Developing Java Applications with ArcGIS Engine

Eric Bader and Steve Rozic

Introductions

- Who are we?
  - Eric Bader: Product Manager – Java Products
  - Steve Rozic: Instructor – Java, ArcObjects
- Who are you?
  - ArcGIS Desktop Developers?
  - Current ArcGIS Engine Developers?
  - Target Platforms?
  - Preferred IDE?
  - Beginner/Intermediate/Advanced Java Developers?

Schedule

- Today we will cover
  - Introduction to ArcGIS Engine
  - Initialization modes
  - Customization
  - ArcObjects
  - Geoprocessing
  - Conclusion

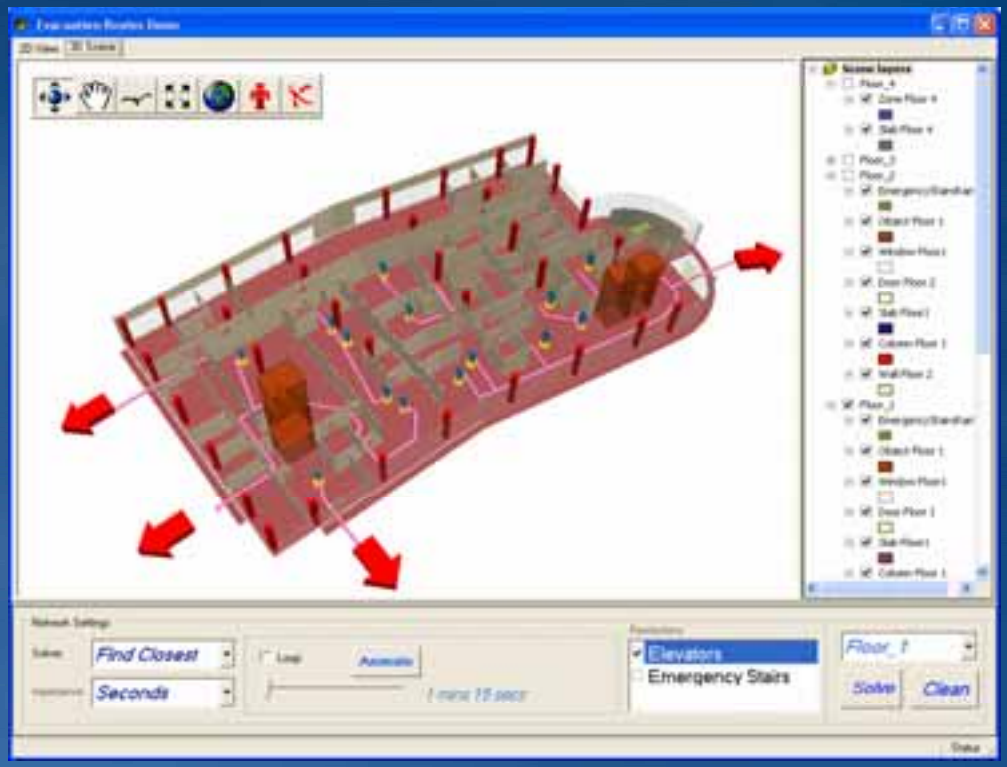
- 10-15 minutes for questions at the end of the session

Please complete the session survey!

What is ArcGIS Engine?

- **Software developer kit for developing cross-platform desktop GIS applications**
  - **Create stand-alone GIS applications**
  - **Embed GIS functions**

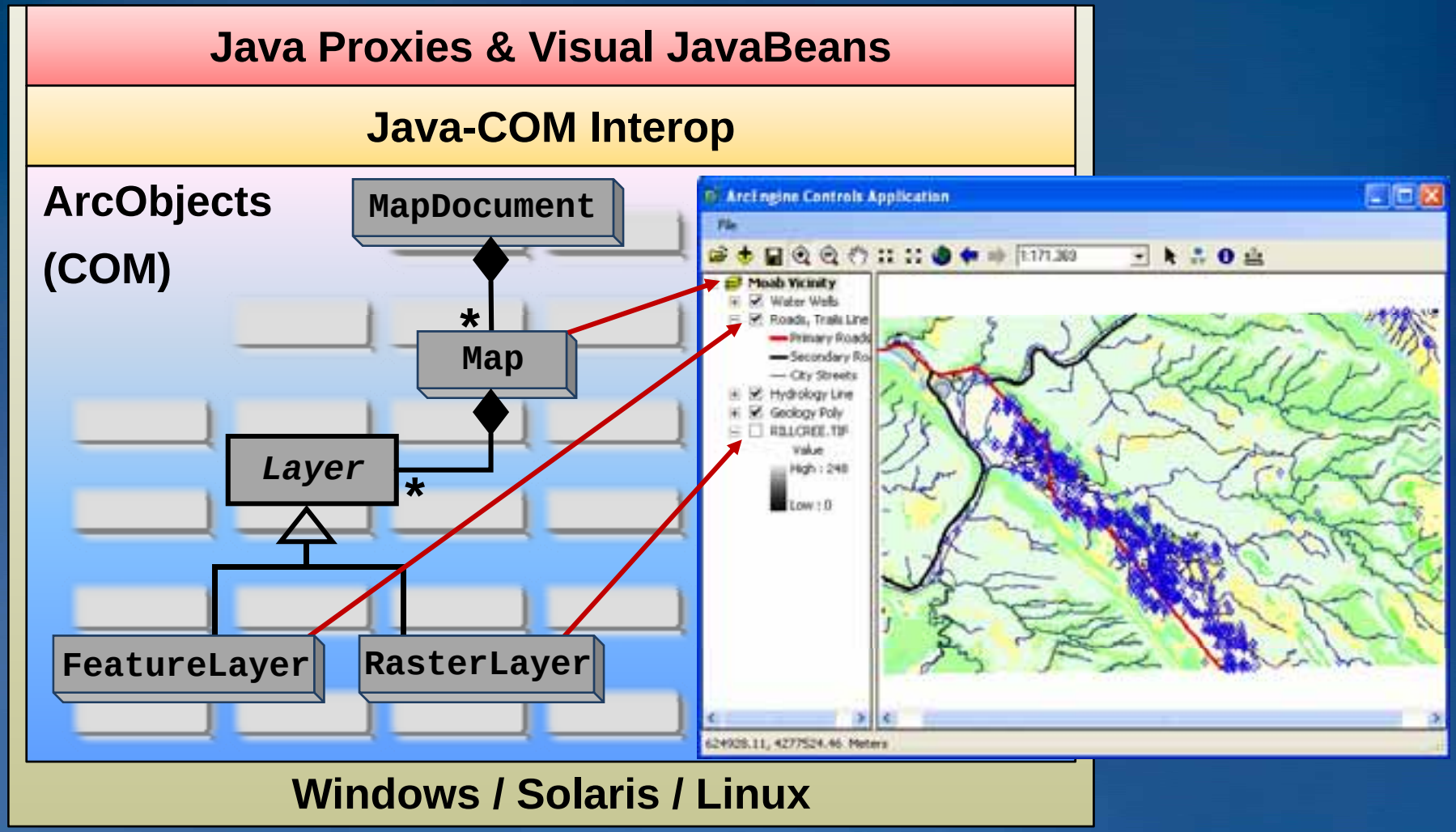
    - ~~Mapping and visualization~~
    - Data management
    - Queries
    - Editing
    - Analysis



- **Engine Includes:**
  - **Visual JavaBeans & Proxy Classes**
  - **ArcObjects**

Developer Kit for developing cross-platform desktop GIS applications…

High-Level Architecture

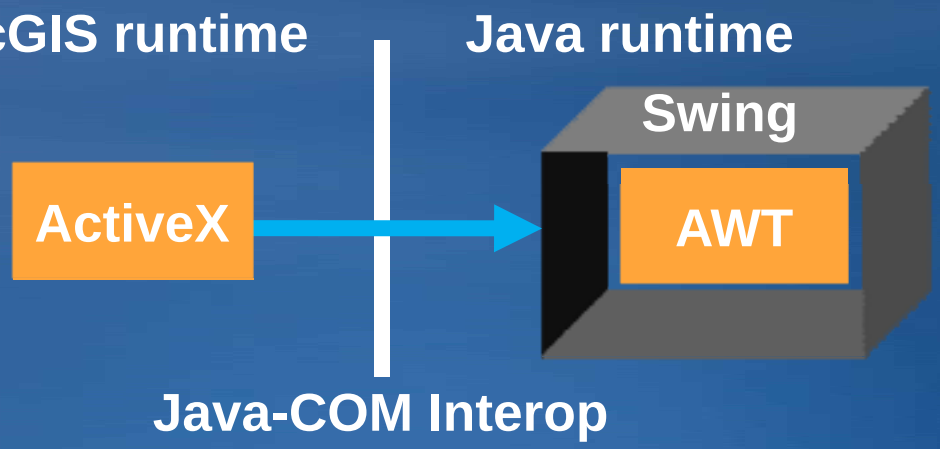


Java communicates with ArcObjects through a Java-COM Interop…

ArcGIS Visual JavaBeans

- Visual components to build GUIs
  - `MapBean`, `ToolbarBean`, `TOCBean`, etc…

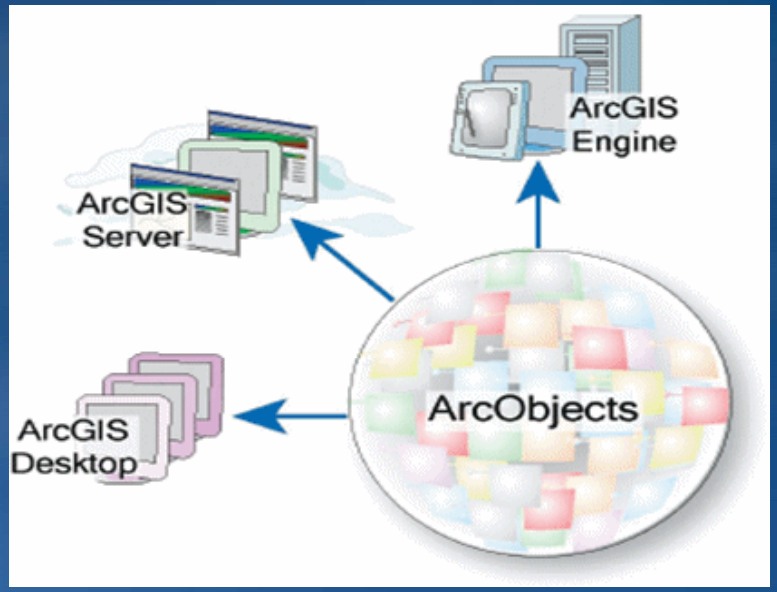
- What are they really?
  - ArcGIS ActiveX Controls
  - Exposed as AWT Controls by a Java-COM interop
  - Wrapped in Swing JavaBeans for IDE



Visual JavaBeans are really ArcGIS ActiveX Controls…

What is ArcObjects?

- **Core GIS Components**
  - **Written in C++ following COM technology**
- **Includes fine-grained and coarse-grained objects**
- **Can be accessed by:**
  - ***Java***
  - .NET
  - C++
- **Used to create custom applications**
  - ***Desktop***
  - **Web**



ArcObjects are core GIS components written in C++…

Demonstration #1

- **Use Case: Where do I get started when using the ArcGIS Engine product to develop a desktop GIS application?**
- **Motivation: Getting new developers started**
- **Solution:**
  - **Examine SDK help**
  - **Show samples dialog**
  - **Create basic template application**
  - **Create a new ArcGIS Engine application**
  - **Resource Center**

Summary

Demonstration #1

- **SDK includes:**
  - Eclipse IDE plug-ins (Code snippets, Templates, Samples, etc.)
  - Developer help and doc
- **Creating an Engine application**
  - Step 1: Design UI
  - Step 2: Initialize
  - Step 3: Licensing
  - Step 4: Display GUI
  - Step 5: Shutdown
- **Resource center for Java ArcGIS Engine**
  - Blog, code gallery, forums, knowledge base, web help and doc

It is easy to build ArcGIS Engine applications…

Step 2: Initialize

ArcObjects must be initialized before they can be used

- **Initialize ArcObjects for usage in ArcGIS Engine app.**
  1. **`initializeVisualBeans()`: optimal for using Visual JavaBeans**

```
public static void main(String args[]){
  EngineInitializer.initializeVisualBeans(); //1st line of code
}
```

  2. **`initializeEngine()`: optimal for console applications**

```
public static void main(String args[]){
  EngineInitializer.initializeEngine(); //1st line of code
}
```

GUI Applications	Console Applications
`initializeVisualBeans()`	`initializeEngine()`

See "Understanding the ArcGIS Engine Java Interop" for a deeper explanation…

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Demonstration #2

- **Use Case: I need a custom command that allows my end user to export to a ".pdf" document?**
- **Motivation: Customize ArcGIS Engine**
- **Solution:**
  - **One can implement the `ICommand` interface**
  - **OR extend the `BaseCommand` class (impelemnts `ICommand`)**
  - **Override two methods:**
    - **`onCreate()` and `onClick()`**
  - **Use `HookHelper` to help you write custom commands**
  - **Call the `addItem()` on the `ToolbarBean` to add the command**

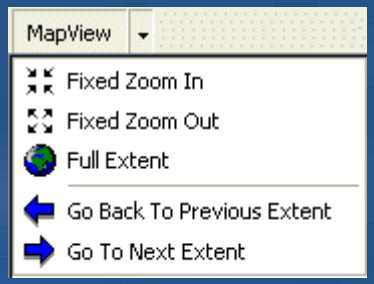
Summary

Demonstration #2

- **Create your own tools**
  - **Implement `ICommand` & `ITool` or extend `BaseTool` class**

- **Create your own custom menus**
  - **Implement `IMenuDef` or instantiate a `ToolbarMenu`**
  - **9 standard menus out of the box**

    (e.g. `ControlsMapViewMenu`)



- **Create your own custom palette**
  - **Implement `IPaletteDef` or instantiate `ToolbarPalette`**
  - **3 standard palettes out-of-the-box**

    (e.g. `ControlsInkHighlightPalette`)

There are many ways to help you customize your Engine applications…

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Demonstration #3

- **Use Case: I would like to add data to my application. How do I access a Feature Class that is on my local disk?**
- **Motivation: Define workflows and examine casting**
- **Solution:**
  - **Present "Accessing data" workflow**
  - **Examine Java-style casting and special cases**
  - **Identify casting guideline when working with ArcObjects**

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Summary

Demonstration #3

- **Workflow: Access existing data**

1. **Instantiate `WorkspaceFactory` class**

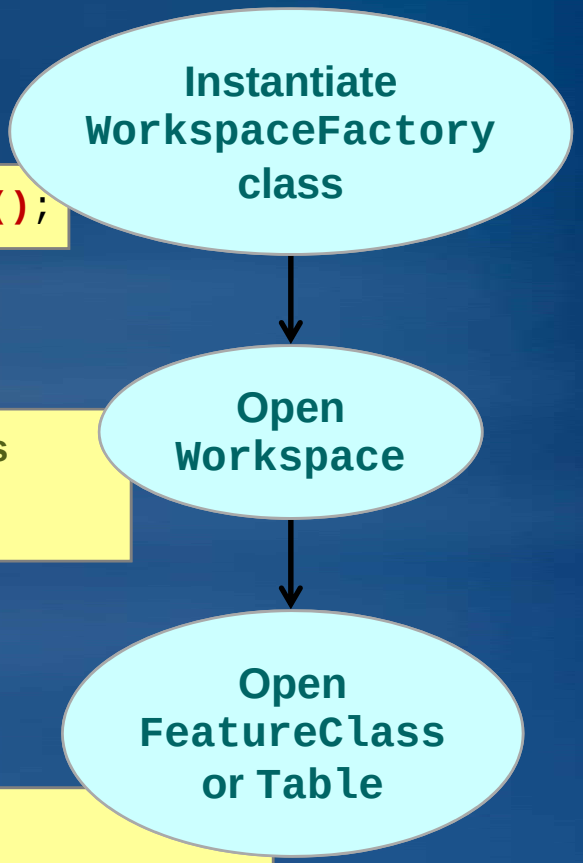
```
SdeWorkspaceFactory sde = new SdeWorkspaceFactory();
```

2. **Open existing `Workspace`**

```
Workspace ws;       //Specify Connection Properties
ws = new Workspace(sde.open(connProp, hWnd));
```

3. **Open the `Dataset`**

```
FeatureClass fClass;
fClass = new FeatureClass(ws.openFeatureClass("FClassName"));
```



You can follow this workflow for accessing existing data and adding it to a map…

Summary

Demonstration #3

- **Workflow: Access existing data**

4. **Instantiate Layer and set properties**

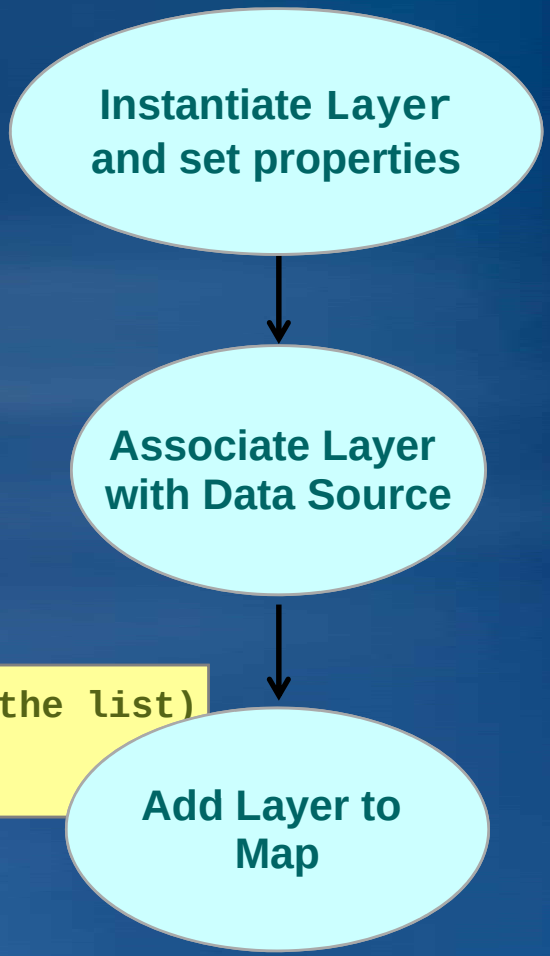
```
FeatureLayer fLayer = new FeatoreLayer();
fLayer.setName("LayerName");
```

5. **Associate Layer with Data Source**

```
fLayer.setFeatureClassByRef(fClass);
```

6. **Add the Layer to the Map**

```
//Specify layer and index position (0 – top of the list)
mapBean.addLayer(fLayer, 0);
```



You can follow this workflow for accessing existing data and adding it to a map…

Summary

Demonstration #3

- **Java-style casting & instanceof support**
  - **Is available for 90% of ArcObjects**

```
ILayer layer = mapDocument.getLayer(0, 1); //Get the second layer
FeatureLayer featureLayer;
if(layer instanceof FeatureLayer)
   featureLayer = (FeatureLayer) layer;
```

  - **However, return values of certain methods cannot be cast to a particular category of types (the other 10%)**

```
//Single argument constructor for Proxy class is not deprecated
Workspace ws = (Workspace) fGDBWF.openFromFile("PathFile", 0);

//This is correct way
Workspace ws = new Workspace(fGDBWF.openFromFile("PathFile", 0));
```

Instantiate the object instead of casting when `ClassCastException` is thrown…

Java-COM Interop

- **Provides a Java-based API for working with ArcObjects**
  - **Java classes for every ArcObjects class (e.g. `Feature` class)**
  - **Java interfaces for every ArcObjects interface (e.g. `IFeature` interface)**
  - **Java proxy class for every interface and implements it (e.g. `IFeatureProxy` class implements `IFeature` interface)**

- **Dealing with `ClassCastException` and Interfaces**

```
//Single argument constructor for Proxy is not deprecated
IGeoDataset gds = (IGeoDataset) ws.openFeatureClass("FC Name");

//This is correct
IGeoDataset gds = new IGeoDatasetProxy(ws.openFeatureClass("FC Name"));
```

Interface Proxy Classes allow us to get around the `ClassCastException`...

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Demonstration #4

- **Use Case: How do I create standard annotation in a Geodatabase?**
  - **Annotation allows each piece of 'text' to store its own position, text string, and display properties**
- **Motivation: Simplify your coding effort with coarse-grained ArcObjects.**
  - **Dealing with `AutomationException`**
- **Solution:**
  - **Present a coarse-grained ArcObject that solves this problem**
    - **`ConvertLabelsToAnnotation`**
  - **Examine the `AutomationException` error**
  - **Examine the state of ArcObjects using Eclipse's debug mode**

Summary

Demonstration #4

- **Coarse-grained ArcObjects simplify the fine-grained details**
  - **E.g. 95 lines of code versus only 4 lines**
  - **Coarse-grained objects can be identified in the Javadoc**
  - **Utilize these objects whenever possible!**

Use Coarse-grained ArcObjects whenever possible to minimize your coding effort…

Summary

Demonstration #4

- **ArcObjects exceptions**
  - Java has no data types for exceptions in ArcObjects
  - Errors reported as hexadecimal number – HRESULT
- **Java-COM Interop**
  - Warps HRESULT in `AutomationException` class
  - Retrieves description when available
  - When description not available…

```
AutomationException: 0x8004005 – Unspecified error
   at com.esri.arcgis.interop.NativeObjRef.nativeVtblInvoke(Native Method)
   at com.esri.arcgis.interop.NativeObjRef.a(Unknown Source)
   at com.esri.arcgis.interop.Dispatch.vtblInvoke(Unknown Source)
```

All ArcObjects code in Java must be surrounded by Try/Catch blocks…

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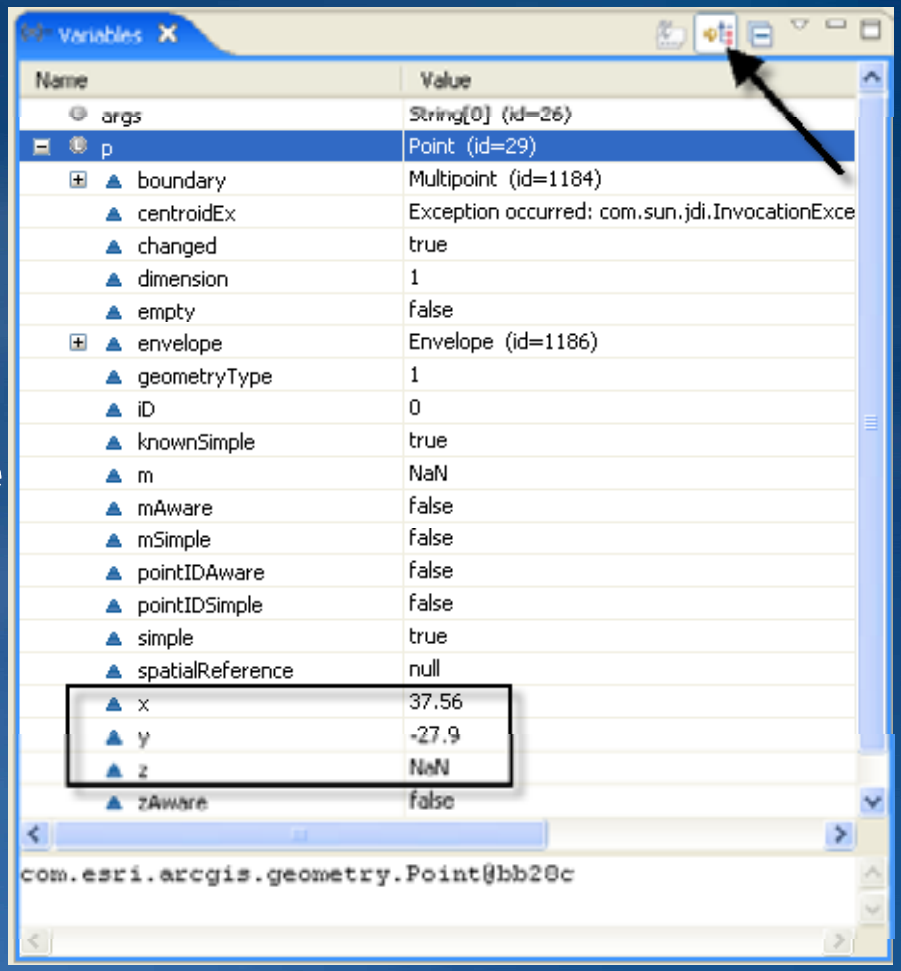
Summary

Demonstration #4

- **Eclipse's debug mode to help trace the state of ArcObjects**
  - **Instead of using `System.out.println();`**
  - **Help you trace your code**
  - **Select "Show Logical Structure" to present more comprehensible information**



Eclipse's debug mode can help you figure out the state of your ArcObjects…

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Demonstration #5

- **Use Case: I would like to narrow down the number of houses I need to visit as I try to purchase a home.**
- **Motivation: Leveraging geoprocessing power in your Java programs**
- **Solution:**
  - **Utilize Geoprocessor Tool Code Generator plug-in**
  - **Design a custom Geoprocessing Model**
  - **Use custom model in Java to run analysis**

Summary

Demonstration #5

- Author custom models, scripts with Desktop software
  - Use Geoprocessing tool code generator to generate Java wrapper
  - Invoke the custom tool using the execute method
- Every standard geoprocessing tool has a wrapper class
  - Wrappers know about tool parameters
  - Constructors accept all mandatory parameters

```
import com.esri.arcgis.geoprocessing.tools.analysistools.*;
//Pass in Strings, ArcObjects, or results from GPUtilities
Clip clipTool = new Clip(input, clipper, output);
GeoProcessor gp = new GeoProcessor();
gp.execute(clipTool, null);
```

- GeoProcessor class only supports one instance of the object (singleton)

R *GeoProcessor knows about all the system tools, but requires an appropriate license …*

Summary

Demonstration #5

- **Wrapper: Java class that represents tool**
  - Every standard geoprocessing tool has wrapper class
  - Wrappers know about all parameters for tool
  - Constructors accept all mandatory tool parameters
- **Using tool wrappers reduces code**
  - Import toolbox alias to distinguish tools you wish to execute
    Wrappers know about tool parameters

```
//Import declaration
import com.esri.arcgis.geoprocessing.tools.analysistools.*;

//Pass in feature classes
Clip clipTool = new Clip(input, clipper, output);

gp.execute(clipTool, null);
```

Whenever possible, utilize Geoprocessing to simplify your code …

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Summary

Demonstration #5

- `Cleaner.release()` explicitly releases ArcObjects references

- Java-COM Interop performs garbage collection most times
  - Relies on JVM's garbage collector (non-deterministic nature)

```
//Iterate a set of features, where featureCount is a large number
for(int index = 0; index < featureCount; index++){
   Feature feature = (Feature) cursor.nextFeature();
   //Do some work with the feature
   Cleaner.release(feature); //Release the feature ArcObject
}
```

Use com.esri.arcobjects.system.Cleaner package when working with the Cleaner class…

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Other Sessions and Demo Theatre

Developer Summit 2009

- **Demo Theatre:**
  - **Leverage Dynamic Display in ArcGIS Engine Applications**
    - **Wednesday March 25, 2009, 4-5pm, Oasis 1**
- **Technical Sessions:**
  - **Extending ArcGIS with Java**
    - **Wednesday, March 25, 2009, 1 – 2:15pm, Primrose C/D**
  - **Building and Extending Tasks for ArcGIS Server Java Web Apps**
    - **Tuesday, March 24, 2009, 2:45 – 4:00pm, Smoketree A-E**
  - **Implementing Security for ArcGIS Server Java Solutions**
    - **Tuesday, March 24, 2009, 4:30 – 5:45pm, Mesquite C**

Other Sessions and Demo Theatre

Developer Summit 2009

- **Technical Sessions:**
  - **Customizing Editing Workflows with the Java Web ADF**
    - Wednesday, March 25, 2009, 10:30 – 11:45am, Mesquite C
  - **Extending ArcGIS Server with Java**
    - Wednesday, March 25, 2009, 2:45 – 4:00pm, Primrose C/D
  - **Customizing Graphics and MapTips with the Java Web ADF**
    - Wednesday, March 25, 2009, 4:30 – 5:45pm, Mesquite C

Want to Learn More?

ESRI Training and Education Resources

- **Instructor-Led Training:**
  - **Introduction to Programming ArcObjects using the Java Platform**
    - Structure of ArcObjects, utilize SDK resources, develop Desktop apps
    - Utilizes ArcGIS Engine for visualization
    - Describes how ArcObjects can be used to extend Server Applications
  - **Developing Applications with ArcGIS Server using the Java Platform**
    - Utilize the components of the Web ADF framework
    - Observe ArcGIS Server programming rules and development patterns
    - Use ADF controls to develop custom applications
    - Develop custom tasks and add them to applications
- **Virtual Campus Training (Self Study):**
  - **Building Applications with ArcGIS Server Using the Java Platform**
  - **Implementing Security for ArcGIS Server 9.3 Java Solutions**

http://www.esri.com/training

Summary

- Today we covered
  - Basics of ArcGIS Engine
  - Initialization modes
  - Customization
  - ArcObjects
  - Geoprocessing

Still have questions?

Additional Resources

Questions, answers and information…

- ***Thank you! Questions?***
  - ***Complete the session survey!***
- ***Tech Talk***
  - ***Outside this room right now!***
- ***Meet the Team***
  - ***"6:00 pm at the Conference Party"***

- ***ESRI Resource Centers***
  - **PPTs, code and video**

resources.esri.com

- ***Social Networking***

www.twitter.com/ESRIDevSummit

tinyurl.com/ESRIDevSummitFB