol (blue dot) to the symbol of the current point layer. The macro listens for current layer changes and checks to see if the new target layer is a point layer; if so, it changes the editor snap symbol to that of the point layer. The point layer must be using a unique value renderer.

```
Option Explicit
Private m_pEditor As IEditor
Private m_pEditProps As IEditProperties
Private m_pEditLyrs As IEditLayers
Private m_pOrigSym As ISymbol
Private WithEvents EditorEvents As esriCore.Editor

Private Sub Driver()
  'Run Driver once to setup the environment
  Dim pApp As IApplication
  Dim pID As New UID
  pID = "esriCore.Editor"

  Set pApp = Application
  Set m_pEditor = pApp.FindExtensionByCLSID(pID)
  Set EditorEvents = m_pEditor
  Set m_pEditProps = m_pEditor
  Set m_pEditLyrs = m_pEditor

  'Keep the original symbol for polyline and polygon layers
  Set m_pOrigSym = m_pEditProps.SnapSymbol
End Sub

Private Sub EditorEvents_OnCurrentLayerChanged()
  Dim pSym As ISymbol
  Dim pClone As IClone
  Dim pMySym As ISymbol
  Dim pGeoFeatureLayer As IGeoFeatureLayer
  Dim pUniqueRender As IUniqueValueRenderer
  Dim sValue As String
  Dim pRenderer As IFeatureRenderer
  Dim pSubTypes As ISubtypes
  'Check that the current layer contains point features
  If m_pEditLyrs.CurrentLayer.FeatureClass.ShapeType = esriGeometryPoint Then
    Set pGeoFeatureLayer = m_pEditLyrs.CurrentLayer
    Set pRenderer = pGeoFeatureLayer.Renderer

    'Make sure a uniquevalue renderer is used to display the points
    If Not TypeOf pRenderer Is IUniqueValueRenderer Then Exit Sub

    'Check if data has subtypes
    Set pSubTypes = m_pEditLyrs.CurrentLayer.FeatureClass
    Set pUniqueRender = pGeoFeatureLayer.Renderer
    If pSubTypes.HasSubtype Then
      Value = m_pEditLyrs.CurrentSubtype
      Set pSym = pUniqueRender.Symbol(sValue)
    Else
      Set pSym = pUniqueRender.DefaultSymbol
    End If

    'Clone the symbol
    Set pClone = pSym
    Set pMySym = pClone.Clone

    'Set the ROP property so the symbol will clear itself on redraw
    pMySym.ROP2 = esriROPNotXOrPen
    Set m_pEditProps.SnapSymbol = pMySym
  Else
    'Layer must be polyline or polygon so use default symbol
    Set m_pEditProps.SnapSymbol = m_pOrigSym
  End If
End Sub

Private Sub EditorEvents_OnStopEditing(ByVal bSave As Boolean)
  Set EditorEvents = Nothing
End Sub
```



Task: Create New Feature

This illustration shows a polygon edit sketch being created with the main sketch tool.

IEditSketch : IUnknown	Access and manipulate the edit sketch.
■—□ Geometry: IGeometry	*Geometry stored in the edit sketch.*
■—■ GeometryType: tagesriGeometryType	*Type of the geometry stored in the edit sketch.*
■— LastPoint: IPoint	*Returns the last point in the edit sketch.*
■— Part: Long	*Returns the index of the current part of the sketch.*
■— Segment: Long	*Returns the index of the current segment of the sketch.*
■— Vertex: Long	*Returns the index of the current vertex of the sketch.*
◄— AddPoint (in Point: IPoint, in allowUndo: Boolean)	*Adds a point to the edit sketch. If allowUndo is true, a new operation will be created.*
◄— FinishSketch	*Completes the current edit sketch.*
◄— FinishSketchPart	*Completes a part for the current edit sketch.*
◄— ModifySketch	*Call to notify listeners that the sketch has been changed.*
◄— RefreshSketch	*Invalidates the portion of the display that is occupied by the sketch.*

The purpose of the *IEditSketch* interface is to manage the edit sketch geometry: a geometry used by the current task. For example, when the user completes the sketch, the Create New Feature task takes the sketch geometry and creates a new feature, using that shape, in the target layer.

ArcMap creates a new empty geometry when the *Editor* object is instantiated. Edit tasks set the geometry type of the edit sketch, and the sketch tools add points to that geometry. For example, the Create New Feature task sets the edit sketch geometry type to be the same as the geometry type of the target layer. In contrast, the Select Features Using a Line task always sets the edit sketch geometry type to *esriGeometryPolyline*, with no regard to the current layer geometry type.

Edit tasks often set the edit sketch geometry to *esriGeometryNull,* causing the sketch tools to become inactive. For example, the Reshape task will set the edit sketch geometry to *esriGeometryNull* if there are no polygon or polyline features selected. This prevents users from creating an edit sketch that would otherwise do nothing. Edit tasks respond to editor events such as *OnSelectionChanged* and *OnCurrentLayerChanged* to accomplish this.

Use the *AddPoint* method to build (add data to) the edit sketch geometry or directly manipulate the sketch geometry within the context of a sketch operation. Use *FinishSketch* to signal to the current task that the geometry is ready for use. To move an existing feature into the edit sketch, set the *Geometry* property to the desired feature and call *RefreshSketch*.

IEditSketch2 : IEditSketch	Access and manipulate the edit sketch.
■—■ CurrentZ: Double	*Current Z value for the edit sketch.*
■—□ EditSketchExtension: IEditSketchExtension	*The current edit sketch extension.*
■—■ MAware: Boolean	*If True, the edit sketch geometry will contain Ms.*
■—■ ZAware: Boolean	*If True, the edit sketch geometry will contain Zs.*
◄— VertexAdded (in Point: IPoint)	*Call to notify listeners that a sketch vertex has been added.*
◄— VertexDeleted (in Point: IPoint)	*Call to notify listeners that a sketch vertex has been deleted.*
◄— VertexMoved (in Point: IPoint)	*Call to notify listeners that a sketch vertex has been moved.*

The *IEditSketch2* interface extends the functionality of the edit sketch by adding support for making the sketch z-aware and for setting z-values on a vertex, as well as managing the current *EditSketchExtension*. *IEditSketch2* also exposes three functions that fire event notifications when vertices are added, modified, or deleted.

Whenever a vertex is deleted from an edit sketch, *VertexDeleted* should be called so that any clients listening for this event have the opportunity to respond.

IExtensionManager : IUnknown	*Provides access to members that query extension.*
■— Extension (in Index: Long) : IExtension	*The extension at the specified index.*
■— ExtensionCount: Long	*The number of extensions loaded in the application.*

To help manage the editor extensions, the *Editor* object implements *IExtensionManager* interface. For more information on this interface, see the *Application* object in Volume 1, Chapter 3, 'Customizing the user interface'.

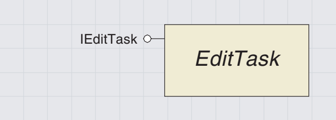
The following sample returns the number of editor extensions:

```
Public Function GetEditorExtensionCount(pEditor As IEditor) As Long
  Dim pExtensionManager As IExtensionManager
  Set pExtensionManager = pEditor 'QI
  GetEditorExtensionCount = pExtensionManager.ExtensionCount
End Function
```

ISnapEnvironment : IUnknown	*Manages the snap agents used by the editor.*
■— SnapAgent (in Index: Long) : ISnapAgent	*Returns a snap agent given an index.*
■— SnapAgentCount: Long	*Returns the number of active snap agents.*
■—■ SnapTolerance: Double	*Controls the snap tolerance, measured in pixels or map units.*
■—■ SnapToleranceUnits: esriSnapToleranceUnits	*Controls the units used for the snap tolerance.*
← AddSnapAgent (in SnapAgent: ISnapAgent)	*Adds a new snap agent to the snap environment.*
← ClearSnapAgents	*Removes all snap agents.*
← RemoveSnapAgent (in Index: Long)	*Removes the snap agent at the given index.*
← SnapPoint (in Point: IPoint) : Boolean	*Attempts to snap the point using the current snap environment.*

The *ISnapEnvironment* interface manages the collection of snap agents, the snap tolerance, and the snap tolerance units.

To add a new snap agent, call *AddSnapAgent;* to remove a snap agent, call *RemoveSnapAgent*. Use *SnapPoint* to snap a point—for more details, see the discussion on snap agents earlier in this chapter.



The Editor *manages a collection of* EditTask *objects that perform a specific, unique operation with the edit sketch.*

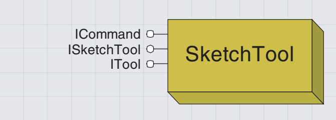
All edit tasks implement the *IEditTask* interface. Edit tasks must be registered in the ESRI Edit Tasks component category to appear in the Edit Task dropdown menu on the Editor toolbar.

IEditTask : IUnknown	***A task that receives notification when the sketch is complete.***
■— Name: String	*The name of the edit task.*
← Activate (in Editor: IEditor, in oldTask: IEditTask)	*Called by the editor when the task becomes active.*
← Deactivate	*Called by the editor when the task becomes inactive.*
← OnDeleteSketch	*Notifies the task that the edit sketch has been deleted.*
← OnFinishSketch	*Notifies the task that the edit sketch is complete.*

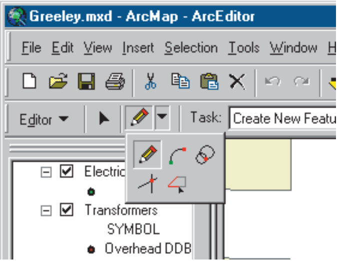
The *IEditTask* interface is primarily used when implementing a new edit task and when programmatically changing the current edit task.

Below is a complete edit task sample. This task sets the geometry of the edit sketch to *esriGeometryPolygon* and uses the polygon created to select those features the sketch intersects.

```
Option Explicit

Implements IEditTask

Private m_pEditor As IEditor
Private m_pEditSketch As IEditSketch
Private m_pArcMapDoc As IMxDocument
Private m_pApp As IMxApplication
Private m_pMXApp As IMxApplication

Private Sub IEditTask_Activate(ByVal Editor As IEditor, _
     ByVal oldTask As IEditTask)
  Set m_pEditor = Editor
  Set m_pEditSketch = Editor
  m_pEditSketch.GeometryType = esriGeometryPolygon
  Set m_pApp = Editor.Parent
  Set m_pMXApp = m_pApp  'QI
End Sub

Private Sub IEditTask_Deactivate()
End Sub

Private Property Get IEditTask_Name() As String
  IEditTask_Name = "Custom Select Task"
End Property

Private Sub IEditTask_OnDeleteSketch()
End Sub

Private Sub IEditTask_OnFinishSketch()
  Dim pMap As IMap
  Dim pActiveView As IActiveView
  Dim pSelectionEnv As ISelectionEnvironment
  Dim pSearchGeo As IGeometry
  Dim pTopoOp As ITopologicalOperator

  Set pMap = m_pEditor.Map
   Set pActiveView = pMap 'QI
   Set pSelectionEnv = m_pMXApp.SelectionEnvironment
   Set pSearchGeo = m_pEditSketch.Geometry
   'Refresh old selection
   pActiveView.PartialRefresh esriViewGeoSelection, Nothing, Nothing
   Set pTopoOp = pSearchGeo 'QI
   pTopoOp.Simplify 'Close polygons
   'Do the Selection.
   'SelectByShape automatically fires the SelectionChanged event
   pMap.SelectByShape pSearchGeo, pSelectionEnv, False
   'Refresh the new selection
   pActiveView.PartialRefresh esriViewGeoSelection, Nothing, Nothing
End Sub
```



The sketch tool is the main tool for creating an edit sketch.


Greeley.mxd - ArcMap - ArcEditor
File Edit View Insert Selection Tools Window H
Editor
Task: Create New Featu
Electric
Transformers
SYMBOL
Overhead DDB

This illustration shows the sketch tools available with the editor. Only the main sketch tool has an interface exposed to developers.

The *SketchTool* object is the default sketch tool on the Editor toolbar. This sketch tool has its own context menu with commands such as Angle, Length, and Parallel. Add your own custom commands or macros to the Sketch Tool context menu using the Customize dialog box.

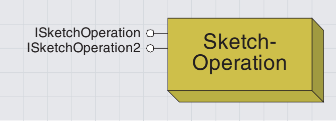
Like most commands and tools, this object is not cocreatable and is hidden in the type library. However, one interface is exposed, allowing developers to customize its behavior.

ISketchTool : IUnknown	*SketchTool*
Anchor: IPoint	*The anchor of the sketch.*
AngleConstraint: Double	*Controls the angular constraint.*
Constraint: esriSketchConstraint	*Controls the sketch constraint.*
DistanceConstraint: Double	*Controls the distance constraint.*
IsStreaming: Boolean	*Indicates whether stream mode digitizing is enabled.*
Location: IPoint	*The current location of the mouse.*
AddPoint (in Point: IPoint, in Clone: Boolean, in allowUndo: Boolean)	*Adds a point to the sketch.*

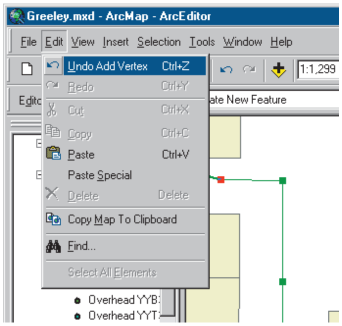
Use *ISketchTool* when you want to set and get specific information about the Sketch tool. For example, when creating a custom Sketch tool menu item, you may need to get the Sketch tool's current location or the edit sketch anchor point. For example, the Parallel command uses the *Location* property to find the feature on which the sketch tool was right-clicked before the command was selected.

This interface also allows you to set constraints on the Sketch tool, as well as add new points to the edit sketch. The sample below prompts the user for an input angle and then constrains the edit sketch to this angle. The command should be added to the Edit Sketch context menu so that the command is only available when the user right-clicks it.

```
Public Sub SetAngleConstraint()
  Dim pEditor As IEditor
  Dim pID As New UID
  pID = "esriCore.Editor"
  Set pEditor = Application.FindExtensionByCLSID(pID)

  Dim pSketchTool As ISketchTool
  Dim pNumberDialog As INumberDialog
  Dim dPI As Double
  dPI = 4 * Atn(1)

  'Get a reference to the sketch tool
  Set pSketchTool = Application.CurrentTool.Command
  'Use a number dialog to get user input angle
  Set pNumberDialog = New NumberDialog
  If pNumberDialog.DoModal("Angle", 0, 4, 0) Then
    pSketchTool.AngleConstraint = pNumberDialog.Value * dPI / 180
    pSketchTool.Constraint = esriConstraintAngle
  End If
End Sub
```



Sketch operations allow edit sketch modifications to be undone.



This illustration shows a sketch operation added to the document's operation stack after a vertex has been added to the edit sketch.

Create a Sketch operation whenever you need to provide undo/redo capabilities for modifications made to the edit sketch. For example, custom code that deletes one of the vertices in the edit sketch should use a Sketch operation so the user can undo the edit.

Both *IEditSketch::AddPoint* and *ISketchTool::AddPoint* automatically create a Sketch operation.

ISketchOperation : IOperation	*Provides undo/redo capabilities for edit sketch modifications.*
MenuString: String	*Sets the text that appears in the undo menu choice.*
Finish (in invalEnv: IEnvelope)	*Finishes the operation and puts it into the operation stack. Call this after the sketch has been modified.*
Start (in Editor: IEditor)	*Starts the operation, caching the existing sketch. Call this before modifying the sketch.*

Sketch operations are very similar to Editor operations. First, call *Start* to flag the beginning of the Sketch operation. Use the *MenuString* property to give the operation a name. Perform the edits. Call *Finish* to complete the edit operation. *Finish* requires an envelope parameter that is used to invalidate/refresh the display.

ISketchOperation2 : IUnknown	*Provides undo/redo capabilities for edit sketch modifications.*
Finish (in invalEnv: IEnvelope, opType: esriSketchOperationType, in data: Variant)	*Finishes the operation and puts it into the operation stack. Call this after the sketch has been modified.*

ISketchOperation2 was added to provide a new implementation for the *Finish* method. The new implementation allows tools to give more information about what they modified; typically, the edited sketch point is passed back to clients listening to editor events (*IEditEvents2*).

For example, if a point is deleted from an edit sketch and *ISketchOperation2::Finish* is used to complete the operation, the deleted point is passed to clients responding to *IEditEvents2::OnVertexDeleted*.

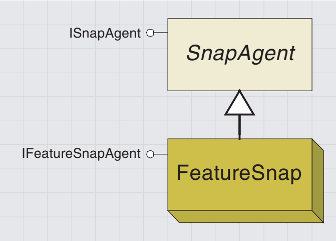
The sample below rewrites the *DeleteEditSketchVertex* subroutine from the first section of this chapter to use *ISketchOperation2*.

```
Public Sub DeleteEditSketchVertex2(pEditor As IEditor)
  Dim pEditSketch As IEditSketch
  Dim pPointColl As IPointCollection
  Dim pPoint As IPoint
  Dim pSketchOp As ISketchOperation
  Dim pSketchOp2 As ISketchOperation2
  Dim pID As New UID
  Dim index As Long

  Set pEditSketch = pEditor 'QI
  index = pEditSketch.Vertex
  If index = -1 Then Exit Sub 'Exit if I don't have a vertex

  'Create a sketch operation to get undo/redo capabilities
  Set pSketchOp = New SketchOperation
  Set pSketchOp2 = pSketchOp
```

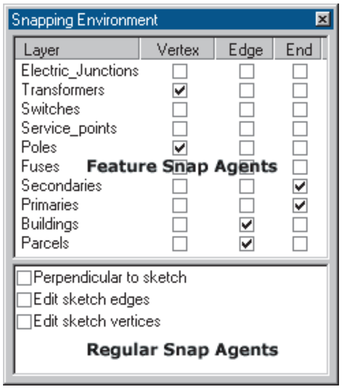
```
 pSketchOp.MenuString = "Delete Vertex" 'Give the operation a name
  pSketchOp.start pEditor 'Start the operation

  'Delete the point from the edit sketch and refresh
  Set pPointColl = pEditSketch.Geometry
  Set pPoint = pPointColl.Point(index)
  pPointColl.RemovePoints index, 1
  pEditSketch.RefreshSketch

  'Finish the operation to add it to the operation stack
  pSketchOp2.Finish pEditSketch.Geometry.Envelope, _
  esriSketchOperationVertexDeleted, pPoint

End Sub
```

Using *IEditEvents2,* you can draw the deleted vertex.

```
Private Sub EditorEvents_OnVertexDeleted(ByVal Point As IPoint)
 With m_pScreenDisplay
   .StartDrawing 0, esriNoScreenCache
   .SetSymbol New SimpleMarkerSymbol
   .DrawPoint Point
   .FinishDrawing
  End With
End Sub
```



Feature snap agents are a class of snap agents that help position features and edit sketch vertices by snapping them to other features.


Snapping Environment

Layer	Vertex	Edge	End
Electric_Junctions	□	□	□
Transformers	☑	□	□
Switches	□	□	□
Service_points	□	□	□
Poles	☑	□	□
Fuses			□
Secondaries	□	□	☑
Primaries	□	□	☑
Buildings	□	☑	□
Parcels	□	☑	□

□ Perpendicular to sketch
□ Edit sketch edges
□ Edit sketch vertices

This image shows how the feature snap agents are separated from the regular snap agents in the snapping environment window.

For information on the esriGeometryHitPartType *enumeration, please see Chapter 9, 'Shaping features with geometry'.*

The *Editor* manages a collection of snap agents that perform feature and sketch snapping. All snap agents implement the *ISnapAgent* interface. All nonfeature snap agents are registered in the ESRI Snap Agent's component category and appear in the bottom half of the the ArcMap snapping window. Feature snap agents are not registered in this component category, as you cannot develop custom feature snap agents.

For more information on snap agents and the snapping environment, see the 'Snap agents' section earlier in this chapter.

ISnapAgent : IUnknown	Snaps point locations using a tolerance.
Name: String	The name of the snap agent shown in the UI.
Snap (in geom: IGeometry, in Point: IPoint, in Tolerance: Double) : Boolean	Called by the editor to perform the actual snapping logic.

The *ISnapAgent* interface is typically used in two scenarios: creating new custom snap agents and accessing properties of an existing snap agent.

Custom snap agents must implement *ISnapAgent* and *IPersistStream* or *IPersistVariant* to save its state. For example, a snap agent may want to persist its settings in the map document so that when the document is next loaded, the user does not have to reset anything.

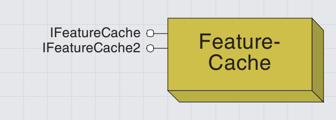
Use *ISnapEnvironment::SnapAgent* on the *Editor* object to get an *ISnapAgent* reference to a specific snap agent. For example, there may be cases where you need to loop through all of the available snap agents to find the one you want to work with.

Feature snap agents are a specific class of snap agents. The sketch tools and other editing tools use feature snap agents to find features to which to snap. A feature snap agent is automatically instantiated for each editable feature class the first time the snapping window is opened. Alternatively, you can cocreate a new feature snap agent, set its properties, and manually add it to the snapping environment. The editor will not replace manually added feature snap agents when the snapping window is opened.

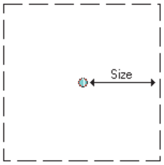
IFeatureSnapAgent : ISnapAgent	Controls a feature snap agent's properties.
FeatureCache: IFeatureCache	Retrieves the FeatureCache associated with the feature snap agent.
FeatureClass: IFeatureClass	The feature class the feature snap agent snaps to.
HitType: esriGeometryHitPartType	The part of a geometry the feature snap agent snaps to.

The *IFeatureSnapAgent* interface is used to set the properties of a feature snap agent. *IFeatureSnapAgent* inherits from *ISnapAgent* so all of the members on *ISnapAgent* are directly available.

Enumeration esriGeometryHitPartType	Describes the parts of a geometry that can be located by their proximity to a query point.
0 - esriGeometryPartNone	No part was located by the hit test.
1 - esriGeometryPartVertex	Locate the vertex of a geometry closest to the query point.
4 - esriGeometryPartBoundary	Locate the closest point on the boundary of a polygon, or the closest point on a polyline, to the query point.
8 - esriGeometryPartMidpoint	Locate the segment midpoint that is closest to the query point.
16 - esriGeometryPartEndpoint	Locate the 'from' or 'to' point of the polyline closest to the query point.
32 - esriGeometryPartCentroid	Locate the ring centroid closest to the query point.



Use feature caches to store a small set of features in memory. Having these features stored in memory enables you to perform extremely quick operations on these features.



This illustration shows the extent of a feature cache initialized around a point.

The features stored in a feature cache are typically those that are near the current mouse location. For example, each feature snap agent tracks the current mouse location and continually reinitializes a feature cache and fills it with the features residing near this point. The snap agents then cycle through all of the features in their cache, checking if any are within the snap tolerance.

IFeatureCache : IUnknown	***A cache of features in memory for a particular spatial extent.***
Count: Long	*Returns the number of features in the cache.*
Feature (in Index: Long) : IFeature	*Returns the nth feature.*
AddFeatures (in fclass: IFeatureClass)	*Fills the cache with features from the featureclass. All previously loaded features in the cache are removed.*
Contains (in Point: IPoint) : Boolean	*Returns true if the point is contained in the cache.*
Initialize (in Point: IPoint, in Size: Double)	*Initializes the cache with a given size and location.*

Use the *IFeatureCache* interface to initialize and fill a feature cache as well as iterate through it.

A *FeatureCache* must be initialized before it can be used. The required *Point* and *Size* parameters specify an area that *AddFeatures* will use to find features and add them to the cache.

To reload a cache with new features, reinitialize the cache around a new point and call *AddFeatures* again.

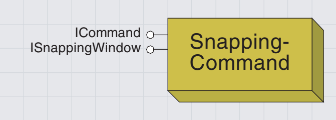
The *Point* parameter is typically a point defined by the current mouse location.

The *Size* parameter is usually an arbitrary number, such as ten times the snap tolerance.

IFeatureCache2 : IUnknown	***Provides access to members that control a cache of features in memory for a particular spatial extent.***
Count: Long	*The number of features in the cache.*
Feature (in Index: Long) : IFeature	*The nth feature.*
AddFeatures (in fclass: IFeatureClass, addToCache: Boolean, Clip: IEnvelope)	*Fills the cache with features from the featureclass. Optionally clears the cache before filling it. Clip envelope may be null.*
Contains (in Point: IPoint) : Boolean	*Returns true if the point is contained in the cache.*
Initialize (in Point: IPoint, in Size: Double)	*Initializes the cache with a given size and location.*

IFeatureCache2 is exactly the same as *IFeatureCache* with one enhancement—the *AddFeatures* method has an additional parameter that lets you append features into an existing cache or, like *IFeatureCache*, create a new cache.

Use this interface to fill a cache with multiple feature classes. For example, the Intersection sketch tool uses this interface because, unlike a snap agent, it works with all the selectable layers in the focus map.



The snapping command object represents the snapping environment window, which gives a user interface to the ArcMap snapping environment.

The snapping window reveals all the snap agents currently available. All custom snap agents appear in the bottom half of the dialog box with all regular snap agents; only feature snap agents appear in the top half.

A feature snap agent is created for each editable feature class the first time the snapping window is opened. Each feature snap agent initially has its *HitType* property set to *esriGeometryPartNone*. Change the *HitType* by checking the appropriate box in the snapping window or programmatically change it using *IFeatureSnapAgent::HitType*.

Snap agents other than feature snap agents, for example, Snap Perpendicular, are also instantiated the first time the snapping window is opened, but these are not added to the snap environment until the user checks them on.

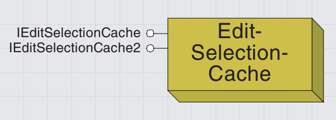
ISnappingWindow : IUnknown	*Provides methods for working with the SnappingWindow*
← Hide	*Hides the window.*
← RefreshContents	*Refreshes the contents.*
← Show	*Shows the window.*

Use the *ISnappingWindow* interface after programmatically changing the snapping environment to refresh the contents of the Snapping Window. You can also programmatically close or open the snapping window using the *Hide* and *Show* methods.

Call *RefreshContents* to update the snapping window with any programmatic changes made to the snapping environment.

To get a handle to the snapping window, use *ICommandBars::Find*. The VBA example below shows a standalone subroutine that clears all the snap agents. To see how this works, turn some snap agents on before running this code.

```
Sub ClearSnapAgents(pEditor As IEditor)
  Dim pSnapUID As New UID
  Dim pSnapEnv As ISnapEnvironment
  Dim pSnapWindow As ISnappingWindow

  pSnapUID = "esriCore.SnappingCommand"
  Set pSnapEnv = pEditor
  'Clear all of the loaded snap agents
  pSnapEnv.ClearSnapAgents
  'Get a handle to the snapping window by searching for it
  Set pSnapWindow = _
        Application.Document.CommandBars.Find(pSnapUID).Command
  pSnapWindow.RefreshContents
 End Sub
```



The edit selection cache works with an offscreen bitmap representing the map's selection to very quickly determine if the mouse is on top of a selected feature. For example, the Edit tool cursor changes when you move over the selection.

Use the *EditSelectionCache* object to quickly determine if the mouse is over a selected feature.

IEditSelectionCache : IUnknown	*Caches the selection for fast hit testing.*
← HitTest (in loc: IPoint) : Boolean	*Tests if the location is over the selection or not.*
← Initialize (in Editor: IEditor, in sizePixels: Long)	*Initializes the cache using the editor's selection.*

Use the *IEditSelectionCache* interface to initialize and fill the cache and to perform hit tests against the features in the cache. In this case, topological features are not added to the edit selection cache even if they are selected because they cannot be edited in the same fashion as simple features. For example, coverage polygons cannot be moved using the Edit tool, as this will break the coverage's topology; instead, the Shared Edit tool must be used to signal that all coincident edges be moved as well.

The following sample changes a *UIToolControl*'s cursor whenever it moves over the map feature selection.

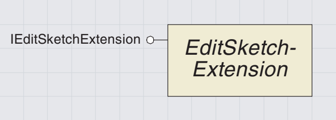
```
Private m_pEditor As IEditor
Private m_pMxDoc As IMxDocument
Private m_pEditSelectionCache As IEditSelectionCache

Private Function UIToolControl1_CursorID() As Variant
  If IsMouseOverSelection(m_pMxDoc.CurrentLocation) Then
    UIToolControl1_CursorID = 5
  Else
    UIToolControl1_CursorID = 0
  End If
End Function

Private Sub UIToolControl1_Select()
 Dim pID As New UID
 pID = "esriCore.Editor"
 Set m_pEditor = Application.FindExtensionByCLSID(pID)
 Set m_pMxDoc = Application.Document
End Sub

Private Function IsMouseOverSelection(pPoint As IPoint) As Boolean
  Set m_pEditSelectionCache = New EditSelectionCache
  m_pEditSelectionCache.Initialize m_pEditor, 400
  IsMouseOverSelection = m_pEditSelectionCache.HitTest(pPoint)
End Function
```

IEditSketchCache2 *is used for adding topological features in code.*

IEditSelectionCache2 : IUnknown	*Caches the selection for fast hit testing.*
← Initialize (in Editor: IEditor, in sizePixels: Long, in blockTopoFeatures: Boolean)	*Initializes the cache using the editor's selection.*

IEditSelectionCache2 allows developers to control whether or not topological features are added to the edit selection cache. This is done with a new parameter on *Initialize* called *blockTopoFeatures*.

IEditSelectionCache::Initialize always works as though this parameter is set to *True*. Using *IEditSelectionCache2::Initialize* with *blockTopoFeatures* set to *False* brings topologic features into the edit selection cache.



Edit sketch extensions provide developers with a mechanism for managing the behavior of edit tasks to ensure application-specific feature construction and modification.

Edit sketch extensions let programmers alter the edit sketch geometry and edit sketch display feedback mechanism. For more details, see the discussion on these earlier in this chapter.

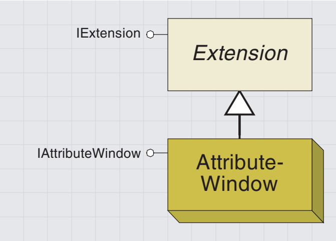
IEditSketchExtension : IUnknown	***Extends the edit sketch.***
■— CanDeleteVertices: Boolean	*Does the sketch allow the deleting of vertices?*
■— CanInsertVertices: Boolean	*Does the sketch allow the inserting of additional vertices?*
■— CanMoveVertices: Boolean	*Does the sketch allow the moving of vertices?*
■— HasFeedback: Boolean	*Returns true if the SketchExtension will use a custom feedback.*
■— SketchGeometryType: tagesriGeometryType	*The geometry type used for the edit sketch when creating new features.*
◀— Activate (in Editor: IEditor)	*Called when the sketch extension is about to be used.*
◀— Applies (in Editor: IEditor) : Boolean	*Does this extension apply to the current edit environment?*
◀— BeforeStoreFeature (in Feature: IFeature, in Geometry: IGeometry)	*Lets the extension know the feature is about to be stored.*
◀— CreateFeedback: IDisplayFeedback	*Called when a new feedback is needed.*
◀— CreateSketchGeometry (in Feature: IFeature) : IGeometry	*The geometry that will be used in the sketch when modifying a feature.*
◀— Deactivate	*Called when the sketch extension is no longer needed.*
◀— StartFeedback (in Point: IPoint)	*Called when the feedback needs to be started.*
◀— StopFeedback: IGeometry	*Called when the feedback is no longer necessary.*

Implement this interface along with *IExtension* to create a custom edit sketch extension.

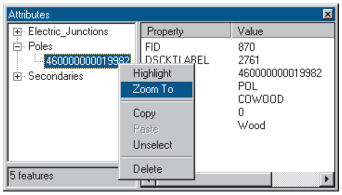
Edit sketch extensions typically work as follows:

The current edit task calls each registered edit sketch extension's *Applies* function; the first one to return *True* becomes the active extension and its *Activate* method is called. Each extension performs certain tests in its *Applies* method to determine if it should be activated. This typically involves checking the current task, the current target layer, and, when modifying a feature, the currently selected features. Most extensions just override the Create New Feature task and the Modify Feature task.

Once an extension has become active, it sets the geometry type of the edit sketch. The extension then optionally sets up a new feedback mechanism; this typically involves the use of one of the feedback objects, such as *NewLineCircleFeedback*. For example, a custom edit sketch extension may create perfect circles by allowing users to enter a center point and another point defining the radius. When a user modifies the feature, they are presented with one point instead of an entire polygon; this limits them to only changing the radius, rather than adding new vertices and creating a shape that is an imperfect circle.



The attribute window extension is the ArcMap attribute editing window.



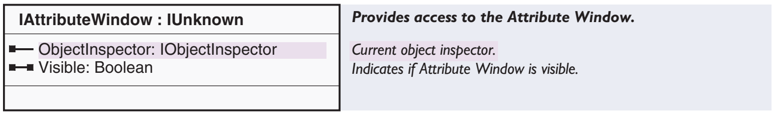
Property	Value
FID	870
DSCKTLABEL	2761
	460000000019982
	POL
	COWOOD
	0
	Wood

This image shows the two panels in the attributes window and the context menu available to selected features.

The *AttributeWindow* is an *Editor* extension that provides a window for viewing additional information about selected features involved in the current edit session. The attributes window has two panels: the left panel lists the selected features, and the right panel houses an object inspector.

ArcMap ships with a default object inspector called the *FeatureInspector*, which facilitates attribute editing. A custom object inspector may be associated with geodatabase feature classes; in this case, the custom inspector will show up in the right attributes window panel whenever a feature that belongs to one of these features classes is selected in the left panel.

Right-clicking a feature listed in the attributes window reveals a context menu with commands such as Highlight and Zoom To. This menu is not customizable, that is, you cannot add or remove commands from this menu.



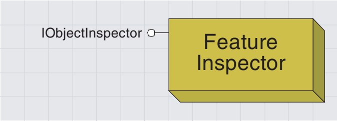
IAttributeWindow : IUnknown

Provides access to the Attribute Window.

ObjectInspector: IObjectInspector	*Current object inspector.*
Visible: Boolean	*Indicates if Attribute Window is visible.*

Use this interface to hide or show the Attributes dialog box and access the object inspector currently loaded inside of it. The sample below opens the Attributes dialog box if it is closed and closes it if it is open.

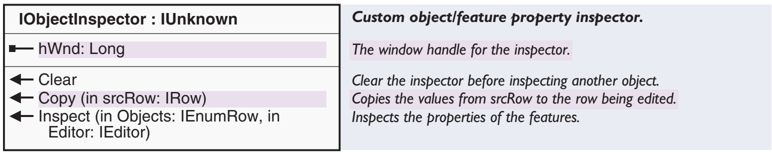
```
Private Sub ToggleAttributeWindow(pEditor As IEditor)
 Dim pExtension As IExtension
  Dim pExtensionManager As IExtensionManager
  Dim pAttributeWindow As IAttributeWindow
  Dim iExtensionCount As Integer

  'Ensure an active edit session
  If Not pEditor.EditState = esriStateEditing Then Exit Sub
  'Loop through all of the extensions to find the attribute window
  Set pExtensionManager = pEditor 'QI
  For iExtensionCount = 0 To pExtensionManager.ExtensionCount - 1
    Set pExtension = pExtensionManager.Extension(iExtensionCount)
    If pExtension.Name = "AttributeWindow" Then Exit For
 Next iExtensionCount
  'Open the window if it is closed; close it, if it is open
  If Not TypeOf pExtension Is IAttributeWindow Then Exit Sub
  Set pAttributeWindow = pExtension 'QI
  If Not pAttributeWindow.Visible Then
    pAttributeWindow.Visible = True
  Else
    pAttributeWindow.Visible = False
  End If
End Sub
```



The feature inspector is the default object inspector that facilitates attribute editing.

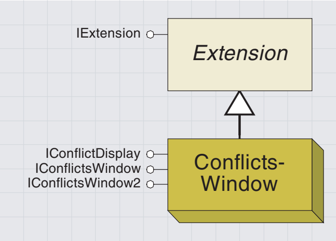
The *FeatureInspector* has been made cocreateable so that custom feature inspectors can incorporate it. You may want to create a custom feature inspector for features that contain complex attributes or behavior.

For example, you may want to create a custom property inspector that lets you edit the flow of electricity through a switch gear or regulate the pressure attribute of natural gas through a regulator station.

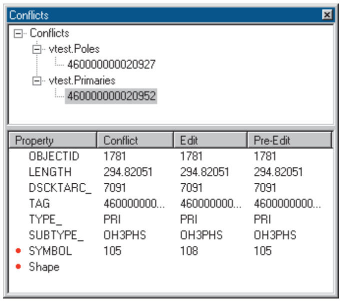


IObjectInspector : IUnknown	*Custom object/feature property inspector.*
hWnd: Long	*The window handle for the inspector.*
Clear	*Clear the inspector before inspecting another object.*
Copy (in srcRow: IRow)	*Copies the values from srcRow to the row being edited.*
Inspect (in Objects: IEnumRow, in Editor: IEditor)	*Inspects the properties of the features.*

To create your own custom property inspector for features in a specific feature class, implement the *IObjectInspector* and *IClassExtension* interfaces, then add your extension's *GUID* to the *EXTCLSID* field for that feature class in the *GDB_ObjectClasses* table. When the user opens the Attributes dialog box, it will display the custom inspector instead of the default inspector.



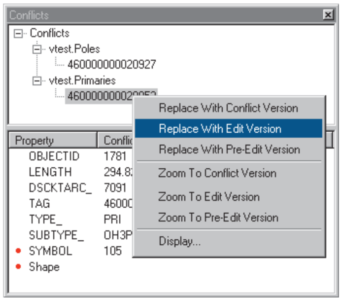
The conflicts window extension allows users to resolve conflicts when saving edits in a versioned geodatabase.



Conflicts
- vtest.Poles
  - 460000000020927
- vtest.Primaries
  - 460000000020952

	Property	Conflict	Edit	Pre-Edit
	OBJECTID	1781	1781	1781
	LENGTH	294.82051	294.82051	294.82051
	DSCKTARC_	7091	7091	7091
	TAG	460000000...	460000000...	4600000000...
	TYPE_	PRI	PRI	PRI
	SUBTYPE_	OH3PHS	OH3PHS	OH3PHS
●	SYMBOL	105	108	105
●	Shape			

This image shows a conflicts window listing two conflict features.The red dots in the bottom pane show which attributes are different; in this case, the Shape of the feature and the SYMBOL attribute value differ.



Conflicts
- vtest.Poles
  - 460000000020927
- vtest.Primaries
  - 46000000002

	Property	Conflic
	OBJECTID	1781
	LENGTH	294.8
	DSCKTARC_	7091
	TAG	4600C
	TYPE_	PRI
	SUBTYPE_	OH3P
●	SYMBOL	105
●	Shape	

A customizable Conflicts Menu is available when you right-click on conflict features. Standard commands on this menu include Replace With Edit Version and Zoom To Edit Version.

The Conflicts dialog box is an extension that presents the conflicts between the current edit version, the version the edits are being saved into, and the original state of the editor's data when its edit session first started. Conflicts arise when features are modified by more than one person. For example, if two people start an edit session on the same version and edit the same feature, the last editor to save the modifications will get a conflict that must be resolved if any edits made are to be commited to the database.

IConflictsWindow : IUnknown	Provides access to Conflicts Display Window.
Class (in Index: Long) : IConflictClass	Class by index.
ClassCount: Long	The number of classes with conflicts.
CurrentClass: IConflictClass	Class of the selected feature, or 0 if no ConflictClass.
CurrentRow: Long	ID of the selected row or feature, or -1 if no current row.
IDs (in conflictClass: IConflictClass) : IEnumIDs	Enumerate the feature IDs for a ConflictClass.
Visible: Boolean	Indicates if Conflicts Window is visible.
FindTable (in conflictClass: IConflictClass, in vers: esriVersion) : ITable	Finds a cached table corresponding to the conflict class and version.
HasConflicts: Boolean	Indicates if conflicts have been detected.
Reset	Resets the conflicts.

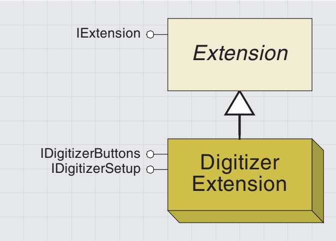
The *IConflictsWindow* interface lets the developer manipulate the Conflicts dialog box. For example, if you wanted to process all conflicts automatically, use *IConflictsWindow* to create a custom reconciliation process eliminating the manual conflict resolution step.

IConflictDisplay : IUnknown	Provides access to the Conflict display environment.
FillSymbol (in vers: esriVersion) : IFillSymbol	Display symbol used to draw polygon features.
LineSymbol (in vers: esriVersion) : ILineSymbol	Display symbol used to draw line features.
MarkerSymbol (in vers: esriVersion) : IMarkerSymbol	Display symbol used to draw point features.
VersionVisible (in vers: esriVersion) : Boolean	The start editing, pre-reconcile or reconcile version used for display.

The Conflicts dialog box can symbolize a conflict feature as it appears in three different versions: the current edit session, directly prior to the local edit session, and the version the edit session is reconciling against. The *IConflictDisplay* interface manages point, line, and polygon symbols for each of these versions. For example, you may want all conflict polygons in the reconcile version drawn in red. The *IConflictDisplay* interface additionally controls whether or not conflict features from a particular version are displayed. For example, you can elect not to draw conflict features in the preedit session version.

Enumeration esriVersion	ESRI Version type.
0 - esriReconcileVersion	The version the edit session is reconciling against.
1 - esriPreReconcileVersion	The version prior to reconciliation.
2 - esriStartEditingVersion	The version prior to start editing.

The *esriVersion* enumeration works with all of the properties managed by *IConflictDisplay*. Use this enumeration to specify a particular version.



The digitizer extension enables the editor to receive input from a digitizing board and puck.

The *DigitizerExtension* object connects a digitizing board and puck with ArcMap. This object is primarily responsible for the transformation between digitizing space and map space. After a transformation has been established, the location of the puck directly correlates to a location on the focus map.

IDigitizerSetup : IUnknown	***Provides access to members that define the transformation used by the digitizer.***
■— ControlPointCount: Long	*The number of control points used for digitizing.*
■—□ Transformation: ITransformation	*The transformation used by the digitizer.*
← AddControlPoint (in xDigitizer: Double, in yDigitizer: Double, in xMap: Double, in yMap: Double)	*Adds a control point to the transformation.*
← ClearControlPoints	*Removes all control points.*
← GetControlPoint (in Index: Long, out xDigitizer: Double, out yDigitizer: Double, out xMap: Double, out yMap: Double)	*A control point's X,Y coordinates in Digitizer and Map units.*

The *IDigitizerSetup* interface manages the transformation between digitizer coordinates and map units. The transformation is based on control points.

The *IDigitizerSetup* uses an affine transformation to transform digitizer coordinates to map units. The affine transformation can differentially scale, skew, rotate, and translate your data. Using the *Transformation* method located on the *IDigitizerSetup* interface, you can control the parameters used to perform these affine functions.

IDigitizerButtons : IUnknown	***Provides access to map digitizer puck buttons to ArcMap commands.***
■—■ Button (in Button: Long) : IUID	*Button to map on the digitizer puck.*

The *IDigitizerButtons* interface allows you to map ArcMap commands directly to the buttons on the digitizer puck. For example, button 4 can be mapped to the Edit tool, button 5 mapped to the Sketch tool, and button 6 mapped to the Arc tool.

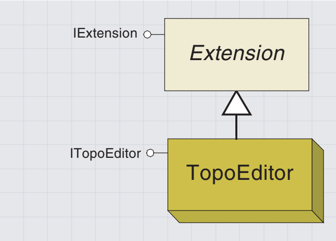
Commands or tools that are mapped to digitizer buttons will only work when in digitizing mode. To use the digitizer puck in digitizing mode, you must check the Enabled check box on the Digitizer tab of the Editor Options dialog box.

When digitizing is enabled, the only tools that display a cursor on the screen when you move the puck are the sketch tools. You will not, for example, see the Edit tool cursor when it is the active tool and you are driving it from the digitizing board. For tools other than the sketch tools, you must rely on the position of the puck. Mouse events work the same for all tools. For example, when the Edit tool is the active tool, pressing the Left Click button will select the feature over which the puck is positioned, but looking at the screen will not show you the Edit tool's position.

This sample creates relationships between digitizer puck buttons and ArcMap commands/tools. For example, button 8 on the puck is set to call the ArcMap ZoomInFixed command. All mouse-related events must be set in the digitizer control panel. For this sample, you should set Left Click, Left Drag, and Left Double-Click to 0, 1, and 2, respectively. Make sure buttons 3, 4, 5, 6, 8, 9, 12, and 15 are set to none.

This sample shows a faster approach to obtaining a reference to the desired extension compared to the *AttributesWindow* extension sample.

```
Public Sub SetDigitizerBtns(pEditor as IEditor)
 Dim pDigitizerBnts As IDigitizerButtons
  Dim pID As New UID

  'Get a handle to the editor's digitizer extension
  pID = "esriCore.DigitizerExtension"
  Set pDigitizerBnts = pEditor.FindExtension(pID)

  'Set button 3 on digitizer puck to execute FinishSketch command
  pID = "esriCore.FinishSketchCommand"
  pDigitizerBnts.Button(3) = pID

  'Set button 4 on the digitizer puck to switch to the EditTool
  pID = "esriCore.EditTool"
  pDigitizerBnts.Button(4) = pID

  'Set button 5 on the digitizer puck to switch to the SketchTool
  pID = "esriCore.SketchTool"
  pDigitizerBnts.Button(5) = pID

  'Set button 6 on the digitizer puck to switch to the ArcTool
  pID = "esriCore.ArcTool"
  pDigitizerBnts.Button(6) = pID

  'Set button 8 on digitizer puck to execute ZoomIn fixed command
  pID = "esriCore.ZoomInFixedCommand"
  pDigitizerBnts.Button(8) = pID

  'Set button 9 on digitizer puck to execute ZoomOut fixed command
  pID = "esriCore.ZoomOutFixedCommand"
  pDigitizerBnts.Button(9) = pID

  'Set button 12 on digitizer puck to turn Streaming digitizing
  'on and off
  pID = "esriCore.StreamingSketchMenuItem"
  pDigitizerBnts.Button(12) = pID

  'Set button 15 on the digitizer puck to delete the edit sketch
  pID = "esriCore.DeleteSketchCommand"
  pDigitizerBnts.Button(15) = pID

End Sub
```



The topological editor extension performs shared edge editing.

The *TopoEditor* extension provides the ability to create and edit topological associations between features. Topological associations are managed using a specialized selection called a shared edit selection.

ITopoEditor : IUnknown	*Controls the behavior of the topology editor.*
ClusterTolerance: Double	*The current cluster tolerance used in Integrate.*
Geometry: IGeometry	*The geometry of a Shared Edge or Point.*
InteGrateFullExtent: Boolean	*Indicates if Integrate will be limited to the current extent.*
LineSelectionSymbol: ISymbol	*The current line symbol used for shared selections.*
PointSelectionSymbol: ISymbol	*The current marker symbol used for shared selections.*
AutoComplete (in pClass: IFeatureClass, in pSketch: IGeometry)	*Intersects a Polyline onto the FeatureClass.*
Clear	*Internally clears the shared edge or point, removing associated internal arrays.*
ClearSelection	*Clears the current Shared Edge or Point selection.*
CreateSharedFeature (in pClass: IFeatureClass, in pSketch: IGeometry, out ppFeature: IFeature)	*Creates a shared feature in the FeatureClass.*
DeleteFeatures (in menuText: String)	*Deletes the features associated with the Shared Edge or Point.*
InteGrateClass (in pClass: IFeatureClass, in pTrackCancel: ITrackCancel)	*Integrates the FeatureClass.*
InteGrateDataset (in pDataset: IFeatureDataset, in pTrackCancel: ITrackCancel)	*Integrates the Feature Dataset.*
Reset (in pUpdatedGeom: IGeometry)	*Resets the Shared Edge or Point selection.*
Select (in pPoint: IPoint, in tol: Double)	*Selects the Shared Edge or Point.*
SetVertexIndices (in pFirstFeedback: IVertexFeedback, in pLastFeedback: IVertexFeedback)	*Builds the associated array of vertices for the current Shared Edge.*
UpdateFeatures (in pUpdatedGeom: IGeometry, in menuText: String)	*Updates the features associated with the Shared Edge or Point.*

Use the *ITopoEditor* interface if you need to create or modify the topological associations between features. Shared edits affect all feature classes inside the feature dataset you are editing. For example, if the shape shared between two adjacent county boundaries in one feature class and a river in another feature class are modified, all features in all classes will be updated.

This sample creates a new polyline based on a shared edge selection. If a coverage workspace is being edited, *CreateSharedFeature* is used; otherwise, the *CreateFeature/Store* combination is used.

```
Public Sub CreateFeatureFromSharedEdge2()
  Dim pActiveView As IActiveView
  Dim pEditLayers As IEditLayers
  Dim pEditor As IEditor
  Dim pNewFeature As IFeature
  Dim pSharedGeometry As IGeometry
  Dim pTargetFeatureClass As IFeatureClass
  Dim pTopoEditor As ITopoEditor
  Dim pUID As New UID

  'Get a handle to the editor extension
  pUID = "esriCore.Editor"
  Set pEditor = Application.FindExtensionByCLSID(pUID)
  If pEditor Is Nothing Then
    Exit Sub
  ElseIf Not pEditor.EditState = esriStateEditing Then
    Exit Sub
  End If

  Set pEditLayers = pEditor 'QI
  pUID = "esriCore.TopoEditor"
  Set pTopoEditor = pEditor.FindExtension(pUID)
  If pTopoEditor Is Nothing Then Exit Sub

  pEditor.StartOperation 'Start an edit operation right away
  On Error GoTo ErrorHandler

  'Check if a shared edge exits
  Set pSharedGeometry = pTopoEditor.Geometry
  If pSharedGeometry Is Nothing Then
    MsgBox "Select a shared edge."
    Exit Sub
  ElseIf Not pSharedGeometry.GeometryType = esriGeometryPolyline Then
    MsgBox "Select a shared edge."
    Exit Sub
  End If

  If Not pEditLayers.CurrentLayer.FeatureClass.ShapeType =
esriGeometryPolyline Then
    MsgBox "Target layer must be a polyline layer.:"
    Exit Sub
  End If

  If TypeOf pEditor.EditWorkspace Is ICoverage Then
    pTopoEditor.CreateSharedFeature _
      pEditLayers.CurrentLayer.FeatureClass, pSharedGeometry, _
         pNewFeature
  Else
    Set pNewFeature = _
      pEditLayers.CurrentLayer.FeatureClass.CreateFeature
    Set pNewFeature.Shape = pSharedGeometry
    pNewFeature.Store
  End If

  pEditor.StopOperation "Create New Feature"

  Set pActiveView = pEditor.Map
  pTopoEditor.ClearSelection
  pActiveView.PartialRefresh esriViewGeography, Nothing, _
    pSharedGeometry.Envelope

  Exit Sub 'Exit to avoid error handler
ErrorHandler:
  pEditor.AbortOperation

End Sub
```

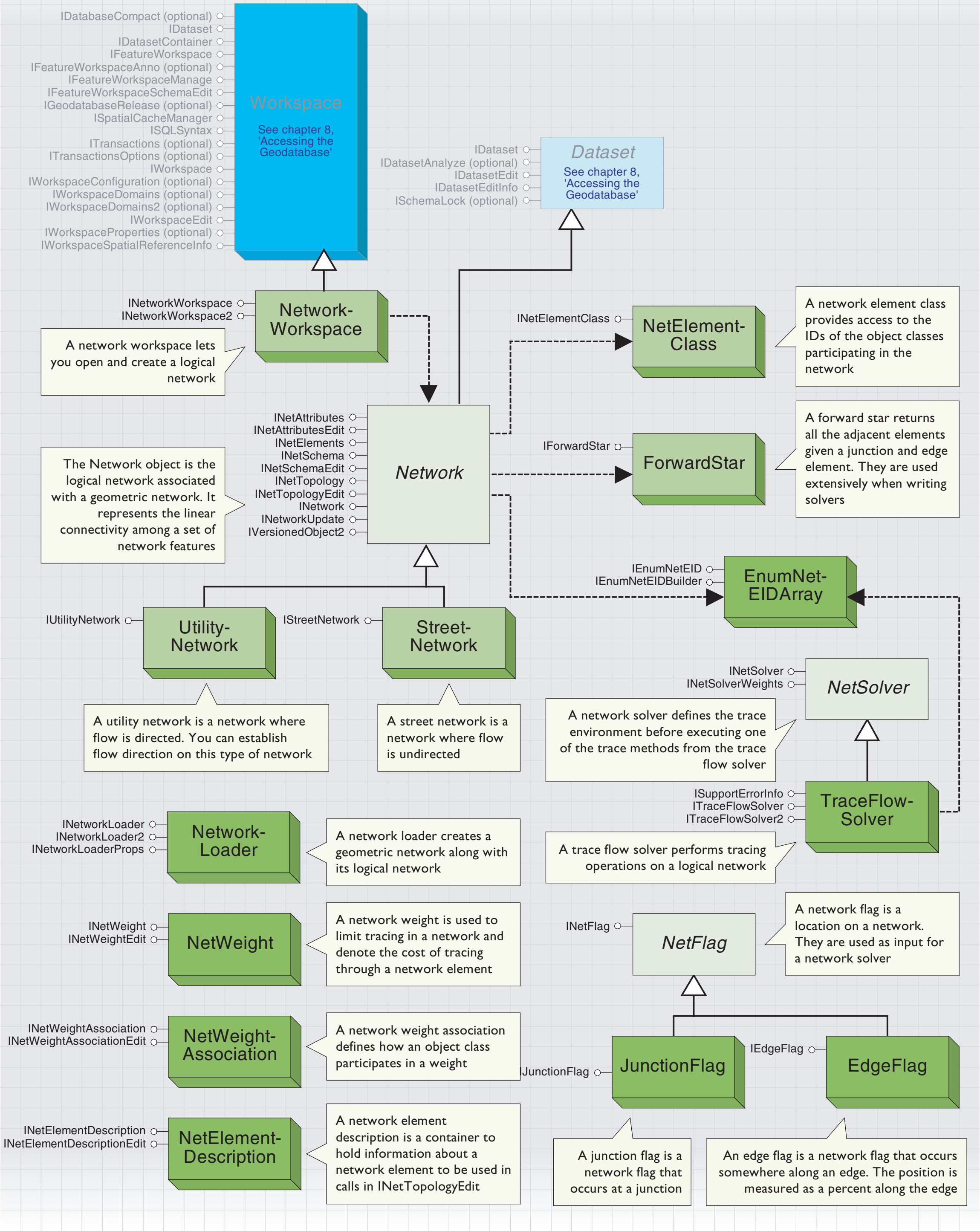
12 Solving linear networks

Larry Young

Feature classes in a geodatabase can participate together in a network. Because the features have geometry and can be mapped, such a network is called a geometric network. There are a variety of tools and objects for analyzing networks and a rich set of objects for building custom networks with complex behavior.

Feature classes that participate in a geometric network contain either edge features (lines) or junction features (points). Every geometric network has a corresponding logical network, which is a "behind-the-scenes" data structure that stores edge and junction elements and the connectivity between them. A software developer writing programs to analyze flow through a network deals almost exclusively with a logical network. Database designers, data builders, and analysts can all benefit from understanding the correspondence between geometric network features and logical network elements.

Network



A network workspace lets you open and create a logical network

A network element class provides access to the IDs of the object classes participating in the network

The Network object is the logical network associated with a geometric network. It represents the linear connectivity among a set of network features

A forward star returns all the adjacent elements given a junction and edge element. They are used extensively when writing solvers

A utility network is a network where flow is directed. You can establish flow direction on this type of network

A street network is a network where flow is undirected

A network solver defines the trace environment before executing one of the trace methods from the trace flow solver

A network loader creates a geometric network along with its logical network

A trace flow solver performs tracing operations on a logical network

A network weight is used to limit tracing in a network and denote the cost of tracing through a network element

A network flag is a location on a network. They are used as input for a network solver

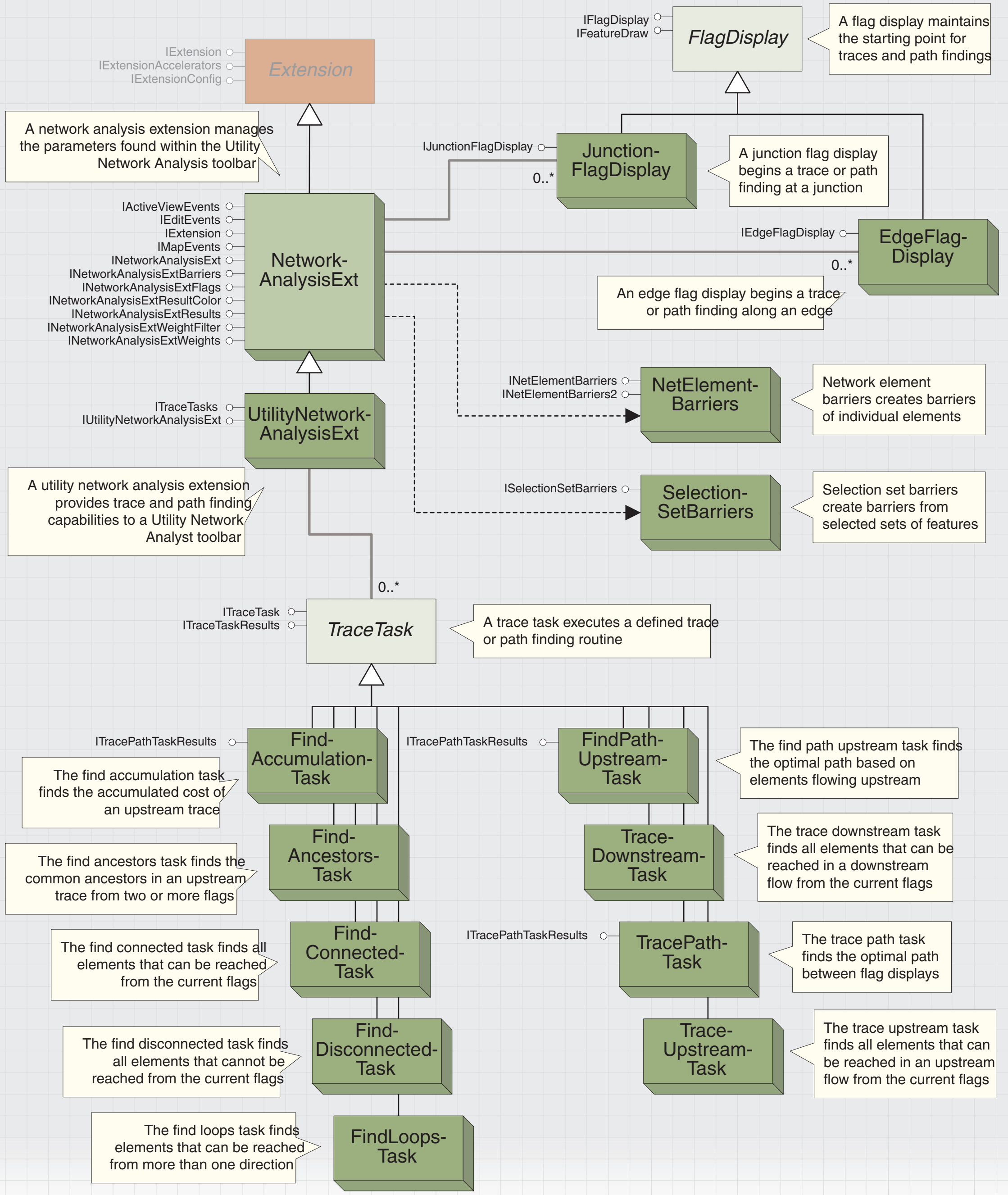
A network weight association defines how an object class participates in a weight

A network element description is a container to hold information about a network element to be used in calls in INetTopologyEdit

A junction flag is a network flag that occurs at a junction

An edge flag is a network flag that occurs somewhere along an edge. The position is measured as a percent along the edge

objects



A flag display maintains the starting point for traces and path findings

A network analysis extension manages the parameters found within the Utility Network Analysis toolbar

A junction flag display begins a trace or path finding at a junction

An edge flag display begins a trace or path finding along an edge

Network element barriers creates barriers of individual elements

A utility network analysis extension provides trace and path finding capabilities to a Utility Network Analyst toolbar

Selection set barriers create barriers from selected sets of features

A trace task executes a defined trace or path finding routine

The find accumulation task finds the accumulated cost of an upstream trace

The find path upstream task finds the optimal path based on elements flowing upstream

The find ancestors task finds the common ancestors in an upstream trace from two or more flags

The trace downstream task finds all elements that can be reached in a downstream flow from the current flags

The find connected task finds all elements that can be reached from the current flags

The trace path task finds the optimal path between flag displays

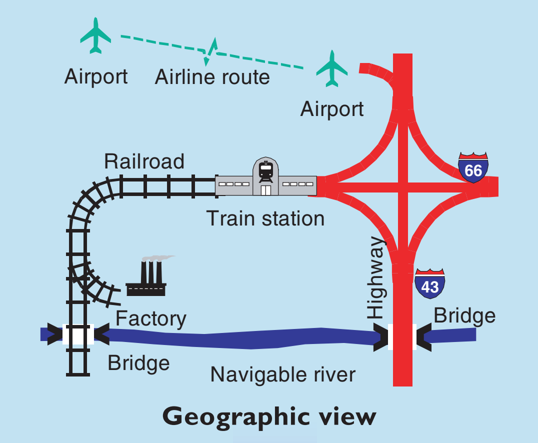
The find disconnected task finds all elements that cannot be reached from the current flags

The trace upstream task finds all elements that can be reached in an upstream flow from the current flags

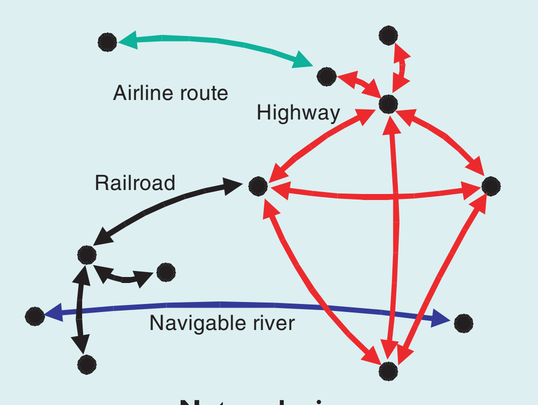
The find loops task finds elements that can be reached from more than one direction

Two views of a network

You can view a network as a collection of geographic objects, such as rails, roads, stations, and bridges, and also as a pure network of edges and junctions.



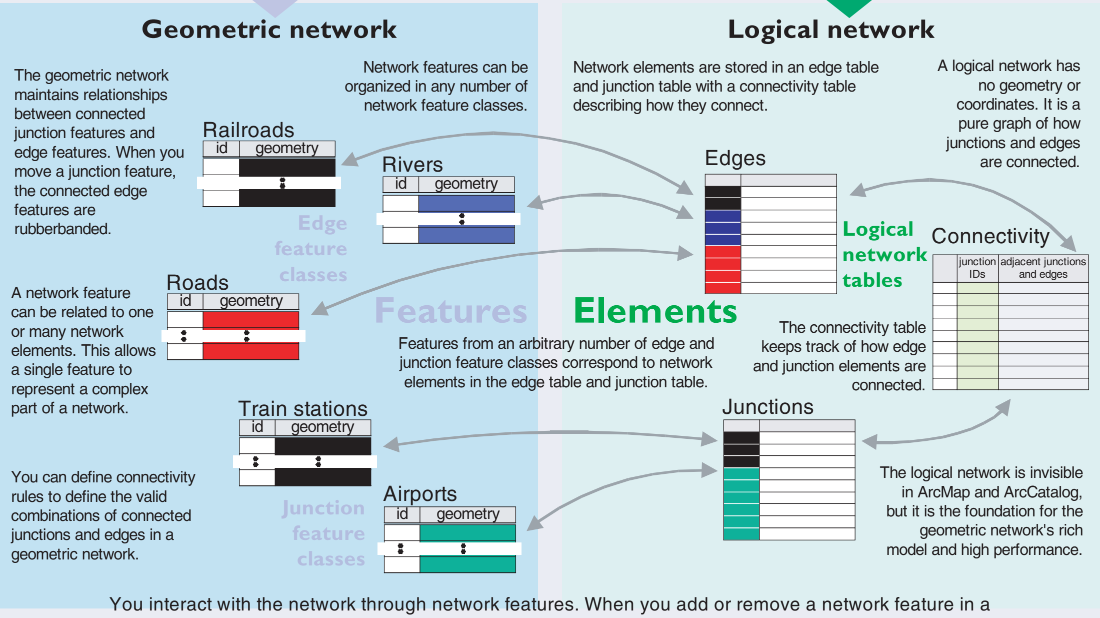
Geographic view



Network view

A geometric network is the representation of geographic features that comprise a network.

A logical network is a pure graph of junction elements and edge elements.



Geometric network

The geometric network maintains relationships between connected junction features and edge features. When you move a junction feature, the connected edge features are rubberbanded.

Network features can be organized in any number of network feature classes.

A network feature can be related to one or many network elements. This allows a single feature to represent a complex part of a network.

You can define connectivity rules to define the valid combinations of connected junctions and edges in a geometric network.

Features

Features from an arbitrary number of edge and junction feature classes correspond to network elements in the edge table and junction table.

Elements

Logical network

Network elements are stored in an edge table and junction table with a connectivity table describing how they connect.

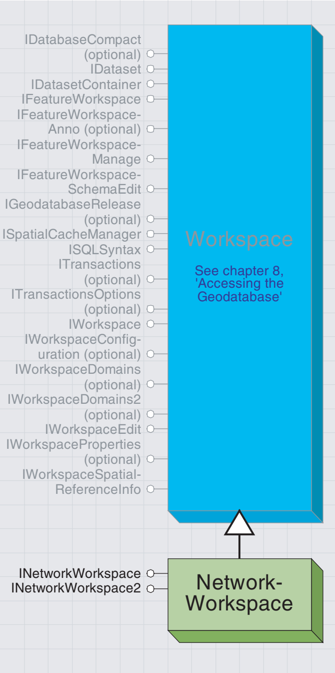
A logical network has no geometry or coordinates. It is a pure graph of how junctions and edges are connected.

The connectivity table keeps track of how edge and junction elements are connected.

The logical network is invisible in ArcMap and ArcCatalog, but it is the foundation for the geometric network's rich model and high performance.

You interact with the network through network features. When you add or remove a network feature in a geometric network, ArcGIS adds or removes the matching network elements. When you perform network analysis, ArcGIS submits a solver to the logical network.

The geometric network and logical network are always synchronized.


IDatabaseCompact (optional)
IDataset
IDatasetContainer
IFeatureWorkspace
IFeatureWorkspace-Anno (optional)
IFeatureWorkspace-Manage
IFeatureWorkspace-SchemaEdit
IGeodatabaseRelease (optional)
ISpatialCacheManager
ISQLSyntax
ITransactions (optional)
ITransactionsOptions (optional)
IWorkspace
IWorkspaceConfig-uration (optional)
IWorkspaceDomains (optional)
IWorkspaceDomains2 (optional)
IWorkspaceEdit
IWorkspaceProperties (optional)
IWorkspaceSpatial-ReferenceInfo
Workspace
See chapter 8, 'Accessing the Geodatabase'
INetworkWorkspace
INetworkWorkspace2
Network-Workspace

The network workspace creates and opens logical networks.

The *NetworkWorkspace* coclass creates and opens logical networks.

INetworkWorkspace : IUnknown	***Provides access to members that create and open a logical network.***
← CreateNetwork (in NetworkName: String, in NetworkType: esriNetworkType, in BuildNormalizedTables: Boolean) : INetwork	*Creates a logical network.*
← GetNetworkNames: IEnumBSTR	*Sets the workspace*
← OpenNetwork (in NetworkName: String, in NetworkType: esriNetworkType, in networkAccess: esriNetworkAccess) : INetwork	*Opens a logical network.*

The *INetworkWorkspace* interface is used for creating and opening a logical network. This interface should be used when you need to create or open a logical network that does not have a geometric network associated with it. This may be necessary when you want to model relationships that do not have a spatial representation.

OpenNetwork should only be used to open a logical network that does not have an associated geometric network. Opening a network that does have a geometric network and updating elements can cause corruption of the network.

CreateNetwork should be used to create logical networks without geometric networks. To create a geometric network, use *INetworkCollection::CreateGeometricNetwork*.

INetworkWorkspace2:INetworkWorkspace	***Provides access to a member that create a logical network based on a configuration keyword.***
← CreateNetworkEx (in NetworkName: String, in NetworkType: esriNetworkType, in BuildNormalizedTables: Boolean, in ConfigKeyword: String) : INetwork	*Creates a logical network based on the specified configuration keyword.*

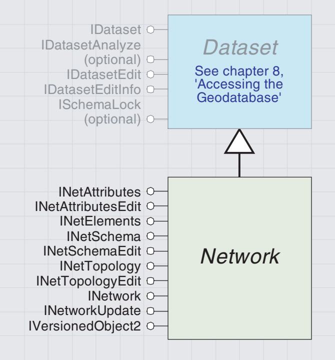
Use the *INetworkWorkspace2* interface when you want to create a logical network that is not associated with a geometric network. This interface differs from *INetworkWorkspace* in that the *CreateNetwork* method allows for the entry of a configuration keyword. The keyword is used by ArcSDE to determine what set of parameters from the dbtune file to employ.

Enumeration esriNetworkType	***Network type options.***
0 - esriNTStreetNetwork	*Street network.*
1 - esriNTUtilityNetwork	*Utility network.*

The *esriNetworkType* enumeration lists the types of networks that can be created.

Enumeration esriNetworkAccess	***Network read/write access privileges.***
0 - esriNAReadOnly	*Opens the network with read only permission.*
1 - esriNAReadWrite	*Opens the network with read and write permissions.*
2 - esriNACreate	*Creates a network.*

The *esriNetworkAccess* enumeration lists the possible modes to open a network with when using the *OpenNetwork* method.



The Network *abstract class represents the logical network. There are two types of network objects,* StreetNetwork *and* UtilityNetwork*.*

The *Network* abstract class provides access to the individual elements of the network and any associated weights. With a network, you can examine and update the schema, attributes, and topology of a logical network.

INetwork : IUnknown	***Provides access to members that give general information about the network and its elements.***
■— EdgeCount: Long	*Number of edges in the network.*
■— JunctionCount: Long	*Number of junctions in the network.*
■— MaxDegree: Long	*Maximum degree of a junction.*
■— MaxTurn: Long	*Maximum number of turns associated with a junction.*
■— Status: esriNetworkStatus	*Status of the network.*
■— TurnCount: Long	*Number of turns in the network.*
← CreateForwardStar (in honorState: Boolean, in pJunctionWeight: INetWeight, in pFromToEdgeWeight: INetWeight, in pToFromEdgeWeight: INetWeight, in turnWeight: INetWeight) : IForwardStar	*Creates a forward star cursor on the network index.*
← CreateNetBrowser (in ElementType: esriElementType) : IEnumNetEID	*Creates a network index element browser.*

The *INetwork* interface provides descriptive information for the logical network and provides the ability to create a *ForwardStar* object for traversing the network.

MaxTurn and *TurnCount* properties apply only to *StreetNetwork* objects and will return 0 for *UtilityNetwork* objects. *MaxDegree* returns a valid value for utility networks.

CreateForwardStar requires *INetWeight* objects as parameters even if the network does not have any weights associated with it. In this case, set the *INetWeight* to *Nothing* before using it as an argument.

```
Sub CreateFwdStar(pNetwork as INetwork)
  Dim pNetWeight As INetWeight, pForward As IForwardStar
  Set pNetWeight = Nothing
  Set pForward = pNetwork.CreateForwardStar(False, pNetWeight, _
    pNetWeight, pNetWeight, pNetWeight)
End Sub
```

Enumeration esriNetworkStatus	***Specifies the current status of the network.***
0 - esriNSInvalidConnection	*The network connection is invalid.*
1 - esriNSNetworkAlreadyExist	*The network already exists and hence cannot be created.*
2 - esriNSReadOnlyNetwork	*The network is read only.*
3 - esriNSCannotOpenTables	*The network tables cannot be opened.*
4 - esriNSCannotCreateTables	*The network tables cannot be created.*
5 - esriNSInvalidElementClasses	*The network element classes are invalid.*
6 - esriNSInvalidWeights	*The network weights are invalid.*
7 - esriNSUnknownStatus	*The status of the network is unknown.*
8 - esriNSValidNetwork	*The network is valid.*

esriNetworkStatus lists the possible returned status values for the *Status* property of a *Network* object.

This interface is designed specifically for the editing of a logical network that does not have an associated geometric network. It is imperative that if you have a geometric network, you must edit a logical network through its associated geometric network.You risk data corruption if you use the Edit interfaces on logical networks that have associated geometric networks.

INetworkUpdate : IUnknown	***Provides access to members that start and end sessions for updating the attributes, schema, and topology of the network.***
■— IsAttributesBeingUpdated: Boolean	*Indicates if the attributes of the network are currently being updated.*
■— IsSchemaBeingUpdated: Boolean	*Indicates if the schema of the network is currently being updated.*
■— IsTopologyBeingUpdated: Boolean	*Indicates if the topology of the network is currently being updated.*
← StartAttributesUpdating	*Starts a session for updating the attributes of the network.*
← StartSchemaUpdating	*Starts a session for updating the schema of the network.*
← StartTopologyUpdating	*Starts a session for updating the topology of the network.*
← StopAttributesUpdating	*Ends the session for updating the attributes of the network.*
← StopSchemaUpdating	*Ends the session for updating the schema for the network.*
← StopTopologyUpdating	*Ends the session for updating the topology of the network.*

The *INetworkUpdate* interface is implemented only by the *Network* abstract class to provide access to the different update processes for the network. Updates can be made to the attributes, schema, and topology of the network. For each process, it is necessary to be in an edit session before attempting to perform an update. An edit session can be started through the Editor toolbar or by executing one of the *Start* methods from the *INetworkUpdate* interface.

For example, if you want to edit the attributes (weight value or enabled/disabled state) of a network element, you need to be in an edit session or need to execute *StartAttributesUpdating* before performing the update. None of the start procedures can be executed when an edit session is in progress, and an edit session can't be started once one of the start procedures has been executed.

Once you have executed a start procedure, you can't perform a Start Editing procedure (from the Editor toolbar) until you have run the appropriate stop procedure.

Use the *IsAttributesBeingUpdated, IsSchemaBeingUpdated,* and *IsTopologyBeingUpdated* interfaces to determine if you need to run the appropriate start procedure.

The following VBA code can be used to update the disabled property of the selected simple edges. This code assumes there is not an active edit session.

```
Sub NetworkUpdate()
  Dim pDoc As IMxDocument, pMap As IMap
  Dim pFeatSel As IEnumFeature, pFeat As IFeature
  Set pDoc = ThisDocument
  Set pMap = pDoc.FocusMap

  Set pFeatSel = pMap.FeatureSelection
  Set pFeat = pFeatSel.Next
  Do While Not pFeat Is Nothing
    Dim pNetFeat As INetworkFeature, pNetAtt As INetAttributesEdit
    Dim pSimpleEdge As ISimpleEdgeFeature, pNetUpdate As INetworkUpdate
    Set pNetFeat = pFeat
    Set pNetAtt = pNetFeat.GeometricNetwork.Network
    Set pSimpleEdge = pNetFeat
    Set pNetUpdate = pNetAtt
    pNetUpdate.StartAttributesUpdating
    pNetAtt.SetDisabledState pSimpleEdge.EID, esriETEdge, True
    pNetUpdate.StopAttributesUpdating
    Set pFeat = pFeatSel.Next
  Loop
End Sub
```

INetElements : IUnknown	Provides access to members that convert between user IDs and network element IDs (EIDs).
← GetEID (in UserClassID: Long, in UserID: Long, in UserSubID: Long, in ElementType: esriElementType) : Long	Returns the network element ID (EID).
← GetEIDCount (in UserClassID: Long, in UserID: Long, in ElementType: esriElementType) : Long	Returns the number of network element IDs (EIDs) corresponding to the specified user class ID and user ID.
← GetEIDs (in UserClassID: Long, in UserID: Long, in ElementType: esriElementType) : IEnumNetEID	Returns the network element IDs (EIDs) corresponding to the specified user classID and user ID.
← IsValidElement (in EID: Long, in ElementType: esriElementType) : Boolean	Returns whether the specified element is part of the network.
← QueryIDs (in EID: Long, in ElementType: esriElementType, out UserClassID: Long, out UserID: Long, out UserSubID: Long)	Returns the user class ID, user ID, and user sub ID for the specified network element.

The *INetElements* interface is implemented by the *Network* abstract class to access the individual elements of the logical network. This interface is important because it provides the ability to go from a network element to a feature or from a feature to its elements.

As an example of when the interface would be used, consider an upstream trace operation. The trace operation is performed on the network with the results being the elements that are traversed. The *INetElements* interface is necessary to take this set of elements and determine the actual features that were traversed. The features could then be listed as part of report or simply highlighted.

GetEID returns the *EID* of the first associated element when there is more than one.

Use *GetEIDCount* to determine whether you should run *GetEID* (when you have only one associated element) or *GetEIDs* (when you have more than one element).

This interface is designed specifically for the editing of a logical network that does not have an associated geometric network. It is imperative that if you have a geometric network, you must edit a logical network through its associated geometric network.You risk data corruption if you use the Edit interfaces on logical networks that have associated geometric networks.

INetSchema : IUnknown	Provides access to members that get information about the schema of the network.
▪— ElementClass (in Index: Long) : INetElementClass	Element class by index.
▪— ElementClassByUserID (in elementClassUserID: Long) : INetElementClass	Element class corresponding to the specified user class ID.
▪— ElementClassCount: Long	Number of element classes in the network.
▪— Weight (in WeightInternalID: Long) : INetWeight	Network weight corresponding to the specified weight internal ID.
▪— WeightAssociations (in WeightInternalID: Long) : IEnumNetWeightAssociation	Network weight associations corresponding to the specified weight internal ID.
▪— WeightAssociationsByTableName (in TableName: String) : IEnumNetWeightAssociation	Network weight associations corresponding to the specified table name.
▪— WeightByName (in WeightName: String) : INetWeight	Network weight corresponding to the specified name.
▪— WeightCount: Long	Number of weights in the network.
← GetAncillaryRole (in UserClassID: Long, out ancillaryRole: esriNetworkClassAncillaryRole, out ancillaryRoleFieldName: String)	Returns the ancillary role type and the name of the field containing the ancillary role information.
← GetEnabledDisabledFieldName (in UserClassID: Long) : String	Returns the name of the filed containing the enabled/disabled information for the specified user class.

The *INetSchema* interface is implemented by the *Network* abstract class to provide read-only access to the schema of the network.

The schema consists primarily of the classes and weights that make up the network, but it also includes identification of the classes that provide sources and sinks (ancillary role) and a specification of the field name that represents this property and the enabled/disabled property. Use the *INetSchemaEdit* interface when you want to update the schema properties.

The *Weight* property returns information about a weight (name and type) as an *INetWeight*, while the *WeightAssociations* property returns the tables and field names associated with a particular weight as an *IEnumNetWeightAssociation*. A single *INetWeight* object can have zero to many *INetWeightAssociation* objects related to it, while a single *INetWeightAssocation* object must be related to a single *INetWeight* object.

An empty string will be returned for the *ancillaryRoleFieldName* when the *GetAncillaryRole* method is executed with a feature class that does not have an ancillary role.

WeightCount returns the number of defined weights, not the number of weight associations.

The *Weight* and *WeightAssociations* properties both require a *WeightInternalID* parameter as input. This parameter is the same thing as an index value. To access all the weights in a network, check the *WeightCount* and loop the index (or *WeightInternalID* number) from 0 to the *WeightCount* – 1.

```
Sub SetWeight()
  Dim pApp As IApplication, pUID As New UID, pNetExt As INetworkAnalysisExt
  Dim pNetWeight As INetWeight, pSchema As INetSchema, lLoop As Long
  Set pApp = Application
  pUID = "esricore.UtilityNetworkAnalysisExt"
  Set pNetExt = pApp.FindExtensionByCLSID(pUID)
  Set pSchema = pNetExt.CurrentNetwork.Network
  For lLoop = 0 To pSchema.WeightCount - 1
    Set pNetWeight = pSchema.Weight(lLoop)
    Debug.Print pNetWeight.WeightName
  Next lLoop
End Sub
```

This interface is designed specifically for the editing of a logical network that does not have an associated geometric network. It is imperative that if you have a geometric network, you must edit a logical network through its associated geometric network.You risk data corruption if you use the Edit interfaces on logical networks that have associated geometric networks.

INetSchemaEdit : INetSchema	***Provides access to members that modify the schema of the network.***
← AddElementClass (in UserClassID: Long) : INetElementClass	*Adds a new element class to the network.*
← AddWeight (in networkWeight: INetWeight)	*Adds a new weight to the network.*
← AddWeightAssociation (in weightSource: INetWeightAssociation)	*Adds a new weight association to the network.*
← PutAncillaryRole (in UserClassID: Long, in ancillaryRole: esriNetworkClassAncillaryRole, ancillaryRoleFieldName: String)	*Sets the ancillary role type and the name of the field containing the ancillary role information for the specified user class.*
← PutEnabledDisabledFieldName (in UserClassID: Long, in enabledDisabledRoleFieldName: String)	*Sets the name of the field containing the enabled/disabled information for the specified user class.*

The *INetSchemaEdit* interface is implemented by the *Network* abstract class. *INetSchemaEdit* is a companion interface to *INetSchema*. *INetSchema* provides read-only information about the schema of the network, while *INetSchemaEdit* is a write-only interface for updating the schema. The interface allows you to add a new feature class or weight to the network and to update the ancillary and enable/disable properties.

INetSchemaEdit inherits from *INetSchema*, so all of the read-only properties and methods of this interface are also available. If you need to do both read and write operations on the schema, it is best to declare a single *INetSchemaEdit* variable.

Before executing an update on the schema, you need to make sure you are in an edit session. You can check this by checking the value of *INetworkUpdate::IsSchemaBeingUpdated*. If the value is *False*, then you can start an edit session by clicking Start Editing and using the Edit tool, or you can execute *INetworkUpdate::StartSchemaUpdating*. If you take the latter approach, be sure to execute *INetworkUpdate::StopSchemaUpdating* when you have finished your updates.

AddElementClass will add a new feature class to the network based on the *IObjectClass::ObjectClassID*.

INetAttributes : IUnknown	***Provides access to members that get the disabled state and weight values of individual elements in the network.***
← GetDisabledState (in EID: Long, in ElementType: esriElementType) : Boolean	*Returns the disabled state of the specified network element.*
← GetWeightValue (in EID: Long, in ElementType: esriElementType, in WeightInternalID: Long) : Variant	*Returns the weight value of the specified network element for the specified weight.*

The *INetAttributes* interface is implemented by the *Network* abstract class to provide read-only access to the attributes of the network elements. The network attributes of an element are the enabled/disabled state (whether you can trace through the element) and any values related to a defined weight. Use this interface when you only want to view these attribute values (use *INetAttributesEdit* to update them).

The *WeightInternalID* input parameter for *GetWeightValue* is equivalent to an Index value (0 to *INetSchema.WeightCount* - 1).

Enumeration esriElementType	*Types of network elements.*
0 - esriETNone	*Deleted element.*
1 - esriETJunction	*Junction element.*
2 - esriETEdge	*Edge element.*
3 - esriETTurn	*Turn element.*

The *esriElementType* enumeration lists the types of elements.

INetAttributesEdit : INetAttributes	***Provides access to members that modify the disabled state and weight values of individual elements in the network.***
← SetDisabledState (in EID: Long, in ElementType: esriElementType, in disableState: Boolean)	*Sets the disabled state of the specified network element.*
← SetWeightValue (in EID: Long, in ElementType: esriElementType, in WeightInternalID: Long, in WeightValue: Variant)	*Sets the weight value of the specified network element for the specified weight.*

The *INetAttributesEdit* interface is implemented by the *Network* abstract class. *INetAttributesEdit* is a companion interface to *INetAttributes* interface. *INetAttributes* provides read-only information about the attributes of the network, while *INetAttributesEdit* is a write-only interface for updating the schema. The interface allows you to edit the enabled/disabled property of an element as well as the field values of any associated weights.

INetAttributesEdit inherits from *INetAttributes*, so all of the read-only properties and methods of this interface are also available. If you need to do both read and write operations on the attributes, it is best to declare a single *INetAttributesEdit* variable.

Before executing an update on the attributes, make sure you are in an edit session. You can check this by checking the value of *INetworkUpdate::IsAttributesBeingUpdated*. If the value is *False*, you can start an edit session by clicking Start Editing and using the Edit tool, or you can execute *INetworkUpdate::StartAttributesUpdating*.

If you take the latter approach, execute *INetworkUpdate::StopAttributesUpdating* when you have finished your updates.

INetTopology : IUnknown	***Provides access to members that get information about the elements adjacent to the specified element.***
← GetAdjacentEdge (in atJunctionEID: Long, in Index: Long, out AdjacentEdge: Long, out ReverseOrientation: Boolean)	*Returns the network element ID of the index'th adjacent edge to the specified junction.*
← GetAdjacentEdgeCount (in atJunctionEID: Long) : Long	*Returns the number of edges adjacent to the specified junction.*
← GetAdjacentEdges (in atJunctionEID: Long, in adjacentEdgesCount: Long, out adjacentEdges: Long, out ReverseOrientation: Boolean)	*Returns the network element IDs of all the edges adjacent to the specified junction.*
← GetFromToJunctionEIDs (in EdgeEID: Long, out FromJunctionEID: Long, out ToJunctionEID: Long)	*Returns the network element IDs of the junctions adjacent to the specified edge.*

The *INetTopology* interface is implemented only by the *Network* class for read-only access to the topology parameters of the network. The interface has methods for identifying the edges adjacent to the specified junction element and the to and from junctions for the specified edge.

The following VBA code prints the EIDs and reverse orientation values for the edges connected to a selected simple junction.

```
Sub ListEIDs()
  Dim pDoc As IMxDocument, pMap As IMap
  Dim pFeatSel As IEnumFeature
  Dim pFeat As IFeature
  Set pDoc = ThisDocument
  Set pMap = pDoc.FocusMap

  Set pFeatSel = pMap.FeatureSelection
  pFeatSel.Reset
  Set pFeat = pFeatSel.Next
  Do While Not pFeat Is Nothing
    Dim pNetFeat As INetworkFeature
    Dim pSimpleJunc As ISimpleJunctionFeature
    Set pNetFeat = pFeat
    If pFeat.FeatureType = esriFTSimpleJunction Then
      Set pSimpleJunc = pNetFeat
      Dim pTopo As INetTopology, lEdgeCount As Long
      lEdgeCount = pSimpleJunc.EdgeFeatureCount
      Set pTopo = pNetFeat.GeometricNetwork.Network
      Dim lAdjacentEdges() As Long, bRev() As Boolean, lLoop As Long

      ReDim lAdjacentEdges(lEdgeCount - 1)

      ReDim bRev(lEdgeCount - 1)
      pTopo.GetAdjacentEdges pSimpleJunc.EID, lEdgeCount, _
          lAdjacentEdges(0), bRev(0)
      For lLoop = 0 To lEdgeCount - 1
        Debug.Print lAdjacentEdges(lLoop) & " - " & bRev(lLoop)
      Next lLoop
    End If
    Set pFeat = pFeatSel.Next
  Loop

End Sub
```

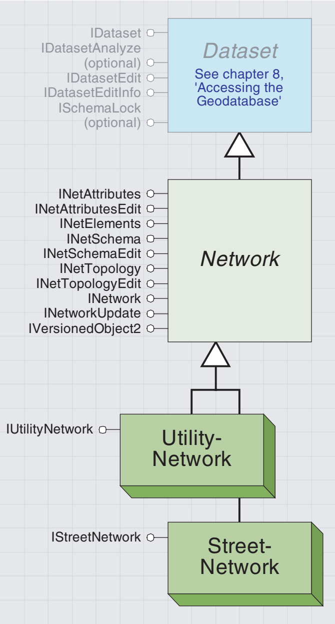
This interface is designed specifically for the editing of a logical network that does not have an associated geometric network. It is imperative that if you have a geometric network, you must edit a logical network through its associated geometric network.You risk data corruption if you use the Edit interfaces on logical networks that have associated geometric networks.

INetTopologyEdit : INetTopology	***Provides access to members that add and delete network elements from the logical network.***
← AddEdgeByEndEIDs (in edgeDescription: INetElementDescription, in FromJunctionEID: Long, in ToJunctionEID: Long) : Long	*Adds an edge element to the logical network between the specified junction elements.*
← AddJunction (in junctionDescription: INetElementDescription) : Long	*Adds a junction element to the logical network.*
← DeleteByEID (in EID: Long, in ElementType: esriElementType)	*Deletes the specified network element from the logical network.*
← DeleteByEIDs (in ElementType: esriElementType, in ElementCount: Long, in elementEIDs: Long)	*Deletes the specified network elements from the logical network.*
← DeleteByID (in UserClassID: Long, in UserID: Long, in UserSubID: Long, in ElementType: esriElementType)	*Deletes the specified network element from the logical network.*

The *INetTopologyEdit* interface is implemented only by the *Network* abstract class. *INetTopologyEdit* is a companion interface to *INetTopology*. *INetTopology* provides read-only information about the topology of the network, while *INetTopologyEdit* is a write-only interface for updating the topology. The interface allows you to add and delete network elements (junctions and edges).

INetTopologyEdit inherits from *INetTopology*, so all of the read-only properties and methods of this interface are also available. If you need to do both read and write operations on the topology, it is best to declare a single *INetTopologyEdit* variable.

Before executing an update on the topology, make sure you are in an edit session. You can check this by checking the value of *INetworkUpdate::IsTopologyBeingUpdated*. If the value is *False*, then you can start an edit session by clicking Start Editing and using the Edit tool, or you can execute *INetworkUpdate::StartTopologyUpdating*. If you take the latter approach, execute *INetworkUpdate::StopTopologyUpdating* when you have finished your updates.



The utility network object represents facility networks with directed flow. Networks of this type allow upstream and downstream types of analysis.

The street network object represents transportation network without any defined flow.

A *StreetNetwork* is a type of *Network* designed for working with roadways (highways, streets, and so on). Future releases of ArcGIS will include additional interfaces implemented on the class to provide street-specific types of operations. The only distinguishing characteristic of a *StreetNetwork* class is that it is not a *UtilityNetwork*.

IStreetNetwork : INetwork	***Provides accesss to members that get and set properties specific to a street network.***

The *IStreetNetwork* class is the default interface for the *StreetNetwork* class. This interface has no properties or methods and exists only to distinguish a *StreetNetwork* from a *UtilityNetwork*.

A *UtilityNetwork* is a type of *Network* designed for working with facilities data (gas, electric, water, telecommunications). The purpose of the class is to provide utility-specific operations, such as the establishment of flow direction for the network.

IUtilityNetwork : INetwork	***Provides access to members that get and set flow direction in a utility network.***
ValidFlowDirection: Boolean	*Property not implemented.*
EstablishFlowDirection (in sourceCount: Long, in sourceEIDs: Long, in sinkCount: Long, in sinkEIDs: Long)	*Sets the flow direction of all edge elements based on the placement of sources and sinks.*
GetFlowDirection (in EdgeEID: Long) : esriFlowDirection	*Returns the flow direction of the specified edge element.*
SetFlowDirection (in EdgeEID: Long, in flowDirection: esriFlowDirection)	*Sets the flow direction for the specified edge element.*

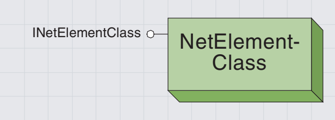
The *IUtilityNetwork* interface is the default interface for the *UtilityNetwork* class. The interface deals with the establishment of flow direction on the network. Flow direction is used in trace operations to determine such things as the upstream or downstream facilities from a particular location.

EstablishFlowDirection sets the flow direction of the entire network based on specified sources and sinks. Sources and sinks can be stored persistently in the network through an ancillary role, but they can also be dynamic.

SetFlowDirection sets the flow direction for a single specified element. This method allows for the setting of flow direction based on the digitized direction or other specialized methods.

Enumeration esriFlowDirection	***Direction of flow along an edge in a network.***
0 - esriFDUninitialized	*The flow direction is uninitialized.*
1 - esriFDWithFlow	*The flow direction is in the direction of digitization.*
2 - esriFDAgainstFlow	*The flow direction is opposite the direction of digitization.*
3 - esriFDIndeterminate	*The flow direction is indeterminate.*

The *esriFlowDirection* enumeration lists the possible flow direction settings for an edge element.



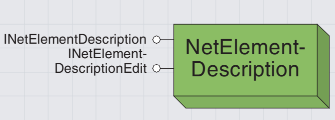
The net element class provides access to the IDs of the object class represented in the network.

A *NetElementClass* object can be obtained through various methods including the *ElementClass* and *ElementClassByUserID* on the *INetSchema* interface.

This class allows access to the IDs of the user classes participating in the logical network. As with most interfaces and classes related to the logical network, this class is only important when dealing with a logical network that does not have an associated geometric network.

INetElementClass : IUnknown	***Provides access to a member that gets the user class ID of an element class in the logical network.***
UserClassID: Long	*UserClassID of an element class in the logical network.*

The *INetElementClass* interface is the only interface for the *NetElementClass* class. Use this interface when you want to access the ID of a class participating in the logical network.



The net element description object provides access to the parameters of an element. This object allows you to define a new element based on the specified object class and object ID.

The *NetElementDescription* coclass creates network elements to be added to a logical network without an associated geometric network. (If you do have a geometric network, you should add new elements by adding new features to your feature classes.)

The *AddEdgeByEndEID* and *AddJunction* methods on *ITopologyEdit* take *NetElementDescription* objects as input for creating new network elements.

INetElementDescription : IUnknown	***Provides access to members that get information about the element described by this NetElementDescription object.***
ElementType: esriElementType	*Type of network element described by this NetElementDescription object.*
UserClassID: Long	*User class ID for the element described by this NetElementDescription object.*
UserID: Long	*User ID for the element described by this NetElementDescription object.*
UserSubID: Long	*User sub ID for the element described by this NetElementDescription object.*

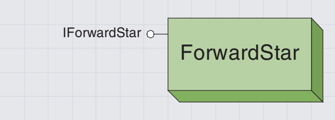
The *INetElementDescription* interface provides read-only access to the properties of a network element (element type, user class, and user ID).

UserSubID returns the index number of an element that is part of a complex network feature. For simple network features (edges and junctions), the *UserSubID* is 0 when that feature is added. Subsequent edits will change this value.

INetElementDescriptionEdit : INetElementDescription	***Provides access to members that set information for this NetElementDescription object.***
ElementType: esriElementType	*Type of network element for this NetElementDescription object.*
UserClassID: Long	*User class ID for this NetElementDescription object.*
UserID: Long	*User ID for this NetElementDescription object.*
UserSubID: Long	*User sub ID for this NetElementDescription object.*

INetElementDescriptionEdit is an interface on the *NetworkDescription* coclass that edits network element properties. This interface inherits from *INetElementDescription*, so it provides read–write access to the element description. Use this interface when creating a new network element to add to a logical network that is not associated with a geometric network.

ElementType returns or sets the type of the element. The possible types are *esriETEdge* (value of 2), *esriETJunction* (value of 1), *esriETNone* (value of 0), and *esriETTurn* (value of 3).



The forward star is important when you wish to create your own trace solver routines or want to walk through the network connectivity for some other reason.

The *ForwardStar* class is created through the *INetwork* interface and is designed to allow incremental stepping through a logical network. The ESRI trace solver routines are all based on the *ForwardStar* class.

IForwardStar : IUnknown	***Provides access to members that query information about adjacent elements in the logical network.***
■— Network: INetwork	*Underlying network of this forward star cursor.*
← FindAdjacent (in fromEdgeEID: Long, in atJunctionEID: Long, out adjacentEdgesCount: Long)	*Finds the edge elements that are adjacent to the given junction element and returns the count.*
← QueryAdjacentEdge (in Index: Long, out adjacentEdgeEID: Long, out ReverseOrientation: Boolean, out adjacentEdgeWeightValue: Variant)	*Returns index'th adjacent edge found with FindAdjacent, its orientation, and its weight value.*
← QueryAdjacentEdges (in Count: Long, out adjacentEdgeEIDs: Long, out ReverseOrientation: Boolean, out adjacentEdgesWeightValue: Variant)	*Returns the adjacent edges found with FindAdjacent into the specified user-defined array.*
← QueryAdjacentJunction (in Index: Long, out adjacentJunctionEID: Long, out adjacentJunctionWeightValue: Variant)	*Returns the opposite junction of the index'th adjacent edge found with FindAdjacent, and the weight value for this junction.*
← QueryAdjacentJunctions (in Count: Long, out adjacentJunctionEIDs: Long, out adjacentJunctionsWeightValue: Variant)	*Returns the opposite junctions of the adjacent edges found with FindAdjacent into the specified user-defined array.*
← QueryAtTurn (in Index: Long, out adjacentTurnEID: Long, out adjacentTurnWeightValue: Variant)	*Returns the turn through which the index'th adjacent edge found with FindAdjacent passes, and the weight value of the turn.*
← QueryAtTurns (in Count: Long, out adjacentTurnEIDs: Long, out adjacentTurnsWeightValue: Variant)	*Returns the turns through which the adjacent edges found with FindAdjacent passes into the user-defined array.*

The *IForwardStar* interface provides methods for querying the connectivity between junctions, edges, and turns. Use this interface when you want to create your own trace solving routines, generate a network schematic, or perform some other operation based on the connectivity of the logical network.

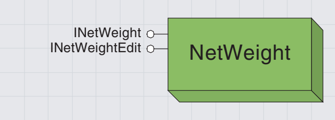
In order to use any of the Query *methods, you must first run the* FindAdjacent *method. This code demonstrates how to use the* FindAdjacent *method to set the stage for the* Query *methods (*m_pForward *is a variable defined as an* IForwardStar*).*

```
Sub TraverseSegment(pForward as IForwardStar, lEdgeEID As Long, _
  lInJunc As Long)
  Dim lLoop As Long, lEdgeCount As Long, lOutEID As Long
  Dim bOrient As Boolean, pWeight As Variant, lOutJuncEID As Long
  pForward.FindAdjacent lEdgeEID, lInJunc, lEdgeCount
  For lLoop = 0 To lEdgeCount - 1
    pForward.QueryAdjacentEdge pLoop, pOutEID, bOrient, pWeight
    If lOutEID <> lEdgeEID Then
      pForward.QueryAdjacentJunction lLoop, lOutJuncEID, pWeight
    End If
  Next lLoop
End Sub
```

FindAdjacent returns a count of all the edges connected to the specified edge through the specified junction. This method must be run before you use any of the other *Query* methods on the interface.

QueryAdjacentEdge returns the EID and weight value of an edge indicated by the index value. This method needs to be run after the *FindAdjacent* method.

QueryAdjacentJunctions returns an array of junctions based on the user-specified count. This method needs to be run after the *FindAdjacent* method.



The net weight object defines the type of constraining parameter to apply to a network, while net weight association objects define the object classes and fields that will participate in that weight.

Weights actually serve two purposes: to limit tracing in a network and to denote cost of tracing through a network element.

Edges and junctions can have any number of weights associated with them. Weights are typically used to store the cost of traversing across an edge or through a junction. A typical weight is the length of the edge. Weights are created from field values on the edge and junction feature classes.

Weights are stored with the logical network so that analysis programs can access them efficiently. When a weight value is modified on a feature table, it is automatically updated in the logical network.

The *NetWeight* coclass objects define the weight categories to apply to a particular network. *NetWeight* objects define the type of weight to be applied (*Null, BitGate, Integer, Single,* and *Double*), while *NetWeightAssociation* objects define which field in a feature class will participate in a weight. For example, a *NetWeight* object that specifies an integer weight with a name of "phase" might be created. A number of *NetWeightAssociation* objects would then be created to specify the name of the field in each participating feature class that contains the phase information.

INetWeight : IUnknown	***Provides access to members that get information about the network weight described by this NetWeight object.***
BitGateSize: Long	*Bit gate size of the network weight described by this NetWeight object.*
WeightID: Long	*Internal ID of the network weight described by this NetWeight object.*
WeightName: String	*Name of the network weight described by this NetWeight object.*
WeightType: esriWeightType	*Type of network weight described by this NetWeight object.*

INetWeight, the default interface on the *NetWeight* coclass, provides read-only access to the properties of a network weight object. The interface provides access to the name, type, ID, and bitgatesize (where applicable) properties of the weight.

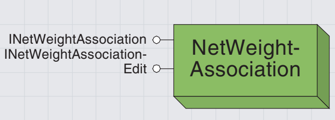
BitGateSize defines the number of bits to be used as the bit gate.

WeightName is an arbitrary name given to the weight when it is created.

INetWeightEdit : INetWeight	***Provides access to members that set information for this NetWeight object.***
BitGateSize: Long	*Bit gate size of this NetWeight object.*
WeightName: String	*Name of this NetWeight object.*
WeightType: esriWeightType	*Type of network weight of this NetWeight object.*

INetWeightEdit is an interface on the *NetWeight* coclass that edits *NetWeight* object properties. This interface inherits from *INetWeight*, so it provides read–write access to the *NetWeight* object. Use this interface when you are creating a weight object to add to your logical network.

WeightType defines the type of weight being defined (*Null, BitGate, Integer, Single,* or *Double*).



Net weight association objects define the object classes and fields that will participate in that weight.

The *NetWeightAssociation* objects define how a particular object class participates in a network weight. Object classes participate in a weight when a *NetWeightAssociation* that specifies the name of the table and the field containing attribute values that correspond to the particular weight is created. For example, a *NetWeight* object might be created with an integer type. Any *NetWeightAssociation* objects that want to participate in that weight must define a table field that contains integer values.

Once a weight is defined, it can be employed during trace-solving procedures to dictate flow through the different elements.

Once a *NetWeightAssociation* object is defined, any update to the specified table and field will propagate to the logical network.

INetWeightAssociation : IUnknown	*Provides access to members that get information about the network weight association described by this NetWeightAssociation object.*
FieldName: String	*Name of the field that contains the values for this weight.*
TableName: String	*Name of the table to which this weight is associated.*
WeightID: Long	*Weight internal ID of the weight to which this table is associated.*

The *INetWeightAssociation* interface is implemented by the *NetWeightAssociation* coclass and provides read-only access to the properties of the object. The interface provides access to the table name, field name, and ID of the associated weight.

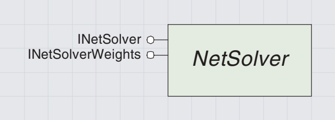
WeightID refers to the weight (*NetWeight* object) in which the association participates.

INetWeightAssociationEdit : INetWeightAssociation	*Provides access to members that set information for this NetWeightAssociation object.*
FieldName: String	*Name of the field that contains the values for this associated weight.*
TableName: String	*Name of the table to be associated in this weight association.*
WeightID: Long	*Weight internal ID of the weight to be associated in this weight association.*

INetWeightAssociationEdit is an interface on the *NetWeightAssociation* coclass that edits *NetWeightAssociation* object properties. This interface inherits from *INetWeightAssociation*, so it provides read–write access to the properties.

Use this interface when you want to specify a field (from a particular table or feature class) to participate in a defined weight object in the network.

TableName designates the name of the table/feature class that contains the field to use in the weight object.



The NetSolver *object is a key object for anyone that wishes to write their own trace-solving routines based on existing ESRI methods. The* NetSolver *abstract class only supports the* TraceFlowSolver *coclass.*

The *NetSolver* object sets the table for the trace methods found in the *TraceFlowSolver* class. Through this object, you can specify the network you are working on, disable entire network classes, specify individual barriers, and define weights. The derived *TraceFlowSolver* class can then be used to run a trace on the defined problem.

INetSolver : IUnknown	*Provides access to members that specify the network and the barriers to be used with this solver.*
ElementBarriers (in ElementType: esriElementType) : INetElementBarriers	*Network element barrier set to be used in this solver.*
SelectionSetBarriers: ISelectionSetBarriers	*Selection set barriers to be used in this solver.*
SourceNetwork: INetwork	*Source network to be used in this solver.*
DisableElementClass (in ClassID: Long)	*Sets an element class as disabled within this solver.*

The *INetSolver* interface specifies barriers and disabled classes. This interface is key when you need to limit your traces based on the exclusion of entire classes or individual elements. This interface offers three different ways to set barriers for the purpose of limiting traces.

The *DisableElementClass* method stops traces at every instance of the specified class. For example, if you have a gas pipe that has burst and you need to identify all valves to shutoff, then you would use this method to set barriers at every valve in the network.

The *ElementBarriers* property lets you specify an *INetElementBarriers* object that contains individual elements to use as barriers. These could be barriers composed of closed street segments, bridges that are out, or individual electric switches that have been opened for some reason.

The *SelectionSetBarriers* property is similar to the *ElementBarriers* property. It allows you to specify an *ISelectSetBarriers* object to use as a barrier in your trace-solving routine. *SelectionSetBarriers* are meant to be barriers based on a selected set of elements, such as 8-inch pipes and six-lane highways.

Here is some sample code for using the *ElementBarriers* property to set barriers based on a set of identified elements.

```
Sub SetEdgeBarrier(pNetwork As INetwork, pFeatClass As IFeatureClass,
lEdgeOID1 As Long, lEdgeOID2 As Long)
  'Create the NetElementBarriers object
  Dim pNetEdgeBarriers As INetElementBarriers, lOIDs(1) As Long
  Set pNetEdgeBarriers = New NetElementBarriers
  lOIDs(0) = lEdgeOID1
  lOIDs(1) = lEdgeOID2
  Set pNetEdgeBarriers.Network = pNetwork
  pNetEdgeBarriers.ElementType = esriETEdge
  pNetEdgeBarriers.SetBarriers pFeatClass.FeatureClassID, 2, lOIDs(0)
'Pass in the first element of the array

  'Set the edge barrier in the TraceFlowSolver
  Dim pTraceFlowSolver As ITraceFlowSolver, pNetSolver As INetSolver
  Set pTraceFlowSolver = New TraceFlowSolver
  Set pNetSolver = pTraceFlowSolver
  Set pNetSolver.SourceNetwork = pNetwork
  Set pNetSolver.ElementBarriers(esriETEdge) = pNetEdgeBarriers
End Sub
```

An alternative method for using the *SetBarriers* method above is to collect all the *OIDs* of all the elements in order to use the barriers in the *pOIDs* array, then execute *SetBarriers* once.

INetSolverWeights : IUnknown	*Provides access to members that specify the weights to be used for this solver.*
FromToEdgeFilterWeight: INetWeight	*Weight to be used for filtering edge elements traced in the digitized direction.*
FromToEdgeWeight: INetWeight	*Weight to be used to determine the cost of passing through edge elements in the digitized direction.*
JunctionFilterWeight: INetWeight	*Weight to be used for filtering junction elements.*
JunctionWeight: INetWeight	*Weight to be used to determine the cost of passing through junction elements.*
ToFromEdgeFilterWeight: INetWeight	*Weight to be used for filtering edge elements traced against the digitized direction.*
ToFromEdgeWeight: INetWeight	*Weight to be used to determine the cost of passing through edge elements against the digitized direction.*
SetFilterRanges (in ElementType: esriElementType, in rangeCount: Long, in fromValues: Variant, in toValues: Variant)	*Sets the range of values to be filtered for the specified network element type.*
SetFilterType (in ElementType: esriElementType, in weightFilterType: esriNetWeightFilterType, in applyNotOperator: Boolean)	*Sets the filter type for the specified network element type.*

The *INetSolverWeights* interface specifies the weights to use during trace-solving procedures. For a description of how weights are used, see the *NetWeight* coclass documentation. This interface allows you to specify junction and edge weights and also set the filters to be used in conjunction with the weights. The filters specify the attribute values or ranges to use or not use when tracing. For instance, a cathodic protection trace might be done by tracing on steel pipe, so the weight filter would indicate to trace only on the value representing steel pipe.

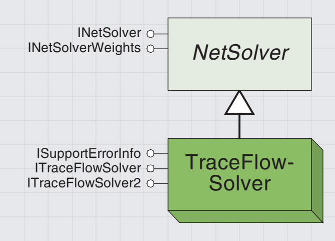
Filter weights (*FromToEdgeFilterWeight, ToFromEdgeFilterWeight,* and *JunctionFilterWeight*) are used to explicitly specify the type of feature on which you do or do not want to trace.

FromToEdgeFilterWeight, FromToEdgeWeight, ToFromEdgeFilterWeight, and *ToFromEdgeWeight* get their from and to direction based on the digitized direction of the edge.

Here is some sample code for setting filter weights on edges and junctions. The edge weight is called “Material”, and the filter is being set to not trace on values of 1. The junction weight is called “Fitting_Type”, and the filter is being set to not trace on values of 8.

```
Sub SetFilterWeights()
  Dim pApp As IApplication, pUID As New UID
  Dim pNetSolverWeights As INetSolverWeights
  Dim pWeight As INetWeight, pSchema As INetSchema
  Dim lRange(1) As Long, pNetExt As INetworkAnalysisExt
  Set pApp = Application
  pUID = "esricore.UtilityNetworkAnalysisExt"
  Set pNetExt = pApp.FindExtensionByCLSID(pUID)
```

```
' Establish the trace flow solver
  Dim pTraceFlowSolver As ITraceFlowSolver
  Set pTraceFlowSolver = New TraceFlowSolver
  Dim pNetSolver As INetSolver
  Set pNetSolver = pTraceFlowSolver
  Set pNetSolver.SourceNetwork = pNetExt.CurrentNetwork.Network

  'Add the weights
  Set pSchema = pNetExt.CurrentNetwork.Network
  Set pNetSolverWeights = pTraceFlowSolver
  Set pWeight = pSchema.WeightByName("Material")

  Set pNetSolverWeights.FromToEdgeFilterWeight = pWeight
  Set pNetSolverWeights.ToFromEdgeFilterWeight = pWeight

  pNetSolverWeights.SetFilterType esriETEdge, esriWFRange, True
  lRange(0) = 1
  pNetSolverWeights.SetFilterRanges esriETEdge, 1, lRange(0), lRange(0)
  Set pWeight = pSchema.WeightByName("Fitting_Type")
  Set pNetSolverWeights.JunctionFilterWeight = pWeight

  pNetSolverWeights.SetFilterType esriETJunction, esriWFRange, True

  lRange(0) = 8
  pNetSolverWeights.SetFilterRanges esriETJunction, 1, lRange(0), lRange(0)
End Sub
```



The trace flow solver object is a type of NetSolver *used to perform traces on the network based on the limitations (barriers and weights) specified with the* NetSolver *object.*

The *TraceFlowSolver* object contains a set of traces developed by ESRI for use with custom code. You also have the option of generating your own trace routines by using the *ForwardStar* object.

ITraceFlowSolver : IUnknown	***Provides access to members that perform basic traces on a network.***
TraceIndeterminateFlow: Boolean	*Indicates if directional traces include edges with indeterminate or uninitialized flow direction.*
FindCircuits (in flowElements: esriFlowElements, out junctionEIDs: IEnumNetEID, out edgeEIDs: IEnumNetEID)	*Finds all reachable network elements that are parts of closed circuits in the network.*
FindCommonAncestors (in flowElements: esriFlowElements, out junctionEIDs: IEnumNetEID, out edgeEIDs: IEnumNetEID)	*Finds all reachable network elements that are upstream from all the specified origins.*
FindFlowElements (in FlowMethod: esriFlowMethod, in flowElements: esriFlowElements, out junctionEIDs: IEnumNetEID, out edgeEIDs: IEnumNetEID)	*Finds all reachable network elements based on the specified flow method.*
FindFlowEndElements (in FlowMethod: esriFlowMethod, in flowElements: esriFlowElements, out junctionEIDs: IEnumNetEID, out edgeEIDs: IEnumNetEID)	*Finds all reachable network end elements based on the specified flow method.*
FindPath (in FlowMethod: esriFlowMethod, in objFn: esriShortestPathObjFn, out junctionEIDs: IEnumNetEID, out edgeEIDs: IEnumNetEID, in Count: Long, segmentCosts: Variant)	*Finds a path between the specified origins in the network.*
PutEdgeOrigins (in edgeOriginCount: Long, in edgeOrigins: IEdgeFlag)	*Sets the starting edges for this trace solver.*
PutJunctionOrigins (in junctionOriginCount: Long, in junctionOrigins: IJunctionFlag)	*Sets the starting junctions for this trace solver.*

The *ITraceFlowSolver* interface lets you specify junction and edge origins and then execute one of the trace methods. These trace methods should allow you to perform the majority of required tracing tasks; traces not included with this interface need to be constructed via the *ForwardStar* object.

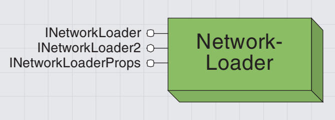
ITraceFlowSolver2 : ITraceFlowSolver	***Provides access to members that perform traces on a network.***
FindAccumulation (in FlowMethod: esriFlowMethod, in flowElements: esriFlowElements, out junctionEIDs: IEnumNetEID, out edgeEIDs: IEnumNetEID, out pTotalCost: Variant)	*Finds the total cost of all reachable network elements based on the specified flow method.*
FindFlowUnreachedElements (in FlowMethod: esriFlowMethod, in flowElements: esriFlowElements, out junctionEIDs: IEnumNetEID, out edgeEIDs: IEnumNetEID)	*Finds all unreachable network elements based on the flow method.*
FindSource (in FlowMethod: esriFlowMethod, in objFn: esriShortestPathObjFn, out junctionEIDs: IEnumNetEID, out edgeEIDs: IEnumNetEID, in Count: Long, segmentCosts: Variant)	*Finds a path upstream to a source or downstream to a sink, depending on the specified flow method.*

ITraceFlowSolver2 adds more trace solvers to the *TraceFlowSolver* object. It can be used in a similar way as the *ITraceFlowSolver* interface.

Many of the traces require that flow direction has been established on the network. You can set flow direction through the *IUtilityNetwork* interface.

There are four basic trace algorithms that can be used to solve a variety of trace-flow problems. These methods are used in the Utility Network Analyst toolbar to create the nine trace tasks available there, and they can also be used by the developer to create an unlimited number of new tasks.

- *FindCircuits* (sometimes known as find loops) finds elements that can be reached from more than one direction. This method is important for such things as electrical networks, where electricity traveling in both directions on an edge can cause problems.
- *FindCommonAncestors* finds the common elements in an upstream trace from more than one location. This method helps determine potential pollution sources based on sites where contaminants have been discovered or identify potential outage locations when multiple customers have reported that their service is out.
- *FindFlowElements* and *FindFlowEndElements* perform the same type of analysis. The only difference is that *FindFlowEndElements* returns only the termination elements of the trace. These methods are probably the most important trace methods because they solve problems, such as what is upstream from this location, what is downstream, what is connected, and so on. By applying further constraints (such as disabling classes), these methods can perform additional analysis, such as shutoff modeling.
- *FindPath* determines the optimal path between two or more flags. The flags will be routed in order beginning with the first flag entered and ending with the last. By default, the optimal path is based on the number of elements traversed, with optimal being the least number of elements. Define weights on the network to base the optimal path on length of segments, travel time, or some other parameter.



Besides the Network object, the NetworkLoader object may be the key object in the network model. Even though you may only use this object one time, it is important because it builds the geometry network and its logical network when you have existing feature classes. All the other objects are of no use until you have somehow made use of the NetworkLoader object to generate the network.

If you wish to create a network without an associated geometric network, then use the NetworkWorkspace object and the interfaces provided there.

The *NetworkLoader* coclass allows you to specify input parameters for the name and type of network, the feature classes to be included, the feature classes to be used as sources and sinks, and the weights you wish to employ. All of these parameters are specified up front through the object, and then the *LoadNetwork* method is executed to generate the logical network.

INetworkLoader : IUnknown	***Provides access to members used to create a new geometric network.***
—□ FeatureDatasetName: IDatasetName	*Feature dataset name to where the new geometric network is to be created.*
—■ NetworkName: String	*Name of the new geometric network.*
—■ NetworkType: esriNetworkType	*Network type of the new geometric network.*
—■ SnapTolerance: Double	*Snap tolerance to be used in creating the new geometric network.*
← AddFeatureClass (in FeatureClassName: String, in newFeatureType: esriFeatureType, in newClsID: IUID, in canChangeGeometry: Boolean)	*Adds a feature class to the new geometric network.*
← AddWeight (in networkWeightName: String, in WeightType: esriWeightType, in BitGateSize: Long)	*Adds a weight to the new geometric network.*
← AddWeightAssociation (in networkWeightName: String, in FeatureClassName: String, in FieldName: String)	*Adds an association between a network weight and a feature class attribute.*
← LoadNetwork	*Creates the new geometric network inside the feature dataset.*
← PutAncillaryRole (in FeatureClassName: String, in ancillaryRole: esriNetworkClassAncillaryRole, in ancillaryRoleFieldName: String)	*Specifies the ancillary role attribute field for the specified feature class.*
← PutEnabledDisabledFieldName (in FeatureClassName: String, in enabledDisabledFieldName: String)	*Specifies the enabled/disabled field for the specified feature class.*

The *INetworkLoader* lets you set the parameters to use in building a logical network out of a set of feature classes within the same dataset. Use this interface when you want to define and generate your logical network.

At present, the majority of network functionality has been implemented for utility networks.

NetworkType specifies the type of network to be built: street or utility.

LoadNetwork generates the network based on the specified parameters. Do not execute this method until you have finished setting the parameters.

Use *PutEnabledDisabledFieldName* when you want to specify a field to hold the enabled/disabled setting for a feature that differs from the default defined in the *INetworkLoaderProps* interface.

INetworkLoader2 : INetworkLoader	Provides access to members that specify parameters for creating a new geometric network.
ConfigurationKeyword: String	Configuration keyword for the new geometric network.
ErrorTableName: String	Name of the table containing errors encountered while building the new geometric network.
MinSnapTolerance: Double	Minimum nonzero snap tolerance for creating a new geometric network.
NumInvalidFeatures (in FeatureClassName: String) : Long	Number of features with invalid geometry in the given feature class.
PreserveEnabledValues: Boolean	Indicates if the Network Loader should preserve the values in the existing Enabled fields.
TotalNumInvalidFeatures: Long	Total number of features with invalid geometry.
CanUseFeatureClass (in FeatureClassName: String) : esriNetworkLoaderFeatureClassCheck	Determines if the given feature class can participate in a network.
CheckAncillaryRoleField (in FeatureClassName: String, in FieldName: String) : esriNetworkLoaderFieldCheck	Determines whether the given AncillaryRole field is valid.
CheckEnabledDisabledField (in FeatureClassName: String, in FieldName: String) : esriNetworkLoaderFieldCheck	Determines whether the given Enabled field is valid.

The *INetworkLoader2* interface provides access to members that specify parameters for creating a new geometric network.

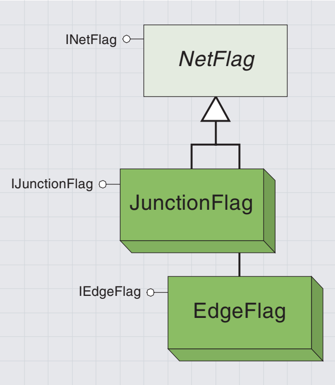
INetworkLoaderProps : IUnknown	Provides access to memebers that return the default names of fields and domains used by the network loader.
DefaultAncillaryRoleDomain: String	Default ancillary role domain name.
DefaultAncillaryRoleField: String	Default ancillary role field name.
DefaultEnabledDomain: String	Default enabled domain name.
DefaultEnabledField: String	Default enabled field name.

The *INetworkLoaderProps* interface returns names for the ancillary and enabled/disabled fields and domains.

When you execute the *LoadNetwork* method on *INetworkLoader*, a logical network is generated based on the feature classes you specify. An enabled/disabled field is added within the table for each feature class to keep track of whether flow can go through each individual feature. There is also a domain created with the values of “enabled” and “disabled”. This domain is automatically assigned to the created field within each feature class.

The *INetworkLoaderProps* interface allows you to see the default field names that will be added to each feature class and the name of the domain. In addition, default field and domain names can be returned for the ancillary role (feature classes that contain sources or sinks).

DefaultEnabledField returns the field name that will be added to each feature class to keep the enabled/disabled property of the individual features.



Net flag objects designate the starting points for traces and path-finding routines. The net flag object itself maintains a description of the feature on which the flag has been placed.

The junction flag object indicates a starting point on a junction feature, while an edge flag object indicates a starting point somewhere along an edge feature.

The UserSubID *must be specified, even for noncomplex network features. You can look up any nework element's ID by calling* INetElements::QueryIDs *and passing in its EID.*

The *NetFlag* abstract class has two classes that are derived from it: *EdgeFlag* and *JunctionFlag*. The purpose of the class is to specify the starting points (flags) of traces and path-finding routines. When a flag is created, it is necessary to specify whether that flag is on an edge or a junction. The *PutEdgeOrigins* and *PutJunctionOrigins* methods on *ITraceFlowSolver* include the flags in the current trace.

INetFlag : IUnknown	***Provides access to members that specify the network element on which a flag is located.***
ClientClassID: Long	*User-specified client class ID of this flag.*
ClientID: Long	*User-specified client ID of this flag.*
Label: String	*Label of this flag.*
UserClassID: Long	*User class ID of the network element on which this flag is placed.*
UserID: Long	*User ID of the network element on which this flag is placed.*
UserSubID: Long	*User sub ID of the network element on which this flag is placed.*

The *INetFlag* interface is the only interface on the *NetFlag* object. This interface allows set and retrieve access on the individual properties of the element being used as a flag. Use this interface to specify the user class and ID of the element.

UserSubID specifies the index of the particular element you want to use as a flag within a complex junction or edge feature.

An *EdgeFlag* object is a type of *NetFlag* object. The *EdgeFlag* object specifies the starting point of a trace or path algorithm. As the name implies, the flag (or starting point) must be on an edge feature. This object creates a flag that is associated with an edge feature.

IEdgeFlag : IUnknown	***Provides access to members that return and set properties that are specific to edge flags on the network.***
Position: Single	*Position of the flag along the edge.*
TwoWay: Boolean	*Indicates if the trace can proceed in either direction from this edge flag.*

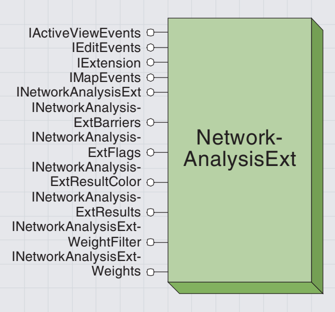
The *IEdgeFlag* interface is the only interface on the *EdgeFlag* object. This interface provides access to the flag properties unique for an edge. Use this interface to specify the position of the flag on the edge and whether or not the flag is to be used for flow in both directions along the edge.

The *Position* property specifies the percentage location of the flag down the edge beginning at the "from" point.

A *JunctionFlag* object is a type of *NetFlag* object. The *JunctionFlag* object specifies the starting point (flag) of a trace or path algorithm. As the name implies, the flag must be on a junction feature.

IJunctionFlag : IUnknown	***Provides access to members that return and set properties that are specific to junction flags on the network.***

The *IJunctionFlag* interface is the only interface on the *JunctionFlag* object. This interface has no properties or methods but serves as a way to identify what type of flag you have. For instance, if an object supports *IJunctionFlag*, then you know you have a *JunctionFlag* object.


IActiveViewEvents
IEditEvents
IExtension
IMapEvents
INetworkAnalysisExt
INetworkAnalysis-ExtBarriers
INetworkAnalysis-ExtFlags
INetworkAnalysis-ExtResultColor
INetworkAnalysis-ExtResults
INetworkAnalysisExt-WeightFilter
INetworkAnalysisExt-Weights
Network-AnalysisExt

The network analysis extension object manages the Utility Network Analyst toolbar. Through this object, you can set and retrieve all of the toolbar parameters.

Much of the analysis capabilities of the network model are exposed to the user through the Utility Network Analyst toolbar. The primary purpose of the toolbar is to allow users to perform traces and display the results. Traces are executed by specifying one or more "flags" (starting points), selecting the type of traces to perform (upstream, downstream, find connected, and so on), and clicking the Trace button. Traces can be further limited by adding barriers, disabling layers, and setting weight values. All of these options are available through the toolbar and are supported by a group of objects developed specifically for that purpose.

The toolbar can be extended by creating additional custom trace tasks and registering them under the ESRI Utility NetworkTasks category. These custom tasks are developed using the same set of objects the toolbar is based on. The easiest way for a developer to create their own tracing functionality is to extend the toolbar. Through the objects discussed below, the developer can retrieve all the flags, barriers, and so on, that the user has set through the toolbar and can then apply these to a custom trace. This process saves the developer from having to write code to manage the flags, barriers, and so on.

The *NetworkAnalysisExt* class implements several different interfaces that support the general characteristics of network analysis. These characteristics include the flags (starting points) that have been set, barriers that have been added, weights and filters that have been defined, and what to do with the results of any analysis. At present, there is only one "type" of *NetworkAnalysisExt*, *UtilityNetworkAnalysisExt*, but more will be coming in future releases.

INetworkAnalysisExt: IUnknown	***Provides access to members that add or remove networks and feature layers from the Network Analysis extension.***
■— Application: IApplication	*Parent application of the Network Analysis extension.*
■—□ CurrentNetwork: IGeometricNetwork	*Current network being used by the Network Analysis extension.*
■— FeatureLayer (Index: Long) : IFeatureLayer	*Returns a feature layer in the Network Analysis extension by index.*
■— FeatureLayerCount: Long	*Returns the number of feature layers currently loaded into the Network Analysis extension.*
■— Network (in Index: Long) : IGeometricNetwork	*Geometric network in the Network Analysis extension by index.*
■— NetworkCount: Long	*Number of geometric networks currently loaded into the Network Analysis extension.*
■—■ SnapTolerance: Long	*Snap tolerance, in pixels, for placing flags and barriers on the map.*
← AddLayer (in Layer: ILayer)	*Adds a layer to the Network Analysis extension.*
← AddNetwork (GeometricNetwork: IGeometricNetwork)	*Loads a geometric network into the Network Analysis extension.*
← DeleteNetwork (GeometricNetwork: IGeometricNetwork)	*Unloads a geometric network from the Network Analysis extension.*
← DropLayer (in Layer: ILayer)	*Removes a layer from the Network Analysis extension.*

The *INetworkAnalysisExt* interface provides information about the networks and layers available for analysis. Through this interface, the developer can add and remove networks and layers from the analysis process.

A key property of this interface is *Application*, which provides access to the application housing the toolbar. When creating a custom trace task, *INetworkAnalysisExt::Application* is the way to get a reference back to the application, and through that, the document, and so on.

The *CurrentNetwork* property allows the developer to set (and retrieve) the network being used for analysis.

SnapTolerance is used when adding a new flag or barrier to the analysis process.

DropLayer removes a layer from the toolbar but not the map. Traces will still go through layers that have been "dropped", but they will not display as part of the results.

The following VBA code will drop a layer called "Regulators" from the network analysis extension (the toolbar).

```
Sub Drop()
  Dim pNetAnal As INetworkAnalysisExt, pUID As New UID, _
 pApp As IApplication
  Set pApp = Application
  pUID = "esricore.utilitynetworkanalysisext"
  Set pNetAnal = pApp.FindExtensionByCLSID(pUID)

  Dim pDoc As IMxDocument, pMap As IMap, pLayer As ILayer, lLoop As Long
  Set pDoc = ThisDocument
  Set pMap = pDoc.FocusMap
  For lLoop = 0 To pMap.LayerCount - 1
    If UCase(pMap.Layer(lLoop).Name) = "REGULATORS" Then
      Set pLayer = pMap.Layer(lLoop)
      Exit For
    End If
  Next lLoop

  If Not pLayer Is Nothing Then
    pNetAnal.DropLayer pLayer
  End If
End Sub
```

INetworkAnalysisExtFlags : IUnknown	***Provides access to members that manage flags in the Network Analysis extension.***
■— EdgeFlag (in Index: Long) : IEdgeFlagDisplay	*Edge flag on the current network by index.*
■— EdgeFlagCount: Long	*Number of edge flags on the current network.*
■— JunctionFlag (in Index: Long) : IJunctionFlagDisplay	*Junction flag on the current network by index.*
■— JunctionFlagCount: Long	*Number of junction flags on the current network.*
◀— AddEdgeFlag (in EdgeFlag: IEdgeFlagDisplay)	*Adds an edge flag to the current network.*
◀— AddJunctionFlag (in JunctionFlag: IJunctionFlagDisplay)	*Adds a junction flag to the current network.*
◀— ClearFlags	*Removes all flags from the current network.*

The *INetworkAnalysisExtFlags* interface manages the flags being monitored by the toolbar. Flags are the starting points for traces and the *FindPath* routine. Use this interface when you want to retrieve, set, or clear the flags to be used during the analysis process. Use the *INetworkAnalysisExtFlags* interface if you want to write a custom trace task in which you explicitly set the flags.

EdgeFlagCount returns the number of flags set on edge features in the network.

ClearFlags removes all edge and junction flags.

INetworkAnalysisExtBarriers : IUnknown	***Provides access to members that manage barriers in the Network Analysis extension.***
■— EdgeBarrier (in Index: Long) : IEdgeFlagDisplay	*Edge barrier on the current network by index.*
■— EdgeBarrierCount: Long	*Number of edge barriers on the current network.*
■— JunctionBarrier (in Index: Long) : IJunctionFlagDisplay	*Junction barrier on the current network by index.*
■— JunctionBarrierCount: Long	*Number of junction barriers on the current network.*
■—■ SelectionSemantics: esriAnalysisType	*Indicates if trace tasks are performed on selected features, unselected features, or all features.*
◀— AddEdgeBarrier (in Barrier: IEdgeFlagDisplay)	*Adds an edge barrier to the current network.*
◀— AddJunctionBarrier (in Barrier: IJunctionFlagDisplay)	*Adds a junction barrier to the current network.*
◀— ClearBarriers	*Removes all barriers from the current network.*
◀— CreateElementBarriers (out junctionBarriers: INetElementBarriers, out edgeBarriers: INetElementBarriers)	*Returns a NetElementBarriers object corresponding to the barriers added to the current network.*
◀— CreateSelectionBarriers (out selectionBarriers: ISelectionSetBarriers)	*Returns a SelectionSetBarriers object corresponding to the currently selected features in the current network and the SelectionSemantics property.*
◀— GetDisabledLayer (in pFeatureLayer: IFeatureLayer) : Boolean	*Gets the disabled state for the specified feature layer.*
◀— SetDisabledLayer (in DisabledLayer: IFeatureLayer, in isDisabled: Boolean)	*Sets the disabled state for the specified feature layer.*

The *INetworkAnalysisExtBarriers* interface manages the barriers monitored by the toolbar. Barriers are short-term blockages of flow within your network. For long-term blockages of flow (for example, shutting off a valve or opening a switch), use the *Enabled* property on the individual feature. This interface sets blockages based on pipes that have burst or other short-term issues or to monitor layers that have been completely disabled. When a layer is disabled, tracing cannot go through any feature in that layer. You might disable a layer (in this case, "valves") to determine which valves need to be shutoff to isolate a break in the pipe.

SelectionSemantics allows the developer to specify on which features the tracing is performed. The options are all features, only selected features, or only nonselected features.

CreateElementBarriers and *CreateSelectionBarriers* return a set of barriers that can be passed to the *NetSolver* object within your custom trace task. The barriers returned are based on what the user has set through the toolbar.

GetDisabledLayer returns a Boolean indicating whether the user has disabled the *FeatureLayer* that is passed in.

INetworkAnalysisExtResults : IUnknown	***Provides access to members that set and clear the trace task results.***
■—■ DrawComplex: Boolean	*Indicates if sub elements of complex edges are rendered individually in the results.*
■— ResultFeatureCount: Long	*Number of elements in the current results.*
■—■ ResultsAsSelection: Boolean	*Indicates if results are returned as a selection.*
← ClearResults	*Clears the current results.*
← CreateSelection (in junctionEIDs: IEnumNetEID, in edgeEIDs: IEnumNetEID)	*Creates a selection set from the specified set of network elements.*
← SetResults (in junctionEIDs: IEnumNetEID, in edgeEIDs: IEnumNetEID)	*Sets the current results to the specified network elements.*

The *INetworkAnalysisExtResults* interface retrieves and sets the conditions for the results returned from a trace and manipulates the results after they are returned. Use this interface when you want to specify whether the individual elements of a complex edge will be drawn or whether or not the results will be returned as a selection set.

DrawComplex specifies whether the individual elements of a complex feature are displayed or not. When this property is *False*, all elements within a complex feature are drawn regardless of whether each element is traversed or not (assuming at least one element of the feature is traversed).

CreateSelection selects the features specified in the *IEnumNetEIDs* that are passed in.

SetResults is called after executing your custom trace in order to display the results. Once *SetResults* is called, the corresponding network elements are displayed until the results are cleared (through *ClearResults*) or the user exits ArcMap.

INetworkAnalysisExtWeightFilter: IUnknown	Provides access to members that set and return the weight filter information to be used when performing trace tasks.
■— FilterRangeCount (in ElementType: esriElementType) : Long	Number of filter ranges for the specified network element type.
■—■ FromToEdgeWeightFilterName: String	Name of the weight to be used for filtering edge elements traced in the digitized direction.
■—■ JunctionWeightFilterName: String	Name of the weight to be used for filtering junction elements.
■—■ ToFromEdgeWeightFilterName: String	Name of the weight to be used for filtering edge elements traced against the digitized direction.
← AddFilterRange (in ElementType: esriElementType, in fromValue: Variant, in toValue: Variant)	Adds a range of values to be filtered for the specified network element type.
← ClearRanges (in ElementType: esriElementType)	Clears all filter ranges for the specified network element type.
← GetFilterRange (in ElementType: esriElementType, in Index: Long, out fromValue: Variant, out toValue: Variant)	Returns a filter range by index for the specified network element type.
← GetFilterType (in ElementType: esriElementType, out weightFilterType: esriNetWeightFilterType, out applyNotOperator: Boolean)	Gets the filter type for the specified network element type.
← SetFilterType (in ElementType: esriElementType, in weightFilterType: esriNetWeightFilterType, in applyNotOperator: Boolean)	Sets the filter type for the specified network element type.

Weights limit the trace based on the attribute values of the features.The network must be built with weight parameters to allow values to be set through the toolbar. Filter weights (those that are set and retrieved by INetworkAnalysisExtWeightFilter*) are used for most tracing tasks to specify pass or don't pass types of values. For instance, traces can only be perfomed on 8-inch pipes or should exclude certain types of transformers (where the value of the specified field is between 5 and 8).*

The *INetworkAnalysisExtWeightFilter* interface is used in conjunction with *INetworkAnalysisExtWeights* to set and retrieve the weight values that have been set through the toolbar.

FromToEdgeWeightFilterName and *ToFromEdgeWeightFilterName* are based on the digitized direction of the segment, not necessarily the direction of flow. In most cases, these two values should be set to the same filter.

AddFilterRange allows the setting of a range of values for either junction or edge filters. There is only one setting for edge filters, regardless of whether the *FromTo* and *ToFrom* filter names are the same.

Here is some VBA code for adding junction filter ranges 2–5 and 8–10.

```
Sub AddJunctionFilters()
  Dim pApp As IApplication, pUID As New UID
  Dim pWeightFilter As INetworkAnalysisExtWeightFilter
  Dim lFilterRangeCount As Long
  Set pApp = Application
  pUID = "esricore.UtilityNetworkAnalysisExt"
  Set pWeightFilter = pApp.FindExtensionByCLSID(pUID)

  pWeightFilter.ClearRanges esriETJunction
  lFilterRangeCount = pWeightFilter.FilterRangeCount(esriETJunction)
  MsgBox "FilterRangeCount: " & lFilterRangeCount

  pWeightFilter.AddFilterRange esriETJunction, 2, 5
  pWeightFilter.AddFilterRange esriETJunction, 8, 10

  lFilterRangeCount = pWeightFilter.FilterRangeCount(esriETJunction)
  MsgBox "FilterRangeCount " & lFilterRangeCount
End Sub
```

INetworkAnalysisExtWeights: IUnknown	***Provides access to members that set and return the weights to be used when performing trace tasks.***
■–■ FromToEdgeWeightName: String	*Weight to be used to determine the cost of traversing edge elements in the digitized direction.*
■–■ JunctionWeightName: String	*Weight to be used to determine the cost of passing through junction elements.*
■–■ ToFromEdgeWeightName: String	*Weight to be used to determine the cost of traversing edge elements against the digitized direction.*

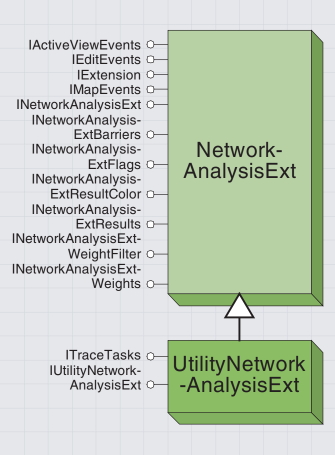
The *INetworkAnalysisExtWeights* interface is used in conjunction with *INetworkAnalysisExtFilterWeights* to set and retrieve the weight values that have been set through the toolbar.

INetworkAnalysisExtWeights differs from *INetworkAnalysisExtFilterWeights* in that these weights are applied during cumulative traces, such as *FindPath* or *FindUpstreamAccumulation*. For example, *FindPath* can be used to find the optimal path between two flags. By default, the results will be based on the shortest path, but by applying a weight you can cause the results to be based on the time it takes to travel to each element or some other parameter. The weight values are added up to determine the “least-cost” path.

With no weights specified, “shortest path” is based on the number of edge elements encountered, regardless of length. To find “shortest” based on length, a weight must be specified.

FromToEdgeWeightName and *ToFromEdgeWeightName* can be different to allow for a different cost in traveling the digitized and against-digitized directions of a feature.

UtilityNetworkAnalysisExt coclass


IActiveViewEvents
IEditEvents
IExtension
IMapEvents
INetworkAnalysisExt
INetworkAnalysis-ExtBarriers
INetworkAnalysis-ExtFlags
INetworkAnalysis-ExtResultColor
INetworkAnalysis-ExtResults
INetworkAnalysisExt-WeightFilter
INetworkAnalysisExt-Weights
Network-AnalysisExt
ITraceTasks
IUtilityNetwork-AnalysisExt
UtilityNetwork-AnalysisExt

The utility network analyst extension object manages the trace tasks defined for utility networks. Through this object, you can retrieve the defined tasks and manipulate how the traces are implemented.

The *UtilityNetworkAnalysisExt* coclass is a type (currently the only type) of *NetworkAnalysisExt* class. It is designed to manage the trace tasks created for the Utility Network Analyst toolbar in ArcMap.

Each trace task performs a different type of analysis on the currently selected network, such as find connected, trace upstream, trace downstream, and so on. The toolbar and the set of trace tasks can be extended by creating a custom task through the implementation of the *ITraceTask* interface. By extending the list of available traces, the developer can take advantage of the flag and barrier management code within the toolbar.

IUtilityNetworkAnalysisExt: IUnknown	***Provides access to a member that determines whether flow direction can be set for the current network.***
■— EnableSetFlowDirection: Boolean	*Indicates if flow direction can be set for the current network.*

The *IUtilityNetworkAnalysisExt* interface has only one property, *EnableSetFlowDirection*, which indicates whether the flow direction can be calculated for the current network. The value of this property is based on whether or not the user has an edit session open on the network workspace. The value is *True* for an open edit session and *False* otherwise.

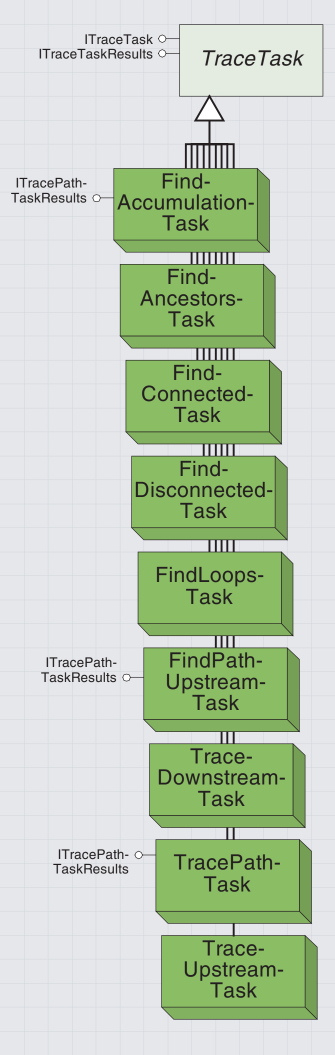
This value is also determined by whether or not the current network (specified as *INetworkAnalysisExt::CurrentNetwork*) has any sources and sinks feature classes. If there are no sources and sinks feature classes in the current network, then the value is *False*, regardless of whether an edit session is open or not.

ITraceTasks: IUnknown	***Provides access to members that set and return the current trace task and the options for tracing.***
■—□ CurrentTask: ITraceTask	*Current trace task.*
■— Task (in Index: Long) : ITraceTask	*Trace task by index.*
■— TaskCount: Long	*Number of available trace tasks.*
■—■ TraceEnds: Boolean	*Indicates if trace tasks return end features.*
■—■ TraceFlowElements: esriFlowElements	*Elements to include in the trace results.*
■—■ TraceIndeterminateFlow: Boolean	*Indicates if directional traces include features with indeterminate or uninitialized flow direction.*

The *ITraceTasks* interface is used to track the set of trace tasks registered with the Utility Network Analyst extension (ESRI Utility Network Task category) and to set parameters specifying how to perform the trace. This interface is important for the toolbar but is often not used when creating custom tasks. One exception to this comes when the developer wishes to set parameters, such as the tracing of ends (*TraceEnds*), edges with indeterminate flow (*TraceIndeterminateFlow*), or what types of elements to trace (*TraceFlowElements*).

CurrentTask retrieves and sets the current task to be solved. The task can be manually executed through the *ITraceTask* interface that is returned.

TraceFlowElements specifies what types of elements (junctions, edges, both, or none) to trace with a custom task.



Out of the box, ESRI provides nine trace tasks for use with the Utility Network Analyst toolbars. Each of these tasks is registered under the ESRI Utility Network Task category.

Additional trace task classes can be created by the developer through implementation of the ITraceTask *interface. The developer samples include a couple of examples of custom tasks.*

The *UtilityNetworkAnalysisExt* object contains one or more trace task coclasses. These trace task coclasses represent a different network analysis option to perform on the current network.

ITraceTask : IUnknown	*Provides access to members that execute a trace task.*
EnableSolve: Boolean	*Indicates if the trace task is ready to be executed.*
Name: String	*Name of the trace task.*
OnCreate (in utilityNetworkAnalysis: IUtilityNetworkAnalysisExt)	*Initializes the trace task.*
OnTraceExecution	*Executes the trace task.*

The *ITraceTask* interface is the key interface when creating custom trace tasks for use with the Utility Network Analyst toolbar. This interface must be implemented by the class the developer creates and includes properties for naming the task and determining if it should be enabled given the current conditions. In addition, methods are called after creating the task (*OnCreate*) and when a user attempts to execute the task (*OnTraceExecution*).

EnableSolve specifies whether the trace task can be executed under the current conditions.

OnCreate receives a hook to the network analysis extension. Through this hook the developer can get to the flags, barriers, and weights set by the user via the toolbar.

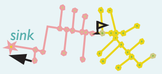
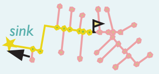
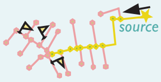
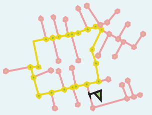
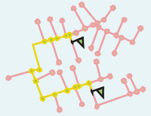
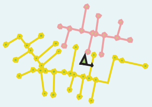
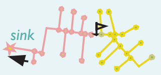
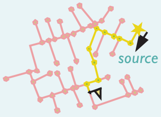
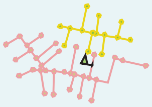
ITraceTaskResults : IUnknown	*Provides access to members that return the network elements returned by the trace task.*
ResultEdges: IEnumNetEID	*Edges in the trace task result.*
ResultJunctions: IEnumNetEID	*Junctions in the trace task result.*

The *ITraceTaskResults* interface provides access to the edges and junctions that have been selected by the trace. The purpose of the interface is to allow developers to get to the results of a trace for their own processing. For instance, you may want to do further processing of the results of each trace the user executes. Instead of writing your own trace tasks and manipulating the results, you can write a tool that gets the current *ITraceTaskResults* object and queries that for the results that were returned.

If you choose to write your own custom trace tasks, it is only required that you implement *ITraceTask*. However, you should also implement *ITraceTaskResults* in case some other code attempts to retrieve the results through that interface.

Here is some VBA code for displaying the number of edges selected by the current trace task.

```
Sub TraceTaskResults()
  Dim pApp As IApplication, pUID As New UID, pNetUtil As _
      IUtilityNetworkAnalysisExt
  Set pApp = Application
  pUID = "esricore.utilitynetworkanalysisext"
  Set pNetUtil = pApp.FindExtensionByCLSID(pUID)
```

Trace upstream  flow direction needed to solve	Traces against flow from an origin (a netflag) until stopped by barriers, sources, or end of network	flow statistics at a point determine valves to shut off to isolated edge find sources of pollution from a monitoring station
Trace downstream  flow direction needed to solve	Traces with flow from origin (a netflag) until stopped by barriers, sinks, or end of network.	calculate contribution to flow distance from sink
Find common ancestors  flow direction not required	From each netflag, traces against flow to source or barrier, then finds the features (ancestors) common to all traces.	trouble call analysis - find common transformers or switches
Find loops  flow direction not required	Finds all loops or cycles regardless of flow direction.	database quality assurance, logical consistency of network find causes of indeterminate flow directions
Find path  flow direction not required	Finds a path between two netflags regardless of flow direction. If there is more then one path, only the first path found is returned.	database quality assurance, logical consistency of network check for connectivity between two points
Find connected  flow direction not required	Finds all elements that are connected to the netflag. The connected elements are referred to as the connected component.	database quality assurance, logical consistency of network find and label connected components
Find upstream accumulation  flow direction needed to solve	Traces on all elements upstream from origin (a netflag) and returns the total value of these elements.	flow statistics at a point find number of facilities upstream from a monitoring station
Find path upstream  flow direction needed to solve	Finds a path from a netflag against flow to the source.	database quality assurance, logical consistency of network find source of pollution from a monitoring station
Find disconnected  flow direction not required	Finds all elements that cannot be reached from the netflag.	database quality assurance, logical consistency of network find and label non-connected components

```
  Dim pTraceResults As ITraceTaskResults, pTasks As ITraceTasks
  Set pTasks = pNetUtil
  Set pTraceResults = pTasks.CurrentTask

  Dim pEnum As IEnumNetEID
  Set pEnum = pTraceResults.ResultEdges
  MsgBox pEnum.Count

End Sub
```

ITracePathTaskResults : IUnknown	Provides access to members that return cost information about the path or tree found by certain trace tasks.
SegmentCost (in Segment: Long) : Variant	Cost of tracing the elements in the specified segment of the trace results.
TotalCost: Variant	Total cost of tracing all elements in the trace results.

The *ITracePathTaskResults* interface provides access to the total cost and cost by segment for the results of the task. The task determines the least-cost path between two flags.

TotalCost returns the accumulated cost based on the optimal path between two flags.

The *TracePathTask* coclass is used by the Utility Network Analyst toolbar to find the optimal path between two flags.

The *FindAccumulationTask* coclass is used by the Utility Network Analyst toolbar to find the accumulated cost of an upstream trace.

The *FindPathUpstreamTask* coclass is used by the Utility Network Analyst toolbar to find the least-cost path through the upstream elements.

The *FindAncestorsTask* coclass is used by the Utility Network Analyst toolbar to find the common upstream elements based on a trace from two or more flags.

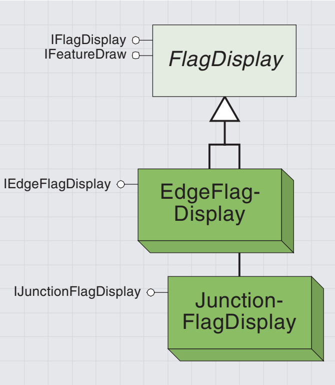
The *FindConnectedTask* coclass is used by the Utility Network Analyst toolbar to find the elements that can be reached from a trace out from one or more flags.

The *FindDisconnectedTask* coclass is used by the Utility Network Analyst toolbar to find all network elements that cannot be reached from a trace originating from the current set of one or more flags.

The *TraceDownstream* coclass is used by the Utility Network Analyst toolbar to find the elements downstream from one or more flags.

The *FindLoopsTask* coclass is used by the Utility Network Analyst toolbar to find the elements that can be reached in more than one direction based on a trace from one or more flags.

The *TraceUpstreamTask* coclass is used by the Utility Network Analyst toolbar to find the elements upstream from one or more flags.



Flag display objects designate the starting points for traces defined through the Utility Network Analyst toolbar. The objects contain information about which network feature the flag was placed on and the geometry of the location for display.

There are two types of flag display objects. The junction flag display indicates a starting point on a junction feature, while the edge flag display object indicates a starting point somewhere along an edge feature.

The *FlagDisplay* abstract class supports two coclasses, *JunctionFlagDisplay* and *EdgeFlagDisplay*, for the tracking of flags set through the Utility Network Analyst toolbar. The purpose of the class is to monitor flags set through the toolbar and make sure they are correctly displayed when the map is redrawn. Flags are used by the network toolbar as starting points for traces.

IFlagDisplay : IUnknown	***Provides access to members that specify the network element on which a flag is located.***
ClientClassID: Long	*User-specified client class ID of this flag.*
ClientFID: Long	*User-specified feature ID of the flag.*
FeatureClassID: Long	*Feature class ID of the element on which the flag is placed.*
FID: Long	*Feature ID of the network element on which the flag is placed.*
Geometry: IGeometry	*Point object containing the flag's coordinates.*
SubID: Long	*Sub ID of the network element on which the flag is placed.*
Symbol: ISymbol	*Symbol used to display the flag.*

The *IFlagDisplay* interface provides access to the properties of flags set through the Utility Network Analyst toolbar. These properties include the feature class, ID, and SubID (if a complex network feature) of the feature the flag was placed on, as well as the symbol used to draw the flag. The *UserSubID* must be specified, even for noncomplex network features. You can look up any network element's ID by calling *INetElements::QueryIDs* and passing in its EID.

The *ClientClassID* and *ClientFID* properties are specifically for developer use. These properties are not used by the core ArcGIS software in any way.

Geometry returns a point object representing the location of the flag.

The *JunctionFlagDisplay* coclass is a type of *FlagDisplay* that supports flags placed on junction elements through the network toolbar. At any time, there can be zero to many *JunctionFlagDisplay* objects associated with the toolbar.

IJunctionFlagDisplay : IUnknown	***Provides access to members that return and set the properties that are specific to junction flags.***

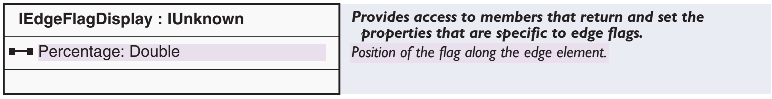
The *IJunctionFlagDisplay* interface has no properties or methods but can be used to determine if the *FlagDisplay* object is a *JunctionFlagDisplay* object.

The following code demonstrates how to take the flags set within the network toolbar and pass them to a *TraceSolver* object. *pFlags* is of type *INetworkAnalysisExtFlags*, and *pTraceFlowSolver* is of type *ITraceFlowSolver*.

```
Sub FlagDisplay(pFlags as INetworkAnalysisExtFlags, _
   pTraceSolver as ITraceFlowSolver)
  Dim pEFlags() As IEdgeFlag, pEdgeFlagDisplay As IFlagDisplay
  Dim pEdgeFlag As INetFlag, lLoop As Long
  ReDim pEFlags(pFlags.EdgeFlagCount - 1)
  For lLoop = 0 To pFlags.EdgeFlagCount - 1
```

```
    Set pEdgeFlagDisplay = pFlags.EdgeFlag(lLoop)
    Set pEdgeFlag = New EdgeFlag
    pEdgeFlag.UserID = pEdgeFlagDisplay.FID
    pEdgeFlag.UserClassID = pEdgeFlagDisplay.FeatureClassID
    pEdgeFlag.Label = "Edge"
    Set pEFlags(pLoop) = pEdgeFlag
  Next lLoop
  Dim lCount As Long
  lCount = pFlags.EdgeFlagCount
  pTraceFlowSolver.PutEdgeOrigins lCount, pEFlags(0)
End Sub
```

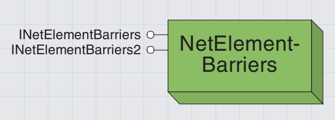
The *EdgeFlagDisplay* coclass is a type of *FlagDisplay* that supports flags placed on edge elements through the Utility Network Analyst toolbar. At any time, there can be zero-to-many *EdgeFlagDisplay* objects associated with the toolbar.



Provides access to members that return and set the properties that are specific to edge flags.

Position of the flag along the edge element.

The *IEdgeFlagDisplay* interface allows the developer to determine if the *FlagDisplay* object is of type *EdgeFlagDisplay*. The only property on the interface (*Percentage*) returns the position of the flag on the edge measured as a percentage from the digitized “from” end of the feature.



The network element barriers object maintains the set of barriers (stopping points) defined for the network. These barriers can be defined through code or through the Utility Network Analyst toolbar.

The *NetElementBarriers* coclass is one of the few network coclasses that is used by the Utility Network Analyst toolbar but is also employed outside the toolbar.

This coclass creates network element barriers (elements that trace and path tasks cannot go through) that can then be applied through the *INetSolver* object during the analysis process.

You have the option of creating the object directly (since it is a creatable object) and setting the barriers manually or generating the object through *INetworkAnalysisExtBarriers::CreateElementBarriers*. When this object is generated through *CreateElementBarriers*, the resulting barrier elements are based on what was set by the user through the toolbar.

INetElementBarriers : IUnknown	***Provides access to members that specify a set of barriers for the TraceFlowSolver object.***
ElementType: esriElementType	*Type of network element on which the barriers are placed.*
Network: INetwork	*Network on which the barrier set is placed.*
SetBarriers (in UserClassID: Long, in Count: Long, in userIDs: Long)	*Specifies a set of network features to use as barriers.*

The *INetElementBarriers* interface is used to set the type of element (edge or junction) contained within the class and to set the barriers.

SetBarriers is expecting an array of IDs to be passed in as an argument even if only one ID is being used. Always pass in the first element of the array (*array_name(0)*) regardless of what count you specify.

INetElementBarriers2:INetElementBarriers	***Provides access to members that specify a set of barriers by EIDs for the TraceFlowSolver object.***
SetBarriersByEID (in Count: Long, in EIDs: Long)	*Specifies a set of network element IDs to use as barriers.*

The *INetElementBarriers2* interface was added at ArcGIS 8.1 to allow barrier elements to be added without it acting on the entire complex feature.

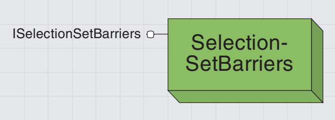
SetBarriersByEID allows barriers to be specified by their element EID. This option saves the developer from having to perform a query on the element to determine the feature class ID and feature ID.

When creating custom traces that you wish to stop at certain element types (for instance, isolation traces that need to stop at plastic pipes or open switches), there are basically three options.

The first option is to use the Enabled *field added to each feature class. Tracing cannot go through features that have their* Enabled *value set to* False*. The downside to this option is that you have to have an edit session open to make the change, or you have to save the settings.*

The second option is to use weight filters. Weight filters require you to specify during the building of the network which fields will contain the values for each feature class. When you execute a trace, you can specify a range of values to stop a trace at or, alternatively, to trace within. This option is best when you wish to trace on 8-inch pipes or stop traces from going through certain types of fittings.

The third option is to use a NetElementBarriers *class and manually set barriers on each location you wish to stop at. This option requires the least amount of work up front but requires a substantial amount of work during the actual analysis process. The user (through the toolbar) or the developer (through code) is required to identify each stopping point and manually place a barrier to limit tracing and path finding.*



The selection set barriers object maintains a set of barriers for use with the different trace methods. This object differs from network element barriers in that it can maintain a set of barriers on both junction and edge elements.

The *SelectionSetBarriers* coclass is also employed both by the toolbar and outside the toolbar.

This coclass is similar to *NetElementBarriers* but can contain both junction and edge elements. When creating your own custom trace tool, you can create your own *SelectionSetBarriers* object or generate one through *INetworkAnalysisExtBarriers::CreateSelectionBarriers*. The resulting class can then be applied during the analysis process through the *NetSolver* object.

SelectionSetBarriers offers an additional advantage over *NetElementBarriers* in that the *Not* method can be used to specify that elements not within the class will act as barriers.

ISelectionSetBarriers : IUnknown	***Provides access to members that specify a set of barriers for the TraceFlowSolver object.***
← Add (in UserClassID: Long, in UserID: Long)	*Adds a network feature to the set of barriers.*
← Not	*Specifies that the network features not in this set act as barriers.*

The *ISelectionSetBarriers* interface allows new barriers to be added to the set through the *Add* method but also offers the *Not* method to specify that elements not currently within the set (instead of what is within the set) will serve as barriers.

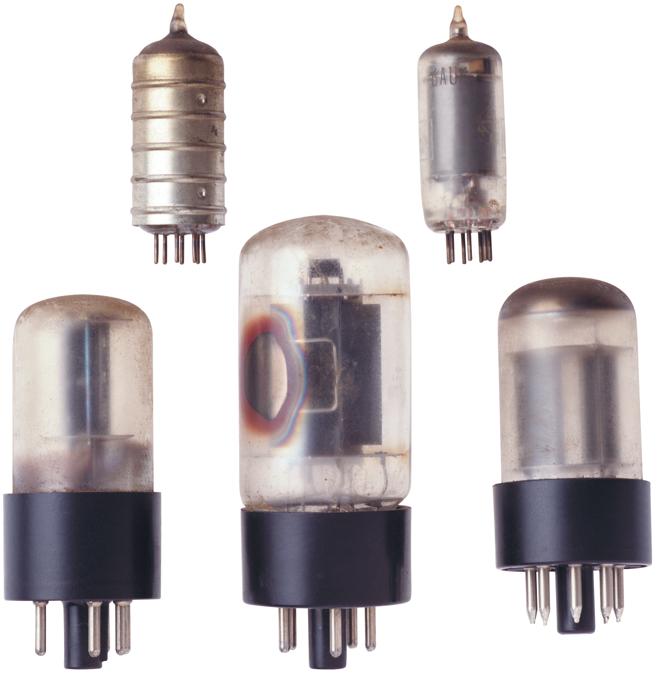
13 Integrating raster data

Bruce Payne

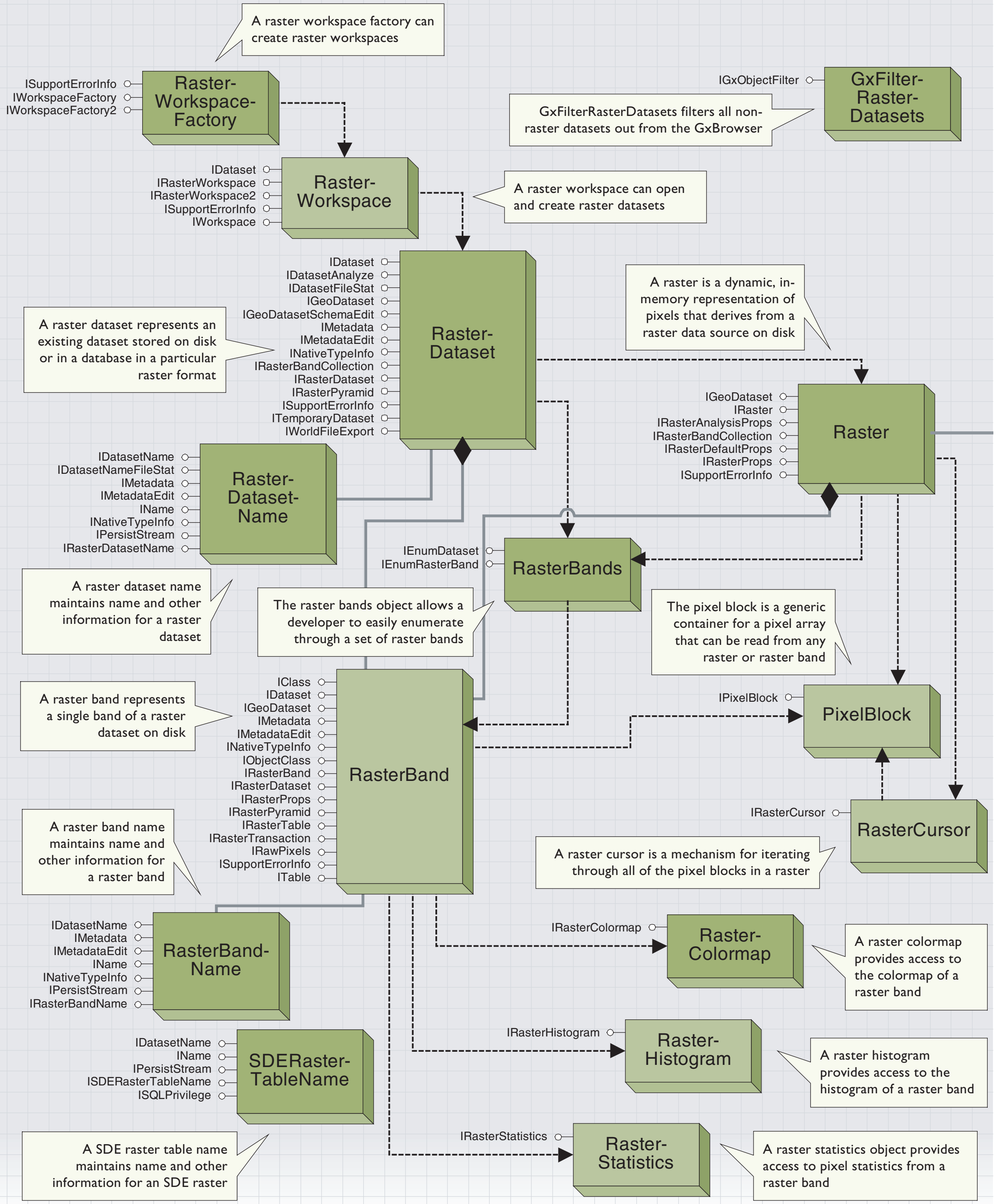
Raster data consists of a rectangular array of equally spaced cells, which taken as a whole represent thematic, spectral, or picture data. Raster data can represent everything from qualities of a land surface, such as elevation or vegetation, to satellite images, scanned maps, and photographs.

Many different formats are used to store raster data. The raster objects allow you to display and analyze your raster data whether your raster is a GRID, TIFF, or any of our other supported raster formats.

The combination of powerful analytical tools enabling you to read and write raster data from a variety of different formats and visualization tools for many different types of raster data allows you to truly integrate raster data into your GIS.



Raster



A raster workspace factory can create raster workspaces

GxFilterRasterDatasets filters all non-raster datasets out from the GxBrowser

A raster workspace can open and create raster datasets

A raster dataset represents an existing dataset stored on disk or in a database in a particular raster format

A raster is a dynamic, in-memory representation of pixels that derives from a raster data source on disk

A raster dataset name maintains name and other information for a raster dataset

The raster bands object allows a developer to easily enumerate through a set of raster bands

The pixel block is a generic container for a pixel array that can be read from any raster or raster band

A raster band represents a single band of a raster dataset on disk

A raster band name maintains name and other information for a raster band

A raster cursor is a mechanism for iterating through all of the pixel blocks in a raster

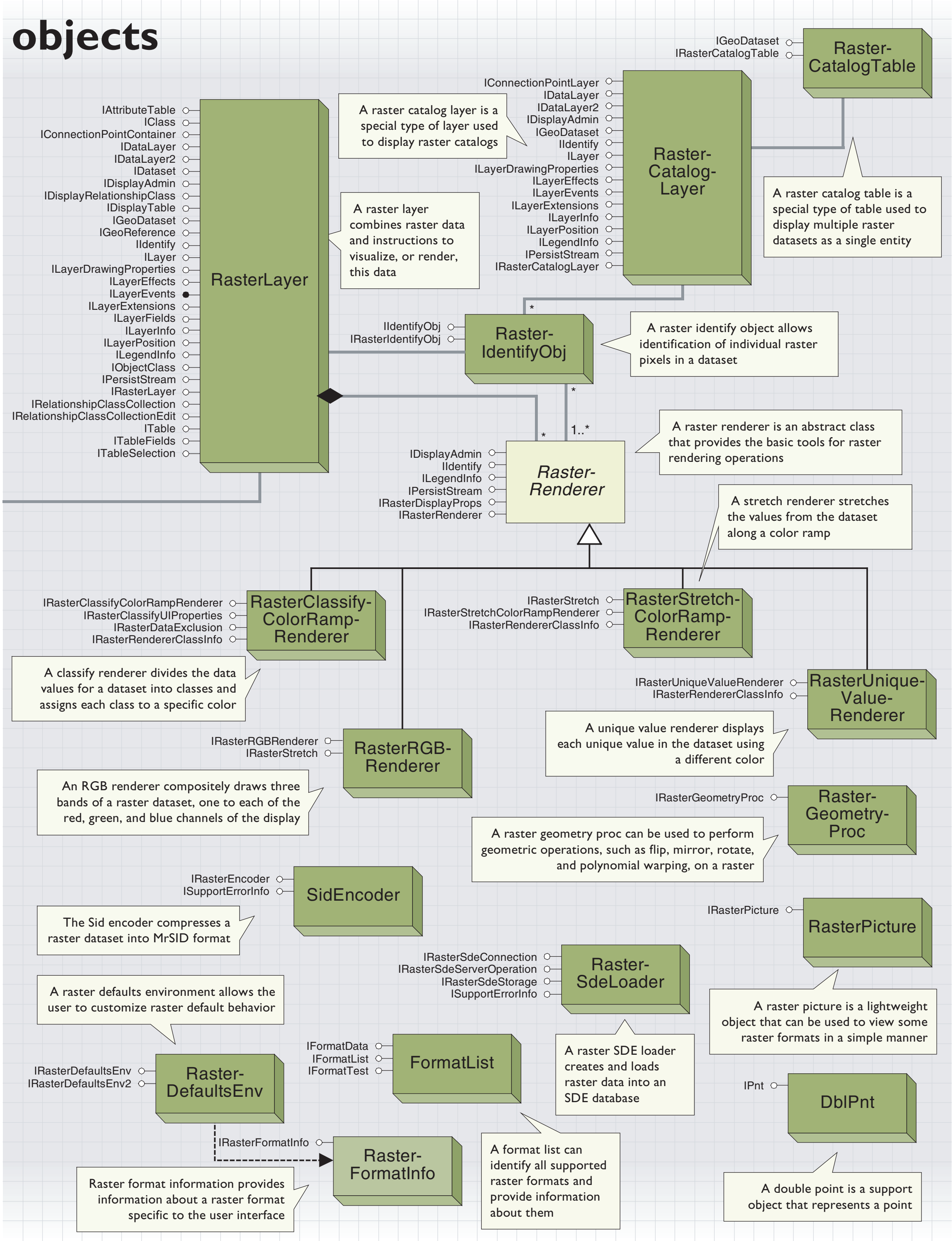
A raster colormap provides access to the colormap of a raster band

A raster histogram provides access to the histogram of a raster band

A SDE raster table name maintains name and other information for an SDE raster

A raster statistics object provides access to pixel statistics from a raster band

objects



A raster catalog layer is a special type of layer used to display raster catalogs

A raster catalog table is a special type of table used to display multiple raster datasets as a single entity

A raster layer combines raster data and instructions to visualize, or render, this data

A raster identify object allows identification of individual raster pixels in a dataset

A raster renderer is an abstract class that provides the basic tools for raster rendering operations

A stretch renderer stretches the values from the dataset along a color ramp

A classify renderer divides the data values for a dataset into classes and assigns each class to a specific color

A unique value renderer displays each unique value in the dataset using a different color

An RGB renderer compositely draws three bands of a raster dataset, one to each of the red, green, and blue channels of the display

A raster geometry proc can be used to perform geometric operations, such as flip, mirror, rotate, and polynomial warping, on a raster

The Sid encoder compresses a raster dataset into MrSID format

A raster defaults environment allows the user to customize raster default behavior

A raster picture is a lightweight object that can be used to view some raster formats in a simple manner

A raster SDE loader creates and loads raster data into an SDE database

A format list can identify all supported raster formats and provide information about them

Raster format information provides information about a raster format specific to the user interface

A double point is a support object that represents a point

The raster data objects (RDO) analyze and display raster data. They provide raster data management, pixel access, and visualization tools and are designed to work with any raster dataset, regardless of format. This means that you can perform the same functions with any supported data format including GRID, TIFF, ERDAS® IMAGINE®, PNG, and others.

Some raster formats, such as GRID and TIFF, support projection, statistics, and other ancillary data about datasets in these formats. Others, such as GIF and JPEG, cannot maintain any of this information. To provide a common foundation, ArcGIS stores ancillary data not maintained in a raster's native format within an auxiliary file associated with a raster dataset the first time it is used by ArcObjects. The auxiliary file has the same name as the raster dataset with the extension .aux. It is capable of maintaining statistics, color maps, projection, tables, geometric transformations, and other information that can make your raster data more useful for spatial analysis.

The three objects that directly access raster data on disk are the *RasterDataset* coclass, *Raster*, and *RasterBand* objects. Understanding the roles and functions of these three objects is fundamental to working with the raster objects.

The *RasterDataset* represents an existing dataset stored on disk or in a database in a particular raster format. It can manage raster data on disk and instantiate *Raster* and *RasterBand* objects for that data.

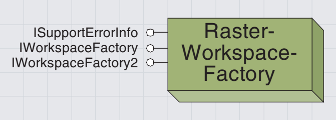
The *Raster* object is a virtual representation of raster data derived from a raster data source on disk. The *Raster* can be modified without affecting the properties of your persistent data. The *Raster* object provides resampling, reprojection, data type conversion, and the ability to combine bands from multiple raster datasets when reading pixels for display or analysis.

The *RasterBand* can read and write raw pixel data and read statistics, color maps, or tables for a band of a disk-based raster dataset. The *Raster* and the *RasterDataset* contain raster bands and, regardless of whether the band is obtained from a *Raster* or a *RasterDataset*, the band has an essentially static nature similar to the dataset.

The spatial relationships in your raster data are easier to analyze when displayed in a manner appropriate for your data. For example, elevation data looks best when the data range is mapped to a color ramp, while categorical data, such as land use, looks best when displaying each land use type with its own color. The *RasterLayer* and *RasterRenderers* control the visualization techniques that can be applied to your raster data. The *RasterRenderers* control the instructions used to display a particular raster dataset, while the *RasterLayer* contains a reference to a raster data source and a renderer to provide instructions on how to paint that data to the screen.

Other objects with more specific functionality are also included in the raster objects. The *RasterWorkspaceFactory* and *RasterWorkspace* let you open raster datasets. The *SDELoader* and *SidEncoder* allow you to convert your raster data into different formats. The *GxFilterRasterDatasets* displays only raster datasets in the *Gx Browser*. The *RasterGeometryProc* object allows you to perform geometric operations, such as flip, warp, and merge.

While this chapter is intended as a general reference, new raster developers may find it useful to read the chapter from the beginning. It begins with the *RasterWorkspaceFactory* and *RasterWorkspace*, which are used to access the *RasterDataset*. This is followed by a discussion of the *RasterDataset, RasterBand,* and *Raster* objects, which form the core objects used for raster data analysis. Interspersed within this section are objects used for raster data input, output, and manipulation. Following this is a section describing the *RasterLayer* and *RasterRenderers*, raster extensions to the ArcMap object model. The chapter ends with a variety of objects that provide specific functionality and are difficult to group within the context of the chapter.



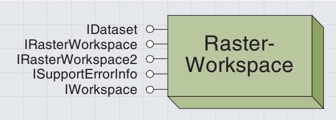
A raster workspace factory creates raster workspaces.

The *RasterWorkspaceFactory* coclass creates *RasterWorkspace* objects.

The main function of the *RasterWorkspaceFactory* is to create *RasterWorkspaces*. A *RasterWorkspaceFactory* object must be used to create a *RasterWorkspace*. The functionality of the *RasterWorkspaceFactory* is exposed through the generic *IWorkspaceFactory* and *IWorkspaceFactory2* interfaces, which is common to all workspace factory types. For more information on the *IWorkspaceFactory* interface and workspace objects, see Chapter 8, 'Accessing the geodatabase'.

This example provides a function that returns a *RasterWorkspace* using the *RasterWorkspaceFactory*. This function is used in many of the code samples throughout this chapter.

```
Public Function SetRasterWorkspace(sName As String) As IRasterWorkspace
  ' Given a pathname, returns the raster workspace object for that path
  ' If not a valid raster workspace returns nothing. Caller must test!!
  On Error GoTo ErrorSetWorkspace

  Dim pWKSF As IWorkspaceFactory
  Set pWKSF = New RasterWorkspaceFactory

  Dim pWKS As IRasterWorkspace
  Set pWKS = pWKSF.OpenFromFile(sName, 0)

  Set SetRasterWorkspace = pWKS
  Exit Function

ErrorSetWorkspace:
  Set SetRasterWorkspace = Nothing
End Function
```



The raster workspace object opens existing raster datasets and creates new datasets on disk.

The *RasterWorkspace* object must be created using a *RasterWorkspaceFactory*. This mechanism is detailed in the section describing the *RasterWorkspaceFactory*.

IRasterWorkspace : IUnknown	***Provides access to members that control a raster workspace.***
← CanCopy: Boolean	*Indicates if this dataset can be copied.*
← Copy (in copyName: String, in copyWorkspace: IWorkspace) : IDataset	*Copies this workspace to a new workspace with the specified name.*
← IsWorkspace (in Name: String) : Boolean	*Indicates if the file path specified is a raster workspace.*
← OpenRasterDataset (in Name: String) : IRasterDataset	*Opens a RasterDataset in the workspace given its name.*

The *IRasterWorkspace* interface opens datasets, verifies whether a directory location is a workspace, and copies workspaces.

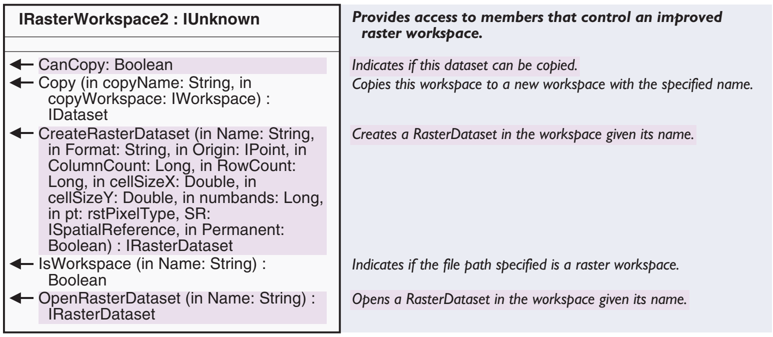
The *IsWorkspace* property returns *True* if the directory location input is a valid RasterWorkspace.

If the *CanCopy* property is *True*, the *Copy* method copies all raster datasets in the workspace into an existing or new workspace. At ArcGIS 8.1, the *Copy* method is not implemented and *CanCopy* will always return *False*.

The *OpenRasterDataset* method provides a way to open a raster dataset and is the main way that many developers will gain access to the *RasterDataset* object.

This example provides a function that can be used to open a raster dataset from a path and filename. Note the use of the *SetRasterWorkspace* function defined in the *RasterWorkspaceFactory* section of this chapter. This function is also frequently used in code samples throughout this chapter.

```
Public Function OpenRasterDataset(sPath As String, sFile As String) _
    As IRasterDataset
  ' Given a path and filename, returns the raster dataset object
  ' If not a valid raster dataset returns nothing. Caller must test!!
  On Error GoTo ErrorOpenRasterDataset
  Dim pRasWKS As IRasterWorkspace
  Set pRasWKS = SetRasterWorkspace(sPath)
  Dim pRasDS As IRasterDataset
  Set pRasDS = pRasWKS.OpenRasterDataset(sFile)
  Set OpenRasterDataset = pRasDS
ErrorOpenRasterDataset:
  Set OpenRasterDataset = Nothing
End Function
```



IRasterWorkspace2 : IUnknown

Provides access to members that control an improved raster workspace.

CanCopy: Boolean	*Indicates if this dataset can be copied.*
Copy (in copyName: String, in copyWorkspace: IWorkspace) : IDataset	*Copies this workspace to a new workspace with the specified name.*
CreateRasterDataset (in Name: String, in Format: String, in Origin: IPoint, in ColumnCount: Long, in RowCount: Long, in cellSizeX: Double, in cellSizeY: Double, in numbands: Long, in pt: rstPixelType, SR: ISpatialReference, in Permanent: Boolean) : IRasterDataset	*Creates a RasterDataset in the workspace given its name.*
IsWorkspace (in Name: String) : Boolean	*Indicates if the file path specified is a raster workspace.*
OpenRasterDataset (in Name: String) : IRasterDataset	*Opens a RasterDataset in the workspace given its name.*

The *IRasterWorkspace2* interface provides the functionality of *IRasterWorkspace* plus *CreateRasterDataset*, which lets you create new raster datasets on disk.

At ArcGIS 8.1, *CreateRasterDataset* can only be used to create GRID, TIFF, or ERDAS IMAGINE format rasters. The case-sensitive strings input to the format argument are “GRID”, “TIFF”, and “IMAGINE Image”.

The *Name* argument is the name of the new dataset in the workspace.

The *Origin* argument determines the lower-left corner of the new *RasterDataset* coclass.

RowCount and *ColumnCount* specify the number of rows and columns, and these combine with the *cell sizeX* and *cell sizeY* arguments to determine the extent of the new dataset. GRID datasets can only be created with square cells.

The spatial reference *(SR)* argument allows you to specify a spatial reference that will be used for the output grid. Passing *Nothing* to the spatial reference argument will result in a dataset with unknown spatial reference.

The *Permanent* argument allows you to create temporary datasets if desired.

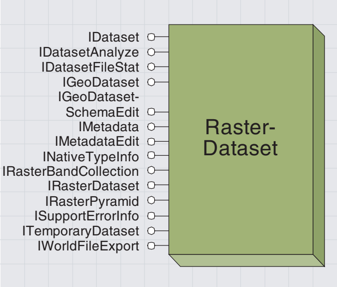
These datasets are useful for temporary analysis outputs because they delete themselves when they are no longer being used. This mechanism can also be used to produce behavior similar to ArcView® Spatial Analyst and ArcGIS Spatial Analyst, which create temporary grids as output by default.

The initial values in the dataset are NODATA for GRID, 0 for TIFF, and the highest value available for the data type for ERDAS IMAGINE.

This example shows how to create a new three-band raster in TIFF format. The dataset will have 512 rows and columns with its lower-left corner at the origin and a cell size of 2. The cell values will be of floating point type, and the dataset will be permanent.

```
' Create the workspace and QI for IRasterWorkspace2
Dim pRasWKS As IRasterWorkspace2
Set pRasWKS = SetRasterWorkspace("c:\temp")

' Create a point for the origin and set the coordinates
 Dim pOrigin As IPoint
 Set pOrigin = New Point
 pOrigin.PutCoords 0, 0

 ' Create the new dataset
 Dim pOutDS as IRasterDataset
 Set pOutDS = pOutWKS.CreateRasterDataset("test.tif", "TIFF", pOrigin, _
   512, 512, 2, 2, 3, PT_FLOAT, Nothing, True)
```

RasterDataset coclass



The raster dataset object represents a dataset stored on disk or in a database in a particular raster format.

The *RasterDataset* object represents a dataset on disk or in a database. The properties of this dataset cannot be modified, as these properties are determined by the existing dataset. This dataset is composed of one or more persistent raster bands. The dataset provides access only to operations that apply to the entire dataset, with the *RasterBand* providing access to operations that occur on individual bands.

The *RasterDataset* object performs basic dataset management functions, such as copy, rename, and delete. It can also instantiate *RasterBand* and *Raster* objects representing other aspects of the data. It can be used to examine dataset properties including different format, extent, spatial reference, and number of bands.

The *RasterDataset* can only modify the properties of the dataset in two ways. First, it can change the spatial reference associated with the dataset. This does not project the dataset from one projection to another; it only changes the coordinate system associated with the dataset. Second, the *RasterDataset* object can be used to build pyramids, or reduced-resolution datasets, which improve display performance for large raster datasets.

To access a raster dataset from the path and filename, open the *RasterDataset* using a *RasterWorkspace* as shown in the previous section. The *RasterDataset* may also be retrieved from a band in the dataset using the *RasterDataset* property. To access the *RasterDataset* from a *Raster* object, first access a band from the *Raster*, then obtain a reference to the dataset from the band.

The IRasterDataset *interface accesses information about a raster dataset.*

IRasterDataset : IUnknown	***Provides access to members that control a raster dataset.***
■— CompleteName: String	*The full path of the RasterDataset.*
■— CompressionType: String	*The compression technique applied to this RasterDataset.*
■— Format: String	*The format of this RasterRataset.*
← CanCopy: Boolean	*Returns true if this dataset can be copied.*
← Copy (in copyName: String, in copyWorkspace: IWorkspace) : IDataset	*Copies this dataset to a new dataset with the specified name.*
← CreateDefaultRaster: IRaster	*Creates a raster object with the default properties for this dataset.*
← PrecalculateStats (in index_list: Variant)	*Calculates statistics and histograms for specified bands.*

The *IRasterDataset* interface offers you a way to determine the raster format, compression type, and complete name of the dataset.

If the *CanCopy* property returns *True*, the *Copy* method will create a new copy of this dataset.

The *CreateDefaultRaster* method creates a *Raster* object with properties derived from the source dataset. This default raster has the height, width, extent, and spatial reference from the source dataset and contains one band for single-band data and three bands if the dataset is multiband. The bands that populate the three-band raster and their order in the raster can be controlled using the *RasterDefaultsEnv* object. The *PrecalculateStats* method takes a variant array of band indices in the raster dataset and calculates approximate statistics for those bands. These statistics are not exact but can be calculated more quickly than using a full statistics calculation.

Raster pyramids store a progressively smaller set of resampled versions of a dataset into a reduced resolution dataset (raster_name.rrd) file on disk. The pyramid layers reduce the amount of resampling that must be performed at display time and thus speed drawing of large raster datasets.

IRasterPyramid : IUnknown	***Provides access to members that control the pyramids for a raster dataset.***
▪—▪ MinimumSize: IPnt	*The minimum raster pyramid size.*
▪— Present: Boolean	*Indicates whether pyramid layers exist.*
◀— Create	*Build raster pyramids for this raster.*

The *IRasterPyramid* interface accesses raster pyramids.

The *Present* property returns *True* if pyramids exist for this dataset.

The *MinimumSize* property returns the smallest size for which pyramids will automatically be considered. For datasets larger than this size, pyramids will be created or not created, or you will be prompted to ask if you wish to build them depending on a setting you can adjust using the *RasterDefaultsEnv* object.

The *Create* method creates pyramids for the current dataset regardless of its size.

For more information on the IDataset, IGeoDataset, *and* IGeoDatasetSchemaEdit *interfaces, see Chapter 8, 'Accessing the geodatabase'.*

IGeoDataset : IUnknown	***GeoDataset Interface.***
▪— Extent: IEnvelope	*The extent of the GeoDataset.*
▪— SpatialReference: ISpatialReference	*The spatial reference of the GeoDataset.*

The *IGeoDataset* interface allows you to read extent and spatial reference existing for the dataset.

IGeoDatasetSchemaEdit : IUnknown	***Interface to change the schema of a GeoDataset.***
▪— CanAlterSpatialReference: Boolean	*True if the spatial reference of the dataset can be altered.*
◀— AlterSpatialReference (in SpatialReference: ISpatialReference)	*Alters the spatial reference of the dataset to match the coordinate system of the input spatial reference, does not reproject the data.*

The *IGeoDatasetSchemaEdit* interface modifies the spatial reference system applied to a raster dataset.

If the *CanAlterSpatialReference* property returns *True*, calling the *AlterSpatialReference* method will change the projection definition associated with a raster dataset. For raster formats that natively support projection definition (such as GRID, GeoTIFF, and IMAGINE), the projection will be written using the format-specific projection method. For other formats, the projection information will be maintained in the raster's auxiliary file. This will not project the data; it will only change the projection definition of the raster dataset. If previous projection information exists for the raster, it will be overwritten.

The following example changes the projection of *pNoPrjRasterDataset* to the projection from *pUTMRasterDataset*.

```
' QI the source dataset for IGeoDataset to read projection
Dim pGeoDataset as IGeoDataset
Set pGeoDataset = pUTMRasterDataset

' QI the target dataset for IGeoDatasetSchemaEdit to write projection
Dim pGeoDatasetSchemaEdit as IGeoDatasetSchemaEdit
Set pGeoDatasetSchemaEdit = pNoPrjRasterDataset
```

```
If pGeoDatasetSchemaEdit.CanAlterSpatialReference Then
  PGeoDatasetSchemaEdit.AlterSpatialReference pGeoDataset.SpatialReference
End If
```

IWorldFileExport : IUnknown	Provides access to members that export Georeference information to a WorldFile.
← Write	Write WorldFile.

The *IWorldFileExport* interface outputs a world file for this raster dataset.

The *Create* method outputs a world file for the current raster dataset. The contents of the world file will be determined from the coordinates of the dataset header or transformation contained in the raster's auxiliary file. For GRID format datasets or datasets that get their georeference information from a world file, this method has no effect. The world file maintains coordinate transformation information for a raster dataset that allows the georeference information in the raster to be used with other GIS and image processing software.

IRasterBandCollection : IUnknown	Provides access to members that control a collection of RasterBands.
■— BandByName (in Name: String) : IRasterBand	A RasterBand given its name.
■— BandIndex (in Name: String) : Long	The index of a RasterBand given its name.
■— Bands: IEnumRasterBand	All the bands in the collection as an interface to the RasterBands enumerator object.
■— Count: Long	The number of bands in the collection.
← Add (in Element: IRasterBand, in Index: Long)	Adds a RasterBand to the band collection.
← AppendBand (in Element: IRasterBand)	Appends a RasterBand to the band collection.
← AppendBands (in Bands: IRasterBandCollection)	Appends a collection of RasterBands to the band collection.
← Clear	Removes all the elements in the collection.
← Item (in BandIndex: Long) : IRasterBand	Returns a RasterBand given its index.
← Remove (in Index: Long)	Removes an element from the collection.
← SaveAs (in new_name: String, in worksp: IWorkspace, in Format: String) : IDataset	Creates a new persistent RasterDataset with the bands in the collection.

The *IRasterBandCollection* interface accesses individual bands in a *RasterDataset*.

The *Count* property on the *IRasterBandCollection* interface returns the number of bands in the raster dataset.

The *BandByName* and *BandIndex* properties return a reference to the *RasterBand* or the index of the band from the band's name.

The *Item* method returns a raster band from the dataset. The *Item* returned is determined from the zero-based band index, so the first band is band 0, the second band is band 1, and so on.

The *SaveAs* method converts a *RasterDataset* to a different raster format. This method can only create GRID, TIFF, and IMAGINE format rasters.

The *Add, AppendBand, AppendBands, Clear,* and *Remove* methods should not be used with the *RasterDataset*.

ITemporaryDataset : IUnknown	*Provides access to members that control temporary datasets.*
← IsTemporary: Boolean	*Indicates if the dataset is temporary.*
← MakePermanent	*Persists this temporary dataset permanent.*
← MakePermanentAs (in new_name: String, in Workspace: IWorkspace, in Format: String) : IDataset	*Persists this temporary dataset to a new permanent dataset.*

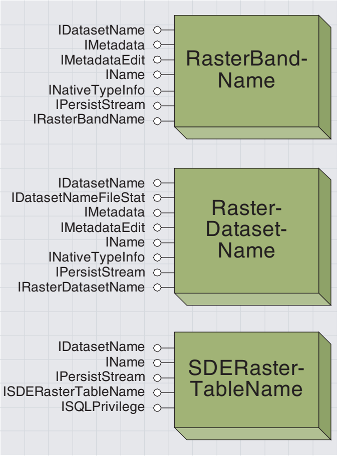
The *ITemporaryDataset* interface supports temporary raster datasets.

Temporary datasets are created by most operations performed by the ArcView Spatial Analyst and ArcGIS Spatial Analyst extensions and can be created using the *CreateRasterDataset* method of the *RasterWorkspace* object.

The *IsTemporary* property returns *True* if the dataset is temporary.

The *MakePermanent* method changes the status of a dataset from temporary to permanent. If this dataset is permanent, this method does nothing.

The *MakePermanentAs* method makes the current dataset permanent by creating a new raster dataset that contains the same data. The new dataset can be created in any raster workspace and can be in GRID, TIFF, or IMAGINE format. The current dataset will be deleted when all references to it are released. If this dataset is already permanent, this method performs a *SaveAs* operation. This method may fail if it is called while any *Raster* objects or *RasterBand* using this dataset exist.

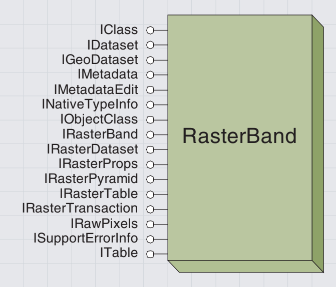


These raster name objects are not intended for use by external developers.

A *RasterDatasetName* maintains name and other information for a raster dataset. Its main function is to allow ArcCatalog to browse dataset information about a *RasterDatatset* using generic interfaces, as well as to allow ArcGIS to perform searches as with each other dataset type. It is not intended for use by external developers.

A *RasterBandName* maintains name and other information for a raster band. This allows ArcCatalog to browse band information about a *RasterBand* using generic interfaces and allows ArcGIS to perform searches as with each other dataset type. It is not intended for use by external developers.

An *SDERasterTableName* maintains name and other information for a raster dataset stored in an ArcSDE database. This object allows ArcCatalog to browse information about an ArcSDE Raster table using generic interfaces and allows ArcGIS to perform searches as with each other dataset type. It is not intended for use by external developers.



The raster band object accesses a single band of a raster dataset stored on disk.

The *RasterBand* object represents an existing band of a raster dataset on disk. This band may be the only band in a single-band raster dataset or one band in a multiband raster dataset.

The *RasterBand* is the only object in the raster data objects that allows you to change pixel values in datasets stored on disk.

One band of raster data can contain statistics, a color map, a table, a histogram, and values for each pixel in the band. These properties, which exist only for single bands of raster datasets, are accessible using the *RasterBand.*

The *RasterBand* may be accessed from either the *Raster* or the *RasterDataset* coclass but, regardless of whether derived from the static *RasterDataset* or the transient *Raster,* the *RasterBand* always represents a static band of raster data on disk.

The following code shows how to access a *RasterBand* from either a *Raster* or a *RasterDataset* object.

```
Dim pRasBC as IRasterBandCollection
Set pRasBC = pRasterPtr 'May be a Raster or a RasterDataset
MsgBox "Number of bands in Raster: " & CInt(pRasBC.Count)

' Get the first band of the raster
' Band Index must be less than or equal to pRasBC.Count-1
Dim pRasBand as IRasterBand
Set pRasBand = pRasBC.Item(0)
```

IRasterBand : IUnknown	***Provides access to members that control a raster band object.***
■— AttributeTable: ITable	*The attribute table of this raster band.*
■— Bandname: String	*The name of this raster band.*
■— Colormap: IRasterColormap	*The colormap of this raster band.*
■— Histogram: IRasterHistogram	*The histogram of this raster band.*
■— RasterDataset: IRasterDataset	*The RasterDataset associated with this raster band.*
■— Statistics: IRasterStatistics	*The statistics of this raster band.*
◀— CanCopy: Boolean	*Returns true if this dataset can be copied.*
◀— ComputeStatsAndHist	*Calculates statistics and histogram if not previously stored.*
◀— Copy (in copyName: String, in copyWorkspace: IWorkspace) : IDataset	*Copies this raster band to a new dataset with the specified name.*
◀— HasColormap (out b: Boolean)	*Indicates if this band has a colormap.*
◀— HasStatistics (out b: Boolean)	*Indicates if this band has statistics.*
◀— HasTable (out b: Boolean)	*Indicates if this band has an attribute table.*

The *IRasterBand* interface provides access to aspects of a raster band.

The *BandName* method returns the name of the band within its associated dataset. For most formats, this is the string “Band_1”, “Band_2”, and so on, but for GRID the band name is the same as the name of the dataset.

The *Statistics, Histogram,* and *Colormap* methods return references to objects that represent these aspects of the *RasterBand.*

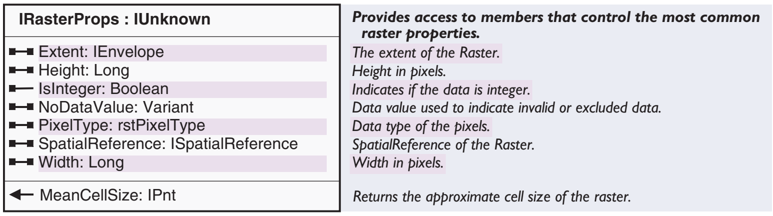
The *RasterDataset* method returns a reference to the *RasterDataset* that contains this band.

The *AttributeTable* method returns a table of the values contained in this band. At ArcGIS 8.1, this table is a copy of the table from the band, and modifications to this table will not have any effect on the data in the band.

The *ComputeStatsAndHist* method calculates statistics and a histogram for the band.

The *HasStatistics, HasHistogram,* and *HasColormap* methods set the output parameter to *True* if the band contains a histogram, colormap, or statistics and *False* if the band does not.

At ArcGIS 8.1, the *CanCopy* method always returns *False*, and the *Copy* method does nothing.



IRasterProps : IUnknown	*Provides access to members that control the most common raster properties.*
Extent: IEnvelope	*The extent of the Raster.*
Height: Long	*Height in pixels.*
IsInteger: Boolean	*Indicates if the data is integer.*
NoDataValue: Variant	*Data value used to indicate invalid or excluded data.*
PixelType: rstPixelType	*Data type of the pixels.*
SpatialReference: ISpatialReference	*SpatialReference of the Raster.*
Width: Long	*Width in pixels.*
MeanCellSize: IPnt	*Returns the approximate cell size of the raster.*

The *IRasterProps* interface accesses properties of the data in a raster band.

The *Height* and *Width* properties return the number of rows and columns in this band of raster data.

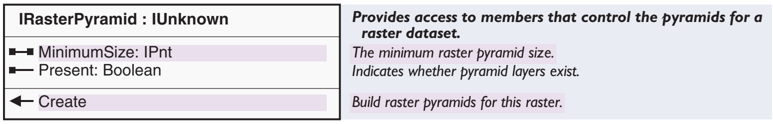
The *Extent* property returns an envelope surrounding the data in the band.

The *SpatialReference* returns the projection associated with this band of raster data on disk.

The *IsInteger* property returns *True* if the band contains data of integer type, and the *PixelType* property returns the bit depth and data type of the values in the raster band.

The *NoDataValue* returns the value stored in the dataset that is used to represent *NoData*. This value is returned in a variant with the same data type as that returned by the *PixelType* method. If there is no *NoDataValue* in the dataset, this property returns an empty variant.

As the *RasterBand* represents a fixed band of data on disk, changing the properties on the *IRasterProps* interface has no effect.



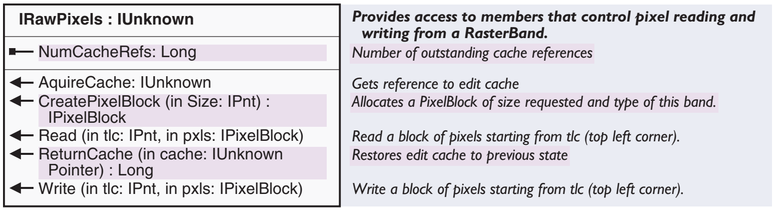
IRasterPyramid : IUnknown	*Provides access to members that control the pyramids for a raster dataset.*
MinimumSize: IPnt	*The minimum raster pyramid size.*
Present: Boolean	*Indicates whether pyramid layers exist.*
Create	*Build raster pyramids for this raster.*

The *IRasterPyramid* interface accesses raster pyramids.

The *Present* property returns *True* if pyramids exist for this band.

The *MinimumSize* property returns the smallest size for which pyramids will automatically be considered.

The *Create* method creates pyramids for the current band regardless of its size. Creating pyramids for the only band in a single-band dataset is the same as creating pyramids for that dataset. If pyramids exist for some bands of a multiband dataset, any band with pyramids will use them, but you will not be prompted to build pyramids for the other bands in your dataset; this may slow display if these bands are visible.



IRawPixels : IUnknown	***Provides access to members that control pixel reading and writing from a RasterBand.***
■— NumCacheRefs: Long	*Number of outstanding cache references*
◄— AquireCache: IUnknown	*Gets reference to edit cache*
◄— CreatePixelBlock (in Size: IPnt) : IPixelBlock	*Allocates a PixelBlock of size requested and type of this band.*
◄— Read (in tlc: IPnt, in pxls: IPixelBlock)	*Read a block of pixels starting from tlc (top left corner).*
◄— ReturnCache (in cache: IUnknown Pointer) : Long	*Restores edit cache to previous state*
◄— Write (in tlc: IPnt, in pxls: IPixelBlock)	*Write a block of pixels starting from tlc (top left corner).*

The *IRawPixels* interface reads and writes pixel values to a *RasterBand* on disk.

At ArcGIS 8.1, the *IRawPixels* interface provides the only mechanism to change pixel values in an existing raster dataset. With the *IRawPixels* interface, you can create a *PixelBlock*, then use the *PixelBlock* to read and write data.

When using a *PixelBlock* created by the *RasterBand* coclass, use only the first plane because the *RasterBand* is a single band. All formats can be read using this technique, but only GRID, TIFF, IMAGINE, BIL, BIP, and BSQ formats can be written. Reading the *PixelBlock* from the band completes the initialization of the *PixelBlock* and should be done before writing to the band.

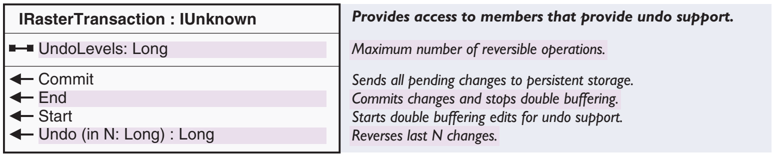
The *CreatePixelBlock* method creates a new *PixelBlock* of the size requested. This *PixelBlock* has the pixel type associated with the data in this band.

The *Read* method reads a block of pixels into the input *PixelBlock* object. The data is read beginning at the top-left corner specified by the input point. The input coordinates are in pixel coordinates, with the top-left corner represented by (0,0) and increasing down and to the right. If data is read from an area outside the band, the NoData value associated with the band will appear in these pixels. If there is no NoData value in the band, these values will most likely contain the minimum or maximum values in the data range of the band.

The *Write* method outputs the contents of a *PixelBlock* to the *RasterBand*. The *PixelBlock* is written to an area in the band specified by its top-left corner in the same pixel coordinate space used by the *Read* method. If transactioning is enabled, this write is persisted temporarily to a memory cache that allows undo support; otherwise, the data is persisted directly to disk at this time.

The *AcquireCache* and *ReturnCache* methods control a cache within the band object that allows the transactioning mechanism used by the *RasterBand* to be activated. Invoking the *AcquireCache* method creates a cache if it does not exist and increments a reference count for this cache if it has already been created. The *IUnknown* return value for this method is a reference to the cache. The user should not directly try to modify this cache. All caches must be returned for the band to free this cache, or data management functions, such as rename and delete, and some other functions will not work. The *ReturnCache* method will decrement the reference count and destroy the cache if it is no longer used (that is, the reference count is decremented to 0.) The *ReturnCache* method accepts a cache, obtained from the *AcquireCache* method, which it will confirm is valid before decrementing the cache reference count. If the cache input to the *ReturnCache* method is anything other than a valid existing cache obtained from the *AcquireCache* method, the reference count will not be decremented and the cache will not go away. The return value from the *ReturnCache* method is the number of caches remaining after this cache is returned.

For more information on how to use the *PixelBlock*, see the *PixelBlock* section in this chapter.



IRasterTransaction : IUnknown	***Provides access to members that provide undo support.***
UndoLevels: Long	*Maximum number of reversible operations.*
Commit	*Sends all pending changes to persistent storage.*
End	*Commits changes and stops double buffering.*
Start	*Starts double buffering edits for undo support.*
Undo (in N: Long) : Long	*Reverses last N changes.*

The *IRasterTransaction* interface allows you to undo edits made to a raster band.

This interface allows you to set up and maintain a transaction stack that can revert from changes that have been made in memory before persisting these changes to disk. In this mechanism, a transaction is defined as either a write called on the dataset outside a double-buffered transaction or a set of writes contained within a single Start/End transaction block. The *Start* and *End* methods allow you to perform multiple writes that are managed by the undo stack as a single transaction.

To enable the transactioning mechanism, a band cache must first be created. To create the cache, call the *AcquireCache* method on the *IRawPixels* interface. After you are done editing, free the cache using the *ReturnCache* method.

The *UndoLevels* property controls the number of changes that are maintained in the Undo stack.

The *Start* method creates a second buffer that allows multiple writes to be treated by the transaction controller as a single transaction. Calling the *Start* method means any further writes will be combined as a single virtual transaction to reduce long transaction lists and make it easier to remove logically grouped transactions.

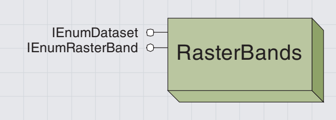
The *End* method closes a second buffer if initialized using the *Start* method, then closes the virtual transaction.

The *Commit* method flushes all changes to the persistent raster band.

The *Undo* method reverts the band to its state before one or more pending transactions. The input value specifies the number of changes that should be undone. The return value of the *Undo* method is the number of remaining transactions that have been made since the last call to commit. For example, if four writes are made to a band, and the *Undo* method called with an input of one, the return value indicates that three changes were made since the transaction was persisted.

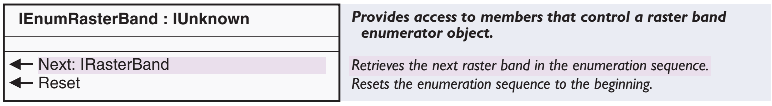
The following example uses the *IRawPixels* interface and the *PixelBlock* object to convert each cell value in a raster band from degrees to radians. The *IRasterProps* interface is used to get properties about the band.

```
Public Sub ConvertDegreesToRadians(pRasBand as IRasterBand)
  ' This example shows the usage of the IRawPixels interface to
  ' Read and write pixels to a raster band that is passed in.
  ' QI for the IRawPixels interface
  Dim pRawPixels As IRawPixels
  Set pRawPixels = pRasterBand

  ' QI for the IRasterProps interface to get height and width
  Dim pProps As IRasterProps
  Set pProps = pRasterBand

  Dim pPnt As IPnt
  Set pPnt = New DblPnt
  pPnt.SetCoords pProps.Width, pProps.Height
  ' Use the RawPixels interface to create a new PixelBlock
  Dim pPixelBlock As IPixelBlock
  Set pPixelBlock = pRawPixels.CreatePixelBlock(pPnt)

  ' Create a new point to specify where to begin reading, then read
  ' Note:the origin is specified in pixel (or image) coordinates
  Dim pOrigin As IPnt
  Set pOrigin = New DblPnt
  pOrigin.SetCoords 0, 0
  pRawPixels.Read pOrigin, pPixelBlock

  ' get the variant SafeArray from the pixelblock
  Dim vPixels As Variant
  vPixels = pPixelBlock.SafeArray(0)

  ' Loop through the safearray and change all the pixel values
  ' in this case, convert degrees to radians
  Dim i As Long, j As Long
  For i = 0 To pProps.Width - 1
    For j = 0 To pProps.Height - 1
      vPixels(i, j) = vPixels(i, j) * 3.14 / 180
    Next
  Next
  ' Write the data back to the dataset
  pRawPixels.Write pOrigin, pPixelBlock

  ' Clean up the remaining interface pointers
  Set pProps = Nothing
  Set pRawPixels = Nothing
  Set pRasterBand = Nothing
  Set pRasBC = Nothing
  Set pPixelBlock = Nothing
End Sub
```



The RasterBands *object allows you to enumerate through a set of raster bands.*

The *RasterBands* class is not cocreatable but must be retrieved from other objects. It is an enumerator object that iterates through either the *RasterBands* in a dataset or the *RasterDatasets* in a workspace.



IEnumRasterBand : IUnknown

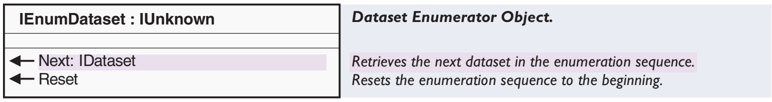
Provides access to members that control a raster band enumerator object.

← Next: IRasterBand	*Retrieves the next raster band in the enumeration sequence.*
← Reset	*Resets the enumeration sequence to the beginning.*

The *IEnumRasterBand* interface returns an *IRasterBand* reference to the next band in the collection.

The *IEnumRasterBand* interface to this object is returned by the *Bands* method on the *IRasterBandCollection* interface from either the *Raster* or *RasterDataset* object.

The *Next* method returns an *IRasterBand* pointer to the next band in the collection, and the *Reset* method sets the object to the first band in the collection.



IEnumDataset : IUnknown

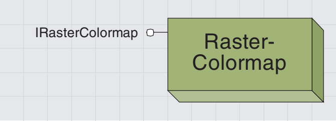
Dataset Enumerator Object.

← Next: IDataset	*Retrieves the next dataset in the enumeration sequence.*
← Reset	*Resets the enumeration sequence to the beginning.*

The *IEnumDataset* interface returns an *IDataset* reference to the next *RasterDataset* or *RasterBand* in the collection.

The *IEnumDataset* interface to this object is returned by the *Datasets* method on the *IWorkspace* interface on the *RasterWorkspace* object. When returned from the raster workspace, it enumerates through all datasets in the workspace. It can also be returned from the *Subsets* method on the *IDataset* interface of the *RasterDataset* object. When obtained from the dataset, it enumerates through all bands in the raster dataset.

The *Next* method returns an *IDataset* pointer to the next object in the collection, and the *Reset* method sets the object to the first dataset in the collection.



A raster colormap object provides access to the colormap of a raster band.

The *RasterColormap* is available for any raster that has a table with fewer than 2,048 values but is most useful when used with a dataset that contains a predefined colormap.

Rasters that contain a colormap, referred to as pseudocolor rasters, come in a variety of formats, but each specifies how each pixel value in the dataset is mapped to a color in the display. These colors are typically specified using red, green, and blue components, but using the *RasterColormap* object gives you the option of reading the specific components for each value or reading OLE_COLOR color objects. At ArcGIS 8.1, the values contained in the colormap cannot be changed using this object.

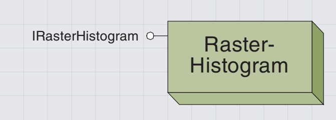
IRasterColormap : IUnknown	***Provides access to members that control a raster colormap.***
■—■ BlueValues: Variant	*Array of blue ratios as doubles between 0.0 and 1.0.*
■—■ Colors: Variant	*Array of colors as OLE_COLORs.*
■—■ GreenValues: Variant	*Array of green ratios as doubles between 0.0 and 1.0.*
■—■ RedValues: Variant	*Array of red ratios as doubles between 0.0 and 1.0.*
◀— Bin (in pixval: Double) : Long	*Translates pixel values into integers to index into the colormap.*

The *IRasterColormap* interface controls the colormap used when displaying a *RasterBand*.

The *RedValues, BlueValues,* and *GreenValues* properties return variant arrays of double-precision floating-point values. These arrays contain one value for each entry in the colormap. The values, which range from 0.0 to 1.0, represent the fraction of possible brightness to be displayed for that channel.

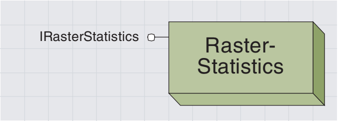
The *Colors* property returns a variant array of OLE_COLOR objects, one for each value in the colormap.

The *Bin* function converts a pixel value from the dataset into an index in the color array, which can be used to determine the correct color for each pixel.



A raster histogram object provides access to the histogram of a raster band.

The *RasterHistogram* object is not intended for outside developers and should not be used.



A raster statistics object provides access to statistics from a raster band.

The *RasterStatistics* class is not cocreatable and must be retrieved from a *RasterBand* object. The statistics only provide information about a single band and are used when displaying the raster. The statistics may be modified or recalculated using this object.

IRasterStatistics : IUnknown	*Provides access to members that control raster statistics.*
IgnoredValues: Variant	*Array of doubles indicating the pixel values not included in the statistics calculation.*
IsValid: Boolean	*Indicates if statistics are fresh.*
Maximum: Double	*Approximate largest value.*
Mean: Double	*Approximate average value.*
Median: Double	*Divides pixel population approximately in halves.*
Minimum: Double	*Approximate smallest value.*
Mode: Double	*Approximate most popular pixel value.*
RasterBand: IRasterBand	*The Raster Band.*
SkipFactorX: Long	*Number of horizontal pixels between samples for purposes of calculating statistics.*
SkipFactorY: Long	*Number of vertical pixels between samples for purposes of calculating statistics.*
StandardDeviation: Double	*Measures spread of pixel values about the mean.*
Recalculate	*Recalculate statistics based upon current skip factors and ignored values.*

The *IRasterStatistics* interface reads statistics values and recalculates statistics.

The statistics provided include *Minimum, Maximum, Mean,* and *Standard* deviation. These values will always exist if statistics have been calculated for the dataset and can be edited. Changing the values of these statistics may affect the display of the dataset, particularly when using a stretched or RGB renderer. Changes made to these values are temporary and are lost when the band goes out of scope.

The *Mode* and *Median* may not always be present and cannot be changed.

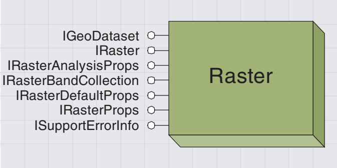
With the *IgnoredValues* property, you may set a value or values not used in the statistics calculation. This property may be useful if there is a background or other invalid value in the dataset.

The *SkipFactorX* and *SkipFactorY* properties allow you to skip some of the values in each direction when computing statistics. This results in statistics that are less accurate, but the calculation time required is decreased. By default, the skip factor is one, which means every value in the dataset will be used. Calculating statistics with skip factors greater than 1 can result in a table with empty rows or other undesirable behavior.

The *Recalculate* method calculates the values of the statistics using the specified skip factors and ignored values. *Recalculate* will not work if the statistics are valid, so you must set the *IsValid* property to *False* before calculating statistics. Changing the skip factors will automatically invalidate any existing statistics. When calculated, the statistics will be stored into the raster or written into the auxiliary file if they can be stored in the raster's native format.

The example below shows how to display the statistics of a raster band.

```
' Get the statistics from a RasterBand
Dim pStats As IRasterStatistics
Set pStats = pRasterBand.Statistics

' Recalculate the statistics if necessary
If Not pStats.IsValid Then pStats.Recalculate

MsgBox "Mean: " & pStats.Mean & vbLf & _
          "Std. Dev.: " & pStats.StandardDeviation
```



The Raster *object is a transient representation of raster data that performs resampling and reprojection.*

The *Raster* object, in contrast to the static *RasterDataset* and *RasterBand* objects, is transient in nature and can be modified without affecting the source data. This allows the raster to represent what you want, as you may specify a projection, extent, and cell size into which the input data will be transformed. This makes the raster quite useful for performing display or analysis in a coordinate system different from that which is stored in the raster data on disk.

Because of the transient nature of the raster, any modifications that are made to this object will be lost when the object is released. Although the *Raster* object is always transient in nature, it must be associated with one or more raster bands on disk, which provide a source for data to be read through the raster. As such, the *Raster* is most easily understood as a vehicle to provide resampling, projection, and data type conversion from one or more raster bands to a desired output coordinate system.

You can read data from the *Raster* using the *PixelBlock* object, which is discussed later in this chapter. The *RasterCursor* may also be used for reading data, providing a mechanism to iterate from one *PixelBlock* to the next throughout the entire *Raster*. It is important to remember that any data read through the raster has been resampled and has potentially also been projected and undergone data type conversion during the reading process. The *Raster* may read data from a raster's pyramids, if they exist, to provide faster performance when reading a raster at reduced resolution.

The *Raster* object may be obtained from a *RasterLayer* or *RasterDataset,* or it can be cocreated.

A *Raster* returned from the *RasterLayer* already has some properties modified by the layer, which makes it difficult to return to the original properties of the raster data. This also means that you could mistakenly operate on a subset of a raster dataset or use a resampled version based on the raster's pyramids by using a *Raster* obtained from the layer without first setting these properties.

The *Raster* created from the *RasterDataset* has the properties of the dataset on disk, except that rasters with more than three bands will only have three bands. The three bands used are determined by the settings for default raster behavior made on the *RasterDefaultsEnv*.

Cocreating a new *Raster* results in an empty raster that is not useful until one or more bands are placed into the raster, providing data for the raster to read. Creating a new raster and populating it with the desired bands provides the most flexibility. Any time a band is added or removed from a raster, its default settings for spatial reference, extent, and cell size may be changed, and these default settings will be applied to the raster if they have not been previously set by the user.

Each of these techniques is demonstrated in the sample code below:

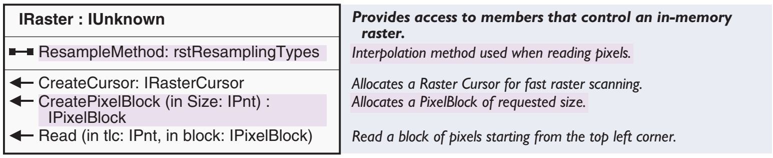
```
 ' Get Raster from RasterLayer
Set pRaster = pRasterLayer.Raster
```

```
' Create Default Raster from RasterDataset
Set pRaster = pRasterDataset.CreateDefaultRaster
' Cocreate new raster and add one band, more could be added
Set pRaster = New Raster
Dim pRasBC as IRasterBandCollection
Set pRasBC = pRaster
pRasBC.AppendBand pRasterBand
```

Sometimes it is necessary to find the *RasterDataset* that is associated with a *Raster*. This can be done by first accessing a band of the *Raster*, then retrieving the dataset from that band.

This technique is shown here:

```
‘ QI IRasterBandCollection from the Raster object
Dim pRasBC As IRasterBandCollection
Set pRasBC = pRaster

‘ Get the first band from the Raster
Dim pRasBand As IRasterBand
Set pRasBand = pRasBC.Item(0)

‘ Get the Raster’s dataset from the first band
Dim pRasDS As IRasterDataset
Set pRasDS = pRasBand.RasterDataset
```



IRaster : IUnknown

Provides access to members that control an in-memory raster.

ResampleMethod: rstResamplingTypes — *Interpolation method used when reading pixels.*

CreateCursor: IRasterCursor — *Allocates a Raster Cursor for fast raster scanning.*

CreatePixelBlock (in Size: IPnt) : IPixelBlock — *Allocates a PixelBlock of requested size.*

Read (in tlc: IPnt, in block: IPixelBlock) — *Read a block of pixels starting from the top left corner.*

The *IRaster* interface controls the reading of pixels from a *Raster* object.

The *IRaster* interface provides the ability to read data from a raster. This interface controls the resampling technique used when pixels are read from the *Raster* through the *ResampleMethod* property.

The *CreatePixelBlock* method creates a *PixelBlock* that can be used to read data from the *Raster*.

The input *Size* specifies the number of rows and columns in the *PixelBlock* and is specified with the *DblPnt* object.

The *Read* method transfers data into a *PixelBlock* after it is created. Once the data is read into the *PixelBlock*, it can be accessed through the methods on that object. The read can be initiated from any point in the raster, and the top-left corner of the area being read is specified as a *DblPnt* using the *tlc* argument.

The *CreateCursor* method creates a *RasterCursor* that can be used to successively read the set of *PixelBlocks* that make up the *Raster*. For more information, see the section of this chapter detailing the *RasterCursor* object.

IRasterBandCollection : IUnknown	***Provides access to members that control a collection of RasterBands.***
■— BandByName (in Name: String) : IRasterBand	*A RasterBand given its name.*
■— BandIndex (in Name: String) : Long	*The index of a RasterBand given its name.*
■— Bands: IEnumRasterBand	*All the bands in the collection as an interface to the RasterBands enumerator object.*
■— Count: Long	*The number of bands in the collection.*
← Add (in Element: IRasterBand, in Index: Long)	*Adds a RasterBand to the band collection.*
← AppendBand (in Element: IRasterBand)	*Appends a RasterBand to the band collection.*
← AppendBands (in Bands: IRasterBandCollection)	*Appends a collection of RasterBands to the band collection.*
← Clear	*Removes all the elements in the collection.*
← Item (in BandIndex: Long) : IRasterBand	*Returns a RasterBand given its index.*
← Remove (in Index: Long)	*Removes an element from the collection.*
← SaveAs (in new_name: String, in worksp: IWorkspace, in Format: String) : IDataset	*Creates a new persistent RasterDataset with the bands in the collection.*

The *IRasterBandCollection* interface controls the bands in a raster.

The *IRasterBandCollection* interface allows you to access the raster bands that compose the raster.

The *Count* property on the *IRasterBandCollection* interface returns the number of bands in the raster dataset.

The *BandByName* and *BandIndex* properties return a reference to the *RasterBand* or the index of the band in the raster from the band's name.

The *Item* method returns a raster band from the dataset. The *Item* returned is determined from the zero-based band index, so the first band is band 0, the second band is band 1, and so on.

The *IRasterBandCollection* interface allows you to manage the bands present in the raster. The *Add, Append, AppendBands, Clear,* and *Remove* methods change the contents of the *Raster* object.

The *Add* method inserts a *RasterBand* into the raster at the specified band index, while the *AppendBand* method adds a *RasterBand* after all existing bands in the *Raster*.

The *AppendBand* accepts a *RasterDataset* or another *Raster* object and appends all bands in that object to the current *Raster*.

The *Remove* method removes the specified band from the *Raster*, while the *Clear* method removes all bands and resets the *Raster* to its empty state.

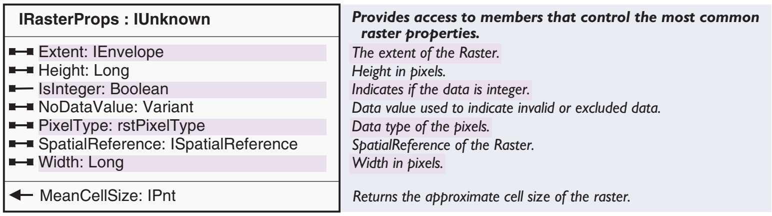
When a band is added to or removed from a *Raster* object, the *Raster* recomputes a default cell size, extent, and spatial reference based on the bands in the *Raster*. If the user has not manually adjusted these properties, the default settings will be applied to the raster object.

The spatial reference is determined first. If the user has not specified a spatial reference system to be applied to the raster, it is calculated from the first band in the raster that has a spatial reference other than unknown. If all bands have an unknown spatial reference, the spatial reference system of the raster will be unknown.

Next the cell size is calculated, if the cell size and number of rows and columns have not been changed by the user. The cell size is the maximum cell size of any input bands projected into the current spatial reference system. If no spatial reference system is known, the largest cell size of any band in the *Raster* is selected.

Finally, if the extent has not been specified by the user, it is calculated. The extent is the smallest bounding box with an integer number of rows and columns that can be placed around all bands of the input raster while aligning with the bottom-left corner of the *Raster*. Because of the way these defaults are calculated, the *Raster* can be used to project data from one coordinate system to another. Simply add your projected data to an empty *Raster*, then change the spatial reference system on the *Raster*. When the data is read or saved, it will be in the new coordinate system, and the correct extent and cell size will be calculated automatically.

The *SaveAs* method on the *IRasterBandCollection* interface persists a resampled or reprojected *Raster* to disk. The output dataset has all of the properties, including spatial reference, cell size, extent, and pixel type of the raster, when this method is invoked. Thus, this method can be useful to project raster data, convert data from one pixel type to another, or resample raster data. This method, like *CreateRasterDataset*, can only write out GRID, TIFF, and IMAGINE format rasters.



IRasterProps : IUnknown	*Provides access to members that control the most common raster properties.*
Extent: IEnvelope	*The extent of the Raster.*
Height: Long	*Height in pixels.*
IsInteger: Boolean	*Indicates if the data is integer.*
NoDataValue: Variant	*Data value used to indicate invalid or excluded data.*
PixelType: rstPixelType	*Data type of the pixels.*
SpatialReference: ISpatialReference	*SpatialReference of the Raster.*
Width: Long	*Width in pixels.*
MeanCellSize: IPnt	*Returns the approximate cell size of the raster.*

The *IRasterProps* interface controls properties of the data in a raster.

Many properties of the *Raster* object can be accessed and modified using the *IRasterProps* interface. It is important to remember that these modifications only affect the in-memory raster representation and in no way change any of the data stored on disk. Therefore, the *Raster* can be used to change the extent, dimensions, pixel-bit depth, and spatial reference to one that is nonnative to the disk-based raster dataset and provide for automatic resampling or reprojection before reading from the dataset.

The *Raster* also utilizes raster pyramids to provide faster reading at low resolutions if pyramids exist for the dataset with which it is associated. The resampling method used when reading can be set using the *Resample* method on the *IRaster* interface.

The *Height* and *Width* properties return the number of rows and columns in the *Raster*. This height and width determine the number of rows and columns into which to divide the input extent.

The *Extent* property controls the extent for which data in the *Raster* will be read.

The *SpatialReference* controls the projection of the *Raster*'s extent.

The *IsInteger* property returns *True* if the band contains data of integer type; the *PixelType* property controls the bit depth and data type of the values in the raster. If the *PixelType* specified is not the same as a band of the raster, the pixel values will automatically be converted to the correct data type.

The *NoDataValue* controls an array of values used to represent *NoData*. This variant array of values has the pixel type of the raster and contains one *NoData* value for each band. This allows the different bands in the raster to contain a different *NoData* value. If there is no *NoDataValue* in the band, the value in the corresponding member of the array will be empty.

IRasterAnalysisProps : IUnknown	***Provides access to members that control the properties for raster analysis.***
AnalysisExtent: IEnvelope	*The analysis extent of the raster.*
PixelHeight: Double	*The pixel height in ground resolution.*
PixelWidth: Double	*The pixel width in ground resolution.*
RasterDataset: IRasterDataset	*The RasterDataset, if there is one.*
MakePermanent	*Makes a temporary raster a permanent raster dataset.*

The *IRasterAnalysisProps* interface controls properties of a *Raster* that are useful when performing analysis.

The *AnalysisExtent* property returns an envelope object containing the intersection of all bands in the *Raster*.

The *PixelHeight* and *PixelWidth* properties control the height and width of each pixel in the dataset.

The *MakePermanent* method changes the status of the dataset associated with this *Raster* to permanent if it is currently temporary.

The *RasterDataset* property returns the dataset associated with a raster if all bands contained in the raster come from the same dataset. If bands from multiple datasets are present in this raster, this property will return NULL.

IRasterDefaultProps : IUnknown	***Provides access to members that control the default raster properties.***
DefaultIntersectExtent: IEnvelope	*The default intersect extent.*
DefaultPixelHeight: Double	*The default pixel size in Y.*
DefaultPixelWidth: Double	*The default pixel size in X.*
DefaultSpatialReference: ISpatialReference	*The default spatial reference.*
DefaultUnionExtent: IEnvelope	*The default union extent.*
ResetToDefault	*Resets the raster to default state*

The *IRasterDefaultProps* interface accesses the default properties of a *Raster*.

The default properties of a raster are updated each time a band is added or removed from the raster. This allows the raster to provide useful defaults while still obeying any settings you adjust. The default properties of the raster allow you to examine what these defaults would be if you changed the properties on the raster.

The *DefaultSpatialReference* returns the spatial reference system associated with the first band of the raster whose coordinate system is not *Unknown* or *Unknown* if all bands in the raster are unprojected.

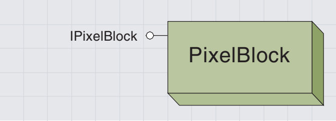
The *DefaultPixelHeight* and *DefaultPixelWidth* properties return the default height and width of each cell in the specified coordinate system.

The *DefaultUnionExtent* returns the smallest bounding box that surrounds all bands in the raster; it has an integral number of default size pixels.

The *ResetToDefault* method causes the system to revert to these settings and forces subsequent addition or removal of bands to recompute these settings automatically.

The following example creates a raster object, then resamples it to half its original size and reprojects it before writing the results to a new dataset.

```
Dim pUTMRasterDataset As IRasterDataset
Set pUTMRasterDataset = OpenRasterDataset("d:\Workspace", "utmGridName")

Dim pGeoDataset As IGeoDataset
Set pGeoDataset = pUTMRasterDataset

Dim pOutputSpatialReference As ISpatialReference
Set pOutputSpatialReference = pGeoDataset.SpatialReference

Dim pRasterDS As IRasterDataset
Set pRasterDS = OpenRasterDataset("D:\Workspace\", "drg.tif")

Dim pRaster As IRaster
Set pRaster = pRasterDS.CreateDefaultRaster

'Change the pRaster's properties
Dim pProps As IRasterProps
Set pProps = pRaster
pProps.Height = pProps.Height / 2
pProps.Width = pProps.Width / 2
pProps.SpatialReference = pOutputSpatialReference

Dim pRasBC As IRasterBandCollection
Set pRasBC = pRaster
pRasBC.SaveAs "loresdrg.tif", SetRasterWorkspace("D:\Workspace\"), "TIFF"
```



The PixelBlock *object contains a pixel array that can be read from a raster or raster band.*

The *PixelBlock* can be created for *Raster* and *RasterBand* objects.

The behavior of the *PixelBlock* is different depending on which object created it. A *PixelBlock* read from a *RasterBand* can only have one band, while one read from a *Raster* may contain multiple bands. From the *RasterBand* coclass, the *PixelBlock* can be modified and written back to the band.

From the *Raster*, the *PixelBlock* is resampled, can be reprojected, and will read from raster pyramids, if available, to improve performance. Conversely, the *RasterBand* does not resample or reproject; it reads only the raw pixel values contained in the dataset.

The *PixelBlock* object is designed to handle generic pixel arrays from any raster data source. This means it must be able to handle single and multiband data, as well as support different pixel types. To support different pixel types, the *PixelBlock* transports pixels in a *SafeArray*, which has the ability to contain many different data types. To support multiple bands, or planes, of raster data, the *PixelBlock* provides a separate array for each plane in the raster.

A *Raster* or *RasterBand* object must create the *PixelBlock* unless it is being read from a *RasterCursor*, which will create the object automatically. A *PixelBlock* that is created for use with one object may not be usable with another object because of the way the *PixelBlock* is initialized. If you think this may be a problem in your application, you should simply release the old *PixelBlock*, then create a new *PixelBlock* with the object from which you will be reading.

The *PixelBlock* can be created in any size, but after it is created, its size cannot be changed. For small rasters, the *PixelBlock* can be the size of the entire dataset, which can usually be held in memory at one time. Larger rasters can be read in as smaller pieces by creating a smaller *PixelBlock* and reading portions of the raster sequentially. This is done by specifying the top-left corner of the *PixelBlock* within the raster each time data is read into the *PixelBlock*.

The top-left corner of the *RasterBand PixelBlock* is determined based on pixel coordinates for the dataset. The top-left corner of the *Raster PixelBlock* is determined by the extent, width, and height specified in the raster properties. The top-left corner of the dataset is (0,0), with the values ascending as the pixels go down and to the right.

	IPixelBlock : IUnknown	***Provides access to members that control a PixelBlock.***
■—	BytesPerPixel: Long	*The number of bytes per pixel for the PixelBlock.*
■—	Height: Long	*The height of the PixelBlock in pixels.*
■—■	PixelType (in plane: Long) : rstPixelType	*The pixel type of the PixelBlock.*
■—	Planes: Long	*The number of pixel arrays contained in the PixelBlock.*
■—■	SafeArray (in plane: Long) : Variant	*A variant SafeArray of pixels for a specified plane.*
■—	Width: Long	*The width of the PixelBlock in pixels.*
←	GetVal (in plane: Long, in X: Long, in Y: Long) : Variant	*The value for a specified pixel.*

The *IPixelBlock* interface controls a generic pixel array.

The *Height* and *Width* properties return the number of rows and columns in the *PixelBlock*. The *Planes* argument specifies the number of bands in the *PixelBlock*.

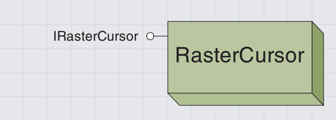
The *PixelType* property returns the data type and bit depth of the pixels in the specified band.

The *SafeArray* property returns the variant *SafeArray* for the specified band.

The *GetVal* method returns an individual value for the pixel specified by the band and pixel location input.

The sample below reads an entire raster as one block, then displays how many times the value 0 occurs in the dataset.

```
'Create a default raster from the dataset
Dim pRaster As IRaster
Set pRaster = pRasterDataset.CreateDefaultRaster

'QI the raster properties interface
Dim pRasProps As IRasterProps
Set pRasProps = pRaster

'Create a DblPnt to hold the PixelBlock size
Dim pPnt As IPnt
Set pPnt = New DblPnt
pPnt.SetCoords pRasProps.Width, pRasProps.Height

'Create the empty PixelBlock
Dim pBlock As IPixelBlock
Set pBlock = pRaster.CreatePixelBlock(pPnt)

'Create a DblPnt to hold the Top Left Corner read location
Dim pOrigin As IPnt
Set pOrigin = New DblPnt
pOrigin.SetCoords 0, 0

'Read in the PixelBlock from the Raster
pRaster.Read pOrigin, pBlock

'Get the Safearray associated with the first plane, or band
Dim pRasSafe As Variant 'Safearray is a variant type
pRasSafe = pBlock.SafeArray(0)
Dim j As Integer, k As Integer
Dim count As Long

'Loop through the values in the SafeArray and count zeroes
For j = 0 To pPnt.X - 1
  For k = 0 To pPnt.Y - 1
    If pRasSafe(j, k) = 0 Then count = count + 1
  Next
Next

MsgBox "There are " & CStr(count) & " zeroes in this raster."
```



A raster cursor object is a mechanism for iterating through all of the pixel blocks in a raster.

The *RasterCursor* is useful for rasters that are too large to be brought into memory at once.

The *RasterCursor* divides the *Raster* into blocks 128 pixels high that span the full width of the raster. Each successive *PixelBlock* is read 128 lines below the previous *PixelBlock*.

To create a *RasterCursor*, use the *CreateCursor* method on the *Raster* object. The object may then be used to iterate through the *PixelBlocks* in a raster.

IRasterCursor : IUnknown	***Provides access to members that provide optimized raster access.***
PixelBlock: IPixelBlock	*The current PixelBlock.*
TopLeft: IPnt	*The offset of the current pixelblock.*
Next: Boolean	*Iterates to the next PixelBlock.*
Reset	*Return to state when first created.*

The *IRasterCursor* interface controls enumeration through the *PixelBlocks* in a *Raster*.

The *PixelBlock* property retrieves the current *PixelBlock* object from the cursor.

The *PixelBlock* is the full width of the input raster and 128 pixels tall.

The *TopLeft* property returns the coordinates of the upper-left corner of the current *PixelBlock* within the source raster. Because the *PixelBlock* spans the full width of the raster, the x-coordinate of this value is always 0.

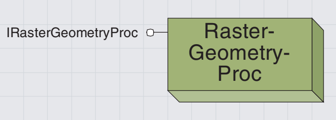
The *Next* method updates the cursor to the next *PixelBlock* within the raster. This method returns *True* when the next *PixelBlock* begins within the extent of the *Raster*. If the return value is *False*, the cursor has iterated through the entire raster, and subsequent *PixelBlock* accesses will produce empty *PixelBlock*s.

The *Reset* method returns the cursor to its initial state at the top of the *Raster*.

The following code loops through all of the *PixelBlock*s in a raster using the *RasterCursor*. It outputs the top-left corner coordinates of the *PixelBlock* after reading it.

```
Dim pCursor As IRasterCursor
Set pCursor = pRaster.CreateCursor
Dim pBlock As IPixelBlock

Do
  Set pBlock = pCursor.PixelBlock
  MsgBox pCursor.TopLeft.X & " " & pCursor.TopLeft.Y
Loop Until Not pCursor.Next
```

RasterGeometryProc coclass



The RasterGeometryProc *object performs geometric processing, such as flipping, scaling, rotation, and polynomial warping, on a raster.*

The *RasterGeometryProc* manipulates only *Raster* objects, not *RasterBand* or *RasterDataset* objects. This is because the *Raster* is transient, as are the effects of the *RasterGeometryProc*. This means that any transformation will also go away when the *Raster* object goes out of scope.

To keep the transformed data for later use, you must persist the transformation using *Register* or *Rectify*. Alternatively, you can use the *SaveAs* method on the transformed *Raster* to persist the transformation to a new dataset. If used on a *Raster* contained within a *RasterLayer*, processing performed by this object will be visible when the display is refreshed.

IRasterGeometryProc : IUnknown	***Provides access to members that allow raster geometry processing.***
← Clip (in ipRectangle: IEnvelope, in ipRaster: IRaster)	*Clips the input raster based on the specified envelope.*
← Flip (in ipRaster: IRaster)	*Flips the input raster.*
← isPixelToMapTransSimple (in ipRaster: IRaster) : Boolean	*Determines if the transformation of pixel to map is simple.*
← LeastSquareFit (in sourceControlPoints: IPointCollection, in targetControlPoints: IPointCollection, in transformType: tagesriGeoTransTypeEnum, in forwardTransformation: Boolean, in returnTransformationCoef: Boolean) : Variant	*Computes a least squares fit for the input control points.*
← Merge (in saveas_name: String, in ipWorkspace: IWorkspace, in OutRasterFormat: String, in Cellsize: Double, in ipSR: ISpatialReference, in ipRaster: IRaster) : IRaster	*Merges the input rasters into a single dataset.*
← Mirror (in ipRaster: IRaster)	*Mirrors the input raster.*
← Mosaic (in saveas_name: String, in ipWorkspace: IWorkspace, in OutRasterFormat: String, in Cellsize: Double, in ipSR: ISpatialReference, in ipRaster: IRaster) : IRaster	*Mosaics the input rasters into a single dataset.*
← PointsTransform (in inPoints: IPointCollection, in isForward: Boolean, in ipRaster: IRaster) : IPointCollection	*Transforms a set of points based upon the transformation being applied to the input raster.*
← Project (in ipNewSR: ISpatialReference, in PrjMethodType: tagesriRasterPrjMethodTypeEnum, in resampleType: rstResamplingTypes, in newCellsize: Double, in ipRaster: IRaster)	*Projects the input raster using specified transformation type.*
← ProjectFast (in ipNewSR: ISpatialReference, in resampleType: rstResamplingTypes, Cellsize: Variant, in ipRaster: IRaster)	*Projects the input raster using a single polynomial fit to compute the adjustment between coordinate systems.*
← Rectify (in saveas_name: String, in Format: String, in ipRaster: IRaster)	*Persists the input raster to a new dataset of the specified format.*
← Register (in ipRaster: IRaster)	*Outputs the current transformation properties to the dataset header or auxilliary file.*
← Resample (in resampleType: rstResamplingTypes, in newCellsize: Double, in ipRaster: IRaster)	*Resamples the input raster to a new cellsize.*
← ReScale (in XScale: Double, in YScale: Double, in ipRaster: IRaster)	*Scales the input raster by the specified x and y scale factors.*
← Reset (in ipRaster: IRaster)	*Resets the input raster to its native coordinate space.*
← Rotate (in ipPivotPoint: IPoint, in rotateAngle: Double, in ipRaster: IRaster)	*Rotates the input raster around the specified pivot by an angle specified in degrees.*
← Shift (in deltaX: Double, in deltaY: Double, in ipRaster: IRaster)	*Shifts the input raster by deltaX and deltaY map units.*
← TwoPointsAdjust (in sourceControlPoints: IPointCollection, in targetControlPoints: IPointCollection, in ipRaster: IRaster)	*Performs a Hermite Transformation on the input raster based upon the 2 input control point pairs.*
← Warp (in sourceControlPoints: IPointCollection, in targetControlPoints: IPointCollection, in transformType: tagesriGeoTransTypeEnum, in ipRaster: IRaster)	*Warps the input raster based upon the input control points using the transformation type specified.*

The *IRasterGeometryProc* interface controls geometric processing for raster data.

The *Clip* method extracts the portion of a raster within a box.

The *Flip* and *Mirror* methods flip an input raster horizontally or vertically.

The *Shift* method translates the raster to a new position without changing its size. The *deltaX* and *deltaY* parameters specify the distance to shift the raster in the x and y directions.

The *Rescale* method scales the input raster by the scale factors specified. Negative values should not be input for the scale factor arguments.

The *Rotate* method rotates the raster by the angle input in degrees around the input pivot point, if specified. If no pivot point is specified, the raster is rotated around its center point.

The *Resample* method changes the cell size of the raster.

The *Reset* method sets the raster back to its initial state.

This interface also allows you to reproject raster data. The *ProjectFast* method projects a raster to a new spatial reference using a polynomial warp. This is similar to the PROJECTGRID command in ArcGrid™. This method is much faster than projecting each cell and is accurate over small regions with limited distortion but can produce poor results if the input raster covers a large geographic extent or is at high latitude. At ArcGIS 8.1, true raster projection must be performed using ArcGrid; this functionality will be supported in a future release of ArcGIS.

The *IRasterGeometryProc* interface can also adjust a raster based on a set of input control points or links.

The *TwoPointsAdjust* method accepts a pair of links that are used to compute a Hermite transformation, which is applied to the raster. A Hermite transformation can shift, rotate, and scale a raster.

The *Warp* method computes a polynomial transformation based on the input links, then applies this transformation to the input raster. At ArcGIS 8.1, first-, second-, and third-order polynomial transformations are available.

The *LeastSquaresFit* method returns the parameters that would be used to transform a dataset based on the input links.

The *PointsTransform* method takes a set of input points and transforms them using the transformation currently held in the raster. The points can be transformed forwards or backwards.

All of the preceding methods modify the transient raster object and will be cleared when the raster goes out of scope. To persist the transformation for later use, you must use the *Register* or *Rectify* methods.

The *Rectify* method creates a new dataset using the current transformation. This dataset is rectangular in extent and therefore will be resampled. New datasets can be created in GRID, TIFF, and

ERDAS IMAGINE format. Resampling can degrade your data and is not recommended unless it is necessary.

To prevent the need for resampling, the *Register* method persists the transformation into the auxiliary file associated with the dataset on disk. The presence of this transformation on disk means that the data can be transformed on the fly to its correct position for display and analysis. However, because the transformation is stored in the auxiliary file, only ArcGIS, ArcObjects, and ERDAS IMAGINE will be able to use this information. *Register* will not correctly maintain the transformation for rasters that have been clipped. To provide compatibility with ArcInfo Workstation, complex transformations cannot be written to GRID-format datasets.

The *IRasterGeometryProc* interface also provides the ability to combine multiple raster datasets into a single output dataset.

The *Merge* and *Mosaic* methods combine multiple adjacent datasets into a single output dataset. The *Raster* that is input to these methods should be composed of multiple bands from separate datasets. The easiest way to do this is to cocreate an empty raster, then *QI* for the *IRasterBandCollection* interface, and add each band to be combined into the input raster. The difference between these methods results from how they handle overlapping areas.

The *Merge* command determines the value of an overlapping output cell from the first non*NoData* cell input from any input raster.

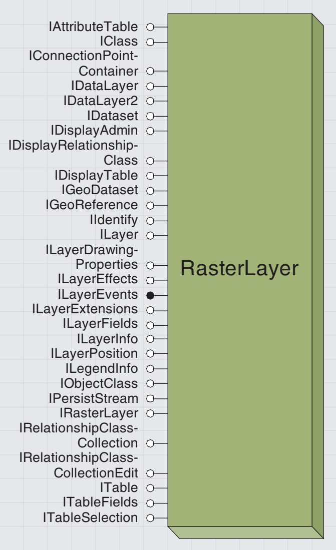
The *Mosaic* method performs an average weighted by the distance from the edge of the input raster to determine the value of these cells.

These methods are different from the rest of the geometric processing operations because they do not operate on the input raster but, instead, create a new output dataset. Therefore, an output name, workspace, and format must be specified to perform these methods. The case-sensitive output format argument must be "GRID", "TIFF", or "IMAGINE Image". Raster datasets of any format may be input to these methods. The bounding box of the output dataset is the union of the bounding boxes of all input datasets.

The following example merges two raster datasets using the *RasterGeometryProc*. Note the usage of the *OpenRasterDataset* function defined in the *RasterWorkspace* section of this chapter.

```
' Cocreate the geometric processing object
Dim pProc As IRasterGeometryProc
Set pProc = New RasterGeometryProc

' cocreate the new empty raster
Dim pRas As IRaster
Set pRas = New Raster
```

```
' QI the raster for IRasterBandCollection
Dim pRasBC As IRasterBandCollection
Set pRasBC = pRas


Dim pRasterDataset As IRasterDataset

' open the first dataset and add its bands to the raster
Set pRasterDataset = OpenRasterDataSet("e:\drgs", "038106f6.tif")
pRasBC.AppendBands pRasterDataset

' open the second dataset and add its bands to the raster
Set pRasterDataset = OpenRasterDataSet("e:\drgs ", "038106f5.tif")
pRasBC.AppendBands pRasterDataset

' merge the datasets, creating a new dataset named merged
pProc.Merge "merged.img", SetRasterWorkspace("e:\drgs "), _
"IMAGINE Image", 3, Nothing, pRas
```



The RasterLayer *object is the raster extension to the* ArcMap *object model used for visualizing raster data.*

The *RasterLayer* contains raster data and instructions for how to visualize it. The *RasterLayer* provides raster-specific functionality and supports generic layer functionality that is needed for raster layers to behave like other layer types. Only the raster-specific aspects of the *RasterLayer* are discussed in this section.

The *RasterLayer* visualizes all types of raster data supported by ArcGIS except raster catalogs, which must use the *RasterCatalogTable* and *RasterCatalogLayer*.

The *Raster* object obtained from the layer will have had its properties modified by the layer. Therefore, it will not have the extent and cell size of the original dataset. Because these properties have been set, the raster will not be able to use its default settings either. This is because the *Raster* is used by the *RasterLayer* to perform resampling, reprojection if necessary, and data type conversion when needed.

The easiest way to access the unmodified *Raster* is to open a *RasterDataset* based on the file path from the layer and use the *CreateDefaultRaster* method to get the desired raster.

IRasterLayer : ILayer	***Provides access to members that create or modify a raster layer.***
BandCount: Long	*Number of bands in the layer.*
ColumnCount: Long	*Number of columns in the layer.*
DataFrameExtent: IEnvelope	*Extent of the dataframe that contains the layer.*
DisplayResolutionFactor: Long	*Display resolution factor. Factor value is expressed as a percentage between 0 and 100.*
FilePath: String	*Filepath of the data source.*
PrimaryField: Long	*Layer's primary field.*
PyramidPresent: Boolean	*Indicates if pyramids are present for the layer.*
Raster: IRaster	*Layer's Raster object.*
Renderer: IRasterRenderer	*Layer's renderer.*
RowCount: Long	*Number of rows in the layer.*
ShowResolution: Boolean	*Indicates if the raster resolution should be displayed in the Table of Contents.*
VisibleExtent: IEnvelope	*Visible extent of the layer in the data frame.*
CreateFromDataset (in RasterDataset: IRasterDataset)	*Creates a layer from a RasterDataset object.*
CreateFromFilePath (in FilePath: String)	*Creates a layer from a file path to raster data.*
CreateFromRaster (in Raster: IRaster)	*Creates a layer from a Raster object.*

All of the raster-specific functionality of the *RasterLayer* is exposed through the *IRasterLayer* interface.

Many properties accessed from the *RasterLayer* provide information about the layer, including the number of rows, columns, and bands in the raster; the full path of the source raster dataset; whether pyramids are present; and the *Raster* object being used by this layer.

The user can also set some of the properties exposed on the *IRasterLayer* interface.

The *ShowResolution* property controls whether the current display resolution is listed in the table of contents next to the entry for the layer.

The *VisibleExtent* specifies a subset of the raster layer to be drawn, which can speed the drawing of the layer.

The *PrimaryField* property controls the field that provides map tips and the field that appears in the left pane of the Identify window. The integer property value represents the column number of the selected field, where the value field equals 1.

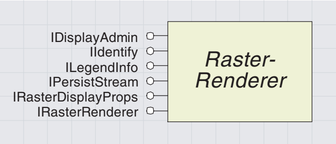
The *Renderer* property controls the renderer being used by the layer. The raster renderers are instructions for how the data should be displayed; they are discussed next.

The *RasterLayer* must be initialized with data before it can be used. When the layer is intialized, a default renderer is selected for the dataset based on the number of bands, statistics, and whether a colormap or other table exists for the data. Other internal properties of the layer are also set at this time.

A raster layer can be initialized with a path to a disk-based raster dataset, a *Raster* object, or a *RasterDataset* object.

This example shows how to create a *RasterLayer* from a file path, raster, or raster dataset.

```
' Cocreate the new RasterLayer
Dim pRasLyr as IRasterLayer
Set pRasLyr = New RasterLayer

' Initialize one of the following three methods
pRasLyr.CreateFromFilePath "D:\data\dem.bsq"
pRasLyr.CreateFromDataset pRasterDataset
pRasLyr.CreateFromRaster pRaster
```



The RasterRenderer *object controls how raster datasets are displayed.*

The *RasterRenderer* is an abstract class that cannot be created or used directly. All of its functionality is inherited by the four raster renderers; the unique value, classified, and stretched renderers for single-band data; and the RGB renderer for multiband data.

Each of these raster renderer types aggregates the functionality described here. This means that although the interfaces here are not listed in the object model diagram on the specific renderer classes, these interfaces may be queried and used from each raster renderer.

IRasterRenderer : IUnknown	***Provides acess to methods that define a generic raster renderer.***
■—■ DisplayResolutionFactor: Long	*Display resolution factor. Factor value is expressed as a percentage between 0 and 100.*
■—□ Raster: IRaster	*Raster to be rendered.*
■—■ ResamplingType: rstResamplingTypes	*Resampling method for displaying a raster.*
■— Updated: Boolean	*Indicates whether the renderer requires updating.*
← CanRender (in Raster: IRaster) : Boolean	*Indicates if the raster can be rendered.*
← Copy (in pSource: IRasterRenderer)	*Selects a raster as the current copy object.*
← Draw (in Raster: IRaster, in drawPhase: tagesriDrawPhase, in pDisplay: IDisplay, in pTrackCancel: ITrackCancel)	*Draws the raster on the display.*
← Update	*Updates the renderer for any changes that have been made.*

Use the *IRasterRenderer* interface to attach a new renderer to any raster layer.

The *ResamplingType* property controls the resampling method used when resampling the raster for display.

The *DisplayResolutionFactor* property gets or sets the raster display quality parameter. This value is expressed as a percentage from 0 to 100, where 100 represents full raster quality and lower values select fewer input values to be used to paint each display pixel. This results in a drawing performance boost at the cost of display quality.

The *Raster* property controls the raster being displayed by the renderer. Because the renderers depend on dataset statistics, after changing the raster to be displayed, the *Update* method must be called before performing using the renderer.

The *Update* method returns *False* if the raster has been changed since the last update. The *Update* method should also be called after making changes to the renderer but before assigning the renderer to a layer.

The *CanRender* method returns *True* if the input raster can be displayed using the current renderer.

IRasterDisplayProps : IUnknown	***Provides access to members that control the raster display properties.***
■—■ BrightnessValue: Long	*Brightness value for a raster.*
■—■ ContrastValue: Long	*Contrast value for a raster.*
■—□ NoDataColor: IColor	*Nodata color for a raster.*
■—■ TransparencyValue: Long	*Transparency value for a raster.*

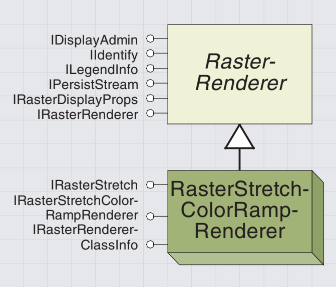
The *IRasterDisplayProps* interface controls display properties common to all raster renderers.

The *TransparencyValue, ContrastValue,* and *BrightnessValue* properties provide access to these properties of raster display.

The *TransparencyValue* value ranges from 0 to 100, with 0 representing opaque and 100 representing fully transparent.

The *ContrastValue* and *BrightnessValue* properties range from -100 to 100, representing a percentage of increase or decrease in the property.

The *NoDataColor* property controls how *NoData* cells in your raster are displayed. By default, *NoData* cells appear transparent.



The RasterStretchColorRampRenderer *object stretches the values from the dataset along a color ramp.*

Continuous raster data can be displayed by stretching the values from the dataset along a color ramp.

The color ramp to be used is divided into 256 segments, and a color is obtained at each location in the ramp. The raster dataset is then reclassified into 256 classes, and each class is drawn with the corresponding color in the palette. The stretched renderer is the default display for all rasters in ArcGIS that contain more than 25 unique values.

IRasterStretchColorRampRenderer : IUnknown	*Provides access to members that control the color ramp of a contrast stretch.*
BandIndex: Long	*Index of the band to be rendered.*
ColorRamp: IColorRamp	*Color ramp.*
ColorScheme: String	*ColorScheme name.*
LabelHigh: String	*Label for highest value.*
LabelLow: String	*Label for lowest value.*
LabelMedium: String	*Label for medium value.*
← ResetLabels	*Makes default labels.*

The *IRasterStretchColorRampRenderer* interface controls the display of a raster dataset stretched along a color ramp.

The *BandIndex* property specifies the band in the raster dataset to be drawn. For single-band data, this should be 0, but with multiband data any band may be selected.

The color ramp to be used can be specified using the *ColorRamp* property. This color ramp is used to display the raster and appears in the table of contents.

The *ColorScheme* property specifies the text name of the color scheme from the style gallery displayed in the color ramp selection list on the layer property page. The default is black to white.

The *LabelHigh, LabelMedium,* and *LabelLow* properties specify the text that appears at the top, center, and bottom of the color ramp.

The *ResetLabels* method changes the labels to their original state, with the center label empty and the top and bottom labels showing the maximum and minimum values in the dataset.

IRasterStretch : IUnknown	*Provides access to members which control contrast stretching.*
Background: Boolean	*Indicates if a background value is being used.*
BackgroundColor: IColor	*Background display color.*
BackgroundValues: Double	*Indicates whether an array of background values is being used.*
Invert: Boolean	*Indicates if the stretch is inverted.*
StandardDeviationsParam: Double	*Standard deviation parameter for the stretch renderer.*
StretchType: tagesriRasterStretchTypesEnum	*Current stretch type.*

The *IRasterStretch* interface controls how the values in a band are binned for display.

Data can be binned to the data range used for display in several ways. This binning is controlled by the *IRasterStretch* interface. If no stretch is applied, the data values from the full range of the data type, for example, 0 to 255 for 8-bit unsigned, or -32,768 to 32,767 for 16-bit signed, are divided into 255 classes, and each pixel in the input dataset is placed in one of these classes.

With the standard deviation and min–max stretches, the range of values that defines the classes is determined by the statistics of the dataset. For the min–max stretch, the range from the minimum to the maximum values of the dataset is used, while the standard deviation stretch uses the mean value plus and minus a certain number of standard deviations (two by default) to determine the bounds of the stretch.

The histogram equalization method does not divide the data range into classes with the same interval; instead, it creates the classes so that each class has approximately the same number of values.

Dataset statistics are required for many of these stretches, including standard deviation, min–max, and histogram equalization, to work correctly. Statistics will be built automatically if one of these stretches is selected. If no statistics exist for the dataset, no stretch is applied by default; otherwise, a standard deviation stretch is applied.

The *StretchType* property controls the minimum and maximum values between which the data is stretched using the stretch types discussed above.

When using the standard deviation stretch, the *StandardDeviationsParam* property controls the number of standard deviations from the mean used to determine the minimum and maximum values for the stretch. The default is two.

The *Invert* parameter flips the color ramp used to display the data so the data is displayed with the colors inverted.

If one value in the dataset does not belong in the stretch, it may be displayed as background. *Background* is different from *NoData* because it is still a valid pixel value; it is simply displayed in a color that is not determined by the stretch. If the *Background* property is *True*, the *BackgroundValues* property specifies a value that can be displayed as background.

The *BackgroundColor* property controls the color in which the background value is displayed. By default, the background is disabled but, if enabled, the background defaults to the value 0 and is displayed transparently.

IRasterRendererClassInfo : IUnknown	***Provides access to members which contain info about renderer classes.***
■— ClassCount: Long	*Number of classes in the renderer.*
■— ClassificationField: String	*Classification field name or an empty string if a table doesn't exist.*
■— IsNumericClasses: Boolean	*Indicates if the classification field is numeric.*
■— NormalizationField: String	*Normalization field name or an empty string if none.*
← QueryNumberClass (in ClassIndex: Long, out MinValue: Double, out MaxValue: Double, out outValue: Long)	*Information for a number class by index.*
← QueryStringClass (in ClassIndex: Long, out inValue: String, out outValue: Long)	*Information for a string class by index.*

The *IRasterRendererClassInfo* interface provides the ability to read classification properties from each single-band renderer.

While each of the single-band renderers produces different display effects, each at some point must divide the input data into classes. The unique value renderer creates a class for each value, the classified renderer creates an arbitrary number of classes defined by the user, and the stretched renderer divides the input data into 255 classes. The *IRasterRendererClassInfo* interface provides the ability to read these classes from each renderer through a common mechanism.

The *ClassCount* property returns the number of classes into which the current renderer has divided the input data.

The *ClassificationField* returns the name of the field in the raster table that is currently being rendered. If the raster has no table, the string is empty.

The *NormalizationField* property returns the field being used to normalize the data being classified and an empty string if there is none.

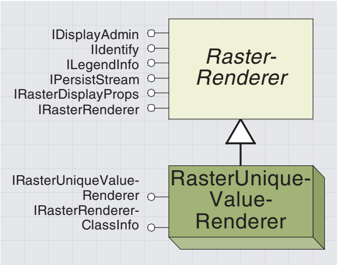
The *IsNumericClasses* property returns *True* if the class is numeric and *False* if the field is a string. The return value from this field determines which of the *Query* methods should be used.

The *QueryNumberClass* method returns the minimum and maximum values for the specified class, as well as the value to which any input value in this range will be mapped.

The *QueryStringClass* method returns the input string and output value to which the string will be mapped.

This example creates a stretched renderer and adds it to a raster layer.

```
   'Cocreate the new RasterLayer
  Dim pOutRasterLayer As IRasterLayer
  Set pOutRasterLayer = New RasterLayer
  pOutRasterLayer.CreateFromDataset pRasterDataset

 ' create the renderer and get the correct interface pointers
  Dim pRen As IRasterStretchColorRampRenderer
  Set pRen = New RasterStretchColorRampRenderer
  Dim pRasRen As IRasterRenderer
  Set pRasRen = pRen
  ' get the raster from the layer and update
  Set pRasRen.Raster = pOutRasterLayer.Raster
  pRasRen.Update
  ' create color ramp
  Dim pRamp As IAlgorithmicColorRamp
  Set pRamp = New AlgorithmicColorRamp
  pRamp.Size = 255
  Dim blTest As Boolean
  pRamp.CreateRamp blTest
  ' plug colorramp into the renderer and select a band
  pRen.BandIndex = 0
  pRen.ColorRamp = pRamp
  ' update the renderer with the new settings and plug into layer
  pRasRen.Update
  Set pOutRasterLayer.Renderer = pRen
```



The RasterUniqueValueRenderer *object displays each value in a raster dataset with a different color.*

The *RasterUniqueValueRenderer* is most commonly used for displaying a dataset containing a colormap, such as a pseudocolor image. However, it is also useful for categorical data, such as classification results, land use type, or soil type. For this type of data, each value can be displayed with a distinct color, which makes it easy to distinguish between the classes. Multiple values can be displayed using the same color by combining them into classes. The unique value renderer is the default renderer used for all raster datasets with less than 25 unique values.

For documentation on *IRasterRendererClassInfo*, see the *RasterSketchColorRampRenderer* coclass.

IRasterUniqueValueRenderer : IUnknown	***Provides access to members that relate to the unique value rendering of rasters.***
ClassCount (in iHeading: Long) : Long	*Number of classes in the specified heading.*
ColorScheme: String	*Current renderer color scheme.*
DefaultLabel: String	*Default label for the unique value renderer.*
DefaultSymbol: ISymbol	*Default unique value renderer.*
Description (in iHeading: Long, in IClass: Long) : String	*Description for a particular class in the specified heading.*
Field: String	*Currently active renderer field.*
Heading (in iHeading: Long) : String	*One heading in the heading list based on its index.*
HeadingCount: Long	*Number of headings used by the renderer.*
Label (in iHeading: Long, in IClass: Long) : String	*Label for a particular class in the specified heading.*
Symbol (in iHeading: Long, in IClass: Long) : ISymbol	*Symbol for a particular class in the specified heading.*
UseDefaultSymbol: Boolean	*Indicates whether the default unique value renderer is currently active.*
Value (in iHeading: Long, in IClass: Long, in iValue: Long) : Variant	*Value of a particular class in the specified heading based on its index.*
ValueCount (in iHeading: Long, in IClass: Long) : Long	*Number of values in a particular class in the specified heading.*
AddValue (in iHeading: Long, in IClass: Long, in Value: Variant)	*Adds a value to a particular class in the specified heading.*
RemoveValues (in iHeading: Long, in IClass: Long)	*Removes a value from a particular class in the specified heading*

The *IRasterUniqueValueRenderer* interface controls the display of rasters in which each value is displayed in a unique color.

The unique value renderer allows you to create multiple groups of values that can be separately used to display the raster. These values are called headings. Each heading can contain one or more classes. Each class consists of one or more values from the dataset and a symbol that draws all values in the class. Most applications use only one heading with multiple classes, and most classes contain only one value.

The *HeadingCount* property controls the number of headings used by the renderer, and the *Heading* property specifies the name for each heading.

The *ClassCount* property controls the number of classes in each heading.

The *Symbol, Label,* and *Description* properties are unique for each heading and class.

The *Symbol* property controls the color used to display values in this class.

The *Label* for each class is displayed next to the symbol in the table of contents.

The *Description* property controls a name that can be used when creating a legend for the raster.

The *ValueCount* property returns the number of values in a particular class, and the *Value* property returns a specific value from a class.

The *AddValue* method inserts a new value in the specified class.

The *RemoveValues* method removes all values from the input class.

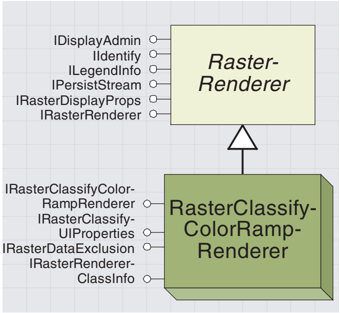
The *Field* property controls the field in the raster's table that provides the values that are associated with symbols. By default, the value field is used. Any values that are not associated with any class are considered default values.

If the *UseDefaultSymbol* property is *False*, the default values are displayed transparently. If this property is *True*, the *DefaultSymbol* property controls the symbol used to display these values, and the *DefaultLabel* is displayed next to the symbol in the table of contents.

The *ColorScheme* property selects a color scheme from the style gallery to be displayed in the property page of the renderer.

This example provides a VBA macro that takes the first layer in a map, if it is a raster layer, and changes the renderer to unique values. This macro works best for 8-bit unsigned data where the data values all fall within the range of 0 to 255.

```
Sub ChangeRendererToUV()
  Dim m_pMXdoc As IMxDocument
  Dim pRasLyr As IRasterLayer
  Set m_pMXdoc = ThisDocument
  Set pRasLyr = m_pMXdoc.FocusMap.Layer(0)

  Dim pUVRen As IRasterUniqueValueRenderer
  Set pUVRen = New RasterUniqueValueRenderer

  Dim pRen As IRasterRenderer
  Set pRen = pUVRen
  Set pRen.Raster = pRasLyr.Raster
  pRen.Update

  Dim pColor As IRgbColor
  Set pColor = New RgbColor

  Dim pSym As IColorSymbol

  pUVRen.HeadingCount = 1
  pUVRen.Heading(0) = "All Data Values"
  pUVRen.ClassCount(0) = 255
  Dim i As Long
  For i = 0 To 255 - 1
    pUVRen.AddValue 0, i, i
    pUVRen.Description(0, i) = "Desc" & CStr(i)
    pUVRen.Label(0, i) = "Label" & CStr(i)
    pColor.Red = i
    pColor.Blue = 255 - i
    pColor.Green = i * i Mod 255
    Set pSym = New ColorSymbol
    pSym.Color = pColor
    pUVRen.Symbol(0, Int(i / 10)) = pSym
  Next i

  ' Set up a display symbol for values not in any class
  pUVRen.UseDefaultSymbol = True
  pUVRen.DefaultLabel = "Defaults"
  Set pUVRen.DefaultSymbol = pSym

  ' update the renderer and plug into layer
   pRen.Update
  Set pRasLyr.Renderer = pRen
End Sub
```


IDisplayAdmin
IIdentify
ILegendInfo
IPersistStream
IRasterDisplayProps
IRasterRenderer
Raster-Renderer
IRasterClassifyColor-RampRenderer
IRasterClassify-UIProperties
IRasterDataExclusion
IRasterRenderer-ClassInfo
RasterClassify-ColorRamp-Renderer

The RasterClassifyColorRampRenderer *object draws a raster by dividing the data into groups and assigning a specific color to each group.*

The *RasterClassifyColorRampRenderer* visualizes a raster as a set of classes. Each class is displayed using a unique color. Each class contains one or more values from within the raster. This renderer allows you to control the way the raster is split into classes and determine the color used to paint each class to the screen.

For a description of the *IRasterRendererClassInfo* interface, see the *RasterStretchColorRampRenderer* coclass.

IRasterClassifyColorRampRenderer : IUnknown	***Provides access to members that relate to the classified rendering of rasters.***
■-■ Break (in Index: Long) : Double	*Break at the index.*
■-■ ClassCount: Long	*Number of classes.*
■-■ ClassField: String	*Field this renderer is using.*
■-■ Description (in Index: Long) : String	*Description for the class at the given index.*
■-■ Label (in Index: Long) : String	*Label for the class at the given index.*
■-■ NormField: String	*Normalization field this renderer is using.*
■-■ SortClassesAscending: Boolean	*Sort direction for the legendClass labels.*
■-■ Symbol (in Index: Long) : ISymbol	*Symbol representing the class at the index.*

The *IRasterClassifyColorRampRenderer* controls the classes used by the renderer and how they are displayed.

The *ClassField* property determines the field of the raster on which the classification will be performed. With the *NormField* property, you may optionally specify another field by which the class field will be divided before the classes are determined. The *ClassField* and *NormField* must be numeric. By default, the *ClassField* is *Value* and the *NormField* is empty.

The *ClassCount* property controls the number of classes into which the dataset is divided. The rest of the properties are specific to each class.

The *Break* property determines the value that separates one class from the next.

The *Label* for each class is displayed next to the symbol in the table of contents.

The *Description* property specifies a string that can be used when creating a legend for the raster.

The *Symbol* property controls the color used to display values in this class.

IRasterClassifyUIProperties : IUnknown	***Provides access to members that control the classification properties in the UI.***
■-□ ClassificationMethod: IUID	*Classification method.*
■-■ ColorRamp: String	*Color ramp name.*
■-■ DeviationInterval: Double	*Deviation interval. Range is 0 to 1 where 0 means no deviation is used.*
■-□ NumberFormat: INumberFormat	*Number format for labels.*
■-■ ShowClassGaps: Boolean	*Indicates if gaps between classes are shown.*

The *IRasterClassifyUIProperties* interface controls the properties that appear in the Classification dialog box of the raster property page.

The *ClassificationMethod* controls the classification method used to divide the dataset into classes. The default is a natural breaks classification.

This must be specified as a *ClassID* of the classification coclass. This can be obtained by performing *QI* for the *IClassify* interface on any of the coclasses that support *IClassify*, then passing the *ClassID* property to the *ClassificationMethod* property of the renderer.

If the *ClassificationMethod* is standard deviation, the *DeviationInterval* property determines the number of standard deviations that separate each class.

The *ColorRamp* property controls the name of the color scheme from the style gallery that is selected in the dropdown list on the raster property page.

The *NumberFormat* property passes an object supporting the *INumberFormat* interface, which controls how the data values are formatted in the Classification dialog box.

If *ShowClassGaps* is *True*, neighboring classes that have gaps between them will have classification boundaries that do not visibly match through the user interface.

IRasterDataExclusion : IUnknown	***Provides access to members that exclude data values from classification.***
■—■ ExcludeColor: IColor	*Color for the excluded values.*
■—■ ExcludeDescription: String	*Description for the excluded values.*
■—■ ExcludeLabel: String	*Label for the excluded values.*
■—■ ExcludeRanges: Variant	*Array of doubles indicating the excluded ranges.*
■—■ ExcludeShowClass: Boolean	*Indicates if color is shown for the excluded values.*
■—■ ExcludeValues: Variant	*Array of doubles indicating the excluded values.*

The *IRasterDataExclusion* interface controls the display of values that are not in any class.

The *ExcludeValues* property allows you to select the value or values that will not be included in any class.

The *ExcludeRanges* property specifies a range of values to exclude.

The *ExcludeShowClass* property determines whether this class will appear in the table of contents with the rest of the classes.

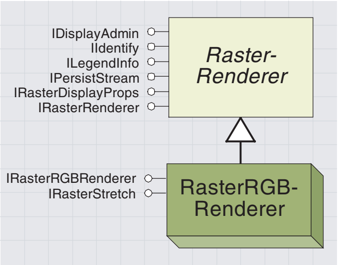
The *ExcludeColor* property controls the color with which any excluded values will be displayed. The different display for excluded values is black.

The *ExcludeLabel* and *ExcludeDescription* properties determine the labels used for this class in the table of contents and the legend.

This example shows how to change the renderer of a raster layer to the classified renderer.

```
'Cocreate the new RasterLayer
Dim pOutRasterLayer As IRasterLayer
Set pOutRasterLayer = New RasterLayer
pOutRasterLayer.CreateFromDataset pRasterDataset

' create the renderer and QI for both interfaces
Dim pRen As IRasterClassifyColorRampRenderer
```

```
Set pRen = New RasterClassifyColorRampRenderer
Dim pRasRen As IRasterRenderer
Set pRasRen = pRen

' get the raster from the layer and update
Set pRasRen.Raster = pOutRasterLayer.Raster
pRen.ClassCount = 3
pRasRen.Update

' create a color ramp to use
Dim pRamp As IAlgorithmicColorRamp
Set pRamp = New AlgorithmicColorRamp
pRamp.Size = pRen.ClassCount
Dim blOk As Boolean
pRamp.CreateRamp blOk

' create the symbol for this class
Dim pSym As IColorSymbol
Set pSym = New ColorSymbol

' loop through the classes and apply the correct color and label
Dim i As Integer
For i = 0 To pRen.ClassCount - 1
 ' the color does not need to be set from a ramp,
 ' and may be specified as desired
 ' must provide symbol not color to the renderer
 pSym.Color = pRamp.Color(i)
 pRen.Symbol(i) = pSym
 pRen.Label(i) = "Label" & CStr(i)
Next i

' update the renderer and plug into layer
pRasRen.Update
Set pOutRasterLayer.Renderer = pRen
```



An RGB renderer draws three bands of a raster dataset, one to each of the red, green, and blue channels of the display.

An RGB composite is a raster displayed using three bands of a dataset where each band is painted to a different display channel. Each band is stretched to fit in the display range for that channel, then the three bands are displayed together, resulting in what is known as a true color display.

The RGB renderer is only available for rasters that contain three or more bands. Any band of the dataset can be selected for each display channel, and one band can be displayed in more than one display channel. Displaying one band to the red, green, and blue channels simultaneously is like using a stretch of the same band from black to white, as equal values of red, green, and blue correspond to shades of gray.

The only customizations that can be performed with this renderer are adjusting the stretch for each band and changing which band is displayed in which channel.

IRasterRGBRenderer : IUnknown	***Provides access to members which control the raster Red/ Green/Blue renderer.***
BlueBandIndex: Long	*Band to be represented in blue.*
GreenBandIndex: Long	*Band to be represented in green.*
RedBandIndex: Long	*Band to be represented in red.*
UseBlueBand: Boolean	*Indicates if the blue band is used.*
UseGreenBand: Boolean	*Indicates if the green band is used.*
UseRedBand: Boolean	*Indicates if the red band is used*
QueryBandIndices (out redIndex: Long, out greenIndex: Long, out blueIndex: Long)	*Band numbers for red, green, and blue bands.*
SetBandIndices (in redIndex: Long, in greenIndex: Long, in blueIndex: Long)	*Band numbers for red, green, and blue bands.*

The *IRasterRGBRenderer* interface controls how raster bands are drawn in each display channel.

The *RedBandIndex, BlueBandIndex,* and *GreenBandIndex* properties control which band is displayed in each display channel.

The *BandIndex* is zero based, with a value of zero representing band one, a value of one representing band two, and so on. Each channel can be set to display or not display using the *UseRedBand, UseGreenBand,* and *UseBlueBand* properties.

To check or set the band indices for all three bands with one call, use the *QueryBandIndices* or *SetBandIndices* functions.

IRasterStretch : IUnknown	***Provides access to members which control contrast stretching.***
Background: Boolean	*Indicates if a background value is being used.*
BackgroundColor: IColor	*Background display color.*
BackgroundValues: Double	*Indicates whether an array of background values is being used.*
Invert: Boolean	*Indicates if the stretch is inverted.*
StandardDeviationsParam: Double	*Standard deviation parameter for the stretch renderer.*
StretchType: tagesriRasterStretchTypesEnum	*Current stretch type.*

The *IRasterStretch* interface controls how the values in a band are binned for display.

The data from each band can be binned to the data range used for display in several ways. This binning is controlled by the *IRasterStretch* interface.

If no stretch is applied, the data values from the full range of the data type, for example, 0 to 255 for 8-bit unsigned or -32,768 to 32,767 for 16-bit signed, are divided into 255 classes, and each pixel in the input dataset is placed in one of these classes.

With the standard deviation and min–max stretches, the range of values that defines the classes is determined by the statistics of the dataset. For the min–max stretch, the range from the minimum to the maximum values of the dataset is used, while the standard deviation stretch uses the mean value plus and minus a certain number of standard deviations (two by default) to determine the bounds of the stretch.

The histogram equalization method does not divide the data range into classes with the same interval; instead, it creates the classes so that each class has approximately the same number of values.

Dataset statistics are required for many of these stretches, including standard deviation, min–max, and histogram equalization, to work correctly. Statistics will be automatically built if one of these stretches is selected. If no statistics exist for the dataset, no stretch is applied by default; otherwise, a standard deviation stretch is applied.

The *StretchType* property controls the minimum and maximum values between which the data is stretched using the stretch types discussed above.

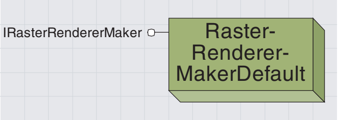
When using the standard deviation stretch, the *StandardDeviationsParam* property controls the number of standard deviations from the mean used to determine the min and max values for the stretch. The default is two.

The *Invert* parameter flips the color ramp used to display the data so the data is displayed with the colors inverted.

If one value in the dataset does not belong in the stretch, it may be displayed as background. *Background* is different than *NoData* because it is still a valid pixel value; it is simply displayed in a color that is not determined by the stretch. For a pixel to appear as background, the values for the pixel in each of the red, green, and blues bands must match the specified background value.

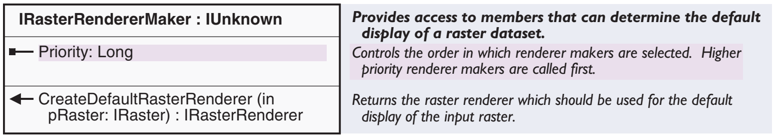
If the *Background* property is *True*, the *BackgroundValues* property specifies a value that can be displayed as background.

The *BackgroundColor* property controls the color in which the background value is displayed. By default, the background is disabled but, if enabled, the background defaults to the value 0 and is displayed transparently.



The RasterRendererMakerDefault *object determines the renderer used to display a raster by default.*

The *RasterRendererMakerDefault* object is used by the system to determine the default renderer used to display a raster. The default renderer is used when a raster is initially added to ArcMap or ArcScene or the raster is displayed in ArcCatalog. The renderer can later be changed in ArcMap and ArcScene but is not adjustable within ArcCatalog. Custom renderer-maker objects can be created if you wish to use different renderer defaults than those provided by this object. This object can be cocreated to see which renderer will be used by default for any *Raster* object.



IRasterRendererMaker : IUnknown

Provides access to members that can determine the default display of a raster dataset.

Priority: Long — *Controls the order in which renderer makers are selected. Higher priority renderer makers are called first.*

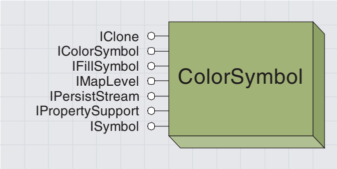
CreateDefaultRasterRenderer (in pRaster: IRaster) : IRasterRenderer — *Returns the raster renderer which should be used for the default display of the input raster.*

The *IRasterRendererMaker* interface controls the renderer used to display a raster upon initial display.

The priority method returns the priority of this renderer maker relative to others in the system. Renderer makers are called with decreasing priority until a renderer is provided for a raster. As soon as a renderer is returned, the priority of the *RasterRendererMakerDefault* is 0. The *CreateRasterDefaultRenderer* method returns the renderer that will be used by default for the input raster.

To create your own raster renderer maker, implement the *IRasterRendererMaker* interface in an object and register this renderer-maker object with the Raster Renderer Makers component category. If the priority returns a value greater than 0, this renderer will have the ability to provide a renderer before the system default. For rasters for which you wish to use the system default, return *Null* instead of a valid renderer. If no renderer is returned from this renderer maker, the raster will be passed to the next highest priority until a renderer is created. This allows you to specify multiple custom rendering combinations that can be used with different priority levels. The default renderer maker will create a renderer for any raster dataset.

ColorSymbol coclass



A ColorSymbol *object specifies a color to be displayed by a raster renderer.*

Because raster data has no explicit boundaries between cells, each value is frequently symbolized using a color. The *ColorSymbol* coclass allows you to provide this color for the *RasterStretchColorRampRenderer, RasterUniqueValueRenderer,* and *RasterClassifyColorRampRenderer*. Examples of how to use the *ColorSymbol* object are shown in each of these renderers.

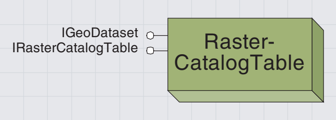
IColorSymbol : IFillSymbol	***Provides access to members that control the color symbol.***
Color: IColor	*Fill color.*
Outline: ILineSymbol	*Line symbol of fill outline.*

The *IColorSymbol* interface controls a color used to display a value in a raster dataset.

The *IColorSymbol* allows you to control the way values in a raster are drawn.

The *Color* property controls the ESRI color object (typically *RGBColor* or *GrayColor*) used for display.

The *Outline* property allows you to specify a *LineSymbol* that will display around the boundary of the data. For raster data, this property is ignored.



A RasterCatalogTable *object is a table that contains multiple raster datasets that can be viewed as a single entity.*

The spatial reference for the raster catalog is taken from the first raster present in the raster catalog.

Formerly known as an image catalog, a raster catalog is a table in any supported table format (including INFO, dbf, access, text, and others) that contains a list of raster datasets and their geographic extents. This table allows the list of datasets contained in the table to be displayed as a single entity.

The first five columns of the table must be called "Image", "Xmin", "Ymin", "Xmax", and "YMax" for the table to be identified as a raster catalog. The first column contains the path to a dataset on disk, while the next four contain the bounding box around the dataset. Additional fields in the table are allowed but will have no effect on the display of the raster catalog.

IRasterCatalogTable : IUnknown	***Provides access to members that control a raster catalog table.***
FieldBoundsLocation (out pLocXmin: Long, out pLocYmin: Long, out pLocXmax: Long, out pLocYMax: Long)	*Bounds of the field location of the raster catalog.*
FieldNameLocation (out pLocName: Long)	*Location of the field name of the raster catalog.*
OID (in idx: Long) : Long	*OID of the ith raster in the raster catalog.*
RasterDataset (in idx: Long) : IRasterDataset	*Reference to the ith raster dataset in the raster catalog.*
RasterExtent (in idx: Long) : IEnvelope	*Extent of the ith raster in the catalog.*
RasterName (in idx: Long) : String	*Name of the ith raster in the raster catalog.*
Size: Long	*Number of rasters in the raster catalog.*
Table: ITable	*The table object underlying the raster catalog table.*
WhereClause: String	*A SQL expression limiting the list of rasters currently viewed.*
Update	*Updates the object after the table is changed.*

The *IRasterCatalogTable* interface supports all the functionality of the *RasterCatalogTable*.

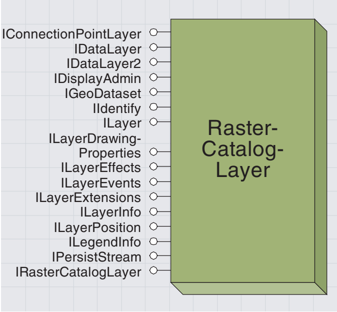
The *RasterCatalogTable* object allows you to access information about a raster catalog including the extent and name for each dataset in the catalog and the number of datasets (*Size*) and *Extent* of the entire *RasterCatalog*.

You can also provide a table in the correct format to be used as the *RasterCatalogTable*. You must call the *Update* method after putting a table in the *RasterCatalogTable*.

Finally, the *RasterCatalogTable* allows you to specify an SQL WhereClause to be applied to the table to limit the rasters currently being viewed using a logical query.

The following example shows how to take a raster catalog table that has been opened as a *Table* object and turn it into a *RasterCatalogTable*. If the first five fields of the table do not identify the table as a raster catalog, an error will occur.

```
Dim pRasCatTbl as IRasterCatalogTable
Set pRasCatTbl = New RasterCatalogTable

' Insert the Table into the RasterCatalog and update
Set pRasCatTbl.Table = pTable
pRasCatTbl.Update
MsgBox "There are " & pRasCatTbl.Size & " rasters in the raster catalog."
```



A RasterCatalogLayer *object displays raster catalogs.*

A *RasterCatalogLayer* contains a *RasterCatalogTable* and instructions on how to display that table.

The *RasterCatalogLayer* provides raster-specific functionality and supports generic layer functionality required for these layers to behave like other layer types. Only the raster-specific behavior is discussed in this section. The default renderer for the raster catalog is taken from the first raster present in the table.

IRasterCatalogLayer : ILayer	***Provides access to members that create or modify a raster catalog.***
CatalogTable: IRasterCatalogTable	*Raster catalog table.*
DisplayRasters: Long	*Indicates whether to display rasters.*
PrimaryField: Long	*Layer's primary field.*
Renderer: IRasterRenderer	*Layer's RasterRenderer.*
Symbol: ISymbol	*Layer's symbol.*
Create (in pCatalog: IRasterCatalogTable)	*Creates a raster catalog layer.*

The *RasterCatalogLayer* provides all of its raster-specific functionality through the *IRasterCatalogLayer* interface.

The main function of the *RasterCatalogLayer* is to provide a drawing mechanism for a *RasterCatalogTable*.

This *RasterCatalogTable* can be retrieved from the layer using the *CatalogTable* property.

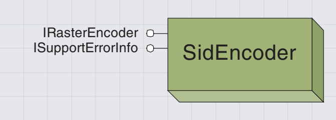
To place a new catalog in the layer, the *Create* method, which provides some dataset-specific layer initialization, must be used.

The *DisplayRasters* property specifies the threshold, in raster datasets, of how many datasets must be visible for the pixel data to be drawn.

If too many datasets are within the display extent, a wire frame will show the bounding box of each raster dataset with the name of the dataset. The symbol used in wire frame drawing mode can be controlled using the *Symbol* property, and the renderer used in raster drawing mode can be controlled using the *Renderer* property.

The following sample shows how to set the renderer used for a raster catalog table from the renderer used on one dataset contained in the catalog. This VBA code must be added to a map document before it can be used. Then, add a raster catalog layer and any single raster contained in the catalog. Move the catalog below the raster layer in the table of contents, then adjust the renderer on the raster layer to the renderer you wish to apply to the catalog. Finally, run this script and the renderer of the raster layer will be applied to the raster catalog.

```
Sub ChangeCatalogSymbology()
  ' Reference the current document
  Dim m_pMxDoc As IMxDocument
  Set m_pMxDoc = ThisDocument

  ' Get a reference to the raster layer
  Dim pRasLyr As IRasterLayer
  Set pRasLyr = m_pMxDoc.FocusMap.Layer(0)
  ' Get a reference to the raster catalog layer
  Dim pCatLyr As IRasterCatalogLayer
  Set pCatLyr = m_pMxDoc.FocusMap.Layer(1)

  ' Set the catalog's renderer from the individual layer
  Set pCatLyr.Renderer = pRasLyr.Renderer

  ' Refresh the display
  m_pMxDoc.ActiveView.Refresh
End Sub
```



The SidEncoder *object compresses one or more raster datasets into MrSID format.*

Multiresolution Seamless Image Database (MrSID®) is a proprietary raster format that uses wavelet compression and can provide compression ratios greater than 50 to 1. This compression algorithm provides lossy compression and as such should not be used for data that will be used for analysis later.

The *SidEncoder* can encode single files of up to 50 MB uncompressed for no additional cost. To mosaic multiple datasets or encode datasets larger than 50 MB, you must purchase an additional license from your ESRI distributor.

IRasterEncoder : IUnknown	*Provides access to members that control the RasterEncoder.*
■—■ BandIndices: Variant	*The input raster band indices.*
■— BlackValue: Double	*The minimum sample value for background and transparent pixels.*
■—■ Datasets: IGxObjectArray	*The input raster datasets.*
■—■ EncodingRatio: Single	*The encoding ratio.*
■—■ NoDataValues: Variant	*The NoData values.*
■— OutputBandCount: Long	*The number of bands of the output.*
■—■ TransparentValues: Variant	*The transparent values.*
■— WhiteValue: Double	*The maximum sample value for background and transparent pixels.*
← CanEncode: tagesriRasterCanEncodeResult	*Returns evaluation result whether the input raster can be encoded.*
← Encode (in FileName: String, in Workspace: IWorkspace)	*Performs the encoding process and output the encoded raster to the specified filename.*

The *IRasterEncoder* interface controls the settings and process of creating new raster datasets.

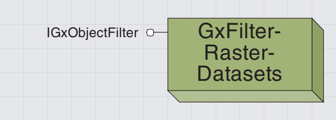
The *SidEncoder* has a number of properties that may be set to specify the properties desired for the dataset to be encoded; it also has one method, *Encode*. Once the desired properties have been set (*Datasets* is the only required property), calling the *Encode* method produces a new MrSID dataset.

The *Datasets* property controls the raster or set of rasters as an *IGxObjectArray*, which represents the datasets to be compressed into MrSID format. The encoding ratio property can be used to specify the desired compression ratio.

The following code allows the user to select a raster dataset from the *Gx Browser*, which will be compressed into a new MrSID archive.

```
' Create the GxDialog and filter to display only rasters
Dim pGXDlg As IGxDialog
Set pGXDlg = New GxDialog
Dim pGxRasterFilter As IGxObjectFilter
Set pGxRasterFilter = New GxFilterRasterDatasets
Set pGXDlg.ObjectFilter = pGxRasterFilter
pGXDlg.Title = "Select Raster Dataset"
pGXDlg.AllowMultiSelect = False

' Display the dialog to allow the user to select datasets
Dim pEnumGxObj As IEnumGxObject
pGXDlg.DoModalOpen 0, pEnumGxObj

' Place the GxObjects into an array to put into the SidEncoder
```

```
Dim pGxCatalog As IGxCatalog
Set pGxCatalog = pGXDlg.InternalCatalog
Dim pArr As IGxObjectArray
Set pArr = New GxObjectArray
Dim i As Integer
For i = 1 To pGxCatalog.Selection.count
  pArr.Insert 0, pGxCatalog.Selection.SelectedObjects.Next
Next i

' Set the datasets and encode the new MrSID dataset
Dim pSid As IRasterEncoder
Set pSid = New SidEncoder
pSid.Datasets = pArr
pSid.Encode "test.sid", SetRasterWorkspace("c:\temp")
```

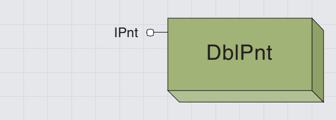


The GxFilterRasterDatasets *object displays only raster datasets from the* Gx Browser.

This object allows you to provide a *Gx Browser* to the end user, who can select one or more raster datasets. No other dataset types will be shown when this filter is used. The only interface supported by this object is the generic *IGxObjectFilter* interface.

This example shows how to create a *GxDialog* to allow the user to select one or more raster datasets.

```
' Create the GxObject Filter
Dim pGxRasterFilter As IGxObjectFilter
Set pGxRasterFilter = New GxFilterRasterDatasets

' Create the ArcCatalog MiniBrowser
Dim pGXDlg As IGxDialog
Set pGXDlg = New GxDialog

' Assign the Filter to the MiniBrowser and show a correct title
Set pGXDlg.ObjectFilter = pGxRasterFilter
pGXDlg.Title = "Select Raster Dataset"

Dim pEnumObj As IEnumGxObject
' Open the MiniBrowser and allow user to select dataset or datasets
If pGXDlg.DoModalOpen(0, pEnumObj) Then
 ' Process user selected objects in the enumeration here
End If
```



A DblPnt *object represents a point.*

The *DblPnt* object is used by raster objects, including the *Raster, RasterBand,* and *PixelBlock*, to specify coordinates or extent information.

IPnt : IUnknown	*Provides access to members that control a portable point.*
X: Double	*X coordinate of the point.*
Y: Double	*Y coordinate of the point.*
Convert2Point (in env: IPoint)	*Set ESRI's Point Object from Pnt.*
Set2Point (in env: IPoint)	*Reset from ESRI's Point Object.*
SetCoords (in X: Double, in Y: Double)	*Set X and Y coordinates of the point.*

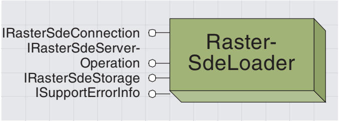
The *IPnt* interface provides the ability to get and set point coordinates and convert to a *Point* object.

The *X* and *Y* properties allow you to get or set the coordinates of the point individually, while the *SetCoords* method allows you to set the x,y coordinates with a single call.

The *ConvertToPoint* method sets the coordinates of the input point object to those of the *DblPnt*, while the *Set2Point* method sets the coordinates of the *DblPnt* to those of the input *Point*.

This example uses a *DblPnt* to specify the size of a *PixelBlock* to be created by a *Raster*.

```
' Create the new DblPnt object
Dim pPnt As IPnt
Set pPnt = New DblPnt
pPnt.SetCoords 512,512

' create a new PixelBlock from an existing raster
Dim pPix As IPixelBlock
Set pPix = pRaster.CreatePixelBlock(pPnt)
```



The raster ArcSDE loader object controls raster data loading in an ArcSDE database.

The *RasterSDELoader* creates new raster datasets in ArcSDE and controls the loading and mosaicing of data into these datasets.

At ArcGIS 8.1, raster data is not supported in personal geodatabases and can only be loaded into ArcSDE databases using Oracle®, SQL Server, Informix, and DB2.

The *RasterSDELoader* can control the projection, tile size, tuning parameters, and other properties of datasets being created. It also provides the ability to overwrite all or part of the dataset as well as to delete datasets. Rasters in any format supported in ArcGIS can be loaded into a database.

IRasterSdeConnection : IUnknown	*RasterSDE Connection object.*
■–■ database: String	*The database name.*
■–■ InputBitMaskName: String	*The input 1-bit raster dataset name to be used as mask.*
■–■ InputRasterName: String	*The input raster dataset name.*
■–■ instance: String	*The server instance.*
■–■ Password: String	*The password.*
—■ SdeConnection: IGxDatabase	*Sets SDE Connection through GxDatabase object.*
■–■ SdeRasterName: String	*The output raster dataset name.*
—■ SdeWorkspaceName: IWorkspaceName	*Sets SDE Connection through WorksapceName object.*
■–■ ServerName: String	*The server name.*
■–■ UserName: String	*The username.*

The *IRasterSDEConnection* interface defines the connection information for the ArcSDE database server.

Database connection information is needed for the *RasterSDELoader* to communicate with a database server. There are three ways to specify this connection: a *WorkspaceName* object, a *GxDatabase*, or the connection properties for the database.

The *SdeConnection* property allows you to specify a *GxDatabase* object, which can be retrieved from ArcCatalog containing the connection properties.

The *SdeWorkspaceName* property lets you specify the connection using a *WorkspaceName* object that contains the connection information.

To connect without using a *WorkspaceName* or *GxDatabase* object, the *ServerName, Instance, UserName, Password,* and *Database* properties must be specified.

The *ServerName* property accesses the name of the server that contains the database.

The *Instance* is the name of the instance used by the database. Typically, this is the port number.

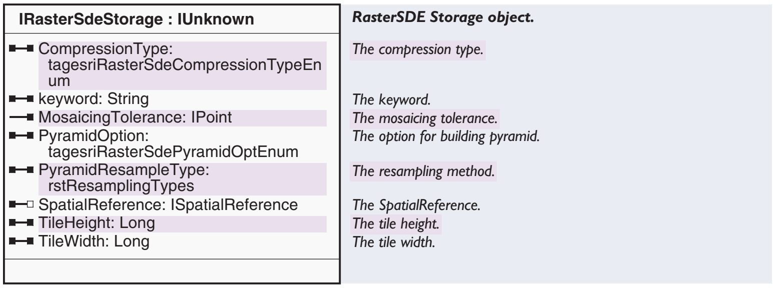
The *Database* property specifies the name of the database and is not required for Oracle databases.

The *UserName* and *Password* properties control the access privileges to the database. If the *UserName* and *Password* do not match, or the account does not have sufficient rights on the server, loading raster data into ArcSDE will be unsuccessful.

The *InputRasterName* specifies the full path to the raster that is to be loaded into the database.

The *InputBitMaskName* specifies the full path to an optional mask dataset. If a mask is specified, any cells containing a 1 will be inserted from the input raster into the dataset, and any cells containing 0 in the mask raster will not be inserted.

The *SDERasterName* property controls the name of the raster in the database.



IRasterSdeStorage : IUnknown	***RasterSDE Storage object.***
■━■ CompressionType: tagesriRasterSdeCompressionTypeEnum	*The compression type.*
■━■ keyword: String	*The keyword.*
━■ MosaicingTolerance: IPoint	*The mosaicing tolerance.*
■━■ PyramidOption: tagesriRasterSdePyramidOptEnum	*The option for building pyramid.*
■━■ PyramidResampleType: rstResamplingTypes	*The resampling method.*
■━□ SpatialReference: ISpatialReference	*The SpatialReference.*
■━■ TileHeight: Long	*The tile height.*
■━■ TileWidth: Long	*The tile width.*

The *IRasterSDEStorage* interface controls the properties of the raster dataset in ArcSDE.

The *IRasterSDEStorage* interface allows you to set parameters used by the new SDE raster dataset. Specify any of the properties that you desire before creating a raster because once the raster has been created, these properties cannot be changed.

The *CompressionType* property selects the compression type used for the new dataset. At ArcGIS 8.1, only LZ77 compression is supported. By default, the data is uncompressed.

The *PyramidOption* property specifies how pyramids will be built. Pyramids will be built by default.

The *PyramidResampleType* determines which resampling method will be used to compute the pyramids. For categorical data, nearest neighbor resampling is best, while for continuous data, bilinear interpolation or cubic convolution are appropriate.

The *SpatialReference* property determines the coordinate system that will be defined for the new raster. Rasters inserted into the database will not be reprojected during loading.

The *TileHeight* and *TileWidth* properties determine the size of the storage block inserted into the database. The default tile size is 128 x 128.

The *Keyword* property allows you to specify a configuration keyword in a dbtune file to optimize the performance of your database for raster retrievals.

The *MosaicingTolerance* property specifies the offset between the output raster cell corners and input raster cell corners. By default, the tolerance is 0, which means that if the input raster is not perfectly aligned with the output raster in x and y, data loading will fail. At ArcGIS 8.1, this property has no effect.

IRasterSdeServerOperation : IUnknown	*RasterSDE Operation object.*
← BuildPyramids	*Instructs Raster SDE Server to build pyramid layers based on the defined storage properties.*
← ComputeStatistics	*Computes statistics on a raster SDE.*
← Create	*Creates a raster dataset on an SDE server.*
← Delete	*Deletes raster dataset from SDE server.*
← Mosaic	*Instructs Raster SDE Server to mosaic data based on the defined storage properties.*
← Update	*Updates properties of raster dataset on SDE server.*

The *IRasterSDEServerOperation* interface controls the operation of an ArcSDE session that modifies raster data in an ArcSDE database.

The *Create* method creates a new ArcSDE raster dataset in the dataset.

The *ComputeStatistics* and *BuildPyramids* methods create the ancillary data that is associated with the dataset.

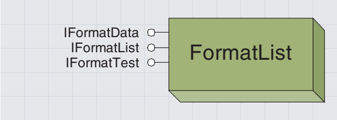
The *Delete* method deletes the current raster dataset from the database.

The *Mosaic* method mosaics a new raster into an existing dataset.

The *Update* method replaces an existing raster with the current input raster.

The following example uses an ArcSDE connection to create a new ArcSDE raster dataset with pyramids and statistics using the default storage properties.

```
Dim pSDEConn As IRasterSdeConnection
Dim pSDEOperation As IRasterSdeServerOperation

Set pSDEConn = New RasterSdeLoader
pSDEConn.InputRasterName = "d:\data\dem"
pSDEConn.SdeRasterName = "raster.dataset"
pSDEConn.SDEWorkspaceName = pInSDEWorkspaceName
Set pSDEOperation = pSDEConn
pSDEOperation.Create
pSDEOperation.ComputeStatistics
```



A format list object can identify all available raster formats and provide information about them.

The *FormatList* object contains information about all available raster formats. It can be used to access this information or to check if a particular file is a raster and determine its format.

This object will provide information about all native formats and any formats that have been added to ArcMap by external developers. Formats that have multiple possible file extensions may appear more than once in this list.

IFormatList : IUnknown	***Provides access to members that contain information about all raster formats currently supported.***
Count: Long	*Total number of formats.*
CurrentRecord: Long	*Index of currently accessed format information.*
Item (in Index: Long) : IFormatData	*Return format information for a given index.*

The *IFormatList* interface maintains the most general information including the number of supported raster formats.

The *Count* property returns the number of formats available.

The *CurrentRecord* property and *Item* method set the object to provide information about specific raster formats.

IFormatData : IUnknown	***Provides access to members that provide access to information about specific raster formats.***
Creatable: Boolean	*Indicates whether this format supports 'SaveAs'.*
Directory: Boolean	*Indicates whether this format is directory based, as opposed to file based.*
Extension: String	*Default extension (without the dot).*
order: Long	*Order to display in UI.*
Pseudo: Boolean	*Indicates if wildcard match is enough for verification.*
ShortName: String	*Name used for icon registration.*
Templ: String	*Wildcard string for file matching.*
Title: String	*Implementor name of format.*
UITitle: String	*User legible name of format.*
UserFile: Boolean	*Indicates whether this format is intended for display to user (eg. NOT *.rrd, or *.aux).*

The *IFormatData* interface allows you to read information about specific raster formats.

The *Creatable* property indicates whether or not new raster datasets in this format can be created. Only GRID, TIFF, and IMAGINE currently provide this functionality.

The *Directory* property returns whether datasets in this format are directory-based (like GRID) or file-based.

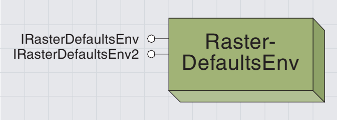
The *Pseudo* property determines whether the file extension can be reliably used to detect raster datasets of this format. Any format that has *Pseudo* set to *True* will not be viewable in ArcGIS.

The format name and default extension, if any, associated with the format and the title of the format in the ArcMap and ArcCatalog interface are also accessible through this interface.

IFormatTest : IUnknown	Provides access to members that provide information on the format of a raster .
← FormatIdentify (in Path: String) : IFormatData	The title of the dataset's format, if supported.
← FormatVerify (in Path: String, in Title: String) : Boolean	Tests whether a dataset is an raster format given a title.

The *IFormatTest* interface determines if a specific raster file is of a known raster format and can determine which raster format.

The *FormatVerify* method returns *True* if the input path and file point to a raster of a supported format. The *FormatIdentify* method can then return a pointer to specific information about that format.



The RasterDefaultsEnv *object allows you to customize raster default behavior in the ArcGIS user interface.*

The defaults that can be accessed include band combinations for the RGB renderer on multiband data, behavior for raster pyramid creation, and how raster datasets are found. This information can also be controlled in ArcMap and ArcCatalog by clicking the Tools menu, clicking Options, then clicking the Raster tab.

IRasterDefaultsEnv : IUnknown	***Provides access to members that control the default raster environment.***
Format (in i: Long) : IRasterFormatInfo	*Information about the format indicated by index i.*
NumFormats: Long	*Number of supported raster formats.*
PyramidCreateOpt: tagesriRasterPyramidOptEnum	*Default pyramid creation option.*
UseExtChecking: Boolean	*Use extension checking flag.*
Query3BandRGB (out redIndex: Long, out greenIndex: Long, out blueIndex: Long)	*Default zero indexed bands for a 3 band raster.*
Query4BandRGB (out redIndex: Long, out greenIndex: Long, out blueIndex: Long)	*Default zero indexed bands for a 4 or more band raster.*
Set3BandRGB (in redIndex: Long, in greenIndex: Long, in blueIndex: Long)	*Default zero indexed bands for a 3 band raster.*
Set4BandRGB (in redIndex: Long, in greenIndex: Long, in blueIndex: Long)	*Default zero indexed bands for a 4 or more band raster.*

The *IRasterDefaultsEnv* interface provides access to raster default properties that are shared between all supported raster formats.

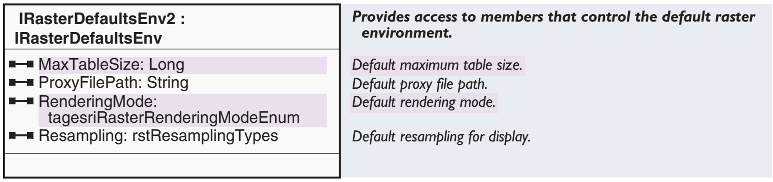
The *PyramidCreateOpt* property selects whether pyramids will be built when a large raster is previewed in ArcCatalog or added as a layer to ArcMap. The options are to always build pyramids, to never build pyramids, or to be prompted by a dialog box asking if you want to build pyramids each time a large raster without pyramids is viewed.

The *UseExtChecking* property specifies how ArcCatalog and the *Gx Browser* search for raster datasets. A *True* value for extension checking means that files or folders will be identified as raster datasets only if their extension matches the list of supported raster format extensions. A *False* value means that all files and folders will be opened to determine whether they are a raster dataset in any of the supported raster formats. This is more reliable but is much slower than extension checking only. Extension checking only is the default.

The *NumFormats* property returns the number of supported raster formats, and the *Format* method returns a *RasterFormatInfo* object specific to one raster format, which can specify default properties for that format.

The *Query3BandRGB, Query4BandRGB, Set3BandRGB,* and *Set4BandRGB* methods allow you to view or set the default band combinations used to display rasters with three or more bands. The indices set for these defaults will populate the red, green, and blue channels of the RGB renderer when a raster is initially displayed.

The *Query3BandRGB* and *Set3BandRGB* methods apply only to three-band rasters, while the *Query4BandRGB* and *Set4BandRGB* methods apply to all rasters containing four or more bands. This can be useful if you use three-band true color data but also view Landsat TM imagery and want to have six-band TM scenes display by default as a color infrared composite that corresponds to the band combination of four, three, and two for RGB.



IRasterDefaultsEnv2 : IRasterDefaultsEnv

- MaxTableSize: Long
- ProxyFilePath: String
- RenderingMode: tagesriRasterRenderingModeEnum
- Resampling: rstResamplingTypes

Provides access to members that control the default raster environment.

Default maximum table size.
Default proxy file path.
Default rendering mode.

Default resampling for display.

The *IRasterDefaultsEnv2* interface controls all of the common raster default properties of *IRasterDefaultsEnv* and more.

Each method and property on the *IRasterDefaults* interface perform the same function when called on this interface. This interface also provides four additional functions that customize other raster behavior. Proxy files are token files that allow statistics and pyramids to be used with read-only datasets, such as datasets on a CD.

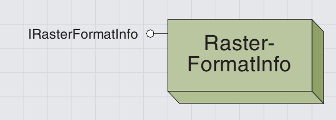
The *ProxyFilePath* property controls the directory location where these proxy files, as well as any auxiliary or pyramid files for these datasets, are located. This property can only be set by users with Administrator access to their computer. The rest of these properties control the appearance of raster datasets when first viewed in ArcGIS.

The *Resampling* property controls the default resampling technique used when a raster is first displayed. Single-band rasters are displayed using the stretched renderer or unique value renderer by default.

If a dataset has more entries in its table then the *MaxTableSize* property, it will be displayed by default using the stretched renderer. A dataset with fewer unique values than this threshold will display using the unique value renderer. This value is 25 by default.

The *RenderingMode* property specifies the drawing mode used when displaying a raster dataset. The full option waits until the entire raster has been drawn to a backing store, then displays it to the screen at once.

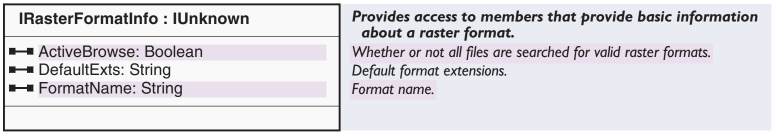
Block mode draws the raster one block at a time, starting at the upper left and progressing left to right and then down. Top-to-bottom mode begins at the top and draws a few lines at a time as it progresses down the screen.



The RasterFormatInfo *object provides a way to view and set ArcMap and ArcCatalog browsing properties for specific raster formats.*

This object is not cocreatable but must be obtained using the *Format* method of the *RasterDefaultsEnv*.

The input to the *Format* method specifies the index of the raster format from the user interface, not from the list of formats that can be obtained from the *FormatList* object.



IRasterFormatInfo : IUnknown

ActiveBrowse: Boolean	*Whether or not all files are searched for valid raster formats.*
DefaultExts: String	*Default format extensions.*
FormatName: String	*Format name.*

Provides access to members that provide basic information about a raster format.

The *IRasterFormatInfo* interface exposes all of the format-specific raster defaults used in ArcMap and ArcCatalog.

The *FormatName* property specifies the name shown for this raster format in the formats pane of the Raster tab on the Options menu. The other properties specify how ArcMap and ArcCatalog determine if a disk file is a raster dataset when extension browsing is active.

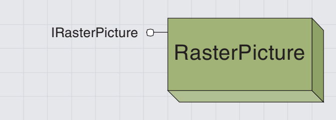
The *DefaultExts* property specifies one or more comma-delimited file extensions that are used to filter for raster datasets of this format.

The *ActiveBrowse* property determines if ArcMap and ArcCatalog are currently scanning for datasets in this format.

The following code snippet displays the current extensions being used to find raster datasets in DTED format, then changes the list of extensions used to find DTED datasets.

```
Dim pEnv As IRasterDefaultsEnv
Set pEnv = New RasterDefaultsEnv

Dim pInfo As IRasterFormatInfo
Set pInfo = pEnv.Format(15)

MsgBox "Raster Format: " & pInfo.FormatName & _
 " browses using the following extensions: " & pInfo.DefaultExts
pInfo.DefaultExts = "*.dt1,*.dt2"

Set pEnv = Nothing
Set pInfo = Nothing
```

RasterPicture coclass



The RasterPicture *object displays some raster formats simply and efficiently.*

The *RasterPicture* object can load a raster into a *Picture* object, such as that exposed by a PictureBox control.

The *RasterPicture* object supports these formats: JPEG, GIF, TIFF, EMF, and PNG. The picture can only be displayed at its true resolution, with each raster pixel mapping to a single pixel on the display.

IRasterPicture : IUnknown	***Raster Picture Interface.***
← DrawPicture (in FileName: String, in hDC: Long, in pOutputRect: tagRECT)	*Draws the picture.*
← LoadPicture (in FileName: String) : IPicture	*Gets number of classes.*

The *IRasterPicture* interface exposes all of the functionality of the *RasterPicture* object.

The *LoadPicture* method displays a raster into a picture control.

The *DrawPicture* method offers more complete control over the display of the picture.

In the following example, the *RasterPicture* object paints a raster into a PictureBox control on a VB form.

```
Dim pPic As IRasterPicture
Set pPic = New RasterPicture
'pict1 is defined as a PictureBox in a VB form
Set pict1.Picture = pPic.LoadPicture("e:\data\logo.gif")
```

Appendix A

Open data access in ArcGIS

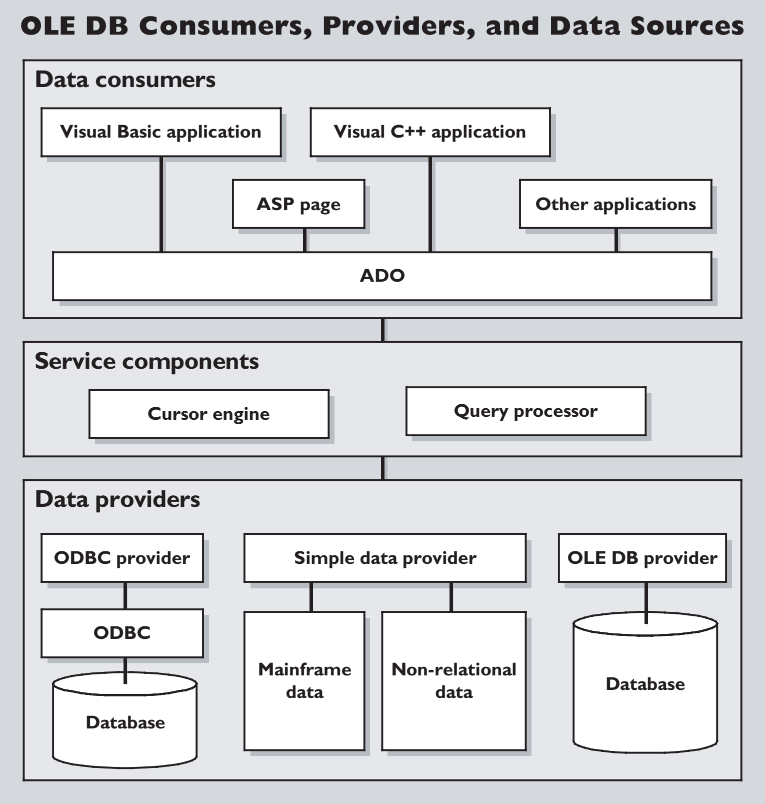
Jillian Clark

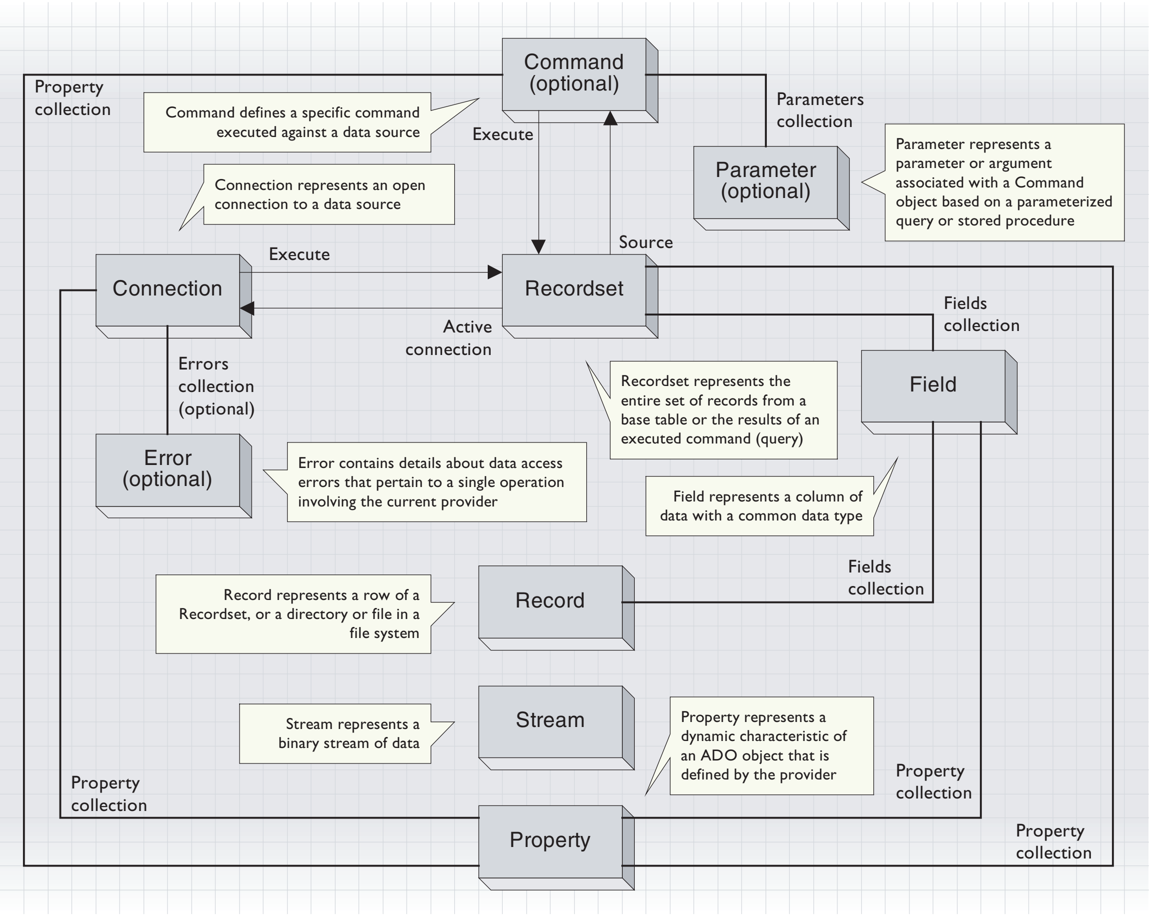
ArcGIS incorporates Microsoft's Data Access Components (MDAC) and the functionality available to developers with ArcObjects. MDAC, which consists of ActiveX® Data Objects (ADO), OLE DB, and Open Database Connectivity (ODBC), represents Microsoft's implementation of the Universal Data Access strategy. The philosophy behind this strategy is to provide easy access to information maintained in a variety of data sources, both relational and nonrelational, regardless of data type and proprietary format.

The topics in this appendix include: Microsoft's ADO and OLE DB technology • the ESRI OLE DB provider • third-party OLE DB providers

OLE DB is a new database-access API (set of interfaces) based on Microsoft's Component Object Model (COM) technology. OLE DB is a low-level programming environment that stores and retrieves records from a data source. It is an open specification that expands on, but does not replace, ODBC technology.

ADO is a COM-based front end to OLE DB; it is aimed primarily at application and Web developers. ADO will work with any compliant OLE DB provider in a consistent manner; programmers have access to the same set of features in different programming environments. ADO provides ArcGIS users with an alternative development option for customizing the existing user interface or developing standalone applications outside the ArcGIS application framework.





Command defines a specific command executed against a data source

Connection represents an open connection to a data source

Parameter represents a parameter or argument associated with a Command object based on a parameterized query or stored procedure

Recordset represents the entire set of records from a base table or the results of an executed command (query)

Error contains details about data access errors that pertain to a single operation involving the current provider

Field represents a column of data with a common data type

Record represents a row of a Recordset, or a directory or file in a file system

Stream represents a binary stream of data

Property represents a dynamic characteristic of an ADO object that is defined by the provider

The ADO model, which incorporates nine objects and four collections (errors, parameters, fields, and properties), presents a much less daunting set of objects with related properties and methods than the ArcGIS object model. Developers are shielded from the complexities of the geodatabase data-access model. However, although ADO supports simple data-manipulation and data-creation operations, it is not as robust as the ArcGIS object model.

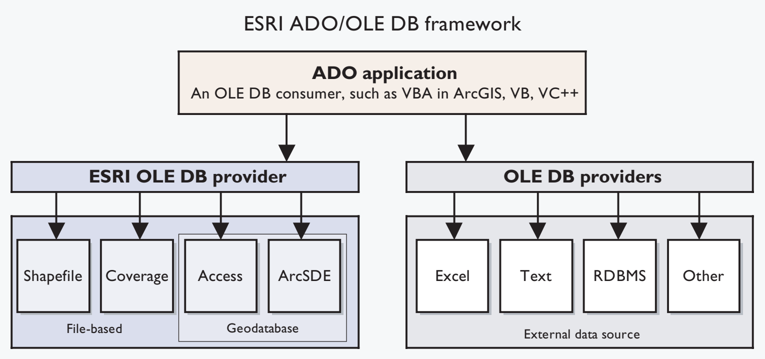
For further information on Microsoft's Universal Data Access strategy, ADO, and OLE DB, please refer to http://www.microsoft.com/data.

Further information on Microsoft's OLE DB provider specification can be obtained from www.microsoft.com/data and www.microsoft.com/data/oledb/prodinfo.htm.

Information on the OGIS specification can be found at www.opengis.org/techno/specs.htm.

In ArcGIS, ESRI has included a proprietary OLE DB provider capable of serving spatial data. The ESRI provider is a minimum (level 0) OLE DB 2.0 provider (as defined by Microsoft) that conforms to the OpenGIS® Simple Features Specification for OLE/COM from the Open GIS Consortium (OGIS).

The ESRI OLE DB provider supports shapefiles, coverages, personal geodatabase files (Access .mdb file), and ArcSDE data sources.



The following ADO/VB samples illustrate some of the connection string permutations required for connections to ESRI data sources.

When implementing ADO in Visual Basic, the project must reference the current Microsoft ActiveX Data Objects library file (version 2.5 with ArcGIS 8.1). To take advantage of the ArcGIS object model functionality, the VB project must also reference the ArcGIS object library.

To set ArcSDE connection parameters, you can either directly specify these parameters or you can use an existing binary connection file created via the desktop user interface.

These are the connection parameters:

- The provider is ESRI.GeoDB.OLEDB.1.
- The location is *server name.*
- The data source is *database name.*
- The user ID is *user name*, and the password is *password.*
- The Extended Properties is WorkspaceType, which is esriCore.SDEWorkspaceFactory.1.
- The instance is *ArcSDE service.*
- The version is *ArcSDE version.*
- The geometry is WKB|OBJECT.

The following Visual Basic sample shows the setting of these parameters:

```
sConString = "Provider=ESRI.GeoDB.OleDB.1;Location=fabio;" & _
```

```
 "Data Source=world;User Id=avtest;Password=avtest;" & _
 "Extended Properties=workspacetype=esriCore." & _
  "SdeWorkspaceFactory.1;Instance=sql8;Version=SDE.DEFAULT;Geometry=WKB"
```

This is how an existing binary connection file could be utilized to open the connection to an ArcSDE data source:

- The provider is ESRI.GeoDB.OLEDB.1.
- The Extended Properties is WorkspaceType, which is esriCore.SDEWorkspaceFactory.1.
- The ConnectionFile is *path to and name of binary ArcSDE connection file.*

This Visual Basic sample shows how to implement these connection files:

```
sConString = "Provider=ESRI.GeoDB.OleDB.1;Extended " & _
"Properties=workspacetype=esriCore.SdeWorkspaceFactory.1;" & _
"ConnectionFile=c:\winnt\profiles\jill\Application Data\ESRI\" & _
"ArcCatalog\connection to springs.sde"
```

To set personal geodatabase connection parameters, the Access workspace factory requires the name of and path to a Microsoft Access file (.mdb).

- The provider is ESRI.GeoDB.OLEDB.1.
- The data source is *access file(.mdb).*
- The Extended Properties is WorkspaceType, which is esriCore.AccessWorkspaceFactory.1.
- The geometry is WKB|OBJECT.

This example VB code shows the application of these settings:

```
sConString = "Provider=ESRI.GeoDB.OLEDB.1;" & _
  "Data Source=d:\testdata\access\oledb_testdata.mdb;" & _
  "Extended Properties=workspacetype=" & _
  "esriCore.AccessWorkspaceFactory.1; Geometry=WKB"
```

For coverages and shapefiles with the extended properties workspace type set to esriCore.ArcInfoWorkspaceFactory.1 and esriCore.ShapefileWorkspaceFactory.1, respectively, set the data source parameter path to a directory that contains coverage or shapefile data, not a specific coverage or shapefile itself. Other than the different connection strings, the create and open connection syntax is then standard ADO code:

```
Dim AdoCon as ADODB.connection
Set AdoCon = New ADODB.Connection
Dim sConString As String
'Set Connection string according to data source
sConString = " <see samples > "
AdoCon.Open sConString
```

The OGIS standard includes support for GIS metadata. For each connection to an ESRI data source, this information can be viewed by opening three schema recordsets via an *Openschema* method on the ADO connection or by opening a property set on the data source.

The metadata available includes:

- Which tables are considered to be GIS features
- Which columns contain geometry (and what type of geometry it is)
- What the spatial references for the data source are
- What spatial operators are supported by the OLE DB data provider

The following code shows how to create the three schema recordset objects for an existing ADO connection.

```
Dim ogisFTSchema As String, ogisGCSchema As String, _
  ogisSRSchema As String
'Initialize the OGIS GUIDs.
'DBSCHEMA_OGIS_FEATURE_TABLES recordset
ogisFTSchema = "{a0690a29-faf5-11d1-baf5-080036db0b03}"

'DBSCHEMA_OGIS_GEOMETRY_COLUMNS Recordset
ogisGCSchema = "{a0690a2a-faf5-11d1-baf5-080036db0b03}"

'DBSCHEMA_OGIS_SPATIAL_REFERENCE_SYSTEMS Recordset
ogisSRSchema = "{a0690a2b-faf5-11d1-baf5-080036db0b03}"

'DBSCHEMA_OGIS_FEATURE_TABLES recordset
Dim rsFT  As ADODB.Recordset
Set rsFT = New ADODB.Recordset
Set rsFT = Adocon.OpenSchema(adSchemaProviderSpecific, _
  ,ogisFTSchema)

'DBSCHEMA_OGIS_GEOMETRY_COLUMNS Recordset
Dim rsGC As ADODB.Recordset
Set rsGC = New ADODB.Recordset
Set rsGC = Adocon.OpenSchema(adSchemaProviderSpecific, _
  ,ogisGCSchema)

'DBSCHEMA_OGIS_SPATIAL_REFERENCE_SYSTEMS Recordset
Dim rsSR As ADODB.Recordset
Set rsSR = New ADODB.Recordset
Set rsSR = Adocon.OpenSchema(adSchemaProviderSpecific, _
  ,ogisSRSchema)
```

The spatial data contained in the geometry column can be returned to the consumer in either OGIS Well Known Binaries (WKB) format or as ESRI geometry objects. The ESRI provider supports read–write operations to both the geometry and the attribute columns.

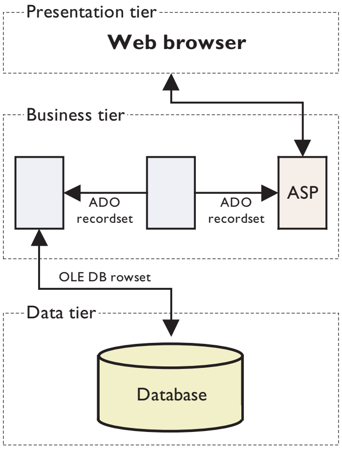
The following code sample illustrates how to read the spatial data in either WKB format or as ESRI objects from a personal geodatabase file. It also demonstrates how to filter and edit the recordset.

```
Dim pGeomCol As IGeometryCollection
```

```
Set pGeomCol = New GeometryBag
Dim pGeoEnv As GeometryEnvironment
Dim pGFact As IGeometryFactory
Set pGeoEnv = New GeometryEnvironment
Set pGFact = pGeoEnv
Dim pEnv As IEnvelope
Set pEnv = New Envelope
Dim pGeom As IGeometry
Dim sStr As String, sConString As String, sChoice As String

Dim WKBData As Variant
Dim BytesRead As Long
Dim Adocon As ADODB.Connection
Set Adocon = New ADODB.Connection
Dim Adors As ADODB.Recordset
Set Adors = New ADODB.Recordset

sChoice = InputBox("Enter geometry format -  WKB (OGIS WKB),  OBJ (ESRI
OBJECTS):", , "WKB")

If sChoice = "WKB" Then
'Either Geometry = WKB format
sConString = "Provider=ESRI.GeoDB.OLEDB.1;" & _
"Data Source=d:\data\access\oledb_testdata.mdb;" & _
"ExtendedProperties=workspacetype=esriCore." & _
"AccessWorkspaceFactory.1;Geometry=WKB"
Else
'OR Geometry = ESRI OBJECT
sConString = "Provider=ESRI.GeoDB.OLEDB.1;" & _
"Data Source=d:\data\access\oledb_testdata.mdb;" & _
"ExtendedProperties=workspacetype=" & _
"esriCore.AccessWorkspaceFactory.1;Geometry=OBJECT"
End If

Adocon.Open sConString

sStr = "Select * from us_states"
Adors.Open sStr, Adocon, adOpenForwardOnly, adLockOptimistic

If sChoice = "WKB" Then
'EITHER - Read spatial data in WKB format
 Do Until Adors.EOF
  If Not IsNull(Adors.Fields.Item(1).Value) Then
   WKBData = Adors.Fields.Item(1).Value
   pGFact.CreateGeometryFromWkbVariant WKBData, pGeom, BytesRead
   pEnv.Union pGeom.Envelope
   pGeomCol.AddGeometry pGeom
   End If
  Adors.MoveNext
 Loop
```

```
Else
'OR - Read spatial data as ESRI OBJECTS
 Do Until Adors.EOF
   If Not IsNull(Adors.Fields.Item(1).Value) Then
    Set pGeom = Adors.Fields.Item(1).Value
    pEnv.Union pGeom.Envelope
    pGeomCol.AddGeometry pGeom
   End If
  Adors.MoveNext
 Loop
End If

Adors.MoveFirst

'Update the recordset via an edit transaction
Adocon.BeginTrans

'Filter the recordset and apply an update
Adors.Filter = "STATE_NAME = 'Ohio'"

Do Until Adors.EOF
 Adors.Update Adors.Fields.Item(3).Name, "New Name"
 Adors.MoveNext
Loop

Adocon.CommitTrans
```

ADO can also be used in conjunction with Active Server Pages (ASP) and embedded VBScript to develop Web-based geodatabase browse and edit applications in the following system architecture.



Implementing the ESRI OLE DB provider in this manner involves serverside (business tier) scripts that create ADO connections and recordsets based on data source choices and SQL query statements forwarded from the client. The recordset can be returned to the client in the form of an HTML table or passed to data-aware ActiveX grid control. Attribute data may be edited locally and the changes applied to the data source via the recordset.

ArcGIS users have “out-of-the-box” access to all the OLE DB providers that are installed as part of the MDAC package. These include Microsoft’s OLE DB providers for Jet, SQL Server, and Oracle, as well as an OLE DB provider for ODBC drivers.

The Microsoft Data Link Properties utility, installed as part of the MDAC package and integrated within the desktop user interface, enables users to create and manage their OLE DB connections. The data may then be viewed in a consistent, although read-only, tabular format.

To overcome the read-only restriction, it is possible to programmatically connect to an external data source using ADO and an appropriate OLE DB provider to support read–write and simple data-creation operations.

The following VB code samples illustrate how to programmatically make an ADO connection to an external (nonESRI) data source and execute SQL commands. There are many more samples available on Microsoft’s Web site at www.microsoft.com/data.

1. Make an ADO connection using the MS OLE DB provider for SQL Server and modify a table and the database schema.

```
'Modify the connection string, table name and SQL commands
'accordingly.

Dim AdoCon As ADODB.Connection
Set AdoCon = New ADODB.Connection

Dim AdoRS As ADODB.Recordset
Set AdoRS = New ADODB.Recordset

Dim cmdstr1 As String, cmdstr2 As String, sConstring As String
Dim sqlstr As String

'MS OLE DB provider for SQL Server
sConstring = "Provider=SQLOLEDB.1;Password=test;User ID=test;" & _
 "Persist Security Info=True;Initial Catalog=test;Data Source=fabio"

AdoCon.Open sConstring

'Modify a schema object
cmdstr1 = "alter table codemog add test_col integer "
AdoCon.Execute cmdstr1

'Create a new schema object via the OLE DB connection
cmdstr2 = "create view my_view as select name, state_name, " & _
  "state_fips from codemog"
AdoCon.Execute cmdstr2
```

2. Make an ADO connection to an Excel worksheet using the MS OLE DB provider for ODBC drivers and open a recordset.

```
'Modify the ODBC parameter and table name accordingly.
Dim AdoCon As ADODB.Connection
```

```
Set AdoCon = New ADODB.Connection

Dim AdoRS As ADODB.Recordset
Set AdoRS = New ADODB.Recordset

Dim sConstring As String, sqlstr as string

'The data source in this case is an ODBC DSN (Data Source Name)
sConstring = "Provider= MSDASQL.1;data source=Excel_wks"

AdoCon.Open sConstring

sqlstr = "select * from codemog"
AdoRS.Open sqlstr, AdoCon, adOpenDynamic, adLockOptimistic
```

Appendix B

Geodatabase modeling with UML

Julio Andrade

The geodatabase data model is an object-oriented data model for geographic data. To create blueprints of the objects, their relationships, and their behavior, you can use UML, a graphical modeling language. Utilize the CASE tools to create the storage medium (geodatabase schema) and object behavior (custom features and class extensions).

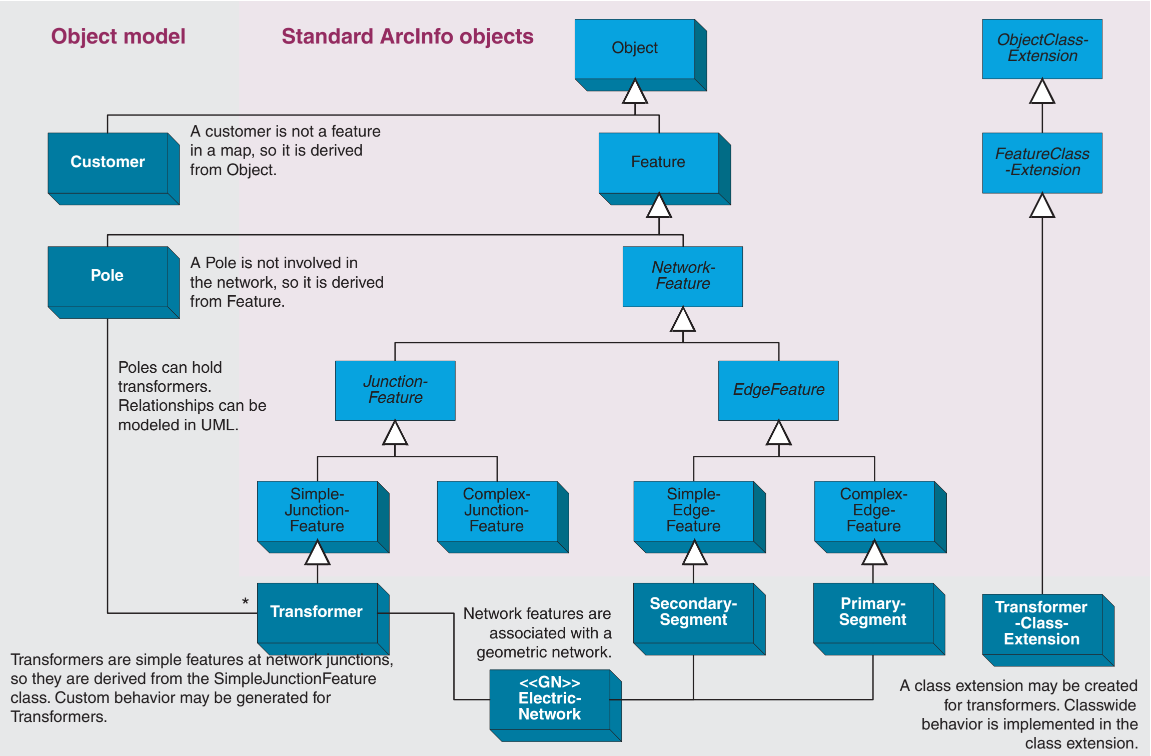
This appendix explores the concepts involved in modeling object behavior using UML and the Code Generation Wizard.

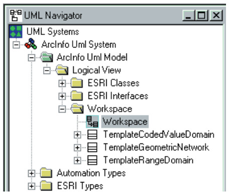
UML is the universal language of object modeling. With UML you can build object models that help you and others better understand the system in development. The more complex a system is, the more difficulty you will have understanding it. Modeling helps you understand such complex systems.

Using UML, you can create object models that include geodatabase elements. These elements may be subdivided into structural elements, parameterized elements, and custom behavior elements. Structural elements and parameterized behavior elements are covered in *Building a Geodatabase*. This appendix discusses the modeling of custom behavior using UML.

Structural Elements	Parameterized Behavior	Custom Behavior Elements
Feature datasets Geometric networks Feature classes Relationship classes Fields Subtypes	Elements Domains Default values Connectivity rules Relationship rules	Custom features Feature class extensions Custom interfaces

Modeling these elements lets you clearly visualize the structure and behavior of your system. For example, you can easily see what feature classes are involved in a geometric network, how features may be associated through relationship classes, or what services a custom feature provides.


Object model
Standard ArcInfo objects
Object
ObjectClass-Extension
Customer
A customer is not a feature in a map, so it is derived from Object.
Feature
FeatureClass-Extension
Pole
A Pole is not involved in the network, so it is derived from Feature.
Network-Feature
Poles can hold transformers. Relationships can be modeled in UML.
Junction-Feature
EdgeFeature
Simple-Junction-Feature
Complex-Junction-Feature
Simple-Edge-Feature
Complex-Edge-Feature
*
Transformer
Network features are associated with a geometric network.
Secondary-Segment
Primary-Segment
Transformer-Class-Extension
Transformers are simple features at network junctions, so they are derived from the SimpleJunctionFeature class. Custom behavior may be generated for Transformers.
<<GN>> Electric-Network
A class extension may be created for transformers. Classwide behavior is implemented in the class extension.



The UML navigator

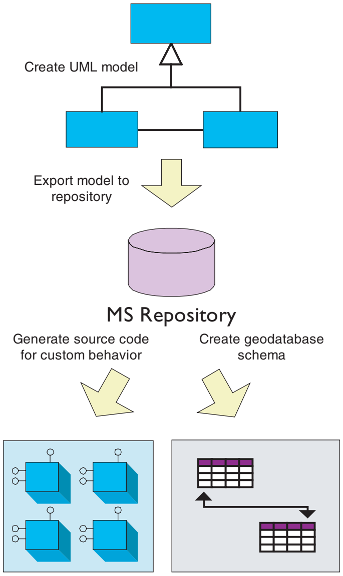
New object models are created from a template diagram that contains information about the geodatabase data access objects, specifically classes and interfaces relevant to the creation of custom features and class extensions.

The template diagram has a hierarchical structure based on UML packages. A given model has, at the minimum, a logical view package—a logical root, ESRI interfaces, ESRI classes, and workspace packages. Interfaces of the geodatabase API are defined under the ESRI interfaces package, for example, *IRowEvents*. Likewise, COM classes of the same API are defined under ESRI Classes. The workspace package represents a geodatabase. Under it, you can create common geodatabase elements, such as domains, feature datasets, and tables.

The illustration to the left shows the procedure to use CASE tools. You create an object model based on the provided template, export it to the Microsoft Repository, then generate code for the custom behavior in the form of a C++, ATL-based project. The developer writes the custom behavior and compiles the project into a Dynamic Link Library (DLL). The DLL acts as a carrier for COM classes, the custom features, and class extensions. The last step is to create a schema for the model using the Schema Wizard in ArcCatalog. The Schema Wizard associates the custom features and class extensions with the created feature classes.

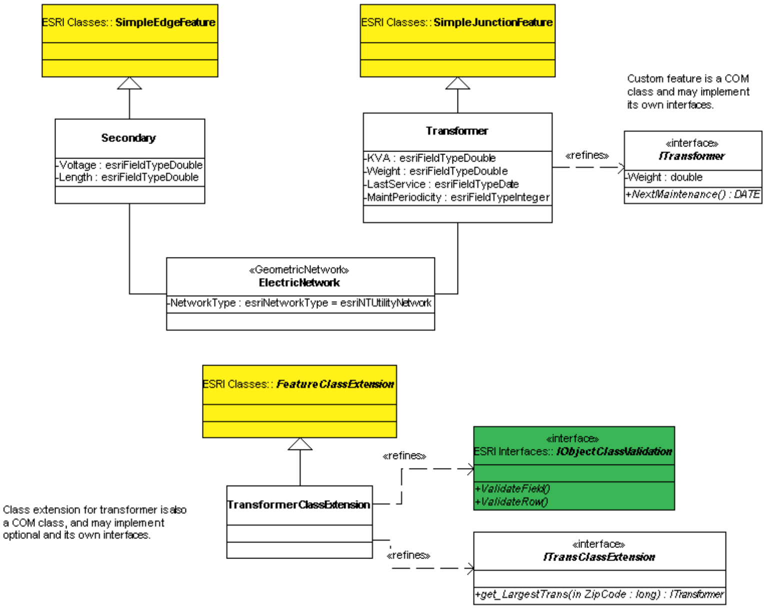
Code generation is an optional step. If code is not generated, the Schema Wizard associates ArcGIS COM classes to the created feature classes. In a given model you can generate code for only a selected set of feature classes, not necessarily for all of them. The Schema Wizard associates the correct behavior COM class for each created feature class.

The semantics checker can be used to verify the validity of a model. Available from the template diagram in Visio®, it verifies that the geodatabase elements in a model are correctly specified. For more information about the semantics checker, see *Building a Geodatabase*.


Create UML model
Export model to repository
MS Repository
Generate source code for custom behavior
Create geodatabase schema

A conceptual view of storing and applying an object model in the repository

To explain the concepts involved in modeling custom behavior, a sample object model is shown. The model represents a transformer custom feature and its associated class extension.


ESRI Classes:: SimpleEdgeFeature
ESRI Classes:: SimpleJunctionFeature
Secondary
-Voltage : esriFieldTypeDouble
-Length : esriFieldTypeDouble
Transformer
-KVA : esriFieldTypeDouble
-Weight : esriFieldTypeDouble
-LastService : esriFieldTypeDate
-MaintPeriodicity : esriFieldTypeInteger
«refines»
«interface»
ITransformer
-Weight : double
+NextMaintenance() : DATE
«GeometricNetwork»
ElectricNetwork
-NetworkType : esriNetworkType = esriNTUtilityNetwork
ESRI Classes:: FeatureClassExtension
TransformerClassExtension
«refines»
«interface»
ESRI Interfaces:: IObjectClassValidation
+ValidateField()
+ValidateRow()
«refines»
«interface»
ITransClassExtension
+get_LargestTrans(in ZipCode : long) : ITransformer

Custom feature is a COM class and may implement its own interfaces.

Class extension for transformer is also a COM class, and may implement optional and its own interfaces.

Transformer is derived from *SimpleJunctionFeature*. This means a transformer will provide exactly the same services as a simple junction feature. In other words, it will implement the same interfaces its parent implements (type inheritance). In total, the transformer must implement approximately 20 system-defined interfaces, such as *IRow, IFeatureDraw,* and *ISimpleJunctionFeature*. Clients of such interfaces include ArcMap, ArcCatalog, and the geodatabase itself.

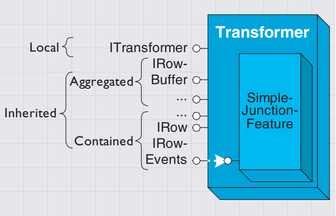
Custom features are COM classes that implement interfaces. This relationship is modeled in UML with a dependency stereotyped as “refines”. In the sample model, *Transformer* implements *ITransformer*. An interface is modeled as a UML class marked with the stereotype interface. Interfaces are abstract classes because they do not have code implementing them. In a way, they are a specification of the services the implementing class must provide.

ITransformer is a developer-created interface. Through these interfaces, custom features provide services on a specific domain, in this case, electrical utilities. Applications developed on top of ArcGIS are the clients of these services.

Class extensions are created by type-inheriting either from *ObjectClassExtension* or *FeatureClassExtension*. In UML, they are required to follow a naming convention—the name of the class followed by “ClassExtension” (*TransformerClassExtension*, for example).

Class extensions do not have fields but may implement developer-designed or optional geodatabase interfaces such as *IObjectClassValidation*. Optional class extension interfaces are available under the ESRI interfaces package.

When the schema is created for this model, *Transformer* will become a feature class and its attributes will become fields (for example, KVA). Notice the types of the fields are taken from the *esriFieldType* enumeration, while the types in the interfaces are C++ automation types. During schema creation, the custom feature and its class extension are assigned to the feature class if code was generated.



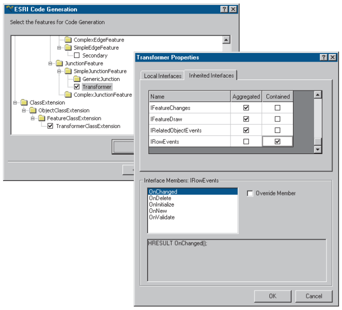
For each custom feature, the Code Generation Wizard will allow you to select what interfaces should be contained or aggregated.

The Code Generation Wizard works inside Developer Studio. The wizard generates an ATL-based C++ project with stub code for custom features and class extensions in your model.

To load the Code Generation Wizard, follow these steps:

1. In Developer Studio, click Tools and click Customize.
2. Click the Add-ins and Macro Files tab.
3. Click Browse to search for the add-in. Click CodeGenWiz.dll (under the bin directory in the ArcGIS installation directory).

When using the wizard you will connect to a repository, select the object model, define implementation reuse options for each object in your model, then specify an output name for the C++ project.


ESRI Code Generation

Select the features for Code Generation

- ComplexEdgeFeature
- SimpleEdgeFeature
  - □ Secondary
- JunctionFeature
  - SimpleJunctionFeature
    - GenericJunction
    - ☑ Transformer
  - ComplexJunctionFeature
- ClassExtension
  - ObjectClassExtension
    - FeatureClassExtension
      - ☑ TransformerClassExtension

Transformer Properties

Local Interfaces | Inherited Interfaces

Name	Aggregated	Contained
IFeatureChanges	☑	□
IFeatureDraw	☑	□
IRelatedObjectEvents	☑	□
IRowEvents	□	☑

Interface Members: IRowEvents

- OnChanged
- OnDelete
- OnInitialize
- OnNew
- OnValidate

□ Override Member

```
HRESULT OnChanged();
```

It is not necessary to generate code for all the UML classes in a model. In this case, Secondary is not selected for code generation. The Schema Wizard will assign ArcGIS software's SimpleEdgeFeature COM class to the feature class created to store secondaries.

Code reuse

A custom feature is required to implement a number of system-defined interfaces so ArcGIS can use it. Implementing all the services could prove to be a difficult task. COM aggregation and containment are simple techniques developers can employ to reuse the implementation already present in ArcGIS software's COM classes. See the discussion on COM aggregation and containment in Volume 1, Chapter 2, 'Developing with ArcObjects'.

In both cases, the object to reuse is placed inside the object reusing the implementation. Each interface implemented by the inner object can be directly exposed (COM aggregation) or indirectly exposed (COM containment).

When developing custom features, COM containment is used when the custom feature changes or adds behavior to the implementation provided by the inner object. In the sample model, *Transformer* could contain *IRowEvents*, for example, so that it could respond to the *OnNew* or *OnDelete* events. However, a custom feature may aggregate all the interfaces implemented by its inner object and provide custom behavior only through its own interfaces (*ITransformer*, for example).

The code generator will create a Developer Studio C++ workspace with the following:

1. Registration script (.rgs), header (.h), and implementation (.cpp) files for each custom feature and class extension
2. IDL with the definition of COM classes, interfaces, and type library
3. Other standard C++/ATL files

The registration script creates the registry keys and values in the registry for each custom feature and class extension. It also registers them under the appropriate component category.

The project's IDL contains the definition of the COM classes and interfaces created by the developer in the model. ArcGIS software's COM classes and interfaces are imported using the importlib directive, so types such as *IRowEvents* are available to the type library being created.

Attributes in interfaces yield to accessor and mutator methods. For example, the *Weight* attribute in the *ITransformer* interface generates the following IDL code:

```
[  propget  ]    HRESULT Weight([out, retval] double* pWeight);
[  propput  ]    HRESULT Weight([in] double Weight);
```

UML operations yield to methods in the interface. The method *NextMaintenance* generates the following IDL code:

```
HRESULT NextMaintenance([out, retval] DATE* pNextMaintenance);
```

Read-only and write-only properties are created using methods prefixed with get_, put_, and propput_, as shown in the following table.

Prefix / Sample	IDL
`get_Foo : double`	`[ propget ] HRESULT Foo ([out, retval] double * pFoo);`
`put_Foo (Y : double)`	`[ propput ] HRESULT Foo ([in] double Y);`
`putref_Foo (Y : IY)`	`[ propputref ] HRESULT Foo ([in] IY * pIY);`

Each time a custom feature is created, an instance of the inner ArcGIS COM class is created as well. The C++ code generated for *Transformer* includes the creation of the inner *SimpleJunctionFeature* in its *FinalConstruct* (ATL calls *FinalConstruct* as soon as the C++ class has been instantiated).

In the same function, a query interface is made for each COM-contained interface, *IRowEvents*, in this example. A member variable will hold a reference to the interface implemented by the inner object.

```
HRESULT Transformer::FinalConstruct()
{
  // Creates instance of inner object
  IUnknown * pOuter = GetControllingUnknown();
  if (FAILED (CoCreateInstance(__uuidof(SimpleJunctionFeature),
/* create inner object  */
              pOuter,
              CLSCTX_INPROC_SERVER,
              IID_IUnknown,
             (void**) &m_pInnerUnk)))
           /* hold it */
        return E_FAIL;

    // QI for IRowEvents
    if (FAILED(m_pInnerUnk->QueryInterface(IID_IRowEvents,
         (void**)&m_pIRowEvents)))
        return E_FAIL;
    pOuter->Release();

    return S_OK;
  }
```

The header generated for the transformer declares the ATL COM MAP. These macros are used to specify which interfaces are implemented locally and which are aggregated.

In the example, *ITransformer* and *IRowEvents* are implemented locally, and all other interfaces implemented by the inner object are aggregated.

```
BEGIN_COM_MAP(Transformer)
      COM_INTERFACE_ENTRY(ITransformer)
      COM_INTERFACE_ENTRY(IRowEvents)
      COM_INTERFACE_ENTRY_AGGREGATE_BLIND(m_pInnerUnk)
END_COM_MAP()
```

Stub code is generated for the interfaces defined in the model. The generated code returns *E_NOTIMPL* for each method. The implementation of the methods in these interfaces is the responsibility of the developer.

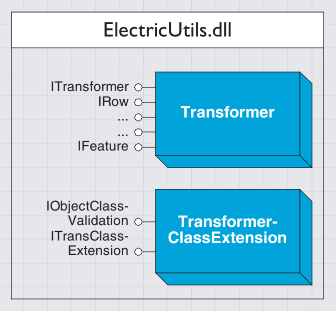
In our sample model, the code generated for the interface *ITransformer* in the transformer C++ class looks like the code below.

```
// ITransformer ----------
//
STDMETHODIMP Transformer::get_Weight(double* pWeight)
{    return E_NOTIMPL; }

STDMETHODIMP Transformer::put_Weight(double Weight)
{    return E_NOTIMPL; }

STDMETHODIMP Transformer::NextMaintenance(DATE* pNextMaintenance)
{    return E_NOTIMPL; }
```

The custom feature may add or change the implementation of a contained interface provided by the inner object. For each method in the interface, the custom feature can forward the call to the inner feature or use its own implementation. The former option is used by the Code Generation Wizard by default.

In the sample, the generated code for *IRowEvents* inside the transformer C++ class looks like the following code (recall that pointers to contained interfaces are acquired in the *FinalConstruct*). The developer may write its own implementation for each method in the interface.

```
//  Methods of Contained Interfaces

// IRowEvents methods ——————————
//
STDMETHODIMP Transformer::OnChanged()
{    return m_pIRowEvents->OnChanged();  }

STDMETHODIMP Transformer::OnDelete()
{    return m_pIRowEvents->OnDelete();  }

STDMETHODIMP Transformer::OnInitialize()
{    return m_pIRowEvents->OnInitialize();  }

STDMETHODIMP Transformer::OnNew()
{    return m_pIRowEvents->OnNew();  }

STDMETHODIMP Transformer::OnValidate()
{    return m_pIRowEvents->OnValidate();  }
```

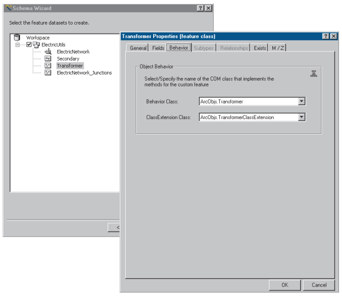


A view of the DLL created in the sample

The Code Generation Wizard will optionally create a class description COM class for each custom feature in the model. Such COM classes describe the custom feature itself, so a feature class can be created using ArcCatalog without using the Schema Wizard. The *IObjectClassDescription* and *IFeatureClassDescription* interfaces are implemented by these COM classes. Code for class descriptions can be generated if the model does not have relationship classes, subtypes, or geometric networks.

COMPILED CUSTOM FEATURES AND CLASS EXTENSIONS

Upon compilation of the project, a DLL will be created. It can be seen as the carrier for the COM classes in your model. All custom features, class extensions, and class descriptions are COM classes inside the DLL. Registering the DLL in a system registers the COM classes in the DLL.



Select the feature datasets to create.

- Workspace
  - ☑ ElectricUtils
    - ElectricNetwork
    - Secondary
    - Transformer
    - ElectricNetwork_Junctions

Object Behavior

Select/Specify the name of the COM class that implements the methods for the custom feature

Behavior Class: ArcObjs.Transformer

ClassExtension Class: ArcObjs.TransformerClassExtension

The Schema Wizard

SCHEMA CREATION

The Schema Wizard, a command available in ArcCatalog, can be used to create a schema for a UML object model. A feature in the object model will create the feature class in the target geodatabase. If code was generated for the custom feature or class extension, the COM classes are associated with the feature class. When behavior classes were not code generated, the wizard will use the appropriate ArcGIS COM class.

The lists of available custom features and class extensions are filled based on those registered in the system; therefore, the DLL should be registered before running the wizard.

The Schema Wizard creates an instance of every custom feature or class extension registered in the system and queries them for some information, for example, their feature type. To avoid crashes, custom features and class extensions should handle error conditions properly during construction.

Appendix

C

Developing for ArcGIS deployments

Euan Cameron

Developing with ArcObjects should not be done in isolation from the deployment of the final application solution. Currently, there are three possible deployments with ArcGIS: ArcInfo, ArcEditor™, and ArcView. To maximize the number of potential users of your components, you should develop your code so that all three products can use your code no matter what their license restrictions are. This appendix outlines how to write code in a way that requires only one code base to support all the possible deployment options, both now and in the future.

ArcObjects is the underlying technology that ESRI has used to develop ArcMap, ArcCatalog, and ArcScene, the new ArcGIS Desktop applications. These applications can be deployed in a number of ways that include ArcView 8.1, ArcEditor 8.1, and ArcInfo 8.1. There may be more deployment options in the future. As a developer, you must think carefully when developing your solutions so that you do not limit yourself unnecessarily to one of these deployment options. Well-designed code should continue to work if new deployments of ArcGIS are released by ESRI.

DEPLOYMENT OBJECT MODELS

The object models for ArcView, ArcEditor, and ArcInfo at ArcGIS 8.1 are identical. All classes, interfaces, methods, and properties are present in all products. This means that the same DLLs containing the same components with the same GUIDs are installed for all deployments; in other words, code written on one deployment will successfully compile on another. What will differ for the various deployments is the behavior of certain method calls.

When executing code, no query interface call will fail because of a license issue, as this would break the rules of COM as stated in Volume 1, Chapter 2, 'Developing with ArcObjects'. If license checking was implemented at the query-interface level, depending on licenses being checked in and out, the query interface call may succeed the first time but fail the next or vice versa.

All the ESRI-developed components handle the different possible deployment options in a unified manner. The functionality available with these different deployments is controlled via a license. This means that if a user installs a new license, the software does not require a reinstallation to access the functionality permitted under the new license.

ArcObjects performs several types of license checking:

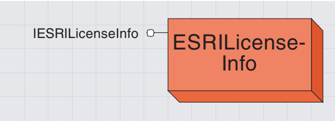
- Application: Each ArcGIS application requires a valid application license to run.
- Extension: Extension products also have licenses associated with them.
- Component: The components within ArcObjects perform license checking.
- Functional: When methods are executed, the behavior of the method varies depending on the available licenses.

It is likely that you will be interacting with more than one of these license-checking mechanisms. For instance, you may check for the appropriate component-level license, then, when working with individual methods, you will have to be aware of the license restrictions associated with these methods.

ESRI engineers use the same coding techniques outlined in this appendix to write code that works with the various deployment options of ArcGIS. Using these techniques, you will be able to write your code to handle the various deployment models.

Application license checking

The simplest form of license checking for you to deal with is when your components are running within an ArcGIS application since there is little for you to do. The license-checking procedures are contained within the ArcGIS applications, and the fact that your components are initialized means that the user has a valid ArcGIS license. However, determining what license is currently checked out by the user can be useful for working with licensing at the functional level.



IESRILicenseInfo : IUnknown	Provides access to members that check software licenses.
■— DefaultProduct: esriProductCode	Indicates the product code that will be used on the current machine.
← IsLicensed (in ProductCode: esriProductCode) : Boolean	Indicates if the specified product is licensed.

To determine the level of license currently in use, use the *ESRILicense-Info* coclass and the *DefaultProduct* property on its *IESRILicenseInfo* interface.

```
Private Function GetDeploymentName() As String
  Dim pLicense As IESRILicenseInfo
  Set pLicense = New ESRILicenseInfo

  Select Case pLicense.DefaultProduct
    Case esriProductCodeViewer
      GetDeploymentName = “ArcView”
    Case esriProductCodeEditor
      GetDeploymentName = “ArcEditor”
    Case esriProductCodeProfessional
      GetDeploymentName = “ArcInfo”
  End Select
End Function
```

Extension license checking

Extension products provided by ESRI supply functionality via a user interface and an API. To use either of these, a valid extension license must be available. Before making calls to objects within an extension, an appropriate license must be checked out. If the following lines of code are executed in a VBA macro, an error will be raised when the *StartExporting* method is executed since an ArcPress™ license has not been checked out. The method calls do not attempt to check one out; they only ensure that one already has been checked out. This gives you license usage control.

```
  Dim pExporter As IExporter
  Set pExporter = New ArcPressExporterJPEG
  ...
  Dim hDc As OLE_HANDLE
  hDc = pExporter.StartExporting
```

For the above code to execute without the license error, the ArcPress extension must be initialized before the call to the *StartExporting* method. The function below shows how to check out an ArcPress license:

```
Public Function GetArcPressLicense() As Boolean
   Dim pUid As UID
   Set pUid = New UID
   pUid.Value = “esricore.ArcPressExtension”

  Dim pExtAdmin As IExtensionManagerAdmin
```

```
   Set pExtAdmin = New ExtensionManager
   'Necessary in standalone application
   pExtAdmin.AddExtension pUid, 0

  Dim pExtManager As IExtensionManager
  Set pExtManager = pExtAdmin
  Dim pExtConfig As IExtensionConfig
  Set pExtConfig = pExtManager.FindExtension(pUID)

  If (Not pExtConfig.State = esriESUnavailable) Then
    On Error Resume Next
     pExtConfig.State = esriESEnabled
    GetArcPressLicense = (pExtConfig.State = esriESEnabled)
  End If

  If (Not GetArcPressLicense) Then _
    MsgBox "No ArcPress licenses available"
End Function
```

Assuming that the process of exporting only requires access to the license for a short time, the license should be released upon completion of the export. Releasing the license means that another user can export using the same license; the only restriction is that the other user cannot export at the same time.

```
Public Sub ReleaseArcPressLicense()
  Dim pUid As UID
  Set pUid = New UID
  pUid.Value = "esricore.ArcPressExtension"

  Dim pExtManager As IExtensionManager
  Set pExtManager = New ExtensionManager

  Dim pExtConfig As IExtensionConfig
  Set pExtConfig = pExtManager.FindExtension(pUID)

  If (Not pExtConfig.State = esriESUnavailable) Then
    pExtConfig.State = esriESDisabled
  End If
End Sub
```

If you are developing an extension that you want to add license checking to in a way similar to ESRI, you must follow certain rules when dealing with the configuration state of your extension. These rules are outlined in Volume 1, Chapter 3, 'Customizing the user interface'.

Component license checking

For more information on singleton objects, see Volume 1, Chapter 2, 'Developing with ArcObjects'.

When embedding ArcObjects within another application, careful thought must be given to license issues. If you instantiate an ArcObjects object, a license is checked out. Any subsequent objects that request licenses make use of the same checked-out license. When you release all of the ArcObjects objects, your created license is also released. However, there are a number of singleton objects within ArcObjects that require a valid license. Since singleton objects exist for the lifetime of the process, once a license is acquired it will not be released until the hosting application is shut down. Once created, you cannot release singleton objects in a way that causes them to remove themselves from the process. If temporal use of licenses is an issue, you should design your main application to make use of ArcObjects in another process so that when that process ends the license is released.

It is important to check that a valid license is available before making any calls to ArcObjects. You can check for a valid license using the *ESRILicenseInfo* coclass. The function below, *GetArcInfoLicense*, makes a call to the *ESRILicenseInfo* object to inquire whether or not an ArcInfo license is available. If a license is not available, the function will behave in two possible ways depending on why there is no license. If the license server has run out of licenses, the function returns *False*. If the license server does not have any ArcInfo licenses installed, or there is no running license server available, the *IsLicensed* method shuts down the host process. The process is shut down for license security; you have no control over this automatic shutdown procedure. For instance, an ArcInfo user may not have any viewer licenses installed; hence, a call to the function similar to the one below asking for a viewer license would cause the application making the call to shut down.

```
Private Function GetArcInfoLicense() As Boolean
  Dim pLicense As IESRILicenseInfo
  Set pLicense = New ESRILicenseInfo

  GetArcInfoLicense = _
   pLicense.IsLicensed(esriProductCodeProfessional)

  If (Not GetArcInfoLicense) Then _
   MsgBox “No ArcInfo licenses available”
End Function
```

To ensure that you ask for a license that the user installed, you should call the *IsLicensed* method using the default product code for the installation.

```
Private Function GetArcGISDefaultLicense() As Boolean
  Dim pLicense As IESRILicenseInfo
  Set pLicense = New ESRILicenseInfo

  GetArcGISDefaultLicense = _
   pLicense.IsLicensed(pLicense.DefaultProduct)

  If (Not GetArcGISDefaultLicense) Then _
    MsgBox “No licenses available”
End Function
```

Functional license checking

Interaction with the three previous forms of license checking in ArcObjects is relatively straightforward. Depending on the functionality accessed, the functional license checking is more involved.

A personal geodatabase is stored in the Microsoft Access .mdb format. An enterprise geodatabase is stored within an RDBMS.

The differences between ArcObjects-based functionality available through ArcGIS deployments are centered on the geodatabase. ArcEditor 8.1 and ArcInfo 8.1 products have the same capabilities, while ArcView 8.1 has reduced functionality.

The ArcInfo and ArcEditor licenses have full access to ArcObjects, particularly the geodatabase. This includes full read access, full editing, and schema definition for both personal and enterprise geodatabases.

ArcView 8.1 can view all supported ArcGIS data sources, but only shapefiles and personal geodatabases can be edited. Editing of coverages is not supported. Geodatabase functionality is further refined to provide a user read access to all geodatabases. What can be created and edited within a personal geodatabase is further refined to prohibit the following:

- Geometric networks
- Feature classes using nonsimple classes (for example, network feature classes and dimension classes), except annotation
- Feature classes with subtypes
- Features classes participating in a relationship class (for example, feature-linked annotation)
- Tables with subtypes
- Tables participating in a relationship class

In addition, when editing within ArcMap, the Integrate command cannot be accessed using the ArcView license.

Knowing this list of supported functionality will help you make decisions on whether licensing issues are of concern for the components you are developing.

As a developer, you have the choice to write proactive or reactive code when dealing with these functional license checks. Proactive code determines the license that is currently in use, which dictates the flow through the program. Reactive code does not perform up-front checking, but it does perform checks after the methods with license behavior are called. In reality, you will most often employ a mixture of both techniques.

An example of proactive code might involve an application that will display and edit data from a variety of data sources. You might choose to limit the data that a user can add to the application based on the license in use. This can be achieved in conjunction with the *GxDialog* coclass and a selection of *GxObject* filters, as illustrated below:

```
Private Function SelectLicensedEditClasses() As IEnumGxObject
  Dim pGxDialog As IGxDialog
  Set pGxDialog = New GxDialog

  Dim pFilters As IGxObjectFilterCollection
  Set pFilters = pGxDialog
 pFilters.RemoveAllFilters
 pFilters.AddFilter New GxFilterShapefiles, False
 pFilters.AddFilter New GxFilterPGDBFeatureClasses, False
 pFilters.AddFilter New GxFilterPGDBFeatureDatasets, False
 pFilters.AddFilter New GxFilterPGDBTables, False

 Dim pLicInfo As IESRILicenseInfo
 Set pLicInfo = New ESRILicenseInfo

 If ((pLicInfo.DefaultProduct = esriProductCodeEditor) Or _
  (pLicInfo.DefaultProduct = esriProductCodeProfessional)) Then
  pFilters.AddFilter New GxFilterCoverageAnnotationClasses, False
   pFilters.AddFilter New GxFilterCoverageFeatureClasses, False
   pFilters.AddFilter New GxFilterCoverages, False
   pFilters.AddFilter New GxFilterDimensionFeatureClasses, False
   pFilters.AddFilter New GxFilterGeometricNetworks, False
   pFilters.AddFilter New GxFilterInfoTables, False
   pFilters.AddFilter New GxFilterRelationshipClasses, False
   pFilters.AddFilter New GxFilterSDEFeatureClasses, False
   pFilters.AddFilter New GxFilterSDEFeatureDatasets, False
   pFilters.AddFilter New GxFilterSDETables, False
 End If

 With pGxDialog
   .AllowMultiSelect = True
   .Title = "Select Editable data"
   .DoModalOpen 0, SelectLicensedEditClasses
 End With
End Function
```

Functional changes take two forms. A method either returns an appropriate error HRESULT to signal that there is not an appropriate license available to successfully execute the method, or it returns a successful HRESULT but the behavior of the method changes to reflect the available licenses.

As an example of the first kind of functional license check, the *Delete* method on the *IDataset* interface may return the HRESULT FDO_E_NO_OPERATION_LICENSE to say that you did not have the correct license to complete the operation. This type of error can be easily trapped for reactively, then reported to the user using an informative message box.

```
Private Function DeleteDataset(pDataset As IDataset) As Boolean
  On Error GoTo ErrorHandler

  pDataset.Delete
  DeleteDataset = True

  Exit Function
ErrorHandler:
  If (Err.Number = FDO_E_NO_OPERATION_LICENSE) Then
   MsgBox "You do not have a license that enables you to delete _
         dataset " & pDataset.Name, vbCritical
  Else
    MsgBox "Error Deleting Dataset " & pDataset.Name & vbCrLf & _
        "Error Description : " & Err.Description, vbCritical
  End If
End Function
```

The alternative is to determine the license in use, the type of dataset that the user wants to delete, and then decide whether or not to allow the *DeleteDataset* function to be called.

The more difficult scenario is when the behavior of a method changes depending on the available licenses. For instance, assume that the user has defined a personal geodatabase using ArcEditor and has a number of classes defined. Two of these feature classes have a relationship class. This means that as long as an ArcEditor or ArcInfo license is used to edit the database, all classes are editable. If an ArcView user starts editing on the database, the start editing will succeed for all the classes except the two with the relationship. The method's behavior has changed, but there was no failure HRESULT returned from the method call since it successfully started editing all the other classes. In this case, you must perform another step after calling *StartEdit* to determine whether or not the start edit operation was successful on all classes. If you find that it was not successful, you can retrieve the reason from the database and present that information to the user or perhaps just configure your tools accordingly.

```
Private Sub StartEditWithCheck(pWorkspace As IWorkspace)
  Dim pWorkspaceEdit As IWorkspaceEdit
  Set pWorkspaceEdit = pWorkspace
  pWorkspaceEdit.StartEditing True
  Dim pDatasets As IEnumDataset

  Set pDatasets = pWorkspace.Datasets(esriDTFeatureClass)
  pDatasets.Reset

  Dim pDataset As IDataset
  Dim pDatasetEdit As IDatasetEdit
  Set pDatasetEdit = pDatasets.Next

  Dim failedClasses As String
  Do Until (pDatasetEdit Is Nothing)
    If (Not pDatasetEdit.isBeingEdited) Then
      Set pDataset = pDatasetEdit
      failedClasses = failedClasses & pDataset.Name & vbCrLf
     End If

    Set pDatasetEdit = pDatasets.Next
  Loop
  If (failedClasses <> "") Then _
    MsgBox "Start edit failed for the following classes : " & _
       failedClasses, vbCritical
End Sub
```

The above function can be changed slightly to perform the checking proactively. In the following function, the class is checked to see if it can be edited using its *IDatasetEditInfo* interface. This is the preferred method of checking since there are a number of reasons in addition to the license issues discussed here that a user may not be able to start editing a feature class. For more information, see Chapter 8, 'Accessing the geodatabase'.

```
Private Function AllOrNothingStartEdit(pWorkspace As IWorkspace) As Boolean
  Dim pDatasets As IEnumDataset
  Set pDatasets = pWorkspace.Datasets(esriDTFeatureClass)
  pDatasets.Reset
  Dim pDatasetEditInfo As IDatasetEditInfo
  Set pDatasetEditInfo = pDatasets.Next

  Do Until (pDatasetEditInfo Is Nothing)
    If (Not pDatasetEditInfo.CanEdit) Then Exit Function
    Set pDatasetEditInfo = pDatasets.Next
  Loop

  Dim pWorkspaceEdit As IWorkspaceEdit
  Set pWorkspaceEdit = pWorkspace

  pWorkspaceEdit.StartEditing True
  AllOrNothingStartEdit = True
End Function
```

When designing your functionality, being aware of these license issues will help you create a solid application that will work on any deployment of the ArcGIS functionality.

Using the tables on the next page will help you decide when it is appropriate to check for license-related HRESULTs. You should not treat this as a fixed list of method calls since changes in ArcGIS deployments may result in changes to the functional license-checking routines.

The following table lists the license-related HRESULTs:

Name	Hexidecimal value	Decimal value
E_NOTLICENSED	0x80040101	-2147221247
FDO_E_LICENSE_FAILURE	0x80040212	-2147220974
FDO_E_NO_EDIT_LICENSE	0x8004021E	-2147220962
FDO_E_NO_SCHEMA_LICENSE	0x8004021F	-2147220961
FDO_E_NO_OPERATION_LICENSE	0x80040220	-2147220960
E_RASTER_FILE_LZW_FAILED	0x80041006	-2147217402
E_RASTERENCODER_NO_LICENSE	0x80041001	-2147217407
E_LICENSENOTAVAILABLE	0x80040302	-2147220734
FDO_E_SE_LICENSE_FAILURE	0x8004152B	-2147216085
FDO_E_SE_OUT_OF_LICENSES	0x8004152C	-2147216084
FDO_E_SE_LICENSE_EXPIRED	0x80041542	-2147216062
E_TIN_LICENSE_NOT_AVAILABLE	0x80042B65	-2147210395
E_SPATIAL_ANALYST_LICENSENOTAVAILABLE	0x80041068	-2147217304
E_SPATIAL_ANALYST_SHAREDLICENSENOTAVAILABLE	0x8004106A	-2147217302
E_GEOSTAT_LICENSENOTAVAILABLE	0x80040301	-2147220735
LOCATION_E_NO_LICENSE	0x80040210	-2147220976

The following table lists the method calls that can return license-related HRESULTs:

Interface	Method	HRESULT
IFeatureWorkspace	CreateTable	FDO_E_NO_SCHEMA_LICENSE
	CreateRelationshipClass	FDO_E_NO_SCHEMA_LICENSE
	CreateFeatureClass	FDO_E_NO_SCHEMA_LICENSE
	CreateAnnotationClass	FDO_E_NO_SCHEMA_LICENSE
	CreateFeatureDataset	FDO_E_NO_SCHEMA_LICENSE
IArcInfoWorkspace	CreateCoverage	FDO_E_NO_SCHEMA_LICENSE
	CreateInfoTable	FDO_E_NO_SCHEMA_LICENSE
IClass	AddField	FDO_E_NO_SCHEMA_LICENSE
ISubtypes	AddSubtype	FDO_E_NO_SCHEMA_LICENSE
	DeleteSubtype	FDO_E_NO_SCHEMA_LICENSE
	put_DefaultSubtypeCode	FDO_E_NO_SCHEMA_LICENSE
	put_DefaultValue	FDO_E_NO_SCHEMA_LICENSE
	putref_Domain	FDO_E_NO_SCHEMA_LICENSE
IFeatureDataset	CreateFeatureClass	FDO_E_NO_SCHEMA_LICENSE
	CreateRelationshipClass	FDO_E_NO_SCHEMA_LICENSE
	CreateGeometricNetwork	FDO_E_NO_SCHEMA_LICENSE
	Delete	FDO_E_NO_OPERATION_LICENSE
ITopoEditor	IntegrateDataset	FDO_E_NO_EDIT_LICENSE
	IntegrateClass	FDO_E_NO_EDIT_LICENSE
	Select	FDO_E_NO_EDIT_LICENSE
IPrinter	StartPrinting	E_LICENSENOTAVAILABLE
IExporter	StartExporting	E_LICENSENOTAVAILABLE
IRasterBandCollection	SaveAs	E_RASTER_FILE_LZW_FAILED
IVersion	put_VersionName	FDO_E_NO_OPERATION_LICENSE
	put_Description	FDO_E_NO_OPERATION_LICENSE
	put_Access	FDO_E_NO_OPERATION_LICENSE
	CreateVersion	FDO_E_NO_OPERATION_LICENSE
	Delete	FDO_E_NO_OPERATION_LICENSE
IWorkspaceLicense	putref_Domain	FDO_E_NO_SCHEMA_LICENSE
ITinAdvanced	MakeNodeEnumerator	E_TIN_LICENSE_NOT_AVAILABLE
	MakeEdgeEnumerator	E_TIN_LICENSE_NOT_AVAILABLE
	MakeTriangleEnumerator	E_TIN_LICENSE_NOT_AVAILABLE
	ConvertToVoronoiRegions	E_TIN_LICENSE_NOT_AVAILABLE
ITinEdit	StartEditing	E_TIN_LICENSE_NOT_AVAILABLE
	InitNew	E_TIN_LICENSE_NOT_AVAILABLE
ISurface	GetProjectedArea	E_TIN_LICENSE_NOT_AVAILABLE
	GetSurfaceArea	E_TIN_LICENSE_NOT_AVAILABLE
	GetVolume	E_TIN_LICENSE_NOT_AVAILABLE
	GetVolumeAndArea	E_TIN_LICENSE_NOT_AVAILABLE
	GetPartialVolumeAndArea	E_TIN_LICENSE_NOT_AVAILABLE
	ConvertToPolygons	E_TIN_LICENSE_NOT_AVAILABLE
	GetLineOfSight	E_TIN_LICENSE_NOT_AVAILABLE
	GetContour	E_TIN_LICENSE_NOT_AVAILABLE
	ContourList	E_TIN_LICENSE_NOT_AVAILABLE
	Contour	E_TIN_LICENSE_NOT_AVAILABLE
	AsPolygons	E_TIN_LICENSE_NOT_AVAILABLE
	QueryPixelBlock	E_TIN_LICENSE_NOT_AVAILABLE
	GetSteepestPath	E_TIN_LICENSE_NOT_AVAILABLE

Appendix D

Developing with the Map control

Michael Waltuch

You can create standalone applications—outside ArcGIS applications such as ArcMap and ArcCatalog—using the Map control, an ActiveX control that comes with ArcGIS Desktop.

The Map control provides you with the basic infrastructure, such as managing views, layers, and datasets in your new applications, with relatively little development. In fact, the Map control works in a similar way to MapObjects; the main difference is that the Map control is your gateway to the entire ArcObjects object model.

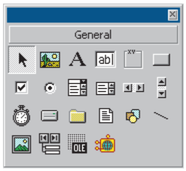
ArcGIS 8.1 includes an ActiveX component called the Map control. No additional installation is required. It's similar to the MapObjects Map control—you can start up any of the standard development environments and languages that support ActiveX controls, such as Visual Basic, Visual C++, Visual Basic for Applications (VBA), Delphi®, and PowerBuilder®, load the control, and start to build applications that display and manipulate geographic data.

If you need to display any of the ArcGIS data sources, either in concert with one of the ArcGIS applications or as a standalone application, the Map control may be an appropriate technology. The application you build with the control may be as simple or as extensive as you wish. In fact, you can build a standalone application in a matter of minutes, use the control to provide access to the entire ArcObjects object model, or add your own COM components.

What you can do with the Map control is limited only by your imagination. Many application scenarios exist, and you may recognize your own situation in this brief list. For example, you can use the control to build:

- Kiosks that allow the public to make simple inquiries about land parcels
- Minicatalogs of available data for in-house use
- Specialized editing task environments
- Enhanced Office applications that include "live" maps
- Equipment and inventory location tracking tools

WHAT DOES THE MAP CONTROL DO?



The Map control in the Visual Basic Toolbox.

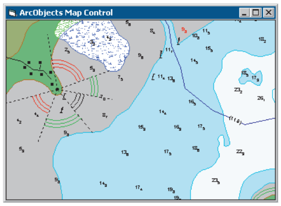
To see how to load this control automatically, see the automated references add-in topic in Volume 1, Chapter 2, 'Developing with ArcObjects.'

Simply put, the Map control does all the plumbing required to get ArcObjects inside another application. At the simplest level you can work with the control interactively, with no code needed. For instance, in Visual Basic you can browse for the control, add it to the Toolbox, and drag it to a Form. This creates a map display that you can use to render geographic data. Right-clicking the control displays a property page that lets you browse for layers to add to the map. These layers can be any ArcGIS-supported data source. If you've already created or have access to an ArcMap document, you can browse for it and the control will display the entire contents of the document using all previously established symbology and spatial references. In addition to working interactively, you can use the appropriate set of methods and properties that the control exposes to handle the data-loading tasks. Here's a simple example of loading an ArcMap document onto the control:

```
Private Sub Form_Load()
  MapControl1.LoadMxFile "c:\data\mxds\StudyArea.mxd"
End Sub
```

Because the Map control is like any standard ActiveX control, it has a full complement of stock events. Thus, you can write code for these events in order to respond to user actions. For example, you can respond to an event, such as *OnMouseDown*, by using a simple method, such as *IMapControl::TrackRectangle*, to create code to set a new spatial extent, as shown with this code:

```
Private Sub MapControl1_OnMouseDown(ByVal button As Long, _
   ByVal shift As Long, ByVal x As Long, ByVal y As Long, _
   ByVal mapX As Double, ByVal mapY As Double)
  With MapControl1
    .MousePointer = esriPointerZoomIn
    .Extent = MapControl1.TrackRectangle
    .MousePointer = esriPointerArrow
  End With
End Sub
```



A sample Map control application with a preloaded MXD file.

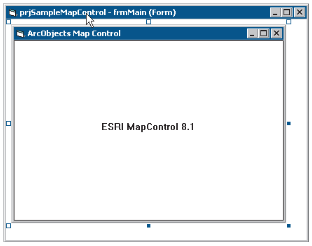
Returning to the original spatial extent is just as easy:

```
Private Sub Command1_Click()
  MapControl1.Extent = MapControl1.FullExtent
End Sub
```

To get going quickly you can avail yourself of the wide-ranging functionality of the sample commands and tools that are provided with the installation. These tools implement *ICommand* and/or *ITool*, provide functionality to identify and select features, produce attribute reports, edit commands (including *StartEditing*, *StopEditing*, *Undo*, *Redo*), and supply tools to add and reorganize layers.

The tools are available in two DLLs stored in the installation's bin folder. One, written in C++, AfCommands.dll, contains two commands, the other, written in Visual Basic, AfCommandsVB.dll, contains several tools; they both can be used in a development environment that supports ActiveX DLLs.

The source for these samples is in the ArcObjects Developer Kit\Kits\ArcObjects Source\Commands folder. If you want to find out more about using the sample commands and tools, or you're looking for a place to start learning from scratch, read the PDF document named Getting started with the Map control.pdf in the ArcObjects Developer Kit\Samples\MapControl folder for more information. Of course, you can also use the samples simply as a model for your own tools.



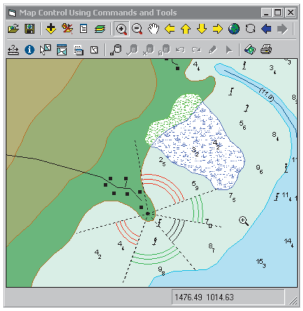
The Map control in a Visual Basic form at design time.

You can create a sophisticated application using the Map control's methods, properties, and events. In some cases, however, you may require the more extensive functionality of the rest of the ArcObjects object model. How do you do this? The control's *Map* property returns an *IMap* and, if you've loaded the ESRI Object Library (esriCore.olb), you can use the members of *IMap* to link the Map control to the rest of the object model. Here is a simple example of how to highlight the selected features of a map. In this case, the selection set is the result of the intersection of any features on the map and a circle you track with the mouse:

```
Private Sub MapControl1_OnMouseDown(ByVal button As Long, _
   ByVal shift As Long, ByVal x As Long, ByVal y As Long, _
   ByVal mapX As Double, ByVal mapY As Double)
  Dim pSelEnv As ISelectionEnvironment
  Dim pRgbColor As IRgbColor
  Set pSelEnv = New SelectionEnvironment
  Set pRgbColor = New RgbColor
  pRgbColor.Red = 255
  pSelEnv.AreaSelectionMethod = esriSpatialRelIntersects
  Set pSelEnv.DefaultColor = pRgbColor
  MapControl1.Map.SelectByShape MapControl1.TrackCircle, pSelEnv, False
  MapControl1.Refresh esriViewGeography
End Sub
```

You may decide to write commands or tools that work both with ArcMap or an application that embeds the Map control. To do so, you must simply determine the type of object that you pass in your implementation of *ICommand_OnCreate*. When the framework creates the command, it calls *OnCreate*. The *IDispatch* interface of the hosting framework gets passed through the method's hook variable:

```
Option Explicit

' Member Variables
Private m_pApp As IApplication          ' Top most object of an ArcGIS
Application
Private m_pMapControl As IMapControl    ' Top most object of the Map
control

Private Sub ICommand_OnCreate(ByVal hook As Object)
  If (TypeOf hook Is IApplication) Then
    Set m_pApp = hook
  ElseIf (TypeOf hook Is IMapControl) Then
    Set m_pMapControl = hook
  End If
End Sub
```



The Map control with some of the sample commands and tools

Once you've made this determination, you can QI for an appropriate interface. For example:

```
Private Function GetFocusMap() As IMap
  ' Try for the IMap member Variable first
  If (Not m_pMapControl Is Nothing) Then
    Set GetFocusMap = m_pMapControl.Map
    Exit Function
  End If

  ' Get The Map From the Application
  If (Not m_pApp Is Nothing) Then
    Dim pMxDoc As IMxDocument
    Set pMxDoc = m_pApp.Document

    Set GetFocusMap = pMxDoc.FocusMap
    Exit Function
  End If
End Function
```

There may be instances when you may be better off not using the control. The ArcObjects Map control is not a lightweight component—it's not the next version of MapObjects, nor should it be used to serve geographic data to a Web-based application. In addition, you may find that you can save development effort by leveraging the existing display- and data-management capabilities inherent in ArcMap or ArcCatalog and just work on implementing your own tools or commands, rather than “reinventing the wheel”. The use of the control is tied to the same licensing requirements as your other ESRI ArcGIS 8.1 applications. A simple rule of thumb is that if you can’t run ArcMap or ArcView on the seat, then you can’t run an application with the control there either.

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