OSGI BASICS

SYSTEM INTEGRATION WITH JBOSS

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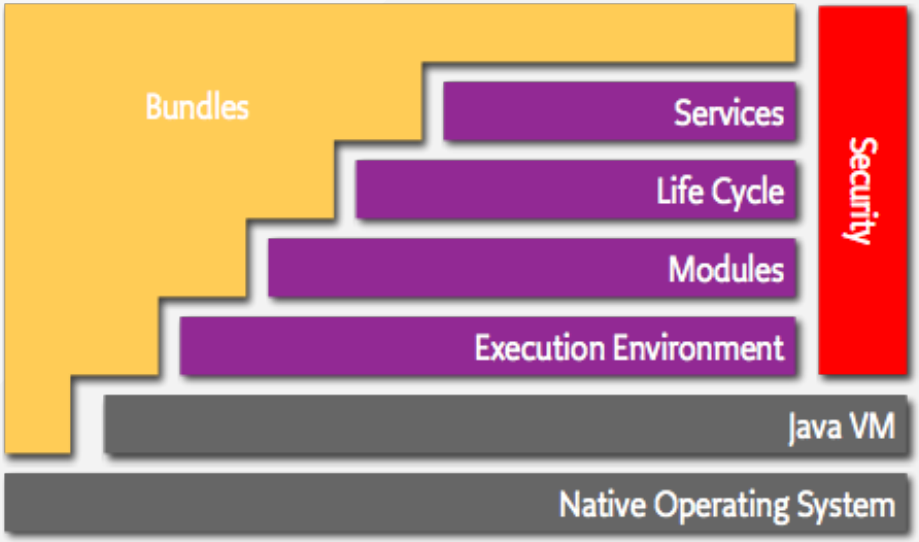
OSGI TECHNOLOGY

- **O**pen **S**ervices **G**ateway **i**nitiative (obsolete)
- Set of specifications (last v6, 2014)
- Managed by OSGi Alliance
- **Modular system** and a **service platform** for the Java programming language
- Implements a complete and **dynamic component model**
- Applications or components, coming in the form of **bundles**
- Bundles have **lifecycle**
- "Service Oriented Architecture" in JVM
- **Enterprise** ready system (web bundles)

OSGI ARCHITECTURE

- Key layers
  - Modules
  - Life Cycle
  - Services
- Execution Environment
  - Defines what methods and classes are available in a specific platform.



OSGI USAGE

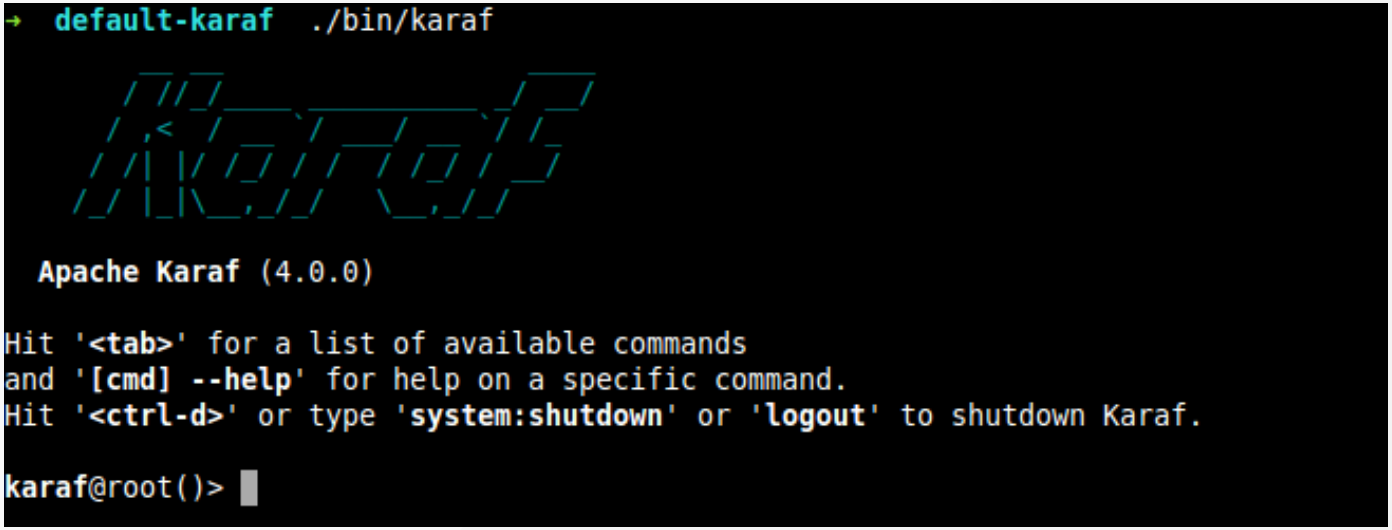
- Main implementations
  - Apache Felix
  - Eclipse Equinox (reference implementation)
  - Knopflerfish
- Usage
  - Middleware products
    - **Apache Karaf**
    - **JBoss Fuse**
    - **JBoss EAP** - Red Hat's JBoss Application Server
    - **GlassFish** (v3) - Application server for Java EE
    - **Weblogic** - Oracle Weblogic Application Server
    - **WebSphere** - IBM Websphere JEE Application Server
    - **Liferay** - Free and open source enterprise portal platform
  - IDE (Integrated Development Environment)
    - **Eclipse**
    - **Netbeans**
    - **IntelliJ**

APACHE KARAF CONTAINER

- Small OSGi based runtime
- Lightweight container
- Various components and applications can be deployed (jar, war)
- Based on Apache Felix
- Features:
  - **Hot deployment** ([home]/deploy)
  - **Dynamic configuratio** ([home]/etc)
  - **Logging System** (centralised, Log4J)
  - **Provisioning** (mvn, http, file etc.)
  - **Extensible Shell console**
  - **Remote access** (ssh)
  - **Security framework** (JAAS)
  - **Managing multiple instances**

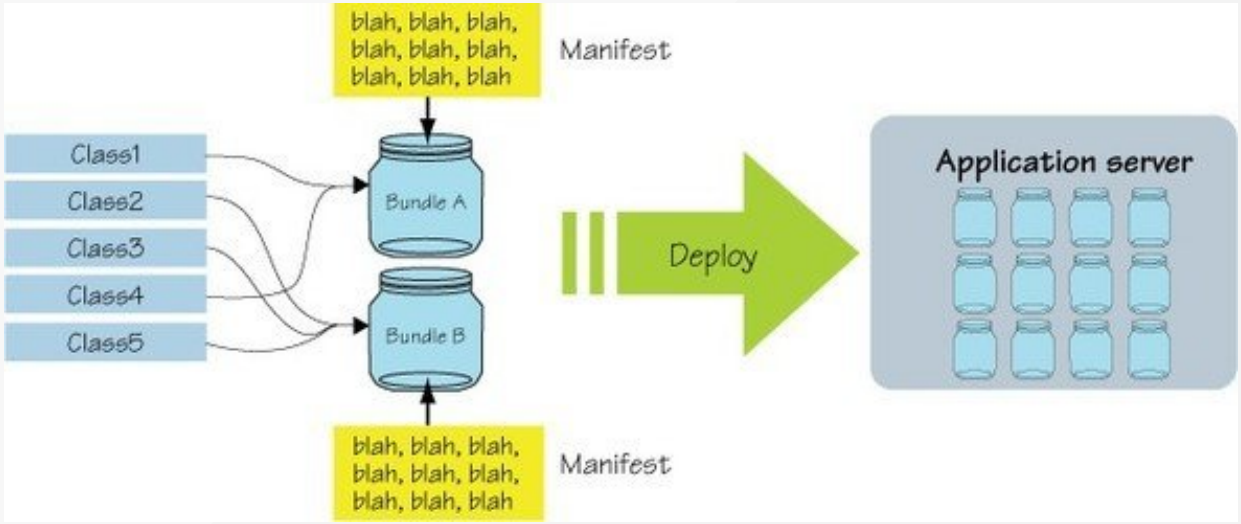
APACHE KARAF (2)

SCREENSHOT



BUNDLE

- Basic module in OSGi container
- = JAR archive + OSGI metadata
- OSGi metadata
  - Properties in META-INF/MANIFEST.MF file
  - Bundle unique static identification
    - Symbolic name + version



MANIFEST HEADERS

- Non-OSGi headers
  - Manifest-Version, Build-Jdk, Build-By, Main-Class
- **OSGI headers**
  - Mandatory
    - **Bundle-SymbolicName**
    - **Bundle-Version**
    - **Bundle-ManifestVersion** (the only value is "2")
  - Optional
    - Human readable
      - Bundle-Name
      - Bundle-Description
      - Bundle-Vendor
    - Lifecycle
      - **Bundle-Activator**
    - Modules
      - **Export-Package**
      - **Import-Package**
      - Bundle-ClassPath (default value is ".")

MANIFEST EXAMPLE

```
Bundle-Name: Hello World
Bundle-SymbolicName: org.wikipedia.helloworld
Bundle-Description: A Hello World bundle
Bundle-ManifestVersion: 2
Bundle-Version: 1.0.0
Bundle-Activator: org.wikipedia.Activator
Export-Package: org.wikipedia.helloworld;version="1.0.0"
Import-Package: org.osgi.framework;version="1.3.0"
```

OSGI PACKAGES

- **Export package**
  - Provided package for other bundles
  - Property "version" - **single value**
- **Import package**
  - Missing package
  - Property "version" - **interval** (always!)
    - *no version* → 0.0.0 <= x <= max
    - "1.2" → 1.2.0 <= x <= max
    - "[2.1, 3)" → 2.1 <= x < 3

Question: Is it possible to to require only single version?

MANIFEST GENERATOR

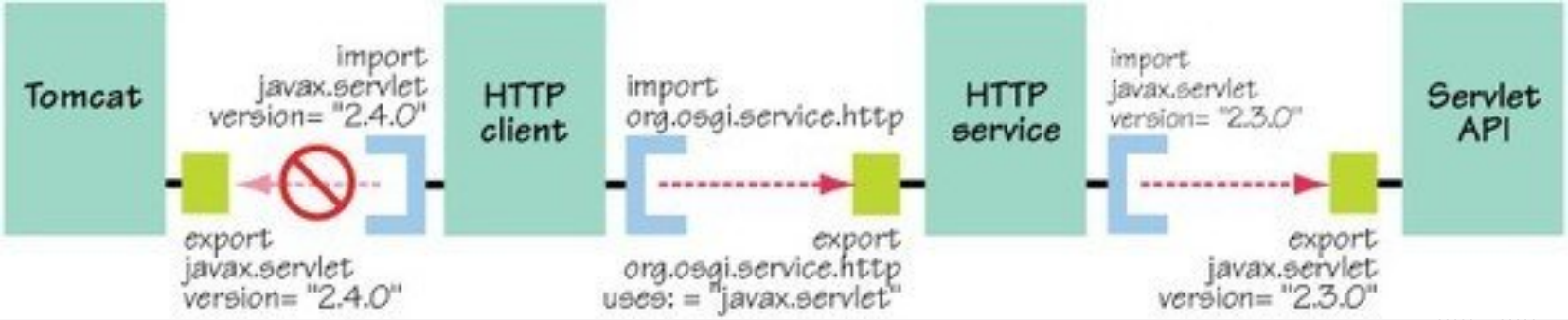
- BND tool
  - Simplifies bundle creation
  - Generates OSGi metadata semi-automatically
  - Syntactic sugars
    - Import-Package: com.library.*; version = 1.21
- Maven bundle plugin
  - Uses BND tool internally

```
<plugin>
   <groupId>org.apache.felix</groupId>
   <artifactId>maven-bundle-plugin</artifactId>
   <extensions>true</extensions>
   <configuration>
      <instructions>
         <Bundle-Activator>org.wikipedia.Activator</Bundle-Activator>
      </instructions>
   </configuration>
</plugin>
```

IMPORT PACK. PRIORITIES

- RESOLVED bundle state has precedence before INSTALLED
- Greater versions have precedence
- Property match (e.g. vendor="sun")
- Directive "uses:=<package-name>"

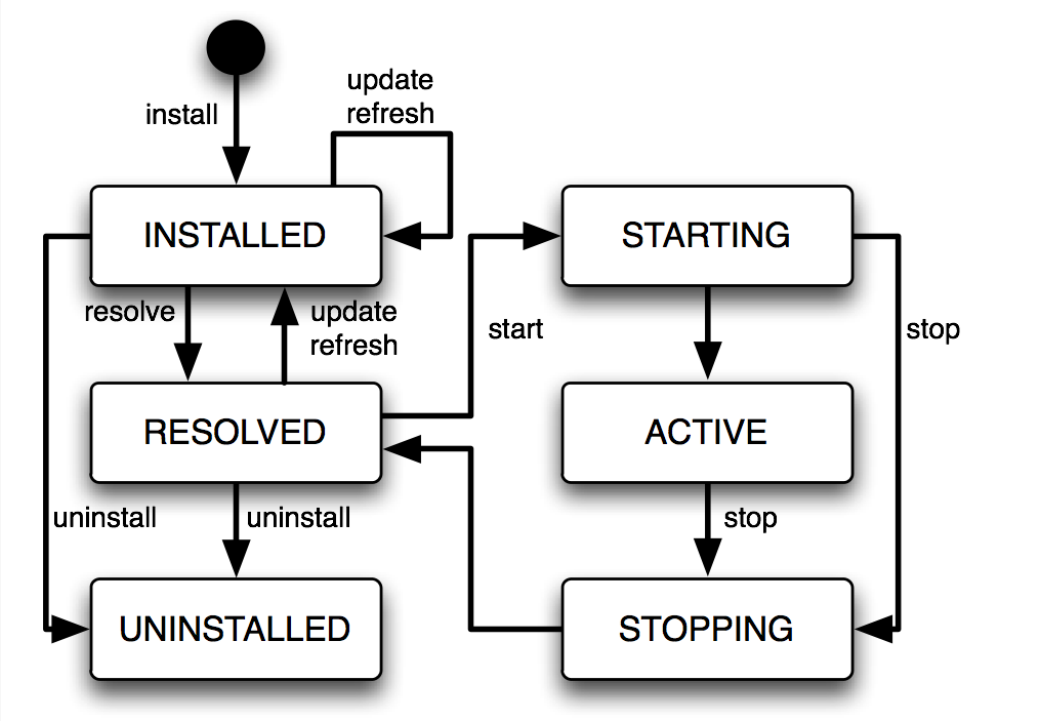
Question: Why HTTP client will not be resolved if other bundles are resolved?



OSGI CLASSLOADING

- Every bundle has its own classloader
- Classloader's structure is Map
- One item for each imported package
  - key - Package name
  - value - Another classloder
- There is no delegation of requests to parent classloaders
- Class searching
  1. java.*
  2. Import packages (Import-Package)
  3. Own packages (Bundle-ClassPath)

OSGI LIFECYCLE



Demo 1 : Bundle events

BUNDLE ACTIVATORS

- Connected with states **STARTING** and **STOPPING**
- Activators implement interface org.osgi.framework.BundleActivator
- OSGi header "Bundle-Activator" in MANIFEST.MF
- Often used for OSGi services registrations

```
public interface BundleActivator {
    public void start(BundleContext context) throws Exception;
    public void stop(BundleContext context) throws Exception;
}
```

OSGI SERVICES

- "SOA" in JVM
- Advantages
  - Less coupling
  - Multiple implementations
- Every service has contract (one or more interfaces)
- Service registration
  - Activator
  - Component framework
- Service discovery
  - Contract + service properties (LDAP syntax)
- Service priority
  1. Atribute "service.ranking"
  2. Attribute "service.id"

SERVICE REGISTRATION

```
public class Activator implements BundleActivator {

    private ServiceRegistration registration;

    public void start(BundleContext ctx) {
        Dictionary props = new Properties();
        props.put("service.ranking", 1);
        registration = ctx.registerService(Foo.class.getName(),
            new FooImpl(), props);
    }

    public void stop(BundleContext ctx) {
        registration.unregister();
    }
}
```

LISTENERS

- **Bundle listener**
  - Tracks bundle events (STARTED, STOPPED, UPDATED, ...)
  - Used in BundleTracker (advanced bundle monitoring)

```
public interface BundleListener extends EventListener {

    public void bundleChanged(BundleEvent event);
}
```

- **Service listener**
  - Tracks service events (REGISTERED, MODIFIED, ...)
  - Used in ServiceTracker (advanced service monitoring)

```
public interface ServiceListener extends EventListener {

    public void serviceChanged(ServiceEvent event);
}
```

Demo 2 : Paint application (OSGi in Action)

COMPONENT FRAMEWORKS

- Simplifies creation of logical components (e.g. OSGi service, java beans, ...)
- Frameworks are based on OSGi listeners
- Component definition
  - XML descriptor
    - Declarative Services, **Blueprint**, **Spring DS**
  - Java annotations
    - Apache Felix iPojo

BLUEPRINT

- Specification of OSGi component framework
- Specification managed by OSGi Aliance
- Uses dependency injection
- Designed to deal with the dynamic nature of OSGi
  - Services can become available and unavailable at any time.
  - Uses proxy objects
- Each bundle has own Blueprint container
- Uses OSGi extender pattern
  - Extension definition
    1. OSGI-INF/blueprint/*.xml
    2. "Bundle-Blueprint" property in MANIFEST.MF
- Implementations
  - Apache Aries
  - Eclipse Gemini (reference implementation)

BLUEPRINT DESCRIPTOR

- XML elements
  - Main
    - <bean>, <service>, <reference>, <reference-list>
  - Other
    - <value>, <ref>, <idref>, <map>, <props>, <list>, <array>, ...

```
<?xml version="1.0" encoding="UTF-8"?>
<blueprint xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns="http://www.osgi.org/xmlns/blueprint/v1.0.0">

  <reference id="bazRef" interface="Baz"/>

  <bean id="barImplRef" class="BarImpl">
    <property name="baz" ref="bazRef"/>
  </bean>

  <service interface="Foo" ref="barImplRef" ranking="1">
    <service-properties>
      <entry key="prop" value="foobar"/>
    </service-properties>
  </service>
</blueprint>
```

SPRING DM

- Spring DM = Spring Dynamic Modules
- An open source project in the Spring portfolio
- Allows to implement Spring Applications on top of an OSGi framework
- Connects the benefits of both technologies
  - Spring - Component management, AOP, Dependency Injection, ...
  - OSGi - Dynamic environment
- Each bundle has own Spring container
- Spring beans can be exported as OSGi services
- Uses OSGi extender pattern
  - Extension definition
    - META-INF/spring/*.xml
    - "Spring-Context" property in MANIFEST.MF

SPRING DESCRIPTOR

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:osgi="http://www.springframework.org/schema/osgi">

  <osgi:reference id="bazRef" interface="Baz"/>

  <bean id="barImplRef" class="BarImpl">
    <property name="baz" ref="bazRef"/>
  </bean>

  <osgi:service interface="Foo" ref="simpleService" ranking="3">
    <osgi:service-properties>
      <entry key="prop" value="foobaz"/>
    </osgi:service-properties>
  </osgi:service>

</beans>
```

OSGI ENTERPRISE

- **Web applications**
  - web.xml
  - Web-ContextPath in MANIFEST.MF
- **Dependency Injection**
  - Blueprint
  - Spring
- **JNDI**
  - osgi:service/<interface>[/<properties>]
  - Service property "osgi.jndi.service.name" for custom JNDI names
    - osgi:service/<jndi-name>
- **JPA**, **JDBC**
  - problems with dynamic classpath
  - solution: OSGi services (Datasources, EntityManagers)
  - persistence.xml ("Meta-Persistence" in MANIFEST.MF)
  - container/aplication managed
- **JTA**
  - container/aplication managed

OSGI ENTERPRISE (2)

- Blueprint + JPA + Transactions

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

   <bean id="inventory" class="fancyfoods.persistence.InventoryImpl">
      <tx:transaction method="*" value="Required" />
      <jpa:context property="entityManager" unitname="fancyfoods" />
   </bean>

   <service ref="inventory" interface="fancyfoods.food.Inventory" />
</blueprint>
```

OSGI ENTERPRISE (3)

- **Enterprise archives**
  - Java EE
    - EAR archives (Enterprise archives)
  - OSGi
    - ESA
      - Enterprise Subsystem Archives
      - no application.xml but SUBSYSTEM.MF
      - Dependencies do not have to be contained in archive
    - EBA
      - Enterprise Bundle Archive
      - similar to ESA (from Aries)
    - **Features**
      - XML descriptor (from Apache)

REFERENCES

- **OSGi in Action -** Richard S. Hall, Karl Pauls, Stuart McCulloch, David Savage
- **Enterprise OSGi in Action -** Holly Cummins, Timothy Ward
- **Spring in Action -** Craig Walls
- **Spring Dynamic Modules in Action** - Arnaud Cogoluegnes, Thierry Templier, Andy Piper
- http://www.osgi.org/Specifications

redhat.

THANK YOU!