

3D 控件的开发



课 4 概述

- ◆ ArcGIS Engine 3D 库和控件
- ◆ 3D 控件
- ◆ 命令和工具
- ◆ 3D 文档和数据源
- ◆ 相关3D对象
- ◆ 关键方法和属性

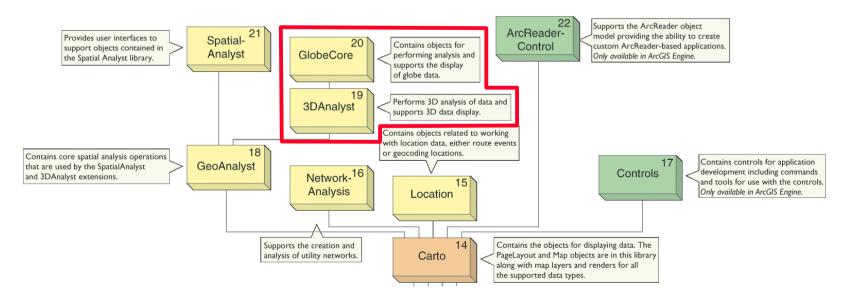
ArcGIS Engine 3D 库

◆ 3DAnalyst (esri3DAnalyst.olb)

SceneControl, Scene, SceneGraph, 3DProperties,
 SceneExporter3D, SceneViewer, 3DSymbol, AnimationTrack, ...

GlobeCore (esriGlobeCore.olb)

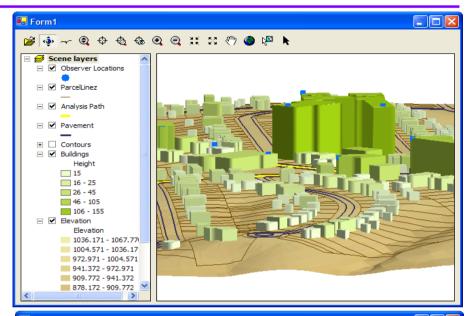
◆ GlobeControl, Globe, GlobeDisplay, GlobeCamera, GlobeViewer, GlobeLayerProperties, GlobeLayer, AnimationTrack, ...

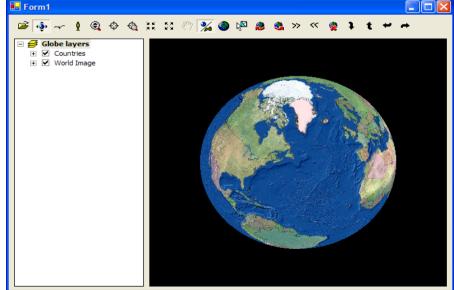


Getting started with the 3D 控件

- ◆ SceneControl
 - ◆对应于ArcScene 3D 视图

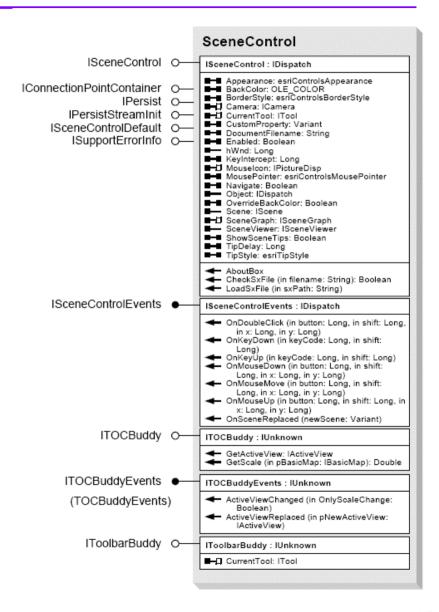
- ◆ GlobeControl
 - ◆对应于ArcGlobe 3D 视图





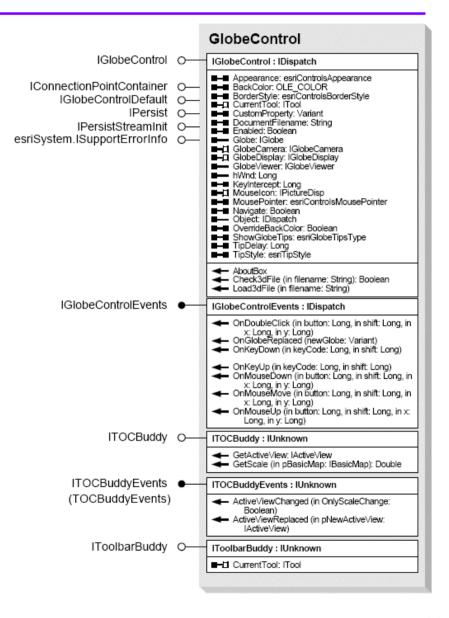
Scene 控件

- SceneControl
 - ◆封装了 SceneViewer 类
 - ◆管理
 - General appearance
 - Scene
 - Scene graph
 - Camera properties
 - ◆ 设置当前工具
 - ◆加载 scene 文档
- ◆库
 - ◆ SceneControl.ocx



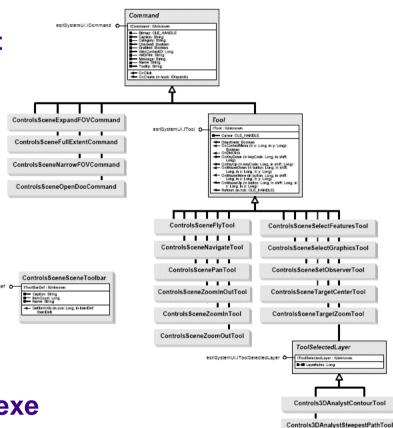
Globe 控件

- GlobeControl
 - ◆封装了GlobeViewer 类
 - ◆管理
 - General appearance
 - Globe
 - Globe display
 - Globe camera properties
 - ◆ 设置当前工具
 - ◆加载 globe 文档
- ◆库
 - ◆ GlobeControl.ocx



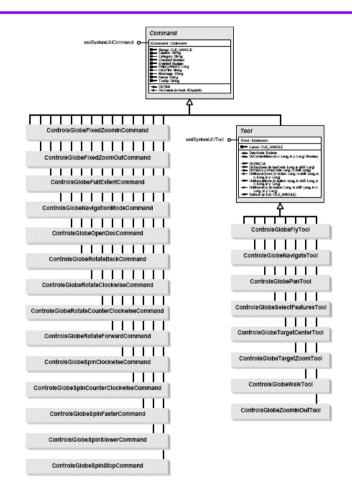
SceneControl 控件命令

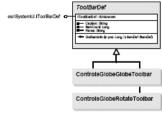
- ◆ 命令和工具
 - ◆ Pan, zoom, fly, set observer, select
- ◆ 工具条
 - ◆ ControlsSceneSceneToolbar
- ◆库
 - ◆ esriSceneControl.ocx
 - ◆ esri3DAnalyst.olb
- ♦ 参考
 - ◆ 对象模型图, 技术文档或 Categories.exe



GlobeControl控件命令

- ◆ 命令和工具
 - ◆ Pan, zoom, fly, target, select
- ◆ 工具条
 - ◆ ControlsGlobeGlobeToolbar
 - ◆ ControlsGlobeRotateToolbar
- ◆库
 - ◆ esriGlobeControl.ocx
 - ◆ esriGlobeCore.olb
- ♦ 参考
 - ◆ 对象模型图, 技术文档或 Categories.exe





增加 3D 控件项目到工具条

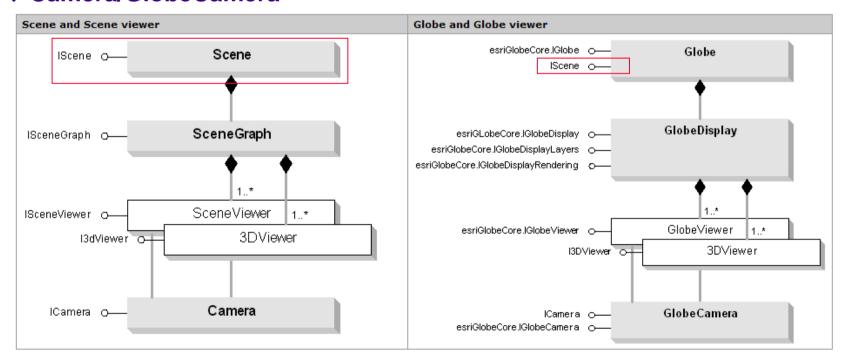
```
Private Sub TabControl1 Click(ByVal sender As Object, ByVal e As
  System. EventArgs) Handles TabControl1.Click
  If TabControl1.SelectedTab Is tbpqSceneCtrl Then
  'Scene
  ElseIf TabControl1.SelectedTab Is tbpgGlobeCtrl Then
  'Globe
        AxToolbarControl1.SetBuddyControl(AxGlobeControl1)
        AxToolbarControl1.RemoveAll()
        Functions.AddGlobeCommands(AxToolbarControl1)
        AxTOCControl1.SetBuddyControl(AxGlobeControl1)
        Functions.SetCurrentTool(AxToolbarControl1, 1)
  End If
End Sub
Public Shared Sub AddGlobeCommands(ByRef toolBarControl As AxToolbarControl)
  toolBarControl.AddItem("esriGlobeCore.ControlsGlobeOpenDocCommand", , -1,
  False, , esriCommandStyles.esriCommandStyleIconOnly)
  toolBarControl.AddItem("esriGlobeCore.ControlsGlobeGlobeToolbar", , -1, True,
  , esriCommandStyles.esriCommandStyleIconOnly)
  toolBarControl.AddItem("esriGlobeCore.ControlsGlobeRotateToolbar", , -1,
  True, , esriCommandStyles.esriCommandStyleIconOnly)
End Sub
```

scene 和 globe的功能区别

Scene	Globe
- 3D 线符号 - tin 图层 - 立体和正面视图 - 最陡路径工具,等高线工具 - 数据无需投影 - 图层动画 (位置变换) - 输出到vrml - 动态山影图 - 图层优先 - '场景' 动画 - 3D 标记符号缩放比例控制	- 数据分页, LODs, 大容量数据处理 - 地理坐标系统 - 纹理图层绘制顺序控制 - 热链接 - 测量和 行走工具 - 导航工具: 放大/缩小,定位视图中心,缩放到目标 - 为栅格化矢量数据设置地图符号 - 旋转工具条 - 平视显示器(HUD) - near/far clip plane control on UI - 默认图层 - MapServer Layers - ArcIMS Image layers - 要素注记图层 - 导航工具的动画选项 - MOLE - 通过要素属性控制要素透明度

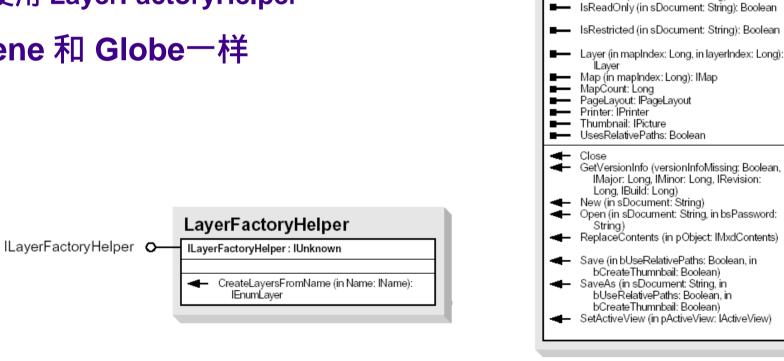
Scene 和 Globe中的相似对象

- ◆ ISceneControl/IGIobeControl
 - ◆ Scene/Globe
 - SceneGraph/GlobeDisplay
 - ◆ SceneViewer/GlobeViewer
 - ◆ Camera/GlobeCamera



3D controls: 访问数据

- ◆ 不同途径
 - ◆ 加载 3D 文档
 - ◆ 访问 MapDocument
 - ◆ 使用 LayerFactoryHelper
- ◆ Scene 和 Globe一样



IMapDocument O-

MapDocument IMapDocument : IUnknown

DocumentVersion:

ActiveView: IActiveView

DocumentFilename: String

DocumentType: esriMapDocumentType

esriMapDocumentVersionInfo

IsPresent (in sDocument: String): Boolean

IsMapDocument (in sDocument: String): IsPasswordProtected (in sDocument; String);

加载 3D 文档

ISceneControl/IGlobeControl

- ◆ CheckSxFile/Check3DFile
- ◆ LoadSxFile/Load3DFile
- ◆ ShowSceneTips/ShowGlobeTips
- ◆ TipStyle
- ◆ TipDelay

```
Private Sub Form1_Load(...) Handles MyBase.Load

Dim fileName As String = "C:\Program Files\ArcGIS\ArcGlobeData\Default_Document.3dd"

If AxGlobeControl1.Check3dFile(fileName) Then

AxGlobeControl1.Load3dFile(fileName)

AxGlobeControl1.TipDelay = 500

AxGlobeControl1.TipStyle = esriTipStyle.esriTipStyleTransparent

AxGlobeControl1.ShowGlobeTips = esriGlobeTipsType.esriGlobeTipsTypeLatLon

End If

End Sub
```

访问 MapDocument

- ◆ 从 mxd, lyr, pmf文件访问图层
- ◆ 使用 ObjectCopy 或 IBasicMap

```
Dim mapDocument As IMapDocument = New MapDocument
If (Not mapDocument.IsMapDocument(sFilePath)) Then Exit Sub
mapDocument.Open(sFilePath)
Dim objCopy As IObjectCopy = New ObjectCopy
Dim map As IMap
map = objCopy.Copy(mapDocument.Map(0))
Dim scene As IScene
If TabControl1.SelectedTab Is tbpgSceneCtrl Then
   'Scene
   scene = AxSceneControl1.Scene
   scene.ClearLayers()
   scene.AddLayers(map.Layers, False)
ElseIf TabControl1.SelectedTab Is tbpgGlobeCtrl Then
   'Globe
   scene = AxGlobeControl1.GlobeDisplay.Scene
   scene.ClearLayers()
   scene.AddLayers(map.Layers, False)
End If
```

通过 LayerFactoryHelper访问数据

◆ 加载任何实现了IName的对象

例子: FileName - lyr, tif, jpg, shp, ...

```
Dim file, files() As String
Dim pFileName As IFileName
Dim pLayerFactoryHelper As ILayerFactoryHelper
Dim pEnumLayer As IEnumLayer
Dim pLayer As ILayer
'Open a file dialog to add data
files = OpenFileDialog1.FileNames
For Each file In files
    pFileName = New FileName
    pFileName.Path = file
    pLayerFactoryHelper = New LayerFactoryHelper
    Try
        'Get the IEnumLayer interface through the ILayerFactoryHelper interface
         pEnumLayer = pLayerFactoryHelper.CreateLayersFromName(pFileName)
        pEnumLayer.Reset()
         pLayer = pEnumLayer.Next
        m scene.AddLayer(pLayer)
    Catch ex As Exception
        MsqBox(file + " is not a valid layer and won't be added to the SceneControl")
    End Try
Next
```

Globe支持的数据源

- ◆与Scene 和 Map不同, 所有的数据源必须定义了空间参考
- ◆ 空间参考可以是任何一种地理的或投影的坐标系统
- ◆ 在 Globe 9.0, 有些数据源是不被支持的
 - ◆ 跟踪分析图层
 - ◆ 测量图层
 - ◆ 地理统计图层
 - ◆不能直接支持TIN; 需要转换为栅格

3D controls: 事件

- ◆ ISceneControlEvents/IGlobeControlEvents
 - OnDoubleClick
 - OnSceneReplaced /OnGlobeReplaced
 - OnKeyDown/Up
 - OnMouseDown/Move/Up
- ◆ ITOCBuddyEvents
 - ActiveViewChanged/Replaced

```
Private Sub AxGlobeControl1_OnGlobeReplaced(...) Handles AxGlobeControl1.OnGlobeReplaced
    Dim pglbbDispRend As IGlobeDisplayRendering
    pglbbDispRend = AxGlobeControl1.GlobeDisplay
    Dim bsun As Boolean
    bsun = pglbbDispRend.IsSunEnabled
    If bsun = True Then chkSun.Checked = True
    'Get the state of globetips from the loaded doc
    m_penumTips = AxGlobeControl1.GlobeViewer.GlobeDisplay.Globe.ShowGlobeTips
End Sub
```

SceneGraph/GlobeDisplay 事件

- ◆ ISceneGraphEvents/IGlobeDisplayEvents
 - ActiveViewerChanged
 - AfterDraw/BeforeDraw
 - InteractionStopped
 - TileOverflow/VectorOverflow
 - ViewerAdded/ViewerRemoved

```
Public WithEvents m_pglbDisplay As GlobeDisplay
...

Private Sub m_pglbDisplay_AfterDraw(ByVal pViewer As ESRI.ArcGIS.Analyst3D.ISceneViewer)
    Handles m_pglbDisplay.AfterDraw

If (chkStartStop.CheckState = CheckState.Checked) Then
    Dim globeDisplay As IGlobeDisplay
    globeDisplay = m_globe.GlobeDisplay

If (Not globeDisplay.IsNavigating) Then
    ' Capture key frames after globe is done drawing
    Functions.CaptureKeyFrame(m_globe, m_animTrack)
    lstKeyFrames.Items.Add(m_animTrack.Keyframe(m_animTrack.KeyframeCount - 1).Name)
    End If
End Sub
```

SceneControl: 设置垂直拉伸

- ◆ 访问 Iscene接口
- ◆ 设置拉伸系数
 - ◆ IScene::ExaggerationFactor
- ◆ 应该刷新显示

```
Private Sub trkVerticalExaggeration_Scroll(ByVal
    sender As System.Object, ByVal e As
    System.EventArgs) Handles
    trkVerticalExaggeration.Scroll

trkVerticalExaggeration.Minimum = 1
    m_scene.ExaggerationFactor =
    trkVerticalExaggeration.Value
    AxSceneControll.Refresh()
End Sub
```

```
IScene ⇔
                  IScene: IUnknown
                  ■■■ ActiveGraphicsLaver: ILaver
                  ■■ AreaOfInterest: IÉnvelopé
                  BasicGraphicsLayer: IGraphicsLayer
                 ■■ Description: String
                  ■■ ExaggerationFactor: Double
                 Extent: IEnvelope
                 ■-□ FeatureSelection: ISelection
                 ■— Laver (in index: Long): ILaver
                 ■— LaverCount: Long
                  Layers (in uid: IUID, in recursive: Boolean):
                         ÍEnumLaver
                  ■■ Name: String
                  SceneGraph: ISceneGraph
                  SelectionCount: Long
                 ■■■ SpatialReference: ISpatialReference
                  AddLayer (in pLayer: ILayer, in autoArrange:
                  AddLayers (in Layers: IEnumLayer, in ...
                         autoArrange: Boolean)
                  Applies (in Object: IUnknown): Boolean
                  ClearLayers
                  ClearSelection

    DelavEvents (in delay: Boolean)

                  DelefeLayer (În Layer: ILayer)

    GetDefaultBackgroundColor (out red: Single.

                         out green: Single, out blue: Single)

    MoveLayer (in Layer: ILayer, in toIndex: Long)

                  ProposéSpatialRéferencé (in pProposedSR:
                         ISpatialReference, out pbChanged:
                         Boolean)
                  RecalculatéExtent
                  SelectByShape (in Shape: IGeometry, in env:
                         ISelectionEnvironment, in justOne:
                  SelectFeature (in Layer: ILayer, in pFeature:
                      SetDefaultBackgroundColor (in red; Single, in
                         green: Single, in blue: Single)
                  SuggestExaggerationFactor (in aspectRatio:
                         Double, out ExaggerationFactor: Double)
```

SceneControl: 在表面上覆盖栅格数据

- ◆ 从TIN 或 raster 获取表面
- ◆ 得到图层的3DProperties
- ◆ 设置TIN 作为基表面
 - ◆ I3DProperties::BaseSurface
- ◆ 使图层无效 (Invalidate)

```
Dim pSurface As ISurface
Dim p3DProps As I3DProperties
Dim i As Integer
Dim pLayerExts As ILayerExtensions
pSurface = Functions.GetSurfaceFromTinLayer(...))
pLayerExts = layer
For i = 0 To pLayerExts.ExtensionCount - 1
    If TypeOf pLayerExts.Extension(i) Is I3DProperties Then
        p3DProps = pLayerExts.Extension(i)
    End If
Next
p3DProps.BaseSurface = pSurface
p3DProps.BaseOption = esriBaseOption.esriBaseSurface
m_scene.SceneGraph.Invalidate(layer, True, False)
AxSceneControl1.Refresh()
```

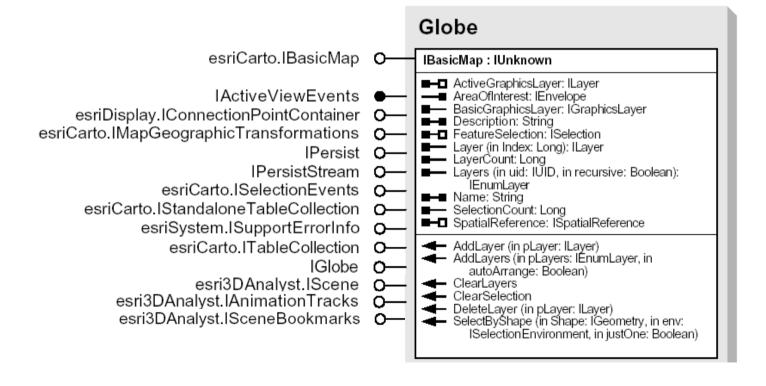
```
3DProperties
        I3DProperties Q-
                                 I3DProperties : IUnknown
                                 ■■ BaseExpressionString: String
               IPersist O-
                                 BaseName: IName
                                ■■■ BaseOption: esriBaseOption
      IPersistStream O-
                                 ■■■ BaseSurface: IFunctionalSurface
                                 ■ DepthPriorityValue: Integer
                                ■—■ ExtrusionExpressionString: String
■—■ ExtrusionType: esriExtrusionType
                                 ■ FaceCulling: esri3DFaceCulling
                                 ■■ Illuminate: Boolean
                                 ■■ MaxRasterColumns: Long
                                 ■■ MaxRasterRows: Long
                                 ■■ MaxTextureMemory: Long
                                 ■■ OffsetExpressionString: String
                                 ■■ RenderMode: esriRenderMode
                                 ■ RenderRefreshRate: Double
                                 RenderVisibility: esriRenderVisibility
                                 ■■ SmoothShading: Boolean
                                 ■ ZFactor: Double

    Apply3DProperties (in Owner: IUnknown)

IDataLayerExtension O-
                                 IDataLaverExtension: IUnknown
      (esriCarto)
                                 ■ RelativeBase: String
                                 Connect (in pOptRepairName: IName):
```

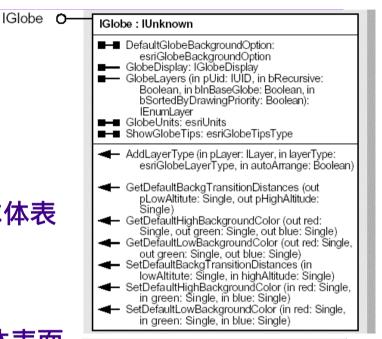
The Globe CoClass

- ◆ GlobeControl控件的主要类
- ◆ 2D 和 3D 图层的容器
- ◆ 和MapControl中的 Map类似



使用 Globe图层

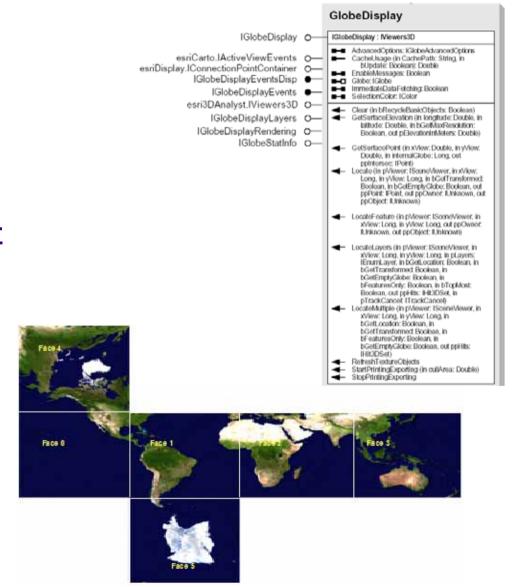
- ◆ IGlobe
 - ◆ AddLayerType: 多种图层类型
- ◆ 图层类型
 - ◆ 高程数据: 使用有高程的栅格数据来定义球体表面
 - ◆ 纹理数据: 覆盖在球体表面
 - ◆漂浮数据: 使用偏移来显示,高出或低于球体表面
- ◆ 也可以设置背景
 - ◆天空颜色,空间颜色,颜色衰减 ...





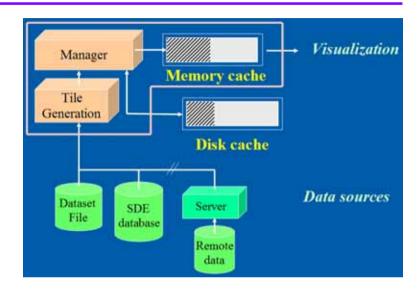
GlobeDisplay CoClass

- ◆ GlobeControl的中心类
- ◆ 把球体分割为6块
 - ◆ 4块沿着赤道
 - ◆ 两块在两极
- ◆ 管理视图, 渲染和数据缓存
- ◆ 在每进程实例上



GlobeDisplay: 数据缓存

- ◆ 用来提高显示和绘制性能
- ◆ 为每一图层的块创建高速缓存
- ◆ 块被存储在
 - ◆内存缓存中,可以立即使用
 - ◆磁盘缓存中,可以以后使用



Globe: 改变漂浮图层的偏移值

- ◆ 分配一个垂直高度,抬高或压低球体上的图层
- ◆ IGlobeHeightProperties
 - ◆ BaseOption: esriGlobeLayerBaseSelf (初始图层高度)
 - ◆ Offset: 高出或低于球体表面的高度

```
Private Sub TrackBar2_Scroll(ByVal sender As System.Object, ByVal e As System.EventArgs)
    Handles TrackBar2.Scroll

...

While Not layer Is Nothing
    If layer.Name = "Countries" Then
        globeLayerProperties = globeDisplayLayers.FindGlobeProperties(layer)
        globeHeightProperties = globeLayerProperties.HeightProperties
        globeHeightProperties.BaseOption = esriGlobeLayerBaseOption.esriGlobeLayerBaseSelf
        globeHeightProperties.Offset = TrackBar2.Value * 500000
        globeHeightProperties.Apply(AxGlobeControll.Globe, layer)
        AxGlobeControll.GlobeDisplay.RefreshViewers()
    End If
    layer = enumlayer.Next
    End While
End Sub
```

Globe: 记录和播放动画

- ◆ 四个基本步骤
 - 1. 创建或获取动画轨迹
 - 2. 捕捉关键帧
 - 3. 播放动画
 - 4. 保存和加载动画文件

Globe: 查找已存在的动画轨迹

- ◆ 动画轨迹是关键帧的容器
- ◆ 你可以使用已经存在的动画轨迹
 - ◆ 访问已存关键帧
 - ◆ 增加/移除关键帧
 - ◆ 通过关键帧导航
- ◆ IAnimationTracks
 - ◆ FindTrack: 字符串名称 (如 "Capture View")

```
Private Function GetTrackFromAnimationFile() As IAnimationTrack

Dim animTracks As IAnimationTracks

animTracks = m_globe

Dim outAnimationTrack As IAnimationTrack

animTracks.FindTrack("Capture View", outAnimationTrack)

Return outAnimationTrack

End Function
```

Globe: 创建新的动画轨迹

- ◆ 创建AnimationTrack 一个新实例
- ◆ 设置 AnimationType 和名称
- ◆ 从ActiveViewer获取摄影机并把它放在AnimationTrack 上
- ◆ 加载动画轨迹到AnimationTracks

```
'Create an animation track
Dim outAnimationTrack As IAnimationTrack
Dim camera As ICamera
Dim animType As IAnimationType
Dim animTracks As IAnimationTracks
animTracks = m_globe
outAnimationTrack = New AnimationTrack
animType = New AnimationTypeGlobeCamera
outAnimationTrack.AnimationType = animType
outAnimationTrack.Name = "Capture View"
camera = m_globe.GlobeDisplay.ActiveViewer.Camera
outAnimationTrack.AttachObject(camera)
outAnimationTrack.ApplyToAllViewers = True
animTracks.AddTrack(outAnimationTrack)
```

Globe: 捕捉关键帧

- ◆ 关键帧即时记录了动画对象在一个特定位置的属性和行为
- ◆ IKeyFrame::CaptureProperties: 从一个对象拷贝属性 (如 GlobeCamera)

```
Public Shared Sub CaptureKeyFrame(ByVal pGlobe As IGlobe, ByVal
   pAnimTrack As IAnimationTrack)
   ' Get the GlobeCamera properties
   pCamera = pGlobe.GlobeDisplay.ActiveViewer.Camera
   pGlobeCamera = pCamera
   pGlobeCamera.OrientationMode =
   esriGlobeCameraOrientationMode.esriGlobeCameraOrientationLocal
   ' Create a New GlobeCamera Keyframe
   pKeyframe = New GlobeCameraKeyframe
   ' Assign GlobeCamera properties to Keyframe
   pKeyframe.CaptureProperties(pGlobe, pGlobeCamera)
   pKeyframe.Name = "Capture View" & pAnimTrack.KeyframeCount + 1
   ' Insert GlobeCamera Keyframe in Animation Track
   pAnimTrack.InsertKeyframe(pKeyframe, pAnimTrack.KeyframeCount + 1)
   pAnimTrack.EvenTimeStamps = True
   pAnimTrack.ResetTimeStamps()
End Sub
```

Globe: 用事件捕捉关键帧

- ◆ 你可以使用绘制事件来捕捉关键帧
- ◆ 最小化捕获的帧数
 - ◆ 监听每个IGIobeDisplay::AfterDraw 事件
 - ◆ 只有当globe处于非导航模式时捕捉

```
Private Sub m_pglbDisplay_AfterDraw(ByVal pViewer As ESRI.ArcGIS.Analyst3D.ISceneViewer)
    Handles m_pglbDisplay.AfterDraw
    If (chkStartStop.CheckState = CheckState.Checked) Then
    Dim globeDisplay As IGlobeDisplay
    globeDisplay = m_globe.GlobeDisplay
    If (Not globeDisplay.IsNavigating) Then
     ' Capture key frames after globe is done drawing
     Functions.CaptureKeyFrame(m_globe, m_animTrack)
     lstKeyFrames.Items.Add(m_animTrack.Keyframe(m_animTrack.KeyframeCount - 1).Name)
    End If
End Sub
```

Globe: 播放动画

- ◆ 应用轨迹到 3D 视图
- IAnimationTracks
 - ApplyTracks
- ◆ 传入共用时间和持续时间参数
 - ◆ 共用时间
 - ◆ 持续时间
- IViewers3D
 - RefreshViewers

esri3DAnalyst.IAnimationTracks O-

IAnimationTracks: IUnknown

- AnimationTypes: IArray
- TrackCount: Long
- Tracks: IArray
- TracksOfType (in pType: IAnimationType): IArray
- AddTrack (in pTrack: IAnimationTrack)
- ApplyTracks (in pViewer: ISceneViewer, in time: Double, in duration: Double)
- ChangePriority (in pTrack: IAnimationTrack, in bAbsolute: Boolean, in blnSameType: Boolean, in changeInIndex: Long)
- DetachObject (in pObject: IUnknown)
- FindTrack (in Name: String, out ppTrack; IAnimationTrack)
- LoadTracks (in pStm: IStream)
 RefreshAttachedObjects
- RemoveAllTracks
- RemoveTrack (in pTrack: IAnimationTrack)
- SaveTracks (in pStm: IStream)

```
st = DateTime.Now
Do
   et = DateTime.Now
   span = et.Subtract(st)
   elapsedTime = span.TotalSeconds
   If (elapsedTime > duration) Then
       elapsedTime = duration
   End If
   ptracks.ApplyTracks( Nothing, elapsedTime, duration)
   IpViewers3D.RefreshViewers()
Loop While elapsedTime < duration
```

Globe: 保存和加载动画文件

- ◆ 容易保存和加载动画
- ◆ IBasicScene
 - ◆ SaveAnimation: 保存当前动画轨迹
 - ◆ LoadAnimation: 加载动画轨迹

```
Public Shared Sub SaveAnimation(ByRef globe As IGlobe, ByVal AnimationFile As String)
   Dim basicScene As IBasicScene
   basicScene = globe
   basicScene.SaveAnimation(AnimationFile)
End Sub
Public Shared Sub LoadAnimation(ByRef globe As IGlobe, ByVal AnimationFile As String)
   Dim basicScene As IBasicScene
   basicScene = globe
   Try
       basicScene.LoadAnimation(AnimationFile)
   Catch ex As Exception
       'If file doesn't exist, create it for the user...
       basicScene.SaveAnimation(AnimationFile)
       basicScene.LoadAnimation(AnimationFile)
   End Try
End Sub
```

练习 4 概述

- ◆ 创建3D 控件应用程序
- ◆ 使用 3D 文档和数据源
- ◆ 控件成员的使用
- ◆ 在场景表面上添加栅格纹理
- ◆ 创建,播放,保存 Globe 动画

课4回顾

- ◆ SceneControl 和 GlobeControl之间的主要区别在哪里?
- ◆ 加载数据到3D控件中的三种方法是什么?
- ◆ 什么是 Globe 的三种不同类型的图层?
- ◆ 哪种类型的 Globe 图层可以设置偏移?
- ◆ 加载关键帧到动画轨迹的命名方法?
- ◆ 在Globe中捕捉和播放动画的步骤有哪些?