ESRI® ArcGIS® 3D Analyst™: Animation Customization

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ESRI ArcGIS 3D Analyst: Animation Customization

An ESRI Technical Paper

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ESRI ArcGIS 3D Analyst: Animation Customization

Document Overview

Animations are an effective way to illustrate complex ideas and concepts. The purpose of this document is to explain how to create simple and complex animations using ESRI® ArcObjects™ in ArcScene™ and ArcGlobe™. It discusses the basic functionality and architecture of the animation objects, the different types of animations supported, and the creation of custom animation types. Also, the document discusses how to control animations and export them to the supported file formats.

Basic Animation Concepts

ArcScene and ArcGlobe have the same underlying architecture for animation. Both these applications allow you to create, save, and share animations in a similar fashion.

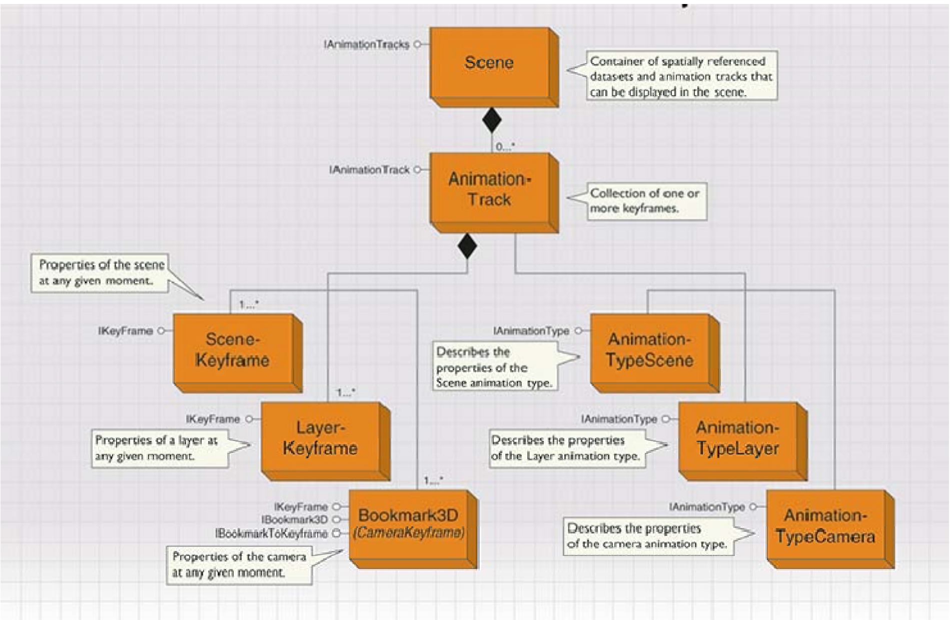
An animation is a description of the changes of a set of objects in time. In ArcScene, the object may be the Scene, Camera, or Layer, whereas in ArcGlobe, the objects can be the Globe Camera or Globe Layer.

To describe how an object changes, the animation framework uses *keyframes,* which are snapshots of the object's state at a certain time. From these keyframes, the state of the object at any given time can be calculated and interpolated between the keyframes. A collection of one or more keyframes of the same type constitutes an *animation track.* Each track is bound to one or more objects and describes their behavior over time. The *animation* is composed of one or more of these animation tracks executed simultaneously.

Customizing Animations in ArcScene

The animation functionality in ArcScene is implemented by a set of objects listed in Figure 1.

Figure 1
Animation Object Model for ArcScene


IAnimationTracks
Scene
Container of spatially referenced datasets and animation tracks that can be displayed in the scene.
0...*
IAnimationTrack
Animation-Track
Collection of one or more keyframes.
Properties of the scene at any given moment.
1...*
IKeyFrame
Scene-Keyframe
IAnimationType
Describes the properties of the Scene animation type.
Animation-TypeScene
1...*
IKeyFrame
Properties of a layer at any given moment.
Layer-Keyframe
IAnimationType
Describes the properties of the Layer animation type.
Animation-TypeLayer
1...*
IKeyFrame
IBookmark3D
IBookmarkToKeyframe
Bookmark3D
(CameraKeyframe)
Properties of the camera at any given moment.
IAnimationType
Describes the properties of the camera animation type.
Animation-TypeCamera

Each kind of object has different properties that can be animated. The AnimationType classes describe these properties for each specific type. The ArcGIS® 3D Analyst™ installation includes three out-of-the-box animation types in ArcScene: *Scene, Camera,* and *Layer.* Each animation type is associated to a different kind of keyframe, so there are three predefined keyframe classes that store configurations of each kind of animated object.

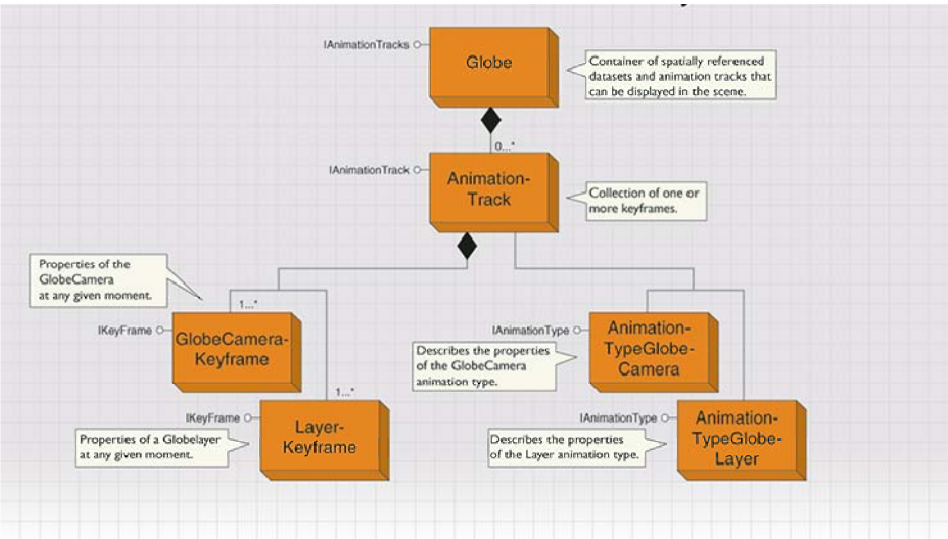
All these keyframe classes (*SceneKeyframe, LayerKeyframe,* and *Bookmark3D*) implement a common interface (*IKeyframe*) used to access and apply the stored properties. Notice that the *Bookmark3D* coclass can be used for managing bookmarks as well as creating camera keyframes. Three-dimensional bookmarks are saved camera perspectives. *Bookmark3D* provides the facility to convert a 3D bookmark to a camera keyframe using the *IBookmarkToKeyframe::ConvertToKeyframe* method.

Individual keyframes can be used to animate an object, but in most cases, you will prefer to create an *AnimationTrack,* which is a group of keyframes meant to control the same object. To take advantage of the ArcScene animation tools for working with multiple animation tracks, the tracks must be added to the Scene by using the *IAnimationTracks* interface.

Customizing Animations in ArcGlobe

As mentioned earlier, the animation functionality in ArcGlobe has a similar architecture to ArcScene and is described by the set of objects listed in Figure 2.

Figure 2
Animation Object Model for ArcGlobe


IAnimationTracks
Globe
Container of spatially referenced datasets and animation tracks that can be displayed in the scene.
0...*
IAnimationTrack
Animation-Track
Collection of one or more keyframes.
Properties of the GlobeCamera at any given moment.
1...*
IKeyFrame
GlobeCamera-Keyframe
1...*
IKeyFrame
Layer-Keyframe
Properties of a Globelayer at any given moment.
IAnimationType
Animation-TypeGlobe-Camera
Describes the properties of the GlobeCamera animation type.
IAnimationType
Animation-TypeGlobe-Layer
Describes the properties of the Layer animation type.

With ArcGIS 9, the 3D Analyst installation includes two out-of-the-box animation types in ArcGlobe: *GlobeCamera* and *GlobeLayer.* Each animation type is associated to a different kind of keyframe. In ArcGlobe, there are two predefined keyframe classes that store configurations of each kind of animated object.

These keyframe classes (*GlobeCameraKeyframe* and *GlobeLayerKeyframe*) implement a common interface (*IKeyframe*) used to access and apply the stored properties. Similar to ArcScene, individual keyframes can then be used to animate an object, which can be grouped to create an *AnimationTrack.* Animation tracks of the same or different type can then be added to the Globe (by using the *IAnimationTracks* interface) and run in parallel to create an animation.

Unlike ArcScene, there is no interface in ArcGlobe, which can be used to convert a bookmark to a camera keyframe. However, the developer sample—*Convert 3D bookmarks to GlobeCamera keyframes*—illustrates how to do the same. This developer sample can be found under the ArcGIS 3D Analyst developer samples available with the ESRI ArcGIS Developer Toolkit or on the Web at ArcGIS Developer Online.

Keyframes

Keyframes are snapshots of an object's properties at any given moment. The *IKeyframe* interface contains methods to set the values of the properties stored in the keyframe and applies them directly to the object. To set a property in the keyframe, you need to know the property index and type. The sorted list of property names for each animation type can be seen by selecting the Keyframes or Tracks tab of the Animation Manager dialog box and clicking the Properties button. For example, in a layer keyframe, the Rotation property has a property index equal to 4, and the property type is Point.

The names and types of each property can also be obtained programmatically; see the code below, using the *IAnimationType* interface corresponding to the *AnimationType* object.

```
Dim pAnimType As IAnimationType
Set pAnimType = New AnimationTypeGlobeCamera

Debug.Print "Count   " & "Name"
Dim counter As Integer
For counter = 0 To pAnimType.PropertyCount - 1
  Debug.Print counter & "       " & pAnimType.PropertyName(counter)
Next
```

For convenience, all property names and types used in ArcScene and ArcGlobe are listed in Appendix A of this document.

The code in *Sample 1a*, listed in Appendix B, creates a single layer keyframe and sets the value of the z rotation angle. This angle is part of the Rotation property supported in ArcScene, a Point-type property with index 4. The Point type contains three floating-point numbers, in this case corresponding to the rotation angles around the x,y, and z axes. The following code is used to set the z rotation value in a *LayerKeyframe* in ArcScene:

```
Dim pAngles As IPoint
Set pAngles = New Point
pAngles.X = 0
pAngles.Y = 0
pAngles.Z = angle
pKeyframe.PropertyValuePoint(4) = pAngles
```

Similarly, the code in *Sample 1b* creates a single *GlobeCamera* keyframe, which moves the observer around the globe by setting the value of the observer latitude, longitude, and altitude. As shown in the code below, to create this effect, the latitude and altitude are kept constant, whereas the longitude value is in increments ranging from 0 to 360 degrees.

```
pKeyframe.PropertyValueDouble(4) = 0              ' set latitude
pKeyframe.PropertyValueDouble(5) = plongitude   ' set longitude
pKeyframe.PropertyValueDouble(6) = 20000         ' set altitude
```

When a keyframe is created, all its properties are active by default. If you do not use some of them in the animation and you want to allow the user to change them interactively, you must explicitly list the active properties. In the code *Sample 1a*, only the Rotation property will be active in the keyframe.

```
Dim pProperties As ILongArray
Set pProperties = New LongArray
```

```
pProperties.Add (4)
pKeyframe.ActiveProperties = pProperties
```

In the code Sample 1b, the properties describing the location of the observer—latitude, longitude, and altitude—will be active in the keyframe.

```
Dim pProperties As ILongArray
Set pProperties = New LongArray
pProperties.Add (4)
pProperties.Add (5)
pProperties.Add (6)
pKeyframe.ActiveProperties = pProperties
```

For the *Camera* keyframe (the *Bookmark3D* object) in ArcScene, there is an internal limitation on the properties that can be active. When the projection mode is Orthographic, all the properties but the ortho extent and the projection mode itself will be inactive. In the Perspective projection mode, the orthographic extent property will be inactive. For this reason, it is *important* to remember that the projection mode must be set before you assign the list of active properties for *Camera* keyframe in ArcScene.

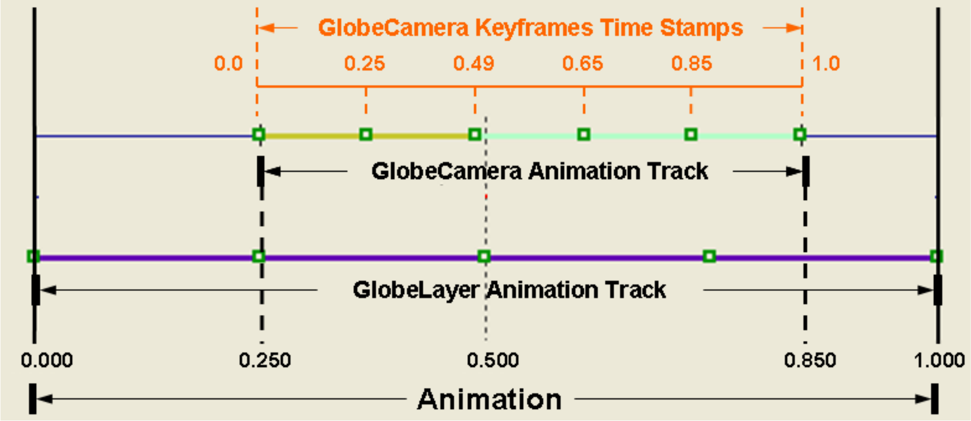
In ArcGlobe, the *GlobeCameraKeyframe* has two modes of navigation, the global navigation mode and the surface navigation mode. Both these navigation modes have the same *Globe Camera* properties. For the surface navigation mode, the target, where the observer is looking toward, is on the surface of the globe, whereas in global navigation mode, the target is at the center of the earth.

Time Scale Properties of an Animation

As you can see in the Animation Manager, the time scale of the animation is normalized to a 0–1 range (see Figure 3), in which 0 means the beginning of the animation and 1 the end of the animation. Individual animation tracks have begin and end times inside this range. For example, the animation described in Figure 3 has a Globe Camera track that spans 0.25 to 0.85. Also, this animation has a Globe Layer track, which spans the entire animation from 0 to 1. This means that the Globe Layer track will start at the beginning of the animation and end at the end of the animation, whereas the Globe Camera track will begin when 25 percent of the animation is completed and end when 85 percent of the animation is done. So if the actual duration of the animation is 100 seconds, the Globe Layer track will run the entire time, but the Globe Camera track will start after 25 seconds and end after 60 seconds, when 85 seconds of the animation have elapsed.

On the other hand, bound keyframes have time stamps relative to the respective tracks to which they belong. The keyframe time stamps can have a value between 0 (meaning the beginning of the track) and 1 (the end of the track). In the animation described in Figure 3, the Globe Camera track has six Globe Camera keyframes with time stamps between 0 and 1.

Figure 3
Time Scale Properties of an Animation


GlobeCamera Keyframes Time Stamps
0.0
0.25
0.49
0.65
0.85
1.0
GlobeCamera Animation Track
GlobeLayer Animation Track
0.000
0.250
0.500
0.850
1.000
Animation

Keyframe Time Stamps

As mentioned earlier, keyframes represent the state of an object at a given moment in an animation. Keyframes can be used to interpolate the state of the object along time, even if they are not bound to an animation track. In this case, keyframe time stamps define the interval at which it is correct to call the *IKeyframe::Interpolate* method. For example, in the code Sample 2a and Sample 2b, two keyframes are utilized to create an interpolated rotation using *LayerKeyframe* and *CameraKeyframe* in ArcScene and the *GlobeCameraKeyframe* in ArcGlobe, respectively. If the first keyframe has a time stamp 0.0 and the second has 1.0, you can call the *Interpolate* method on the first keyframe and pass the second keyframe as an argument of the *Interpolate* method with a time value between 0.0 and 1.0.

When you add the keyframes to an animation track, their time stamps must be between the 0.0 and 1.0 values that represent, respectively, the beginning and the end of the track. Notice that the keyframe time stamps do not refer to the total span of the animation but to the interval occupied by the track. The keyframe time stamps do not change when the begin/end times of the track are modified.

Note: In this second case, the time stamps must be assigned after adding the keyframes to the track. If the time value is set before, it will be overwritten by the automatic time stamp assignation performed by the track object (see below).

Using Unbound Keyframes to Control Objects

You can use a single keyframe to set the state of an object with the *IKeyframe::Apply* method. Usually this does not make much sense, since you can set the state of the object directly by using its own interfaces. However, this technique is useful when creating ArcScene animations that include the positional transformation of layers. For details about how layer transformation works, see the technical paper Advanced Animation in ArcScene.

Note: The transformation properties for layers (translation, rotation, etc.) are currently accessible only through the *LayerKeyframe* object in ArcScene. An easy way to move a layer around is to create a *LayerKeyframe,* set the transformation properties, and apply the keyframe to the layer. This functionality is currently unavailable in ArcGlobe.

The code in *Sample 1a* uses this technique to make a layer rotate 360 degrees in ArcScene. The animation is created by a simple loop that changes the value of the rotation angle, calls the apply method to transform the layer, and refreshes the viewers.

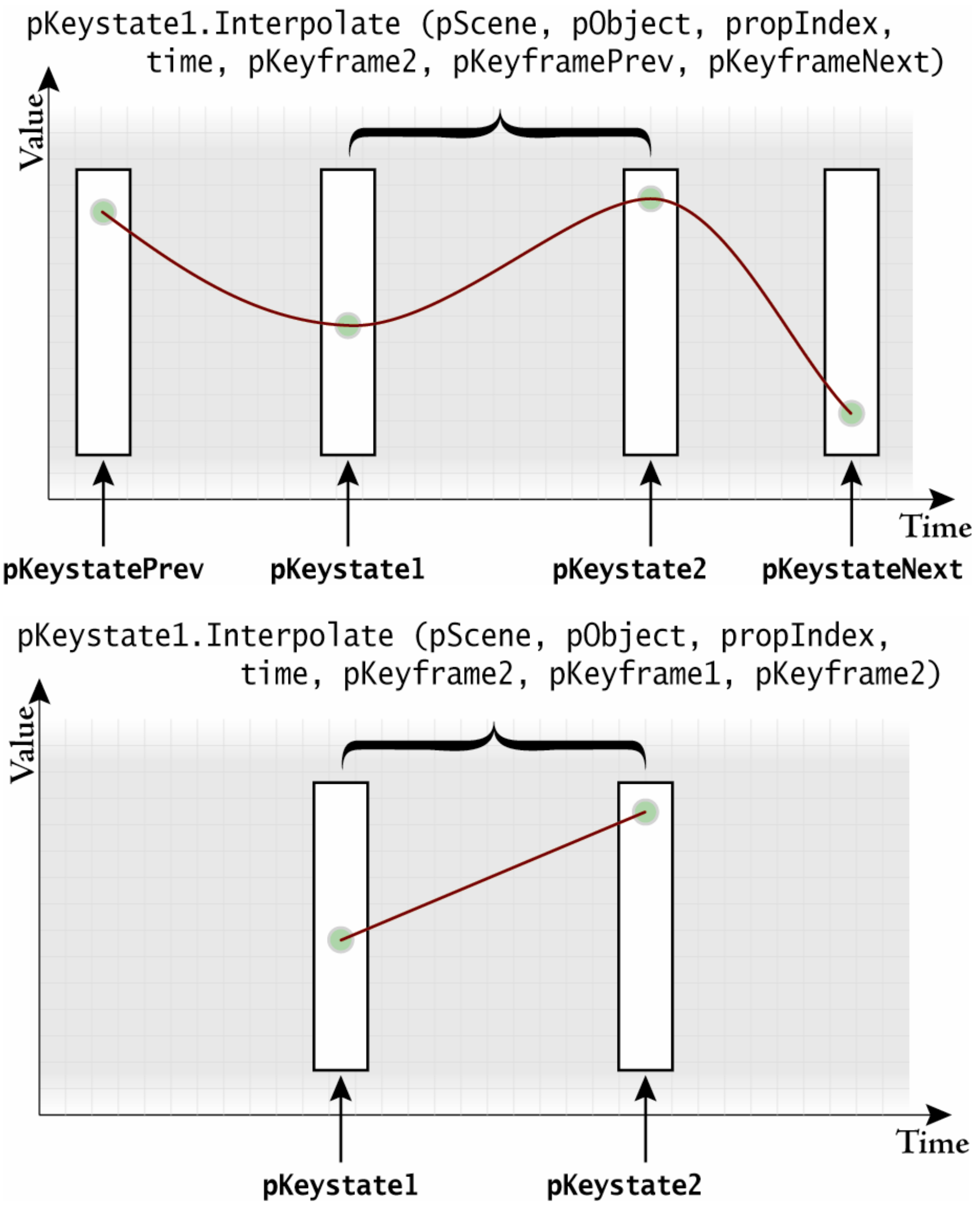
```
 Dim angle As Integer
For angle = 0 To 360
  Dim pAngles As IPoint
  Set pAngles = New Point
  pAngles.X = 0
  pAngles.Y = 0
  pAngles.Z = angle
  pKeyframe.PropertyValuePoint(4) = pAngles ' set rotation
  pKeyframe.Apply pScene, pLayer           ' apply it
  pSceneGraph.RefreshViewers
Next angle
```

Angle Interpolation in Layer Keyframes in ArcScene

The precise behavior of the interpolation might be different for each animation type, since it is implemented internally in each keyframe. In the case of layer keyframes, when moving from one rotation angle to another, the interpolation will always follow the shortest path. This is very convenient for creating smooth movements. Unfortunately, it means that you cannot make a full, 360-degree turn by adding one keyframe with angle 0 and another with angle 360 because the shortest path between them is followed by staying at angle 0. In this case, you would need at least four keyframes, for example, at 0, 120, 240, and 360 degrees. Figure 4 describes the interpolation with four keyframes and a simpler case with two keyframes.

A similar problem occurs with 180-degree turns. When angles are separated 180 degrees, there are two possible ways to rotate (clockwise and counterclockwise), and both are equal in length. If you want to make sure that the object rotates in the direction you want, you should add a third intermediate keyframe.

Figure 4
General Case of Interpolation With Four Keyframes and Simple Case With Only Two Keyframes



```
pKeystate1.Interpolate (pScene, pObject, propIndex,
     time, pKeyframe2, pKeyframePrev, pKeyframeNext)
```

```
pKeystate1.Interpolate (pScene, pObject, propIndex,
          time, pKeyframe2, pKeyframe1, pKeyframe2)
```

Animation Tracks

Animation tracks are containers for one or more similar keyframes. The previous examples used two keyframes that were not inserted in an animation track. In a typical animation, you may need many keyframes and properties. The script code to create the corresponding interpolations could become very complex. It is a good practice to add keyframes (with their proper values and time stamps) to an animation track and use the

IAnimationTrack interface to perform the interpolation for creating dynamic visual effects.

The code in Sample 3a in Appendix B shows a simple use of this technique to create a 360-degree rotation of a layer in ArcScene. First, an animation track with the proper animation type is created, then a number of keyframes are added with their rotation values and time stamps.

```
Dim pKeyframe As IKeyframe
Dim nKeyframes As Integer
nKeyframes = 4
Dim iKeyframe As Integer
For iKeyframe = 0 To nKeyframes - 1
  Set pKeyframe = New LayerKeyframe
  pAnimTrack.InsertKeyframe pKeyframe, -1 ' insert last
  pKeyframe.TimeStamp = 1# * (iKeyframe / (nKeyframes - 1))
  ' set rotation values
  Dim pAngles As IPoint
  Set pAngles = New Point
  pAngles.X = 0
  pAngles.Y = 0
  pAngles.Z = 360# * (iKeyframe / (nKeyframes - 1))
  pKeyframe.PropertyValuePoint(4) = pAngles
Next iKeyframe
```

The active properties for the track can be set optionally, but it is very important that the track be attached to the object or objects that are being animated. For example, in Sample 3a, the layer animation track is attached to the layer object, which is being animated.

```
pAnimationTrack.AttachObject pLayer
```

For creating the animation, the animation loop below uses the *IAnimationType:: ResetObject* to reset the state of the attached layer object. The *IAnimationTrack:: InterpolateObjectProperties* is then used to interpolate the state of the attached layer.

```
Dim time As Double
Dim iteration As Integer
For iteration = 0 To 100
  time = iteration / 100#
  ' reset
  pAnimationType.ResetObject pScene, pLayer
  ' interpolate by using track
  pAnimationTrack.InterpolateObjectProperties pScene, time
  pSceneGraph.RefreshViewers
Next iteration
```

The key of this loop is the call to the *InterpolateObjectProperties* method of the track. This method finds the appropriate keyframes and active properties to interpolate for all the objects attached to the track. Notice that the call to *ResetObject* is still necessary, but the call to *RefreshObject* is internally performed by the track.

The default time stamp assigned to a keyframe when it is inserted in an animation track depends on the value of the *IAnimationTrack::EvenTimeStamps* Boolean property. When this flag is true, the time stamps of the keyframes are automatically redistributed in equally spaced intervals between 0.0 and 1.0. When the flag is false, the default time stamp is 1.0.

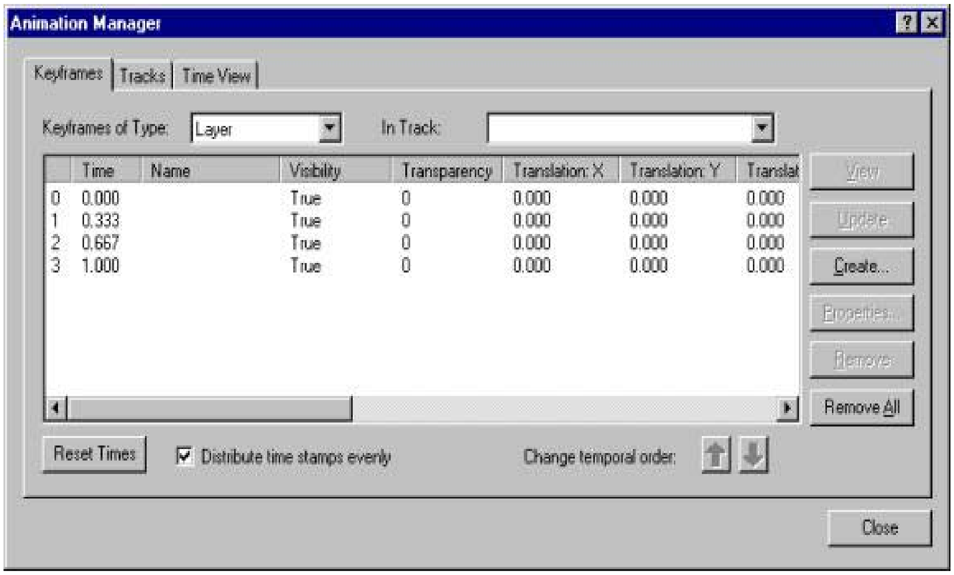
You can have full control of the time stamps assigned to the keyframes by disabling the *EvenTimeStamps* flags and setting the time value after the keyframe is added to the track. If this option is chosen, make sure that the order of the keyframes corresponds to increasing time values. Otherwise, the interpolation results will not be well defined.

Using the Scene or Globe as Container of the Animation Tracks

The previous samples used animation tracks that are not connected to the scene. As a consequence, these tracks are not visible in the Animation Manager dialog box and cannot be played, exported to video, or persisted in the document. To add the animation tracks to the Animation Manager, the animation track has to be added to the scene or globe. The following code can be used for this purpose:

```
 ' add the track to the scene
 Dim pSceneTracks As IAnimationTracks
 Set pSceneTracks = pScene
 pSceneTracks.AddTrack pAnimationTrack
' send event to inform
 Dim pActiveView As IActiveView
 Set pActiveView = pScene
 pActiveView.ContentsChanged
```

Figure 5
Keyframes Property Page in the Animation Manager Dialog Box



Keyframes of Type: Layer

In Track:

	Time	Name	Visibility	Transparency	Translation: X	Translation: Y	Translat
0	0.000		True	0	0.000	0.000	0.000
1	0.333		True	0	0.000	0.000	0.000
2	0.667		True	0	0.000	0.000	0.000
3	1.000		True	0	0.000	0.000	0.000

☑ Distribute time stamps evenly

Figure 5 above shows how the Keyframes page of the Animation Manager dialog box will look after running the code in Sample 3a and adding the track to the scene. Note the four keyframes with their time stamps. Scrolling to the right, you would be able to see the four different rotation z-values (0, 120, 240, 360).

In addition, when you add multiple animation tracks to the scene, you can make an animation loop without calling each track to interpolate the attached objects. In this loop, *ISceneTracks::ApplyTracks* will effectively perform all the object changes described in the tracks. This method accepts two time arguments: the total duration of the animation and the elapsed time for which you want to interpolate. It is the responsibility of the caller to calculate in some way the elapsed time. A simple option is to use a counter that increases in the loop between the initial and ending time values.

Sample 4a and Sample 4b show how to calculate the real elapsed time using the Timer object in Visual Basic and how it can be used to play the animation currently defined in the scene or globe with a desired duration.

```
Dim duration As Double
duration = 10
Dim startTime As Single
startTime = Timer
Do
  Dim elapsedTime As Single
  elapsedTime = Timer - startTime
  If (elapsedTime > duration) Then elapsedTime = duration
  pSceneTracks.ApplyTracks pSceneGraph.ActiveViewer, elapsedTime, duration
  pSceneGraph.ActiveViewer.Redraw True
Loop While elapsedTime < duration
```

This can be used to create custom play controls and custom video export tools. It is important to notice the role of the first argument (a reference to a scene viewer) in the call to *ApplyTracks.* If you pass a specific viewer to *ApplyTracks* and redraw it, as shown in the example, only that viewer will be animated. But if you want to animate multiple viewers simultaneously (you must first set up the appropriate track bindings), pass *Nothing* (a null pointer) as the first argument in *ApplyTracks,* and refresh all the viewers involved. For a discussion about binding tracks to multiple objects, see the *Advanced Animation in ArcScene* technical paper available on the ArcGIS Desktop Technical Papers page at the ESRI Online Support Center Web site.

The Animation Environment

The *SxAnimationEnvironment* is a global object that stores the animation state and playing options such as playing intervals, animation duration, and so forth. These animation properties are set by the 3D Analyst animation controls and are persisted with the document or the 3D animation files (*.asa and *.aga). When a 3D document or animation file is loaded, the *SxAnimationEnvironment* properties are set from the persisted values. This object also stores the animation type, current selection of tracks, and keyframes, which are set through the Animation Manager.

In ArcGIS 9, the *SxAnimationEnvironment* coclass resides in the ESRI 3DAnalyst library and is available in ArcGIS Desktop and ArcGIS Engine. This coclass inherits from *ISxAnimationEnvironment2,* which has properties such as *PlayInAllViewers* and *PlayMode PlayTime.* This facilitates the availability of these properties and methods in both the 3D desktop applications (ArcScene and ArcGlobe) and the ArcGIS Engine controls (SceneControl and GlobeControl).

Reading the Animation Environment

The *SxAnimationEnvironment* can be used to read the animation properties, which are reflected in the Animation Controls and Animation Manager dialog boxes. The code in *Sample 5a* and *Sample 5b* illustrates how to load an existing 3D animation file, which is discussed later in detail in the Saving and Sharing 3D Animations section. The sample code illustrates how simple animation properties stored in the 3D animation file can be read from the animation environment using the *SxAnimationEnvironment* object.

In this code, the ISxAnimationEnvironment2::AnimationDuration is used to obtain the duration of the animation.

```
Dim pSxAnimEnviron As ISxAnimationEnvironment2
Set pSxAnimEnviron = New SxAnimationEnvironment
Dim duration as Double
duration = pSxAnimEnviron.AnimationDuration
```

Animations can be played within a specified interval. This time interval can be obtained using the *GetPlayInterval* method, which returns begin and end times of the animation. This information can be useful in creating your own animation loop, which runs the animation within a specified time interval (see code below from *Sample 5a* and *Sample 5b*).

```
' Get the beginTime and endTime of the play interval
  Dim pBeginTime As Double
  Dim pEndTime As Double
  pSxAnimEnviron.GetPlayInterval sBeginTime, sEndTime

' Animation loop based on the Play Interval
  Dim startTime As Single
  startTime = Timer

  Dim duration As Double
  duration = pSxAnimEnviron.AnimationDuration

  Do
    Dim elapsedTime As Single
    elapsedTime = Timer - startTime + pBeginTime
    If (elapsedTime > duration) Then
      elapsedTime = duration
    End If
    If elapsedTime >= pBeginTime And elapsedTime <= pEndTime Then
      pAnimTracks.ApplyTracks pGlobeDisplay.ActiveViewer, elapsedTime, duration
      pSxAnimEnviron.State = esriAnimationPlaying
      pGlobeDisplay.RefreshViewers
    ElseIf elapsedTime > pEndTime Then
      Exit Do
    End If
  Loop While elapsedTime < duration
```

Setting the Animation Environment

The *SxAnimationEnvironment* allows you to control animation properties such as the animation duration, play interval, playing mode and so forth, which are reflected in the Animation Controls dialog box. As described earlier, these properties are persisted with the document or the exported animation file.

The animation play interval can be set using the *ISxAnimationenvironment2:: PutPlayInterval* (see code in *Sample 6a* and *Sample 6b*). To play the animation within a defined play interval, it is important to set the Boolean property *ISxAnimationenvironment2::IsIntervalPlay* to *True.*

```
' Specify the time interval for which the animation will be played
  pSxAnimEnviron.PutPlayInterval 3, 8

' Check the state of the "Play between intervals" option.
' If IsIntervalPlay = False, set it to True so that the
' animation can be played between the set time interval.
  Dim boolPlayBetweenIntervals As Boolean
  boolPlayBetweenIntervals = pSxAnimEnviron.IsIntervalPlay
  If boolPlayBetweenIntervals = False Then
    pSxAnimEnviron.IsIntervalPlay = True
  End If
```

Animations can be played simultaneously in all viewers. However, sometimes it may be useful to display the data in one viewer and run the animation in another. To do so, the *ISxAnimationEnvironment2::PlayInAllViewers* property should be set to *False.*

```
  pSxAnimEnviron.PlayInAllViewers = False
```

Also, the animation can be set to be played once or loop forward or reverse, depending on which *PlayMode* is set.

```
  pSxAnimEnviron.PlayMode = esriAnimationPlayLoopForward
```

These properties in *SxAnimationEnvironment* are useful when creating your own custom animation controls and video export tools.

Synchronizing Other Tasks With Animations

The *SxAnimationEnvironment* object can also be used to perform other events or tasks parallel to an animation. For example, moving custom 3D objects can be drawn independently while an animation is still being played. The *ISceneGraphEvents::Before Draw* and *ISceneGraphEvents::AfterDraw* methods can be used to draw these custom objects, depending on the animation state (obtained from *ISxAnimationEnvironment2:: State*) and current animation playtime (obtained from *ISxAnimationEnvironment2:: PlayTime*).

The *PlayTime* value changes as the animation is being played. The online developer sample—Group Animation Value Tracker—shows how to display dynamic information based on the animation state and playtime while an animation is being played. This developer sample can be found under the 3D Analyst developer samples available with ESRI's ArcGIS Developer Toolkit or on the Web at ArcGIS Developer Online.

Saving and Sharing 3D Animations

Animations created in ArcScene or ArcGlobe are stored in the document when it is saved. The animation tracks and animation environment can also be saved into an ArcScene animation (*.asa) or an ArcGlobe animation (*.aga) file using *IBasicScene::Save Animation.* These animation files can be reused or loaded within the same 3D document or another 3D document using *IBasicScene::LoadAnimation.*

Note: Prior to ArcGIS 9, the *SaveAnimation* and *LoadAnimation* methods resided in the ISxDocument interface. In ArcGIS 9, these have been moved to a new interface named *IBasicScene* to facilitate their use with both ArcGIS Desktop and ArcGIS Engine.

The code in *Sample 6a* and *Sample 6b* describes how to export the animation to an ArcScene or ArcGlobe animation file.

```
  Dim pBasicScene As IBasicScene
  Set pBasicScene = pScene            ' Get the current scene

' For exporting an *.aga file (ArcGlobe Animation file), use
  pBasicScene.SaveAnimation "c:\tempAGAanim.aga"
```

This animation can be loaded into the same or different ArcGlobe or ArcScene document (see note below) using *IBasicScene::LoadAnimation* and can be played using either the Animation Controls dialog box or programmatically as described in *Sample 5a* and *Sample 5b*.

```
pBasicScene.LoadAnimation "c:\animFile.asa"
```

Also, the developer sample GlobeControl Animation illustrates how a previously saved ArcGlobe animation file can be loaded into the *GlobeViewer* control. This developer sample can be found under the ArcGIS 3D Analyst developer samples available with ESRI's ArcGIS Developer Toolkit or on the Web at ArcGIS Developer Online.

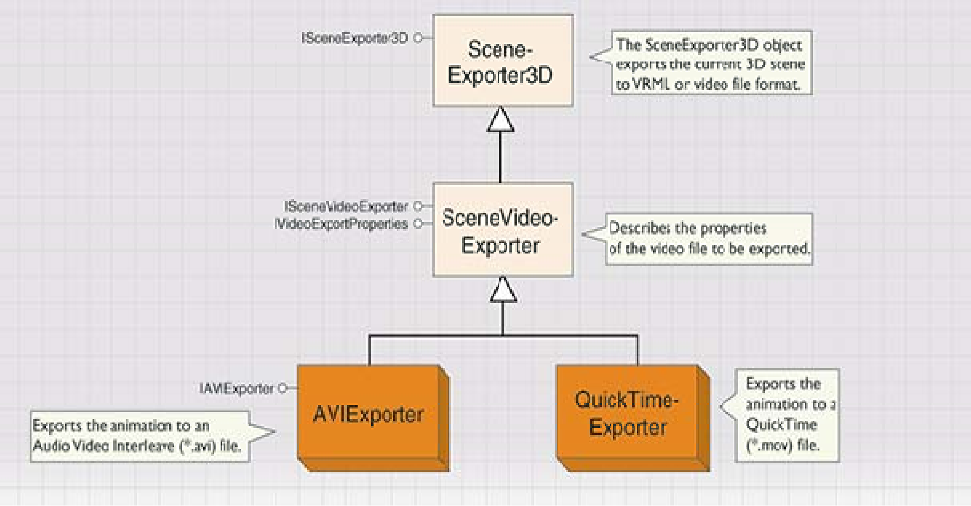
Note: When loading a 3D animation file in another 3D session, the animation track tries to bind itself to the object to which it was bound when the 3D animation file was saved, specified by an index (e.g., Layer 0, 1). If this object is not found, the track will not play correctly.

For example, if the animation file contains a track that is bound to a certain layer in a document, that layer must be present and should be in the correct location in the table of contents (TOC). Because a layer track refers to a layer by its rank or index in the TOC, the track may animate an incorrect layer or may not be enabled to play. Also, if a track is bound to a viewer that is not open in the new document, that track will not play. It must also be noted that geographic coordinates of a moving camera define camera animations. If you have created a camera track in a document's extent and want to play it in a new document, the camera track will still play along the original coordinates. Therefore, you may not see anything if the document has data with a different extent.

Exporting Animations to Video Files

Animations in ArcScene and ArcGlobe can also be saved as Audio Video Interleave (*.avi) or QuickTime™ (*.mov) files. *Note* that to be able to export QuickTime videos, QuickTime should be installed on your computer. Figure 6 below describes the objects involved in exporting animations to video files.

Figure 6
Animation Exporting Objects



The SceneExporter3D object exports the current 3D scene to VRML or video file format.

Describes the properties of the video file to be exported.

Exports the animation to an Audio Video Interleave (*.avi) file.

Exports the animation to a QuickTime (*.mov) file.

The *AVIExporter* and *QuickTimeExporter* objects are used to export animation to AVI and QuickTime files, respectively. As described in *Sample 7a* and *Sample 7b*, the SceneExporter3D object creates a new instance of a QuickTime movie export.

```
 Dim pSceneExporter3D As ISceneExporter3d
  Set pSceneExporter3D = New QuickTimeExporter
```

The SceneVideoExporter must be assigned the active viewer where the animation tracks will be played.

```
  Dim pExporter As ISceneVideoExporter
  Set pExporter = pSceneExporter3D
  Set pExporter.Viewer = pGlobe.GlobeDisplay.ActiveViewer
```

Other video properties for AVI and QuickTime movie file exports, such as the codec type, the data frame rate, and so forth, can be changed using the members of *IVideoExporterProperties* as described in code *Sample 7a* and *Sample 7b*.

```
  Dim pVideoExporterProps As IVideoExporterProperties
  Set pVideoExporterProps = pSceneExporter3D
  pVideoExporterProps.Quality = 90
```

If not set explicitly in the code, the default codec is used when exporting AVI or QuickTime animation files. For more information on codecs, see the help provided for *IVideoExporterProperties* interface.

The duration of an animation can be set using *ISxAnimationenvironment2:: AnimatonDuraition,* as illustrated in the code below.

```
Dim SxAnimationEnviron As ISxAnimationEnvironment2
Set SxAnimationEnviron = New SxAnimationEnvironment
SxAnimationEnviron.AnimationDuration = 10     ' in seconds
```

The final animation export is done by passing in the reference to the Scene or Globe, which contains the animation tracks, to the ISceneExporter3D::ExportScene method as shown in code below.

```
pSceneExporter3D.ExportScene pGlobe
```

For creating custom size (width and height) videos, which can be used for display on larger screens or hign-definition displays, the size of the viewer can be changed, as described in the *Export Custom Size Animation* developer sample. The size of the output video is calculated depending on the display settings of the graphics card. If the user-specified width and height are greater than the display size, the viewer is refreshed, keeping the user-defined aspect ratio intact.

A sequence of images can also be exported at regular intervals while running an animation. This is illustrated in the developer sample *Dump images from animation*. The images can be combined to create an animation using third party software. This developer sample can be found under the 3D Analyst developer samples available with ESRI's ArcGIS Developer Toolkit or on the Web at ArcGIS Developer Online.

Defining Custom Animation Types

The out-of-the-box animation types use properties of different 3D Analyst objects that can be modified easily. Other properties of these objects (e.g., the base height or the symbology of a layer) have not been included because it would take some time to re-create the display after each change and the animation could not be played with an acceptable frame rate. However, even expensive changes can be successfully used to generate video files because their playing speed does not depend on how fast the video was created in the first place.

These remarks suggest that you might be interested in defining custom animation types that control properties or objects other than the ones predefined in the 3D Animation Types. In addition, it is also possible to define animation types that control objects defined externally to ArcScene or ArcGlobe including common object model (COM) objects that you have implemented.

To create a custom animation type, you have to implement both a *Keyframe* and an *AnimationType* class and register the *AnimationType* class in the appropriate component category. After doing this, the animation commands and tools in ArcScene or ArcGlobe will recognize the new type, and you will be able to create keyframes and tracks of the custom type, edit their properties in the Animation Manager, persist, play, and export to video the resulting animation. Optionally, you can also develop specific tools to work with your custom animation type.

Suppose, for example, you have developed a COM class *Radar* that implements the interface *IRadar,* and you want to define a custom animation that controls three properties of this object, the type of radar, its azimuth angle, and its color. The sections below focus on the implementation of the animation objects.

Animation Type Implementation

The main role of the *AnimationType* component is to offer information about the specific properties of each animation type and allow clients to identify the objects that can be animated.

First, you need to specify the type of objects that can be animated with your custom type (the *Radar* object). This can be done by implementing the *AppliesToObject* method.

```
Private Property Get IAnimationType_AppliesToObject(ByVal pObject As Variant) As
Boolean
  ' check that pObject is of type Radar
  IAnimationType_AppliesToObject = (TypeOf pObject Is IRadar)
End Property
```

It may also be desirable to find all the objects of the right type that are available to be animated. In this example, you can assume that you have a global pRadars array (of type Array) where the Radar objects are stored, so you just need to return the array.

```
Private Property Get IAnimationType_ObjectArray(ByVal pScene As IScene) As
IArray
  ' return array with Radar objects
  Set IAnimationType_ObjectArray = pRadars
End Property
```

Each animated object must have a unique ID assigned. This is required to persist the animation. Usually this ID is the index of the object in an array or list, but it can be any long integer that defines a unique object of its type. The value –1 is an invalid ID. First, you need to implement a method that returns the ID for a given object (passed as a Variant with an *Unknown* pointer type). In this case, it simply means finding the index of that *Radar* in your global array.

```
Private Property Get IAnimationType_AnimationObjectID(ByVal pScene As IScene,
ByVal pObject As Variant) As Long
  ' return index of Radar(index)=pObject
  Dim pRadarObj As IRadar
  Set pRadarObj = pObject
  Dim pRadar As IRadar
  Dim lIndex As Long
  For lIndex = 0 To (pRadars.Count - 1)
    Set pRadar = pRadars.Element(lIndex)
    If pRadar Is pRadarObj Then
      IAnimationType_AnimationObjectID = lIndex
      Exit Property
    End If
  Next lIndex
  IAnimationType_AnimationObjectID = -1
End Property
```

A method that returns the animated object when given its ID also needs to be implemented. In this case, use the ID as an index in the global *Radar* array.

```
Private Property Get IAnimationType_AnimationObjectByID(ByVal pScene As
IScene, ByVal objectID As Long) As Variant
  ' return Radar(objectID)
  Set IAnimationType_AnimationObjectByID = pRadars.Element(objectID)
End Property
```

You may also want to display the names of the objects available for animation in ArcScene and ArcGlobe (for instance, one can be chosen from a drop-down list).

```
Private Property Get IAnimationType_AnimationObjectName(ByVal pScene As
IScene, ByVal pObject As Variant) As String
  ' return string for Radar equal to pObject
  Dim pRadar As IRadar
  Set pRadar = pObject
  IAnimationType_AnimationObjectName = pRadar.Name
  Exit Property
End Property
```

Other important information that is required is the object properties, which would be controlled by the custom animation type. In this example, you will assume three properties: the *azimuth angle,* the *color,* and the *property type.*

```
Private Property Get IAnimationType_PropertyCount() As Long
  IAnimationType_PropertyCount = 3
End Property

Private Property Get IAnimationType_PropertyName(ByVal Index As Long) As String
  Select Case Index
    Case 0
      IAnimationType_PropertyName = "Azimuth"
    Case 1
      IAnimationType_PropertyName = "Color"
    Case 2
      IAnimationType_PropertyName = "Type"
    Case Else
      IAnimationType_PropertyName = "unknown"
  End Select
End Property
```

To use the methods of the *Keyframe* object to read and write property values, the type of each property should be known. In your example, the azimuth is a *double* and the color is an *RGB color.*

```
Private Property Get IAnimationType_PropertyType(ByVal Index As Long) As
esriAnimationPropertyType
  Select Case Index
    Case 0
      IAnimationType_PropertyType = esriAnimationPropertyDouble
    Case 1
      IAnimationType_PropertyType = esriAnimationPropertyRGBColor
    Case 2
      IAnimationType_PropertyType = esriAnimationPropertyInt
  End Select
End Property
```

Long and *integer* properties can be used to represent enumerations. For instance, in the *Camera* animation type, the Projection Mode property is an enumeration with two values (see Appendix A). In your example, the Type property is also an enumeration with two values: Type A and Type B. You need to specify each of those values as an integer, for example, 1 = Type A, 2 = Type B.

```
Private Property Get IAnimationType_IsEnumProperty(ByVal Index As Long) As
Boolean
  ' only the "Type" property is enumerated
  If (Index = 2) Then
    IAnimationType_IsEnumProperty = True
  Else
    IAnimationType_IsEnumProperty = False
  End If
End Property
```

The maximum and minimum values allowed for the enumerated properties should also be specified. A symbolic name should also be provided to each of those valid values.

```
Private Property Get IAnimationType_EnumPropertyMaxValue(ByVal Index As
Long) As Long
  If (Index = 2) Then IAnimationType_EnumPropertyMaxValue = 2
  Else               IAnimationType_EnumPropertyMaxValue = -1
  End If
End Property
Private Property Get IAnimationType_EnumPropertyMinValue(ByVal Index As Long)
As Long
  If (Index = 2) Then
    IAnimationType_EnumPropertyMinValue = 1
  Else
    IAnimationType_EnumPropertyMinValue = -1
  End If
End Property
Private Property Get IAnimationType_EnumPropertyValueName(ByVal Index As
Long, ByVal value As Long) As String
  If (Index = 2) Then
  Select Case value
    Case 1
      IAnimationType_EnumPropertyValueName = "Type A"
    Case 2
      IAnimationType_EnumPropertyValueName = "Type B"
    Case Else
      IAnimationType_EnumPropertyValueName = "Type unknown"
  End Select
  End If
End Property
```

The final role of the animation type class is the identification of the COM components. To identify the animation type to the user, the animation type should be provided with a unique name.

```
Private Property Get IAnimationType_Name() As String
  IAnimationType_Name = "Radar"
End Property
```

ArcScene or ArcGlobe applications also need to be informed about the class ID of the animation type and its associated keyframe object so they can instantiate and compare classes. In Visual Basic, the class IDs are assigned when the dynamic link library (DLL) file is built, and they can be inspected using the OLE View tool. The *UIDs* must then be defined as constants in the code and returned in the proper methods.

```
Const clsidRadarAnimType = "{63BD4248-E644-4B4D-B44D-D1D69BB45243}"
Const clsidRadarKeyframe = "{A21A11E7-0C32-47FA-B960-41238EF3CC6F}"

Private Property Get IAnimationType_CLSID() As IUID
  Dim objid As New UID
  objid = clsidRadarAnimType
  Set IAnimationType_CLSID = objid
End Property

Private Property Get IAnimationType_KeyframeCLSID() As IUID
  Dim objid As New UID
  objid = clsidRadarKeyframe
  Set IAnimationType_KeyframeCLSID = objid
End Property
```

Keyframe Implementation

The other key component required to develop a custom animation type is the implementation of a *Keyframe* class that connects to the object to be animated (*Radar* in this case). In this class, you need to declare a number of private members that store information about the object properties.

```
Private sName As String' name of keyframe
Private Const lPropertyCount As Long = 3
Private bIsActive(lPropertyCount) As Boolean
Private dTimeStamp As Double
Private bObjectNeedsRefresh As Boolean
Private dAzimuth As Double   ' property values
Private pColor As IRgbColor   ' property values
Private iType As Integer         ' property values
```

The class initialization includes assigning a predefined keyframe name and initializing all the properties as active.

```
Private Sub Class_Initialize()
  sName = "Radar Keyframe"
  bObjectNeedsRefresh = False
  Dim lProp As Long
  For lProp = 0 To (lPropertyCount - 1)
    bIsActive(lProp) = True
  Next lProp
End Sub
```

The methods for reading and writing the name and time stamp are trivial. More interesting are the methods that read and write the active properties.

```
Private Property Let IKeyframe_ActiveProperties(ByVal arrayIndices As ILongArray)
   If (Not arrayIndices Is Nothing) Then
    Dim lProp As Long
    For lProp = 0 To (lPropertyCount - 1)
      bIsActive(lProp) = False
    Next lProp
    Dim lElements As Long
    lElements = arrayIndices.Count
    For lProp = 0 To (lElements - 1)
      Dim lProperty As Long
      lProperty = arrayIndices.Element(lProp)
      If (lProperty >= 0 And lProperty < lPropertyCount) Then
        bIsActive(lProperty) = True
      End If
    Next lProp
  End If
End Property

Private Property Get IKeyframe_ActiveProperties() As ILongArray
  Dim pArray As ILongArray
  Set pArray = New LongArray
  Dim lProp As Long
  For lProp = 0 To (lPropertyCount - 1)
    If (bIsActive(lProp)) Then pArray.Add lProp
  Next lProp
  Set IKeyframe_ActiveProperties = pArray
End Property
```

The methods for the *"IsActiveProperty"* property only read or write the Boolean value in the *bIsActive* vector of the class. A read-only property of the keyframe is its animation type. In this method, a reference to the custom AnimationType object is returned. In the code below, a new instance in each call is being returned. But the same instance can also be returned if it is defined as a global variable.

```
Private Property Get IKeyframe_AnimationType() As IAnimationType
  Set IKeyframe_AnimationType = New RadarAnimationType
End Property
```

The next step is to implement the read and write methods for the types that correspond to the properties (double for "azimuth", RGB color for "color", and enumerated integer for "Type").

```
Private Property Let IKeyframe_PropertyValueDouble(ByVal propIndex As Long,
ByVal num As Double)
  If (propIndex = 0) Then
    dAzimuth = num
  End If
End Property

Private Property Get IKeyframe_PropertyValueDouble(ByVal propIndex As Long) As
Double
  If (propIndex = 0) Then
    IKeyframe_PropertyValueDouble = dAzimuth
  End If
End Property

Private Property Let IKeyframe_PropertyValueRGBColor(ByVal propIndex As Long,
ByVal color As IColor)
  If (propIndex = 1) Then
    Set pColor = color
  End If
End Property

Private Property Get IKeyframe_PropertyValueRGBColor(ByVal propIndex As Long)
As IColor
  If (propIndex = 1) Then
    Set IKeyframe_PropertyValueRGBColor = pColor
  End If
End Property
```

```
Private Property Let IKeyframe_PropertyValueInt(ByVal propIndex As Long, ByVal
num As Long)
  If (propIndex = 2) Then
    Set iType = num
  End If
End Property

Private Property Get IKeyframe_PropertyValueInt(ByVal propIndex As Long) As
Long
  If (propIndex = 2) Then
    Set IKeyframe_PropertyValueInt = iType
  End If
End Property
```

The keyframe properties can also be assigned to the keyframe from an object of the right type (this happens when the *CreateKeyframe* command in ArcScene is used). To do this, the following method must be implemented (you can assume that the Radar object has properties that match the ones in the keyframe).

```
Private Sub IKeyframe_CaptureProperties(ByVal pScene As IScene, ByVal pObject
As Variant)
  ' set keyframe props from pObject (a Radar object) props
  Dim pRadar As IRadar
  Set pRadar = pObject
  if (Not pRadar Is Nothing) Then
    dAzimuth = pRadar.Azimuth
    Set pColor = pRadar.Color
    iType = pRadar.Type
  End If
End Sub
```

The opposite operation is to set the state of the object from the property values stored in the keyframe. The object may need an additional call to be refreshed after some of its properties have changed. In your example, assume the *IRadar::Update* method must be called to refresh the *Radar* object.

```
Private Sub IKeyframe_Apply(ByVal pScene As IScene, ByVal pObject As Variant)
  ' set properties in pObject (a Radar) from the props of this keyframe
  Dim pRadar As IRadar
  Set pRadar = pObject
  If (Not pRadar Is Nothing) Then
    pRadar.Azimuth = dAzimuth
    Set pRadar.Color = pColor
    pRadar.Type = iType
  End If
  pRadar.Update ' refresh Radar
End Sub
```

Finally, the *Interpolate* method needs to be implemented. This method calculates the value of a property between two keyframes or four (as described in Figure 4). The code below does a simple linear interpolation of the continuous properties (the azimuth and color) between the current keyframe and the next one, ignoring *pPrevKeyframe* and *pAfterNextKeyframe.* For the discrete property (the type), the value in the current keyframe is used.

```
Private Sub IKeyframe_Interpolate(ByVal pScene As IScene, ByVal pObject As
Variant, ByVal propertyIndex As Long, ByVal time As Double, ByVal pNextKeyframe
As IKeyframe, ByVal pPrevKeyframe As IKeyframe, ByVal pAfterNextKeyframe As
IKeyframe)
  Dim pRadar As IRadar
  Set pRadar = pObject
  If (pRadar Is Nothing) Then Exit Sub
  ' discrete property (type): use value in this keyframe
  if (propertyIndex = 2) Then
    pRadarType = iType
    bObjectNeedsRefresh = True
    Exit Sub
  End If
  ' continuous interpolation
  If (pNextKeyframe Is Nothing) Then Exit Sub
  Dim dNextTime As Double
  dNextTime = pNextKeyframe.TimeStamp
  if (dNextTime <= dTimeStamp Or time < dTimeStamp Or time > dNextTime) Then
Exit Sub ' invalid times
  Dim dTimeFactor As Double
  dTimeFactor = (time - dTimeStamp) / (dNextTime - dTimeStamp)

  Select Case propertyIndex
    Case 0 ' dAzimuth
      Dim dNextAzimuth As Double
      dNextAzimuth = pNextKeyframe.PropertyValueDouble(propertyIndex)

      Dim dAzimuth_Interp As Double
      If (dNextAzimuth < dAzimuth) Then
        dAzimuth_Interp = dAzimuth - (dTimeFactor * (dAzimuth - dNextAzimuth))
      Else
        dAzimuth_Interp = dAzimuth + (dTimeFactor * (dNextAzimuth - dAzimuth))
      End If
      pRadar.Azimuth = dAzimuth_Interp
      bObjectNeedsRefresh = True
    Case 1 ' pColor
      Dim pNextColor As IRgbColor
      Set pNextColor = pNextKeyframe.PropertyValueRGBColor(propertyIndex)
      Dim pColor_Interp As IRgbColor
      Set pColor_Interp = New RgbColor
      pColor_Interp.Red = pColor.Red + (dTimeFactor * (pNextColor.Red - pColor.Red))
      pColor_Interp.Green = pColor.Green + (dTimeFactor * (pNextColor.Green -
pColor.Green))
      pColor_Interp.Blue = pColor.Blue + (dTimeFactor * (pNextColor.Blue -
pColor.Blue))
      Set pRadar.Color = pColor_Interp
      bObjectNeedsRefresh = True
  End Select
End Sub
```

Notice that the *Interpolate* method only calculates the value of one property in each call. This is why the object is not refreshed automatically. Inside *Interpolate,* an object with many properties would be refreshed each time one of them is updated, and that would be very inefficient. Instead, whenever one of the properties has changed, the *bObjectNeedsRefresh* flag is raised. The client reads this flag with the *ObjectNeedsRefresh* method to find out whether it needs to refresh the object. This is what ArcScene or ArcGlobe does when the animation is played (see also Sample 2a and Sample 2b).

```
Private Property Get IKeyframe_ObjectNeedsRefresh() As Boolean
  IKeyframe_ObjectNeedsRefresh = bObjectNeedsRefresh
End Property
```

If the client finds that the object has been changed by the *Interpolate* method, it will call *RefreshObject*. In your example, call the Update method in the Radar to refresh it.

```
Private Sub IKeyframe_RefreshObject(ByVal pScene As IScene, ByVal pObject As
Variant)
  Dim pRadar As IRadar
  Set pRadar = pObject
  if (Not pRadar Is Nothing) Then pRadar.Update
  bObjectNeedsRefresh = False
End Sub
```

Registration

To make ArcScene or ArcGlobe recognize the custom animation type, it needs to be registered in the category of animation types. A simple way to perform the registration is to use the *Categories.exe* utility in the ArcGIS binary folder. For ArcScene animation types, search for the *ESRI 3D Animation Types* category and add the DLL file of your custom animation type. For ArcGlobe animation types, search for the *ESRI 3D Animation Types for Globe* category and add the DLL file of your custom animation type. Another option is to add the appropriate registry entry directly. You can do that by creating a text file with the .reg extension and double-clicking it. The file should look like the following:

```
REGEDIT4
 ; This Registry Script enters a CoClass Into a Component Category
[HKEY_LOCAL_MACHINE\SOFTWARE\Classes\CLSID\{custom type
ID}\Implemented Categories\{5980E69C-A95E-11d5-B2A0-00508BCDDE28}]
```

The registration can also be done programmatically by using the Component Category Manager. Below is a simple routine that uses this mechanism to register a test animation type.

```
Sub Register()

  Const cCATID_DDDAnimationTypes = _
                   "{5980E69C-A95E-11d5-B2A0-00508BCDDE28}"
  Const cCLSID_TestAnimType = _
                   "{custom type ID here}"
   Dim pCCM As IComponentCategoryManager
  Set pCCM = New ComponentCategoryManager

  Dim catid As New UID
  Dim objid As New UID
  objid = cCLSID_TestAnimType
  catid = cCATID_DDDAnimationTypes
  pCCM.SetupObject "my_path\TestAnimationType.dll", objid, catid, True

End Sub
```

Appendix A: Properties of Out-of-the-Box Animation Types

Properties of Out-of-the-Box Animation Types in ArcScene

Camera Properties	Name	Type
0	Projection Type	Long*
1	Target	Point
2	Azimuth	Double
3	Inclination	Double
4	Roll	Double**
5	Distance	Double
6	View Angle	Double
7	Ortho Extent	Extent

LAYER PROPERTIES	NAME	TYPE
0	Visibility	Boolean
1	Transparency	Integer
2	Translation	Point
3	Scale	Point
4	Rotation	Point**
5	Center Offset	Point

SCENE PROPERTIES	NAME	TYPE
0	Vertical Exaggeration	Double
1	Sun Azimuth	Integer**
2	Sun Inclination	Integer**
3	Sun Contrast	Integer
4	Background Color	RGB Color

(*) This is an enumerated type. The possible values are 0 = Perspective, 1 = Ortho.
(**) Units in degrees

Properties of Out-of-the-Box Animation Types in ArcGlobe

GlobeCamera Properties	Name	Type
0	Orientation	Long*
1	Target Latitude	Double**
2	Target Longitude	Double**
3	Target Altitude	Double
4	Observer Latitude	Double**
5	Observer Longitude	Double**
6	Observer Altitude	Double
7	View Angle	Double**

GlobeLayer Properties	Name	Type
0	Visibility	Boolean
1	Transparency	Integer

(*) This is an enumerated type. The possible values are 0 = Global, 1 = Local.
(**) Units in degrees

Appendix B: Code Samples Illustrating the Use of Animation Objects in ArcScene and ArcGlobe

Sample 1a VBA macro to create an animated rotation of the first layer by using the Apply method in a single Layer keyframe

```
Public Sub RotateLayer1()

  ' get first layer in the scene
  Dim pSxDocument As ISxDocument
  Set pSxDocument = ThisDocument

 Dim pScene As IScene
  Set pScene = pSxDocument.Scene

  Dim pLayer As ILayer
  Set pLayer = pScene.Layer(0)
  If (pLayer Is Nothing) Then Exit Sub

  ' create keyframe
  Dim pKeyframe As IKeyframe
  Set pKeyframe = New LayerKeyframe

  ' set active properties (only rotation)
  Dim pProperties As ILongArray
  Set pProperties = New LongArray
  pProperties.Add (4)
  pKeyframe.ActiveProperties = pProperties

  ' animation loop
  Dim pSceneGraph As ISceneGraph
  Set pSceneGraph = pScene.SceneGraph

  Dim angle As Integer

  For angle = 0 To 360
    Dim pAngles As IPoint
    Set pAngles = New Point
    pAngles.X = 0
    pAngles.Y = 0
    pAngles.Z = angle

    pKeyframe.PropertyValuePoint(4) = pAngles ' set rotation
    pKeyframe.Apply pScene, pLayer            ' apply it
  pSceneGraph.RefreshViewers
 Next angle

End Sub
```

Sample 1b

VBA macro to create an animated rotation of the globe by using the Apply method in a single GlobeCamera keyframe

```
Public Sub RotateGlobe1()

  ' get Globe Camera in the globe display
  Dim pGMxDocument As IGMxDocument
  Set pGMxDocument = ThisDocument

  Dim pScene As IScene
  Set pScene = pGMxDocument.Scene

  Dim pGlobe As IGlobe
  Set pGlobe = pScene

  Dim pGlobeDisplay As IGlobeDisplay
  Set pGlobeDisplay = pGlobe.GlobeDisplay

  Dim pGlobeCamera As IGlobeCamera
  Set pGlobeCamera = pGlobeDisplay.ActiveViewer.Camera

  ' create keyframe
  Dim pKeyframe As IKeyframe
  Set pKeyframe = New GlobeCameraKeyframe

  ' set active properties
  Dim pProperties As ILongArray
  Set pProperties = New LongArray
  pProperties.Add (4)        ' Observer Lat.
  pProperties.Add (5)        ' Observer Lon.
  pProperties.Add (6)        ' Observer Alt.
  pKeyframe.ActiveProperties = pProperties

  ' animation loop
  Dim plongitude As Integer

  For plongitude = 0 To 360
    pKeyframe.PropertyValueDouble(4) = 0                ' set latitude
    pKeyframe.PropertyValueDouble(5) = plongitude       ' set longitude
    pKeyframe.PropertyValueDouble(6) = 20000            ' set altitude
    pKeyframe.Apply pGlobe, pGlobeCamera                ' apply it
    pGlobeDisplay.RefreshViewers
  Next plongitude

End Sub
```

Sample 2a

ArcScene—VBA macro to create an animated rotation of the ' first layer by interpolating between two Layer keyframes

```
Public Sub RotateLayer2()

  ' get first layer in the scene
  Dim pSxDocument As ISxDocument
  Set pSxDocument = ThisDocument

  Dim pScene As IScene
  Set pScene = pSxDocument.Scene

  Dim pLayer As ILayer
  Set pLayer = pScene.Layer(0)
  If (pLayer Is Nothing) Then Exit Sub

  ' create initial and final keyframe
  Dim pKeyframe1 As IKeyframe
  Set pKeyframe1 = New LayerKeyframe
  Dim pKeyframe2 As IKeyframe
  Set pKeyframe2 = New LayerKeyframe
  pKeyframe1.TimeStamp = 0#
  pKeyframe2.TimeStamp = 1#

  ' set active properties (only rotation)
  Dim pProperties As ILongArray
  Set pProperties = New LongArray
  pProperties.Add (4)
  pKeyframe1.ActiveProperties = pProperties
  pKeyframe2.ActiveProperties = pProperties

  ' set initial and final rotation values
  Dim pAngles As IPoint
  Set pAngles = New Point
  pAngles.X = 0
  pAngles.Y = 0
  pAngles.Z = 0  ' initial azimuth rotation = 0
  pKeyframe1.PropertyValuePoint(4) = pAngles
  pAngles.Z = 90 ' final azimuth rotation = 90
  pKeyframe2.PropertyValuePoint(4) = pAngles

  ' animation loop
  Dim pSceneGraph As ISceneGraph
  Set pSceneGraph = pScene.SceneGraph

  Dim pAnimType As IAnimationType
  Set pAnimType = New AnimationTypeLayer
  Dim time As Double
  Dim iteration As Integer
  For iteration = 0 To 100
    time = iteration / 100#
    ' reset object (only some animation types -layer- need this)
    pAnimType.ResetObject pScene, pLayer
    ' interpolate state of the object
    pKeyframe1.Interpolate pScene, pLayer, 4, time, pKeyframe2, pKeyframe1, pKeyframe2
    ' refresh object (only some animation types -layer- need this)
    If (pKeyframe1.ObjectNeedsRefresh) Then
      pKeyframe1.RefreshObject pScene, pLayer
    End If
    pSceneGraph.RefreshViewers
  Next iteration

End Sub
```

Sample 2b ArcGlobe—VBA macro to create an animation to rotate the globe by interpolating between two GlobeCamera keyframes

```
Public Sub RotateGlobe2()

  ' get Globe Camera in the globe display
  Dim pGMxDocument As IGMxDocument
  Set pGMxDocument = ThisDocument

  Dim pScene As IScene
  Set pScene = pGMxDocument.Scene

  Dim pGlobe As IGlobe
  Set pGlobe = pScene

  Dim pGlobeDisplay As IGlobeDisplay
  Set pGlobeDisplay = pGlobe.GlobeDisplay

  Dim pGlobeCamera As IGlobeCamera
  Set pGlobeCamera = pGlobeDisplay.ActiveViewer.Camera

  ' create initial and final keyframe
  Dim pKeyframe1 As IKeyframe
  Set pKeyframe1 = New GlobeCameraKeyframe
  Dim pKeyframe2 As IKeyframe
  Set pKeyframe2 = New GlobeCameraKeyframe
  pKeyframe1.TimeStamp = 0#
  pKeyframe2.TimeStamp = 1

  ' set active properties
  Dim pProperties As ILongArray
  Set pProperties = New LongArray
  pProperties.Add (4)       ' Observer Lat.
  pProperties.Add (5)       ' Observer Lon.
  pProperties.Add (6)       ' Observer Alt.
  pKeyframe1.ActiveProperties = pProperties
  pKeyframe2.ActiveProperties = pProperties

  ' set initial observer
  pKeyframe1.PropertyValueDouble(4) = 0          ' set latitude
  pKeyframe1.PropertyValueDouble(5) = 0          ' set longitude
  pKeyframe1.PropertyValueDouble(6) = 20000        ' set altitude
    ' set final observer
  pKeyframe2.PropertyValueDouble(4) = 0          ' set latitude
  pKeyframe2.PropertyValueDouble(5) = 180          ' set longitude
  pKeyframe2.PropertyValueDouble(6) = 20000        ' set altitude
  ' animation loop
  Dim pAnimType As IAnimationType
  Set pAnimType = New AnimationTypeGlobeCamera

  Dim time As Double
  Dim iteration As Integer
  For iteration = 0 To 500
    time = iteration / 500#

    ' interpolate state of the object
    pKeyframe1.Interpolate pGlobe, pGlobeCamera, 5, time, pKeyframe2, pKeyframe1,
pKeyframe2

    pGlobeDisplay.RefreshViewers
  Next iteration

End Sub
```

Sample 3a

ArcScene—VBA macro to create an animated rotation of the first layer by adding keyframes to an animation track

```
Public Sub RotateLayer3()

  ' get first layer in the scene
  Dim pSxDocument As ISxDocument
  Set pSxDocument = ThisDocument

  Dim pScene As IScene
  Set pScene = pSxDocument.Scene

  Dim pLayer As ILayer
  Set pLayer = pScene.Layer(0)
  If (pLayer Is Nothing) Then Exit Sub

  ' create an animation track
  Dim pAnimationTrack As IAnimationTrack
  Set pAnimationTrack = New AnimationTrack

  ' set the type before adding keyframes
  Dim pAnimationType As IAnimationType
  Set pAnimationType = New AnimationTypeLayer
  Set pAnimationTrack.AnimationType = pAnimationType

  ' create four keyframes and add them to the track
  Dim pKeyframe As iKeyframe
  Dim nKeyframes As Integer
  nKeyframes = 4
  Dim iKeyframe As Integer
  For iKeyframe = 0 To nKeyframes - 1
    Set pKeyframe = New LayerKeyframe
    pAnimationTrack.InsertKeyframe pKeyframe, -1
    pKeyframe.TimeStamp = 1# * (iKeyframe / (nKeyframes - 1))
    ' set rotation values
    Dim pAngles As IPoint
    Set pAngles = New Point
    pAngles.X = 0
    pAngles.Y = 0
    pAngles.Z = 360# * (iKeyframe / (nKeyframes - 1))
    pKeyframe.PropertyValuePoint(4) = pAngles
  Next iKeyframe

  ' set active properties in the track (only rotation)
  Dim pProperties As ILongArray
  Set pProperties = New LongArray
  pProperties.Add (4)
  pAnimationTrack.ActiveProperties = pProperties
  ' attach the track to the layer
  pAnimationTrack.AttachObject pLayer

  ' animation loop
  Dim pSceneGraph As ISceneGraph
  Set pSceneGraph = pScene.SceneGraph

  Dim time As Double
  Dim iteration As Integer
  For iteration = 0 To 100
    time = iteration / 100#
    ' reset
    pAnimationType.ResetObject pScene, pLayer
    ' interpolate by using track
    pAnimationTrack.InterpolateObjectProperties pScene, time
    pSceneGraph.RefreshViewers
  Next iteration

End Sub
```

Sample 3b

ArcGlobe—VBA macro to create an animated rotation of the globe by adding keyframes to an animation track

```
Public Sub RotateLayer3()

  ' get Globe Camera in the globe display
  Dim pGMxDocument As IGMxDocument
  Set pGMxDocument = ThisDocument

  Dim pScene As IScene
  Set pScene = pGMxDocument.Scene

  Dim pGlobe As IGlobe
  Set pGlobe = pScene

  Dim pGlobeDisplay As IGlobeDisplay
  Set pGlobeDisplay = pGlobe.GlobeDisplay

  Dim pGlobeCamera As IGlobeCamera
  Set pGlobeCamera = pGlobeDisplay.ActiveViewer.Camera

  ' create an animation track
  Dim pAnimationTrack As IAnimationTrack
  Set pAnimationTrack = New AnimationTrack

  ' set the type before adding keyframes
  Dim pAnimationType As IAnimationType
  Set pAnimationType = New AnimationTypeGlobeCamera
  Set pAnimationTrack.AnimationType = pAnimationType

  ' create four keyframes and add them to the track
  Dim pKeyframe As iKeyframe
  Dim nKeyframes As Integer
  nKeyframes = 4
  Dim iKeyframe As Integer
  For iKeyframe = 0 To nKeyframes - 1
    Set pKeyframe = New GlobeCameraKeyframe
    pAnimationTrack.InsertKeyframe pKeyframe, -1
    pKeyframe.TimeStamp = 1# * iKeyframe / (nKeyframes - 1)
    ' set rotation values
    pKeyframe.PropertyValueDouble(4) = 0                              ' set latitude
    pKeyframe.PropertyValueDouble(5) = 360* iKeyframe / (nKeyframes - 1) ' set longitude
    pKeyframe.PropertyValueDouble(6) = 20000                           ' set altitude
  Next iKeyframe

  ' set active properties in the track
  Dim pProperties As ILongArray
  Set pProperties = New LongArray
  pProperties.Add (4)
  pProperties.Add (5)
  pProperties.Add (6)
  pAnimationTrack.ActiveProperties = pProperties

  ' attach the track to the GlobeCamera
  pAnimationTrack.AttachObject pGlobeCamera

  ' animation loop

  Dim time As Double
  Dim iteration As Integer
  For iteration = 0 To 500
    time = iteration / 500#
    ' interpolate by using track
    pAnimationTrack.InterpolateObjectProperties pGlobe, time
    pGlobeDisplay.RefreshViewers
  Next iteration

End Sub
```

Sample 4a

VBA macro to play the current animation in the scene using the system clock to time the duration

```
Public Sub PlayAnimation()

  Dim pSxDocument As ISxDocument
  Set pSxDocument = ThisDocument

  Dim pScene As IScene
  Set pScene = pSxDocument.Scene

  Dim pSceneTracks As IAnimationTracks
  Set pSceneTracks = pScene

  ' animation loop
  Dim pSceneGraph As ISceneGraph
  Set pSceneGraph = pScene.SceneGraph

  Dim duration As Double
  duration = 10

  Dim startTime As Single
  startTime = Timer

  Do

    Dim elapsedTime As Single
    elapsedTime = Timer - startTime

    If (elapsedTime > duration) Then elapsedTime = duration

    pSceneTracks.ApplyTracks pSceneGraph.ActiveViewer, elapsedTime, duration
    pSceneGraph.RefreshViewers

  Loop While elapsedTime < duration

End Sub
```

Sample 4b

VBA macro to play the current animation in the globe using the system clock to time the duration

```
Public Sub PlayAnimation()

  Dim pGMxDocument As IGMxDocument
  Set pGMxDocument = ThisDocument

  Dim pScene As IScene
  Set pScene = pDoc.Scene

  Dim pGlobe As IGlobe
  Set pGlobe = pScene

  Dim pGlobeDisplay As IGlobeDisplay
  Set pGlobeDisplay = pGlobe.GlobeDisplay

  Dim pGlobeTracks As IAnimationTracks
  Set pGlobeTracks = pGlobe

  ' animation loop
  Dim duration As Double
  duration = 10

  Dim startTime As Single
  startTime = Timer

  Do

    Dim elapsedTime As Single
    elapsedTime = Timer - startTime

    If (elapsedTime > duration) Then elapsedTime = duration

    pGlobeTracks.ApplyTracks pGlobeDisplay.ActiveViewer, elapsedTime, duration
    pGlobeDisplay.RefreshViewers

  Loop While elapsedTime < duration

End Sub
```

VBA macro to load and play ArcScene animation (*.asa) in ArcScene

```
Public Sub Scene_PlayInterval_Animation()

  Dim pSxDocument As ISxDocument
  Set pSxDocument = ThisDocument

  Dim pScene As IScene
  Set pScene = pSxDocument.Scene

  Dim pSceneGraph As ISceneGraph
  Set pSceneGraph = pScene.SceneGraph

  Dim pAnimTracks As IAnimationTracks
  Set pAnimTracks = pScene

  Dim pBasicScene As IBasicScene
  Set pBasicScene = pScene

' Load the ArcScene animation file (*.asa)

  'pBasicScene.LoadAnimation "c:\animFile.asa"

  Dim pSxAnimationEnvironment As ISxAnimationEnvironment2
  Set pSxAnimationEnvironment = New SxAnimationEnvironment

' Read the total duration of animation and the play in all viewers option
  Dim duration As Double
  duration = pSxAnimationEnvironment.AnimationDuration

  Debug.Print "The total duration of the animation is = " & duration & " seconds"

  Debug.Print "The animation will be played in all active viewers = " &
pSxAnimationEnvironment.PlayInAllViewers

' Check the state of the "Play between intervals" option.
' If IsIntervalPlay = False, set it to True so that the
' animation can be played between the set time interval.

  Dim boolPlayBetweenIntervals As Boolean
  boolPlayBetweenIntervals = pSxAnimationEnvironment.IsIntervalPlay

  If boolPlayBetweenIntervals = False Then
    pSxAnimationEnvironment.IsIntervalPlay = True
  End If

' Get the beginTime and endTime of the play interval
```

```
  Dim beginTime As Double
  Dim endTime As Double
  pSxAnimationEnvironment.GetPlayInterval beginTime, endTime

' If beginTime = endTime the animation will not run.
' So give it some default time in this case.

  If beginTime = endTime Then
    beginTime = 0
    endTime = pSxAnimationEnvironment.AnimationDuration
  End If

' Animation loop based on the Play Interval

  Dim startTime As Single
  startTime = Timer

  Do

    Dim elapsedTime As Single
    elapsedTime = Timer - startTime + beginTime

    If (elapsedTime > duration) Then
      elapsedTime = duration
    End If

    If elapsedTime >= beginTime And elapsedTime <= endTime Then
      pAnimTracks.ApplyTracks pSceneGraph.ActiveViewer, elapsedTime, duration
      pSxAnimationEnvironment.State = esriAnimationPlaying
      pSceneGraph.RefreshViewers
    ElseIf elapsedTime > endTime Then
      Exit Do
    End If

  Loop While elapsedTime < duration

End Sub
```

Sample 5b

VBA macro to load and play ArcGlobe animation (*.aga) in ArcGlobe

```
Public Sub Globe_PlayInterval_Animation()

  Dim pGMxDocument As IGMxDocument
  Set pGMxDocument = ThisDocument

  Dim pScene As IScene
  Set pScene = pGMxDocument.Scene

  Dim pGlobe As IGlobe
  Set pGlobe = pScene

  Dim pGlobeDisplay As IGlobeDisplay
  Set pGlobeDisplay = pGlobe.GlobeDisplay

  Dim pAnimTracks As IAnimationTracks
  Set pAnimTracks = pScene

  Dim pBasicScene As IBasicScene
  Set pBasicScene = pScene

' Load the ArcGlobe animation (*.aga) file
' pBasicScene.LoadAnimation "c:\animFile.aga"

  Dim pSxAnimationEnvironment As ISxAnimationEnvironment2
  Set pSxAnimationEnvironment = New SxAnimationEnvironment

' Read the total duration of animation and the play in all viewers option
  Dim duration As Double
  duration = pSxAnimationEnvironment.AnimationDuration

  Debug.Print "The total duration of the animation is = " & duration & " seconds"
  Debug.Print "The animation will be played in all active viewers = " &
pSxAnimationEnvironment.PlayInAllViewers

' Check the state of the "Play between intervals" option.
' If IsIntervalPlay = False, set it to True so that the
' animation can be played between the set time interval.

  Dim boolPlayBetweenIntervals As Boolean
  boolPlayBetweenIntervals = pSxAnimationEnvironment.IsIntervalPlay

  If boolPlayBetweenIntervals = False Then
    pSxAnimationEnvironment.IsIntervalPlay = True
  End If
```

```
' Get the beginTime and endTime of the play interval
  Dim beginTime As Double
  Dim endTime As Double
  pSxAnimationEnvironment.GetPlayInterval beginTime, endTime

' If beginTime = endTime the animation will not run.
' So give it some default time in this case.

  If beginTime = endTime Then
    beginTime = 0
    endTime = pSxAnimationEnvironment.AnimationDuration
  End If

' Animation loop based on the Play Interval

  Dim startTime As Single
  startTime = Timer

  Do

    Dim elapsedTime As Single
    elapsedTime = Timer - startTime + beginTime

    If (elapsedTime > duration) Then
      elapsedTime = duration
    End If

    If elapsedTime >= beginTime And elapsedTime <= endTime Then
      pAnimTracks.ApplyTracks pGlobeDisplay.ActiveViewer, elapsedTime, duration
      pSxAnimationEnvironment.State = esriAnimationPlaying
      pGlobeDisplay.RefreshViewers
    ElseIf elapsedTime > endTime Then
      Exit Do
    End If

  Loop While elapsedTime < duration

End Sub
```

Sample 6a

VBA macro to set the Animation Environment and save an ArcScene animation (*.asa)

```
Public Sub Scene_Save_Animation()

  Dim pSxDocument As ISxDocument
  Set pSxDocument = ThisDocument

  Dim pScene As IScene
  Set pScene = pSxDocument.Scene

  Dim pSceneGraph As ISceneGraph
  Set pSceneGraph = pScene.SceneGraph

  Dim pAnimTracks As IAnimationTracks
  Set pAnimTracks = pScene

  Dim pBasicScene As IBasicScene
  Set pBasicScene = pScene

  Dim pSxAnimationEnvironment As ISxAnimationEnvironment2
  Set pSxAnimationEnvironment = New SxAnimationEnvironment

' Set the total duration of animation
  pSxAnimationEnvironment.AnimationDuration = 10

' Specify whether the animation would be played in all viewers
  pSxAnimationEnvironment.PlayInAllViewers = False

' Specify the time interval for which the animation will be played
  pSxAnimationEnvironment.PutPlayInterval 3, 8

' Check the state of the "Play between intervals" option.
' If IsIntervalPlay = False, set it to True so that the
' animation can be played between the set time interval.
  Dim boolPlayBetweenIntervals As Boolean
  boolPlayBetweenIntervals = pSxAnimationEnvironment.IsIntervalPlay

  If boolPlayBetweenIntervals = False Then
    pSxAnimationEnvironment.IsIntervalPlay = True
  End If

' Set the playing option of the animation to loop forward
  pSxAnimationEnvironment.PlayMode = esriAnimationPlayLoopForward

' Save the current animation as an ArcScene animation file (*.asa)

  pBasicScene.SaveAnimation "c:\animFile.asa"

End Sub
```

Sample 6b

VBA macro to set the Animation Environment and save an ArcGlobe animation (*.aga)

```
Public Sub Globe_Save_Animation()

  Dim pGMxDocument As IGMxDocument
  Set pGMxDocument = ThisDocument

  Dim pScene As IScene
  Set pScene = pGMxDocument.Scene

  Dim pGlobe As IGlobe
  Set pGlobe = pScene

  Dim pGlobeDisp As IGlobeDisplay
  Set pGlobeDisp = pGlobe.GlobeDisplay

  Dim pBasicScene As IBasicScene
  Set pBasicScene = pScene

  Dim pSxAnimationEnvironment As ISxAnimationEnvironment2
  Set pSxAnimationEnvironment = New SxAnimationEnvironment

' Set the total duration of animation
  pSxAnimationEnvironment.AnimationDuration = 10

' Specify whether the animation would be played in all viewers
  pSxAnimationEnvironment.PlayInAllViewers = False

' Specify the time interval for which the animation will be played
  pSxAnimationEnvironment.PutPlayInterval 3, 8

' Check the state of the "Play between intervals" option.
' If IsIntervalPlay = False, set it to True so that the
' animation can be played between the set time interval.
  Dim boolPlayBetweenIntervals As Boolean
  boolPlayBetweenIntervals = pSxAnimationEnvironment.IsIntervalPlay

  If boolPlayBetweenIntervals = False Then
    pSxAnimationEnvironment.IsIntervalPlay = True
  End If

' Set the playing option of the animation to loop forward
  pSxAnimationEnvironment.PlayMode = esriAnimationPlayLoopForward

' Save the current animation as an ArcGlobe animation file (*.asa)

  pBasicScene.SaveAnimation "c:\animFile.aga"

End Sub
```

Sample 7a VBA macro to export the current animation in ArcScene to an AVI video file

```
Public Sub Scene_ExportToAVI()

  Dim pSxDocument As ISxDocument
  Set pSxDocument = ThisDocument

  Dim pScene As IScene
  Set pScene = pSxDocument.Scene

  Dim pSceneExporter3D As ISceneExporter3d
  Set pSceneExporter3D = New AVIExporter

' Set the name of the movie file to be exported
  pSceneExporter3D.ExportFileName = "C:\Temp\TempAVI.avi"

' Set the viewer of the exporter
  Dim pSceneVideoExporter As ISceneVideoExporter
  Set pSceneVideoExporter = pSceneExporter3D
  Set pSceneVideoExporter.Viewer = pScene.SceneGraph.ActiveViewer

' Set the video duration in seconds

  Dim pSxAnimationEnvironment As ISxAnimationEnvironment2
  Set pSxAnimationEnvironment = New SxAnimationEnvironment

  pSceneVideoExporter.VideoDuration = pSxAnimationEnvironment.AnimationDuration

' Set the quality percentage of the video (1-100):
  Dim pVideoExporterProperties As IVideoExporterProperties
  Set pVideoExporterProperties = pSceneExporter3D
  pVideoExporterProperties.Quality = 90

' Do the export
  pSceneExporter3D.ExportScene pScene

End Sub
```

Sample 7b VBA macro to export the current animation in ArcGlobe to a QuickTime video file

```
Public Sub Globe_ExportToQuickTime()

  Dim pGMxDocument As IGMxDocument
  Set pGMxDocument = ThisDocument

  Dim pGlobe As IGlobe
  Set pGlobe = pGMxDocument.Scene

  Dim pSceneExporter3D As ISceneExporter3d
  Set pSceneExporter3D = New QuickTimeExporter

' Set the name of the movie file to be exported
  pSceneExporter3D.ExportFileName = "C:\Temp\TempQT.mov"

' Set the viewer of the exporter
  Dim pSceneVideoExporter As ISceneVideoExporter
  Set pSceneVideoExporter = pSceneExporter3D
  Set pSceneVideoExporter.Viewer = pGlobe.GlobeDisplay.ActiveViewer

' Set the video duration in seconds
  Dim pSxAnimationEnvironment As ISxAnimationEnvironment2
  Set pSxAnimationEnvironment = New SxAnimationEnvironment

  pSceneVideoExporter.VideoDuration = pSxAnimationEnvironment.AnimationDuration

' Set the quality percentage of the video (1-100):
  Dim pVideoExporterProps As IVideoExporterProperties
  Set pVideoExporterProps = pSceneExporter3D
  pVideoExporterProps.Quality = 90

' Do the export
  pSceneExporter3D.ExportScene pGlobe

End Sub
```

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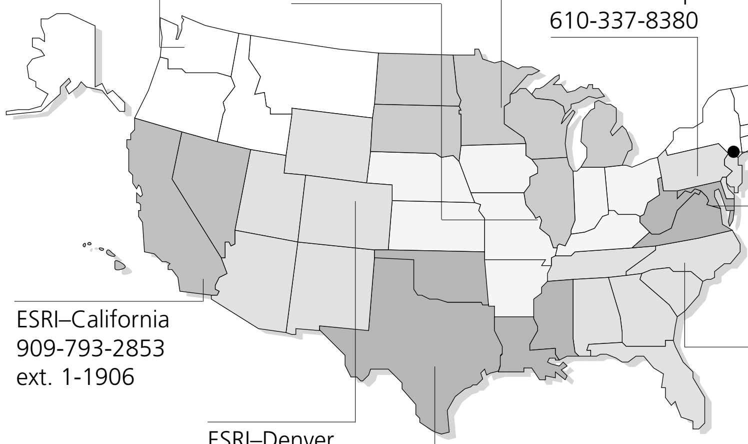

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