Is OSGi Ready for the Enterprise?

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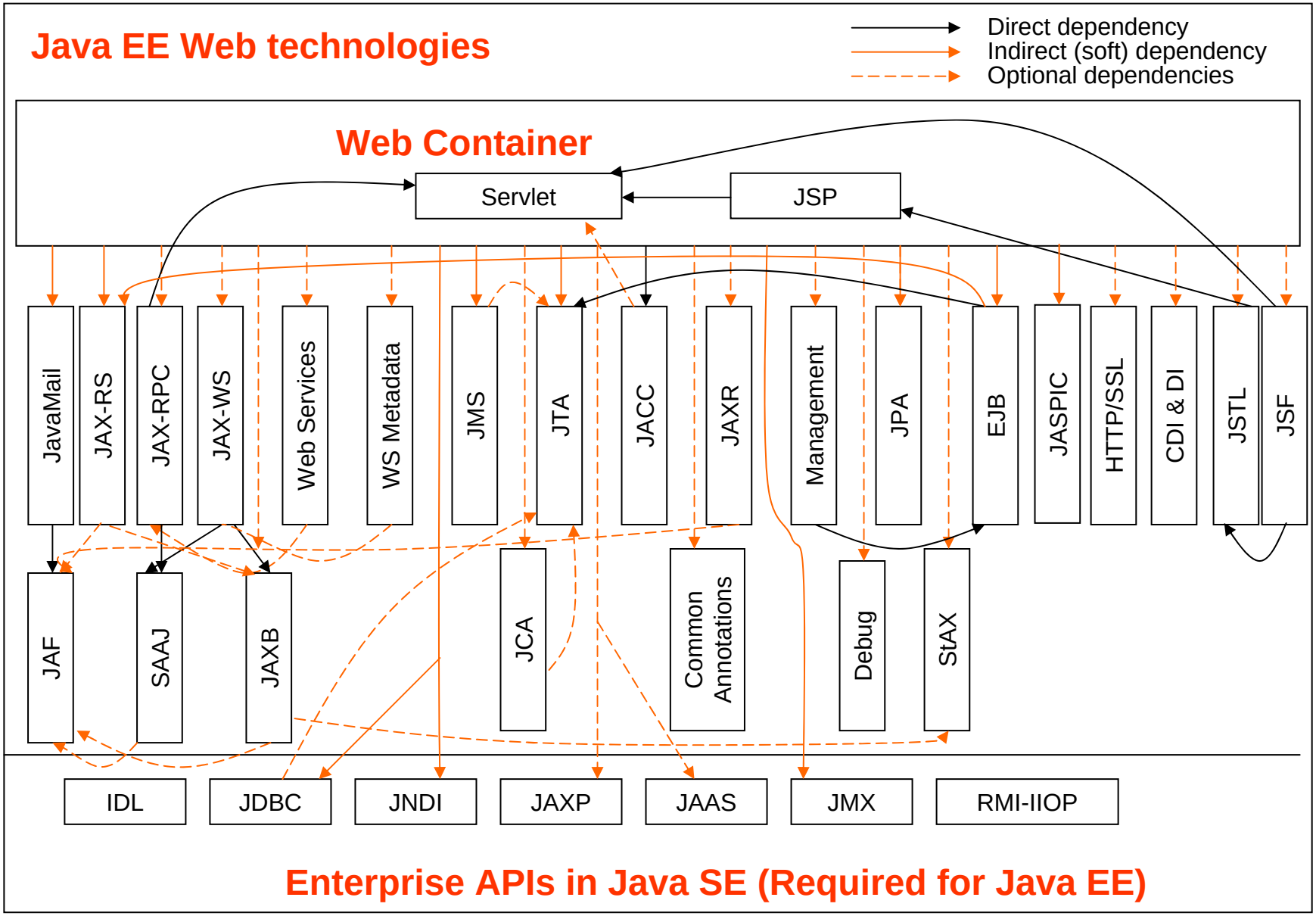
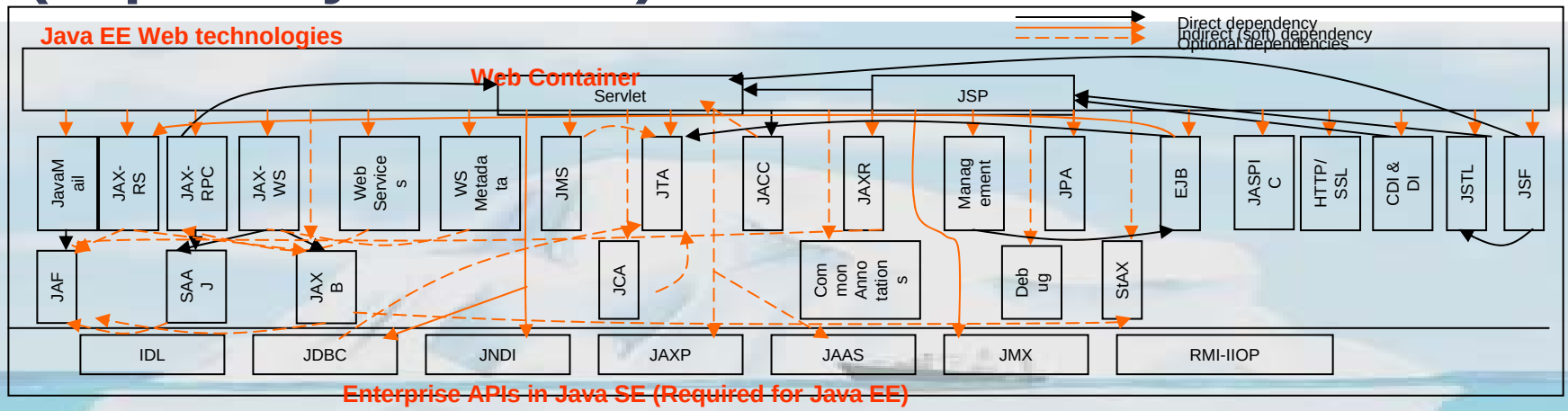
The Questions

- Why should we care?
  - Does Enterprise Java need OSGi?
  - Does OSGi need Enterprise Java?


Java EE Web technologies
Direct dependency
Indirect (soft) dependency
Optional dependencies
Web Container
Servlet
JSP
JavaMail
JAX-RS
JAX-RPC
JAX-WS
Web Services
WS Metadata
JMS
JTA
JACC
JAXR
Management
JPA
EJB
JASPIC
HTTP/SSL
CDI & DI
JSTL
JSF
JAF
SAAJ
JAXB
JCA
Common Annotations
Debug
StAX
IDL
JDBC
JNDI
JAXP
JAAS
JMX
RMI-IIOP
Enterprise APIs in Java SE (Required for Java EE)

(capability == bloat)?



HTTP Session Replication | Connection Management | Persistence Providers | User Registries | Event Mgmt

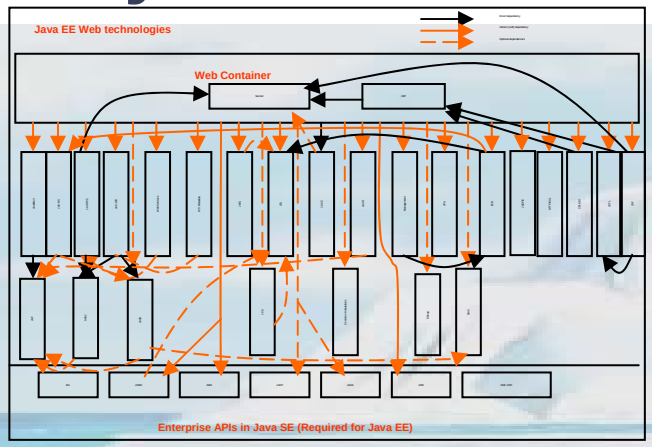
Logging and Tracing | MBean Server | Admin Console and scripting | DataSources | Messaging Engines | Security

Transport Channels | Workload Management | HTTP Serving and routing | High Availability Management | Transaction Logging and Recovery

Thread management | Classloading | Provisioning | Monitoring | Policy and SLA mgmt | Configuration

...

Beyond Java EE…



Batch

Telephony

BPM

Dynamic Scripting

SCA

Business Rules

Complex Event Processing

…

HTTP Session Replication

Connection Management

Persistence Providers

User Registries

Event Mgmt

Logging and Tracing

MBean Server

Admin Console and scripting

DataSources

Messaging Engines

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Thread management

Classloading

Provisioning

Monitoring

Policy and SLA mgmt

Configuration

…

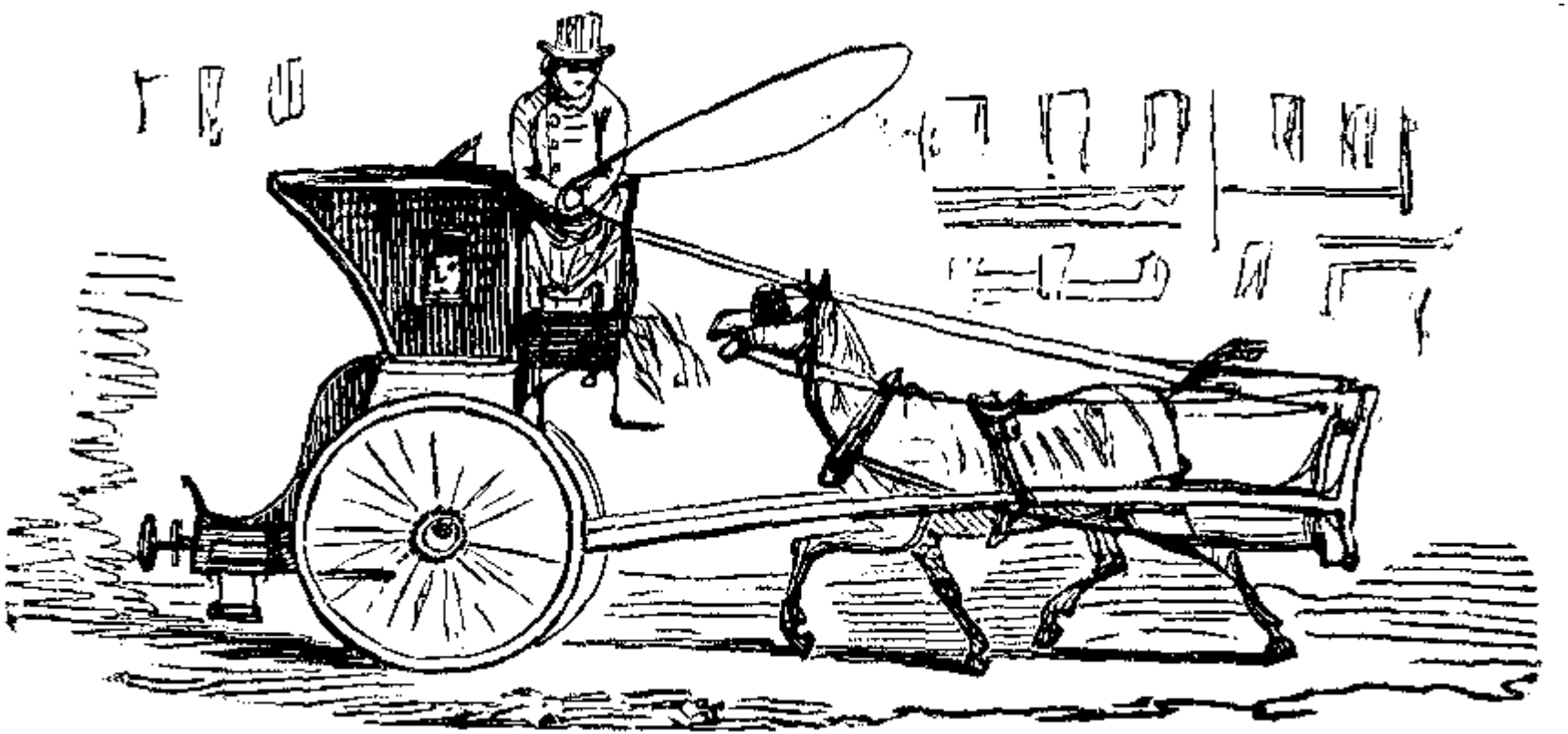
Modularity *inside* Enterprise platforms

- The major AppServer and Integration vendors and Open Source communities have all embraced OSGi for their own internal architecture
  - IBM WebSphere, Oracle WebLogic, Red Hat JBoss, Sun GlassFish, SpringSource dm Server, Paremus Service Fabric, Eclipse Platform, Apache Geronimo, (non-exhaustive list)
    - http://www.osgi.org/wiki/uploads/News/2008_09_16_worldwide_market.pdf
- These complex engineering projects required a modular approach to development as they evolved and grew
  - Breaking the problem into well-defined coherent modules enables development teams to focus on their area of concern.
  - OSGi not only *enables* but *enforces* modularity
- Does the Enterprise *runtime* need OSGi? The vendors answered with a resounding *Yes*.

What about the Applications?

- The enterprise landscape until recently has been OSGi on the inside only. Why?
- Primarily because:
  - Java EE defines an enterprise application programming model and container contracts to honour it
  - OSGi has typically defined platform specifications and services for those platforms.
    - It hasn't had much to say on application concerns such as
      - What's the component model?
      - Whets the persistence architecture?
      - How are qualities of service configured?
      - Remoting
- This has changed in OSGi v4.2.

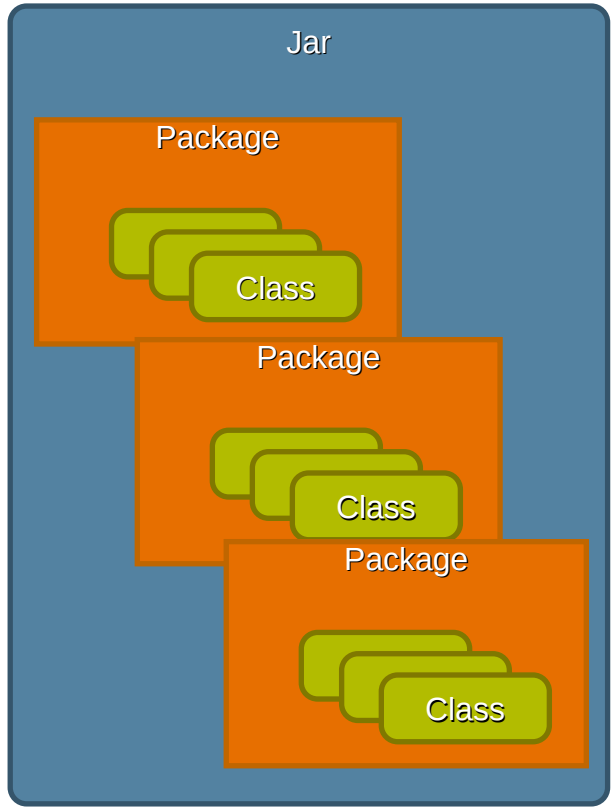
What's the Problem?



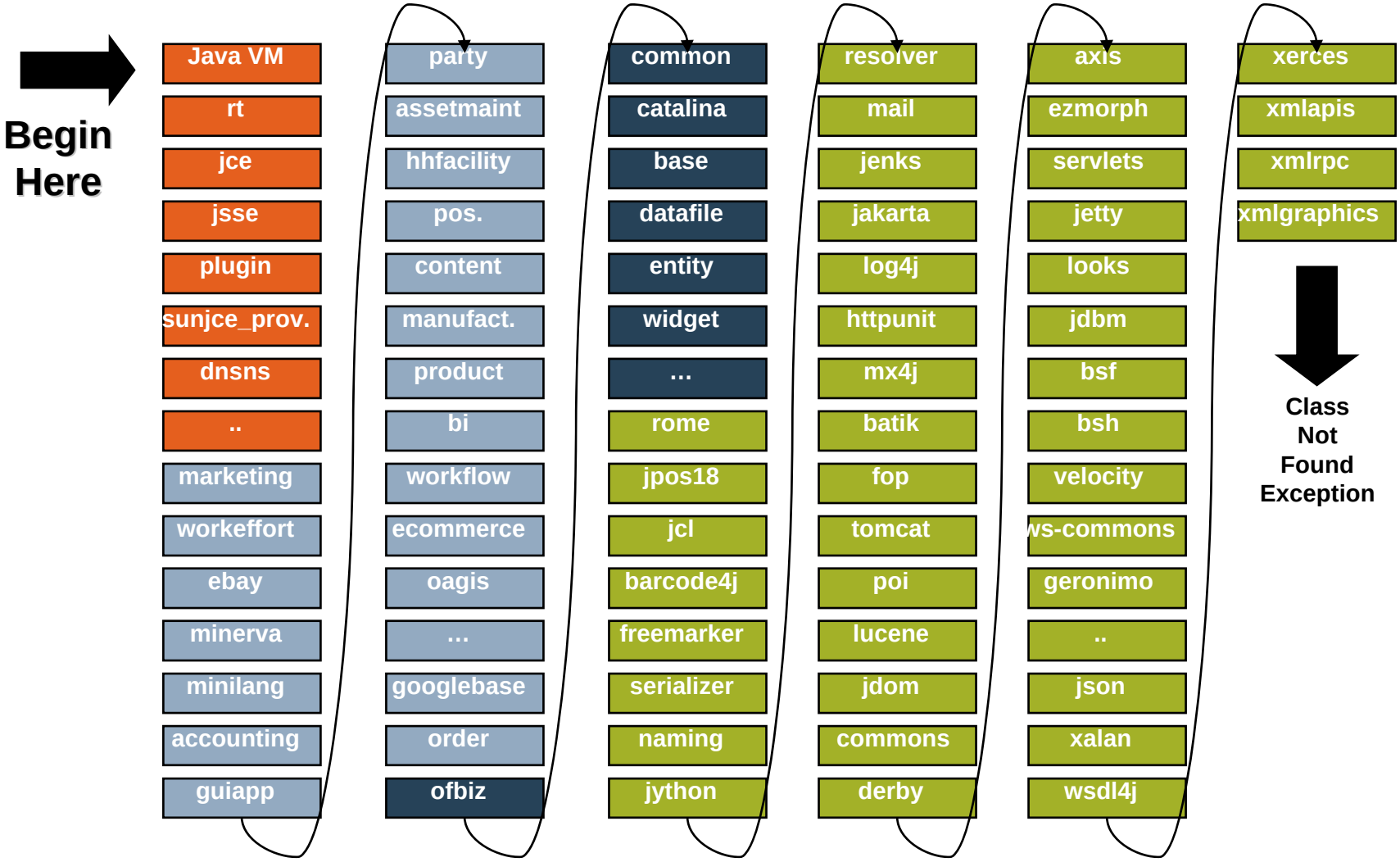
http://www.gutenberg.org

Problems with JARs

- Java Platform Modularity
  - Classes encapsulate data
  - Packages contain classes
  - Jars contain packages
- Class visibility:
  - private, package private, protected, public
- No “jar scoped” access modifiers.
- No means for a jar to declare its dependencies.
- No versioning.
- Jars have no modularization characteristics
  - At runtime there is just a collection of classes on a global classpath



The Global Classpath

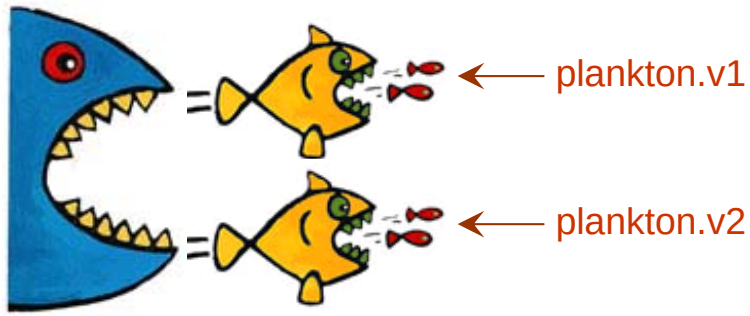


Problems with EARs/WARs

Enterprise Apps have isolated classpaths but…

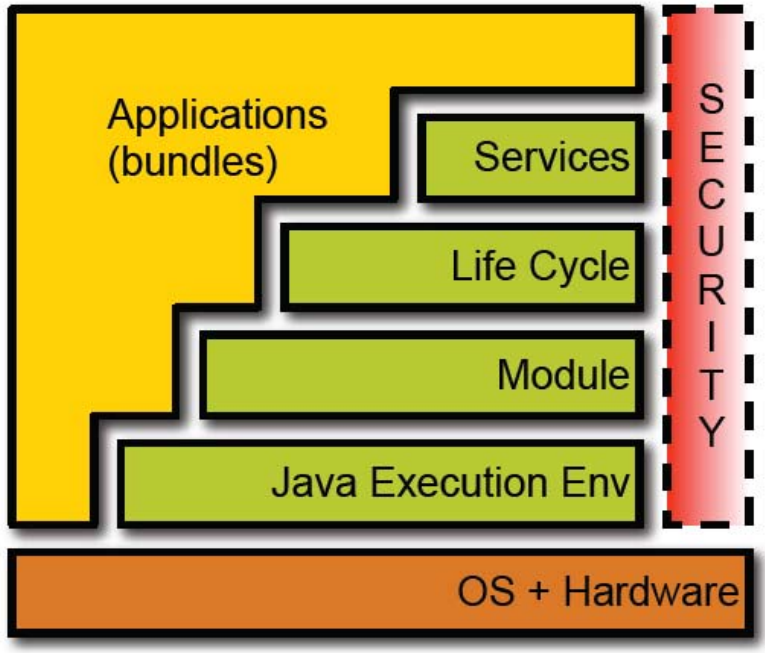
- *Across apps* - each archive typically contains all the libraries required by the application
  - Common libraries/frameworks get installed with each application
  - Multiple copies of libraries in memory

- *Within apps* - 3rd party libraries consume other 3rd party libraries leading to version conflicts



OSGi – The Dynamic Module System for Java

- The OSGi Service Platform specifies a modular architecture for dynamic component based systems
  - Execution Environment
  - Module Layer
  - Life Cycle Layer
  - Service Layer
- Runs on a variety of standard Java profiles.
- Introduces *Bundles* as modules



Bundle Metadata

- The higher-level module is the “bundle” which is a normal jar containing:
  - Classes
  - Resources
  - Manifest

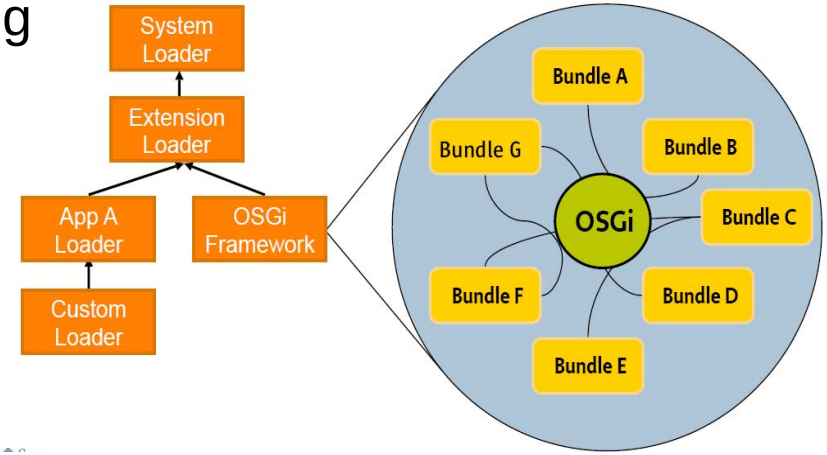
META-INF/MANIFEST.MF

```
Manifest-Version: 1.0
Bundle-ManifestVersion: 2
Bundle-Name: MyService bundle
Bundle-SymbolicName: com.sample.myservice
Bundle-Version: 1.0.0
Bundle-Activator: com.sample.myservice.Activator
Import-Package:
 org.apache.commons.logging;version="1.0.4"
Export-Package:
 com.sample.myservice.api;version="1.0.0"
```

- OSGi headers in the manifest include:
  - Bundle-Version: **Multiple versions** of bundles can be active concurrently.
  - Import-Package: Explicitly declares the (package) **dependencies** on other bundles. Used by the OSGi f/w for bundle resolution.
    - Can explicitly define the required version or version range for each package.
  - Export-Package: Declares **package visibility** outside the bundle. Other packages are encapsulated by the bundle.
  - Bundle-Activator (used to notify the bundle of lifecycle changes)
- Eclipse tooling provides convenient editors for the manifest

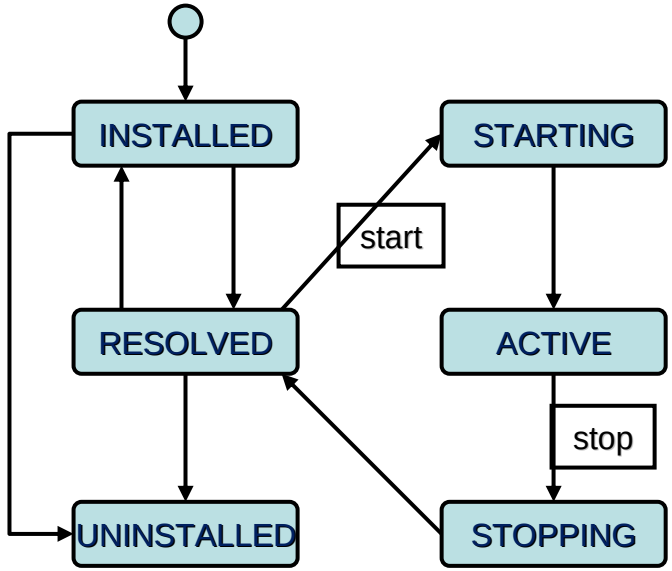
OSGi Class Loading

- No global, flat classpath to search. Each bundle has its own classloader / classpath. More efficient for large systems.
- Class sharing and visibility is based on declarative dependencies
  - Not constrained by hierarchical class loader trees built up at runtime.
  - OSGi f/w takes care of working out the dependencies.
- Multiple versions of bundles supported concurrently.



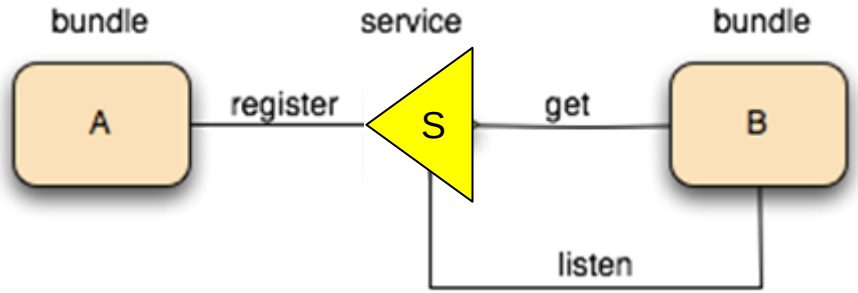
Bundle Lifecycle

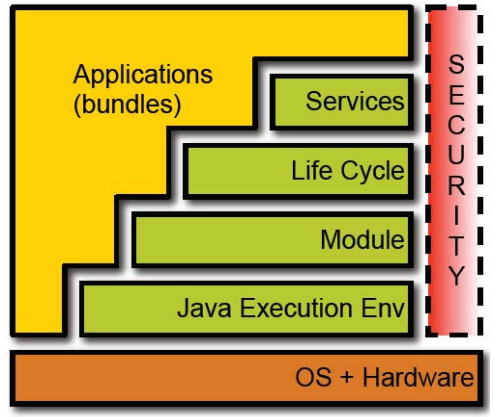
- Optional BundleActivator class has opportunity to initialize and cleanup a bundle
  - Header in Manifest refers to this class
- BundleActivator has 2 methods
  - Start: Initialize bundle
  - Stop: Cleanup



- Resolution of dependencies at deployment time. If resolution fails, bundle is not available for use.
  - No ClassNotFoundExceptions at runtime
- Bundle lifecycle is dynamic and independent of the rest of the f/w.
  - BundleListener can be registered for bundle state change events.

OSGi Service Layer





- OSGi intrinsically supports SOA through its service layer.
- The core platform includes a non-durable “Service Registry” component.
- Services are published to and discovered from this Service Registry.
  - Services are the primary means of collaboration between bundles.
- An OSGi service is a POJO published to the SR under one or more Java interface names with optional key/value pair metadata
  - Service discovery can be filtered on the key/value metadata
- Services are fully dynamic and typically have the same lifecycle as the bundle that provides them.

OSGi Enterprise Specification

- Release date – 22 March 2010
  - The product of the OSGi Enterprise Expert Group (EEG)
- Brings Enterprise technologies and OSGi together
- Using existing Java SE/EE specifications:
  - JTA, JPA, JNDI, JMX, WebApps…
- Adds Spring-derived component model and DI container

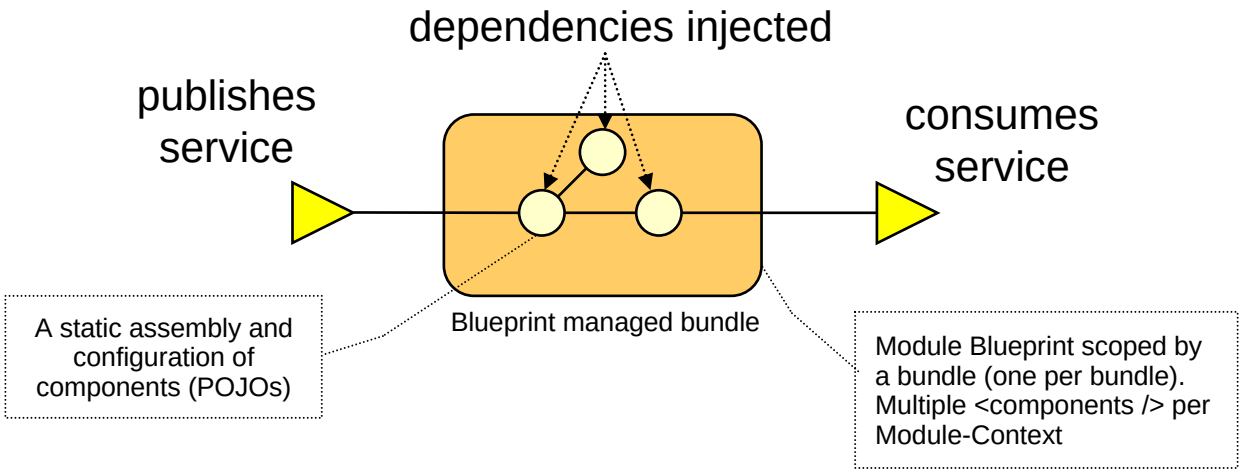
- **Java EE provides the core enterprise application programming model**
- **Deploying modules as OSGi bundles simplifies reuse between applications, provides versioning, encourages (and enforces) modular design and enables dynamic module updates.**

New Open Source Activities

- Apache “Aries” created as a new Apache incubator project in Sep 2009:
  - to provide enterprise OSGi spec implementations http://incubator.apache.org/aries/
  - to provide an environment to collaborate and experiment with new technologies to inform further EEG standardization.
    - In particular the programming model aspects of OSGi applications in an enterprise environment such as multi-bundle composites.
  - to build a broad development community to encourage implementation and adoption of EEG specs
- Eclipse Enterprise Modules (“Gemini”) - currently being provisioned.

  - Sub-projects will provide EEG spec implementations http://www.eclipse.org/proposals/gemini/

Blueprint Components and Service

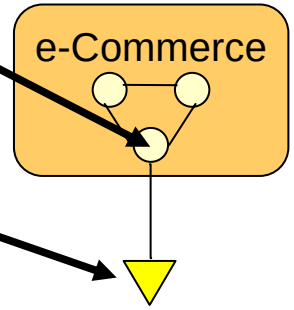


- Specifies a Dependency Injection container, standardizing established Spring conventions
- Configuration and dependencies declared in XML “module blueprint”, which is a standardization of Spring “application context” XML.
  - Extended for OSGi: publishes and consumes components as OSGi services
- Simplifies unit test outside either Java EE or OSGi r/t.
- The Blueprint DI container is a part of the server runtime (compared to Spring which is part of the application.)

Exploiting Blueprint Components and Services

e-Commerce bundle

```
<blueprint>
  <bean id="shop" class="org.example.ecomm.ShopImpl">
    <property name="billingService" ref="billingService" />
  </bean>
  <reference id="billingService"
      interface="org.example.bill.BillingService" />
</blueprint>
```



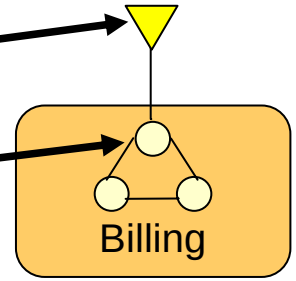

```
public class ShopImpl {

private BillingService billingService;
void setBillingService(BillingService srv) {
      billingService = srv;
      }

void process(Order o) {
      billingService.bill(o);
      }
}
```

-injected service reference
-service can change over time
-can be temporarily absent
  without the bundle caring
-managed by Blueprint container

Exploiting Blueprint Components and Services

Billing service bundle

```
<blueprint>
  <service ref="service" interface =
           "org.example.bill.BillingService" />
  <bean id="service" scope="prototype"
      class="org.example.bill.impl.BillingServiceImpl" />
</blueprint>
```



-"prototype" scope indicates a new instance is created by the container for each use.
-"singleton" scope is the default.

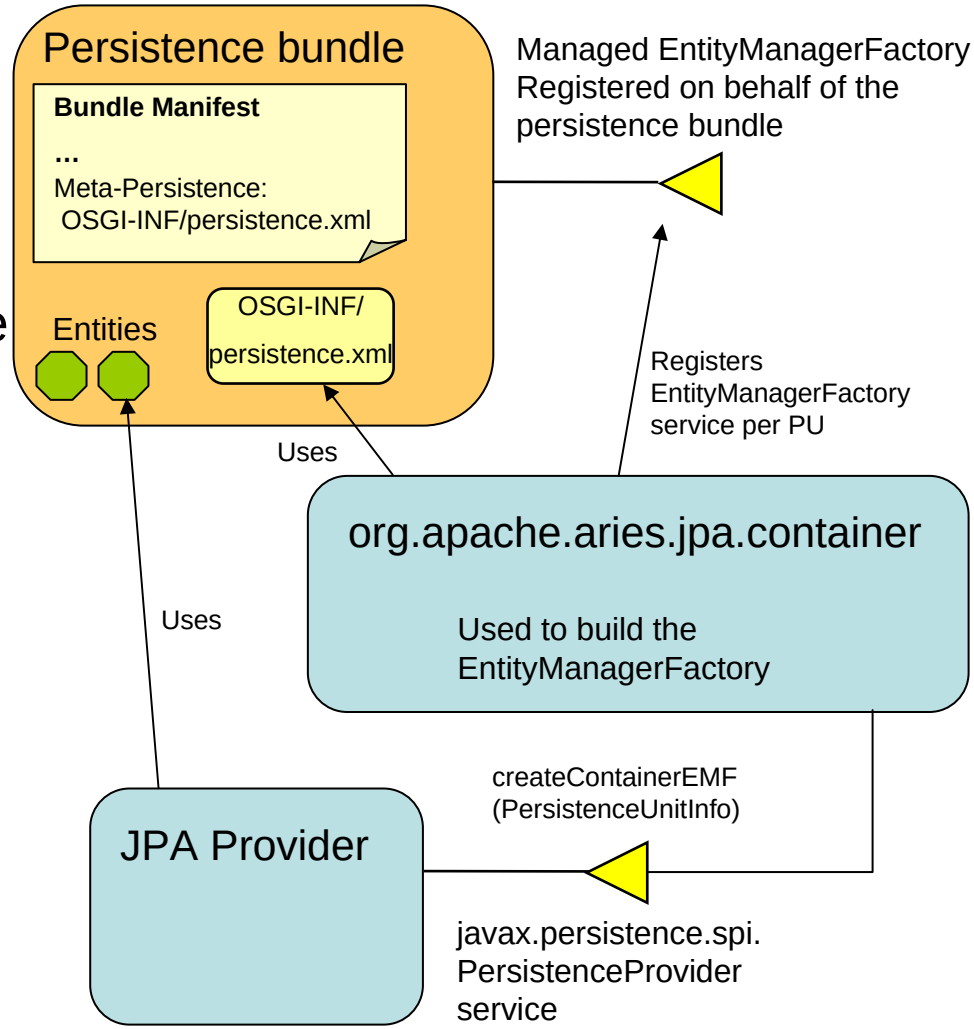
```
public interface BillingService {
      void bill(Order o);
}
```

Aries Blueprint Container

- Pre-dates Aries – moved from Apache Geronimo
- The Aries BP container implementation is highly extensible:
  - Namespace handlers supported to extend the Blueprint definitions
  - Bean interceptors can be registered by handlers
- Other Aries components contribute handlers – “jpa” and “jta” handlers.
- Some other Aries components are implemented as Blueprint bundles themselves
  - e.g. JPA container

Java Persistence and Persistence Bundles

- Each persistence bundle has its standard JPA metadata located through the Meta-Persistence bundle header.
- JPA Container locates a JPA Provider which can service the PU and registers a Provider-created EntityManagerFactory service for each PU in each persistence bundle
  - EMF service lifecyce follows the persistence bundle lifecycle
- JPA Provider gets persistence bundle classloader from PUInfo.



Aries JPA Container – Blueprint Integration

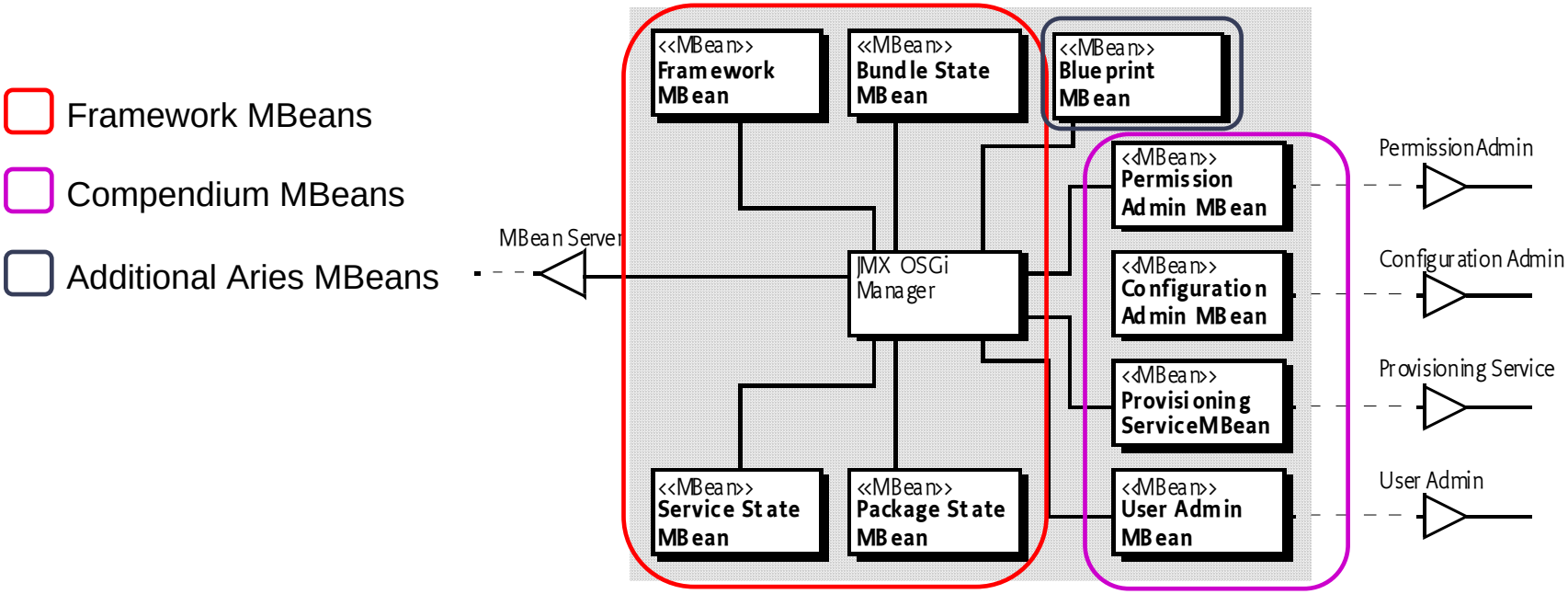
- The Aries JPA container context bundle provides a blueprint namespace for dependency injection of managed JPA resources.
- Managed persistence units (EntityManagerFactory objects) can be injected with or without a JTA Transaction Services implementation.
- Managed persistence contexts (EntityManager objects) are only available with a JTA Transaction Services implementation.
- Both managed persistence units and managed persistence contexts behave as per the JPA specification.

- Example blueprint with JPA resource injection and container-managed transactions:

```
<blueprint
xmlns="http://www.osgi.org/xmlns/blueprint/v1.0.0"
xmlns:jta="http://aries.apache.org/xmlns/transactions/v1.0.0"
xmlns:jpa="http://aries.apache.org/xmlns/jpa/v1.0.0">

  <bean id="appMgd" class="com.acme.AppManaged">
    <jpa:unit property="emf" unitname="myUnit" />
  </bean>

  <bean id="containerMgd" class="com.acme.Container">
    <jpa:context property="em" unitname="myUnit"/>
    <jta:transaction method="*" value="Required" />
  </bean>

</blueprint>
```

JMX Integration

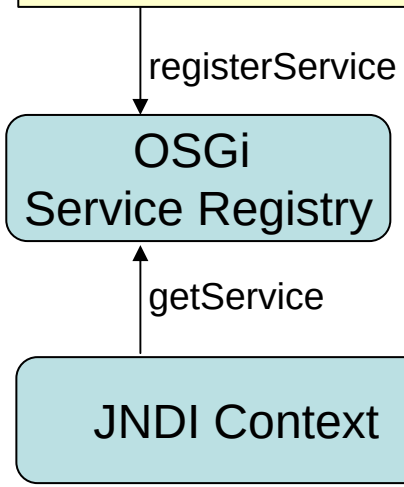
- Implementation of OSGi JMX specification.
- Aries JMX bundle automatically registers the JMX MBeans into any javax.management.MBeanServer service in the OSGi Service Registry.



JNDI integration

- Provides JNDI-based access to OSGi Service Registry

```
<blueprint xmlns=...>
   <bean id="bloggingServiceComponent"
       class="org.apache.aries.BloggingServiceImpl">
   </bean>
   <service ref="bloggingServiceComponent"
      interface="org.apache.aries.samples.blog.api.BloggingService"/>
   ...
</blueprint>
```



- A way for a Web component to access a Blueprint component

```
InitialContext ic = new InitialContext();
BloggingService blog= ic.lookup("osgi:services/"
                + BloggingService.class.getName());
```

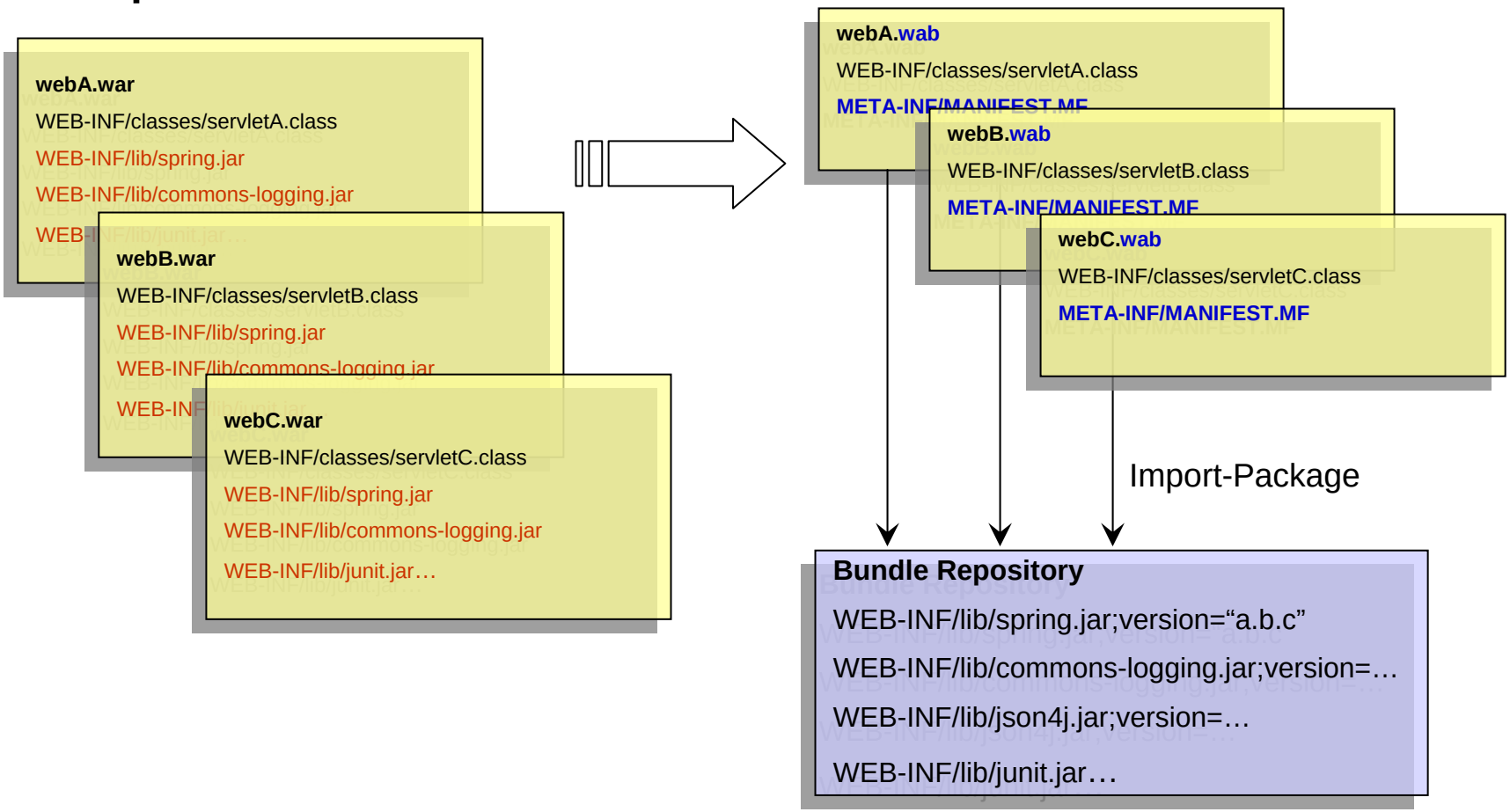
IBM WebSphere Application Server & OSGi

- OSGi used internally in WAS since 2005 (WAS 6.1 shipped in 2006)
- Application-level exploitation of OSGi introduced in Nov 2009…
- WAS V7 Feature Pack for OSGi Applications (Beta) https://www14.software.ibm.com/iwm/web/cc/earlyprograms/websphere/wasfposgiajp/support.shtml
  - Freely available – installs on top of WAS v7.0.0.7
  - Integrates Apache Aries technologies with the WAS runtime and administration.
  - Supports deployment of web applications as isolated applications consisting of one or more OSGi bundles

Module Re-Use Made Easy

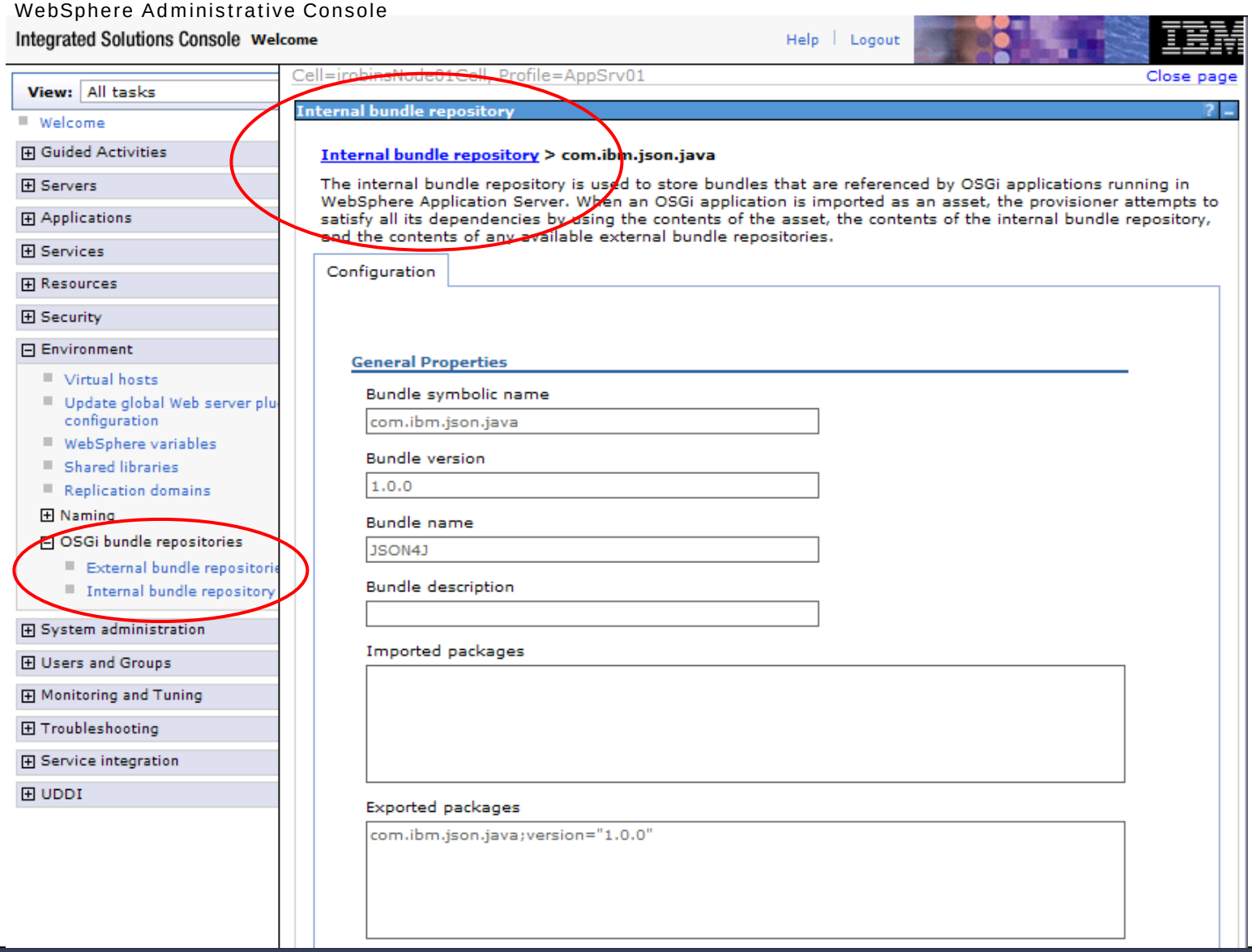
No Java code changes; war modules -> bundles

Common, bundles may be easily factored out of the WARs and used at specific versions



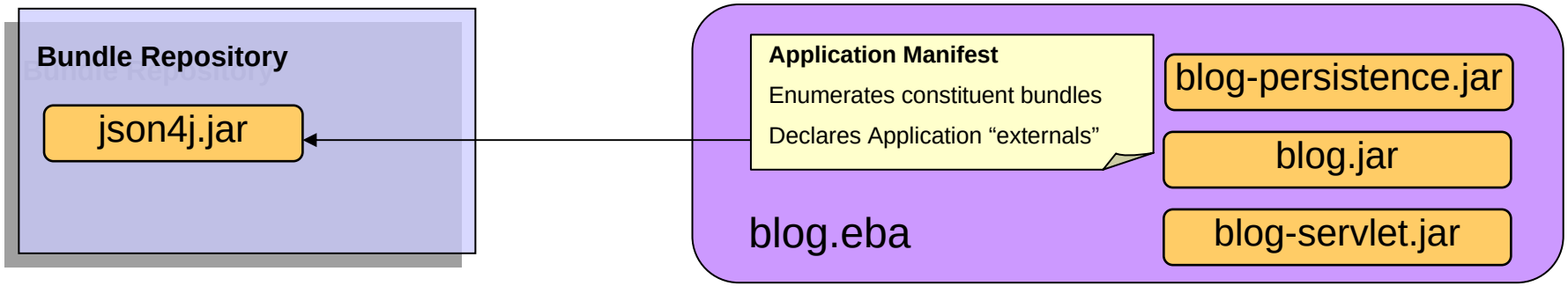
App Deploy Using OSGi Bundle Repositories

WebSphere Administrative Console



“Enterprise Bundle Archive” (EBA)

- An isolated, cohesive application consisting of a collection of bundles, is deployed as a logical unit in a “.eba” archive
  - An “OSGi Application”.
- Constituent bundles may be contained (“by-value”) or referenced from a bundle repository.
- Services provided by the application are isolated to the application unless explicitly exposed through EBA-level application manifest
- Config by exception - absence of APPLICATION.MF means:
  - application content is the set of bundles contained by-value plus any repository-hosted dependencies identified during deployment.



Resolving and “freezing” the deployment

Install (via Admin Console / wsadmin)

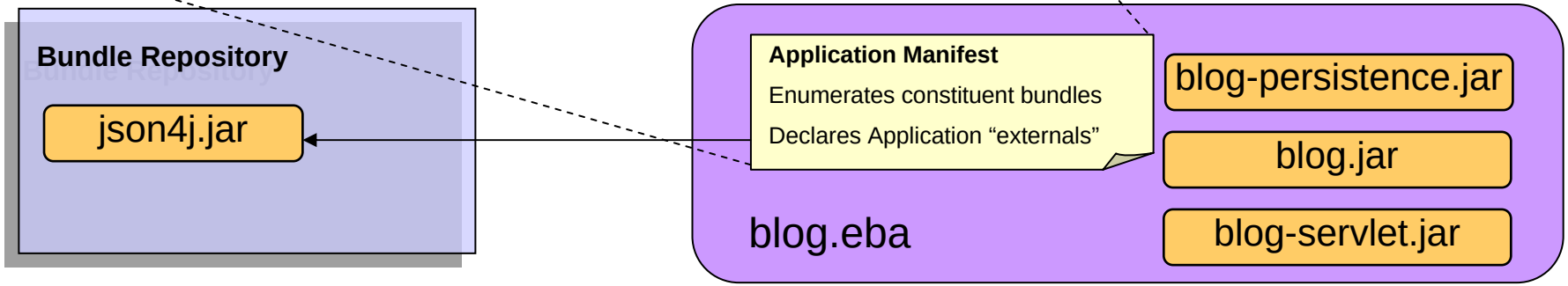
Application Manifest (developer/assembler **authored** artefact)
Enumerates constituent bundles and allowable version ranges
Declares Application “externals”

```
Manifest-Version: 1.0
Application-ManifestVersion: 1.0
Application-Name: Blog Application
Application-SymbolicName: aries.sample.blog
Application-Version: 1.0
Application-Content:
  aries.sample.blog; version="[1.0.0,1.1.0)",
  aries.sample.blog-api; version=1.0.0,
  aries.sample.blog-persistence; version=1.0.0,
  aries.sample.blog-servlet; version="[1.0.0,1.0.0]"
```

Deployed Result

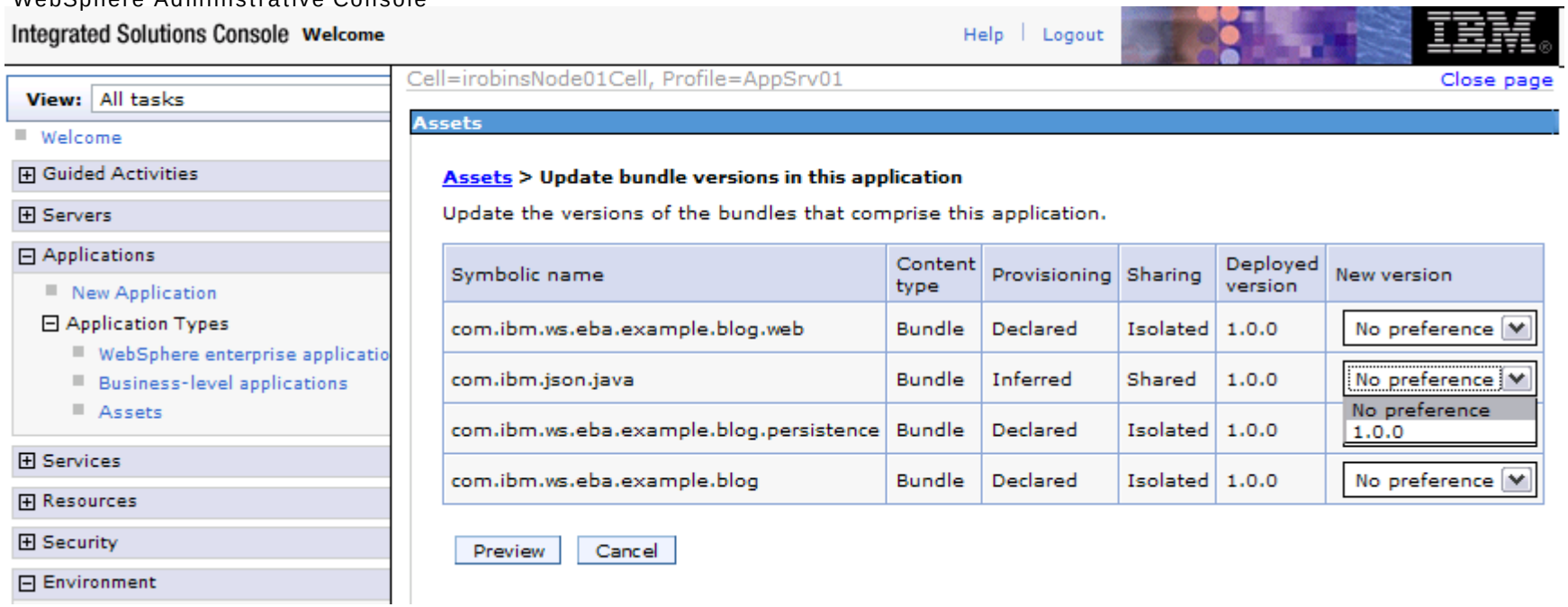
Deployment Manifest (**generated** during *createApplication*)
Transitively closed description of all bundles resolved at specific versions to “freeze-dry” the application.

```
Manifest-Version: 1.0
Deployment-ManifestVersion: 1.0
Application-Name: Blog Application
Application-SymbolicName: aries.sample.blog
Application-Version: 1.0
Deployed-Content:
  aries.sample.blog; deployed-version=1.0.0,
  aries.sample.blog-api; deployed-version=1.0.0,
  aries.sample.blog-persistence; deployed-version=1.0.0,
  aries.sample.blog-servlet; deployed-version=1.0.0,
  com.ibm.json.java; deployed-version=1.0.0
```

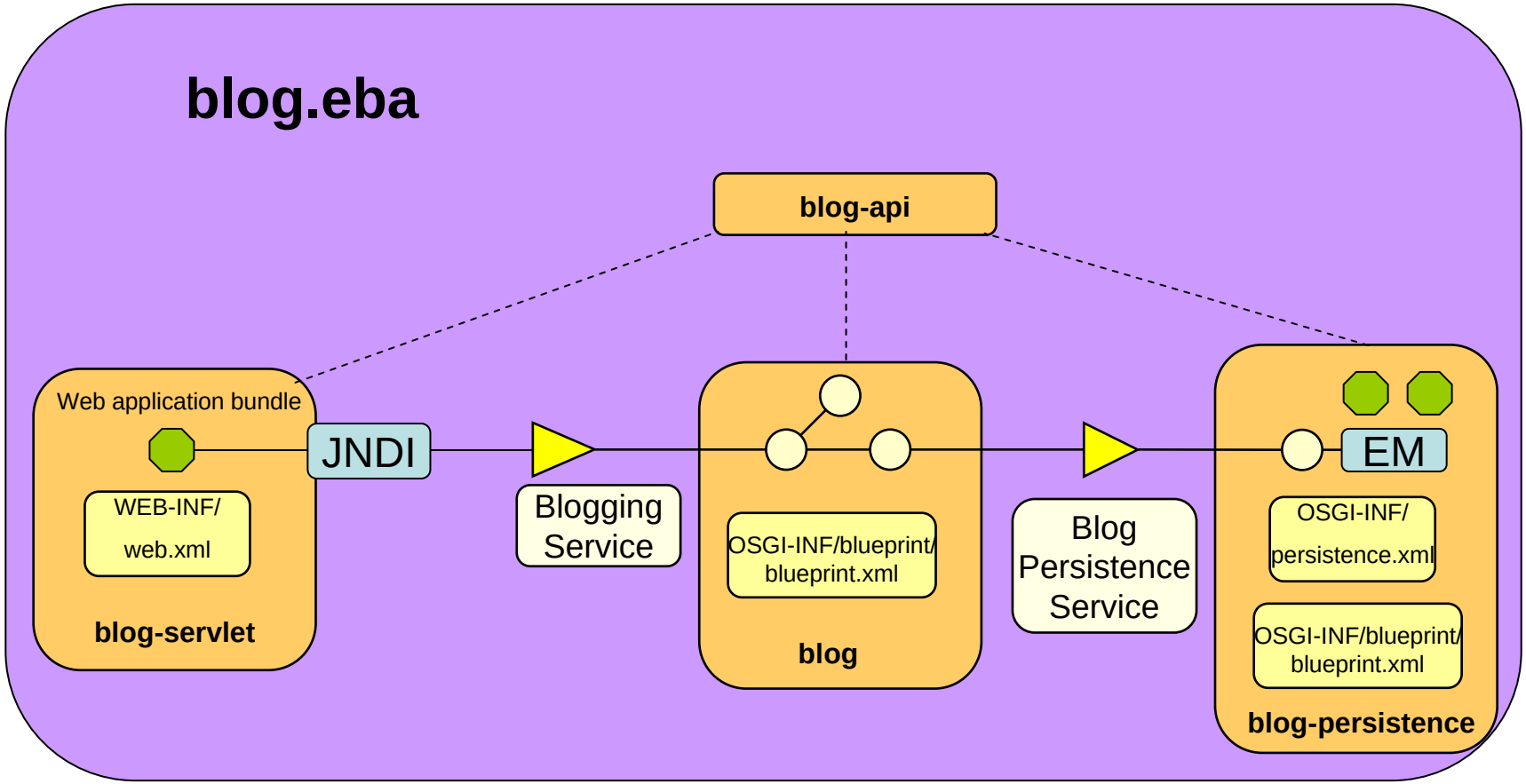


Bundle-level Management

WebSphere Administrative Console



Example “Blog” Application Architecture




In the near future…
all major Java
enterprise runtimes
will support Apps
deployed as bundles

For further information visit:
ibm.com/WebSphere/dev