Developing Java Applications with OSGi

Capital District Java Developers Network

Michael P. Redlich
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My Background (1)

- Degree
  - □B.S. in Computer Science
  - □Rutgers University (go Scarlet Knights!)
- “Petrochemical Research Organization”
  - □Senior Research Technician (1988-1998, 2004-present)
  - □Systems Analyst (1998-2002)
- Ai-Logix, Inc.
  - □Technical Support Engineer (2003-2004)
- Amateur Computer Group of New Jersey (ACGNJ)
  - □Java Users Group Leader (2001-present)
  - □President (2007-present)
  - □Secretary (2006)

My Background (2)

- Publications
  - ❑ Java Boutique (http://www.javaboutique.com/)
    - ❖ Co-authored with Barry Burd
    - ❖ Design Patterns
  - ❑ http://publications.redlich.net/
- Presentations
  - ❑ Trenton Computer Festival (TCF) since 1998
  - ❑ TCF IT Professional Seminars since 2006
  - ❑ Princeton Java Users Group
  - ❑ Capital District Java Developers Network
  - ❑ New York Software Industry Association (NYSIA)

Upcoming Events

- Emerging Technologies for the Enterprise
  - March 26-27, 2008
  - Drexel University
  - Philadelphia, Pennsylvania
  - http://phillyemergingtech.com/

- Trenton Computer Festival
  - April 25-27, 2008
  - The College of New Jersey
  - Ewing, New Jersey
  - http://www.tcf-nj.org/

Objectives

- What is OSGi?
  - ❑OSGi Alliance
  - ❑OSGi Frameworks
  - ❑OSGi Layers
  - ❑How to interact with the framework
- Develop a first OSGi bundle
- Develop a more “Real-World” application
- Source code, source code, source code (*yea!*)

What is OSGi?

- Open Services Gateway initiative (OSGi)
- Originally designed to promote dynamic systems for embedded Java and network devices
- Foundation for an enhanced service-oriented architecture
  - ❑ Defines a standardized, component-oriented environment
  - ❑ Applications can be started, stopped, updated, and uninstalled without requiring the JVM to be restarted

OSGi to the Rescue!

- Component issues
  - ❑ Installation
  - ❑ Start and stop
  - ❑ Manage multiple versions
  - ❑ Update
  - ❑ Uninstall
- JAR file dependency issues
  - ❑ `Class-Path` attribute in MANIFEST file
  - ❑ Versioning in file name

OSGi Alliance

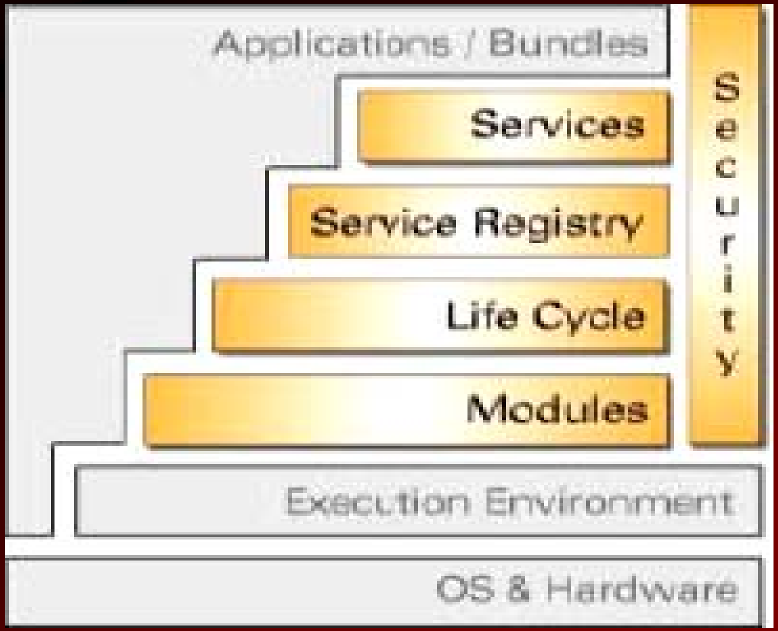
- A non-profit organization formed in March 1999
- "…a worldwide consortium of technology innovators that advances a proven and mature process to assure interoperability of applications and services based on its component integration platform."
- "…provides specifications, reference implementations, test suites and certification to foster a valuable cross-industry ecosystem."

OSGi Frameworks

- Eclipse Equinox (3.3.2)
- Apache Felix (1.0.3)
- Knopflerfish (2.0.5)
- Spring OSGi Modules (1.0.1)
- Newton (0.2)

OSGi Framework Layers

- Modules
  - ❑Class loading policies
- Life Cycle
  - ❑Bundle management
- Service Registry
  - ❑Communication among bundles
  - ❑Service discovery
- Security Layer
  - ❑Spans all other layers

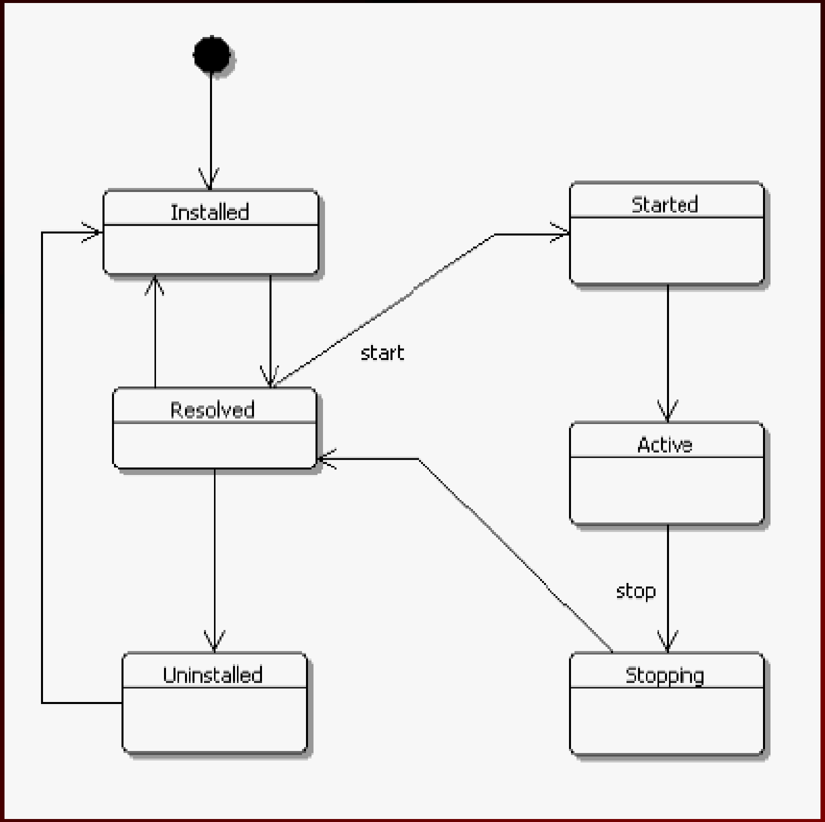


Modules Layer

- Defines class loading policies
- Every bundle can export and import packages
  - ❑A package is always exported with a unique version
  - ❑A bundle can specify a range of versions that it can import
- Supports multiple class spaces where multiple versions of the same class can be used simultaneously
- Ensures that bundles can bind to a new exporting package should the original one be uninstalled

Life Cycle Layer

- Defines how bundles are installed, updated, and uninstalled
  - ❑ UNINSTALLED
  - ❑ INSTALLED
    - ❖ Framework has the bundle
    - ❖ Dependencies not resolved
  - ❑ RESOLVED
    - ❖ Dependencies resolved
    - ❖ Bundle can be started
  - ❑ STARTING
  - ❑ STOPPING
  - ❑ ACTIVE
    - ❖ Bundle is running



Basic APIs to Interact with the Framework

- Bundle
- BundleActivator
- BundleContext
- ServiceRegistration
- ServiceTracker
- ServiceReference

Bundles

- A “module” or “plug-in”
- Packaged in a JAR file
  - ❑Java CLASS files and other resources
  - ❑Special MANIFEST file
- Started through a `BundleActivator`
- Each of the frameworks support special bundles
  - ❑e.g., system bundle that represents the framework

```
Manifest-Version: 1.0
Bundle-Name: Basic Movie Finder
Bundle-Activator:
 org.emergingtech.BasicMovieFinderActivator
Bundle-SymbolicName: org.emergingtech.basicmoviefinder
Bundle-Version: 1.0.0
Import-Package: org.emergingtech;version="[1.0.0,2.0.0)"
Export-Package: org.emergingtech;version="1.0.0"
```

Specifies the name of the class used to start and stop the bundle

Defines a human-readable name (that may contain spaces) for this bundle

Declares imported (including version ranges) and exported packages for this bundle

Specifies a unique, global name for this bundle

BundleActivator

- An interface that may be implemented to start and stop a bundle
- Created by the framework as specified through the `Bundle-Activator` entry in the manifest file
  - ❑ Fully-qualified Java class name

```
void start(BundleContext context);
void stop(BundleContext context);
```

BundleContext

- A bundle's execution context within the framework
  - ❑A “magic ticket” maintained by the framework
- Created by the framework when a bundle is started
- `BundleContext` allows a bundle to:
  - ❑Install new bundles
  - ❑Interrogate other bundles
  - ❑Register services with the Service Registry
  - ❑Subscribe to/consume registered services
  - ❑Retrieve a list of `ServiceReferences` from the Service Registry

And Now For...

- ...our first OSGi example?

Are You Ready?

OSGi Services

- Bundles registered with the Service Registry
  - ❑Services “live” in the Services Registry
- Registered under a Java interface and an optional set of properties
- The framework automatically unregisters all services from a bundle that is stopped
  - ❑Notifies all of its dependents
- Services can be tracked and retrieved

Registering a Service

- To register a service with the framework, use `BundleContext.registerService()` method
- Returns a `ServiceRegistration` object

```
MovieFinder finder = new BasicMovieFinder();

ServiceRegistration registration =
context.registerService(MovieFinder.class.getName(),finder
,properties);
```

Register the specified service, `finder`, with an optional set of specified properties under the specified class name, `MovieFinder`

Consuming a Service

- A separate bundle that is interested in using a registered service
- To discover and retrieve services, use `ServiceTracker`

```
ServiceTracker tracker = new
ServiceTracker(context,MovieFinder.class.getName(),null);

tracker.open();

MovieFinder finder = (MovieFinder)tracker.getService();
```

Creates a `ServiceTracker` object for the specified class name, i.e., the `MovieFinder` service

Returns a `MovieFinder` service being tracked by ServiceTracker

Start tracking instances of `MovieFinder`, i.e., the service, registered in the Service Registry

ServiceRegistration

- A registered service
- For the private use of the registering bundle
  - ❑Should not be shared with other bundles
  - ❑Object returned upon a successful call to `BundleContext.registerService()`
- Used to update the properties of the service or to unregister the service
- Every service registered in the framework has a unique `ServiceRegistration` object

ServiceTracker

- Simplifies using services from the framework's service registry
  - Abstracts away all the gory details of dealing with the Service Registry
- `BundleContext` can also retrieve services, but requires additional maintenance

ServiceReference

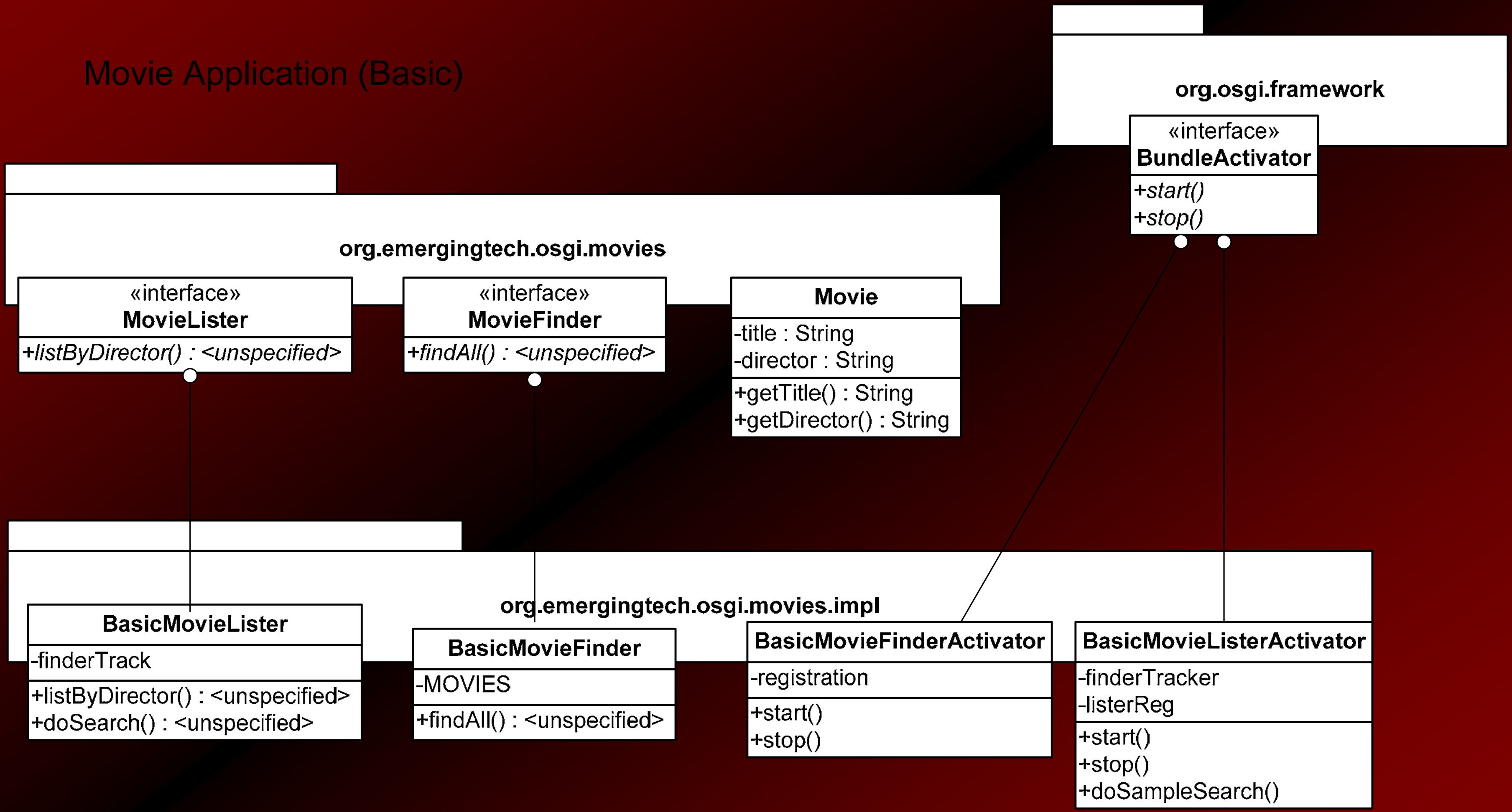
- A reference to a service
- A lightweight handle
- Provides access to a service’s properties but not the actual service object
  - ❑The service object must be acquired through a bundle’s `BundleContext`
  - ❑Can be queried by a bundle to assist in the selection of a service
- Avoids creating unnecessary dynamic service dependencies among bundles

And Now For…

- …a more “real-world” example (*woo-hoo!*)

Are You Ready?

MovieLister Application



Movie Application (Basic)

org.osgi.framework

«interface»
BundleActivator
+start()
+stop()

org.emergingtech.osgi.movies

«interface»
MovieLister
+listByDirector() : <unspecified>

«interface»
MovieFinder
+findAll() : <unspecified>

Movie
-title : String
-director : String
+getTitle() : String
+getDirector() : String

org.emergingtech.osgi.movies.impl

BasicMovieLister
-finderTrack
+listByDirector() : <unspecified>
+doSearch() : <unspecified>

BasicMovieFinder
-MOVIES
+findAll() : <unspecified>

BasicMovieFinderActivator
-registration
+start()
+stop()

BasicMovieListerActivator
-finderTracker
-listerReg
+start()
+stop()
+doSampleSearch()

OSGi Resources (1)

- Equinox
  - ❑ http://www.eclipse.org/equinox/
- Apache Felix
  - ❑ http://felix.apache.org/
- Knopflerfish
  - ❑ http://www.knopflerfish.org/
- Spring OSGi
  - ❑ http://www.springframework.org/osgi/
- Newton
  - ❑ http://newton.codecauldron.org/

OSGi Resources (2)

- OSGi Alliance
  - □ http://www.osgi.org/
- OSGi Technical Whitepaper
  - □ http://www.osgi.org/wiki/uploads/Links/OSGiTechnicalWhitePaper.pdf
- OSGi Best Practices Presentation
  - □ http://www.osgi.org/wiki/uploads/Conference/OSGiBestPractices.pdf
- Getting Started with OSGi
  - □ Neil Bartlett's Point-Free Blog
  - □ http://www.neilbartlett.name/blog/osgi-articles/

Java Resources

- ACGNJ Java Users Group
  - □ facilitated by Mike Redlich
  - □ http://www.javasig.org/
- Princeton Java Users Group
  - □ facilitated by Yakov Fain
  - □ http://www.myflex.org/princetonjug/
- NYJavaSIG
  - □ facilitated by Frank Greco
  - □ http://www.javasig.com/
- Chariot Solutions
  - □ http://www.chariotsolutions.com/