OSGi for Eclipse Developers

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Overview

- Introduction
- Topics
  - Frameworks
  - Import-Package vs. Require-Bundle
  - Dynamic Bundles
  - Extensions and Services
  - Versioning
  - Compendium Services
  - OSGi Tooling
- Conclusion

OSGi...

- The dynamic module system for java

- What’s a module?

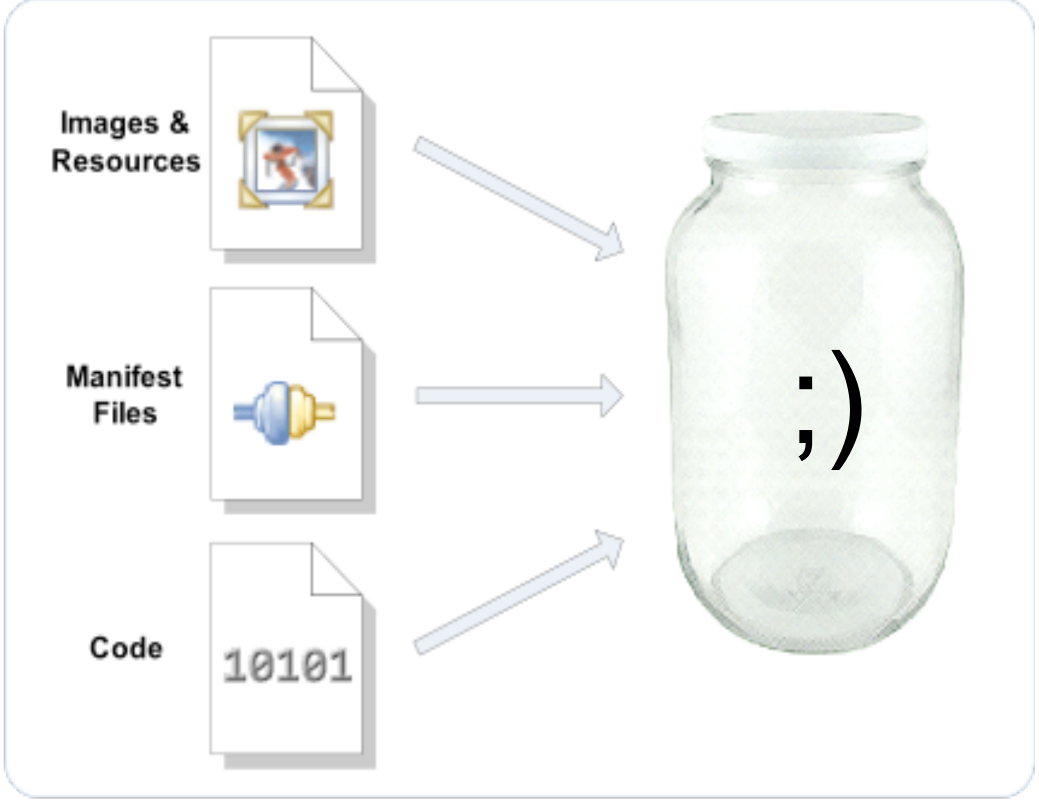
  *“**Modular programming** is a software design technique that increases the extent to which software is composed from separate parts, called modules. Conceptually, modules represent a separation of concerns, and improve maintainability by enforcing logical boundaries between components.”*

JARs != Modules

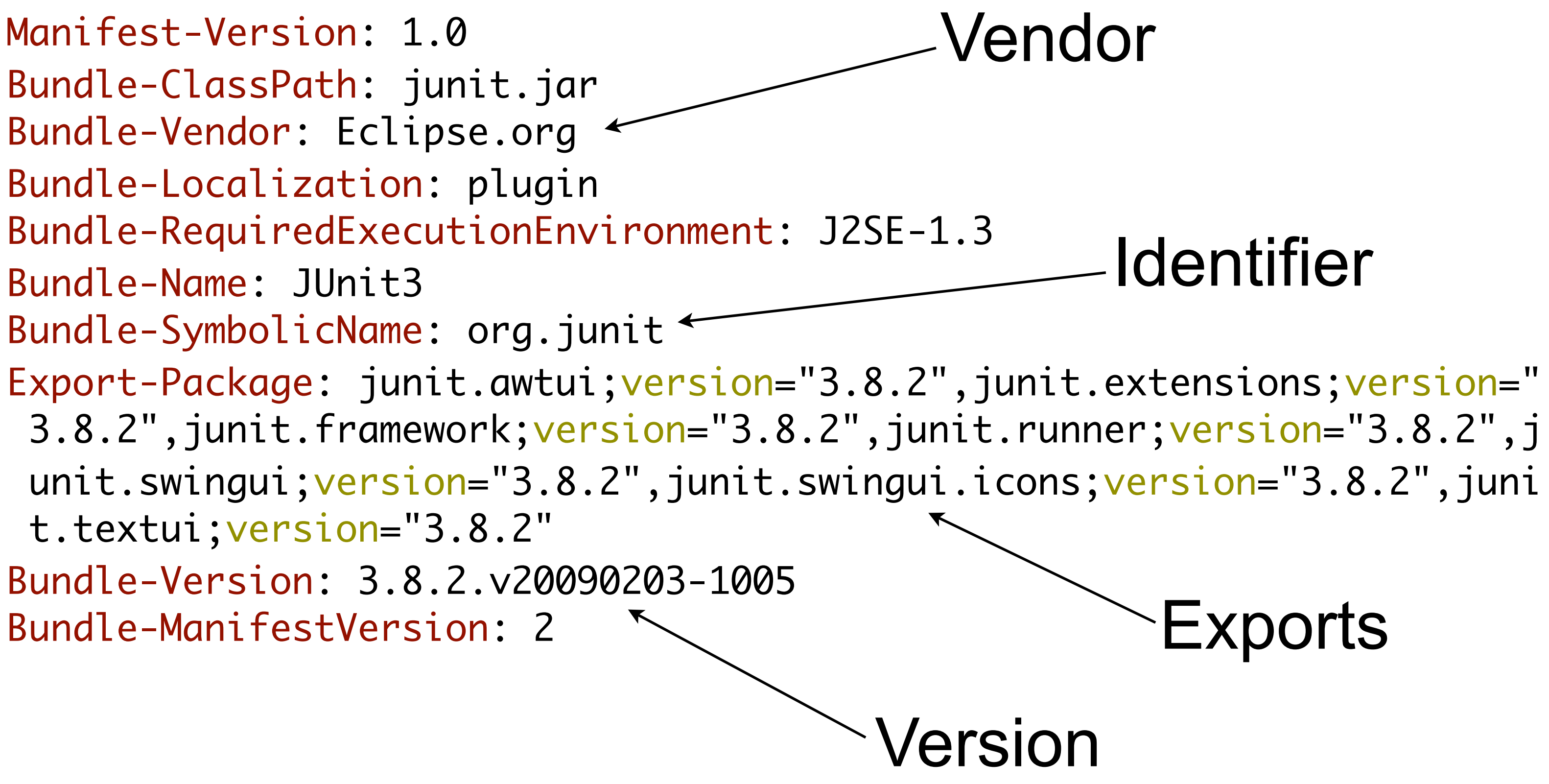
- JARs are deployment artifacts
- JARs have dependencies
- They are not modules... missing crucial information
  - identifier (file name isn’t good enough)
  - version
  - vendor
  - exports
  - dependencies

How does OSGI help?

- OSGi Bundle == Module
- Just a JAR with module related metadata
  - identifier
  - version
  - vendor
  - exports
  - dependencies (imports)



MANIFEST.MF



```
Manifest-Version: 1.0
Bundle-ClassPath: junit.jar
Bundle-Vendor: Eclipse.org
Bundle-Localization: plugin
Bundle-RequiredExecutionEnvironment: J2SE-1.3
Bundle-Name: JUnit3
Bundle-SymbolicName: org.junit
Export-Package: junit.awtui;version="3.8.2",junit.extensions;version="
 3.8.2",junit.framework;version="3.8.2",junit.runner;version="3.8.2",j
 unit.swingui;version="3.8.2",junit.swingui.icons;version="3.8.2",juni
 t.textui;version="3.8.2"
Bundle-Version: 3.8.2.v20090203-1005
Bundle-ManifestVersion: 2
```

Vendor

Identifier

Exports

Version

OSGi in Details

- OSGi Alliance
  - Worldwide consortium of technology innovators that advances OSGi technology

- OSGi Technology
  - Set of *specifications* that define a **module** system for Java
  - Enables modular programming for Java

- Originally designed for embedded systems...
  - Home automation... set-top boxes... vehicles...

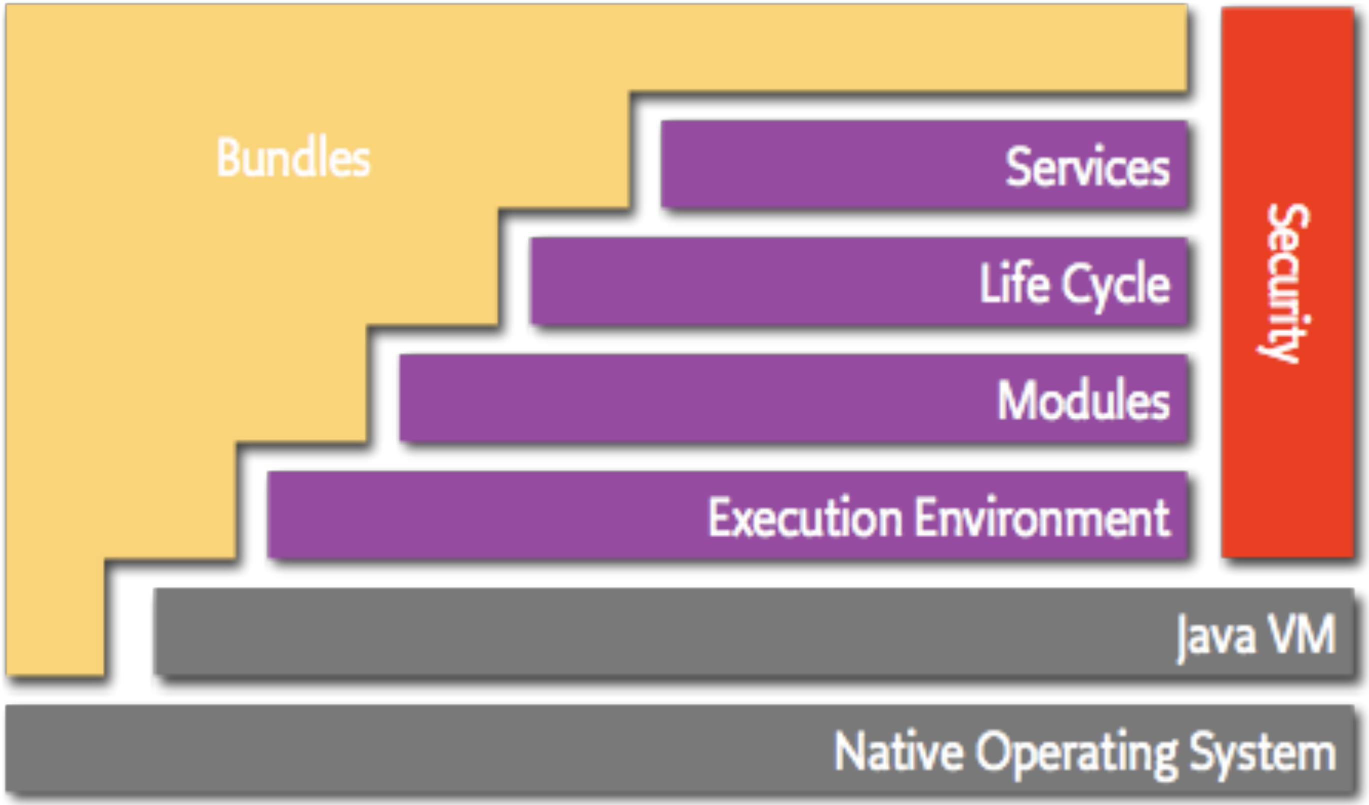
- Now in widespread use in desktop and servers...

OSGi Alliance

- An open standards organization founded in March 1999
  - Founded by Ericsson, IBM, Motorola and Sun Microsystems
- Five expert groups that produce specifications
  - Core Platform
  - Enterprise
  - Mobile
  - Vehicle
  - Residential
- Now ~100 members
  - IBM, Oracle, Tibco, Siemens, SAP, Motorola, Red Hat, etc...

OSGi Layers

- OSGi has a layered model...



OSGi Specifications

- Two major specifications
- Core Specification
  - Covers the core layers of OSGi
- Service Compendium
  - Contains a variety of useful services

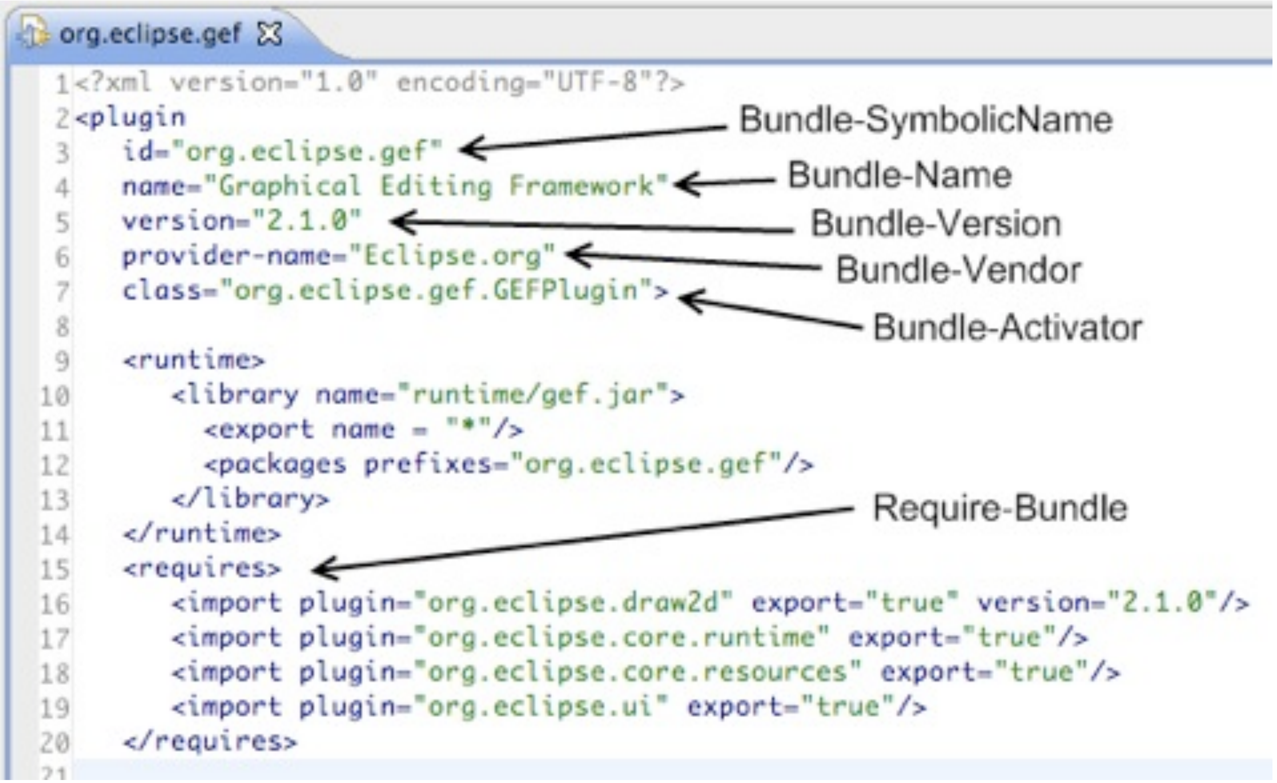
- There are other specifications produced by the various expert groups at OSGi (e.g., Enterprise)

OSGi Specification Releases

- OSGi Release 1 (R1): May 2000
- OSGi Release 2 (R2): October 2001
- OSGi Release 3 (R3): March 2003
- OSGi Release 4 (R4): October 2005
    - Core Specification (R4 Core): October 2005
    - Mobile Specification (R4 Mobile / JSR-232): September 2006
- OSGi Release 4.1 (R4.1): May 2007 (AKA JSR-291)
- OSGi Release 4.2 (R4.2): September 2009
- OSGi Next...?

How does this relate to Eclipse?

- Eclipse had its own non-standard plug-in model
- OSGi and old Eclipse plug-in model were similar



```
<?xml version="1.0" encoding="UTF-8"?>
<plugin
   id="org.eclipse.gef"
   name="Graphical Editing Framework"
   version="2.1.0"
   provider-name="Eclipse.org"
   class="org.eclipse.gef.GEFPlugin">

   <runtime>
      <library name="runtime/gef.jar">
         <export name = "*"/>
         <packages prefixes="org.eclipse.gef"/>
      </library>
   </runtime>
   <requires>
      <import plugin="org.eclipse.draw2d" export="true" version="2.1.0"/>
      <import plugin="org.eclipse.core.runtime" export="true"/>
      <import plugin="org.eclipse.core.resources" export="true"/>
      <import plugin="org.eclipse.ui" export="true"/>
   </requires>
```

Bundle-SymbolicName

Bundle-Name

Bundle-Version

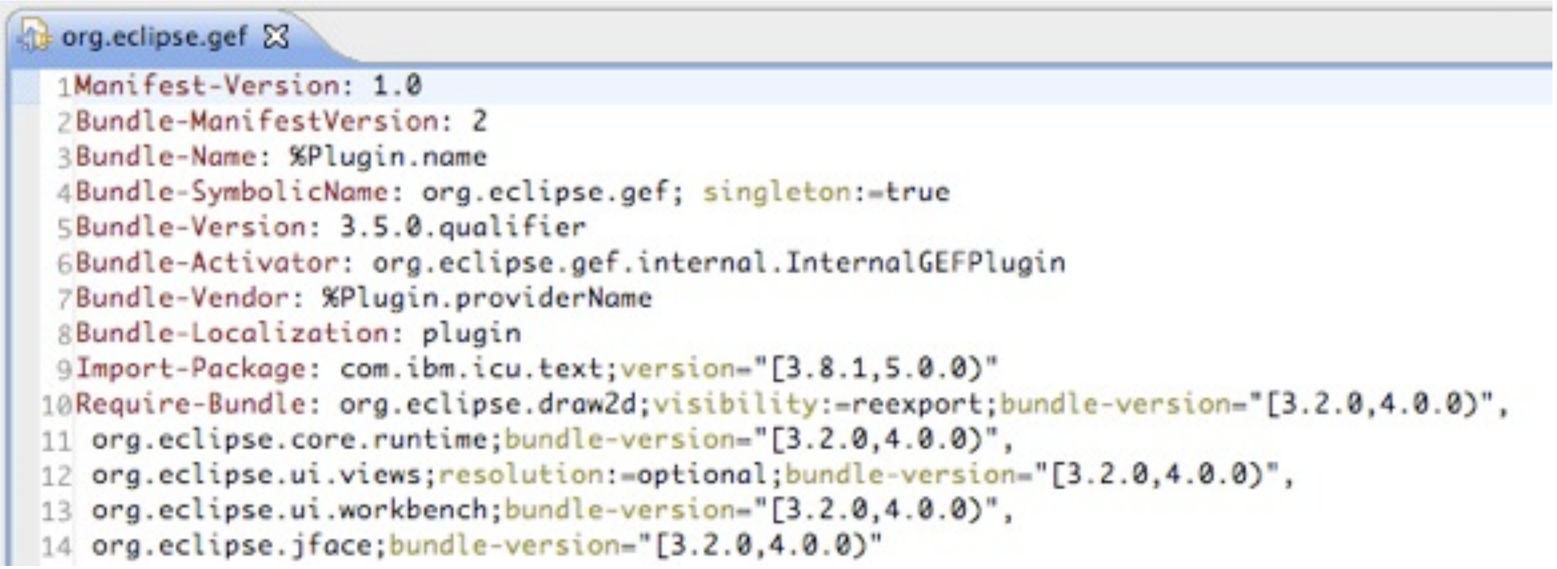
Bundle-Vendor

Bundle-Activator

Require-Bundle

What happened?

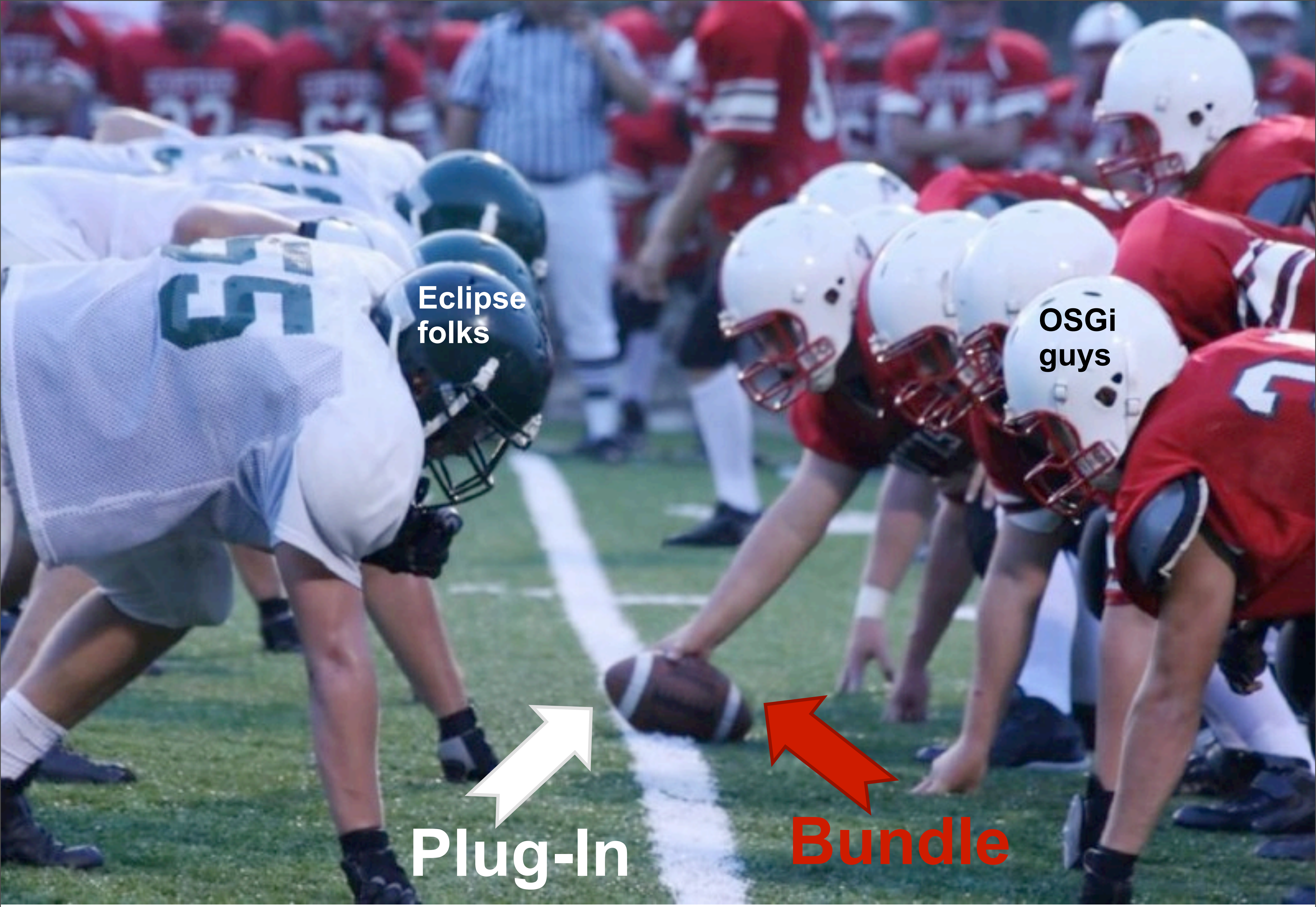
- The world didn’t need two modular systems
- Eclipse went to OSGi in 3.0 with Equinox*
  - Eclipse needed something robust and standard
  - Put OSGi on the map!



```
Manifest-Version: 1.0
Bundle-ManifestVersion: 2
Bundle-Name: %Plugin.name
Bundle-SymbolicName: org.eclipse.gef; singleton:=true
Bundle-Version: 3.5.0.qualifier
Bundle-Activator: org.eclipse.gef.internal.InternalGEFPlugin
Bundle-Vendor: %Plugin.providerName
Bundle-Localization: plugin
Import-Package: com.ibm.icu.text;version="[3.8.1,5.0.0)"
Require-Bundle: org.eclipse.draw2d;visibility:=reexport;bundle-version="[3.2.0,4.0.0)",
 org.eclipse.core.runtime;bundle-version="[3.2.0,4.0.0)",
 org.eclipse.ui.views;resolution:=optional;bundle-version="[3.2.0,4.0.0)",
 org.eclipse.ui.workbench;bundle-version="[3.2.0,4.0.0)",
 org.eclipse.jface;bundle-version="[3.2.0,4.0.0)"
```

*http://portal.acm.org/citation.cfm?id=1086616

Eclipse folks
Plug-In


Eclipse folks
OSGi guys
Plug-In
Bundle

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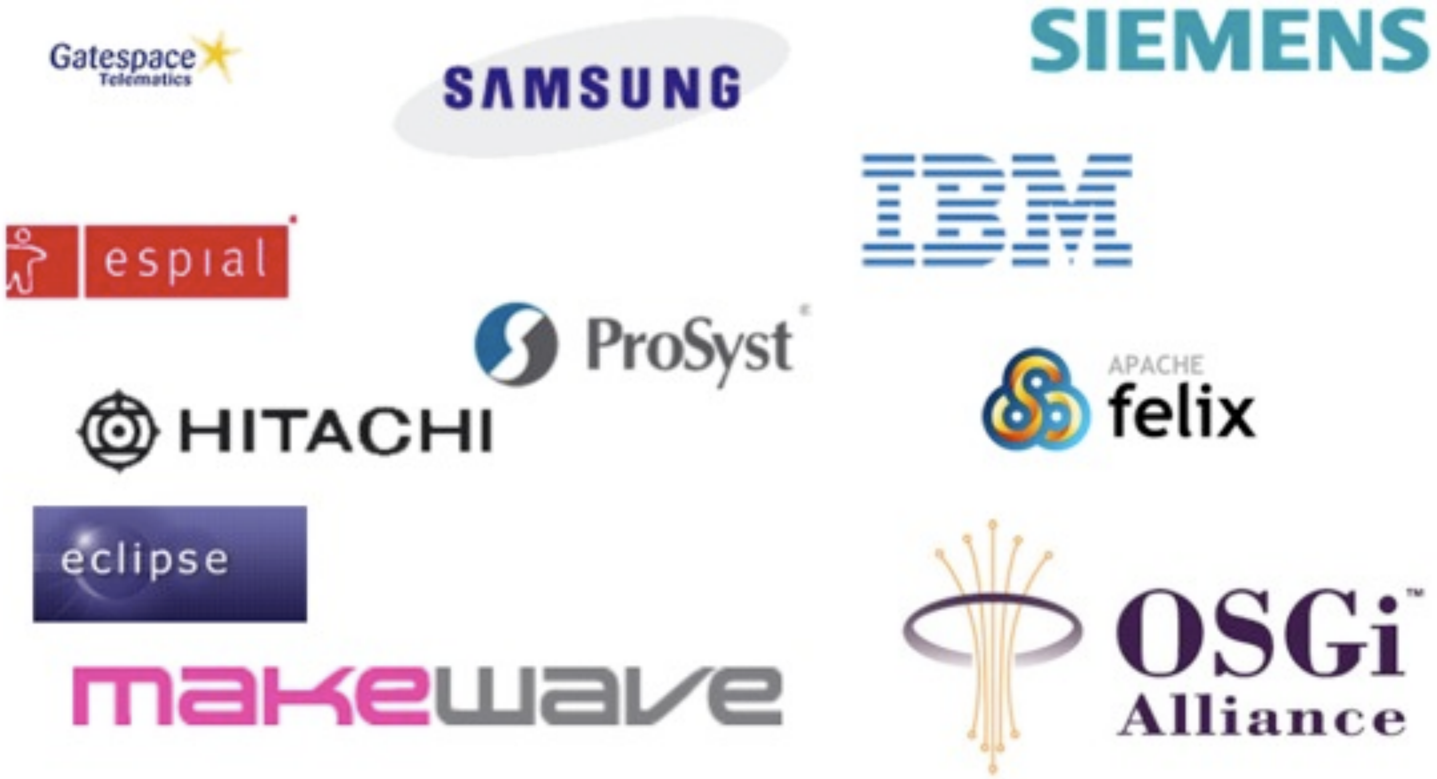
Frameworks

- There's a world outside of Eclipse and Equinox



Framework Implementations

- Equinox (open source)
  - Reference implementation for the core framework and various services
  - Base runtime for all of Eclipse (rich client, server side and embedded)
- Felix (open source)
  - Implementation developed at Apache
  - Ships with GlassFish
- Knopflerfish (open source)
  - BSD license
- Concierge (open source)
  - Highly optimized and tiny R3 implementation
  - Runs in tiny devices
- Many other commercial and private implementations

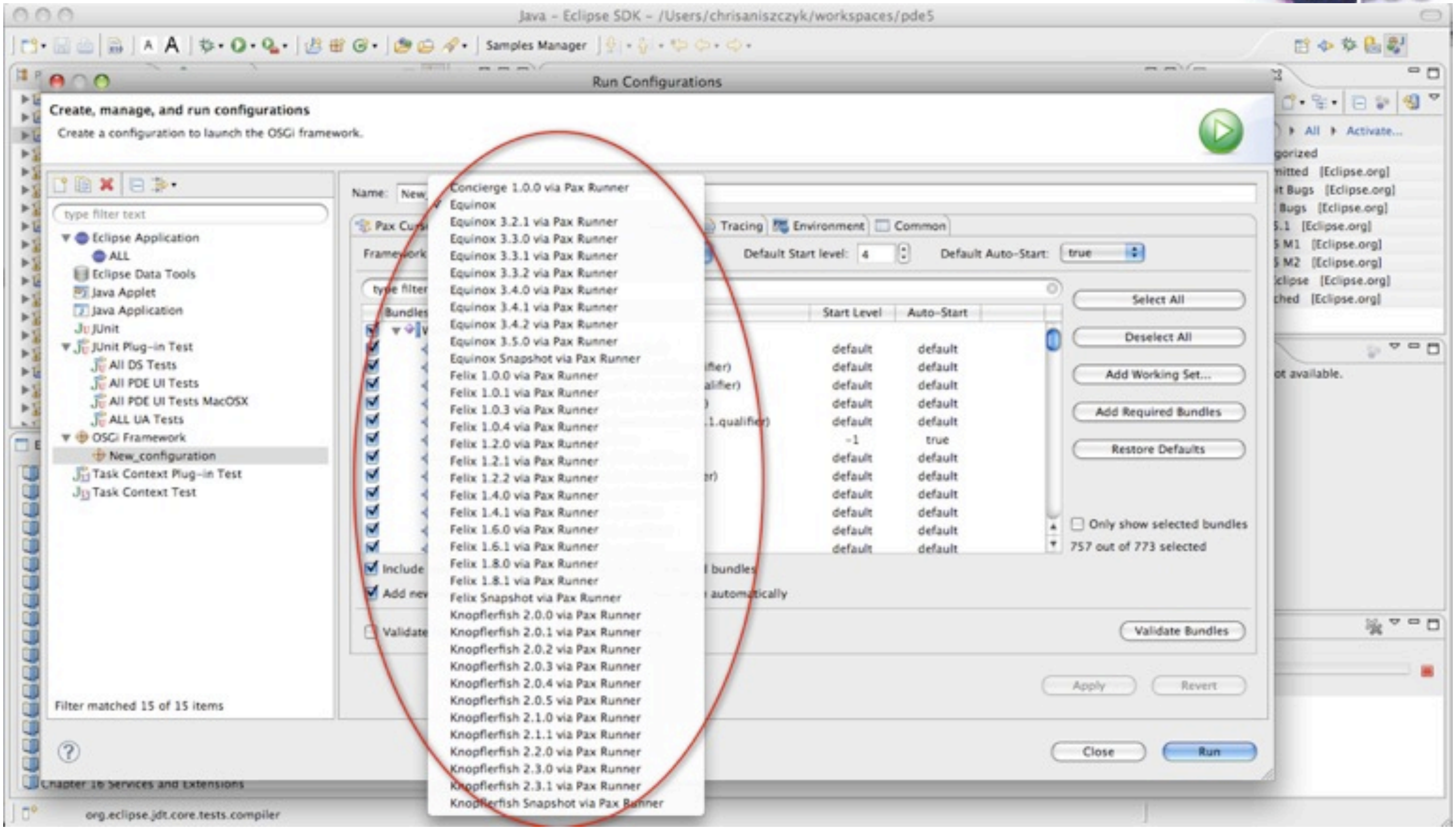
Extensible Framework and Headers

- OSGi is all about extension...

- Becareful framework specific headers:
  - `Eclipse-BuddyPolicy`
  - `Eclipse-PatchFragment`
  - `Eclipse-SourceBundle`
  - `Eclipse-…`

  ➔Otherwise you are tied to Equinox

- Tip: PAX Runner to test against multiple frameworks
  - http://wiki.ops4j.org/display/ops4j/Pax+Runner



Java – Eclipse SDK – /Users/chrisaniszczyk/workspaces/pde5

Run Configurations

Create, manage, and run configurations

Create a configuration to launch the OSGi framework.

Name: New_

Default Start level: 4

Default Auto-Start: true

☐ Only show selected bundles

757 out of 773 selected

Filter matched 15 of 15 items

Samples Manager
type filter text
Eclipse Application
ALL
Eclipse Data Tools
Java Applet
Java Application
JUnit
JUnit Plug-in Test
All DS Tests
All PDE UI Tests
All PDE UI Tests MacOSX
ALL UA Tests
OSGi Framework
New_configuration
Task Context Plug-in Test
Task Context Test
Pax Cu
Tracing
Environment
Common
Framework
Bundles
Start Level
Auto-Start
Concierge 1.0.0 via Pax Runner
Equinox
Equinox 3.2.1 via Pax Runner
Equinox 3.3.0 via Pax Runner
Equinox 3.3.1 via Pax Runner
Equinox 3.3.2 via Pax Runner
Equinox 3.4.0 via Pax Runner
Equinox 3.4.1 via Pax Runner
Equinox 3.4.2 via Pax Runner
Equinox 3.5.0 via Pax Runner
Equinox Snapshot via Pax Runner
Felix 1.0.0 via Pax Runner
Felix 1.0.1 via Pax Runner
Felix 1.0.3 via Pax Runner
Felix 1.0.4 via Pax Runner
Felix 1.2.0 via Pax Runner
Felix 1.2.1 via Pax Runner
Felix 1.2.2 via Pax Runner
Felix 1.4.0 via Pax Runner
Felix 1.4.1 via Pax Runner
Felix 1.6.0 via Pax Runner
Felix 1.6.1 via Pax Runner
Felix 1.8.0 via Pax Runner
Felix 1.8.1 via Pax Runner
Felix Snapshot via Pax Runner
Knopflerfish 2.0.0 via Pax Runner
Knopflerfish 2.0.1 via Pax Runner
Knopflerfish 2.0.2 via Pax Runner
Knopflerfish 2.0.3 via Pax Runner
Knopflerfish 2.0.4 via Pax Runner
Knopflerfish 2.0.5 via Pax Runner
Knopflerfish 2.1.0 via Pax Runner
Knopflerfish 2.1.1 via Pax Runner
Knopflerfish 2.2.0 via Pax Runner
Knopflerfish 2.3.0 via Pax Runner
Knopflerfish 2.3.1 via Pax Runner
Knopflerfish Snapshot via Pax Runner
Select All
Deselect All
Add Working Set...
Add Required Bundles
Restore Defaults
Include
Add new
Validate
bundles
automatically
Validate Bundles
Apply
Revert
Close
Run
All
Activate...
Chapter 16 Services and Extensions
org.eclipse.jdt.core.tests.compiler

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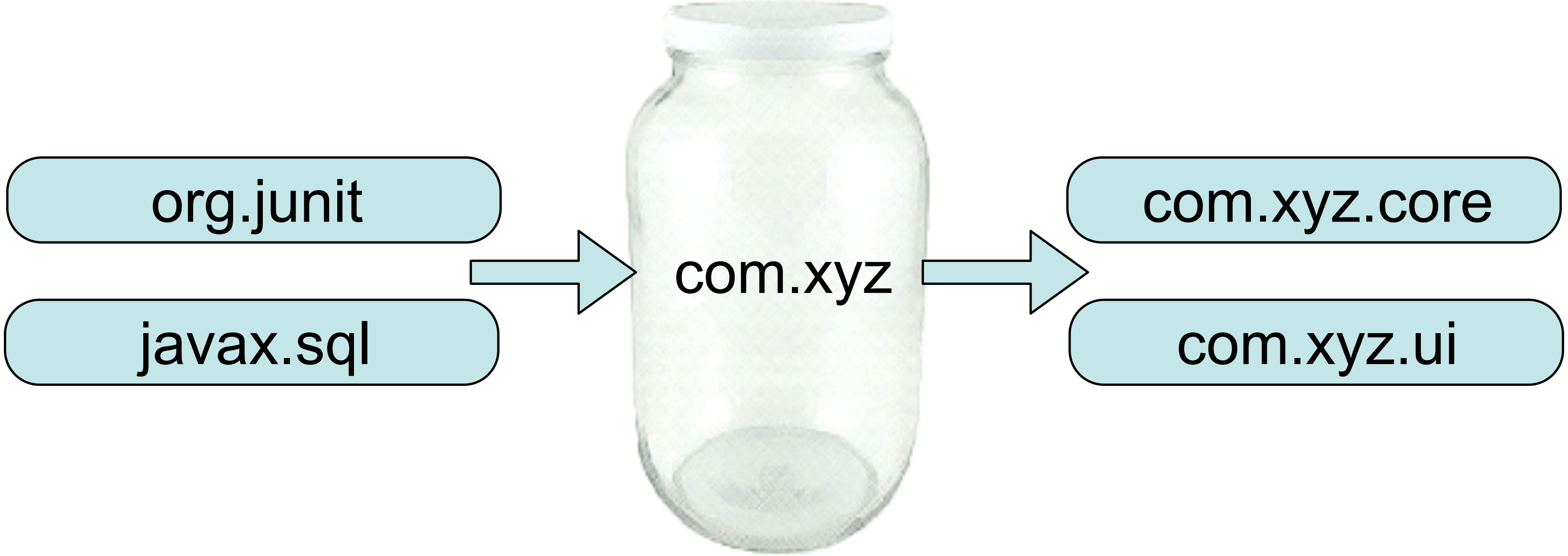
Dependency Management

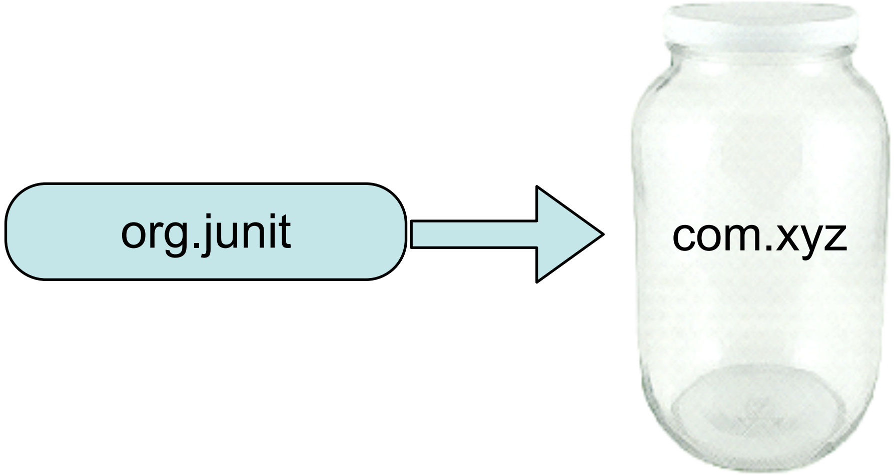
- Eclipse
  - Dependencies are *traditionally* using `Require-Bundle`
  - Never heard of `Import-Package`, sounds strange

- OSGi
  - Please don't use `Require-Bundle` at all
  - Instead, define dependencies using `Import-Package`

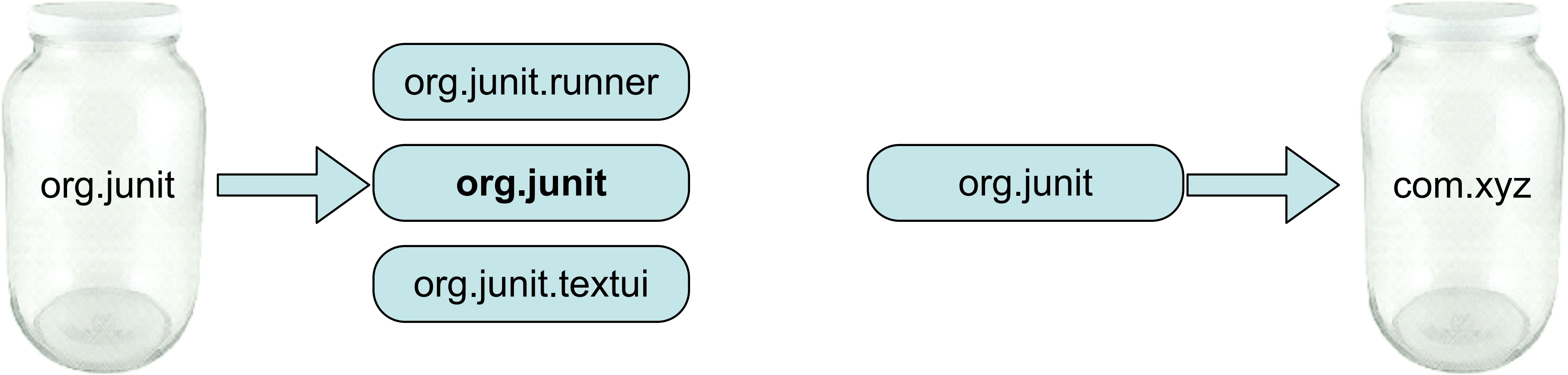
Imports and Exports



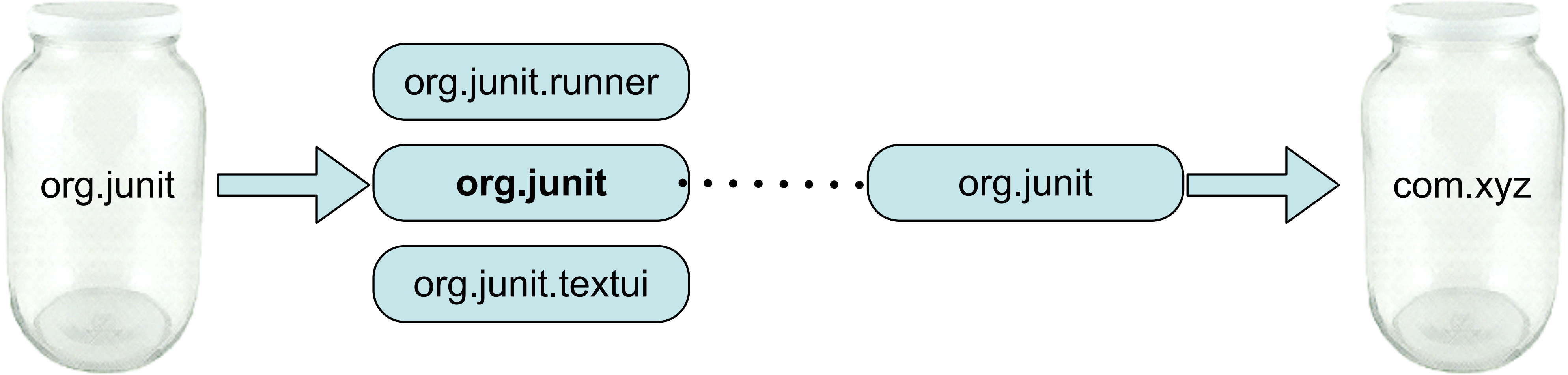
Package Resolution



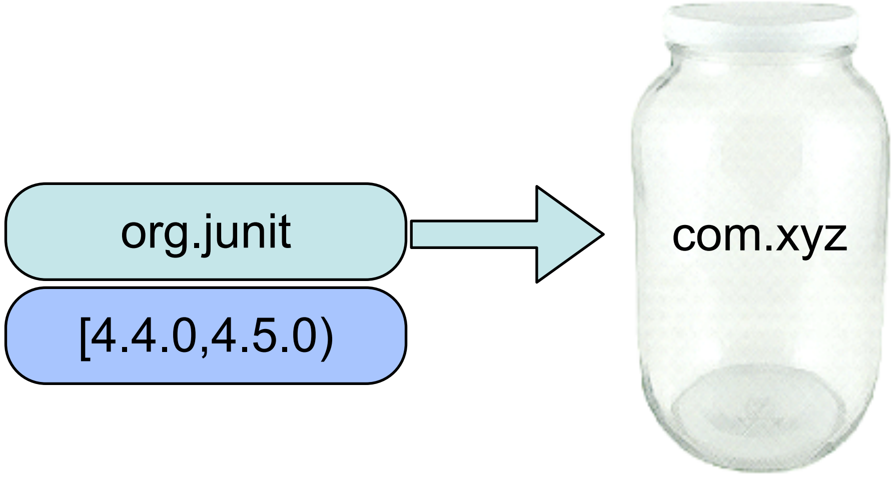
Package Resolution



Package Resolution



Versioned Package Resolution

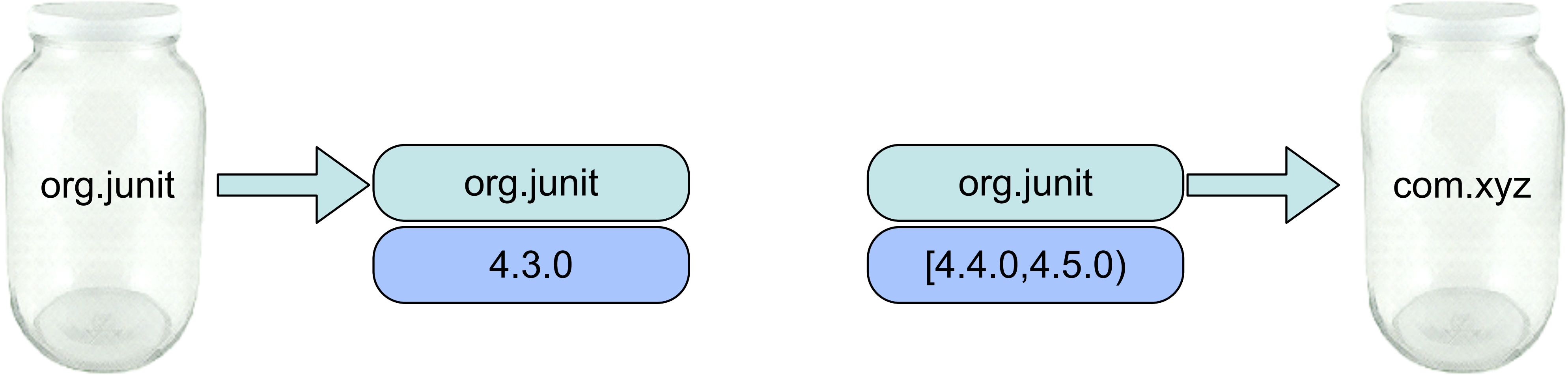


org.junit

[4.4.0,4.5.0)

com.xyz

Versioned Package Resolution



org.junit

org.junit

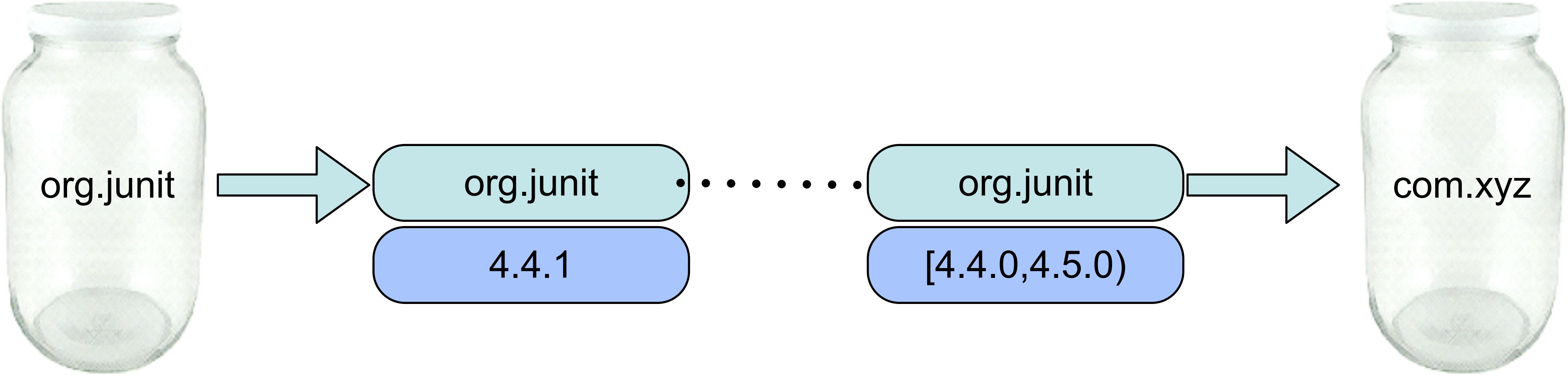
4.3.0

org.junit

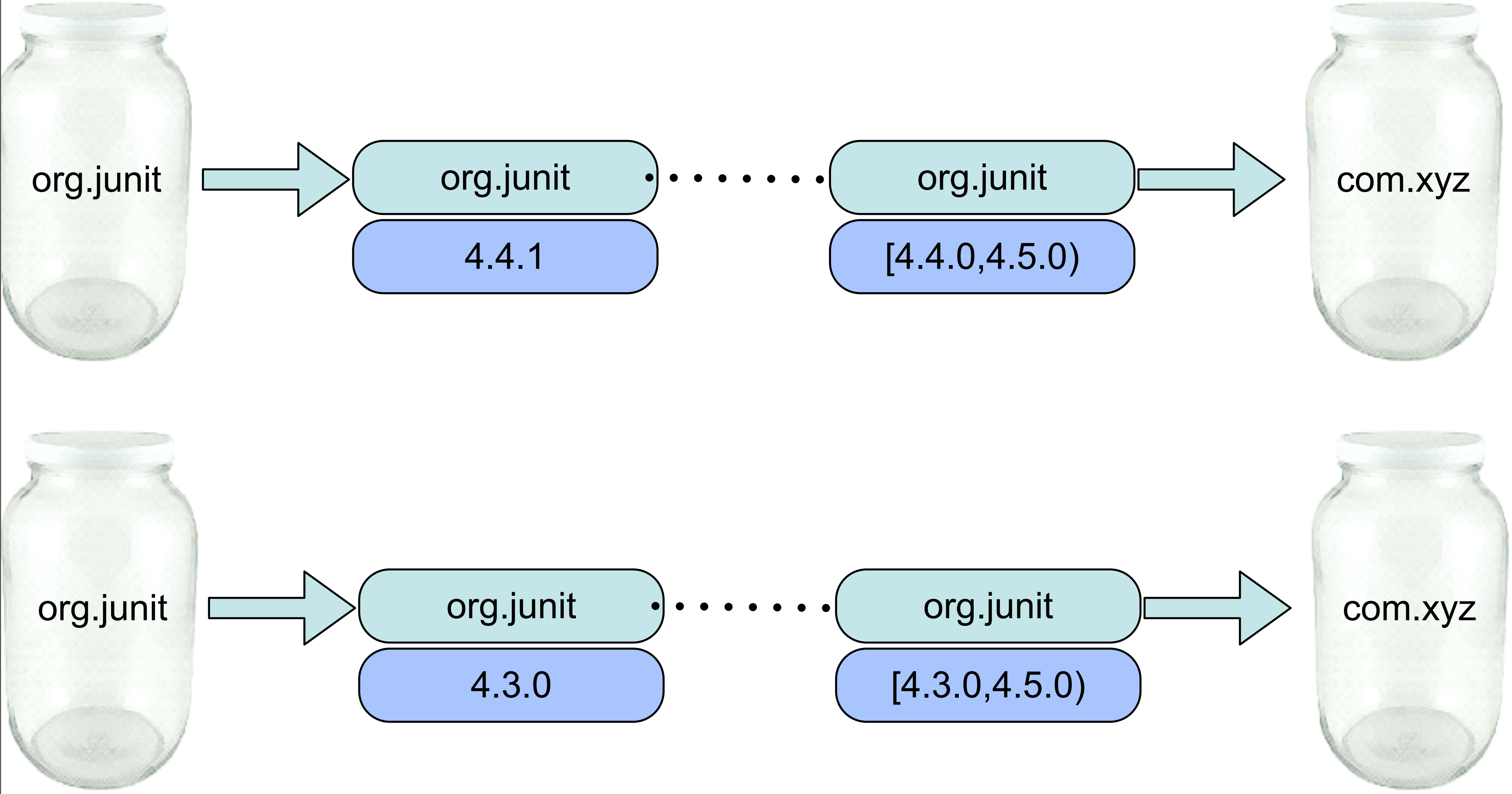
[4.4.0,4.5.0)

com.xyz

Versioned Package Resolution

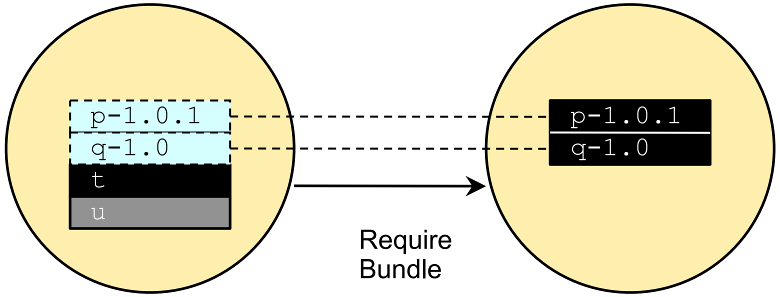


Versioned Package Resolution

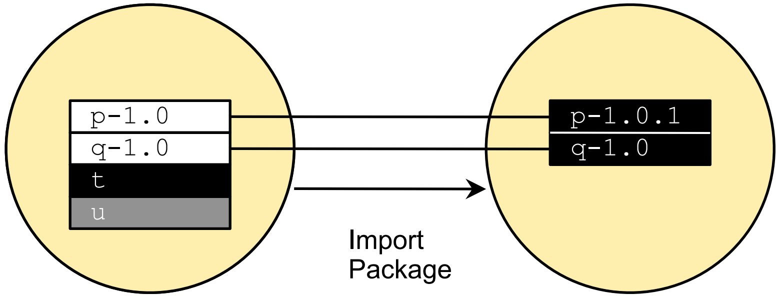


What is the difference?

- `Require-Bundle`
  - Imports all exported packages of the bundle, including re-exported and split bundle packages

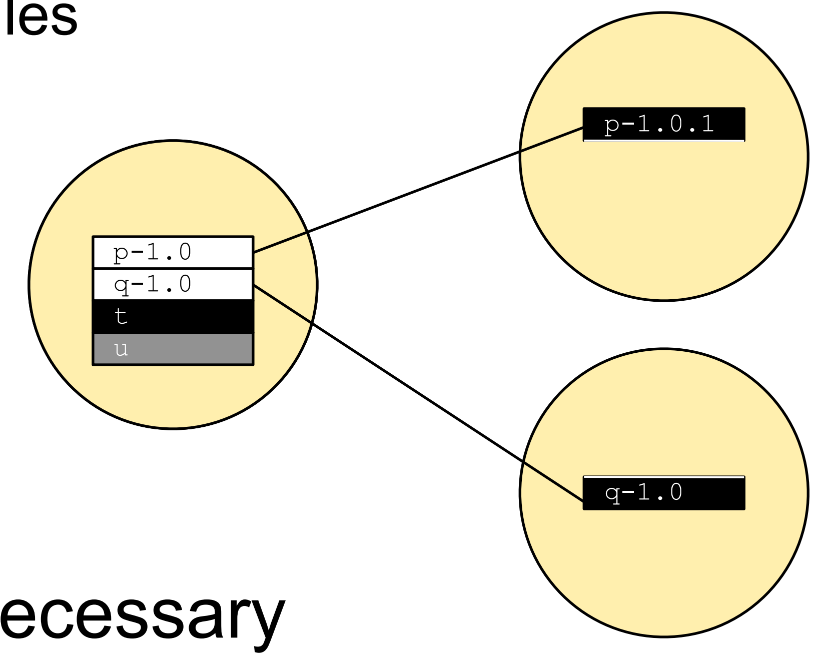


- `Import-Package`
  - Import just the package you need



When to use what?

- Prefer using `Import-Package`
  - Lighter coupling between bundles
  - Less visibilities
  - Eases refactoring



- `Require-Bundle`, when necessary
  - Don’t mind higher coupling between bundles
  - split packages (same package in different bundles)

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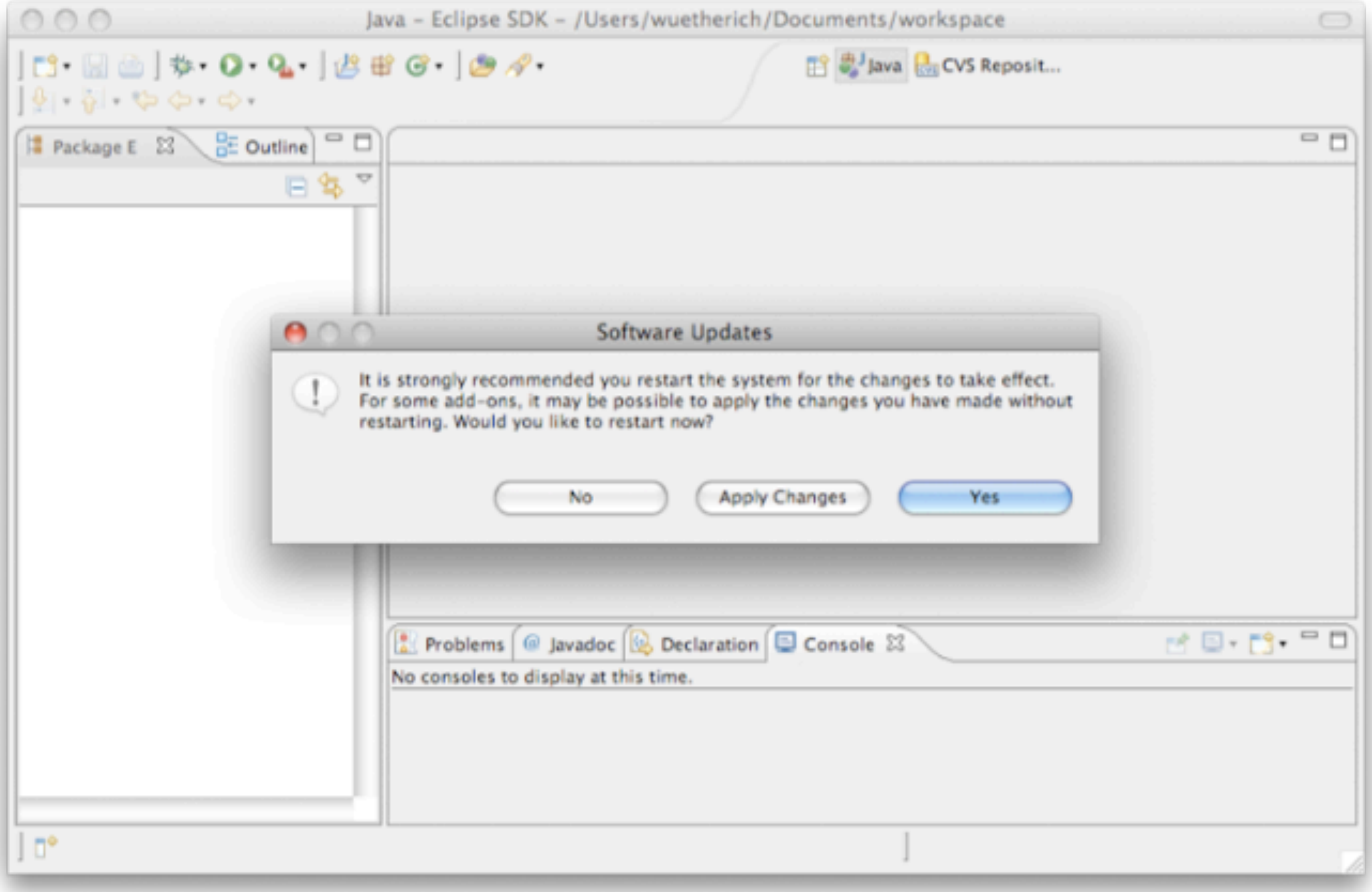
Bundles are dynamic? You're kidding…



It is strongly recommended you restart the system for the changes to take effect. For some add-ons, it may be possible to apply the changes you have made without restarting. Would you like to restart now?

No consoles to display at this time.

Dynamics with OSGi

- OSGi allows you to manage bundles at runtime
  - Install
  - Update
  - Uninstall

- But there is no magic behind the scenes
  - nothing is changed automatically
  - objects stay the same
  - references remain valid

- This means you need to cleanup after yourself!
  - ...so the GC can help you!

Updating a bundle at runtime means...

- Dependent bundles (with wires to the updated bundle via `Require-Bundle` or `Import-Package`) are stopped and re-started

- The consequence:
  - updating a bundle might cause the system to “restart”
  - this is not what I associate with “cool dynamics”

➔ When programming anticipate OSGi’s dynamics

Think about dependencies

- **Less is more!**
  - Less dependencies is a good thing
  - Separation of core and user interface code
  - Dependency Inversion Principle (DIP)

- Think hard about your APIs
  - API should be in a separate bundle
  - depend only on API bundle
  - API implementation can change

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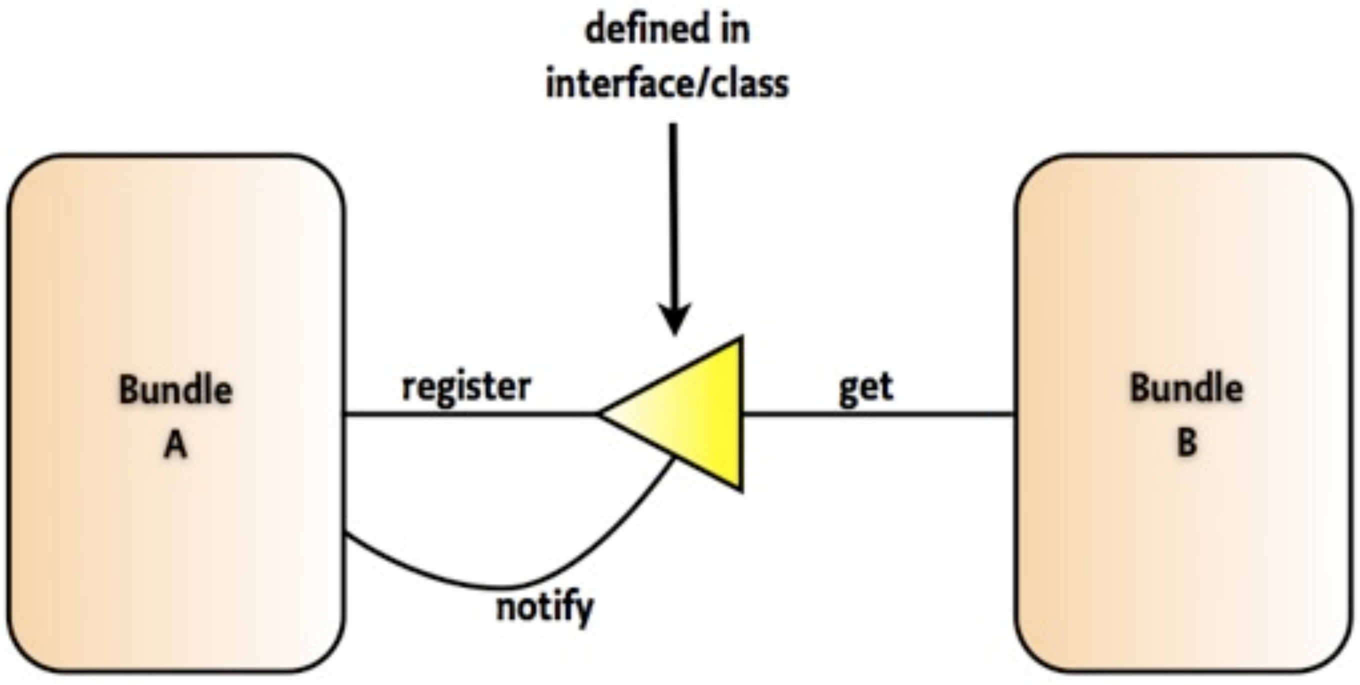
OSGi Services

OSGi Service providers:

implement an interface and register an implementation

OSGi Service consumers:

lookup a service via the interface



Versioned Contracts

- the service interface is the contract
  - many consumers possible
  - many producers possible

- this contract is versioned
  - multiple versions of service might be available
  - you get only those that matches your dependencies

➔You cannot get that with extension points

- singleton bundles
- you always get the latest version

“You come and go”

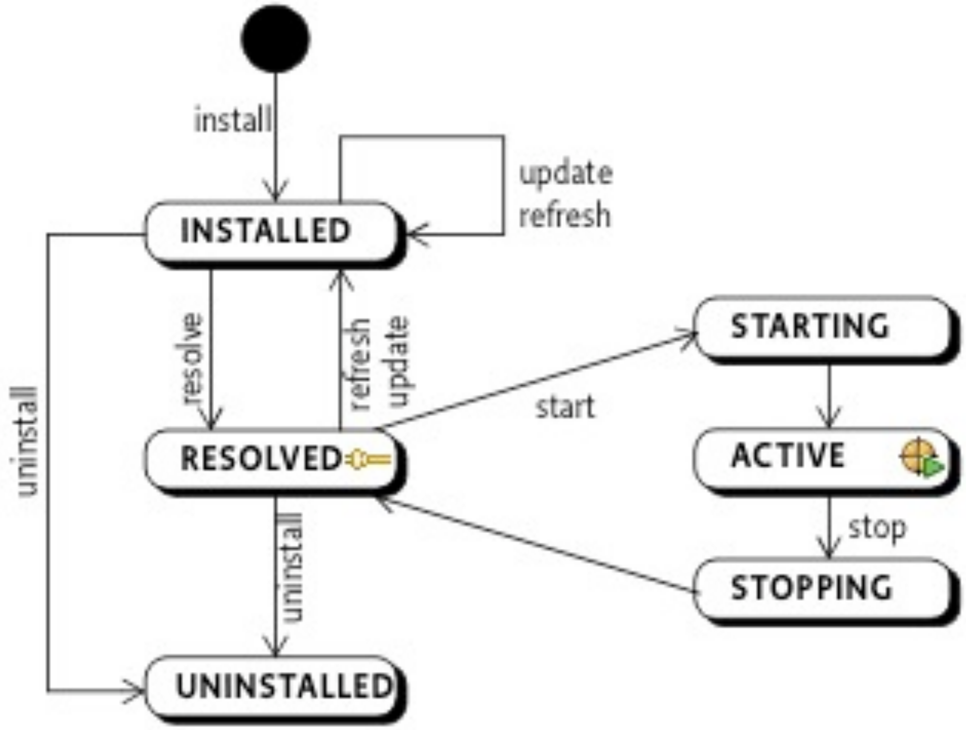
- A bundle is started:
  - services are registered
  - and available from that on

- A bundle is stopped:
  - services are unregistered
  - no longer available

- OSGi services are dynamic by definition!

Life Cycle Differences

- Services are bound to the ACTIVE state
- Extensions are available in RESOLVED state



Declarative and lazy

- OSGi services are **bound to the active state**
  - they need class loading to happen
  - they need objects to be created

- Lazy and declarative approaches for services
  - OSGi Declarative Services
  - OSGi Blueprint
  - iPOJO

When to use what?

- OSGi Services:
  - Dependencies between bundles
  - Dynamics
  - Looser coupling
  - "I provide a service for anybody out there"
  - "I need a service and don't care who delivers it"
- Extension Registry:
  - UI contributions (too small for OSGi services)
  - Non-code contributions
  - "I open up myself for extensions that I don't know upfront"
  - If you have tons of thousand of extensions

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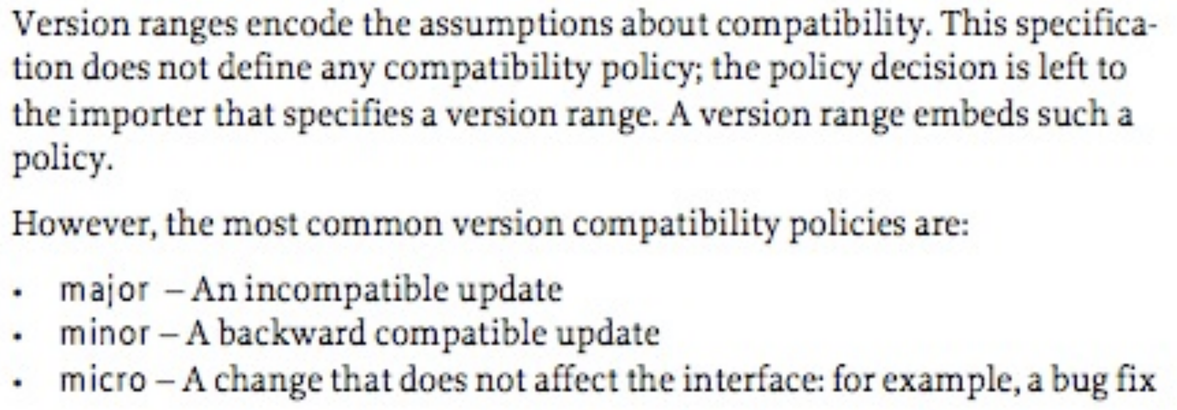
Versioning Guidelines

- Bundle-Version: 3.6.0.qualifier
  - 3 - major version
  - 6 - minor version
  - 0 - micro version
- From the OSGi specification...



Version ranges encode the assumptions about compatibility. This specification does not define any compatibility policy; the policy decision is left to the importer that specifies a version range. A version range embeds such a policy.

However, the most common version compatibility policies are:

- major – An incompatible update
- minor – A backward compatible update
- micro – A change that does not affect the interface: for example, a bug fix

- Eclipse Versioning Guidelines
  - http://wiki.eclipse.org/Version_Numbering

Versioning Bundles

- On Bundle level
  - Each bundle has a version
  - You should set a version when using `Require-Bundle`
- On Package level
  - Packages should also have a version when exported
    - Remember: `Import-Package`
  - Package imports should have version ranges as well!
- Summary
  - Version everything!
  - A version isn’t a marketing number!

Versioning Tools

- PDE API Tools
  - http://www.eclipse.org/pde/pde-api-tools/

- Assists with the mechanics of API evolution
  - Binary compatibility (breaking) issues
  - API leaks
  - API freeze issues
  - API usage scans
  - Suggestions for bundle versions
  - Runs headless in your build and in your workspace

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Compendium Services

- OSGi has spec'd 20+ services

- LogService
- EventAdmin
- HttpService
- Declarative Services
- Configuration Admin

OSGi Service Platform
Service Compendium
The OSGi Alliance

Release 4, Version 4.1
April 2007

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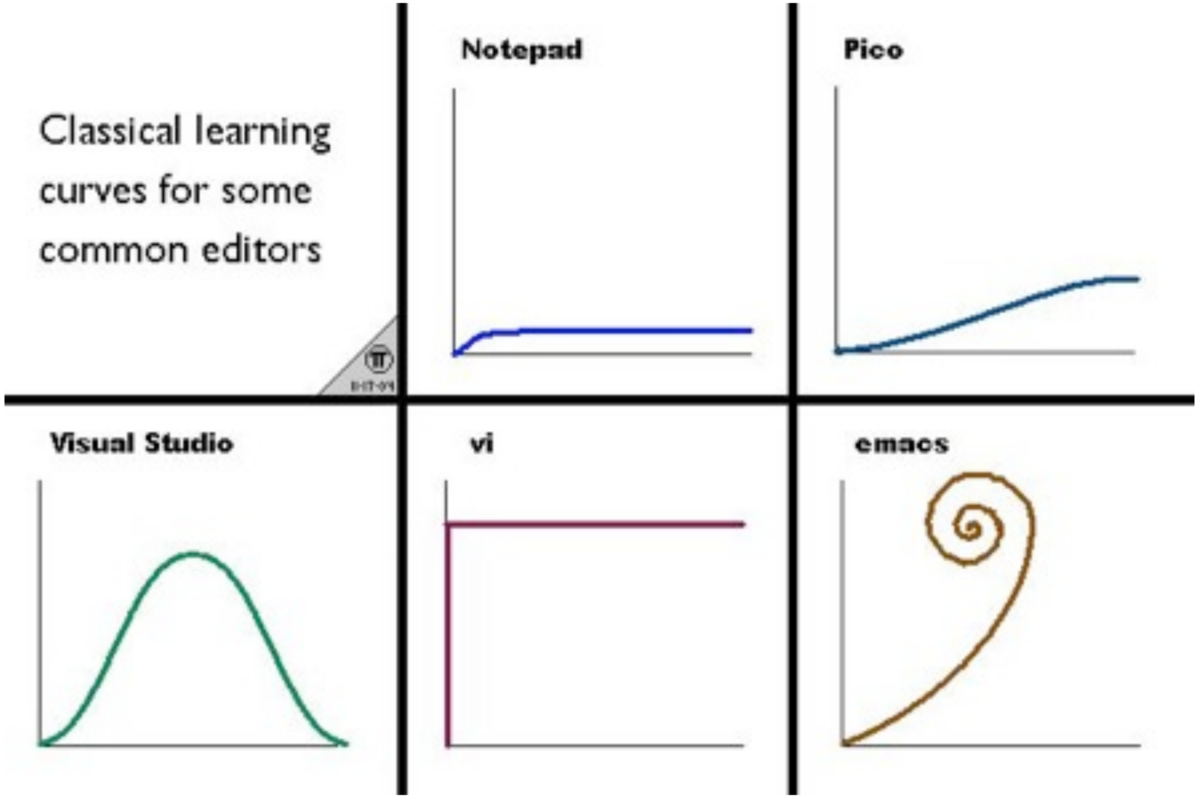
Tools Tools Tools

- In OSGi land, there are lots of options...
  - PDE, Maven, BND...



Tools and Religion

- Tools inspire religious debate sometimes...
- Choice of tooling will be like your choice of religion...
- Remember emacs vs. vi ;)?

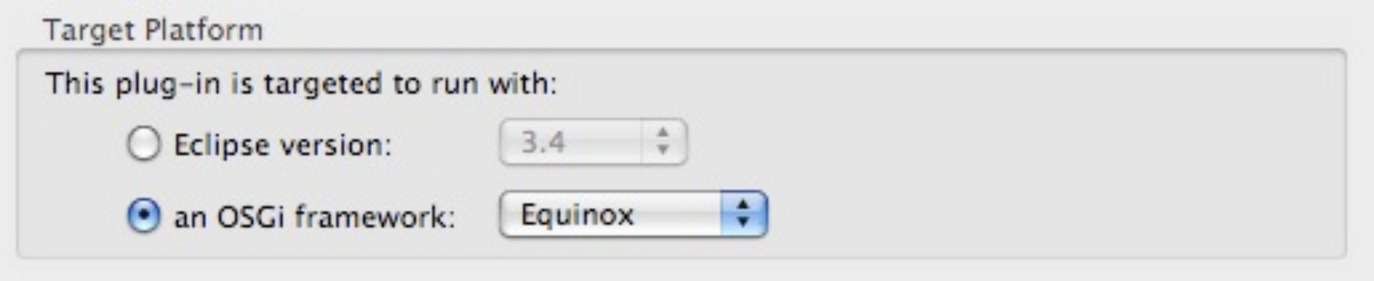
Hackles
By Drake Emko & Jen Brodzik
TERMINAL C
GEEK AIRLINES
Welcome aboard! Which section do you want to sit in?
Quork!
emacs section
vi section
http://hackles.org
Copyright © 2003 Drake Emko & Jen Brodzik

OSGi Tooling Types

- Two main types of OSGi tooling
- Manifest First (e.g., PDE)
  - Provides tooling to hand craft OSGi artifacts
  - Centers around the OSGi manifest
- Template Driven (e.g., BND)
  - Provides tooling to use templates to generate OSGi artifacts

PDE

- Eclipse has been tooling OSGi forever with PDE
  - Plug-ins == Bundles! Blugins?
  - Tens of thousands of developers using PDE for over 5 years
- PDE provides world class tooling for OSGi:
  - Bundles
  - Fragments
  - Declarative Services
- New Plug-in Project wizard has OSGi love



Target Platform

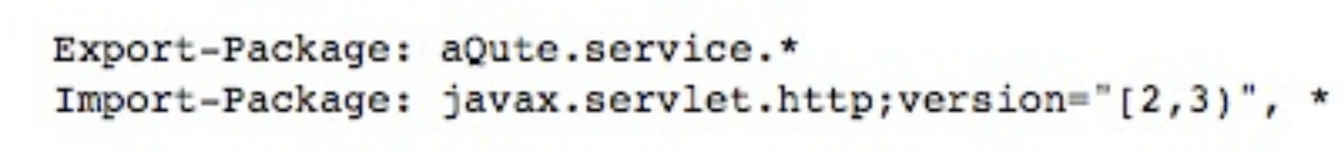
This plug-in is targeted to run with:

○ Eclipse version: 3.4

● an OSGi framework: Equinox

BND

- Bundle Tool (BND)
  - creates and diagnoses OSGi bundles
  - Maven, Eclipse and Ant integration
  - http://www.aqute.biz/Code/Bnd
- Relies on specification (.bnd file) + classpath



```
Export-Package: aQute.service.*
Import-Package: javax.servlet.http;version="[2,3)", *
```

- Generates bundle artifacts like manifests
- Useful for converting third party libs to bundles

Sigil

- Provides OSGi Tooling
  - http://sigil.codecauldron.org/
  - driven by sigil.properties file
  - BND used under the covers
  - being donated to Apache Felix project

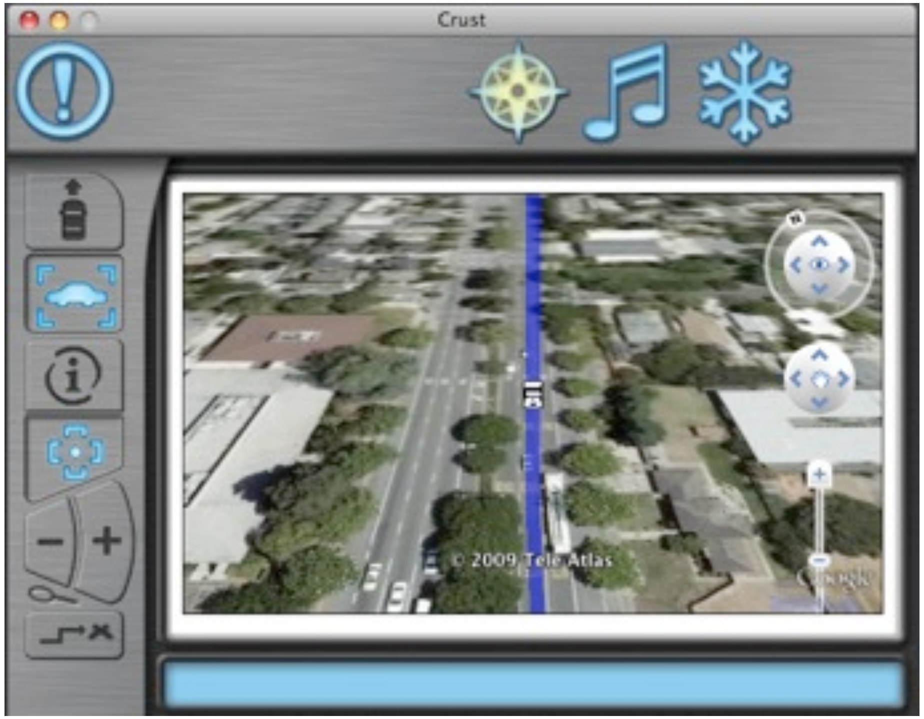
- bundles fetched from repositories
  - based on your Import-Package statements

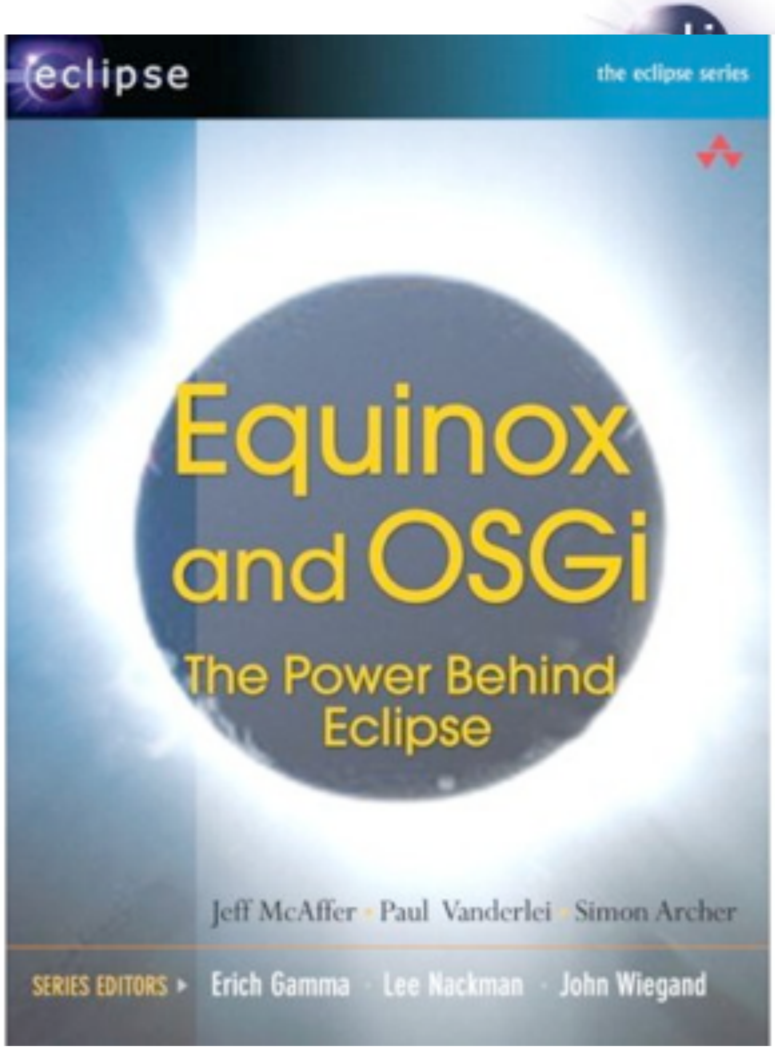
Thank you for your attention!

- In Summary...
  - OSGi is more than Eclipse
  - Eclipse is building on OSGi
- Questions and feedback welcome!

Want to learn more?

- Equinox OSGi Book
  - Learn OSGi using Eclipse
  - TOAST Demo
  - http://wiki.eclipse.org/Toast




eclipse
the eclipse series
Equinox and OSGi
The Power Behind Eclipse
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