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Converting (Large) Applications to OSGi™

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TS-5122



Learn How to Simplify Application Development by Building for the OSGi Service Platform

And have fun doing it!

GOAL

Agenda

- **Modularization**
- Modularization in Java™ Apps
- The OSGi™ Framework
- Legacy Code
- Dynamic Class Loading
- Designing with Services
- Building
- Pitfalls
- Conclusion



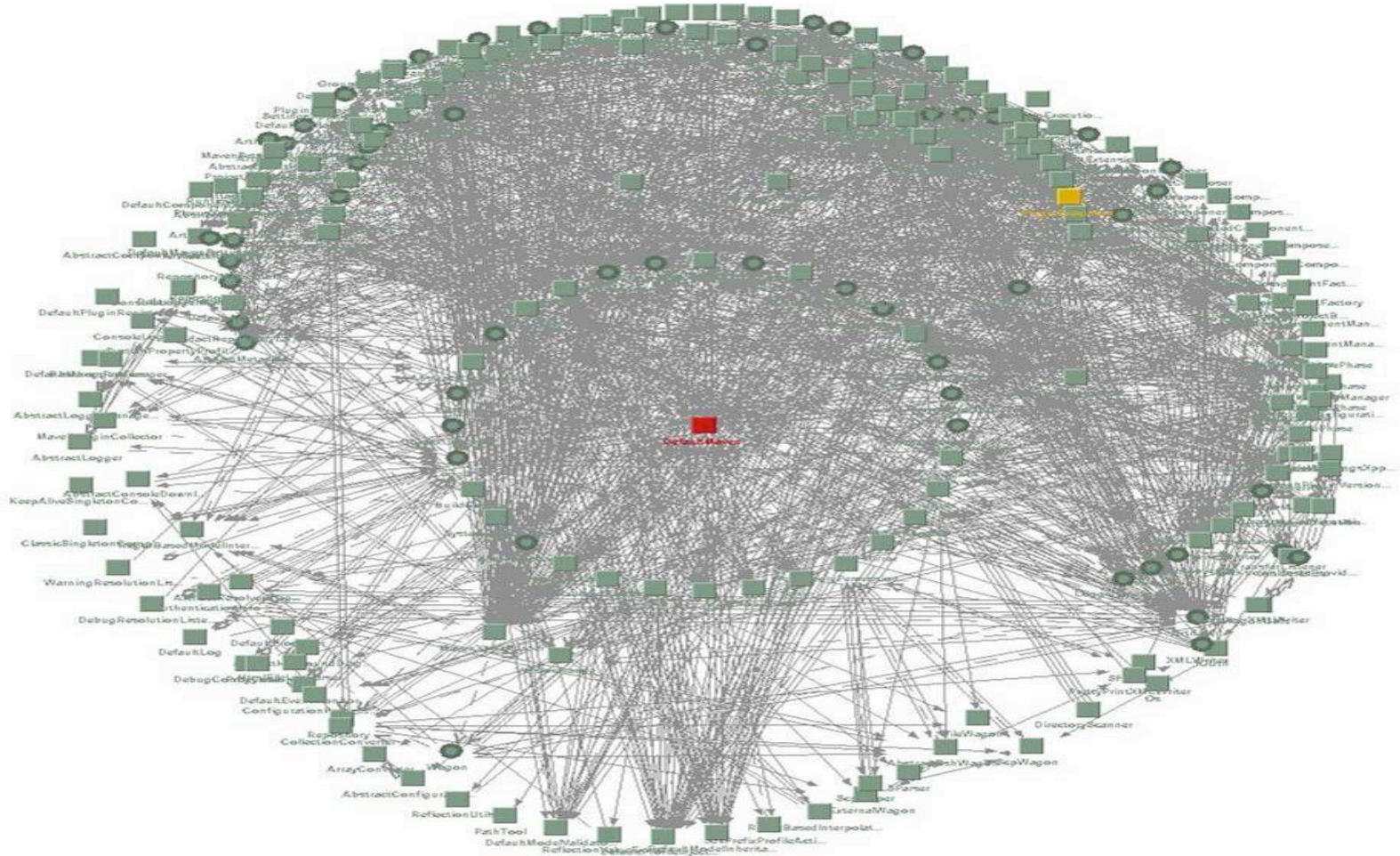
Modularization

- Recycling old ideas that were raised in the early seventies by, among others, David Parnas:
 - High Cohesion
 - Low Coupling
- Modularization minimizes complexity by creating proper boundaries between the parts that compose a system
- Properly modularized systems are easier to maintain and extend
 - Changes are more localized and affect less of the overall system



What happened with Modularization and Object Oriented (OO)?

What happened with Modularization and Object Oriented (OO)?







Was Pollock an Early OO Programmer?

by Damoiselle de Pique

What happened with Modularization and OO?

- Focus in OO was on encapsulation of instance variables, which is some form of modularization, but granularity is too small
- OO systems become tangled webs quickly
 - Program knows its own structure
- Patterns like SOA, Factories, Dependency Injection, Inversion of Control are trying to minimize the consequences of OO and its lack of modularization

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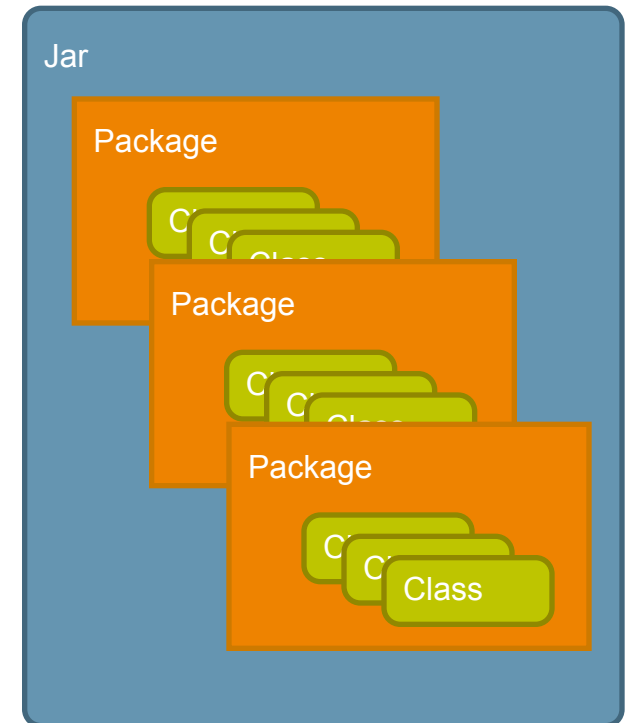
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Modularization in Java Apps

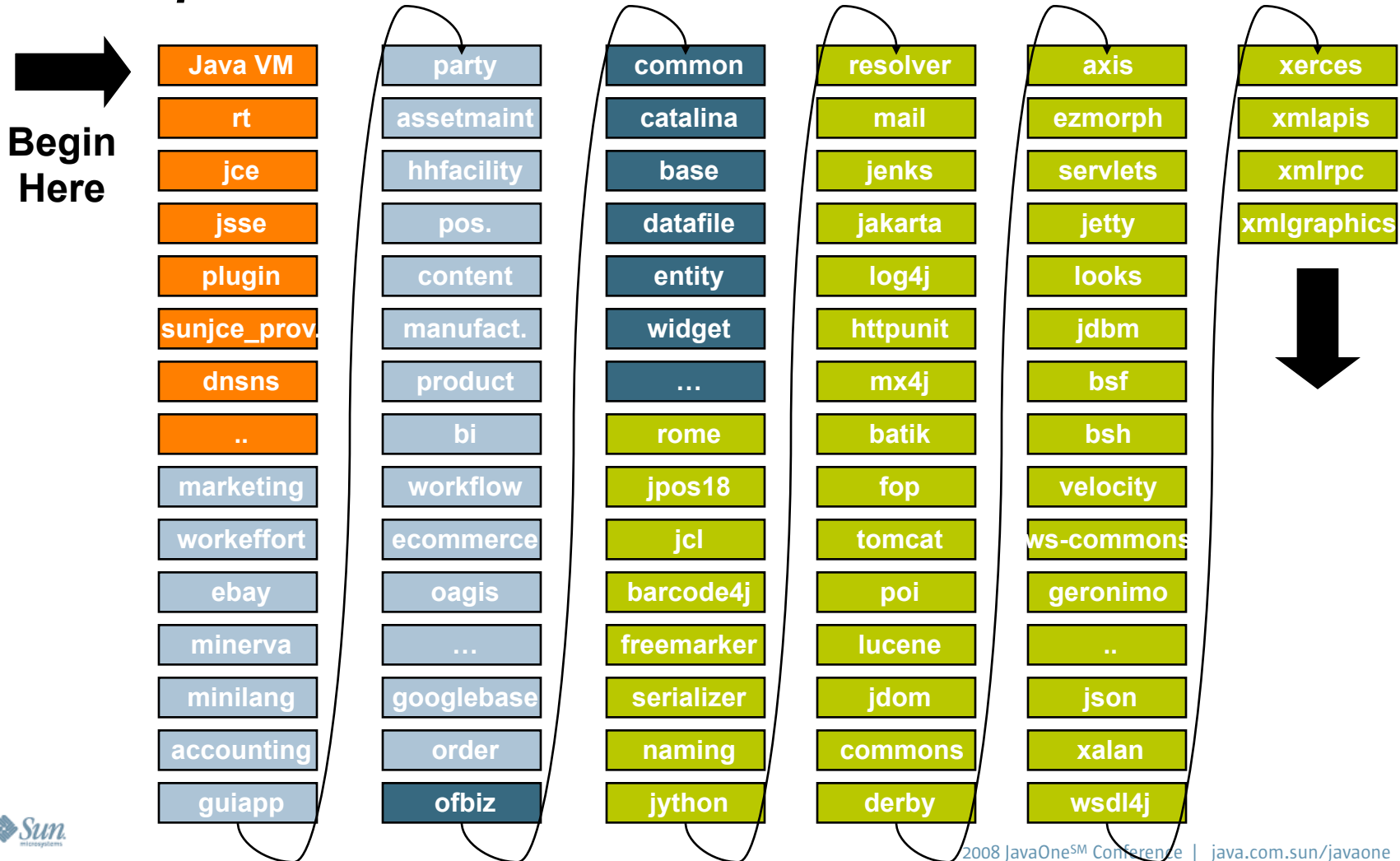
Visibility

- Java Platform Modularity
 - Classes encapsulate data
 - Packages contain classes
 - Jars contain packages
- Visibility Access
 - private, package private, protected, public
- Packages look hierarchical, but are not
- Jars have no modularization characteristics



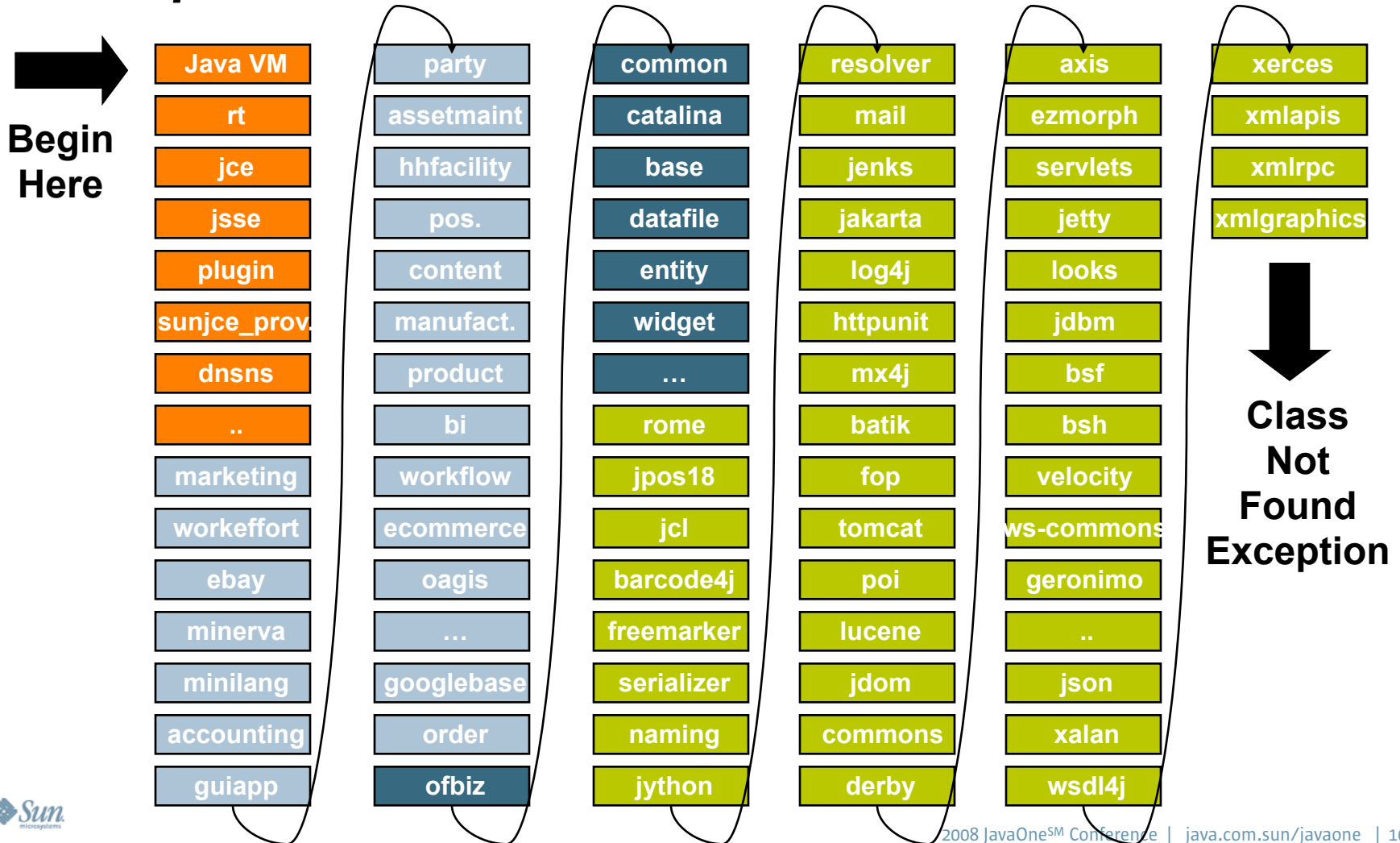
Modularization in Java Apps

Classpath



Modularization in Java Apps

Classpath



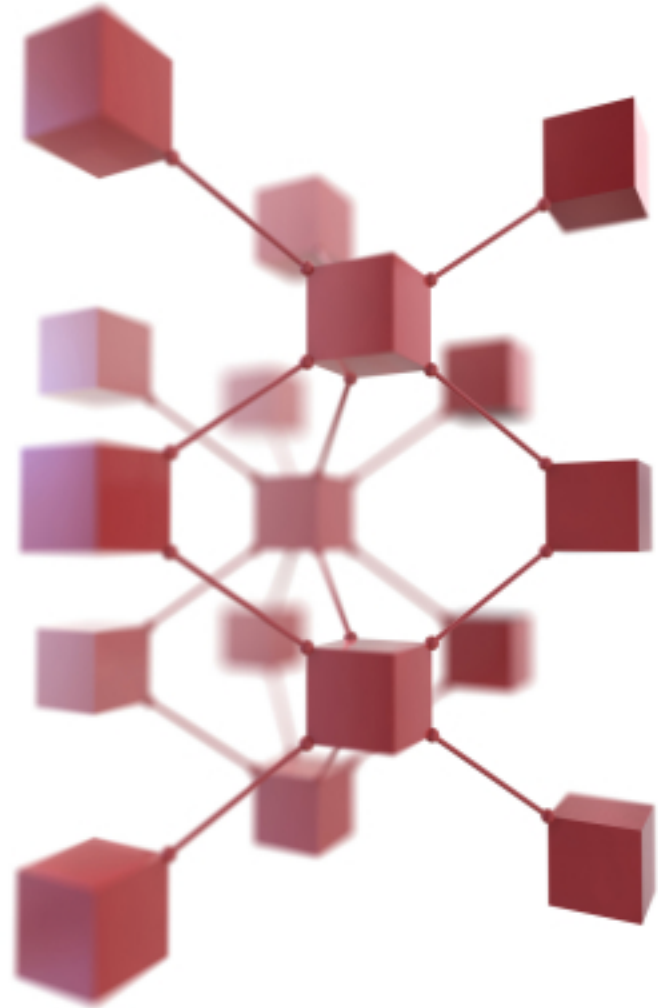
Modularization in Java Apps

Issues

- Granularity of classes and packages is too small for real world applications
- Jars provide packaging, can not be used to restrict access
 - Every public class is visible to every other class
- Severe problems like split packages
 - Multiple jars have classes in the same package
 - Often unintended
- No versioning support
 - Order on CLASSPATH define chosen version
 - Single version of a class in the VM
- Has no proper extension/collaboration model

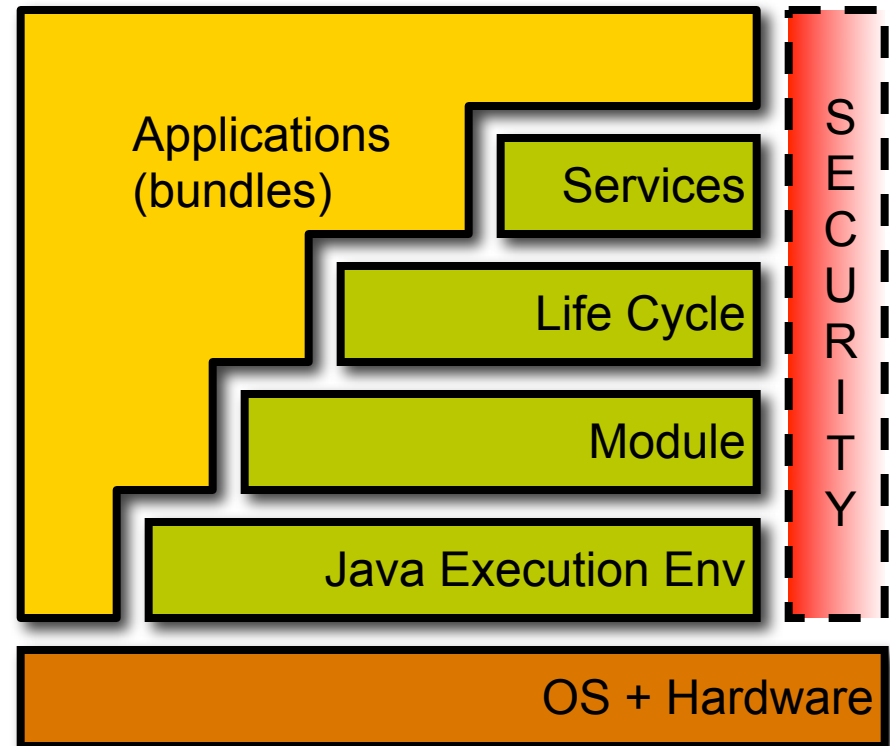
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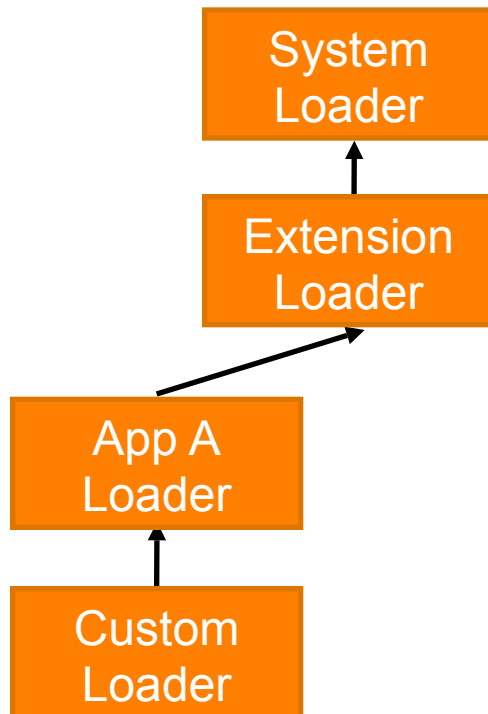
The OSGi Framework Overview

- The OSGi Service Platform specifies a modular architecture for dynamic component based systems
 - Execution Environment
 - Module Layer
 - Life Cycle Layer
 - Service Layer
 - Security
- Introduces *Bundles* as modules



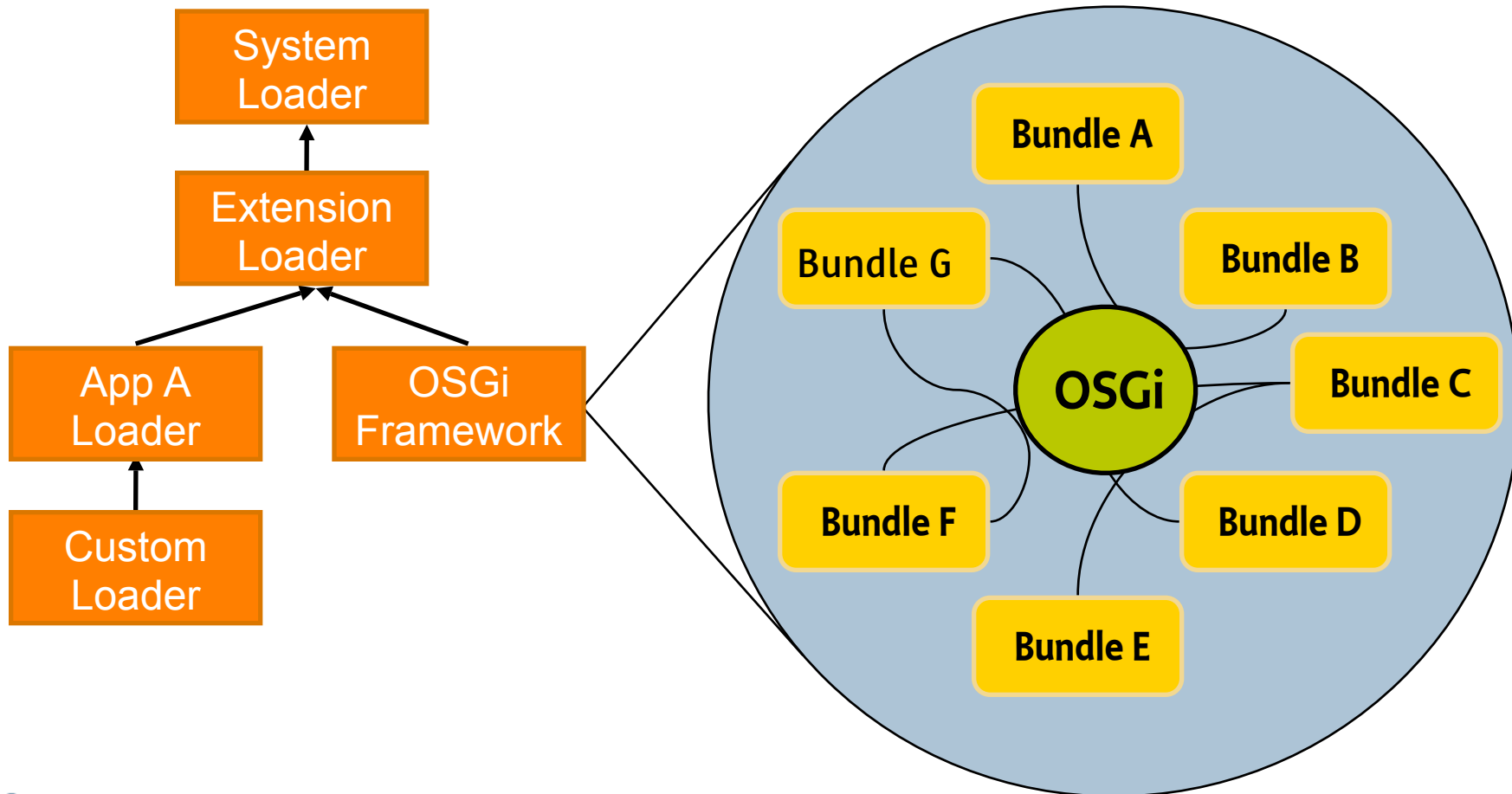
The OSGi Framework

Networked Class Loaders on “Steroids”



The OSGi Framework

Networked Class Loaders on “Steroids”



The OSGi Framework

Features

- Class loading dispatch based on package name
 - Prevents many problems with split packages
 - Faster class loading for large systems
- Allows multiple versions of the same class in one VM
 - Class spaces
- Jars can contain exported packages or Jar private packages
- Bundle == Jar
 - Manifest contains metadata
- Services provide a collaborative in-VM SOA model
 - No invocation overhead
 - Full Life Cycle Model

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Thomas Picard

Legacy Code

... legacy code is a challenge. Many developers say things like: “My code is very modular”, or “My code doesn’t depend on very much”, or “No one uses any of my classes except from the Foo package”

*Unless they are already using OSGi, they are wrong. Until modularity is enforced, **it is not there.***

John Wells, BEA

Legacy Code

Wrapping Libraries

- Analyzing what you have
 - What are the dependencies between the Jars that make up your applications
- OSGi bundles need manifest headers
 - Exported packages,
 - Imported Packages,
 - Optionality,
 - Versions,
 - Bundle identity
 - ...

Legacy Code

Wrapping Libraries

- Several open source projects provide OSGi metadata:
 - Apache (Derby, Struts, Felix, etc)
 - All Eclipse code
 - Codehaus Groovy
- Repositories are coming online:
 - OSGi Bundle Repository (OBR)
 - Apache Felix Commons
 - Eclipse Orbit
 - Maven is increasingly OSGi aware (see Maven Bundle plugin)
 - SpringSource Enterprise Bundle Repository
- When this fails: bnd utility
 - OSGi bundle analyze and build tool ...

Legacy Code Strategy?

The background of the slide is a close-up, high-resolution image of an elephant's skin. The skin is covered in a complex, irregular pattern of deep, raised ridges and grooves, creating a textured, almost crystalline appearance. The colors range from light tan to dark brown, with the ridges often being a lighter shade than the recessed areas. The lighting is somewhat uneven, with brighter areas at the top and darker, more shadowed areas towards the bottom, emphasizing the three-dimensional quality of the skin's texture.

Legacy Code
Strategy?

How do You Eat an Elephant?

The background of the slide is a close-up, high-resolution image of an elephant's skin. The texture is highly detailed, showing deep, irregular wrinkles and creases that create a complex, scale-like pattern. The color is a mix of light tan and darker brown tones, emphasizing the ruggedness of the skin.

Legacy Code
Strategy?

**How do You Eat an
Elephant?**

One Bite at a Time!

Legacy Code

Convert Existing Code

- Make a project with your application and all its dependent jars
 - Include all libraries on the classpath
- Create a bundle activator that calls main
- Include all libraries into one bundle
 - Super sized!
 - Use bnd
- Having a working bundle (whatever the size) is a good baseline and allows for gradually replacing the dependent jars with bundles
 - Keep it working!

Legacy Code

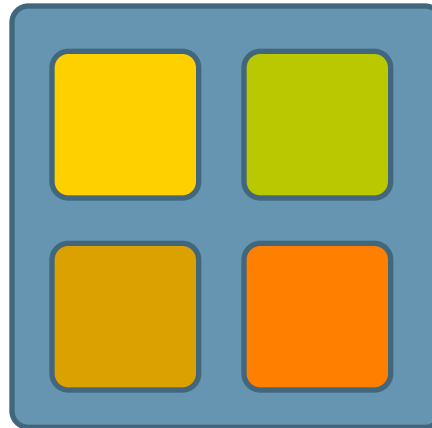
Converting Existing Code



Bundle
Service

Legacy Code

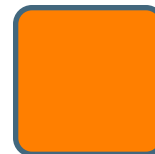
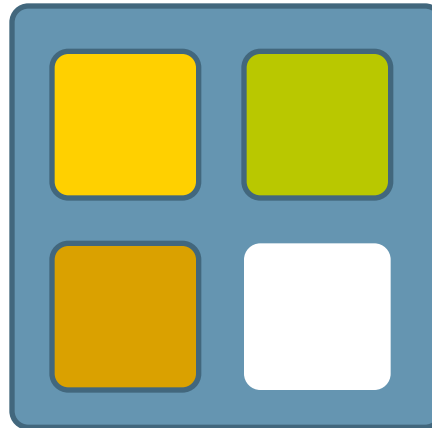
Converting Existing Code



Bundle
Service

Legacy Code

Converting Existing Code



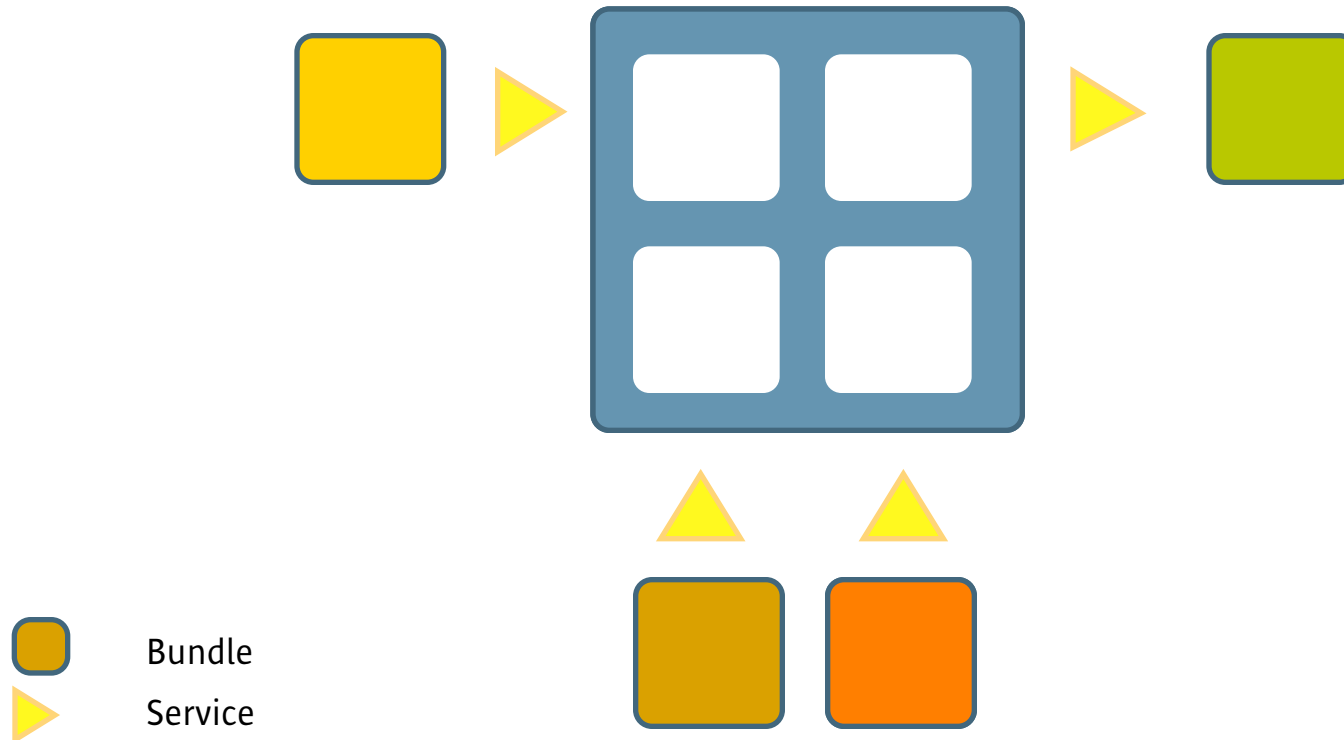
Bundle



Service

Legacy Code

Converting Existing Code



Legacy Code

Breaking out Bundles

- For each dependent jar in the project, call it x.jar
 - If there is an existing bundleized version of that jar
 - use that one
 - Otherwise
 - Create a new bundle project corresponding only to x.jar file.
 - Find the Java source files for x.jar in the old projects and move them into the new source folder.
- The new application bundle project has no more jar libraries or source in it.

Legacy Code

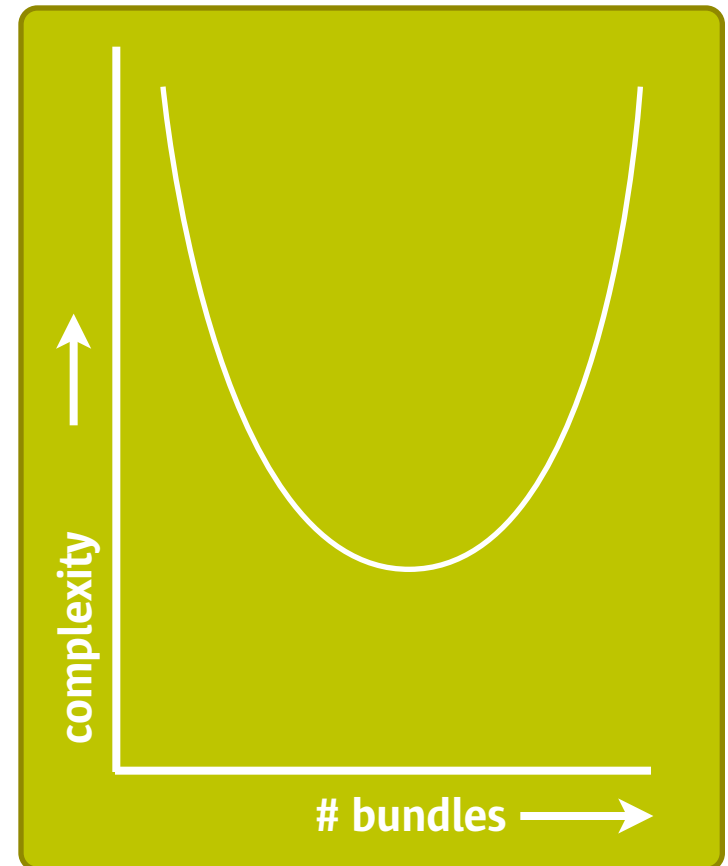
Application Models

- Raw OSGi APIs are powerful but not always easy to use
- Best practices is to write POJOs (Plain Old Java Objects) that are not coupled to a framework
- There are many such application models for OSGi:
 - Spring-DM (formerly called Spring-OSGi)
 - Apache iPOJO
 - Service Application Toolkit
 - OSGi Declarative Services
- Pick one of these application models after you got your existing application running
- Convert the application part-by-part

Legacy Code

To Include or to Refer? That is the Question!

- When to refer to a library?
 - External API
 - Implementations can differ
 - E.g. javax.naming, javax.transaction
 - Very large library
 - Reduces size because of sharing
- When to include a library in the bundle?
 - Pure functions
 - Small
 - Reduces number of dependencies
 - High Cohesion



Legacy Code

Use case: Hibernate

```
> bnd print -impexp hibernate3.jar
```

```
antlr....  
com.opensymphony.oscache....  
javax.naming....  
javax.sql  
net.sf.cglib....  
net.sf.swarmcache  
org.apache.tools.ant....  
org.jboss.cache....  
org.objectweb.asm....  
org.xml.sax
```

```
com.mchange.v2.c3p0  
javassist....  
javax.security....  
javax.transaction....  
net.sf.ehcache  
org.apache.commons....  
org.dom4j....  
org.logicalcobwebs.proxool....  
org.w3c.dom
```

Legacy Code

Create org.hibernate.bnd File

```
-classpath: hibernate3.jar, \  
    lib/antlr-2.7.6.jar, \  
    lib/asm-attrs.jar, \  
    lib/asm.jar, \  
    lib/cglib-2.1.3.jar, \  
    lib/commons-collections-2.1.1.jar, \  
    lib/commons-logging-1.0.4.jar, \  
    lib/dom4j-1.6.1.jar, \  
    lib/log4j-1.2.11.jar, \  
    lib/jta.jar
```

Legacy Code

Wrapping Hibernate

- Minimize dependencies!
 - Managing dependencies is good!
 - Not having dependencies is best!
- Let bnd do:
 - Copy all packages on the classpath
 - Import the missing packages
- Only export the hibernate packages and the javax.transaction packages from jta.jar
- Other libraries should be kept private
- This is a first guess, when we start to use hibernate, we might learn that we want to export more packages

Legacy Code

Next version of bnd file: org.hibernate.bnd

```
-classpath: hibernate3.jar, \  
    lib/antlr-2.7.6.jar, \  
    lib/asm-attrs.jar, \  
    lib/asm.jar, \  
    lib/cglib-2.1.3.jar, \  
    lib/commons-collections-2.1.1.jar, \  
    lib/commons-logging-1.0.4.jar, \  
    lib/dom4j-1.6.1.jar, \  
    lib/log4j-1.2.11.jar, \  
    lib/jta.jar
```

Private-Package: *

Export-Package: javax.transaction.*, \
 org.hibernate.*

Legacy Code

View imported packages

```
> bnd org.hibernate.bnd  
> bnd print -impexp org.hibernate.jar
```

```
com.mchange.v2.c3p0  
com.sun.jdmk.comm  
javassist...  
javax.mail...  
javax.naming...  
javax.sql  
javax.xml...  
net.sf.swarmcache  
org.apache.log  
org.codehaus.aspectwerkz.hook  
org.jaxen...  
org.logicalcobwebs.proxool...  
org.relaxng.datatype  
org.xml.sax...  
com.opensymphony.oscache...  
com.sun.msv.datatype...  
javax.jms  
javax.management  
javax.security...  
javax.swing...  
net.sf.ehcache  
org.apache.avalon.framework.logger  
org.apache.tools.ant...  
org.gjt.xpp  
org.jboss.cache...  
org.objectweb.asm.util  
org.w3c.dom
```

Legacy Code

Wrapping Hibernate

- There are many packages which are obviously not mandatory.
 - `org.apache.avalon.framework.logger`
 - `org.apache.tools.ant`
- These are *glue dependencies*. They are only needed when running inside some “framework”
- There are also optional features that should not be required by hibernate
 - for example `javax.mail`?
- A shortcut is to make all our imports optional
 - Detects problems in runtime
 - With more time and knowledge, it is possible to make this less coarse grained

Legacy Code

Next version bnd file org.hibernate.bnd

```
-classpath: hibernate3.jar, \  
    lib/antlr-2.7.6.jar, \  
    lib/asm-attrs.jar, \  
    lib/asm.jar, \  
    lib/cglib-2.1.3.jar, \  
    lib/commons-collections-2.1.1.jar, \  
    lib/commons-logging-1.0.4.jar, \  
    lib/dom4j-1.6.1.jar, \  
    lib/log4j-1.2.11.jar, \  
    lib/jta.jar
```

Private-Package: *

Import-Package: javax.xml.*, javax.sql.*, \
 *;**resolution:=optional**

Export-Package: javax.transaction.*,org.hibernate.*

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Dynamic Class Loading

- A surprising number of applications created their own unique plugin mechanisms using dynamic class loading
 - Configuration provided by strings
 - `Class.forName` during runtime
- Ignores modularity ...
 - Class name strings never, ever, handle versions
- `Class.forName` has a bug that prevents it from handling these issues correctly
 - At least, use `ClassLoader.loadClass`

Dynamic Class Loading

- Context Class loader tends to revert back to “best effort” linear search
 - Eclipse supports “Buddy Class Loading” (Containerism!)
 - OSGi next specification will address the use cases for Buddy Class Loading
- Recommendations
 - Try to remove all class loading code. Is it really necessary?
 - Convert plugin mechanisms to services because it handles versions and compatibility issues
 - If not possible, use ClassLoader methods, not Class.forName
- Relax, let go of your class loaders, really OSGi does it better :-)

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Designing with Services

One big issue for good component and service oriented architectures is how to achieve loose coupling between components by design. As architects we are looking for minimization of dependencies and maximization of flexibility, preparing a system for future change. The OSGi framework is a great foundation for this endeavor, ...

Dieter Wimberger

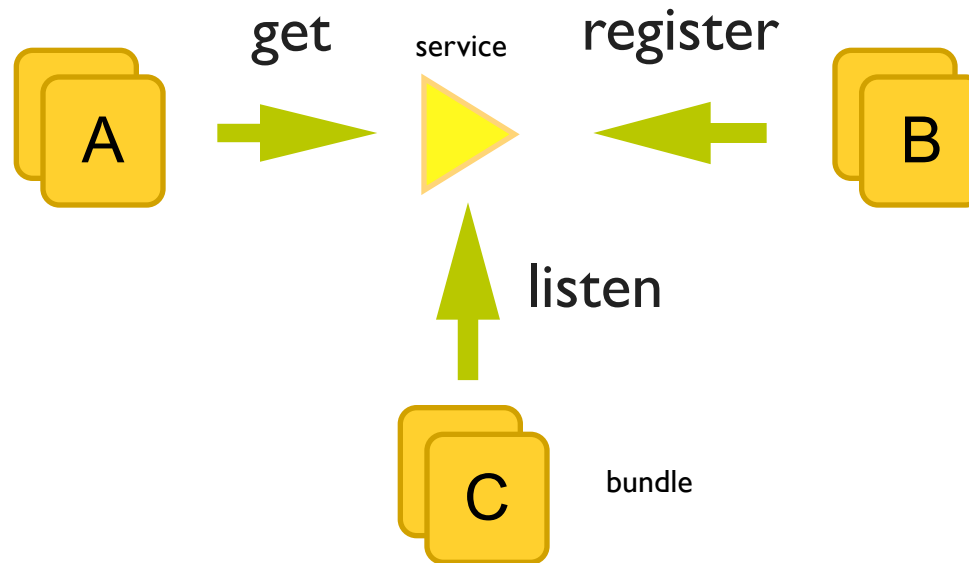
Designing with Services

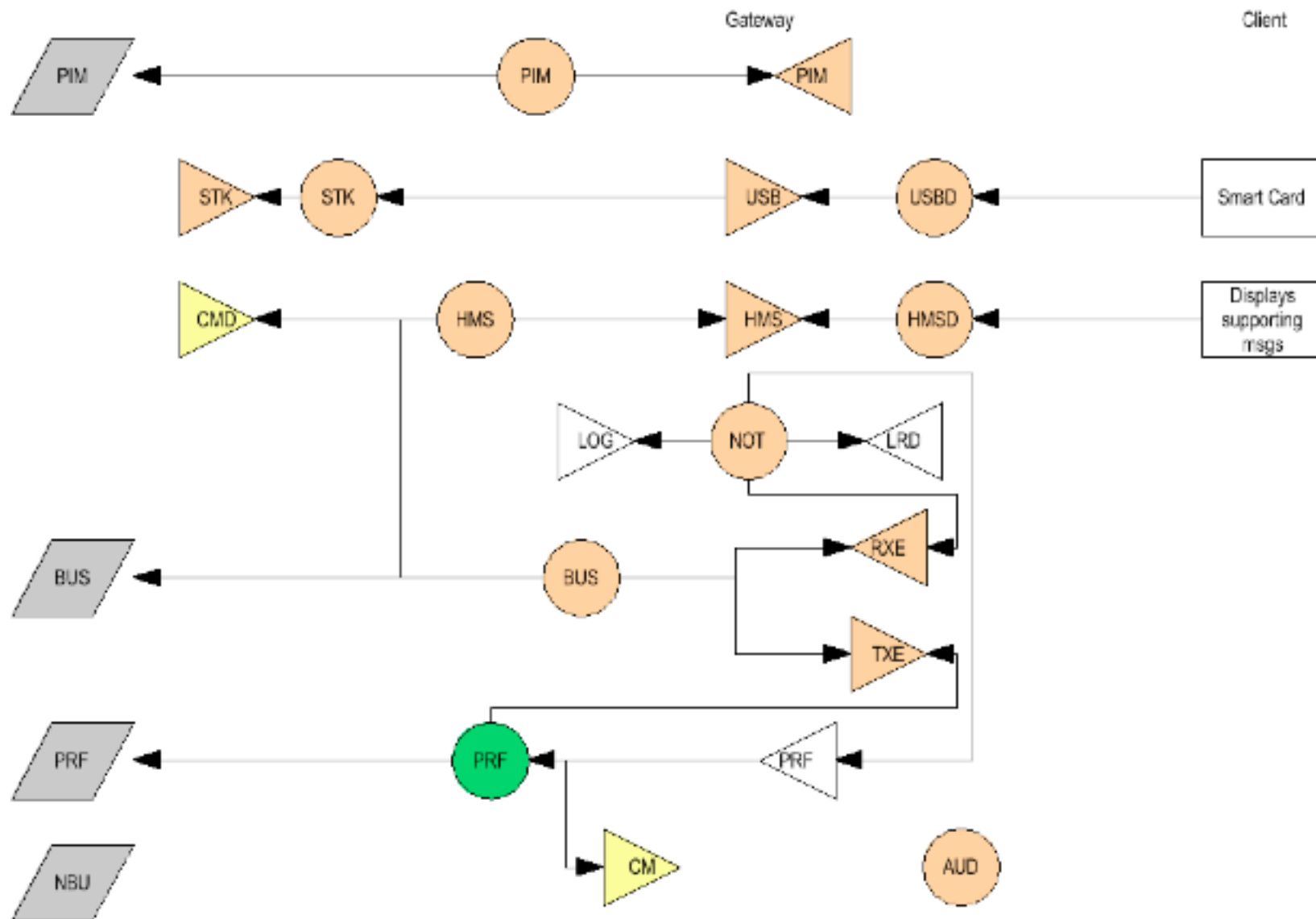
Goals

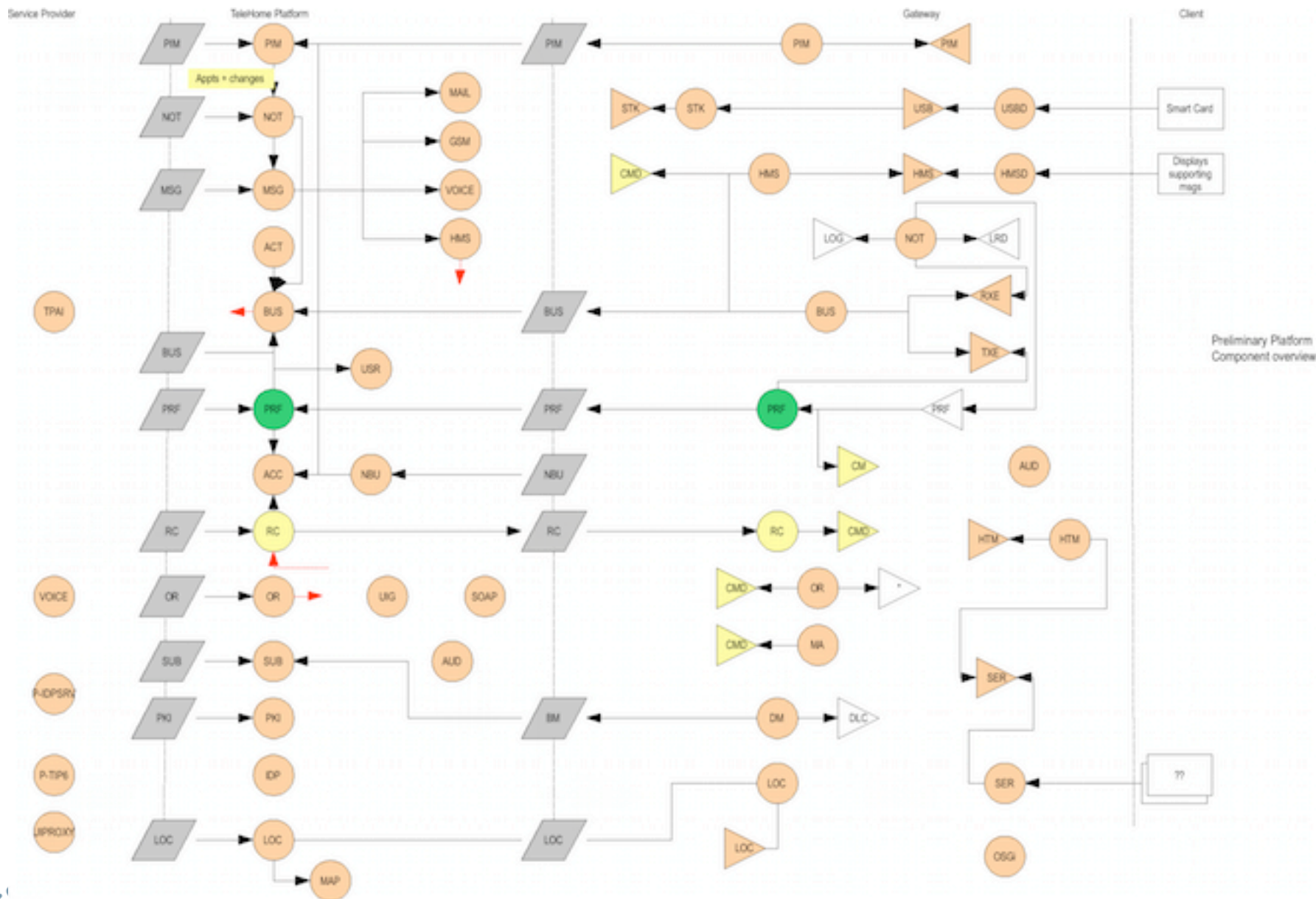
- Services provide a very loose coupling between modules
 - Allows modules to be substituted
- Services are used as input/output ports, they *should* be the *only* links between bundles
- Key is to find connections between modules and map them to services
 - Initially, this is not always obvious so do not go overboard
- Try to use standard services (OSGi)
- Try to use standard interfaces (Java application environment, ...)
- Try to establish in-house standards

Designing with Services

Service Concepts







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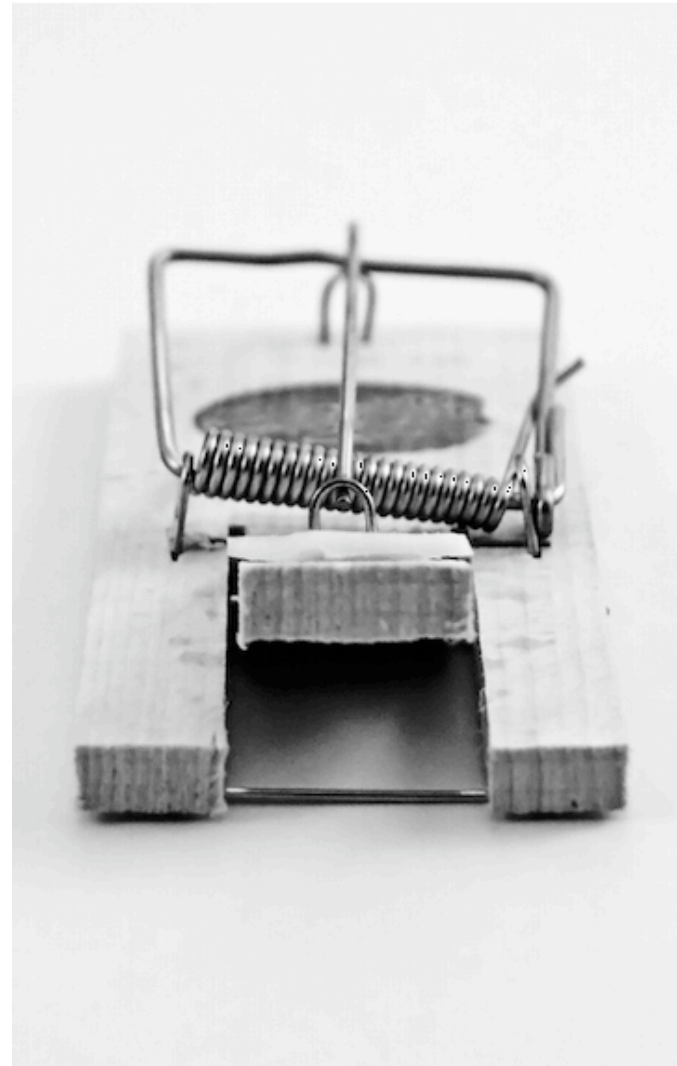


Building

- Your Build system is probably the largest productivity multiplier in your organization
- Eclipse is an excellent IDE for OSGi development
 - PDE - Plugin Development Environment, Pax-Runner, JDT + Bnd
- But bundles can also be built with Netbeans™ software or other IDEs
- Offline build is different, PDE build is not very easy to run offline
- Build Systems
 - Maven + Bundle Plugin (from Apache Felix, based on bnd)
 - Ant + bnd

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Pitfalls

➤ Too much at once

- Get the complete application to work on OSGi, modularize a part, test, and iterate in small increments
- Eat the elephant one bite at a time

➤ Dynamic Class Loading

- Most of the time custom class loaders are abused in applications, get rid of them
- Watch out for the usage of `Class.forName`
- Use Services

Pitfalls

- Framework Implementation Dependencies
 - “Containerisms”
 - Be careful to use OSGi only features and not become dependent on a specific OSGi implementation
 - Almost all problems can be properly solved using the OSGi capabilities
 - In rare cases, it is necessary to escape to an implementation dependent feature, e.g. Buddy loading

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Conclusion

Conclusion

To this day team members still come up to me occasionally to thank me for introducing OSGi, often after being reminded what things were like by having to go back to an old release build. I wish I could take credit but the truth is I never anticipated most of these benefits until I started the conversion.

Bill Kayser, Software Architect StepZero LLC

References

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THANK YOU



Join us in Berlin, June 10-11, 2008
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