Red Hat JBoss Fuse 7.0-TP

Deploying into Apache Karaf

Deploying application packages into the Apache Karaf container

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Legal Notice

Abstract

The guide describes the options for deploying applications into an Apache Karaf container.

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PART I. DEVELOPER GUIDE

This part contains information for developers.

CHAPTER 1. DEPLOYING USING AN OSGI BUNDLE

Abstract

The usual and most common method of deploying into Apache Karaf is using an OSGi bundle.

1.1. OSGI OVERVIEW

Apache Karaf is structured to use OSGi functionality. For more information about the structure of Apache Karaf see Chapter 2, *Introduction to OSGi*.

An OSGi bundle is a collection of JAR files with configuration files, bundled up into a JAR. For more information about creating OSGi bundles see Chapter 3, *Building an OSGi Bundle*.

1.2. PREREQUISITES

Before following the instructions make sure that you have completed the following prerequisites:

- Install Apache Karaf, following the instructions in the https://access.redhat.com/documentation/en-us/red_hat_jboss_fuse/7.0-TP/single/installing_on_apache_karaf/index JBoss FuseInstalling on Apache Karaf Guide
- Make sure you have installed and configured Maven as shown in Chapter 34, *Building with Maven*

1.3. PREPARING THE OSGI BUNDLE

For this example we will use a *quickstart*, which is a ready-prepared bundle. Quickstarts can be found in **`FUSE_HOME/quickstarts`**

To find out more about how to build your own OSGi bundle, see Section 3.1, “Generating a Bundle Project” .

1.4. DEPLOYING THE OSGI BUNDLE

The OSGi bundle is deployed into a running Apache Karaf instance.

1. Start Apache Karaf from the bin direction by executing the **`./karaf`** script in the **`FUSE_HOME/bin/`** directory.
   You will see the prompt:

   ```
   karaf@root()>
   ```

2. On a separate terminal, navigate to the **`FUSE_HOME/quickstarts/beginner/camel-log`** directory. **`camel-log`** is the name of the quickstart we will use to create a bundle.

3. Compile the **`camel-log`** quickstart using Maven:

   ```
   $  mvn clean install
   ```

4. Return to the Karaf terminal and install the project:

```
karaf@root()> osgi:install -s
mvn:org.jboss.fuse.quickstarts/beginner-camel-log/7.0.0.fuse-000145-
redhat-1
```

You will see a bundle ID returned:

```
Bundle ID: 228
```

This is a unique identifier for this bundle on this instance of Apache Karaf

5. To see the output of project, look in the log file at **`FUSE_HOME/data/log/fuse.log`** The output will look like this:

```
12:07:34.542 INFO [Camel (log-example-context) thread #1 - timer://foo]
>>> Hello from Fuse based Camel route! :
12:07:39.530 INFO [Camel (log-example-context) thread #1 - timer://foo]
>>> Hello from Fuse based Camel route! :
12:07:44.530 INFO [Camel (log-example-context) thread #1 - timer://foo]
>>> Hello from Fuse based Camel route! :
```

For more information about deploying OSGi bundles, see Chapter 5, *Hot deployment vs manual deployment*.

CHAPTER 2. INTRODUCTION TO OSGI

Abstract

The OSGi specification supports modular application development by defining a runtime framework that simplifies building, deploying, and managing complex applications.

2.1. OVERVIEW

Apache Karaf is an OSGi-based runtime container for deploying and managing bundles. Apache Karaf also provides native operating system integration, and can be integrated into the operating system as a service so that the lifecycle is bound to the operating system.

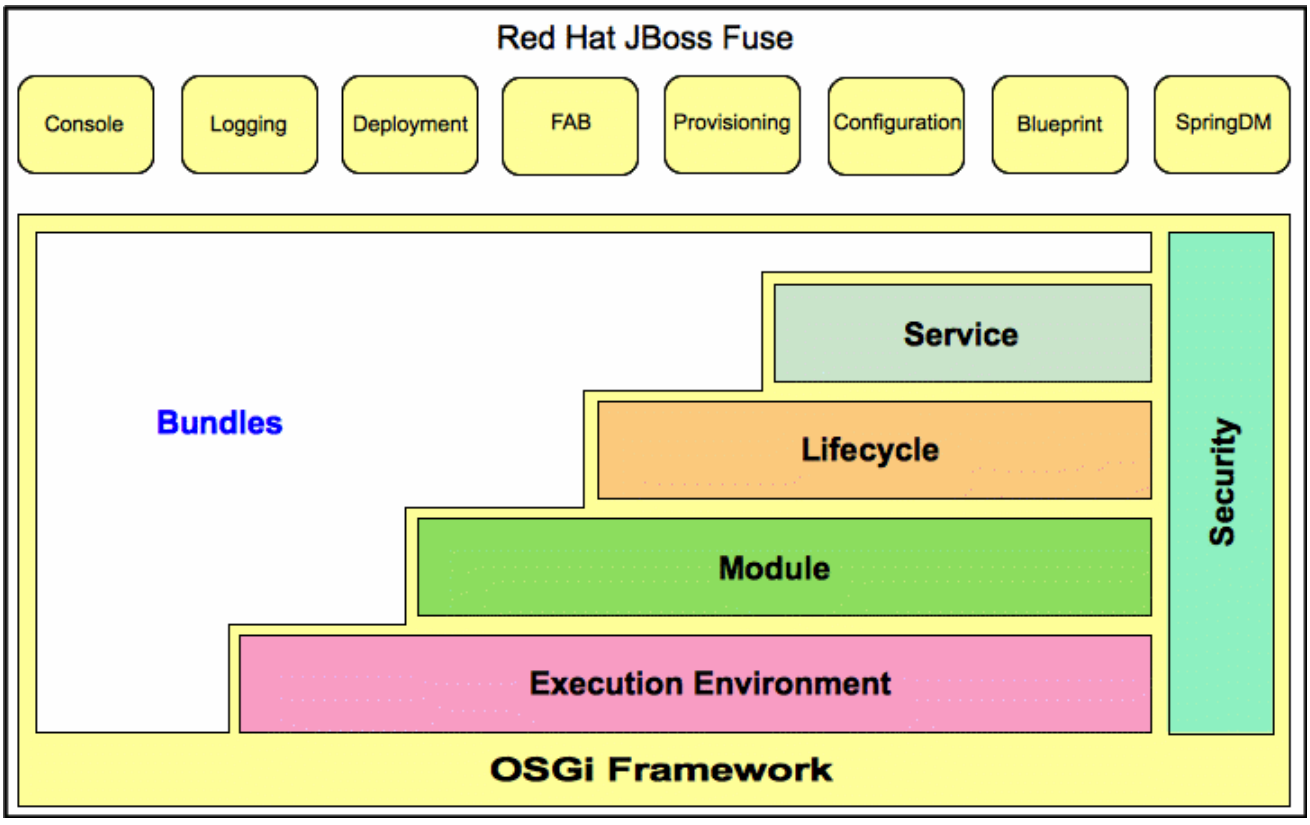
Apache Karaf has the following structure:

- Apache Karaf - a wrapper layer around the OSGi container implementation, which provides support for deploying the OSGi container as a runtime server. Runtime features provided by the JBoss Fuse include hot deployment, management, and administration features.
- OSGi Framework - implements OSGi functionality, including managing dependencies and bundle lifecycles

2.2. ARCHITECTURE OF APACHE KARAF

Figure 2.1, “Apache Karaf Architecture” shows the architecture of Apache Karaf.

Figure 2.1. Apache Karaf Architecture



Apache Karaf extends the OSGi layers with the following functionality:

- **Console** - the console manages services, installs and manages applications and libraries, and interacts with the JBoss Fuse runtime. It provides console commands to administer instances of JBoss Fuse. See the olink:FMQCommandRef/FMQCommandRef.
- **Logging** - the logging subsystem provides console commands to display, view and change log levels.
- **Deployment** - supports both manual deployment of OSGi bundles using the `osgi:install` and `osgi:start` commands and hot deployment of applications. See Section 5.1, "Hot Deployment".
- **Provisioning** - provides multiple mechanisms for installing applications and libraries. See Chapter 8, *Deploying Features*.
- *Configuration - the properties files stored in the *InstallDir*`/etc` folder are continuously monitored, and changes to them are automatically propagated to the relevant services at configurable intervals.
- **Blueprint** - is a dependency injection framework that simplifies interaction with the OSGi container. For example, providing standard XML elements to import and export OSGi services. When a Blueprint configuration file is copied to the hot deployment folder, Red Hat JBoss Fuse generates an OSGi bundle on-the-fly and instantiates the Blueprint context.

2.3. OSGI FRAMEWORK

2.3.1. Overview

The OSGi Alliance is an independent organization responsible for defining the features and capabilities of the OSGi Service Platform Release 4. The OSGi Service Platform is a set of open specifications that simplify building, deploying, and managing complex software applications.

OSGi technology is often referred to as the dynamic module system for Java. OSGi is a framework for Java that uses bundles to modularly deploy Java components and handle dependencies, versioning, classpath control, and class loading. OSGi's lifecycle management allows you to load, start, and stop bundles without shutting down the JVM.

OSGi provides the best runtime platform for Java, a superior class loading architecture, and a registry for services. Bundles can export services, run processes, and have their dependencies managed. Each bundle can have its requirements managed by the OSGi container.

JBoss Fuse uses Apache Felix as its default OSGi implementation. The framework layers form the container where you install bundles. The framework manages the installation and updating of bundles in a dynamic, scalable manner, and manages the dependencies between bundles and services.

2.3.2. OSGi architecture

As shown in Figure 2.1, "Apache Karaf Architecture", the OSGi framework contains the following:

- **Bundles** — Logical modules that make up an application. See Section 2.5, "OSGi Bundles".
- **Service layer** — Provides communication among modules and their contained components. This layer is tightly integrated with the lifecycle layer. See Section 2.4, "OSGi Services".

- **Lifecycle layer** — Provides access to the underlying OSGi framework. This layer handles the lifecycle of individual bundles so you can manage your application dynamically, including starting and stopping bundles.
- **Module layer** — Provides an API to manage bundle packaging, dependency resolution, and class loading.
- **Execution environment** — A configuration of a JVM. This environment uses profiles that define the environment in which bundles can work.
- **Security layer** — Optional layer based on Java 2 security, with additional constraints and enhancements.

Each layer in the framework depends on the layer beneath it. For example, the lifecycle layer requires the module layer. The module layer can be used without the lifecycle and service layers.

2.4. OSGI SERVICES

2.4.1. Overview

An OSGi service is a Java class or service interface with service properties defined as name/value pairs. The service properties differentiate among service providers that provide services with the same service interface.

An OSGi service is defined semantically by its service interface, and it is implemented as a service object. A service's functionality is defined by the interfaces it implements. Thus, different applications can implement the same service.

Service interfaces allow bundles to interact by binding interfaces, not implementations. A service interface should be specified with as few implementation details as possible.

2.4.2. OSGi service registry

In the OSGi framework, the service layer provides communication between Section 2.5, "OSGi Bundles" and their contained components using the publish, find, and bind service model. The service layer contains a service registry where:

- Service providers register services with the framework to be used by other bundles
- Service requesters find services and bind to service providers

Services are owned by, and run within, a bundle. The bundle registers an implementation of a service with the framework service registry under one or more Java interfaces. Thus, the service's functionality is available to other bundles under the control of the framework, and other bundles can look up and use the service. Lookup is performed using the Java interface and service properties.

Each bundle can register multiple services in the service registry using the fully qualified name of its interface and its properties. Bundles use names and properties with LDAP syntax to query the service registry for services.

A bundle is responsible for runtime service dependency management activities including publication, discovery, and binding. Bundles can also adapt to changes resulting from the dynamic availability (arrival or departure) of the services that are bound to the bundle.

Event notification

Service interfaces are implemented by objects created by a bundle. Bundles can:

- Register services
- Search for services
- Receive notifications when their registration state changes

The OSGi framework provides an event notification mechanism so service requesters can receive notification events when changes in the service registry occur. These changes include the publication or retrieval of a particular service and when services are registered, modified, or unregistered.

Service invocation model

When a bundle wants to use a service, it looks up the service and invokes the Java object as a normal Java call. Therefore, invocations on services are synchronous and occur in the same thread. You can use callbacks for more asynchronous processing. Parameters are passed as Java object references. No marshalling or intermediary canonical formats are required as with XML. OSGi provides solutions for the problem of services being unavailable.

OSGi framework services

In addition to your own services, the OSGi framework provides the following optional services to manage the operation of the framework:

- **Package Admin service**—allows a management agent to define the policy for managing Java package sharing by examining the status of the shared packages. It also allows the management agent to refresh packages and to stop and restart bundles as required. This service enables the management agent to make decisions regarding any shared packages when an exporting bundle is uninstalled or updated.
  The service also provides methods to refresh exported packages that were removed or updated since the last refresh, and to explicitly resolve specific bundles. This service can also trace dependencies between bundles at runtime, allowing you to see what bundles might be affected by upgrading.

- **Start Level service**—enables a management agent to control the starting and stopping order of bundles. The service assigns each bundle a start level. The management agent can modify the start level of bundles and set the active start level of the framework, which starts and stops the appropriate bundles. Only bundles that have a start level less than, or equal to, this active start level can be active.

- **URL Handlers service**—dynamically extends the Java runtime with URL schemes and content handlers enabling any component to provide additional URL handlers.

- **Permission Admin service**—enables the OSGi framework management agent to administer the permissions of a specific bundle and to provide defaults for all bundles. A bundle can have a single set of permissions that are used to verify that it is authorized to execute privileged code. You can dynamically manipulate permissions by changing policies on the fly and by adding new policies for newly installed components. Policy files are used to control what bundles can do.

- **Conditional Permission Admin service**—extends the Permission Admin service with permissions that can apply when certain conditions are either true or false at the time the permission is checked. These conditions determine the selection of the bundles to which the permissions apply. Permissions are activated immediately after they are set.

The OSGi framework services are described in detail in separate chapters in the **OSGi Service Platform Release 4** specification available from the release 4 download page on the OSGi Alliance web site.

OSGi Compendium services

In addition to the OSGi framework services, the OSGi Alliance defines a set of optional, standardized compendium services. The OSGi compendium services provide APIs for tasks such as logging and preferences. These services are described in the **OSGi Service Platform, Service Compendium** available from the release 4 download page on the OSGi Alliance Web site.

The **Configuration Admin** compendium service is like a central hub that persists configuration information and distributes it to interested parties. The Configuration Admin service specifies the configuration information for deployed bundles and ensures that the bundles receive that data when they are active. The configuration data for a bundle is a list of name-value pairs. See Section 2.2, “Architecture of Apache Karaf”.

2.5. OSGI BUNDLES

Overview

With OSGi, you modularize applications into bundles. Each bundle is a tightly coupled, dynamically loadable collection of classes, JARs, and configuration files that explicitly declare any external dependencies. In OSGi, a bundle is the primary deployment format. Bundles are applications that are packaged in JARs, and can be installed, started, stopped, updated, and removed.

OSGi provides a dynamic, concise, and consistent programming model for developing bundles. Development and deployment are simplified by decoupling the service’s specification (Java interface) from its implementation.

The OSGi bundle abstraction allows modules to share Java classes. This is a static form of reuse. The shared classes must be available when the dependent bundle is started.

A bundle is a JAR file with metadata in its OSGi manifest file. A bundle contains class files and, optionally, other resources and native libraries. You can explicitly declare which packages in the bundle are visible externally (exported packages) and which external packages a bundle requires (imported packages).

The module layer handles the packaging and sharing of Java packages between bundles and the hiding of packages from other bundles. The OSGi framework dynamically resolves dependencies among bundles. The framework performs bundle resolution to match imported and exported packages. It can also manage multiple versions of a deployed bundle.

Class Loading in OSGi

OSGi uses a graph model for class loading rather than a tree model (as used by the JVM). Bundles can share and re-use classes in a standardized way, with no runtime class-loading conflicts.

Each bundle has its own internal classpath so that it can serve as an independent unit if required.

The benefits of class loading in OSGi include:

- Sharing classes directly between bundles. There is no requirement to promote JARs to a parent class-loader.

- You can deploy different versions of the same class at the same time, with no conflict.

CHAPTER 3. BUILDING AN OSGI BUNDLE

Abstract

This chapter describes how to build an OSGi bundle using Maven. For building bundles, the Maven bundle plug-in plays a key role, because it enables you to automate the generation of OSGi bundle headers (which would otherwise be a tedious task). Maven archetypes, which generate a complete sample project, can also provide a starting point for your bundle projects.

3.1. GENERATING A BUNDLE PROJECT

3.1.1. Generating bundle projects with Maven archetypes

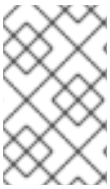
To help you get started quickly, you can invoke a Maven archetype to generate the initial outline of a Maven project (a Maven archetype is analogous to a project wizard). The following Maven archetypes can generate projects for building OSGi bundles:

- Section 3.1.2, “Apache CXF karaf-soap-archetype archetype”.
- Section 3.1.3, “Apache Camel archetype”.

3.1.2. Apache CXF karaf-soap-archetype archetype

The Apache CXF karaf-soap-archetype archetype creates a project for building a service from Java. To generate a Maven project with the coordinates, *GroupId*:*ArtifactId*:*Version*, enter the following command:

```
mvn archetype:generate \
  -DarchetypeGroupId=io.fabric8.archetypes \
  -DarchetypeArtifactId=karaf-soap-archetype \
  -DarchetypeVersion={fabricVersion} \
  -DgroupId=GroupId \
  -DartifactId=ArtifactId \
  -Dversion=Version \
  -Dfabric8-profile=ProfileName
```



NOTE

The backslash character, \, indicates line continuation on Linux and UNIX operating systems. On Windows platforms, you must omit the backslash character and put all of the arguments on a single line.

3.1.3. Apache Camel archetype

The Apache Camel OSGi archetype creates a project for building a route that can be deployed into the OSGi container. To generate a Maven project with the coordinates, *GroupId*:*ArtifactId*:*Version*, enter the following command:

```
mvn archetype:generate \
  -DarchetypeGroupId=org.apache.camel.archetypes \
  -DarchetypeArtifactId=camel-archetype-blueprint \
  -DarchetypeVersion=2.21.0.fuse-000055-redhat-2 \
```

```
  -DgroupId=GroupId \
  -DartifactId=ArtifactId \
  -Dversion=Version
```

3.1.4. Building the bundle

By default, the preceding archetypes create a project in a new directory, whose names is the same as the specified artifact ID, *ArtifactId*. To build the bundle defined by the new project, open a command prompt, go to the project directory (that is, the directory containing the **pom.xml** file), and enter the following Maven command:

```
mvn install
```

The effect of this command is to compile all of the Java source files, to generate a bundle JAR under the *ArtifactId*/**target** directory, and then to install the generated JAR in the local Maven repository.

3.2. MODIFYING AN EXISTING MAVEN PROJECT

3.2.1. Overview

If you already have a Maven project and you want to modify it so that it generates an OSGi bundle, perform the following steps:

1. Section 3.2.2, “Change the package type to bundle” .
2. Section 3.2.3, “Add the bundle plug-in to your POM” .
3. Section 3.2.4, “Customize the bundle plug-in” .
4. Section 3.2.5, “Customize the JDK compiler version” .

3.2.2. Change the package type to bundle

Configure Maven to generate an OSGi bundle by changing the package type to **bundle** in your project's **pom.xml** file. Change the contents of the **packaging** element to **bundle**, as shown in the following example:

```
<project ... >
  ...
  <packaging>bundle</packaging>
  ...
</project>
```

The effect of this setting is to select the Maven bundle plug-in, **maven-bundle-plugin**, to perform packaging for this project. This setting on its own, however, has no effect until you explicitly add the bundle plug-in to your POM.

3.2.3. Add the bundle plug-in to your POM

To add the Maven bundle plug-in, copy and paste the following sample **plugin** element into the **project/build/plugins** section of your project's **pom.xml** file:

```
<project ... >
  ...
  <build>
    <defaultGoal>install</defaultGoal>
    <plugins>
      ...
      <plugin> <groupId>org.apache.felix</groupId> <artifactId>maven-
bundle-plugin</artifactId> <version>2.3.7</version>
<extensions>true</extensions> <configuration> <instructions> <Bundle-
SymbolicName>${project.groupId}.${project.artifactId}</Bundle-
SymbolicName> <Import-Package></Import-Package>
          </instructions>
        </configuration>
      </plugin>*
    </plugins>
  </build>
  ...
</project>
```

Where the bundle plug-in is configured by the settings in the **`instructions`** element.

3.2.4. Customize the bundle plug-in

For some specific recommendations on configuring the bundle plug-in for Apache CXF, see Section 3.3, “Packaging a Web Service in a Bundle”.

For an in-depth discussion of bundle plug-in configuration, in the context of the OSGi framework and versioning policy, see olink:OsgiDependencies/OsgiDependencies.

3.2.5. Customize the JDK compiler version

It is almost always necessary to specify the JDK version in your POM file. If your code uses any modern features of the Java language—such as generics, static imports, and so on—and you have not customized the JDK version in the POM, Maven will fail to compile your source code. It is **not** sufficient to set the **`JAVA_HOME`** and the **`PATH`** environment variables to the correct values for your JDK, you must also modify the POM file.

To configure your POM file, so that it accepts the Java language features introduced in JDK 1.7, add the following **`maven-compiler-plugin`** plug-in settings to your POM (if they are not already present):

```
<project ... >
  ...
  <build>
    <defaultGoal>install</defaultGoal>
    <plugins>
      ...
      <plugin> <groupId>org.apache.maven.plugins</groupId>
<artifactId>maven-compiler-plugin</artifactId> <configuration>
<source>1.7</source> <target>1.7</target> </configuration> </plugin>
    </plugins>
  </build>
  ...
</project>
```

3.3. PACKAGING A WEB SERVICE IN A BUNDLE

3.3.1. Overview

This section explains how to modify an existing Maven project for a Apache CXF application, so that the project generates an OSGi bundle suitable for deployment in the Red Hat JBoss Fuse OSGi container. To convert the Maven project, you need to modify the project's POM file and the project's Blueprint file(s) (located in **`META-INF/spring`**).

3.3.2. Modifying the POM file to generate a bundle

To configure a Maven POM file to generate a bundle, there are essentially two changes you need to make: change the POM's package type to **`bundle`**; and add the Maven bundle plug-in to your POM. For details, see Section 3.1, "Generating a Bundle Project".

3.3.3. Mandatory import packages

In order for your application to use the Apache CXF components, you need to import their packages into the application's bundle. Because of the complex nature of the dependencies in Apache CXF, you cannot rely on the Maven bundle plug-in, or the **bnd** tool, to automatically determine the needed imports. You will need to explicitly declare them.

You need to import the following packages into your bundle:

```
javax.jws
javax.wsdl
javax.xml.bind
javax.xml.bind.annotation
javax.xml.namespace
javax.xml.ws
org.apache.cxf.bus
org.apache.cxf.bus.spring
org.apache.cxf.bus.resource
org.apache.cxf.configuration.spring
org.apache.cxf.resource
org.apache.cxf.jaxws
org.springframework.beans.factory.config
```

3.3.4. Sample Maven bundle plug-in instructions

Example 3.1, "Configuration of Mandatory Import Packages" shows how to configure the Maven bundle plug-in in your POM to import the mandatory packages. The mandatory import packages appear as a comma-separated list inside the **`Import-Package`** element. Note the appearance of the wildcard, **`*`**, as the last element of the list. The wildcard ensures that the Java source files from the current bundle are scanned to discover what additional packages need to be imported.

Example 3.1. Configuration of Mandatory Import Packages

```
<project ... >
    ...
    <build>
        <plugins>
            <plugin>
```

```
                <groupId>org.apache.felix</groupId>
                <artifactId>maven-bundle-plugin</artifactId>
                <extensions>true</extensions>
                <configuration>
                    <instructions>
                        ...
                        <Import-Package>
                            javax.jws,
                            javax.wsdl,
                            javax.xml.bind,
                            javax.xml.bind.annotation,
                            javax.xml.namespace,
                            javax.xml.ws,
                            org.apache.cxf.bus,
                            org.apache.cxf.bus.spring,
                            org.apache.cxf.bus.resource,
                            org.apache.cxf.configuration.spring,
                            org.apache.cxf.resource,
                            org.apache.cxf.jaxws,
                            org.springframework.beans.factory.config,
                            *
                        </Import-Package>
                        ...
                    </instructions>
                </configuration>
            </plugin>
        </plugins>
    </build>
    ...
</project>
```

3.3.5. Add a code generation plug-in

A Web services project typically requires code to be generated. Apache CXF provides two Maven plug-ins for the JAX-WS front-end, which enable tyou to integrate the code generation step into your build. The choice of plug-in depends on whether you develop your service using the Java-first approach or the WSDL-first approach, as follows:

- **Java-first approach**—use the **`cxf-java2ws-plugin`** plug-in.
- **WSDL-first approach**—use the **`cxf-codegen-plugin`** plug-in.

3.3.6. OSGi configuration properties

The OSGi Configuration Admin service defines a mechanism for passing configuration settings to an OSGi bundle. You do not have to use this service for configuration, but it is typically the most convenient way of configuring bundle applications. Both Spring DM and Blueprint provide support for OSGi configuration, enabling you to substitute variables in a Blueprint file using values obtained from the OSGi Configuration Admin service.

For details of how to use OSGi configuration properties, see Chapter 4, *Configuring the Bundle Plug-In* and Section 8.6, “Add OSGi configurations to the feature” .

CHAPTER 4. CONFIGURING THE BUNDLE PLUG-IN

OVERVIEW

A bundle plug-in requires very little information to function. All of the required properties use default settings to generate a valid OSGi bundle.

While you can create a valid bundle using just the default values, you will probably want to modify some of the values. You can specify most of the properties inside the plug-in's **`instructions`** element.

CONFIGURATION PROPERTIES

Some of the commonly used configuration properties are:

- Bundle-SymbolicName
- Bundle-Name
- Bundle-Version
- Export-Package
- Private-Package
- Import-Package

SETTING A BUNDLE'S SYMBOLIC NAME

By default, the bundle plug-in sets the value for the **`Bundle-SymbolicName`** property to *groupId* + **`"."`** + *artifactId*, with the following exceptions:

- If *groupId* has only one section (no dots), the first package name with classes is returned. For example, if the group Id is **`commons-logging:commons-logging`**, the bundle's symbolic name is **`org.apache.commons.logging`**.
- If *artifactId* is equal to the last section of *groupId*, then *groupId* is used. For example, if the POM specifies the group ID and artifact ID as **`org.apache.maven:maven`**, the bundle's symbolic name is **`org.apache.maven`**.
- If *artifactId* starts with the last section of *groupId*, that portion is removed. For example, if the POM specifies the group ID and artifact ID as **`org.apache.maven:maven-core`**, the bundle's symbolic name is **`org.apache.maven.core`**.

To specify your own value for the bundle's symbolic name, add a **`Bundle-SymbolicName`** child in the plug-in's **`instructions`** element, as shown in Example 4.1, "Setting a bundle's symbolic name".

Example 4.1. Setting a bundle's symbolic name

```
<plugin>
  <groupId>org.apache.felix</groupId>
  <artifactId>maven-bundle-plugin</artifactId>
  <configuration>
```

```
    <instructions>
      <Bundle-SymbolicName>${project.artifactId}</Bundle-SymbolicName>
      ...
     </instructions>
  </configuration>
</plugin>
```

SETTING A BUNDLE'S NAME

By default, a bundle's name is set to **`${project.name}`**.

To specify your own value for the bundle's name, add a **`Bundle-Name`** child to the plug-in's **`instructions`** element, as shown in Example 4.2, "Setting a bundle's name".

Example 4.2. Setting a bundle's name

```
<plugin>
  <groupId>org.apache.felix</groupId>
  <artifactId>maven-bundle-plugin</artifactId>
  <configuration>
   <instructions>
     <Bundle-Name>JoeFred</Bundle-Name>
     ...
    </instructions>
  </configuration>
</plugin>
```

SETTING A BUNDLE'S VERSION

By default, a bundle's version is set to **`${project.version}`**. Any dashes (**`-`**) are replaced with dots (**`.`**) and the number is padded up to four digits. For example, **`4.2-SNAPSHOT`** becomes **`4.2.0.SNAPSHOT`**.

To specify your own value for the bundle's version, add a **`Bundle-Version`** child to the plug-in's **`instructions`** element, as shown in Example 4.3, "Setting a bundle's version".

Example 4.3. Setting a bundle's version

```
<plugin>
  <groupId>org.apache.felix</groupId>
  <artifactId>maven-bundle-plugin</artifactId>
  <configuration>
   <instructions>
     <Bundle-Version>1.0.3.1</Bundle-Version>
     ...
    </instructions>
  </configuration>
</plugin>
```

SPECIFYING EXPORTED PACKAGES

By default, the OSGi manifest's **Export-Package** list is populated by all of the packages in your local Java source code (under **src/main/java**), **except** for the deault package, **.**, and any packages containing **.impl** or **.internal**.

IMPORTANT

If you use a **Private-Package** element in your plug-in configuration and you do not specify a list of packages to export, the default behavior includes only the packages listed in the **Private-Package** element in the bundle. No packages are exported.

The default behavior can result in very large packages and in exporting packages that should be kept private. To change the list of exported packages you can add an **Export-Package** child to the plug-in's **instructions** element.

The **Export-Package** element specifies a list of packages that are to be included in the bundle and that are to be exported. The package names can be specified using the * wildcard symbol. For example, the entry **com.fuse.demo.*** includes all packages on the project's classpath that start with **com.fuse.demo**.

You can specify packages to be excluded be prefixing the entry with **!**. For example, the entry **!com.fuse.demo.private** excludes the package **com.fuse.demo.private**.

When excluding packages, the order of entries in the list is important. The list is processed in order from the beginning and any subsequent contradicting entries are ignored.

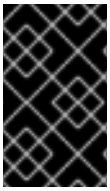
For example, to include all packages starting with **com.fuse.demo** except the package **com.fuse.demo.private**, list the packages using:

```
!com.fuse.demo.private,com.fuse.demo.*
```

However, if you list the packages using **com.fuse.demo.*,!com.fuse.demo.private**, then **com.fuse.demo.private** is included in the bundle because it matches the first pattern.

SPECIFYING PRIVATE PACKAGES

If you want to specify a list of packages to include in a bundle **without** exporting them, you can add a **Private-Package** instruction to the bundle plug-in configuration. By default, if you do not specify a **Private-Package** instruction, all packages in your local Java source are included in the bundle.



IMPORTANT

If a package matches an entry in both the **Private-Package** element and the **Export-Package** element, the **Export-Package** element takes precedence. The package is added to the bundle and exported.

The **Private-Package** element works similarly to the **Export-Package** element in that you specify a list of packages to be included in the bundle. The bundle plug-in uses the list to find all classes on the project's classpath that are to be included in the bundle. These packages are packaged in the bundle, but not exported (unless they are also selected by the **Export-Package** instruction).

Example 4.4, “Including a private package in a bundle” shows the configuration for including a private package in a bundle

Example 4.4. Including a private package in a bundle

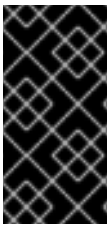
```
<plugin>
  <groupId>org.apache.felix</groupId>
  <artifactId>maven-bundle-plugin</artifactId>
  <configuration>
   <instructions>
     <Private-Package>org.apache.cxf.wsdlFirst.impl</Private-Package>
     ...
    </instructions>
  </configuration>
</plugin>
```

SPECIFYING IMPORTED PACKAGES

By default, the bundle plug-in populates the OSGi manifest's **Import-Package** property with a list of all the packages referred to by the contents of the bundle.

While the default behavior is typically sufficient for most projects, you might find instances where you want to import packages that are not automatically added to the list. The default behavior can also result in unwanted packages being imported.

To specify a list of packages to be imported by the bundle, add an **Import-Package** child to the plug-in's **instructions** element. The syntax for the package list is the same as for the **Export-Package** element and the **Private-Package** element.



IMPORTANT

When you use the **Import-Package** element, the plug-in does not automatically scan the bundle's contents to determine if there are any required imports. To ensure that the contents of the bundle are scanned, you must place an * as the last entry in the package list.

Example 4.5, “Specifying the packages imported by a bundle” shows the configuration for specifying the packages imported by a bundle

Example 4.5. Specifying the packages imported by a bundle

```
<plugin>
  <groupId>org.apache.felix</groupId>
  <artifactId>maven-bundle-plugin</artifactId>
  <configuration>
   <instructions>
     <Import-Package>javax.jws, javax.wsdl, org.apache.cxf.bus,
org.apache.cxf.bus.spring, org.apache.cxf.bus.resource,
org.apache.cxf.configuration.spring, org.apache.cxf.resource,
org.springframework.beans.factory.config, * </Import-Package>
     ...
```

```
    </instructions>
  </configuration>
</plugin>
```

MORE INFORMATION

For more information on configuring a bundle plug-in, see:

- olink:OsgiDependencies/OsgiDependencies
- Apache Felix documentation
- Peter Kriens' aQute Software Consultancy web site

CHAPTER 5. HOT DEPLOYMENT VS MANUAL DEPLOYMENT

Abstract

Apache Karaf provides two different approaches for deploying a single OSGi bundle: hot deployment or manual deployment. If you need to deploy a collection of related bundles, on the other hand, it is recommended that you deploy them together as a *feature*, rather than singly (see Chapter 8, *Deploying Features*).

5.1. HOT DEPLOYMENT

5.1.1. Hot deploy directory

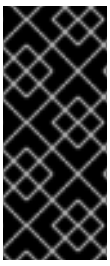
JBoss Fuse monitors JAR files in the **FUSE_HOME/deploy** directory and hot deploys everything in this directory. Each time a JAR file is copied to this directory, it is installed in the runtime and also started. You can subsequently update or delete the JARs, and the changes are handled automatically.

For example, if you have just built the bundle, *ProjectDir*/**target/foo-1.0-SNAPSHOT.jar**, you can deploy this bundle by copying it to the FUSE_HOME/**deploy** directory as follows (assuming you are working on a UNIX platform):

```
% cp ProjectDir/target/foo-1.0-SNAPSHOT.jar FUSE_HOME/deploy
```

5.2. HOT UNDEPLOYING A BUNDLE

To undeploy a bundle from the hot deploy directory, simply delete the bundle file from the **FUSE_HOME/deploy** directory **while the Apache Karaf container is running** .



IMPORTANT

The hot undeploy mechanism does **not** work while the container is shut down. If you shut down the Karaf container, delete the bundle file from **deploy/**, and then restart the Karaf container, the bundle will **not** be undeployed after you restart the container (you can, however, undeploy the bundle manually using the **osgi:uninstall** console command).

5.3. MANUAL DEPLOYMENT

5.3.1. Overview

You can manually deploy and undeploy bundles by issuing commands at the Red Hat JBoss Fuse console.

5.3.2. Installing a bundle

Use the **osgi:install** command to install one or more bundles in the OSGi container. This command has the following syntax:

```
osgi:install [-s] [--start] [--help] UrlList
```

Where *UrlList* is a whitespace-separated list of URLs that specify the location of each bundle to deploy. The following command arguments are supported:

`-s`

Start the bundle after installing.

`--start`

Same as **`-s`**.

`--help`

Show and explain the command syntax.

For example, to install and start the bundle, *ProjectDir*/**`target/foo-1.0-SNAPSHOT.jar`**, enter the following command at the Karaf console prompt:

```
osgi:install -s file:ProjectDir/target/foo-1.0-SNAPSHOT.jar
```

NOTE

On Windows platforms, you must be careful to use the correct syntax for the **`file`** URL in this command. See Section A.1, “File URL Handler” for details.

5.3.3. Uninstalling a bundle

To uninstall a bundle, you must first obtain its bundle ID using the **`osgi:list`** command. You can then uninstall the bundle using the **`osgi:uninstall`** command (which takes the bundle ID as its argument).

For example, if you have already installed the bundle named **`A Camel OSGi Service Unit`**, entering **`osgi:list`** at the console prompt might produce output like the following:

```
...
[ 181] [Resolved   ] [            ] [       ] [   60] A Camel OSGi
Service Unit (1.0.0.SNAPSHOT)
```

You can now uninstall the bundle with the ID, **`181`**, by entering the following console command:

```
osgi:uninstall 181
```

5.3.4. URL schemes for locating bundles

When specifying the location URL to the **`osgi:install`** command, you can use any of the URL schemes supported by Red Hat JBoss Fuse, which includes the following scheme types:

- Section A.1, “File URL Handler”.
-
- === Redeploying bundles automatically using dev:watch

In a development environment—where a developer is constantly changing and rebuilding a bundle—it is typically necessary to re-install the bundle multiple times. Using the **`dev:watch`** command, you can instruct Karaf to monitor your local Maven repository and re-install a particular bundle automatically,

as soon as it changes in your local Maven repository.

For example, given a particular bundle—with bundle ID, **751**—you can enable automatic redeployment by entering the command:

```
dev:watch 751
```

Now, whenever you rebuild and install the Maven artifact into your local Maven repository (for example, by executing **`mvn install`** in your Maven project), the Karaf container automatically re-installs the changed Maven artifact. For more details, see olink:FMQCommandRef/ConsoleDevWatch.

IMPORTANT

Using the **`dev:watch`** command is intended for a development environment only. It is **not** recommended for use in a production environment.

CHAPTER 6. LIFECYCLE MANAGEMENT

6.1. BUNDLE LIFECYCLE STATES

Applications in an OSGi environment are subject to the lifecycle of its bundles. Bundles have six lifecycle states:

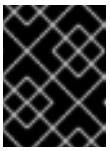
1. **Installed** — All bundles start in the installed state. Bundles in the installed state are waiting for all of their dependencies to be resolved, and once they are resolved, bundles move to the resolved state.

2. **Resolved** — Bundles are moved to the resolved state when the following conditions are met:

   - The runtime environment meets or exceeds the environment specified by the bundle.

   - All of the packages imported by the bundle are exposed by bundles that are either in the resolved state or that can be moved into the resolved state at the same time as the current bundle.

   - All of the required bundles are either in the resolved state or they can be resolved at the same time as the current bundle.

     IMPORTANT

     All of an application's bundles must be in the resolved state before the application can be started.

     If any of the above conditions ceases to be satisfied, the bundle is moved back into the installed state. For example, this can happen when a bundle that contains an imported package is removed from the container.

3. **Starting** — The starting state is a transitory state between the resolved state and the active state. When a bundle is started, the container must create the resources for the bundle. The container also calls the `start()` method of the bundle's bundle activator when one is provided.

4. **Active** — Bundles in the active state are available to do work. What a bundle does in the active state depends on the contents of the bundle. For example, a bundle containing a JAX-WS service provider indicates that the service is available to accept requests.

5. **Stopping** — The stopping state is a transitory state between the active state and the resolved state. When a bundle is stopped, the container must clean up the resources for the bundle. The container also calls the `stop()` method of the bundle's bundle activator when one is provided.

6. **Uninstalled** — When a bundle is uninstalled it is moved from the resolved state to the uninstalled state. A bundle in this state cannot be transitioned back into the resolved state or any other state. It must be explicitly re-installed.

The most important lifecycle states for application developers are the starting state and the stopping state. The endpoints exposed by an application are published during the starting state. The published endpoints are stopped during the stopping state.

6.2. INSTALLING AND RESOLVING BUNDLES

When you install a bundle using the **osgi:install** command (without the **-s** flag), the kernel installs the specified bundle and attempts to put it into the resolved state. If the resolution of the bundle fails for some reason (for example, if one of its dependencies is unsatisfied), the kernel leaves the bundle in the installed state.

At a later time (for example, after you have installed missing dependencies) you can attempt to move the bundle into the resolved state by invoking the **osgi:resolve** command, as follows:

```
osgi:resolve 181
```

Where the argument (**181**, in this example) is the ID of the bundle you want to resolve.

6.3. STARTING AND STOPPING BUNDLES

You can start one or more bundles (from either the installed or the resolved state) using the **osgi:start** command. For example, to start the bundles with IDs, 181, 185, and 186, enter the following console command:

```
osgi:start 181 185 186
```

You can stop one or more bundles using the **osgi:stop** command. For example, to stop the bundles with IDs, 181, 185, and 186, enter the following console command:

```
osgi:stop 181 185 186
```

You can restart one or more bundles (that is, moving from the started state to the resolved state, and then back again to the started state) using the **osgi:restart** command. For example, to restart the bundles with IDs, 181, 185, and 186, enter the following console command:

```
osgi:restart 181 185 186
```

6.4. BUNDLE START LEVEL

A *start level* is associated with every bundle. The start level is a positive integer value that controls the order in which bundles are activated/started. Bundles with a low start level are started before bundles with a high start level. Hence, bundles with the start level, **1**, are started first and bundles belonging to the kernel tend to have lower start levels, because they provide the prerequisites for running most other bundles.

Typically, the start level of user bundles is 60 or higher.

6.5. SPECIFYING A BUNDLE'S START LEVEL

Use the **osgi:bundle-level** command to set the start level of a particular bundle. For example, to configure the bundle with ID, **181**, to have a start level of **70**, enter the following console command:

```
osgi:bundle-level 181 70
```

6.6. SYSTEM START LEVEL

The OSGi container itself has a start level associated with it and this *system start level* determines which bundles can be active and which cannot: only those bundles whose start level is **less than or equal** to the system start level can be active.

To discover the current system start level, enter **`osgi:start-level`** in the console, as follows:

```
JBossFuse:karaf@root> osgi:start-level
Level 100
```

If you want to change the system start level, provide the new start level as an argument to the **`osgi:start-level`** command, as follows:

```
osgi:start-level 200
```

CHAPTER 7. TROUBLESHOOTING DEPENDENCIES

7.1. MISSING DEPENDENCIES

The most common issue that can arise when you deploy an OSGi bundle into the Red Hat JBoss Fuse container is that one or more dependencies are missing. This problem shows itself when you try to resolve the bundle in the OSGi container, usually as a side effect of starting the bundle. The bundle fails to resolve (or start) and a **`ClassNotFound`** error is logged (to view the log, use the **`log:display`** console command or look at the log file in the **`FUSE_HOME/data/log`** directory).

There are two basic causes of a missing dependency: either a required feature or bundle is not installed in the container; or your bundle's **`Import-Package`** header is incomplete.

7.2. REQUIRED FEATURES OR BUNDLES ARE NOT INSTALLED

Evidently, all features and bundles required by your bundle must **already** be installed in the OSGi container, before you attempt to resolve your bundle. In particular, because Apache Camel has a modular architecture, where each component is installed as a separate feature, it is easy to forget to install one of the required components.

NOTE

Consider packaging your bundle as a feature. Using a feature, you can package your bundle together with all of its dependencies and thus ensure that they are all installed simultaneously. For details, see Chapter 8, *Deploying Features*.

7.3. IMPORT-PACKAGE HEADER IS INCOMPLETE

If all of the required features and bundles are already installed and you are still getting a **`ClassNotFound`** error, this means that the **`Import-Package`** header in your bundle's **`MANIFEST.MF`** file is incomplete. The **`maven-bundle-plugin`** (see Section 3.2, "Modifying an Existing Maven Project") is a great help when it comes to generating your bundle's **`Import-Package`** header, but you should note the following points:

- Make sure that you include the wildcard, **`*`**, in the **`Import-Package`** element of the Maven bundle plug-in configuration. The wildcard directs the plug-in to scan your Java source code and automatically generates a list of package dependencies.
- The Maven bundle plug-in is **not** able to figure out dynamic dependencies. For example, if your Java code explicitly calls a class loader to load a class dynamically, the bundle plug-in does not take this into account and the required Java package will not be listed in the generated **`Import-Package`** header.
- If you define a Blueprint XML file (for example, in the **`OSGI-INF/blueprint`** directory), any dependencies arising from the Blueprint XML file are **automatically resolved at run time**.

7.4. HOW TO TRACK DOWN MISSING DEPENDENCIES

To track down missing dependencies, perform the following steps:

1. Perform a quick check to ensure that all of the required bundles and features are actually installed in the OSGi container. You can use **`osgi:list`** to check which bundles are installed and **`features:list`** to check which features are installed.

2. Install (but do not start) your bundle, using the **`osgi:install`** console command. For example:

```
JBossFuse:karaf@root> osgi:install MyBundleURL
```

3. Use the **`dev:dynamic-import`** console command to enable dynamic imports on the bundle you just installed. For example, if the bundle ID of your bundle is 218, you would enable dynamic imports on this bundle by entering the following command:

```
JBossFuse:karaf@root> dev:dynamic-import 218
```

   This setting allows OSGi to resolve dependencies using **any** of the bundles already installed in the container, effectively bypassing the usual dependency resolution mechanism (based on the **`Import-Package`** header). This is **not** recommemded for normal deployment, because it bypasses version checks: you could easily pick up the wrong version of a package, causing your application to malfunction.

4. You should now be able to resolve your bundle. For example, if your bundle ID is 218, enter the followng console command:

```
JBossFuse:karaf@root> osgi:resolve 218
```

5. Assuming your bundle is now resolved (check the bundle status using **`osgi:list`**), you can get a complete list of all the packages wired to your bundle using the **`package:imports`** command. For example, if your bundle ID is 218, enter the following console command:

```
JBossFuse:karaf@root> package:imports 218
```

   You should see a list of dependent packages in the console window (where the package names are highlighted in this example):

```
Spring Beans (67): org.springframework.beans.factory.xml;
version=3.0.5.RELEASE
Web Services Metadata 2.0 (104): javax.jws; version=2.0.0
Apache CXF Bundle Jar (125): org.apache.cxf.helpers;
version=2.4.2.fuse-00-08
Apache CXF Bundle Jar (125): org.apache.cxf.transport.jms.wsdl11;
version=2.4.2.fuse-00-08
...
```

6. Unpack your bundle JAR file and look at the packages listed under the **`Import-Package`** header in the **`META-INF/MANIFEST.MF`** file. Compare this list with the list of packages found in the previous step. Now, compile a list of the packages that are missing from the manifest's **`Import-Package`** header and add these package names to the **`Import-Package`** element of the Maven bundle plug-in configuration in your project's POM file.

7. To cancel the dynamic import option, you must uninstall the old bundle from the OSGi container. For example, if your bundle ID is 218, enter the following command:

```
JBossFuse:karaf@root> osgi:uninstall 218
```

8. You can now rebuild your bundle with the updated list of imported packages and test it in the OSGi container.

CHAPTER 8. DEPLOYING FEATURES

Abstract

Because applications and other tools typically consist of multiple OSGi bundles, it is often convenient to aggregate inter-dependent or related bundles into a larger unit of deployment. Red Hat JBoss Fuse therefore provides a scalable unit of deployment, the *feature*, which enables you to deploy multiple bundles (and, optionally, dependencies on other features) in a single step.

8.1. CREATING A FEATURE

8.1.1. Overview

Essentially, a feature is created by adding a new **`feature`** element to a special kind of XML file, known as a **feature repository**. To create a feature, perform the following steps:

1. Section 8.2, “Create a custom feature repository” .
2. Section 8.3, “Add a feature to the custom feature repository” .
3. Section 8.4, “Add the local repository URL to the features service” .
4. Section 8.5, “Add dependent features to the feature” .
5. Section 8.6, “Add OSGi configurations to the feature” .

8.2. CREATE A CUSTOM FEATURE REPOSITORY

If you have not already defined a custom feature repository, you can create one as follows. Choose a convenient location for the feature repository on your file system—for example, **`C:\Projects\features.xml`**—and use your favorite text editor to add the following lines to it:

```
<?xml version="1.0" encoding="UTF-8"?>
<features name="CustomRepository">
</features>
```

Where you must specify a name for the repository, *CustomRepository*, by setting the **`name`** attribute.

NOTE

In contrast to a Maven repository or an OBR, a feature repository does **not** provide a storage location for bundles. A feature repository merely stores an aggregate of references to bundles. The bundles themselves are stored elsewhere (for example, in the file system or in a Maven repository).

8.3. ADD A FEATURE TO THE CUSTOM FEATURE REPOSITORY

To add a feature to the custom feature repository, insert a new **`feature`** element as a child of the root **`features`** element. You must give the feature a name and you can list any number of bundles belonging to the feature, by inserting **`bundle`** child elements. For example, to add a feature named **`example-camel-bundle`** containing the single bundle, **`C:\Projects\camel-bundle\target\camel-bundle-1.0-SNAPSHOT.jar`**, add a **`feature`** element as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<features name="MyFeaturesRepo">
  <feature name="example-camel-bundle">
    <bundle>file:C:/Projects/camel-bundle/target/camel-bundle-1.0-
SNAPSHOT.jar</bundle>
  </feature>
</features>
```

The contents of the **bundle** element can be any valid URL, giving the location of a bundle (see Appendix A, *URL Handlers*). You can optionally specify a **version** attribute on the feature element, to assign a non-zero version to the feature (you can then specify the version as an optional argument to the **features:install** command).

To check whether the features service successfully parses the new feature entry, enter the following pair of console commands:

```
JBossFuse:karaf@root> features:refreshUrl
JBossFuse:karaf@root> features:list
...
[uninstalled] [0.0.0                ] example-camel-bundle
MyFeaturesRepo
...
```

The **features:list** command typically produces a rather long listing of features, but you should be able to find the entry for your new feature (in this case, **example-camel-bundle**) by scrolling back through the listing. The **features:refreshUrl** command forces the kernel to reread all the feature repositories: if you did not issue this command, the kernel would not be aware of any recent changes that you made to any of the repositories (in particular, the new feature would not appear in the listing).

To avoid scrolling through the long list of features, you can **grep** for the **example-camel-bundle** feature as follows:

```
JBossFuse:karaf@root> features:list | grep example-camel-bundle
[uninstalled] [0.0.0                ] example-camel-bundle
MyFeaturesRepo
```

Where the **grep** command (a standard UNIX pattern matching utility) is built into the shell, so this command also works on Windows platforms.

8.4. ADD THE LOCAL REPOSITORY URL TO THE FEATURES SERVICE

In order to make the new feature repository available to Apache Karaf, you must add the feature repository using the **features:addUrl** console command. For example, to make the contents of the repository, **C:\Projects\features.xml**, available to the kernel, you would enter the following console command:

```
features:addUrl file:C:/Projects/features.xml
```

Where the argument to **features:addUrl** can be specified using any of the supported URL formats (see Appendix A, *URL Handlers*).

You can check that the repository's URL is registered correctly by entering the **features:listUrl** console command, to get a complete listing of all registered feature repository URLs, as follows:

```
JBossFuse:karaf@root> features:listUrl
file:C:/Projects/features.xml
mvn:org.apache.ode/ode-jbi-karaf/1.3.3-fuse-01-00/xml/features
mvn:org.apache.felix.karaf/apache-felix-karaf/1.2.0-fuse-01-
00/xml/features
```

8.5. ADD DEPENDENT FEATURES TO THE FEATURE

If your feature depends on other features, you can specify these dependencies by adding **`feature`** elements as children of the original **`feature`** element. Each child **`feature`** element contains the name of a feature on which the current feature depends. When you deploy a feature with dependent features, the dependency mechanism checks whether or not the dependent features are installed in the container. If not, the dependency mechanism automatically installs the missing dependencies (and any recursive dependencies).

For example, for the custom Apache Camel feature, **`example-camel-bundle`**, you can specify explicitly which standard Apache Camel features it depends on. This has the advantage that the application could now be successfully deployed and run, even if the OSGi container does not have the required features pre-deployed. For example, you can define the **`example-camel-bundle`** feature with Apache Camel dependencies as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<features name="MyFeaturesRepo">
  <feature name="example-camel-bundle">
    <bundle>file:C:/Projects/camel-bundle/target/camel-bundle-1.0-
SNAPSHOT.jar</bundle>
    <feature version="7.0.0.fuse-000163-redhat-2">camel-core</feature>
    <feature version="7.0.0.fuse-000163-redhat-2">camel-spring-
osgi</feature>
  </feature>
</features>
```

Specifying the **`version`** attribute is optional. When present, it enables you to select the specified version of the feature.

8.6. ADD OSGI CONFIGURATIONS TO THE FEATURE

If your application uses the *OSGi Configuration Admin* service, you can specify configuration settings for this service using the **`config`** child element of your feature definition. For example, to specify that the **`prefix`** property has the value, **`MyTransform`**, add the following **`config`** child element to your feature's configuration:

```
<?xml version="1.0" encoding="UTF-8"?>
<features name="MyFeaturesRepo">
  <feature name="example-camel-bundle">
    <config name="org.fusesource.fuseesb.example">
      prefix=MyTransform
    </config>
  </feature>
</features>
```

Where the **name** attribute of the **config** element specifies the *persistent ID* of the property settings (where the persistent ID acts effectively as a name scope for the property names). The content of the **config** element is parsed in the same way as a Java properties file.

The settings in the **config** element can optionally be overridden by the settings in the Java properties file located in the ***InstallDir*/etc** directory, which is named after the persistent ID, as follows:

```
InstallDir/etc/org.fusesource.fuseesb.example.cfg
```

As an example of how the preceding configuration properties can be used in practice, consider the following Blueprint XML file that accesses the OSGi configuration properties:

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

    <!-- osgi blueprint property placeholder -->
    <cm:property-placeholder id="placeholder"
                             persistent-
id="org.fusesource.fuseesb.example">
        <cm:default-properties>
            <cm:property name="prefix" value="DefaultValue"/>
        </cm:default-properties>
    </cm:property-placeholder>

    <bean id="myTransform"
class="org.fusesource.fuseesb.example.MyTransform">
      <property name="prefix" value="${prefix}"/>
    </bean>

</blueprint>
```

When this Blueprint XML file is deployed in the **example-camel-bundle** bundle, the property reference, **${prefix}**, is replaced by the value, **MyTransform**, which is specified by the **config** element in the feature repository.

8.7. AUTOMATICALLY DEPLOY AN OSGI CONFIGURATION

By adding a **configfile** element to a feature, you can ensure that an OSGi configuration file gets added to the ***InstallDir*/etc** directory at the same time that the feature is installed. This means that you can conveniently install a feature and its associated configuration at the same time.

For example, given that the **org.fusesource.fuseesb.example.cfg** configuration file is archived in a Maven repository at **mvn:org.fusesource.fuseesb.example/configadmin/1.0/cfg**, you could deploy the configuration file by adding the following element to the feature:

```
<configfile finalname="etc/org.fusesource.fuseesb.example.cfg">
  mvn:org.fusesource.fuseesb.example/configadmin/1.0/cfg
</configfile>
```

CHAPTER 9. DEPLOYING A FEATURE

9.1. OVERVIEW

You can deploy a feature in one of the following ways:

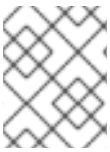
- Install at the console, using **`features:install`**.
- Use hot deployment.
- Modify the boot configuration (first boot only!).

9.2. INSTALLING AT THE CONSOLE

After you have created a feature (by adding an entry for it in a feature repository and registering the feature repository), it is relatively easy to deploy the feature using the **`features:install`** console command. For example, to deploy the **`example-camel-bundle`** feature, enter the following pair of console commands:

```
JBossFuse:karaf@root> features:refreshUrl
JBossFuse:karaf@root> features:install example-camel-bundle
```

It is recommended that you invoke the **`features:refreshUrl`** command before calling **`features:install`**, in case any recent changes were made to the features in the feature repository which the kernel has not picked up yet. The **`features:install`** command takes the feature name as its argument (and, optionally, the feature version as its second argument).



NOTE

Features use a flat namespace. So when naming your features, be careful to avoid name clashes with existing features.

9.3. UNINSTALLING AT THE CONSOLE

To uninstall a feature, invoke the **`features:uninstall`** command as follows:

```
JBossFuse:karaf@root> features:uninstall example-camel-bundle
```

NOTE

After uninstalling, the feature will still be visible when you invoke **`features:list`**, but its status will now be flagged as **`[uninstalled]`**.

9.4. HOT DEPLOYMENT

You can hot deploy **all** of the features in a feature repository simply by copying the feature repository file into the ***`InstallDir`*`/deploy`** directory.

As it is unlikely that you would want to hot deploy an entire feature repository at once, it is often more convenient to define a reduced feature repository or *feature descriptor*, which references only those features you want to deploy. The feature descriptor has exactly the same syntax as a feature

repository, but it is written in a different style. The difference is that a feature descriptor consists only of references to existing features from a feature repository.

For example, you could define a feature descriptor to load the **example-camel-bundle** feature as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<features name="CustomDescriptor">
  <repository>RepositoryURL</repository>
  <feature name="hot-example-camel-bundle">
    <feature>example-camel-bundle</feature>
  </feature>
</features>
```

The repository element specifies the location of the custom feature repository, *RepositoryURL* (where you can use any of the URL formats described in Appendix A, *URL Handlers*). The feature, **hot-example-camel-bundle**, is just a reference to the existing feature, **example-camel-bundle**.

HOT UNDEPLOYING A FEATURES FILE

To undeploy a features file from the hot deploy directory, simply delete the features file from the ***InstallDir*/deploy** directory **while the Apache Karaf container is running** .

IMPORTANT

The hot undeploy mechanism does **not** work while the container is shut down. If you shut down the Karaf container, delete the features file from **deploy/**, and then restart the Karaf container, the features will **not** be undeployed after you restart the container (you can, however, undeploy the features manually using the **features:uninstall** console command).

9.5. ADDING A FEATURE TO THE BOOT CONFIGURATION

If you want to provision copies of Apache Karaf for deployment on multiple hosts, you might be interested in adding a feature to the boot configuration, which determines the collection of features that are installed when Apache Karaf boots up for the very first time.

The configuration file, **/etc/org.apache.karaf.features.cfg**, in your install directory contains the following settings:

```
...
#
# Comma separated list of features repositories to register by default
#
featuresRepositories=\
        mvn:org.apache.karaf.assemblies.features/standard/2.4.0.redhat-
630187/xml/features,\
        mvn:org.apache.karaf.assemblies.features/spring/2.4.0.redhat-
630187/xml/features,\
        mvn:org.apache.karaf.assemblies.features/enterprise/2.4.0.redhat-
630187/xml/features,\
        mvn:org.apache.cxf.karaf/apache-cxf/3.1.5.redhat-
630187/xml/features,\
        mvn:org.apache.camel.karaf/apache-camel/2.17.0.redhat-
```

```
630187/xml/features,\
        mvn:org.apache.activemq/activemq-karaf/5.11.0.redhat-
630187/xml/features-core,\
        mvn:io.fabric8/fabric8-karaf/1.2.0.redhat-630187/xml/features,\
        mvn:org.jboss.fuse/jboss-fuse/6.3.0.redhat-187/xml/features,\
        mvn:io.fabric8.patch/patch-features/1.2.0.redhat-
630187/xml/features,\
        mvn:io.hawt/hawtio-karaf/1.4.0.redhat-630187/xml/features,\
        mvn:io.fabric8.support/support-features/1.2.0.redhat-
630187/xml/features,\
        mvn:org.fusesource/camel-sap/6.3.0.redhat-187/xml/features,\
        mvn:org.switchyard.karaf/switchyard/2.1.0.redhat-630187/xml/core-
features

#
# Comma separated list of features to install at startup
#
featuresBoot=\
        jasypt-encryption,\
        pax-url-classpath,\
        deployer,\
        config,\
        management,\
        fabric-cxf,\
        fabric,\
        fabric-maven-proxy,\
        patch,\
        transaction,\
        jms-spec;version=2.0,\
        mq-fabric,\
        swagger,\
        camel,\
        camel-cxf,\
        camel-jms,\
        camel-amq,\
        camel-blueprint,\
        camel-csv,\
        camel-ftp,\
        camel-bindy,\
        camel-jdbc,\
        camel-exec,\
        camel-jasypt,\
        camel-saxon,\
        camel-snmp,\
        camel-ognl,\
        camel-routebox,\
        camel-script,\
        camel-spring-javaconfig,\
        camel-jaxb,\
        camel-jmx,\
        camel-mail,\
        camel-paxlogging,\
        camel-rmi,\
        war,\
        fabric-redirect,\
        hawtio-offline,\
```

```
        support,\
        hawtio-redhat-fuse-branding,\
        jsr-311

featuresBlackList=\
        pax-cdi-openwebbeans,\
        pax-cdi-web-openwebbeans,\
        spring-struts,\
        cxf-bean-validation-java6,\
        pax-cdi-1.2-web,\
        pax-jsf-support,\
        camel-ignite,\
        camel-jetty8,\
        camel-ironmq,\
        camel-gae
```

This configuration file has two properties:

- **`featuresRepositories`**—comma separated list of feature repositories to load at startup.
- **`featuresBoot`**—comma separated list of features to install at startup.
- **`featuresBlackList`**—comma separated list of features that are prevented from being installed (to protect against unsupported or buggy features).

You can modify the configuration to customize the features that are installed as JBoss Fuse starts up. You can also modify this configuration file, if you plan to distribute JBoss Fuse with pre-installed features.

IMPORTANT

This method of adding a feature is only effective the **first time** a particular Apache Karaf instance boots up. Any changes made subsequently to the **`featuresRepositories`** setting and the **`featuresBoot`** setting are ignored, even if you restart the container.

You could force the container to revert back to its initial state, however, by deleting the complete contents of the **`InstallDir/data/cache`** (thereby losing all of the container's custom settings).

CHAPTER 10. DEPLOYING A PLAIN JAR

Abstract

An alternative method of deploying applications into Apache Karaf is to use plain JAR files. These are usually libraries that contain **no deployment metadata**. A plain JAR is neither a WAR, nor an OSGi bundle.

If the plain JAR occurs as a dependency of a bundle, you must add bundle headers to the JAR. If the JAR exposes a public API, typically the best solution is to convert the existing JAR into a bundle, enabling the JAR to be shared with other bundles. Use the instructions in this chapter to perform the conversion process automatically, using the open source Bnd tool.

For more information on the **Bnd** tool, see Bnd tools website.

10.1. CONVERTING A JAR USING THE WRAP SCHEME

Overview

You have the option of converting a JAR into a bundle using the **wrap:** protocol, which can be used with any existing URL format. The **wrap:** protocol is based on the Bnd utility.

Syntax

The **wrap:** protocol has the following basic syntax:

```
wrap:LocationURL
```

The **wrap:** protocol can prefix any URL that locates a JAR. The locating part of the URL, *LocationURL*, is used to obtain the plain JAR and the URL handler for the **wrap:** protocol then converts the JAR automatically into a bundle.

NOTE

The **wrap:** protocol also supports a more elaborate syntax, which enables you to customize the conversion by specifying a Bnd properties file or by specifying individual Bnd properties in the URL. Typically, however, the **wrap:** protocol is used just with the default settings.

Default properties

The **wrap:** protocol is based on the **Bnd** utility, so it uses exactly the same default properties to generate the bundle as Bnd does.

WRAP AND INSTALL

The following example shows how you can use a single console command to download the plain **commons-logging** JAR from a remote Maven repository, dynamically convert it into an OSGi bundle, and then install it and start it in the OSGi container:

```
karaf@root> osgi:install -s wrap:mvn:commons-logging/commons-logging/1.1.1
```

Reference

The `wrap:` protocol is provided by the Pax project, which is the umbrella project for a variety of open source OSGi utilities. For full documentation on the `wrap:` protocol, see the Wrap Protocol reference page.

CHAPTER 11. CONTEXTS AND DEPENDENCY INJECTION (CDI)

CHAPTER 12. INTRODUCTION TO CDI

Contexts and Dependency Injection (CDI) 1.2 is a JSR specification, which defines a general-purpose dependency injection framework in the Java language. Originally conceived for the Java EE platform, CDI can also be used in the context of an OSGi container. An adapter layer, which is a combination of Pax CDI and JBoss Weld, must be installed and enabled.

CDI 1.2 is treated as a maintenance release of 1.1. Details about CDI 1.1 can be found in JSR 346: Contexts and Dependency Injection for Java™ EE 1.1.

JBoss Fuse includes Weld, which is the reference implementation of JSR-346:Contexts and Dependency Injection for Java™ EE 1.1.

Benefits of CDI

The benefits of CDI include:

- Simplifying and shrinking your code base by replacing big chunks of code with annotations.
- Flexibility, allowing you to disable and enable injections and events, use alternative beans, and inject non-CDI objects easily.
- Optionally, allowing you to include `beans.xml` in your `META-INF/` or `WEB-INF/` directory if you need to customize the configuration to differ from the default. The file can be empty.
- Simplifying packaging and deployments and reducing the amount of XML you need to add to your deployments.
- Providing lifecycle management via contexts. You can tie injections to requests, sessions, conversations, or custom contexts.
- Providing type-safe dependency injection, which is safer and easier to debug than string-based injection.
- Decoupling interceptors from beans.
- Providing complex event notification.

12.1. JBOSS WELD CDI IMPLEMENTATION

Weld is the reference implementation of CDI, which is defined in JSR 346: Contexts and Dependency Injection for Java™ EE 1.1. Weld was inspired by Seam 2 and other dependency injection frameworks, and is included in JBoss Fuse.

CHAPTER 13. USE CDI TO DEVELOP AN APPLICATION

CDI is **not** enabled by default in the Apache Karaf container. To enable CDI in Karaf, follow the instructions in Section 17.3, “Enabling Pax CDI” .

These tasks show you how to use CDI in your enterprise applications.

Exclude Beans From the Scanning Process

One of the features of Weld is the ability to exclude classes in your archive from scanning, having container lifecycle events fired, and being deployed as beans. This is not part of the JSR-346 specification.

The following example has several <weld:exclude> tags:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://java.sun.com/xml/ns/javaee"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:weld="http://jboss.org/schema/weld/beans"
       xsi:schemaLocation="
          http://java.sun.com/xml/ns/javaee
http://docs.jboss.org/cdi/beans_1_0.xsd
          http://jboss.org/schema/weld/beans
http://jboss.org/schema/weld/beans_1_1.xsd">

    <weld:scan>

        <!-- Don't deploy the classes for the swing app! -->
        <weld:exclude name="com.acme.swing.**" />

        <!-- Don't include GWT support if GWT is not installed -->
        <weld:exclude name="com.acme.gwt.**">
            <weld:if-class-available name="!com.google.GWT"/>
        </weld:exclude>

        <!--
            Exclude classes which end in Blether if the system property
verbosity is set to low
            i.e.
              java ... -Dverbosity=low
        -->
        <weld:exclude pattern="^(.*)Blether$">
            <weld:if-system-property name="verbosity" value="low"/>
        </weld:exclude>

       <!--
             Don't include JSF support if Wicket classes are present, and
the viewlayer system
             property is not set
        -->
        <weld:exclude name="com.acme.jsf.**">
            <weld:if-class-available name="org.apache.wicket.Wicket"/>
            <weld:if-system-property name="!viewlayer"/>
        </weld:exclude>
    </weld:scan>
</beans>
```

The four Weld exclude statements in the code above perform the following functions:

`<weld:exclude name="com.acme.swing.**" />` excludes all Swing classes.

```
<weld:exclude name="com.acme.gwt.**">
    <weld:if-class-available name="!com.google.GWT"/>
</weld:exclude>
```

excludes Google Web Toolkit classes if Google Web Toolkit is not installed.

```
<weld:exclude pattern="^(.*)Blether$">
    <weld:if-system-property name="verbosity" value="low"/>
</weld:exclude>
```

excludes classes which end in the string **`Blether`** (using a regular expression), if the system property verbosity is set to **`low`**.

```
<weld:exclude name="com.acme.jsf.**">
    <weld:if-class-available name="org.apache.wicket.Wicket"/>
    <weld:if-system-property name="!viewlayer"/>
</weld:exclude>
```

excludes Java Server Faces (JSF) classes if Wicket classes are present and the viewlayer system property is not set.

The formal specification of Weld-specific configuration options can be found at http://jboss.org/schema/weld/beans_1_1.xsd.

Use an Injection to Extend an Implementation

You can use an injection to add or change a feature of your existing code.

The following example adds a translation ability to an existing class, and assumes you already have a Welcome class, which has a method **`buildPhrase`**. The **`buildPhrase`** method takes as an argument the name of a city, and outputs a phrase like "Welcome to Boston!".

Example: Inject a Translator Bean Into the Welcome Class

The following injects a hypothetical **`Translator`** object into the **`Welcome`** class. The **`Translator`** object can be an EJB stateless bean or another type of bean, which can translate sentences from one language to another. In this instance, the **`Translator`** is used to translate the entire greeting, without modifying the original **`Welcome`** class. The **`Translator`** is injected before the **`buildPhrase`** method is called.

```
public class TranslatingWelcome extends Welcome {

    @Inject Translator translator;

    public String buildPhrase(String city) {
        return translator.translate("Welcome to " + city + "!");
    }
    ...
}
```

13.1. AMBIGUOUS OR UNSATISFIED DEPENDENCIES

Ambiguous dependencies exist when the container is unable to resolve an injection to exactly one bean.

Unsatisfied dependencies exist when the container is unable to resolve an injection to any bean at all.

The container takes the following steps to try to resolve dependencies:

1. It resolves the qualifier annotations on all beans that implement the bean type of an injection point.
2. It filters out disabled beans. Disabled beans are @Alternative beans which are not explicitly enabled.

In the event of an ambiguous or unsatisfied dependency, the container aborts deployment and throws an exception.

To fix an ambiguous dependency, see Use a Qualifier to Resolve an Ambiguous Injection .

Qualifiers

Qualifiers are annotations used to avoid ambiguous dependencies when the container can resolve multiple beans, which fit into an injection point. A qualifier declared at an injection point provides the set of eligible beans, which declare the same Qualifier.

Qualifiers have to be declared with a retention and target as shown in the example below.

Example: Define the @Synchronous and @Asynchronous Qualifiers

```
@Qualifier
@Retention(RUNTIME)
@Target({TYPE, METHOD, FIELD, PARAMETER})
public @interface Synchronous {}
```

```
@Qualifier
@Retention(RUNTIME)
@Target({TYPE, METHOD, FIELD, PARAMETER})
public @interface Asynchronous {}
```

Example: Use the @Synchronous and @Asynchronous Qualifiers

```
@Synchronous
public class SynchronousPaymentProcessor implements PaymentProcessor {
   public void process(Payment payment) { ... }
}
```

```
@Asynchronous
public class AsynchronousPaymentProcessor implements PaymentProcessor {
   public void process(Payment payment) { ... }
}
```

Use a Qualifier to Resolve an Ambiguous Injection

You can resolve an ambiguous injection using a qualifier. Read more about ambiguous injections at Ambiguous or Unsatisfied Dependencies .

The following example is ambiguous and features two implementations of Welcome, one which translates and one which does not. The injection needs to be specified to use the translating Welcome.

Example: Ambiguous injection

```
public class Greeter {
  private Welcome welcome;

  @Inject
  void init(Welcome welcome) {
    this.welcome = welcome;
  }
  ...
}
```

Resolve an Ambiguous Injection with a Qualifier

1. To resolve the ambiguous injection, create a qualifier annotation called @Translating:

```
@Qualifier
@Retention(RUNTIME)
@Target({TYPE,METHOD,FIELD,PARAMETERS})
public @interface Translating{}
```

2. Annotate your translating Welcome with the @Translating annotation:

```
@Translating
public class TranslatingWelcome extends Welcome {
    @Inject Translator translator;
    public String buildPhrase(String city) {
        return translator.translate("Welcome to " + city + "!");
    }
    ...
}
```

3. Request the translating Welcome in your injection. You must request a qualified implementation explicitly, similar to the factory method pattern. The ambiguity is resolved at the injection point.

```
public class Greeter {
  private Welcome welcome;
  @Inject
  void init(@Translating Welcome welcome) {
    this.welcome = welcome;
  }
  public void welcomeVisitors() {
    System.out.println(welcome.buildPhrase("San Francisco"));
  }
}
```

13.2. MANAGED BEANS

Managed Beans are defined as container-managed objects with minimal programming restrictions, otherwise known by the acronym POJO (Plain Old Java Object). They support a small set of basic services, such as resource injection, lifecycle callbacks, and interceptors. Companion specifications, such as EJB and CDI, build on this basic model.

With very few exceptions, almost every concrete Java class that has a constructor with no parameters (or a constructor designated with the annotation **`@Inject`**) is a bean.

Types of Classes That are Beans

A managed bean is a Java class. The basic lifecycle and semantics of a managed bean are defined by the Managed Beans specification. You can explicitly declare a managed bean by annotating the bean class **`@ManagedBean`**, but in CDI you do not need to. According to the specification, the CDI container treats any class that satisfies the following conditions as a managed bean:

- It is not a non-static inner class.
- It is a concrete class, or is annotated **`@Decorator`**.
- It is not annotated with an EJB component-defining annotation or declared as an EJB bean class in **`ejb-jar.xml`**.
- It does not implement interface **`javax.enterprise.inject.spi.Extension`**.
- It has either a constructor with no parameters, or a constructor annotated with **`@Inject`**.

The unrestricted set of bean types for a managed bean contains the bean class, every superclass and all interfaces it implements directly or indirectly.

If a managed bean has a public field, it must have the default scope **`@Dependent`**.

Use CDI to Inject an Object Into a Bean

CDI is activated automatically if CDI components are detected in an application. If you wish to customize your configuration to differ from the default, you can include **`META-INF/beans.xml`** or **`WEB-INF/beans.xml`** to your deployment archive.

Inject Objects into Other Objects

1. To obtain an instance of a class, annotate the field with **`@Inject`** within your bean:

```
public class TranslateController {
   @Inject TextTranslator textTranslator;
   ...
```

2. Use your injected object's methods directly. Assume that TextTranslator has a method **`translate`**:

```
// in TranslateController class

public void translate() {
   translation = textTranslator.translate(inputText);
}
```

3. Use an injection in the constructor of a bean. You can inject objects into the constructor of a bean as an alternative to using a factory or service locator to create them:

```
public class TextTranslator {

   private SentenceParser sentenceParser;
   private Translator sentenceTranslator;

   @Inject
   TextTranslator(SentenceParser sentenceParser, Translator
sentenceTranslator) {
      this.sentenceParser = sentenceParser;
      this.sentenceTranslator = sentenceTranslator;
   }

   // Methods of the TextTranslator class
   ...
}
```

4. Use the **`Instance(<T>)`** interface to get instances programatically. The **`Instance`** interface can return an instance of TextTranslator when parameterized with the bean type.

```
@Inject Instance<TextTranslator> textTranslatorInstance;
...
public void translate() {
   textTranslatorInstance.get().translate(inputText);
}
```

When you inject an object into a bean, all of the object's methods and properties are available to your bean. If you inject into your bean's constructor, instances of the injected objects are created when your bean's constructor is called, unless the injection refers to an instance that already exists. For instance, a new instance would not be created if you inject a session-scoped bean during the lifetime of the session.

13.3. CONTEXTS AND SCOPES

A context, in terms of CDI, is a storage area that holds instances of beans associated with a specific scope.

A scope is the link between a bean and a context. A scope/context combination may have a specific lifecycle. Several pre-defined scopes exist, and you can create your own. Examples of pre-defined scopes are **`@RequestScoped`**, **`@SessionScoped`**, and **`@ConversationScope`**.

Table 13.1. Available contexts

Context	Description
@Dependent	The bean is bound to the lifecycle of the bean holding the reference.
@ApplicationScoped	The bean is bound to the lifecycle of the application.
@RequestScoped	The bean is bound to the lifecycle of the request.

Context	Description
@SessionScoped	The bean is bound to the lifecycle of the session.
@ConversationScoped	The bean is bound to the lifecycle of the conversation. The conversation scope is between the lengths of the request and the session, and is controlled by the application.
Custom scopes	If the above contexts do not meet your needs, you can define custom scopes.

13.4. BEAN LIFECYCLE

This task shows you how to save a bean for the life of a request.

The default scope for an injected bean is **@Dependent**. This means that the bean's lifecycle is dependent upon the lifecycle of the bean that holds the reference. Several other scopes exist, and you can define your own scopes. For more information, see "Contexts and Scopes".

Manage Bean

```
                Lifecycles
Annotate the bean with the desired scope:
```

```
@RequestScoped
@Named("greeter")
public class GreeterBean {
  private Welcome welcome;
  private String city; // getter & setter not shown
  @Inject   void init(Welcome welcome) {
    this.welcome = welcome;
  }
  public void welcomeVisitors() {
    System.out.println(welcome.buildPhrase(city));
  }
}
```

Your bean is saved in the context relating to the scope that you specify, and lasts as long as the scope applies.

Use a Producer Method

This task shows how to use producer methods to produce a variety of different objects that are not beans for injection.

Example: Use a producer method instead of an alternative, to allow

```
                        polymorphism after deployment
The `@Preferred` annotation in the example is a qualifier
annotation. For more information about qualifiers, see
<<about_qualifiers,Qualifiers>>.
```

```
@SessionScoped
public class Preferences implements Serializable {
   private PaymentStrategyType paymentStrategy;
   ...
   @Produces @Preferred
   public PaymentStrategy getPaymentStrategy() {
       switch (paymentStrategy) {
           case CREDIT_CARD: return new CreditCardPaymentStrategy();
           case CHECK: return new CheckPaymentStrategy();
           default: return null;
       }
   }
}
```

The following injection point has the same type and qualifier annotations as the producer method, so it resolves to the producer method using the usual CDI injection rules. The producer method is called by the container to obtain an instance to service this injection point.

```
@Inject @Preferred PaymentStrategy paymentStrategy;
```

Example: Assign a scope to a producer method

The default scope of a producer method is **@Dependent**. If you assign a scope to a bean, it is bound to the appropriate context. The producer method in this example is only called once per session.

```
@Produces @Preferred @SessionScoped
public PaymentStrategy getPaymentStrategy() {
   ...
}
```

Example: Use an injection inside a producer method

Objects instantiated directly by an application cannot take advantage of dependency injection and do not have interceptors. However, you can use dependency injection into the producer method to obtain bean instances.

```
@Produces @Preferred @SessionScoped
public PaymentStrategy getPaymentStrategy(CreditCardPaymentStrategy ccps,
                                          CheckPaymentStrategy cps ) {
   switch (paymentStrategy) {
      case CREDIT_CARD: return ccps;
      case CHEQUE: return cps;
      default: return null;
   }
}
```

If you inject a request-scoped bean into a session-scoped producer, the producer method promotes the current request-scoped instance into session scope. This is almost certainly not the desired behavior, so use caution when you use a producer method in this way.

NOTE

The scope of the producer method is not inherited from the bean that declares the producer method.

Producer methods allow you to inject non-bean objects and change your code dynamically.

13.5. NAMED BEANS

You can name a bean by using the **@Named** annotation. Naming a bean allows you to use it directly in Java Server Faces (JSF) and Expression Language (EL).

The **@Named** annotation takes an optional parameter, which is the bean name. If this parameter is omitted, the bean name defaults to the class name of the bean with its first letter converted to lower-case.

Configure Bean Names Using the @Named Annotation

1. Use the **@Named** annotation to assign a name to a bean.

```
@Named("greeter")
public class GreeterBean {
  private Welcome welcome;

  @Inject
  void init (Welcome welcome) {
    this.welcome = welcome;
  }

  public void welcomeVisitors() {
    System.out.println(welcome.buildPhrase("San Francisco"));
  }
}
```

   In the example above, the default name would be **greeterBean** if no name had been specified.

2. In the context of Camel CDI, the named bean is automatically added to the registry and can be accessed from a Camel route, as follows:

```
from("direct:inbound").bean("greeter");
```

13.6. ALTERNATIVE BEANS

Alternatives are beans whose implementation is specific to a particular client module or deployment scenario.

By default, @Alternative beans are disabled. They are enabled for a specific bean archive by editing its **beans.xml** file.

Example: Defining Alternatives

This alternative defines a implementation of both @Synchronous PaymentProcessor and @Asynchronous PaymentProcessor, all in one:

```
@Alternative @Synchronous @Asynchronous

public class MockPaymentProcessor implements PaymentProcessor {
```

```
    public void process(Payment payment) { ... }

}
```

Override an Injection with an Alternative

You can use alternative beans to override existing beans. They can be thought of as a way to plug in a class which fills the same role, but functions differently. They are disabled by default.

This task shows you how to specify and enable an alternative.

Override an Injection

This task assumes that you already have a TranslatingWelcome class in your project, but you want to override it with a "mock" TranslatingWelcome class. This would be the case for a test deployment, where the true Translator bean cannot be used.

1. Define the alternative.

```
@Alternative
@Translating
public class MockTranslatingWelcome extends Welcome {
  public String buildPhrase(string city) {
    return "Bienvenue Ã  " + city + "!");
  }
}
```

2. Activate the substitute implementation by adding the fully-qualified class name to your **`META-INF/beans.xml`** or **`WEB-INF/beans.xml`** file.

```
<beans>
  <alternatives>
    <class>com.acme.MockTranslatingWelcome</class>
  </alternatives>
</beans>
```

The alternative implementation is now used instead of the original one.

13.6.1. Stereotypes

In many systems, use of architectural patterns produces a set of recurring bean roles. A stereotype allows you to identify such a role and declare some common metadata for beans with that role in a central place.

A stereotype encapsulates any combination of:

- Default scope
- A set of interceptor bindings

A stereotype can also specify either:

- All beans where the stereotypes are defaulted bean EL names
- All beans where the stereotypes are alternatives

A bean may declare zero, one, or multiple stereotypes. A stereotype is an @Stereotype annotation that packages several other annotations. Stereotype annotations may be applied to a bean class, producer method, or field.

A class that inherits a scope from a stereotype may override that stereotype and specify a scope directly on the bean.

In addition, if a stereotype has a **@Named** annotation, any bean it is placed on has a default bean name. The bean may override this name if the @Named annotation is specified directly on the bean. For more information about named beans, see Named Beans.

Use Stereotypes

Without stereotypes, annotations can become cluttered. This task shows you how to use stereotypes to reduce the clutter and streamline your code.

Example: Annotation clutter

```
@Secure
@Transactional
@RequestScoped
@Named
public class AccountManager {
  public boolean transfer(Account a, Account b) {
    ...
  }
}
```

Define and Use

```
                    Stereotypes
. Define the stereotype.
```

+

```
@Secure
@Transactional
@RequestScoped
@Named
@Stereotype
@Retention(RUNTIME)
@Target(TYPE)
public @interface BusinessComponent {
 ...
}
```

1. Use the stereotype.

```
@BusinessComponent
public class AccountManager {
  public boolean transfer(Account a, Account b) {
    ...
  }
}
```

13.7. OBSERVER METHODS

Observer methods receive notifications when events occur.

CDI also provides transactional observer methods, which receive event notifications during the before completion or after completion phase of the transaction in which the event was fired.

Transactional Observers

Transactional observers receive the event notifications before or after the completion phase of the transaction in which the event was raised. Transactional observers are important in a stateful object model because state is often held for longer than a single atomic transaction.

There are five kinds of transactional observers:

- IN_PROGRESS: By default, observers are invoked immediately.
- AFTER_SUCCESS: Observers are invoked after the completion phase of the transaction, but only if the transaction completes successfully.
- AFTER_FAILURE: Observers are invoked after the completion phase of the transaction, but only if the transaction fails to complete successfully.
- AFTER_COMPLETION: Observers are invoked after the completion phase of the transaction.
- BEFORE_COMPLETION: Observers are invoked before the completion phase of the transaction.

The following observer method refreshes a query result set cached in the application context, but only when transactions that update the Category tree are successful:

```
public void refreshCategoryTree(@Observes(during = AFTER_SUCCESS)
CategoryUpdateEvent event) { ... }
```

Assume we have cached a JPA query result set in the application scope:

```
import javax.ejb.Singleton;
import javax.enterprise.inject.Produces;

@ApplicationScoped @Singleton

public class Catalog {
   @PersistenceContext EntityManager em;
   List<Product> products;
   @Produces @Catalog
   List<Product> getCatalog() {
      if (products==null) {
         products = em.createQuery("select p from Product p where
p.deleted = false")
            .getResultList();
      }
      return products;
   }
}
```

Occasionally a Product is created or deleted. When this occurs, we need to refresh the Product catalog. But we have to wait for the transaction to complete successfully before performing this refresh.

The bean that creates and deletes Products triggers events, for example:

```
import javax.enterprise.event.Event;

@Stateless

public class ProductManager {
   @PersistenceContext EntityManager em;
   @Inject @Any Event<Product> productEvent;
   public void delete(Product product) {
      em.delete(product);
      productEvent.select(new AnnotationLiteral<Deleted>()
{}).fire(product);
   }

   public void persist(Product product) {
      em.persist(product);
      productEvent.select(new AnnotationLiteral<Created>()
{}).fire(product);
   }
   ...
}
```

The Catalog can now observe the events after successful completion of the transaction:

```
import javax.ejb.Singleton;

@ApplicationScoped @Singleton
public class Catalog {
   ...
   void addProduct(@Observes(during = AFTER_SUCCESS) @Created Product
product) {
      products.add(product);
   }

   void removeProduct(@Observes(during = AFTER_SUCCESS) @Deleted Product
product) {
      products.remove(product);
   }

}
```

Example: Fire an event

The following code shows an event being injected and used in a method.

```
public class AccountManager {
  @Inject Event<Withdrawal> event;

  public boolean transfer(Account a, Account b) {
    ...
```

```
    event.fire(new Withdrawal(a));
  }
}
```

Example: Fire an event with a qualifier

You can annotate your event injection with a qualifier, to make it more specific. For more information about qualifiers, see Qualifiers.

```
public class AccountManager {
  @Inject @Suspicious Event <Withdrawal> event;

  public boolean transfer(Account a, Account b) {
    ...
    event.fire(new Withdrawal(a));
  }
}
```

Example: Observe an event

To observe an event, use the **@Observes** annotation.

```
public class AccountObserver {
  void checkTran(@Observes Withdrawal w) {
    ...
  }
}
```

You can use qualifiers to observe only specific types of events.

```
public class AccountObserver {
  void checkTran(@Observes @Suspicious Withdrawal w) {
    ...
  }
}
```

13.8. INTERCEPTORS

Interceptors allow you to add functionality to the business methods of a bean without modifying the bean's method directly. The interceptor is executed before any of the business methods of the bean. Interceptors are defined as part of the Enterprise JavaBeans specification, which can be found at https://jcp.org/aboutJava/communityprocess/final/jsr318/index.html.

CDI enhances this functionality by allowing you to use annotations to bind interceptors to beans.

Interception points

- Business method interception: A business method interceptor applies to invocations of methods of the bean by clients of the bean.
- Lifecycle callback interception: A lifecycle callback interceptor applies to invocations of lifecycle callbacks by the container.
- Timeout method interception: A timeout method interceptor applies to invocations of the EJB timeout methods by the container.

Use Interceptors with CDI

CDI can simplify your interceptor code and make it easier to apply to your business code.

Without CDI, interceptors have two problems:

- The bean must specify the interceptor implementation directly.
- Every bean in the application must specify the full set of interceptors in the correct order. This makes adding or removing interceptors on an application-wide basis time-consuming and error-prone.

Example: Interceptors without CDI

```
@Interceptors({
  SecurityInterceptor.class,
  TransactionInterceptor.class,
  LoggingInterceptor.class
})
@Stateful public class BusinessComponent {
  ...
}
```

Use interceptors

```
                    with CDI
. Define the interceptor binding type:
```

+

```
@InterceptorBinding
@Retention(RUNTIME)
@Target({TYPE, METHOD})
public @interface Secure {}
```

1. Mark the interceptor implementation:

```
@Secure
@Interceptor
public class SecurityInterceptor {
  @AroundInvoke
  public Object aroundInvoke(InvocationContext ctx) throws Exception
{
    // enforce security ...
    return ctx.proceed();
    }
}
```

2. Use the interceptor in your business code:

```
@Secure
public class AccountManager {
  public boolean transfer(Account a, Account b) {
```

```
    ...
  }
}
```

3. Enable the interceptor in your deployment, by adding it to **`META-INF/beans.xml`** or **`WEB-INF/beans.xml`**:

```
<beans>
  <interceptors>
    <class>com.acme.SecurityInterceptor</class>
    <class>com.acme.TransactionInterceptor</class>
  </interceptors>
</beans>
```

The interceptors are applied in the order listed.

13.9. DECORATORS

A decorator intercepts invocations from a specific Java interface, and is aware of all the semantics attached to that interface. Decorators are useful for modeling some kinds of business concerns, but do not have the generality of interceptors. A decorator is a bean, or even an abstract class, that implements the type it decorates, and is annotated with **`@Decorator`**. To invoke a decorator in a CDI application, it must be specified in the **`beans.xml`** file.

A decorator must have exactly one **`@Delegate`** injection point to obtain a reference to the decorated object.

Example: Example Decorator

```
@Decorator
public abstract class LargeTransactionDecorator implements Account {

   @Inject @Delegate @Any Account account;
   @PersistenceContext EntityManager em;

   public void withdraw(BigDecimal amount) {
      ...
   }

   public void deposit(BigDecimal amount);
      ...
   }
}
```

13.10. PORTABLE EXTENSIONS

CDI is intended to be a foundation for frameworks, extensions, and for integration with other technologies. Therefore, CDI exposes a set of SPIs for the use of developers of portable extensions to CDI.

Extensions can provide the following types of functionality:

- Integration with Business Process Management engines

- Integration with third-party frameworks, such as Spring, Seam, GWT, or Wicket
- New technology based upon the CDI programming model

According to the JSR-346 specification, a portable extension can integrate with the container in the following ways:

- Providing its own beans, interceptors, and decorators to the container
- Injecting dependencies into its own objects using the dependency injection service
- Providing a context implementation for a custom scope
- Augmenting or overriding the annotation-based metadata with metadata from another source

13.11. BEAN PROXIES

Clients of an injected bean do not usually hold a direct reference to a bean instance. Unless the bean is a dependent object (scope @Dependent), the container must redirect all injected references to the bean using a proxy object.

A bean proxy, which can be referred to as client proxy, is responsible for ensuring the bean instance that receives a method invocation is the instance associated with the current context. The client proxy also allows beans bound to contexts, such as the session context, to be serialized to disk without recursively serializing other injected beans.

Due to Java limitations, some Java types cannot be proxied by the container. If an injection point declared with one of these types resolves to a bean with a scope other than @Dependent, the container aborts the deployment.

Certain Java types cannot be proxied by the container. These include:

- Classes that do not have a non-private constructor with no parameters
- Classes that are declared **`final`** or have a **`final`** method
- Arrays and primitive types

13.11.1. Use a Proxy in an Injection

A proxy is used for injection when the lifecycles of the beans are different from each other. The proxy is a subclass of the bean that is created at run-time, and overrides all the non-private methods of the bean class. The proxy forwards the invocation onto the actual bean instance.

In this example, the **`PaymentProcessor`** instance is not injected directly into **Shop**. Instead, a proxy is injected, and when the **`processPayment()`** method is called, the proxy looks up the current **`PaymentProcessor`** bean instance and calls the **`processPayment()`** method on it.

Example: Proxy Injection

```
@ConversationScoped
class PaymentProcessor
{
  public void processPayment(int amount)
  {
    System.out.println("I'm taking $" + amount);
```

```
  }
}

@ApplicationScoped
public class Shop
{

  @Inject
  PaymentProcessor paymentProcessor;

  public void buyStuff()
  {
    paymentProcessor.processPayment(100);
  }
}
```

CHAPTER 14. CAMEL CDI

14.1. BASIC FEATURES

Overview

The Camel CDI component provides auto-configuration for Apache Camel using CDI as the dependency injection framework, based on **convention-over-configuration**. It auto-detects Camel routes available in the application and provides beans for common Camel primitives like **`Endpoint`**, **`ProducerTemplate`** or **`TypeConverter`**. It implements standard Camel bean integration so that Camel annotations like **`@Consume`**, **`@Produce`** and **`@PropertyInject`** can be used seamlessly in CDI beans. Besides, it bridges Camel events (for example **`RouteAddedEvent`**, **`CamelContextStartedEvent`**, **`ExchangeCompletedEvent`**, ...) as CDI events and provides a CDI events endpoint that can be used to consume / produce CDI events from / to Camel routes.

How to enable Camel CDI in Apache Karaf

To enable Camel CDI in Apache Karaf, perform the following steps:

1. Add the required **`pax-cdi`**, **`pax-cdi-weld`**, and **`camel-cdi`** features to the Karaf container, as follows:

```
JBossFuse:karaf@root> features:install pax-cdi pax-cdi-weld camel-
cdi
```

2. To enable Camel CDI in a bundle, open the **`pom.xml`** file in your bundle's Maven project and add the following **`Require-Capability`** element to the configuration of the Maven bundle plug-in:

```
<project ...>
  ...
  <build>
    <plugins>
      ...
      <plugin>
        <groupId>org.apache.felix</groupId>
        <artifactId>maven-bundle-plugin</artifactId>
        <extensions>true</extensions>
        <configuration>
          <instructions>
            <Bundle-
SymbolicName>${project.groupId}.${project.artifactId}</Bundle-
SymbolicName>
            <Import-Package>*</Import-Package>
            <Require-Capability>
              osgi.extender; filter:="(osgi.extender=pax.cdi)",
              org.ops4j.pax.cdi.extension; filter:="
(extension=camel-cdi-extension)"
            </Require-Capability>
          </instructions>
        </configuration>
      </plugin>
      ...
```

```
    </plugins>
  </build>
  ...
</project>
```

3. To access the CDI annotations in Java, you must add a dependency on the CDI API package and on the Camel CDI package. Edit your bundle's POM file, **pom.xml**, to add the CDI API package as a Maven dependency:

```
<project ...>
  ...
  <dependencies>
    ...
    <!-- CDI API -->
    <dependency>
      <groupId>javax.enterprise</groupId>
      <artifactId>cdi-api</artifactId>
      <version>${cdi-api-1.2-version}</version>
      <scope>provided</scope>
    </dependency>

    <!-- Camel CDI API -->
    <dependency>
      <groupId>org.apache.camel</groupId>
      <artifactId>camel-cdi</artifactId>
      <version>2.21.0.fuse-000055-redhat-2</version>
    </dependency>
    ...
  </dependencies>
  ...
</project>
```

4. Rebuild your bundle in the usual way for your Maven project. For example, using the command:

```
mvn clean install
```

5. Deploy the bundle to the Karaf container in the usual way (for example, using the **osgi:install** console command).

AUTO-CONFIGURED CAMEL CONTEXT

Camel CDI automatically deploys and configures a **CamelContext** bean. That **CamelContext** bean is automatically instantiated, configured and started (resp. stopped) when the CDI container initialises (resp. shuts down). It can be injected in the application, for example:

```
@Inject
CamelContext context;
```

The default **CamelContext** bean is qualified with the built-in **@Default** qualifier, is scoped **@ApplicationScoped** and is of type **DefaultCamelContext**.

Note that this bean can be customised programmatically and other Camel context beans can be deployed in the application as well.

Auto-detecting Camel routes

Camel CDI automatically collects all the **`RoutesBuilder`** beans in the application, instantiates and add them to the **`CamelContext`** bean instance when the CDI container initialises. For example, adding a Camel route is as simple as declaring a class, for example:

```
class MyRouteBean extends RouteBuilder {

 @Override
    public void configure() {
        from("jms:invoices").to("file:/invoices");
    }
}
```

Note that you can declare as many **`RoutesBuilder`** beans as you want. Besides, **`RouteContainer`** beans are also automatically collected, instantiated and added to the **`CamelContext`** bean instance managed by Camel CDI when the container initialises.

AUTO-CONFIGURED CAMEL PRIMITIVES

Camel CDI provides beans for common Camel primitives that can be injected in any CDI beans, for example:

```
@Inject
@Uri("direct:inbound")
ProducerTemplate producerTemplate;

@Inject
MockEndpoint outbound; // URI defaults to the member name, i.e.
mock:outbound

@Inject
@Uri("direct:inbound")
Endpoint endpoint;

@Inject
TypeConverter converter;
```

CAMEL CONTEXT CONFIGURATION

If you just want to change the name of the default **`CamelContext`** bean, you can used the **`@ContextName`** qualifier provided by Camel CDI, for example:

```
@ContextName("camel-context")
class MyRouteBean extends RouteBuilder {

 @Override
    public void configure() {
        from("jms:invoices").to("file:/invoices");
    }
}
```

Else, if more customisation is needed, any **CamelContext** class can be used to declare a custom Camel context bean. Then, the **@PostConstruct** and **@PreDestroy** lifecycle callbacks can be done to do the customisation, for example:

```
@ApplicationScoped
class CustomCamelContext extends DefaultCamelContext {

    @PostConstruct
    void customize() {
        // Set the Camel context name
        setName("custom");
        // Disable JMX
        disableJMX();
    }

    @PreDestroy
    void cleanUp() {
        // ...
    }
}
```

Producer and disposer methods can also be used as well to customize the Camel context bean, for example:

```
class CamelContextFactory {

    @Produces
    @ApplicationScoped
    CamelContext customize() {
        DefaultCamelContext context = new DefaultCamelContext();
        context.setName("custom");
        return context;
    }

    void cleanUp(@Disposes CamelContext context) {
        // ...
    }
}
```

Similarly, producer fields can be used, for example:

```
@Produces
@ApplicationScoped
CamelContext context = new CustomCamelContext();

class CustomCamelContext extends DefaultCamelContext {

    CustomCamelContext() {
        setName("custom");
    }
}
```

This pattern can be used for example to avoid having the Camel context routes started automatically when the container initialises by calling the **setAutoStartup** method, for example:

```
@ApplicationScoped
class ManualStartupCamelContext extends DefaultCamelContext {

    @PostConstruct
    void manual() {
        setAutoStartup(false);
    }
}
```

MULTIPLE CAMEL CONTEXTS

Any number of **`CamelContext`** beans can actually be declared in the application as documented above. In that case, the CDI qualifiers declared on these **`CamelContext`** beans are used to bind the Camel routes and other Camel primitives to the corresponding Camel contexts. From example, if the following beans get declared:

```
@ApplicationScoped
@ContextName("foo")
class FooCamelContext extends DefaultCamelContext {
}

@ApplicationScoped
@BarContextQualifier
class BarCamelContext extends DefaultCamelContext {
}

@ContextName("foo")
class RouteAdddedToFooCamelContext extends RouteBuilder {

 @Override
    public void configure() {
        // ...
    }
}

@BarContextQualifier
class RouteAdddedToBarCamelContext extends RouteBuilder {

 @Override
    public void configure() {
        // ...
    }
}

@ContextName("baz")
class RouteAdddedToBazCamelContext extends RouteBuilder {

 @Override
    public void configure() {
        // ...
    }
}

@MyOtherQualifier
class RouteNotAddedToAnyCamelContext extends RouteBuilder {
```

```
 @Override
    public void configure() {
        // ...
    }
}
```

The **RoutesBuilder** beans qualified with **@ContextName** are automatically added to the corresponding **CamelContext** beans by Camel CDI. If no such **CamelContext** bean exists, it gets automatically created, as for the **RouteAddedToBazCamelContext** bean. Note this only happens for the **@ContextName** qualifier provided by Camel CDI. Hence the **RouteNotAddedToAnyCamelContext** bean qualified with the user-defined **@MyOtherQualifier** qualifier does not get added to any Camel contexts. That may be useful, for example, for Camel routes that may be required to be added later during the application execution.

Since Camel version 2.17.0, Camel CDI is capable of managing any kind of **CamelContext** beans. In previous versions, it is only capable of managing beans of type **CdiCamelContext** so it is required to extend it.

The CDI qualifiers declared on the **CamelContext** beans are also used to bind the corresponding Camel primitives, for example:

```
@Inject
@ContextName("foo")
@Uri("direct:inbound")
ProducerTemplate producerTemplate;

@Inject
@BarContextQualifier
MockEndpoint outbound; // URI defaults to the member name, i.e.
mock:outbound

@Inject
@ContextName("baz")
@Uri("direct:inbound")
Endpoint endpoint;
```

CONFIGURATION PROPERTIES

To configure the sourcing of the configuration properties used by Camel to resolve properties placeholders, you can declare a **PropertiesComponent** bean qualified with **@Named("properties")**, for example:

```
@Produces
@ApplicationScoped
@Named("properties")
PropertiesComponent propertiesComponent() {
    Properties properties = new Properties();
    properties.put("property", "value");
    PropertiesComponent component = new PropertiesComponent();
    component.setInitialProperties(properties);
    component.setLocation("classpath:placeholder.properties");
    return component;
}
```

If you want to use DeltaSpike configuration mechanism you can declare the following **PropertiesComponent** bean:

```
@Produces
@ApplicationScoped
@Named("properties")
PropertiesComponent properties(PropertiesParser parser) {
    PropertiesComponent component = new PropertiesComponent();
    component.setPropertiesParser(parser);
    return component;
}

// PropertiesParser bean that uses DeltaSpike to resolve properties
static class DeltaSpikeParser extends DefaultPropertiesParser {
    @Override
    public String parseProperty(String key, String value, Properties
properties) {
        return ConfigResolver.getPropertyValue(key);
    }
}
```

You can see the **camel-example-cdi-properties** example for a working example of a Camel CDI application using DeltaSpike configuration mechanism.

AUTO-CONFIGURED TYPE CONVERTERS

CDI beans annotated with the **@Converter** annotation are automatically registered into the deployed Camel contexts, for example:

```
@Converter
public class MyTypeConverter {

    @Converter
    public Output convert(Input input) {
        //...
    }
}
```

Note that CDI injection is supported within the type converters.

LAZY INJECTION / PROGRAMMATIC LOOKUP

Available as of Camel 2.17

While the CDI programmatic model favors a type-safe resolution mechanism that occurs at application initialization time, it is possible to perform dynamic / lazy injection later during the application execution using the programmatic lookup mechanism.

Camel CDI provides for convenience the annotation literals corresponding to the CDI qualifiers that you can use for standard injection of Camel primitives. These annotation literals can be used in conjunction with the **javax.enterprise.inject.Instance** interface which is the CDI entry point to perform lazy injection / programmatic lookup.

For example, you can use the provided annotation literal for the **@Uri**qualifier to lazily lookup for Camel primitives, for example for **ProducerTemplate**beans:

```
@Any
@Inject
Instance<ProducerTemplate> producers;

ProducerTemplate inbound = producers
    .select(Uri.Literal.of("direct:inbound"))
    .get();
```

Or for **Endpoint** beans, for example:

```
@Any
@Inject
Instance<Endpoint> endpoints;

MockEndpoint outbound = endpoints
    .select(MockEndpoint.class, Uri.Literal.of("mock:outbound"))
    .get();
```

Similarly, you can use the provided annotation literal for the**@ContextName** qualifier to lazily lookup for **CamelContext** beans, for example:

```
@Any
@Inject
Instance<CamelContext> contexts;

CamelContext context = contexts
    .select(ContextName.Literal.of("foo"))
    .get();
```

You can also refined the selection based on the Camel context type, for example:

```
@Any
@Inject
Instance<CamelContext> contexts;

// Refine the selection by type
Instance<DefaultCamelContext> context =
contexts.select(DefaultCamelContext.class);

// Check if such a bean exists then retrieve a reference
if (!context.isUnsatisfied())
    context.get();
```

Or even iterate over a selection of Camel contexts, for example:

```
@Any
@Inject
Instance<CamelContext> contexts;

for (CamelContext context : contexts)
    context.setUseBreadcrumb(true);
```

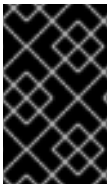
INJECTING A CAMEL CONTEXT FROM SPRING XML

While CDI favors a type safe dependency injection mechanism, it may be useful to reuse existing Camel XML configurations by injecting them into a Camel CDI application. In other use cases, it might be handy to rely on the Camel XML DSL to configure its Camel context(s).

To inject by CDI a camelContext defined in Spring XML, you need to use the Java **`@Resource`** annotation, instead of the **`@Inject @ContextName`** annotations in the Camel CDI extension. For example,

```
...
public class RouteCaller {
    ...
    @Resource(name = "java:jboss/camel/context/simple-context")
    private CamelContext context;
    ...
```

The string **`java:jboss/camel/context/simple-context`** is the name of the deployed context registered in the JNDI registry. **`simple-context`** is the **`xml:id`** of the **`camelContext`** element in the Spring XML file.



IMPORTANT

Using the **`@Inject @ContextName`** annotations can result in the creation of a new camelContext instead of injecting the named context, which later causes endpoint lookups to fail.

CHAPTER 15. CAMEL BEAN INTEGRATION

CAMEL ANNOTATIONS

As part of the Camel bean integration, Camel comes with a set of annotations that are seamlessly supported by Camel CDI. So you can use any of these annotations in your CDI beans, for example:

	Camel annotation	CDI equivalent
Configuration property	`@PropertyInject("key") String value;`	If using DeltaSpike configuration mechanism: `@Inject @ConfigProperty(name = "key") String value;` See configuration properties for more details.
Producer template injection (default Camel context)	`@Produce(uri = "mock:outbound") ProducerTemplate producer;`	`@Inject @Uri("direct:outbound") ProducerTemplate producer;`
Endpoint injection (default Camel context)	`@EndpointInject(uri = "direct:inbound") Endpoint endpoint;`	`@Inject @Uri("direct:inbound") Endpoint endpoint;`
Endpoint injection (Camel context by name)	`@EndpointInject(uri = "direct:inbound", context = "foo") Endpoint contextEndpoint;`	`@Inject @ContextName("foo") @Uri("direct:inbound") Endpoint contextEndpoint;`
Bean injection (by type)	`@BeanInject MyBean bean;`	`@Inject MyBean bean;`
Bean injection (by name)	`@BeanInject("foo") MyBean bean;`	`@Inject @Named("foo") MyBean bean;`

POJO consuming	```@Consume(uri = "seda:inbound") void consume(@Body String body) { //... }```	

BEAN COMPONENT

You can refer to CDI beans, either by type or name, From the Camel DSL, for example with the Java Camel DSL:

```
class MyBean {
 //...
}

from("direct:inbound").bean(MyBean.class);
```

Or to lookup a CDI bean by name from the Java DSL:

```
@Named("foo")
class MyNamedBean {
 //...
}

from("direct:inbound").bean("foo");
```

REFERRING BEANS FROM ENDPOINT URIS

When configuring endpoints using the URI syntax you can refer to beans in the Registry using the # notation. If the URI parameter value starts with a # sign then Camel CDI will lookup for a bean of the given type by name, for example:

```
from("jms:queue:{{destination}}?
transacted=true&transactionManager=#jtaTransactionManager").to("...");
```

Having the following CDI bean qualified with **`@Named("jtaTransactionManager")`**:

```
@Produces
@Named("jtaTransactionManager")
PlatformTransactionManager createTransactionManager(TransactionManager
transactionManager, UserTransaction userTransaction) {
    JtaTransactionManager jtaTransactionManager = new
JtaTransactionManager();
    jtaTransactionManager.setUserTransaction(userTransaction);
    jtaTransactionManager.setTransactionManager(transactionManager);
    jtaTransactionManager.afterPropertiesSet();
    return jtaTransactionManager;
}
```

CHAPTER 16. CDI EVENTS IN CAMEL

CAMEL EVENTS TO CDI EVENTS

Camel provides a set of management events that can be subscribed to for listening to Camel context, service, route and exchange events. Camel CDI seamlessly translates these Camel events into CDI events that can be observed using CDI observer methods, for example:

```
void onContextStarting(@Observes CamelContextStartingEvent event) {
    // Called before the default Camel context is about to start
}
```

When multiple Camel contexts exist in the CDI container, the Camel context bean qualifiers, like **@ContextName**, can be used to refine the observer method resolution to a particular Camel context as specified in observer resolution, for example:

```
void onRouteStarted(@Observes @ContextName("foo") RouteStartedEvent event)
{
    // Called after the route 'event.getRoute()' for the Camel context
'foo' has started
}

void onContextStarted(@Observes @Manual CamelContextStartedEvent event) {
    // Called after the the Camel context qualified with '@Manual' has
started
}
```

Similarly, the **@Default** qualifier can be used to observe Camel events for the **default** Camel context if multiples contexts exist, for example:

```
void onExchangeCompleted(@Observes @Default ExchangeCompletedEvent event)
{
    // Called after the exchange 'event.getExchange()' processing has
completed
}
```

In that example, if no qualifier is specified, the **@Any** qualifier is implicitly assumed, so that corresponding events for all the Camel contexts get received.

Note that the support for Camel events translation into CDI events is only activated if observer methods listening for Camel events are detected in the deployment, and that per Camel context.

CDI EVENTS ENDPOINT

The CDI event endpoint bridges the CDI events with the Camel routes so that CDI events can be seamlessly observed / consumed (resp. produced / fired) from Camel consumers (resp. by Camel producers).

The **CdiEventEndpoint<T>** bean provided by Camel CDI can be used to observe / consume CDI events whose **event type** is **T**, for example:

```
@Inject
CdiEventEndpoint<String> cdiEventEndpoint;
```

```
from(cdiEventEndpoint).log("CDI event received: ${body}");
```

This is equivalent to writing:

```
@Inject
@Uri("direct:event")
ProducerTemplate producer;

void observeCdiEvents(@Observes String event) {
    producer.sendBody(event);
}

from("direct:event").log("CDI event received: ${body}");
```

Conversely, the **CdiEventEndpoint<T>** bean can be used to produce / fire CDI events whose **event type** is **T**, for example:

```
@Inject
CdiEventEndpoint<String> cdiEventEndpoint;

from("direct:event").to(cdiEventEndpoint).log("CDI event sent: ${body}");
```

This is equivalent to writing:

```
@Inject
Event<String> event;

from("direct:event").process(new Processor() {
    @Override
    public void process(Exchange exchange) {
        event.fire(exchange.getBody(String.class));
    }
}).log("CDI event sent: ${body}");
```

Or using a Java 8 lambda expression:

```
@Inject
Event<String> event;

from("direct:event")
    .process(exchange ->
event.fire(exchange.getIn().getBody(String.class)))
    .log("CDI event sent: ${body}");
```

The type variable **T** (resp. the qualifiers) of a particular **CdiEventEndpoint<T>** injection point are automatically translated into the parameterized **event type** (resp. into the **event qualifiers**) for example:

```
@Inject
@FooQualifier
CdiEventEndpoint<List<String>> cdiEventEndpoint;

from("direct:event").to(cdiEventEndpoint);
```

```
void observeCdiEvents(@Observes @FooQualifier List<String> event) {
    logger.info("CDI event: {}", event);
}
```

When multiple Camel contexts exist in the CDI container, the Camel context bean qualifiers, like **@ContextName**, can be used to qualify the **CdiEventEndpoint<T>** injection points, for example:

```
@Inject
@ContextName("foo")
CdiEventEndpoint<List<String>> cdiEventEndpoint;
// Only observes / consumes events having the @ContextName("foo") qualifier
from(cdiEventEndpoint).log("Camel context (foo) > CDI event received:
${body}");
// Produces / fires events with the @ContextName("foo") qualifier
from("...").to(cdiEventEndpoint);

void observeCdiEvents(@Observes @ContextName("foo") List<String> event) {
    logger.info("Camel context (foo) > CDI event: {}", event);
}
```

Note that the CDI event Camel endpoint dynamically adds an observer method for each unique combination of **event type** and **event qualifiers** and solely relies on the container typesafe observer resolution, which leads to an implementation as efficient as possible.

Besides, as the impedance between the **typesafe** nature of CDI and the **dynamic** nature of the Camel component model is quite high, it is not possible to create an instance of the CDI event Camel endpoint via URIs. Indeed, the URI format for the CDI event component is:

```
cdi-event://PayloadType<T1,...,Tn>[?qualifiers=QualifierType1[,...
[,QualifierTypeN]...]]
```

With the authority **PayloadType** (resp. the **QualifierType**) being the URI escaped fully qualified name of the payload (resp. qualifier) raw type followed by the type parameters section delimited by angle brackets for payload parameterized type. Which leads to **unfriendly** URIs, for example:

```
cdi-
event://org.apache.camel.cdi.example.EventPayload%3Cjava.lang.Integer%3E?
qualifiers=org.apache.camel.cdi.example.FooQualifier%2Corg.apache.camel.cd
i.example.BarQualifier
```

But more fundamentally, that would prevent efficient binding between the endpoint instances and the observer methods as the CDI container doesn't have any ways of discovering the Camel context model during the deployment phase.

PART II. OSGI INTEGRATION

AUTO-CONFIGURED OSGI INTEGRATION

The Camel context beans are automatically adapted by Camel CDI so that they are registered as OSGi services and the various resolvers (like **`ComponentResolver`** and **`DataFormatResolver`**) integrate with the OSGi registry. That means that the Karaf Camel commands can be used to operate the Camel contexts auto-configured by Camel CDI, for example:

```
karaf@root()> camel:context-list
 Context        Status              Total #       Failed #     Inflight #
Uptime
 -------        ------              -------       --------     --------
--   ------
 camel-cdi      Started                   1              0
0   1 minute
```

See the **`camel-example-cdi-osgi`** example, available in the list of camel examples for a working example of the Camel CDI OSGi integration.

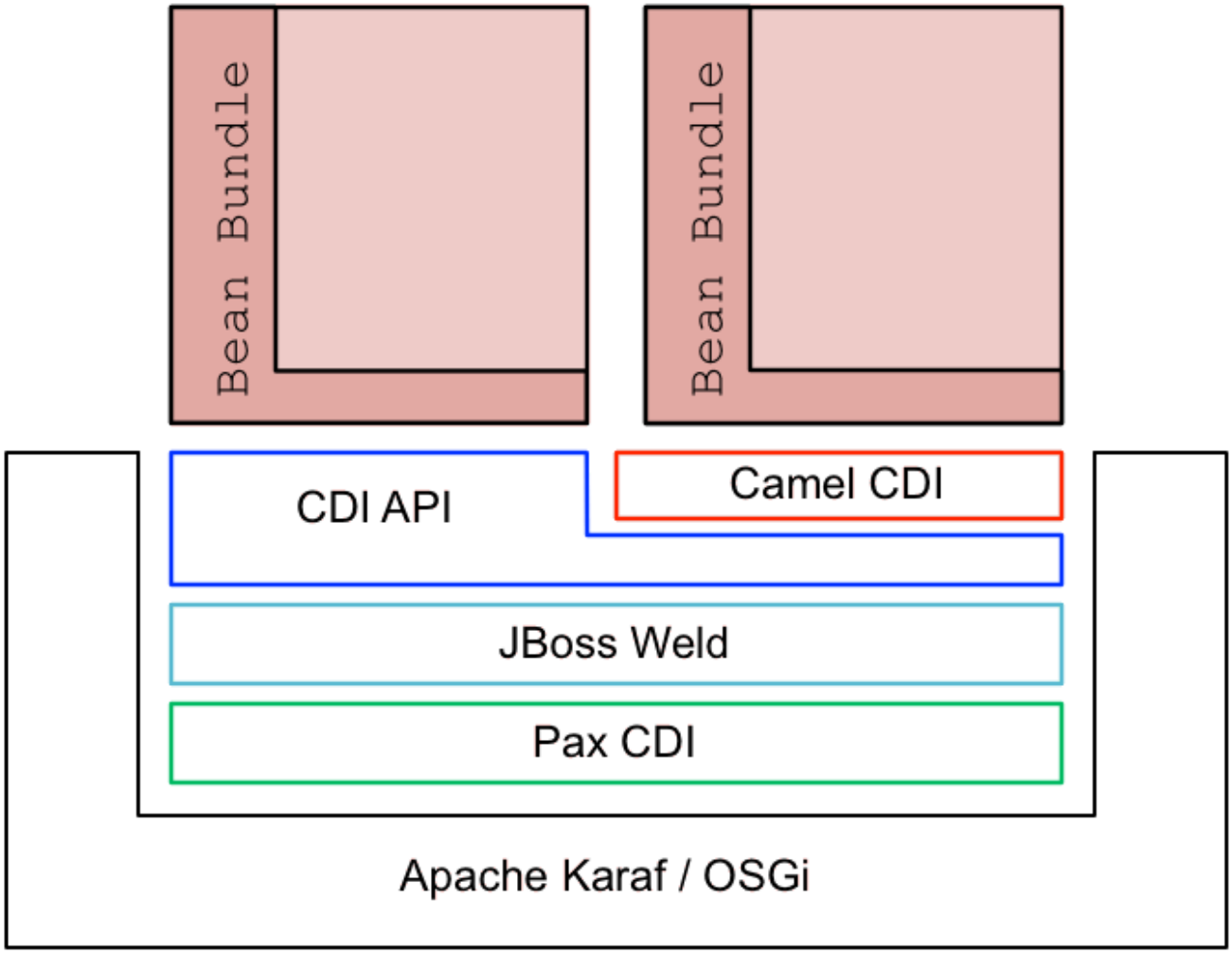
CHAPTER 17. PAX CDI AND OSGI SERVICES

17.1. PAX CDI ARCHITECTURE

17.1.1. Overview

Figure 17.1, “Pax CDI Architecture” gives an overview of the technology stack underlying Pax CDI.

Figure 17.1. Pax CDI Architecture



17.2. PAX CDI

Pax CDI is the integration layer that makes it possible to deploy a CDI container within the Apache Karaf OSGi container.

JBOSS WELD

JBoss Weld provides the CDI implementation for the Pax CDI integration. JBoss Weld is the reference implementation for CDI and comes with its own extensive documentation, CDI Reference Implementation.

BEAN BUNDLE

A *bean bundle* is an OSGi bundle that has been enabled to use Pax CDI. A bundle cannot use CDI by default, it must be explicitly enabled to do so (see the section called “Requirements and capabilities”).

CDI CONTAINER

A CDI container effectively defines the scope for a collection of managed beans under CDI, which are capable of being published and injected within this scope. In the context of OSGi, a CDI container maps to a single bundle. That is, each bean bundle gets its own CDI container.

CAMEL CDI AND OTHER CUSTOMIZATIONS

JBoss Fuse provides additional features that define CDI customizations (that is, non-standard CDI annotations) targeted at different aspects of middleware development. For example:

`camel-cdi`

Provides custom annotations for defining and injecting Camel contexts and routes. See Chapter 14, *Camel CDI*.

`switchyard-cdi`

Provides custom annotations for use with SwitchYard. For example, see the quickstart example under the following directory of your JBoss Fuse installation:

```
quickstarts/switchyard/camel-bus-cdi
```

For more information, see olink:SYDev/chap-Service_Implementations.

`cxf-jaxrs-cdi`

Provides support for CDI in JAX-RS, as defined in the JAX-RS 2.0 Specification (see section 10.2.3).

`deltaspike`

Apache Deltaspike is a general-purpose collection of CDI customizations.

17.3. ENABLING PAX CDI

Overview

Pax CDI is **not** enabled by default in the Karaf container in JBoss Fuse, so you must enable it explicitly. There are two aspects of enabling Pax CDI in the Karaf container: first, installing the requisite Karaf features in the container; second, enabling CDI for a particular bundle, by adding the **`Require-Capability`** header to the bundle's manifest (turning the bundle into a **bean bundle**).

Pax CDI features

To make Pax CDI functionality available in the Karaf container, install the requisite Karaf features into your container. JBoss Fuse provides the following Karaf features for Pax CDI:

`pax-cdi`

Deploys the core components of Pax CDI. This feature must be combined with the **`pax-cdi-weld`** CDI implementation.

`pax-cdi-weld`

Deploys the JBoss Weld CDI implementation (which is the only CDI implementation supported on JBoss Fuse)

`pax-cdi-web`

Adds support for deploying a CDI application as a Web application (that is, deploying the CDI application into the Pax Web Undertow container). This enables support for the CDI features associated with servlet deployment, such as session-scoped beans, request-scoped beans, injection into servlets, and so on. This feature must be combined with the **`pax-cdi-web-weld`** feature (CDI implementation).

`pax-cdi-web-weld`

Deploys the JBoss Weld CDI implementation for Web applications.

Requirements and capabilities

CDI requires you to organize your Java code in a very specific way, so it cannot be enabled arbitrarily for any bundle. It only makes sense to enable CDI for each bundle that needs it, **not** for the entire container. Hence, it is necessary to use an OSGi extension mechanism that switches on the CDI capability on a bundle-by-bundle basis. The relevant OSGi mechanism is known as the *requirements and capabilities* mechanism.

The CDI **capability** is provided by the relevant Pax CDI packages (installed as Karaf features); and the CDI **requirement** is specified for each bundle by adding a **`Require-Capability`** bundle header to the bundle's manifest file. For example, to enable the base Pax CDI functionality, you would add the following **`Require-Capability`** header to the bundle's manifest file:

```
Require-Capability : osgi.extender; filter:="(osgi.extender=pax.cdi)"
```

A bundle that includes the preceding **`Require-Capability`** bundle header effectively becomes a bean bundle (a CDI enabled bundle).

How to enable Pax CDI in Apache Karaf

To enable Pax CDI in Apache Karaf, perform the following steps:

1. Add the required **`pax-cdi`** and **`pax-cdi-weld`** features to the Karaf container, as follows:

   ```
   JBossFuse:karaf@root> features:install pax-cdi pax-cdi-weld
   ```

2. When the Pax CDI features are installed in the Karaf container, this is **not** sufficient to enable CDI. You must also explicitly enable Pax CDI in each bundle that uses CDI (so that it becomes a **bean bundle**). To enable Pax CDI in a bundle, open the **`pom.xml`** file in your bundle's Maven project and add the following **`Require-Capability`** element to the configuration of the Maven bundle plug-in:

   ```
   <project ...>
     ...
     <build>
       <plugins>
         ...
         <plugin>
           <groupId>org.apache.felix</groupId>
           <artifactId>maven-bundle-plugin</artifactId>
           <extensions>true</extensions>
           <configuration>
   ```

```
          <instructions>
            <Bundle-
SymbolicName>${project.groupId}.${project.artifactId}</Bundle-
SymbolicName>
            <Import-Package>*</Import-Package>
            <Require-Capability>
              osgi.extender; filter:="(osgi.extender=pax.cdi)"
            </Require-Capability>
          </instructions>
        </configuration>
      </plugin>
      ...
    </plugins>
  </build>
  ...
</project>
```

3. To access the CDI annotations in Java, you must add a dependency on the CDI API package. Edit your bundle's POM file, **pom.xml**, to add the CDI API package as a Maven dependency:

```
<project ...>
  ...
  <dependencies>
    ...
    <!-- CDI API -->
    <dependency>
      <groupId>javax.enterprise</groupId>
      <artifactId>cdi-api</artifactId>
      <version>${cdi-api-1.2-version}</version>
      <scope>provided</scope>
    </dependency>
    ...
  </dependencies>
  ...
</project>
```

4. Rebuild your bundle in the usual way for your Maven project. For example, using the command:

```
mvn clean install
```

5. Deploy the bundle to the Karaf container in the usual way (for example, using the **osgi:install** console command).

17.4. OSGI SERVICES EXTENSION

Overview

Pax CDI also provides an integration with OSGi services, enabling you to reference an OSGi service or to publish an OSGi service using CDI annotations. This capability is provided by the Pax CDI OSGi Services Extension, which is **not** enabled by default.

Enabling the OSGi Services Extension

To enable the Pax CDI OSGi Services Extension, you must include the following bundle header in the

manifest file:

```
Require-Capability : org.ops4j.pax.cdi.extension; filter:="(extension=pax-
cdi-extension)"
```

In a Maven project, you would normally add a **`Require-Capability`** element to the configuration of the Maven bundle plug-in. For example, to add both the Pax CDI Extender and the Pax CDI OSGi Services Extension to the bundle, configure your project's POM file, **`pom.xml`**, as follows:

```
<project ...>
  ...
  <build>
    <plugins>
      ...
      <plugin>
        <groupId>org.apache.felix</groupId>
        <artifactId>maven-bundle-plugin</artifactId>
        <extensions>true</extensions>
        <configuration>
          <instructions>
            <Bundle-SymbolicName>${project.groupId}.${project.artifactId}
</Bundle-SymbolicName>
            <Import-Package>*</Import-Package>
            <Require-Capability>
              osgi.extender; filter:="(osgi.extender=pax.cdi)",
              org.ops4j.pax.cdi.extension; filter:="(extension=pax-cdi-
extension)"
            </Require-Capability>
          </instructions>
        </configuration>
      </plugin>
      ...
    </plugins>
  </build>
  ...
</project>
```

Maven dependency for the OSGi Services extensions API

To access the OSGi Services annotations in your Java code, you need to add a dependency on the **`pax-cdi-api`** package. Edit your bundle's POM file, **`pom.xml`**, to add the Pax CDI API package as a Maven dependency:

```
<project ...>
  ...
  <dependencies>
    ...
    <!-- CDI API -->
    <dependency>
        <groupId>org.ops4j.pax.cdi</groupId>
        <artifactId>pax-cdi-api</artifactId>
        <version>1.0.0.RC1</version>
    </dependency>
    ...
```

```
  </dependencies>
  ...
</project>
```

INJECTING AN OSGI SERVICE

You can inject an OSGi service into a field using the following annotation:

```
@Inject @OsgiService
private IceCreamService iceCream;
```

Pax CDI finds the OSGi service to inject by matching the type of the OSGi service to the type of the field.

DISAMBIGUATING OSGI SERVICES

If more than one OSGi service of a particular type exists, you can disambiguate the match by filtering on the OSGi service properties—for example:

```
@Inject @OsgiService(filter = "(&(flavour=chocolate)(lactose=false))")
private IceCreamService iceCream;
```

As usual for OSGi services, the properties filter is defined using LDAP filter syntax (see Matching service properties with a filter for more details). For an example of how to set properties on an OSGi service, see the section called “Setting OSGi Service properties” .

Selecting OSGi Services at run time

You can reference an OSGi service dynamically by injecting it as follows:

```
@Inject
@OsgiService(dynamic = true)
private Instance<IceCreamService> iceCreamServices;
```

Calling **`iceCreamServices.get()`** will return an instance of the **`IceCreamService`** service at run time. With this approach, it is possible to reference an OSGi service that is created **after** your bean is created.

Publishing a bean as OSGi Service with singleton scope

You can publish an OSGi service with OSGi singleton scope (which is the default), as follows:

```
@OsgiServiceProvider
public class ChocolateService implements IceCreamService {
    ...
}
```

OSGi singleton scope means that the bean manager creates a single instance of the bean and returns that instance every time a bean instance is requested.

Publishing a bean as OSGi Service with prototype scope

You can publish an OSGi service with OSGi prototype scope, as follows:

```
@OsgiServiceProvider
@PrototypeScoped
public class ChocolateService implements IceCreamService {
    ...
}
```

OSGi prototype scope means that the bean manager creates a new bean instance every time a bean instance is requested.

Publishing a bean as OSGi Service with bundle scope

You can publish an OSGi service with bundle scope, as follows:

```
@OsgiServiceProvider
@BundleScoped
public class ChocolateService implements IceCreamService {
    ...
}
```

Bundle scope means that the bean manger creates a new bean instance for every client bundle. That is, the **@BundleScoped** beans are registered with an **`org.osgi.framework.ServiceFactory`**.

Setting OSGi Service properties

You can set properties on an OSGi service by annotating the service bean as follows:

```
@OsgiServiceProvider
@Properties({
    @Property(name = "flavour", value = "chocolate"),
    @Property(name = "lactose", value = "false")
})
public class ChocolateService implements IceCreamService {
    ...
}
```

Publishing an OSGi Service with explicit interfaces

You can explicitly specify the Java interfaces supported by an OSGi Service bean, as follows:

```
@OsgiServiceProvider(classes = {ChocolateService.class,
IceCreamService.class})
public class ChocolateService implements IceCreamService {
    ...
}
```

CHAPTER 18. DEPLOYING USING A WAR PACKAGE

Abstract

The OSGi specification supports modular application development by defining a runtime framework that simplifies building, deploying, and managing complex applications.

CHAPTER 19. DEPLOYING USING THE OSGI SERVICE LAYER

Abstract

The OSGi specification supports modular application development by defining a runtime framework that simplifies building, deploying, and managing complex applications.

CHAPTER 20. OSGI SERVICES

Abstract

The OSGi core framework defines the *OSGi Service Layer*, which provides a simple mechanism for bundles to interact by registering Java objects as services in the *OSGi service registry*. One of the strengths of the OSGi service model is that **any** Java object can be offered as a service: there are no particular constraints, inheritance rules, or annotations that must be applied to the service class. This chapter describes how to deploy an OSGi service using the OSGi *Blueprint container*.

CHAPTER 21. THE BLUEPRINT CONTAINER

Abstract

The Blueprint container is a dependency injection framework that simplifies interaction with the OSGi container. The Blueprint container supports a configuration-based approach to using the OSGi service registry—for example, providing standard XML elements to import and export OSGi services.

21.1. BLUEPRINT CONFIGURATION

Location of Blueprint files in a JAR file

Relative to the root of the bundle JAR file, the standard location for Blueprint configuration files is the following directory:

```
OSGI-INF/blueprint
```

Any files with the suffix, **.xml**, under this directory are interpreted as Blueprint configuration files; in other words, any files that match the pattern, **OSGI-INF/blueprint/*.xml**.

Location of Blueprint files in a Maven project

In the context of a Maven project, *ProjectDir*, the standard location for Blueprint configuration files is the following directory:

```
ProjectDir/src/main/resources/OSGI-INF/blueprint
```

Blueprint namespace and root element

Blueprint configuration elements are associated with the following XML namespace:

```
http://www.osgi.org/xmlns/blueprint/v1.0.0
```

The root element for Blueprint configuration is **blueprint**, so a Blueprint XML configuration file normally has the following outline form:

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

NOTE

In the **blueprint** root element, there is no need to specify the location of the Blueprint schema using an **xsi:schemaLocation** attribute, because the schema location is already known to the Blueprint framework.

Blueprint Manifest configuration

Some aspects of Blueprint configuration are controlled by headers in the JAR's manifest file, **META-INF/MANIFEST.MF**, as follows:

- Custom Blueprint file locations.

- Mandatory dependencies.

Custom Blueprint file locations

If you need to place your Blueprint configuration files in a non-standard location (that is, somewhere other than **`OSGI-INF/blueprint/*.xml`**), you can specify a comma-separated list of alternative locations in the **`Bundle-Blueprint`** header in the manifest file—for example:

```
Bundle-Blueprint: lib/account.xml, security.bp, cnf/*.xml
```

Mandatory dependencies

Dependencies on an OSGi service are mandatory by default (although this can be changed by setting the **`availability`** attribute to **`optional`** on a **`reference`** element or a **`reference-list`** element). Declaring a dependency to be mandatory means that the bundle cannot function properly without that dependency and the dependency must be available at all times.

Normally, while a Blueprint container is initializing, it passes through a *grace period*, during which time it attempts to resolve all mandatory dependencies. If the mandatory dependencies cannot be resolved in this time (the default timeout is 5 minutes), container initialization is aborted and the bundle is not started. The following settings can be appended to the **`Bundle-SymbolicName`** manifest header to configure the grace period:

`blueprint.graceperiod`

If **`true`** (the default), the grace period is enabled and the Blueprint container waits for mandatory dependencies to be resolved during initialization; if **`false`**, the grace period is skipped and the container does not check whether the mandatory dependencies are resolved.

`blueprint.timeout`

Specifies the grace period timeout in milliseconds. The default is 300000 (5 minutes).

For example, to enable a grace period of 10 seconds, you could define the following **`Bundle-SymbolicName`** header in the manifest file:

```
Bundle-SymbolicName: org.fusesource.example.osgi-client;
 blueprint.graceperiod:=true;
 blueprint.timeout:= 10000
```

The value of the **`Bundle-SymbolicName`** header is a semi-colon separated list, where the first item is the actual bundle symbolic name, the second item, **`blueprint.graceperiod:=true`**, enables the grace period and the third item, **`blueprint.timeout:= 10000`**, specifies a 10 second timeout.

21.2. DEFINING A SERVICE BEAN

Overview

The Blueprint container enables you to instantiate Java classes using a **bean** element. You can create all of your main application objects this way. In particular, you can use the **bean** element to create a Java object that represents an OSGi service instance.

Blueprint bean element

The Blueprint **bean** element is defined in the Blueprint schema namespace, **`http://www.osgi.org/xmlns/blueprint/v1.0.0`**.

Sample beans

The following example shows how to create a few different types of bean using Blueprint's **bean** element:

```
<blueprint xmlns="http://www.osgi.org/xmlns/blueprint/v1.0.0">

  <bean id="label" class="java.lang.String">
    <argument value="LABEL_VALUE"/>
  </bean>

  <bean id="myList" class="java.util.ArrayList">
    <argument type="int" value="10"/>
  </bean>

  <bean id="account" class="org.fusesource.example.Account">
    <property name="accountName" value="john.doe"/>
    <property name="balance" value="10000"/>
  </bean>

</blueprint>
```

Where the **Account** class referenced by the last bean example could be defined as follows:

```
package org.fusesource.example;

public class Account
{
    private String accountName;
    private int balance;

    public Account () { }

    public void setAccountName(String name) {
        this.accountName = name;
    }

    public void setBalance(int bal) {
        this.balance = bal;
    }
    ...
}
```

References

For more details on defining Blueprint beans, consult the following references:

- Spring Dynamic Modules Reference Guide v2.0, Blueprint chapter .
- Section 121 **Blueprint Container Specification**, from the OSGi Compendium Services R4.2 specification.

21.3. EXPORTING A SERVICE

Overview

This section describes how to export a Java object to the OSGi service registry, thus making it accessible as a service to other bundles in the OSGi container.

Exporting with a single interface

To export a service to the OSGi service registry under a single interface name, define a **`service`** element that references the relevant service bean, using the **`ref`** attribute, and specifies the published interface, using the **`interface`** attribute.

For example, you could export an instance of the **`SavingsAccountImpl`** class under the **`org.fusesource.example.Account`** interface name using the Blueprint configuration code shown in Example 21.1, “Sample Service Export with a Single Interface” .

Example 21.1. Sample Service Export with a Single Interface

```
<blueprint xmlns="http://www.osgi.org/xmlns/blueprint/v1.0.0">

  <bean id="savings" class="org.fusesource.example.SavingsAccountImpl"/>

  <service ref="savings" interface="org.fusesource.example.Account"/>

</blueprint>
```

Where the **`ref`** attribute specifies the ID of the corresponding bean instance and the **`interface`** attribute specifies the name of the public Java interface under which the service is registered in the OSGi service registry. The classes and interfaces used in this example are shown in Example 21.2, “Sample Account Classes and Interfaces”

Example 21.2. Sample Account Classes and Interfaces

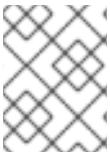
```
package org.fusesource.example

public interface Account { ... }

public interface SavingsAccount { ... }

public interface CheckingAccount { ... }

public class SavingsAccountImpl implements SavingsAccount
{
    ...
}

public class CheckingAccountImpl implements CheckingAccount
{
    ...
}
```

Exporting with multiple interfaces

To export a service to the OSGi service registry under multiple interface names, define a **`service`** element that references the relevant service bean, using the **`ref`** attribute, and specifies the published interfaces, using the **`interfaces`** child element.

For example, you could export an instance of the **SavingsAccountImpl** class under the list of public Java interfaces, **org.fusesource.example.Account** and **org.fusesource.example.SavingsAccount**, using the following Blueprint configuration code:

```
<blueprint xmlns="http://www.osgi.org/xmlns/blueprint/v1.0.0">
  <bean id="savings" class="org.fusesource.example.SavingsAccountImpl"/>
  <service ref="savings">
    <interfaces>
      <value>org.fusesource.example.Account</value>
      <value>org.fusesource.example.SavingsAccount</value>
    </interfaces>
  </service>
  ...
</blueprint>
```



NOTE

The **interface** attribute and the **interfaces** element cannot be used simultaneously in the same **service** element. You must use either one or the other.

Exporting with auto-export

If you want to export a service to the OSGi service registry under **all** of its implemented public Java interfaces, there is an easy way of accomplishing this using the **auto-export** attribute.

For example, to export an instance of the **SavingsAccountImpl** class under all of its implemented public interfaces, use the following Blueprint configuration code:

```
<blueprint xmlns="http://www.osgi.org/xmlns/blueprint/v1.0.0">
  <bean id="savings" class="org.fusesource.example.SavingsAccountImpl"/>
  <service ref="savings" auto-export="interfaces"/>
  ...
</blueprint>
```

Where the **interfaces** value of the **auto-export** attribute indicates that Blueprint should register all of the public interfaces implemented by **SavingsAccountImpl**. The **auto-export** attribute can have the following valid values:

disabled
: Disables auto-export. This is the default.

interfaces
: Registers the service under all of its implemented public Java interfaces.

class-hierarchy
: Registers the service under its own type (class) and under all super-types (super-classes), except for the **Object** class.

all-classes
: Like the **class-hierarchy** option, but including all of the implemented public Java interfaces as well.

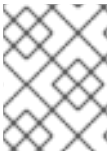
Setting service properties

The OSGi service registry also allows you to associate *service properties* with a registered service. Clients of the service can then use the service properties to search for or filter services. To associate service properties with an exported service, add a **service-properties** child element that contains one or more **beans:entry** elements (one **beans:entry** element for each service property).

For example, to associate the **bank.name** string property with a savings account service, you could use the following Blueprint configuration:

```
<blueprint xmlns="http://www.osgi.org/xmlns/blueprint/v1.0.0"
           xmlns:beans="http://www.springframework.org/schema/beans"
           ...>
  ...
  <service ref="savings" auto-export="interfaces">
    <service-properties>
      <beans:entry key="bank.name" value="HighStreetBank"/>
    </service-properties>
  </service>
  ...
</blueprint>
```

Where the **bank.name** string property has the value, **HighStreetBank**. It is possible to define service properties of type other than string: that is, primitive types, arrays, and collections are also supported. For details of how to define these types, see Controlling the Set of Advertised Properties . in the **Spring Reference Guide**.



NOTE

The **entry** element ought to belong to the Blueprint namespace. The use of the **beans:entry** element in Spring's implementation of Blueprint is non-standard.

Default service properties

There are two service properties that might be set automatically when you export a service using the **service** element, as follows:

- **osgi.service.blueprint.compname**—is always set to the **id** of the service's **bean** element, unless the bean is inlined (that is, the bean is defined as a child element of the **service** element). Inlined beans are always anonymous.
- **service.ranking**—is automatically set, if the ranking attribute is non-zero.

Specifying a ranking attribute

If a bundle looks up a service in the service registry and finds more than one matching service, you can use ranking to determine which of the services is returned. The rule is that, whenever a lookup matches multiple services, the service with the highest rank is returned. The service rank can be any non-negative integer, with **0** being the default. You can specify the service ranking by setting the **ranking** attribute on the **service** element—for example:

```
<service ref="savings" interface="org.fusesource.example.Account"
ranking="10"/>
```

Specifying a registration listener

If you want to keep track of service registration and unregistration events, you can define a *registration listener* callback bean that receives registration and unregistration event notifications. To define a registration listener, add a **registration-listener** child element to a **service** element.

For example, the following Blueprint configuration defines a listener bean, **listenerBean**, which is referenced by a **registration-listener** element, so that the listener bean receives callbacks whenever an **Account** service is registered or unregistered:

```
<blueprint xmlns="http://www.osgi.org/xmlns/blueprint/v1.0.0" ...>
  ...
  <bean id="listenerBean" class="org.fusesource.example.Listener"/>

  <service ref="savings" auto-export="interfaces">
    <registration-listener
        ref="listenerBean"
        registration-method="register"
        unregistration-method="unregister"/>
  </service>
  ...
</blueprint>
```

Where the **registration-listener** element's **ref** attribute references the **id** of the listener bean, the **registration-method** attribute specifies the name of the listener method that receives the registration callback, and **unregistration-method** attribute specifies the name of the listener method that receives the unregistration callback.

The following Java code shows a sample definition of the **Listener** class that receives notifications of registration and unregistration events:

```
package org.fusesource.example;

public class Listener
{
    public void register(Account service, java.util.Map serviceProperties)
{
        ...
    }

    public void unregister(Account service, java.util.Map
serviceProperties) {
        ...
    }
}
```

The method names, **register** and **unregister**, are specified by the **registration-method** and **unregistration-method** attributes respectively. The signatures of these methods must conform to the following syntax:

- **First method argument**—any type T that is assignable from the service object's type. In other words, any supertype class of the service class or any interface implemented by the service class. This argument contains the service instance, unless the service bean declares the **scope** to be **prototype**, in which case this argument is **null** (when the scope is **prototype**, no service instance is available at registration time).

- **Second method argument**—must be of either `java.util.Map` type or `java.util.Dictionary` type. This map contains the service properties associated with this service registration.

21.4. IMPORTING A SERVICE

Overview

This section describes how to obtain and use references to OSGi services that have been exported to the OSGi service registry. You can use either the `reference` element or the `reference-list` element to import an OSGi service. The `reference` element is suitable for accessing **stateless** services, while the `reference-list` element is suitable for accessing **stateful** services.

Managing service references

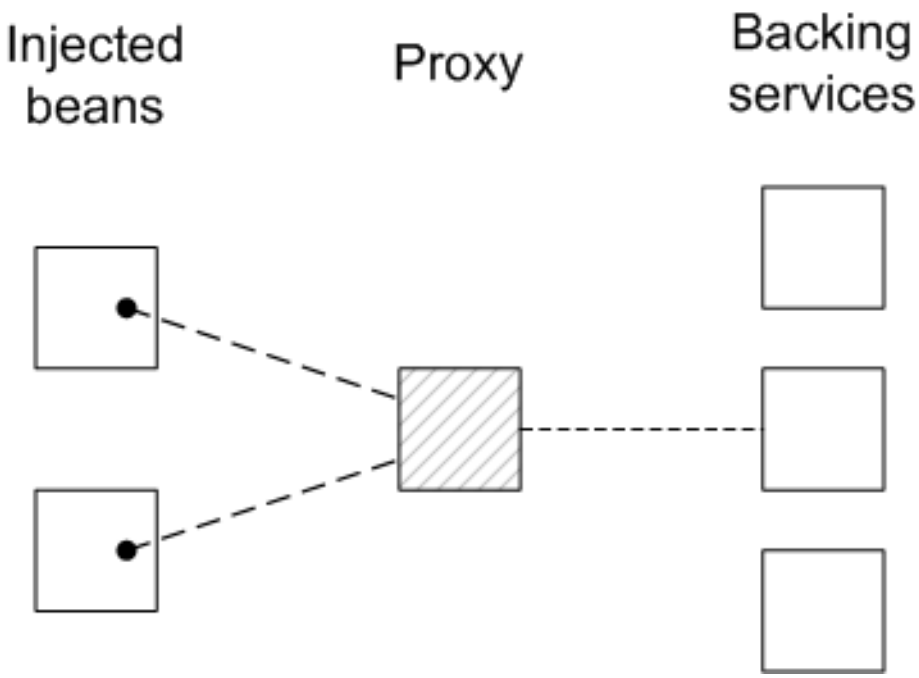
The following models for obtaining OSGi services references are supported:

- Reference manager.
- Reference list manager.

Reference manager

A *reference manager* instance is created by the Blueprint `reference` element. This element returns a single service reference and is the preferred approach for accessing **stateless** services. Figure 21.1, "Reference to Stateless Service" shows an overview of the model for accessing a stateless service using the reference manager.

Figure 21.1. Reference to Stateless Service



Beans in the client Blueprint container get injected with a proxy object (the *provided object*), which is backed by a service object (the *backing service*) from the OSGi service registry. This model explicitly takes advantage of the fact that stateless services are interchangeable, in the following ways:

- If multiple services instances are found that match the criteria in the `reference` element, the reference manager can arbitrarily choose one of them as the backing instance (because they are interchangeable).

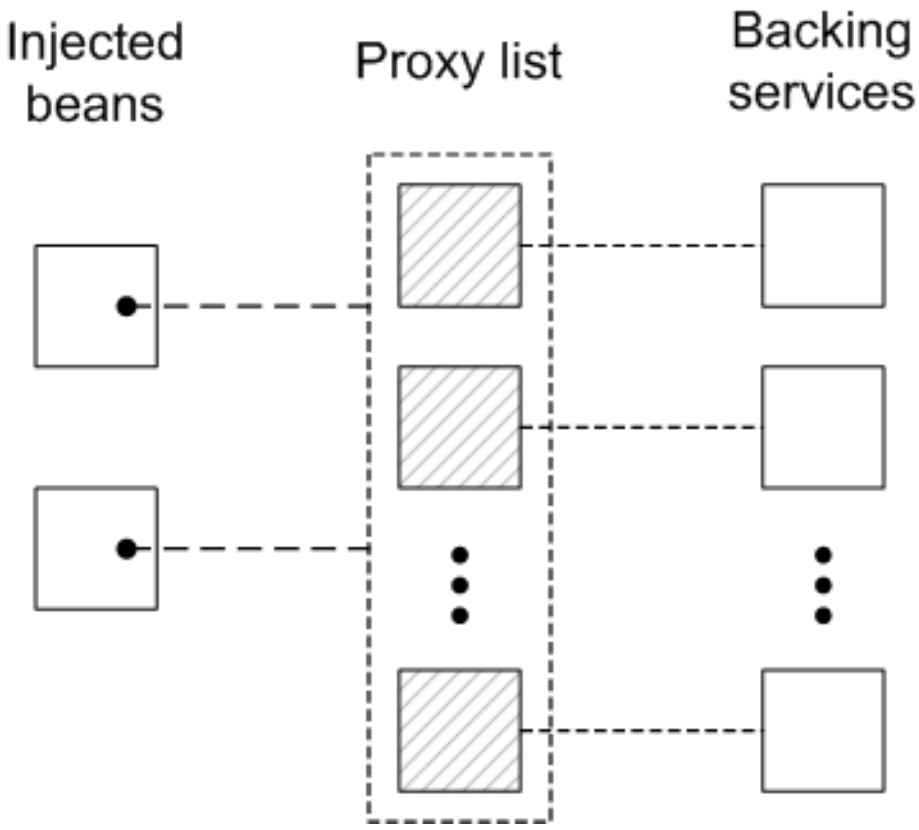
- If the backing service disappears, the reference manager can immediately switch to using one of the other available services of the same type. Hence, there is no guarantee, from one method invocation to the next, that the proxy remains connected to the same backing service.

The contract between the client and the backing service is thus **stateless**, and the client must **not** assume that it is always talking to the same service instance. If no matching service instances are available, the proxy will wait for a certain length of time before throwing the `ServiceUnavailable` exception. The length of the timeout is configurable by setting the `timeout` attribute on the `reference` element.

Reference list manager

A *reference list manager* instance is created by the Blueprint `reference-list` element. This element returns a list of service references and is the preferred approach for accessing **stateful** services. Figure 21.2, "List of References to Stateful Services" shows an overview of the model for accessing a stateful service using the reference list manager.

Figure 21.2. List of References to Stateful Services



Beans in the client Blueprint container get injected with a `java.util.List` object (the *provided object*), which contains a list of proxy objects. Each proxy is backed by a unique service instance in the OSGi service registry. Unlike the stateless model, backing services are **not** considered to be interchangeable here. In fact, the lifecycle of each proxy in the list is tightly linked to the lifecycle of the corresponding backing service: when a service gets registered in the OSGi registry, a corresponding proxy is synchronously created and added to the proxy list; and when a service gets unregistered from the OSGi registry, the corresponding proxy is synchronously removed from the proxy list.

The contract between a proxy and its backing service is thus **stateful**, and the client may assume when it invokes methods on a particular proxy, that it is always communicating with the **same** backing service. It could happen, however, that the backing service becomes unavailable, in which case the proxy becomes stale. Any attempt to invoke a method on a stale proxy will generate the `ServiceUnavailable` exception.

Matching by interface (stateless)

The simplest way to obtain a **stateles** service reference is by specifying the interface to match, using the **`interface`** attribute on the **`reference`** element. The service is deemed to match, if the **`interface`** attribute value is a super-type of the service or if the attribute value is a Java interface implemented by the service (the **`interface`** attribute can specify either a Java class or a Java interface).

For example, to reference a stateless **`SavingsAccount`** service (see Example 21.1, “Sample Service Export with a Single Interface”), define a **`reference`** element as follows:

```
<blueprint xmlns="http://www.osgi.org/xmlns/blueprint/v1.0.0">

  <reference id="savingsRef"
             interface="org.fusesource.example.SavingsAccount"/>

  <bean id="client" class="org.fusesource.example.client.Client">
    <property name="savingsAccount" ref="savingsRef"/>
  </bean>

</blueprint>
```

Where the **`reference`** element creates a reference manager bean with the ID, **`savingsRef`**. To use the referenced service, inject the **`savingsRef`** bean into one of your client classes, as shown.

The bean property injected into the client class can be any type that is assignable from **`SavingsAccount`**. For example, you could define the **`Client`** class as follows:

```
package org.fusesource.example.client;

import org.fusesource.example.SavingsAccount;

public class Client {
    SavingsAccount savingsAccount;

    // Bean properties
    public SavingsAccount getSavingsAccount() {
        return savingsAccount;
    }

    public void setSavingsAccount(SavingsAccount savingsAccount) {
        this.savingsAccount = savingsAccount;
    }
    ...
}
```

Matching by interface (stateful)

The simplest way to obtain a **stateful** service reference is by specifying the interface to match, using the **`interface`** attribute on the **`reference-list`** element. The reference list manager then obtains a list of all the services, whose **`interface`** attribute value is either a super-type of the service or a Java interface implemented by the service (the **`interface`** attribute can specify either a Java class or a Java interface).

For example, to reference a stateful **SavingsAccount** service (see Example 21.1, "Sample Service Export with a Single Interface"), define a **reference-list** element as follows:

```
<blueprint xmlns="http://www.osgi.org/xmlns/blueprint/v1.0.0">

  <reference-list id="savingsListRef"
                  interface="org.fusesource.example.SavingsAccount"/>

  <bean id="client" class="org.fusesource.example.client.Client">
    <property name="savingsAccountList" ref="savingsListRef"/>
  </bean>

</blueprint>
```

Where the **reference-list** element creates a reference list manager bean with the ID, **savingsListRef**. To use the referenced service list, inject the **savingsListRef** bean reference into one of your client classes, as shown.

By default, the **savingsAccountList** bean property is a list of service objects (for example, **java.util.List<SavingsAccount>**). You could define the client class as follows:

```
package org.fusesource.example.client;

import org.fusesource.example.SavingsAccount;

public class Client {
    java.util.List<SavingsAccount> accountList;

    // Bean properties
    public java.util.List<SavingsAccount> getSavingsAccountList() {
        return accountList;
    }

    public void setSavingsAccountList(
                    java.util.List<SavingsAccount> accountList
    ) {
        this.accountList = accountList;
    }
    ...
}
```

Matching by interface and component name

To match both the interface and the component name (bean ID) of a **stateless** service, specify both the **interface** attribute and the **component-name** attribute on the **reference** element, as follows:

```
<reference id="savingsRef"
           interface="org.fusesource.example.SavingsAccount"
           component-name="savings"/>
```

To match both the interface and the component name (bean ID) of a **stateful** service, specify both the **interface** attribute and the **component-name** attribute on the **reference-list** element, as follows:

```
<reference-list id="savingsRef"
           interface="org.fusesource.example.SavingsAccount"
           component-name="savings"/>
```

Matching service properties with a filter

You can select services by matching service properties against a filter. The filter is specified using the **filter** attribute on the **reference** element or on the **reference-list** element. The value of the **filter** attribute must be an *LDAP filter expression*. For example, to define a filter that matches when the **bank.name** service property equals **HighStreetBank**, you could use the following LDAP filter expression:

```
(bank.name=HighStreetBank)
```

To match two service property values, you can use **&** conjunction, which combines expressions with a logical **and**.For example, to require that the **foo** property is equal to **FooValue** and the **bar** property is equal to **BarValue**, you could use the following LDAP filter expression:

```
(&(foo=FooValue)(bar=BarValue))
```

For the complete syntax of LDAP filter expressions, see section 3.2.7 of the **OSGi Core Specification**.

Filters can also be combined with the **interface** and **component-name** settings, in which case all of the specified conditions are required to match.

For example, to match a **stateless** service of **SavingsAccount** type, with a **bank.name** service property equal to **HighStreetBank**, you could define a **reference** element as follows:

```
<reference id="savingsRef"
           interface="org.fusesource.example.SavingsAccount"
           filter="(bank.name=HighStreetBank)"/>
```

To match a **stateful** service of **SavingsAccount** type, with a **bank.name** service property equal to **HighStreetBank**, you could define a **reference-list** element as follows:

```
<reference-list id="savingsRef"
           interface="org.fusesource.example.SavingsAccount"
           filter="(bank.name=HighStreetBank)"/>
```

Specifying whether mandatory or optional

By default, a reference to an OSGi service is assumed to be mandatory (see Mandatory dependencies). It is possible to customize the dependency behavior of a **reference** element or a **reference-list** element by setting the **availability** attribute on the element.

There are two possible values of the **availability** attribute:

- **mandatory** (the default), means that the dependency **must** be resolved during a normal Blueprint container initialization
- **optional**, means that the dependency need **not** be resolved during initialization.

The following example of a **reference** element shows how to declare explicitly that the reference is a mandatory dependency:

```
<reference id="savingsRef"
           interface="org.fusesource.example.SavingsAccount"
           availability="mandatory"/>
```

Specifying a reference listener

To cope with the dynamic nature of the OSGi environment—for example, if you have declared some of your service references to have **optional** availability—it is often useful to track when a backing service gets bound to the registry and when it gets unbound from the registry. To receive notifications of service binding and unbinding events, you can define a **reference-listener** element as the child of either the **reference** element or the **reference-list** element.

For example, the following Blueprint configuration shows how to define a reference listener as a child of the reference manager with the ID, **savingsRef**:

```
<blueprint xmlns="http://www.osgi.org/xmlns/blueprint/v1.0.0">

  <reference id="savingsRef"
             interface="org.fusesource.example.SavingsAccount"
             >
    <reference-listener bind-method="onBind" unbind-method="onUnbind">
      <bean class="org.fusesource.example.client.Listener"/>
    </reference-listener>
  </reference>

  <bean id="client" class="org.fusesource.example.client.Client">
    <property name="savingsAcc" ref="savingsRef"/>
  </bean>

</blueprint>
```

The preceding configuration registers an instance of **org.fusesource.example.client.Listener** type as a callback that listens for **bind** and **unbind** events. Events are generated whenever the **savingsRef** reference manager's backing service binds or unbinds.

The following example shows a sample implementation of the **Listener** class:

```
package org.fusesource.example.client;

import org.osgi.framework.ServiceReference;

public class Listener {

    public void onBind(ServiceReference ref) {
        System.out.println("Bound service: " + ref);
    }

    public void onUnbind(ServiceReference ref) {
        System.out.println("Unbound service: " + ref);
    }

}
```

The method names, **onBind** and **onUnbind**, are specified by the **bind-method** and **unbind-method** attributes respectively. Both of these callback methods take an **org.osgi.framework.ServiceReference** argument.

CHAPTER 22. PUBLISHING AN OSGI SERVICE

22.1. OVERVIEW

This section explains how to generate, build, and deploy a simple OSGi service in the OSGi container. The service is a simple **Hello World** Java class and the OSGi configuration is defined using a Blueprint configuration file.

22.2. PREREQUISITES

In order to generate a project using the Maven Quickstart archetype, you must have the following prerequisites:

- **Maven installation**—Maven is a free, open source build tool from Apache. You can download the latest version from http://maven.apache.org/download.html (minimum is 2.0.9).
- **Internet connection**—whilst performing a build, Maven dynamically searches external repositories and downloads the required artifacts on the fly. In order for this to work, your build machine **must** be connected to the Internet.

22.3. GENERATING A MAVEN PROJECT

The **`maven-archetype-quickstart`** archetype creates a generic Maven project, which you can then customize for whatever purpose you like. To generate a Maven project with the coordinates, **`org.fusesource.example:osgi-service`**, enter the following command:

```
mvn archetype:create
-DarchetypeArtifactId=maven-archetype-quickstart
-DgroupId=org.fusesource.example
-DartifactId=osgi-service
```

The result of this command is a directory, ***`ProjectDir`*`/osgi-service`**, containing the files for the generated project.

NOTE

Be careful not **to choose a group ID for your artifact that clashes with the group ID of an existing product!** This could lead to clashes between your project's packages and the packages from the existing product (because the group ID is typically used as the root of a project's Java package names).

22.4. CUSTOMIZING THE POM FILE

You must customize the POM file in order to generate an OSGi bundle, as follows:

1. Follow the POM customization steps described in Section 3.1, "Generating a Bundle Project".
2. In the configuration of the Maven bundle plug-in, modify the bundle instructions to export the **`org.fusesource.example.service`** package, as follows:

```
<project ... >
  ...
  <build>
```

```
    ...
    <plugins>
      ...
      <plugin>
        <groupId>org.apache.felix</groupId>
        <artifactId>maven-bundle-plugin</artifactId>
        <extensions>true</extensions>
        <configuration>
          <instructions>
            <Bundle-SymbolicName>${pom.groupId}.${pom.artifactId}
</Bundle-SymbolicName>
        <Export-Package>org.fusesource.example.service</Export-
Package>
          </instructions>
        </configuration>
      </plugin>
    </plugins>
  </build>
  ...
</project>
```

22.5. WRITING THE SERVICE INTERFACE

Create the ***ProjectDir*/osgi-service/src/main/java/org/fusesource/example/service** sub-directory. In this directory, use your favorite text editor to create the file, **HelloWorldSvc.java**, and add the code from Example 22.1, "The HelloWorldSvc Interface" to it.

Example 22.1. The HelloWorldSvc Interface

```
package org.fusesource.example.service;

public interface HelloWorldSvc
{
    public void sayHello();
}
```

22.6. WRITING THE SERVICE CLASS

Create the ***ProjectDir*/osgi-service/src/main/java/org/fusesource/example/service/impl** sub-directory. In this directory, use your favorite text editor to create the file, **HelloWorldSvcImpl.java**, and add the code from Example 22.2, "The HelloWorldSvcImpl Class" to it.

Example 22.2. The HelloWorldSvcImpl Class

```
package org.fusesource.example.service.impl;

import org.fusesource.example.service.HelloWorldSvc;

public class HelloWorldSvcImpl implements HelloWorldSvc {

    public void sayHello()
```

```
    {
        System.out.println( "Hello World!" );
    }

}
```

22.7. WRITING THE BLUEPRINT FILE

The Blueprint configuration file is an XML file stored under the **OSGI-INF/blueprint** directory on the class path. To add a Blueprint file to your project, first create the following sub-directories:

```
ProjectDir/osgi-service/src/main/resources
ProjectDir/osgi-service/src/main/resources/OSGI-INF
ProjectDir/osgi-service/src/main/resources/OSGI-INF/blueprint
```

Where the **src/main/resources** is the standard Maven location for all JAR resources. Resource files under this directory will automatically be packaged in the root scope of the generated bundle JAR.

Example 22.3, "Blueprint File for Exporting a Service" shows a sample Blueprint file that creates a **HelloWorldSvc** bean, using the **bean** element, and then exports the bean as an OSGi service, using the **service** element.

Under the ***ProjectDir*/osgi-service/src/main/resources/OSGI-INF/blueprint** directory, use your favorite text editor to create the file, **config.xml**, and add the XML code from Example 22.3, "Blueprint File for Exporting a Service".

Example 22.3. Blueprint File for Exporting a Service

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

  <bean id="hello"
class="org.fusesource.example.service.impl.HelloWorldSvcImpl"/>

  <service ref="hello"
interface="org.fusesource.example.service.HelloWorldSvc"/>

</blueprint>
```

22.8. RUNNING THE SERVICE BUNDLE

To install and run the **osgi-service** project, perform the following steps:

1. **Build the project**—open a command prompt and change directory to ***ProjectDir*/osgi-service**. Use Maven to build the demonstration by entering the following command:

   ```
   mvn install
   ```

If this command runs successfully, the ***ProjectDir*/osgi-service/target** directory should contain the bundle file, **osgi-service-1.0-SNAPSHOT.jar**.

2. **Install and start the osgi-service bundle** —at the Red Hat JBoss Fuse console, enter the following command:

```
JBossFuse:karaf@root> osgi:install -s file:ProjectDir/osgi-
service/target/osgi-service-1.0-SNAPSHOT.jar
```

Where *ProjectDir* is the directory containing your Maven projects and the **-s** flag directs the container to start the bundle right away. For example, if your project directory is **C:\Projects** on a Windows machine, you would enter the following command:

```
JBossFuse:karaf@root> osgi:install -s file:C:/Projects/osgi-
service/target/osgi-service-1.0-SNAPSHOT.jar
```

NOTE

On Windows machines, be careful how you format the **file** URL—for details of the syntax understood by the **file** URL handler, see Section A.1, "File URL Handler".

3. **Check that the service has been created** —to check that the bundle has started successfully, enter the following Red Hat JBoss Fuse console command:

```
JBossFuse:karaf@root> osgi:list
```

Somewhere in this listing, you should see a line for the **osgi-service** bundle, for example:

```
[ 236] [Active     ] [Created     ] [       ] [   60] osgi-service
(1.0.0.SNAPSHOT)
```

To check that the service is registered in the OSGi service registry, enter a console command like the following:

```
JBossFuse:karaf@root> osgi:ls 236
```

Where the argument to the preceding command is the **osgi-service** bundle ID. You should see some output like the following at the console:

```
osgi-service (236) provides:
----------------------------
osgi.service.blueprint.compname = hello
objectClass = org.fusesource.example.service.HelloWorldSvc
service.id = 272

osgi.blueprint.container.version = 1.0.0.SNAPSHOT
osgi.blueprint.container.symbolicname = org.fusesource.example.osgi-
service
objectClass =
org.osgi.service.blueprint.container.BlueprintContainer
service.id = 273
```

CHAPTER 23. ACCESSING AN OSGI SERVICE

23.1. OVERVIEW

This section explains how to generate, build, and deploy a simple OSGi client in the OSGi container. The client finds the simple Hello World service in the OSGi registry and invokes the **`sayHello()`** method on it.

23.2. PREREQUISITES

In order to generate a project using the Maven Quickstart archetype, you must have the following prerequisites:

- **Maven installation**—Maven is a free, open source build tool from Apache. You can download the latest version from http://maven.apache.org/download.html (minimum is 2.0.9).
- **Internet connection**—whilst performing a build, Maven dynamically searches external repositories and downloads the required artifacts on the fly. In order for this to work, your build machine **must** be connected to the Internet.

23.3. GENERATING A MAVEN PROJECT

The **`maven-archetype-quickstart`** archetype creates a generic Maven project, which you can then customize for whatever purpose you like. To generate a Maven project with the coordinates, **`org.fusesource.example:osgi-client`**, enter the following command:

```
mvn archetype:create
-DarchetypeArtifactId=maven-archetype-quickstart
-DgroupId=org.fusesource.example
-DartifactId=osgi-client
```

The result of this command is a directory, ***`ProjectDir`*`/osgi-client`**, containing the files for the generated project.

NOTE

Be careful not **to choose a group ID for your artifact that clashes with the group ID of an existing product!** This could lead to clashes between your project's packages and the packages from the existing product (because the group ID is typically used as the root of a project's Java package names).

23.4. CUSTOMIZING THE POM FILE

You must customize the POM file in order to generate an OSGi bundle, as follows:

1. Follow the POM customization steps described in Section 3.1, "Generating a Bundle Project".
2. Because the client uses the **`HelloWorldSvc`** Java interface, which is defined in the **`osgi-service`** bundle, it is necessary to add a Maven dependency on the **`osgi-service`** bundle. Assuming that the Maven coordinates of the **`osgi-service`** bundle are **`org.fusesource.example:osgi-service:1.0-SNAPSHOT`**, you should add the following dependency to the client's POM file:

```
<project ... >
  ...
  <dependencies>
    ...
    <dependency>
        <groupId>org.fusesource.example</groupId>
        <artifactId>osgi-service</artifactId>
        <version>1.0-SNAPSHOT</version>
    </dependency>
  </dependencies>
  ...
</project>
```

23.5. WRITING THE BLUEPRINT FILE

To add a Blueprint file to your client project, first create the following sub-directories:

```
ProjectDir/osgi-client/src/main/resources
ProjectDir/osgi-client/src/main/resources/OSGI-INF
ProjectDir/osgi-client/src/main/resources/OSGI-INF/blueprint
```

Under the ***ProjectDir*/osgi-client/src/main/resources/OSGI-INF/blueprint** directory, use your favorite text editor to create the file, **config.xml**, and add the XML code from Example 23.1, "Blueprint File for Importing a Service".

Example 23.1. Blueprint File for Importing a Service

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

  <reference id="helloWorld"
        interface="org.fusesource.example.service.HelloWorldSvc"/>

  <bean id="client"
        class="org.fusesource.example.client.Client"
        init-method="init">
    <property name="helloWorldSvc" ref="helloWorld"/>
  </bean>

</blueprint>
```

Where the **reference** element creates a reference manager that finds a service of **HelloWorldSvc** type in the OSGi registry. The **bean** element creates an instance of the **Client** class and injects the service reference as the bean property, **helloWorldSvc**. In addition, the **init-method** attribute specifies that the **Client.init()** method is called during the bean initialization phase (that is, **after** the service reference has been injected into the client bean).

23.6. WRITING THE CLIENT CLASS

Under the ***ProjectDir*/osgi-client/src/main/java/org/fusesource/example/client** directory, use your favorite text editor to create the file, **Client.java**, and add the Java code from Example 23.2, "The Client Class".

Example 23.2. The Client Class

```
package org.fusesource.example.client;

import org.fusesource.example.service.HelloWorldSvc;

public class Client {
    HelloWorldSvc helloWorldSvc;

    // Bean properties
    public HelloWorldSvc getHelloWorldSvc() {
        return helloWorldSvc;
    }

    public void setHelloWorldSvc(HelloWorldSvc helloWorldSvc) {
        this.helloWorldSvc = helloWorldSvc;
    }

    public void init() {
        System.out.println("OSGi client started.");
        if (helloWorldSvc != null) {
            System.out.println("Calling sayHello()");
            helloWorldSvc.sayHello();  // Invoke the OSGi service!
        }
    }

}
```

The **Client** class defines a getter and a setter method for the **helloWorldSvc** bean property, which enables it to receive the reference to the Hello World service by injection. The **init()** method is called during the bean initialization phase, after property injection, which means that it is normally possible to invoke the Hello World service within the scope of this method.

23.7. RUNNING THE CLIENT BUNDLE

To install and run the **osgi-client** project, perform the following steps:

1. **Build the project**—open a command prompt and change directory to ***ProjectDir*/osgi-client**. Use Maven to build the demonstration by entering the following command:

   ```
   mvn install
   ```

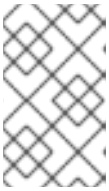
   If this command runs successfully, the ***ProjectDir*/osgi-client/target** directory should contain the bundle file, **osgi-client-1.0-SNAPSHOT.jar**.

2. **Install and start the osgi-service bundle** —at the Red Hat JBoss Fuse console, enter the following command:

```
JBossFuse:karaf@root> osgi:install -s file:ProjectDir/osgi-
client/target/osgi-client-1.0-SNAPSHOT.jar
```

Where *ProjectDir* is the directory containing your Maven projects and the **-s** flag directs the container to start the bundle right away. For example, if your project directory is **C:\Projects** on a Windows machine, you would enter the following command:

```
JBossFuse:karaf@root> osgi:install -s file:C:/Projects/osgi-
client/target/osgi-client-1.0-SNAPSHOT.jar
```



NOTE

On Windows machines, be careful how you format the **file** URL—for details of the syntax understood by the **file** URL handler, see Section A.1, “File URL Handler”.

3. **Client output**—f the client bundle is started successfully, you should immediately see output like the following in the console:

```
Bundle ID: 239
OSGi client started.
Calling sayHello()
Hello World!
```

CHAPTER 24. INTEGRATION WITH APACHE CAMEL

24.1. OVERVIEW

Apache Camel provides a simple way to invoke OSGi services using the Bean language. This feature is automatically available whenever a Apache Camel application is deployed into an OSGi container and requires no special configuration.

24.2. REGISTRY CHAINING

When a Apache Camel route is deployed into the OSGi container, the **`CamelContext`** automatically sets up a registry chain for resolving bean instances: the registry chain consists of the OSGi registry, followed by the Blueprint registry. Now, if you try to reference a particular bean class or bean instance, the registry resolves the bean as follows:

1. Look up the bean in the OSGi registry first. If a class name is specified, try to match this with the interface or class of an OSGi service.
2. If no match is found in the OSGi registry, fall back on the Blueprint registry.

24.3. SAMPLE OSGI SERVICE INTERFACE

Consider the OSGi service defined by the following Java interface, which defines the single method, **`getGreeting()`**:

```
package org.fusesource.example.hello.boston;

public interface HelloBoston {
    public String getGreeting();
}
```

24.4. SAMPLE SERVICE EXPORT

When defining the bundle that implements the **`HelloBoston`** OSGi service, you could use the following Blueprint configuration to export the service:

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

  <bean id="hello"
class="org.fusesource.example.hello.boston.HelloBostonImpl"/>

  <service ref="hello"
interface="org.fusesource.example.hello.boston.HelloBoston"/>

</blueprint>
```

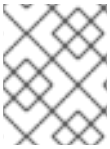
Where it is assumed that the **`HelloBoston`** interface is implemented by the **`HelloBostonImpl`** class (not shown).

24.5. INVOKING THE OSGI SERVICE FROM JAVA DSL

After you have deployed the bundle containing the **HelloBoston** OSGi service, you can invoke the service from a Apache Camel application using the Java DSL. In the Java DSL, you invoke the OSGi service through the Bean language, as follows:

```
from("timer:foo?period=5000")
  .bean(org.fusesource.example.hello.boston.HelloBoston.class,
"getGreeting")
  .log("The message contains: ${body}")
```

In the **bean** command, the first argument is the OSGi interface or class, which must match the interface exported from the OSGi service bundle. The second argument is the name of the bean method you want to invoke. For full details of the **bean** command syntax, see olink:CamelDev/BasicPrinciples-BeanIntegration.



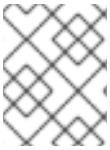
NOTE

When you use this approach, the OSGi service is implicitly imported. It is **not** necessary to import the OSGi service explicitly in this case.

24.6. INVOKING THE OSGI SERVICE FROM XML DSL

In the XML DSL, you can also use the Bean language to invoke the **HelloBoston** OSGi service, but the syntax is slightly different. In the XML DSL, you invoke the OSGi service through the Bean language, using the **method** element, as follows:

```
<beans ...>
  <camelContext xmlns="http://camel.apache.org/schema/spring">
    <route>
      <from uri="timer:foo?period=5000"/>
      <setBody>
          <method ref="org.fusesource.example.hello.boston.HelloBoston"
method="getGreeting"/>
      </setBody>
      <log message="The message contains: ${body}"/>
    </route>
  </camelContext>
</beans>
```



NOTE

When you use this approach, the OSGi service is implicitly imported. It is **not** necessary to import the OSGi service explicitly in this case.

CHAPTER 25. DEPLOYING USING A JMS BROKER

Abstract

The OSGi specification supports modular application development by defining a runtime framework that simplifies building, deploying, and managing complex applications.

APPENDIX A. URL HANDLERS

Abstract

There are many contexts in Red Hat JBoss Fuse where you need to provide a URL to specify the location of a resource (for example, as the argument to a console command). In general, when specifying a URL, you can use any of the schemes supported by JBoss Fuse's built-in URL handlers. This appendix describes the syntax for all of the available URL handlers.

A.1. FILE URL HANDLER

SYNTAX

A file URL has the syntax, **`file:`***PathName*, where *PathName* is the relative or absolute pathname of a file that is available on the Classpath. The provided *PathName* is parsed by Java's built-in file *URL handler*. Hence, the *PathName* syntax is subject to the usual conventions of a Java pathname: in particular, on Windows, each backslash must either be escaped by another backslash or replaced by a forward slash.

EXAMPLES

For example, consider the pathname, **`C:\Projects\camel-bundle\target\foo-1.0-SNAPSHOT.jar`**, on Windows. The following example shows the **correct** alternatives for the file URL on Windows:

```
file:C:/Projects/camel-bundle/target/foo-1.0-SNAPSHOT.jar
file:C:\\Projects\\camel-bundle\\target\\foo-1.0-SNAPSHOT.jar
```

The following example shows some **incorrect** alternatives for the file URL on Windows:

```
file:C:\Projects\camel-bundle\target\foo-1.0-SNAPSHOT.jar         // WRONG!
file://C:/Projects/camel-bundle/target/foo-1.0-SNAPSHOT.jar      // WRONG!
file://C:\\Projects\\camel-bundle\\target\\foo-1.0-SNAPSHOT.jar  // WRONG!
```

CHAPTER 26. HTTP URL HANDLER

SYNTAX

A HTTP URL has the standard syntax, **`http:`*`Host`*`[:`*`Port`*`]/[`*`Path`*`][#`*`AnchorName`*`][?`*`Query`*`]`**. You can also specify a secure HTTP URL using the **`https`** scheme. The provided HTTP URL is parsed by Java's built-in HTTP URL handler, so the HTTP URL behaves in the normal way for a Java application.

CHAPTER 27. MVN URL HANDLER

OVERVIEW

If you use Maven to build your bundles or if you know that a particular bundle is available from a Maven repository, you can use the Mvn handler scheme to locate the bundle.

NOTE

To ensure that the Mvn URL handler can find local and remote Maven artifacts, you might find it necessary to customize the Mvn URL handler configuration. For details, see the section called “Configuring the Mvn URL handler” .

SYNTAX

An Mvn URL has the following syntax:

```
mvn:[repositoryUrl!]groupId/artifactId[/[version][/[packaging]
[/[classifier]]]]
```

Where *repositoryUrl* optionally specifies the URL of a Maven repository. The *groupId*, *artifactId*, *version*, *packaging*, and *classifier* are the standard Maven coordinates for locating Maven artifacts.

OMITTING COORDINATES

When specifying an Mvn URL, only the *groupId* and the *artifactId* coordinates are required. The following examples reference a Maven bundle with the *groupId*, **`org.fusesource.example`**, and with the *artifactId*, **`bundle-demo`**:

```
mvn:org.fusesource.example/bundle-demo
mvn:org.fusesource.example/bundle-demo/1.1
```

When the *version* is omitted, as in the first example, it defaults to **LATEST**, which resolves to the latest version based on the available Maven metadata.

In order to specify a *classifier* value without specifying a *packaging* or a *version* value, it is permissible to leave gaps in the Mvn URL. Likewise, if you want to specify a *packaging* value without a *version* value. For example:

```
mvn:groupId/artifactId///classifier
mvn:groupId/artifactId/version//classifier
mvn:groupId/artifactId//packaging/classifier
mvn:groupId/artifactId//packaging
```

SPECIFYING A VERSION RANGE

When specifying the *version* value in an Mvn URL, you can specify a version range (using standard Maven version range syntax) in place of a simple version number. You use square brackets—**`[`** and **`]`**—to denote inclusive ranges and parentheses—**`(`** and **`)`**—to denote exclusive ranges. For example, the range, **`[1.0.4,2.0)`**, matches any version, **`v`**, that satisfies **`1.0.4 ⇐ v < 2.0`**. You can use this version range in an Mvn URL as follows:

```
mvn:org.fusesource.example/bundle-demo/[1.0.4,2.0)
```

CONFIGURING THE MVN URL HANDLER

Before using Mvn URLs for the first time, you might need to customize the Mvn URL handler settings, as follows:

1. the section called “Check the Mvn URL settings” .
2. the section called “Edit the configuration file” .
3. the section called “Customize the location of the local repository” .

CHECK THE MVN URL SETTINGS

The Mvn URL handler resolves a reference to a local Maven repository and maintains a list of remote Maven repositories. When resolving an Mvn URL, the handler searches first the local repository and then the remote repositories in order to locate the specified Maven artifiact. If there is a problem with resolving an Mvn URL, the first thing you should do is to check the handler settings to see which local repository and remote repositories it is using to resolve URLs.

To check the Mvn URL settings, enter the following commands at the console:

```
JBossFuse:karaf@root> config:edit org.ops4j.pax.url.mvn
JBossFuse:karaf@root> config:proplist
```

The **config:edit** command switches the focus of the **config** utility to the properties belonging to the **org.ops4j.pax.url.mvn** persistent ID. The **config:proplist** command outputs all of the property settings for the current persistent ID. With the focus on **org.ops4j.pax.url.mvn**, you should see a listing similar to the following:

```
   org.ops4j.pax.url.mvn.defaultRepositories =
file:/path/to/JBossFuse/jboss-fuse-7.0.0.fuse-000163-redhat-
2/system@snapshots@id=karaf.system,file:/home/userid/.m2/repository@snapsh
ots@id=local,file:/path/to/JBossFuse/jboss-fuse-7.0.0.fuse-000163-redhat-
2/local-repo@snapshots@id=karaf.local-repo,file:/path/to/JBossFuse/jboss-
fuse-7.0.0.fuse-000163-redhat-2/system@snapshots@id=child.karaf.system
   org.ops4j.pax.url.mvn.globalChecksumPolicy = warn
   org.ops4j.pax.url.mvn.globalUpdatePolicy = daily
   org.ops4j.pax.url.mvn.localRepository = /path/to/JBossFuse/jboss-fuse-
7.0.0.fuse-000163-redhat-2/data/repository
   org.ops4j.pax.url.mvn.repositories =
http://repo1.maven.org/maven2@id=maven.central.repo,
https://maven.repository.redhat.com/ga@id=redhat.ga.repo,
https://maven.repository.redhat.com/earlyaccess/all@id=redhat.ea.repo,
https://repository.jboss.org/nexus/content/groups/ea@id=fuseearlyaccess
   org.ops4j.pax.url.mvn.settings =
/home/fbolton/Programs/JBossFuse/jboss-fuse-7.0.0.fuse-000163-redhat-
2/etc/maven-settings.xml
   org.ops4j.pax.url.mvn.useFallbackRepositories = false
   service.pid = org.ops4j.pax.url.mvn
```

Where the **localRepository** setting shows the local repository location currently used by the handler and the **repositories** setting shows the remote repository list currently used by the

handler.

EDIT THE CONFIGURATION FILE

To customize the property settings for the Mvn URL handler, edit the following configuration file:

```
InstallDir/etc/org.ops4j.pax.url.mvn.cfg
```

The settings in this file enable you to specify explicitly the location of the local Maven repository, remove Maven repositories, Maven proxy server settings, and more. Please see the comments in the configuration file for more details about these settings.

CUSTOMIZE THE LOCATION OF THE LOCAL REPOSITORY

In particular, if your local Maven repository is in a non-default location, you might find it necessary to configure it explicitly in order to access Maven artifacts that you build locally. In your **`org.ops4j.pax.url.mvn.cfg`** configuration file, uncomment the **`org.ops4j.pax.url.mvn.localRepository`** property and set it to the location of your local Maven repository. For example:

```
# Path to the local maven repository which is used to avoid downloading
# artifacts when they already exist locally.
# The value of this property will be extracted from the settings.xml file
# above, or defaulted to:
#     System.getProperty( "user.home" ) + "/.m2/repository"
#
org.ops4j.pax.url.mvn.localRepository=file:E:/Data/.m2/repository
```

REFERENCE

For more details about the **mvn** URL syntax, see the original Pax URL Mvn Protocol documentation.

CHAPTER 28. WRAP URL HANDLER

OVERVIEW

If you need to reference a JAR file that is not already packaged as a bundle, you can use the Wrap URL handler to convert it dynamically. The implementation of the Wrap URL handler is based on Peter Krien's open source Bnd utility.

SYNTAX

A Wrap URL has the following syntax:

```
wrap:locationURL[,instructionsURL][$instructions]
```

The *locationURL* can be any URL that locates a JAR (where the referenced JAR is **not** formatted as a bundle). The optional *instructionsURL* references a Bnd properties file that specifies how the bundle conversion is performed. The optional *instructions* is an ampersand, **&**, delimited list of Bnd properties that specify how the bundle conversion is performed.

DEFAULT INSTRUCTIONS

In most cases, the default Bnd instructions are adequate for wrapping an API JAR file. By default, Wrap adds manifest headers to the JAR's **`META-INF/Manifest.mf`** file as shown in Table 28.1, "Default Instructions for Wrapping a JAR".

Table 28.1. Default Instructions for Wrapping a JAR

Manifest Header	Default Value
`Import-Package`	**`*;resolution:=optional`**
`Export-Package`	All packages from the wrapped JAR.
`Bundle-SymbolicName`	The name of the JAR file, where any characters not in the set **`[a-zA-Z0-9_-]`** are replaced by underscore, _.

EXAMPLES

The following Wrap URL locates version 1.1 of the **`commons-logging`** JAR in a Maven repository and converts it to an OSGi bundle using the default Bnd properties:

```
wrap:mvn:commons-logging/commons-logging/1.1
```

The following Wrap URL uses the Bnd properties from the file, **`E:\Data\Examples\commons-logging-1.1.bnd`**:

```
wrap:mvn:commons-logging/commons-
logging/1.1,file:E:/Data/Examples/commons-logging-1.1.bnd
```

The following Wrap URL specifies the **`Bundle-SymbolicName`** property and the **`Bundle-Version`** property explicitly:

```
wrap:mvn:commons-logging/commons-logging/1.1$Bundle-SymbolicName=apache-comm-log&Bundle-Version=1.1
```

If the preceding URL is used as a command-line argument, it might be necessary to escape the dollar sign, **`\$`**, to prevent it from being processed by the command line, as follows:

```
wrap:mvn:commons-logging/commons-logging/1.1\$Bundle-SymbolicName=apache-comm-log&Bundle-Version=1.1
```

REFERENCE

For more details about the **`wrap`** URL handler, see the following references:

- The Bnd tool documentation, for more details about Bnd properties and Bnd instruction files.
- The original Pax URL Wrap Protocol documentation.

CHAPTER 29. WAR URL HANDLER

OVERVIEW

If you need to deploy a WAR file in an OSGi container, you can automatically add the requisite manifest headers to the WAR file by prefixing the WAR URL with **`war:`**, as described here.

SYNTAX

A War URL is specified using either of the following syntaxes:

```
war:warURL
warref:instructionsURL
```

The first syntax, using the **`war`** scheme, specifies a WAR file that is converted into a bundle using the default instructions. The *warURL* can be any URL that locates a WAR file.

The second syntax, using the **`warref`** scheme, specifies a Bnd properties file, *instructionsURL*, that contains the conversion instructions (including some instructions that are specific to this handler). In this syntax, the location of the referenced WAR file does **not** appear explicitly in the URL. The WAR file is specified instead by the (mandatory) **`WAR-URL`** property in the properties file.

WAR-SPECIFIC PROPERTIES/INSTRUCTIONS

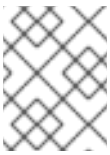
Some of the properties in the **`.bnd`** instructions file are specific to the War URL handler, as follows:

`WAR-URL`

(Mandatory) Specifies the location of the War file that is to be converted into a bundle.

`Web-ContextPath`

Specifies the piece of the URL path that is used to access this Web application, after it has been deployed inside the Web container.



NOTE

Earlier versions of PAX Web used the property, **`Webapp-Context`**, which is now **deprecated**.

DEFAULT INSTRUCTIONS

By default, the War URL handler adds manifest headers to the WAR's **`META-INF/Manifest.mf`** file as shown in Table 29.1, "Default Instructions for Wrapping a WAR File" .

Table 29.1. Default Instructions for Wrapping a WAR File

Manifest Header	Default Value
`Import-Package`	**`javax.,org.xml.,org.w3c.*`**

Manifest Header	Default Value
Export-Package	No packages are exported.
Bundle-SymbolicName	The name of the WAR file, where any characters not in the set **[a-zA-Z0-9_-\.]** are replaced by period, **.**
Web-ContextPath	No default value. But the *WAR extender* will use the value of **Bundle-SymbolicName** by default.
Bundle-ClassPath	In addition to any class path entries specified explicitly, the following entries are added automatically: • **.** • **WEB-INF/classes** • All of the JARs from the **WEB-INF/lib** directory.

EXAMPLES

The following War URL locates version 1.4.7 of the **wicket-examples** WAR in a Maven repository and converts it to an OSGi bundle using the default instructions:

```
war:mvn:org.apache.wicket/wicket-examples/1.4.7/war
```

The following Wrap URL specifies the **Web-ContextPath** explicitly:

```
war:mvn:org.apache.wicket/wicket-examples/1.4.7/war?Web-ContextPath=wicket
```

The following War URL converts the WAR file referenced by the **WAR-URL** property in the **wicket-examples-1.4.7.bnd** file and then converts the WAR into an OSGi bundle using the other instructions in the **.bnd** file:

```
warref:file:E:/Data/Examples/wicket-examples-1.4.7.bnd
```

REFERENCE

For more details about the **war** URL syntax, see the original Pax URL War Protocol documentation.

PART III. USER GUIDE

This part contains configuration and preparation information for Apache Karaf on Red Hat JBoss Fuse.

CHAPTER 30. INTRODUCTION TO THE DEPLOYING INTO APACHE KARAF USER GUIDE PART

Abstract

Before you use this User Guide part of the Deploying into Apache Karaf guide, you must have installed the latest version of Red Hat JBoss Fuse, following the instructions in Installing on Apache Karaf.

30.1. DIRECTORY STRUCTURE

The directory layout of a Karaf installation is as follows:

- **`/bin`**: control scripts to start, stop, login, ...
- **`/demos`**: contains some simple Karaf samples
- **`/etc`**: configuration files
- **`/data`**: working directory
  - **`/data/cache`**: OSGi framework bundle cache
  - **`/data/generated-bundles`**: temporary folder used by the deployers
  - **`/data/log`**: log files
- **`/deploy`**: hot deploy directory
- **`/instances`**: directory containing [instances|instances]
- **`/lib`**: contains libraries
  - **`/lib/boot`**: contains the systeù libraries used at Karaf bootstrap
  - **`/lib/endorsed`**: directory for endorsed libraries
  - **`/lib/ext`**: directory for JRE extensions
- **`/system`**: OSGi bundles repository, laid out as a Maven 2 repository

NOTE

The **`data`** folder contains all the working and temporary files for Karaf. If you want to restart from a clean state, you can wipe out this directory, which has the same effect as using the clean option to the Karaf start.

CHAPTER 31. CONFIGURATION

31.1. FILES

Apache Karaf stores and loads all configuration in files located in the **etc** folder.

By default, the **etc** folder is located relatively to the **KARAF_BASE** folder. You can define another location using the **KARAF_ETC** variable.

Each configuration is identified by a ID (the ConfigAdmin PID). The configuration files name follows the **pid.cfg** name convention.

For instance, **etc/org.apache.karaf.shell.cfg** means that this file is the file used by the configuration with **org.apache.karaf.shell** as PID.

A configuration file is a properties file containing key/value pairs:

```
property=value
```

Properties can be referenced inside configuration files using the syntax **${<name>}**. Default and alternate values can be specified using **${<name>:-<default_value>}** and **${<name>:+<alternate_value>}** syntaxes respectively.

```
existing_property=baz
property1=${missing_property:-foo}   # "foo"
property2=${missing_property:+foo}   # empty string
property3=${existing_property:-bar}  # "baz"
property4=${existing_property:+bar}  # "bar"
```

Environment variables can be referenced inside configuration files using the syntax **${env:<name>}** (e.g. **property=${env:FOO}** will set "property" to the value of the enviroment variable "FOO"). Default and alternate values can be defined for them as well using the same syntax as above.

In Apache Karaf, a configuration is PID with a set of properties attached.

Apache Karaf automatically loads all ***.cfg** files from the **etc** folder.

You can configure the behaviour of the configuration files using some dedicated properties in the **etc/config.properties** configuration file:

```
...
#
# Configuration FileMonitor properties
#
felix.fileinstall.enableConfigSave = true
felix.fileinstall.dir    = ${karaf.etc}
felix.fileinstall.filter = .*\\.(cfg|config)
felix.fileinstall.poll   = 1000
felix.fileinstall.noInitialDelay = true
felix.fileinstall.log.level = 3
felix.fileinstall.log.default = jul
...
```

- **`felix.fileinstall.enableConfigSave`** flush back in the configuration file the changes performed directly on the configuration service (ConfigAdmin). If **`true`**, any change (using **`config:*`** commands, MBeans, OSGi service) is persisted back in the configuration false. Default is **`true`**.
- **`felix.fileinstall.dir`** is the directory where Apache Karaf is looking for configuration files. Default is **`${karaf.etc}`** meaning the value of the **`KARAF_ETC`** variable.
- **`felix.fileinstall.filter`** is the file name pattern used to load only some configuration files. Only files matching the pattern will be loaded. Default value is **`.*\\.(cfg|config)`** meaning *.cfg and *.config files.
- **`felix.fileinstall.poll`** is the polling interval (in milliseconds). Default value is **`1000`** meaning that Apache Karaf "re-loads" the configuration files every second.
- **`felix.fileinstall.noInitialDelay`** is a flag indicating if the configuration file polling starts as soon as Apache Karaf starts or wait for a certain time. If **`true`**, Apache Karaf polls the configuration files as soon as the configuration service starts.
- **`felix.fileinstall.log.level`** is the log message verbosity level of the configuration polling service. More this value is high, more verbose the configuration service is.
- **`felix.fileinstall.log.default`** is the logging framework to use, **`jul`** meaning Java Util Logging.

You can change the configuration at runtime by directly editing the configuration file.

You can also do the same using the **`config:*`** commands or the ConfigMBean.

31.1.1. `config:*` commands

Apache Karaf provides a set of commands to manage the configuration.

31.1.1.1. `config:list`

`config:list` displays the list of all configurations available, or the properties in a given configuration (PID).

Without the **`query`** argument, the **`config:list`** command display all configurations, with PID, attached bundle and properties defined in the configuration:

```
karaf@root()> config:list
----------------------------------------------------------------
Pid:            org.apache.karaf.service.acl.command.system.start-level
BundleLocation:
mvn:org.apache.karaf.shell/org.apache.karaf.shell.console/4.0.0
Properties:
   service.guard = (&(osgi.command.scope=system)
(osgi.command.function=start-level))
   * = *
   start-level = admin                          # admin can set any
start level, including < 100
   start-level[/[^0-9]*/] = viewer              # viewer can obtain the
current start level
   execute[/.*/,/[^0-9]*/] = viewer              # viewer can obtain the
```

```
current start level
   execute = admin                              # admin can set any start
level, including < 100
   service.pid = org.apache.karaf.service.acl.command.system.start-level
   start-level[/.*[0-9][0-9][0-9]+.*/] = manager # manager can set
startlevels above 100
   execute[/.*/,/.*[0-9][0-9][0-9]+.*/] = manager # manager can set
startlevels above 100
----------------------------------------------------------------
Pid:            org.apache.karaf.log
BundleLocation: mvn:org.apache.karaf.log/org.apache.karaf.log.core/4.0.0
Properties:
   service.pid = org.apache.karaf.log
   size = 500
   pattern = %d{ISO8601} | %-5.5p | %-16.16t | %-32.32c{1} | %X{bundle.id}
- %X{bundle.name} - %X{bundle.version} | %m%n
   felix.fileinstall.filename = file:/opt/apache-karaf-
4.0.0/etc/org.apache.karaf.log.cfg
...
```

The **query** argument accepts a query using a LDAP syntax.

For instance, you can display details on one specific configuration using the following filter:

```
karaf@root()> config:list "(service.pid=org.apache.karaf.log)"
----------------------------------------------------------------
Pid:            org.apache.karaf.log
BundleLocation: mvn:org.apache.karaf.log/org.apache.karaf.log.core/4.0.0
Properties:
   felix.fileinstall.filename = file:/opt/apache-karaf-
4.0.0/etc/org.apache.karaf.log.cfg
   pattern = %d{ISO8601} | %-5.5p | %-16.16t | %-32.32c{1} | %X{bundle.id}
- %X{bundle.name} - %X{bundle.version} | %m%n
   service.pid = org.apache.karaf.log
   size = 500
```

31.1.1.2. `config:edit`

`config:edit` is the first command to do when you want to change a configuration. **`config:edit`** command put you in edition mode for a given configuration.

For instance, you can edit the **`org.apache.karaf.log`** configuration:

```
karaf@root()> config:edit org.apache.karaf.log
```

The **`config:edit`** command doesn't display anything, it just puts you in configuration edit mode. You are now ready to use other config commands (like **`config:property-append`**, **`config:property-delete`**, **`config:property-set`**, ...).

If you provide a configuration PID that doesn't exist yet, Apache Karaf will create a new configuration (and so a new configuration file) automatically.

All changes that you do in configuration edit mode are store in your console session: the changes are not directly applied in the configuration. It allows you to "commit" the changes (see **config:update** command) or "rollback" and cancel your changes (see **config:cancel** command).

31.1.1.3. config:property-list

The **config:property-list** lists the properties for the currently edited configuration.

Assuming that you edited the **org.apache.karaf.log** configuration, you can do:

```
karaf@root()> config:property-list
   felix.fileinstall.filename = file:/opt/apache-karaf-
4.0.0/etc/org.apache.karaf.log.cfg
   pattern = %d{ISO8601} | %-5.5p | %-16.16t | %-32.32c{1} | %X{bundle.id}
- %X{bundle.name} - %X{bundle.version} | %m%n
   service.pid = org.apache.karaf.log
   size = 500
```

31.1.1.4. config:property-set

The **config:property-set** command update the value of a given property in the currently edited configuration.

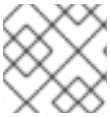
For instance, to change the value of the **size** property of previously edited **org.apache.karaf.log** configuration, you can do:

```
karaf@root()> config:property-set size 1000
karaf@root()> config:property-list
   felix.fileinstall.filename = file:/opt/apache-karaf-
4.0.0/etc/org.apache.karaf.log.cfg
   pattern = %d{ISO8601} | %-5.5p | %-16.16t | %-32.32c{1} | %X{bundle.id}
- %X{bundle.name} - %X{bundle.version} | %m%n
   service.pid = org.apache.karaf.log
   size = 1000
```

If the property doesn't exist, the **config:property-set** command creates the property.

You can use **config:property-set** command outside the configuration edit mode, by specifying the **-p** (for configuration pid) option:

```
karaf@root()> config:property-set -p org.apache.karaf.log size 1000
karaf@root()> config:list "(service.pid=org.apache.karaf.log)"
----------------------------------------------------------------
Pid:            org.apache.karaf.log
BundleLocation: mvn:org.apache.karaf.log/org.apache.karaf.log.core/4.0.0
Properties:
   service.pid = org.apache.karaf.log
   size = 1000
   pattern = %d{ISO8601} | %-5.5p | %-16.16t | %-32.32c{1} | %X{bundle.id}
- %X{bundle.name} - %X{bundle.version} | %m%n
   felix.fileinstall.filename = file:/opt/apache-karaf-
4.0.0/etc/org.apache.karaf.log.cfg
```



NOTE

Using the **pid** option, you bypass the configuration commit and rollback mechanism.

31.1.1.5. config:property-append

The **config:property-append** is similar to **config:property-set** command, but instead of completely replacing the property value, it appends a string at the end of the property value.

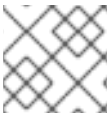
For instance, to add 1 at the end of the value of the **size** property in **org.apache.karaf.log** configuration (and so have 5001 for the value instead of 500), you can do:

```
karaf@root()> config:property-append size 1
karaf@root()> config:property-list
   service.pid = org.apache.karaf.log
   size = 5001
   pattern = %d{ISO8601} | %-5.5p | %-16.16t | %-32.32c{1} | %X{bundle.id}
- %X{bundle.name} - %X{bundle.version} | %m%n
   felix.fileinstall.filename = file:/opt/apache-karaf-
4.0.0/etc/org.apache.karaf.log.cfg
```

Like the **config:property-set** command, if the property doesn't exist, the **config:property-set** command creates the property.

You can use the **config:property-append** command outside the configuration edit mode, by specifying the **-p** (for configuration pid) option:

```
karaf@root()> config:property-append -p org.apache.karaf.log size 1
karaf@root()> config:list "(service.pid=org.apache.karaf.log)"
----------------------------------------------------------------
Pid:            org.apache.karaf.log
BundleLocation: mvn:org.apache.karaf.log/org.apache.karaf.log.core/4.0.0
Properties:
   service.pid = org.apache.karaf.log
   size = 5001
   pattern = %d{ISO8601} | %-5.5p | %-16.16t | %-32.32c{1} | %X{bundle.id}
- %X{bundle.name} - %X{bundle.version} | %m%n
   felix.fileinstall.filename = file:/opt/apache-karaf-
4.0.0/etc/org.apache.karaf.log.cfg
```



NOTE

Using the **pid** option, you bypass the configuration commit and rollback mechanism.

31.1.1.6. config:property-delete

The **config:property-delete** command delete a property in the currently edited configuration.

For instance, you previously added a **test** property in **org.apache.karaf.log** configuration. To delete this **test** property, you do:

```
karaf@root()> config:property-set test test
karaf@root()> config:property-list
```

```
   service.pid = org.apache.karaf.log
   size = 500
   pattern = %d{ISO8601} | %-5.5p | %-16.16t | %-32.32c{1} | %X{bundle.id}
- %X{bundle.name} - %X{bundle.version} | %m%n
   felix.fileinstall.filename = file:/opt/apache-karaf-
4.0.0/etc/org.apache.karaf.log.cfg
   test = test
karaf@root()> config:property-delete test
karaf@root()> config:property-list
   service.pid = org.apache.karaf.log
   size = 500
   pattern = %d{ISO8601} | %-5.5p | %-16.16t | %-32.32c{1} | %X{bundle.id}
- %X{bundle.name} - %X{bundle.version} | %m%n
   felix.fileinstall.filename = file:/opt/apache-karaf-
4.0.0/etc/org.apache.karaf.log.cfg
```

You can use the **config:property-delete** command outside the configuration edit mode, by specifying the **-p** (for configuration pid) option:

```
karaf@root()> config:property-delete -p org.apache.karaf.log test
```

31.1.1.7. config:update and config:cancel

When you are in the configuration edit mode, all changes that you do using **config:property*** commands are stored in "memory" (actually in the console session).

Thanks to that, you can "commit" your changes using the **config:update** command. The **config:update** command will commit your changes, update the configuration, and (if possible) update the configuration files.

For instance, after changing **org.apache.karaf.log** configuration with some **config:property*** commands, you have to commit your change like this:

```
karaf@root()> config:edit org.apache.karaf.log
karaf@root()> config:property-set test test
karaf@root()> config:update
karaf@root()> config:list "(service.pid=org.apache.karaf.log)"
----------------------------------------------------------------
Pid:            org.apache.karaf.log
BundleLocation: mvn:org.apache.karaf.log/org.apache.karaf.log.core/4.0.0
Properties:
   service.pid = org.apache.karaf.log
   size = 500
   pattern = %d{ISO8601} | %-5.5p | %-16.16t | %-32.32c{1} | %X{bundle.id}
- %X{bundle.name} - %X{bundle.version} | %m%n
   felix.fileinstall.filename = file:/opt/apache-karaf-
4.0.0/etc/org.apache.karaf.log.cfg
   test = test
```

On the other hand, if you want to "rollback" your changes, you can use the **config:cancel** command. It will cancel all changes that you did, and return of the configuration state just before the **config:edit** command. The **config:cancel** exits from the edit mode.

For instance, you added the test property in the **org.apache.karaf.log** configuration, but it was a mistake:

```
karaf@root()> config:edit org.apache.karaf.log
karaf@root()> config:property-set test test
karaf@root()> config:cancel
karaf@root()> config:list "(service.pid=org.apache.karaf.log)"
----------------------------------------------------------------
Pid:            org.apache.karaf.log
BundleLocation: mvn:org.apache.karaf.log/org.apache.karaf.log.core/4.0.0
Properties:
   service.pid = org.apache.karaf.log
   size = 500
   pattern = %d{ISO8601} | %-5.5p | %-16.16t | %-32.32c{1} | %X{bundle.id}
- %X{bundle.name} - %X{bundle.version} | %m%n
   felix.fileinstall.filename = file:/opt/apache-karaf-
4.0.0/etc/org.apache.karaf.log.cfg
```

31.1.1.8. config:delete

The **config:delete** command completely delete an existing configuration. You don't have to be in edit mode to delete a configuration.

For instance, you added **my.config** configuration:

```
karaf@root()> config:edit my.config
karaf@root()> config:property-set test test
karaf@root()> config:update
karaf@root()> config:list "(service.pid=my.config)"
----------------------------------------------------------------
Pid:            my.config
BundleLocation: null
Properties:
   service.pid = my.config
   test = test
```

You can delete the **my.config** configuration (including all properties in the configuration) using the **config:delete** command:

```
karaf@root()> config:delete my.config
karaf@root()> config:list "(service.pid=my.config)"
karaf@root()>
```

31.1.1.9. config:meta

The **config:meta** command lists the meta type information related to a given configuration.

It allows you to get details about the configuration properties: key, name, type, default value, and description:

```
karaf@root()> config:meta -p org.apache.karaf.log
Meta type informations for pid: org.apache.karaf.log
key     | name    | type   | default
```

```
| description
----------------------------------------------------------------------
----------------------------------------------------------------
size    | Size    | int    | 500
| size of the log to keep in memory
pattern | Pattern | String | %d{ABSOLUTE} | %-5.5p | %-16.16t | %-
32.32c{1} | %-32.32C %4L | %m%n | Pattern used to display log entries
```

31.1.2. JMX ConfigMBean

On the JMX layer, you have a MBean dedicated to the management of the configurations: the ConfigMBean.

The ConfigMBean object name is: **`org.apache.karaf:type=config,name=*`**.

31.1.2.1. Attributes

The **`Configs`** attribute is a list of all configuration PIDs.

31.1.2.2. Operations

- **`listProperties(pid)`** returns the list of properties (property=value formatted) for the configuration **`pid`**.
- **`deleteProperty(pid, property)`** deletes the **`property`** from the configuration **`pid`**.
- **`appendProperty(pid, property, value)`** appends **`value`** at the end of the value of the **`property`** of the configuration **`pid`**.
- **`setProperty(pid, property, value)`** sets **`value`** for the value of the **`property`** of the configuration **`pid`**.
- **`delete(pid)`** deletes the configuration identified by the **`pid`**.
- **`create(pid)`** creates an empty (without any property) configuration with **`pid`**.
- **`update(pid, properties)`** updates a configuration identified with **`pid`** with the provided **`properties`** map.

31.2. USING THE CONSOLE

31.2.1. Available commands

To see a list of the available commands in the console, you can use the **`help`**:

```
karaf@root()> help
bundle                          Enter the subshell
bundle:capabilities             Displays OSGi capabilities of a given
bundles.
bundle:classes                  Displays a list of classes/resources
contained in the bundle
bundle:diag                     Displays diagnostic information why a
bundle is not Active
```

```
bundle:dynamic-import             Enables/disables dynamic-import for a
given bundle.
bundle:find-class                 Locates a specified class in any
deployed bundle
bundle:headers                    Displays OSGi headers of a given
bundles.
bundle:id                         Gets the bundle ID.
...
```

You have the list of all commands with a short description.

You can use the tab key to get a quick list of all commands:

```
karaf@root()> Display all 294 possibilities? (y or n)
...
```

31.2.2. Subshell and completion mode

The commands have a scope and a name. For instance, the command **`feature:list`** has **`feature`** as scope, and **`list`** as name.

Karaf "groups" the commands by scope. Each scope form a subshell.

You can directly execute a command with its full qualified name (scope:name):

```
karaf@root()> feature:list
...
```

or enter in a subshell and type the command contextual to the subshell:

```
karaf@root()> feature
karaf@root(feature)> list
```

You can note that you enter in a subshell directly by typing the subshell name (here **`feature`**). You can "switch" directly from a subshell to another:

```
karaf@root()> feature
karaf@root(feature)> bundle
karaf@root(bundle)>
```

The prompt displays the current subshell between ().

The **`exit`** command goes to the parent subshell:

```
karaf@root()> feature
karaf@root(feature)> exit
karaf@root()>
```

The completion mode defines the behaviour of the tab key and the help command.

You have three different modes available:

- GLOBAL

- FIRST
- SUBSHELL

You can define your default completion mode using the completionMode property in **`etc/org.apache.karaf.shell.cfg`** file. By default, you have:

```
completionMode = GLOBAL
```

You can also change the completion mode "on the fly" (while using the Karaf shell console) using the **`shell:completion`** command:

```
karaf@root()> shell:completion
GLOBAL
karaf@root()> shell:completion FIRST
karaf@root()> shell:completion
FIRST
```

`shell:completion` can inform you about the current completion mode used. You can also provide the new completion mode that you want.

GLOBAL completion mode is the default one in Karaf 4.0.0 (mostly for transition purpose).

GLOBAL mode doesn't really use subshell: it's the same behavior as in previous Karaf versions.

When you type the tab key, whatever in which subshell you are, the completion will display all commands and all aliases:

```
karaf@root()> <TAB>
karaf@root()> Display all 273 possibilities? (y or n)
...
karaf@root()> feature
karaf@root(feature)> <TAB>
karaf@root(feature)> Display all 273 possibilities? (y or n)
```

FIRST completion mode is an alternative to the GLOBAL completion mode.

If you type the tab key on the root level subshell, the completion will display the commands and the aliases from all subshells (as in GLOBAL mode). However, if you type the tab key when you are in a subshell, the completion will display only the commands of the current subshell:

```
karaf@root()> shell:completion FIRST
karaf@root()> <TAB>
karaf@root()> Display all 273 possibilities? (y or n)
...
karaf@root()> feature
karaf@root(feature)> <TAB>
karaf@root(feature)>
info install list repo-add repo-list repo-remove uninstall version-list
karaf@root(feature)> exit
karaf@root()> log
karaf@root(log)> <TAB>
karaf@root(log)>
clear display exception-display get log set tail
```

SUBSHELL completion mode is the real subshell mode.

If you type the tab key on the root level, the completion displays the subshell commands (to go into a subshell), and the global aliases. Once you are in a subshell, if you type the TAB key, the completion displays the commands of the current subshell:

```
karaf@root()> shell:completion SUBSHELL
karaf@root()> <TAB>
karaf@root()>
* bundle cl config dev feature help instance jaas kar la ld lde log
log:list man package region service shell ssh system
karaf@root()> bundle
karaf@root(bundle)> <TAB>
karaf@root(bundle)>
capabilities classes diag dynamic-import find-class headers info install
list refresh requirements resolve restart services start start-level stop
uninstall update watch
karaf@root(bundle)> exit
karaf@root()> camel
karaf@root(camel)> <TAB>
karaf@root(camel)>
backlog-tracer-dump backlog-tracer-info backlog-tracer-start backlog-
tracer-stop context-info context-list context-start context-stop endpoint-
list route-info route-list route-profile route-reset-stats
route-resume route-show route-start route-stop route-suspend
```

31.2.3. Unix like environment

Karaf console provides a full Unix like environment.

31.2.3.1. Help or man

We already saw the usage of the **help** command to display all commands available.

But you can also use the **help** command to get details about a command or the **man** command which is an alias to the **help** command. You can also use another form to get the command help, by using the **--help** option to the command.

So these commands

```
karaf@root()> help feature:list
karaf@root()> man feature:list
karaf@root()> feature:list --help
```

All produce the same help output:

```
DESCRIPTION
        feature:list

        Lists all existing features available from the defined
repositories.

SYNTAX
        feature:list [options]
```

```
OPTIONS
        --help
                Display this help message
        -o, --ordered
                Display a list using alphabetical order
        -i, --installed
                Display a list of all installed features only
        --no-format
                Disable table rendered output
```

31.2.3.2. Completion

When you type the tab key, Karaf tries to complete:

- subshell
- commands
- aliases
- command arguments
- command options

31.2.3.3. Alias

An alias is another name associated to a given command.

The **shell:alias** command creates a new alias. For instance, to create the **list-installed-features** alias to the actual **feature:list -i** command, you can do:

```
karaf@root()> alias "list-features-installed = { feature:list -i }"
karaf@root()> list-features-installed
Name       | Version | Required | State   | Repository     | Description
-----------------------------------------------------------------------
-------------------------------------------------------
feature    | 4.0.0   | x        | Started | standard-4.0.0 | Features
Support
shell      | 4.0.0   | x        | Started | standard-4.0.0 | Karaf Shell
deployer   | 4.0.0   | x        | Started | standard-4.0.0 | Karaf
Deployer
bundle     | 4.0.0   | x        | Started | standard-4.0.0 | Provide
Bundle support
config     | 4.0.0   | x        | Started | standard-4.0.0 | Provide OSGi
ConfigAdmin support
diagnostic | 4.0.0   | x        | Started | standard-4.0.0 | Provide
Diagnostic support
instance   | 4.0.0   | x        | Started | standard-4.0.0 | Provide
Instance support
jaas       | 4.0.0   | x        | Started | standard-4.0.0 | Provide JAAS
support
log        | 4.0.0   | x        | Started | standard-4.0.0 | Provide Log
support
package    | 4.0.0   | x        | Started | standard-4.0.0 | Package
```

```
commands and mbeans
service    | 4.0.0   | x        | Started | standard-4.0.0 | Provide
Service support
system     | 4.0.0   | x        | Started | standard-4.0.0 | Provide
System support
kar        | 4.0.0   | x        | Started | standard-4.0.0 | Provide KAR
(KARaf archive) support
ssh        | 4.0.0   | x        | Started | standard-4.0.0 | Provide a
SSHd server on Karaf
management | 4.0.0   | x        | Started | standard-4.0.0 | Provide a JMX
MBeanServer and a set of MBeans in
```

At login, the Apache Karaf console reads the **etc/shell.init.script** file where you can create your aliases. It's similar to a bashrc or profile file on Unix.

```
ld = { log:display $args } ;
lde = { log:exception-display $args } ;
la = { bundle:list -t 0 $args } ;
ls = { service:list $args } ;
cl = { config:list "(service.pid=$args)" } ;
halt = { system:shutdown -h -f $args } ;
help = { *:help $args | more } ;
man = { help $args } ;
log:list = { log:get ALL } ;
```

You can see here the aliases available by default:

- **ld** is a short form to display log (alias to **log:display** command)
- **lde** is a short form to display exceptions (alias to **log:exception-display** command)
- **la** is a short form to list all bundles (alias to **bundle:list -t 0** command)
- **ls** is a short form to list all services (alias to **service:list** command)
- **cl** is a short form to list all configurations (alias to **config:list** command)
- **halt** is a short form to shutdown Apache Karaf (alias to **system:shutdown -h -f** command)
- **help** is a short form to display help (alias to ***:help** command)
- **man** is the same as help (alias to **help** command)
- **log:list** displays all loggers and level (alias to **log:get ALL** command)

You can create your own aliases in the **etc/shell.init.script** file.

31.2.3.4. Key binding

Like on most Unix environment, Karaf console support some key bindings:

- the arrows key to navigate in the commands history
- CTRL-D to logout/shutdown Karaf

- CTRL-R to search previously executed command
- CTRL-U to remove the current line

31.2.3.5. Pipe

You can pipe the output of one command as input to another one. It's a pipe, using the | character:

```
karaf@root()> feature:list |grep -i war
pax-war                       | 4.1.4                              |
| Uninstalled | org.ops4j.pax.web-4.1.4  | Provide support of a full
WebContainer
pax-war-tomcat                | 4.1.4                              |
| Uninstalled | org.ops4j.pax.web-4.1.4  |
war                           | 4.0.0                              |
| Uninstalled | standard-4.0.0           | Turn Karaf as a full
WebContainer
blueprint-web                 | 4.0.0                              |
| Uninstalled | standard-4.0.0           | Provides an OSGI-aware Servlet
ContextListener fo
```

31.2.3.6. Grep, more, find, ...

Karaf console provides some core commands similar to Unix environment:

- **`shell:alias`** creates an alias to an existing command
- **`shell:cat`** displays the content of a file or URL
- **`shell:clear`** clears the current console display
- **`shell:completion`** displays or change the current completion mode
- **`shell:date`** displays the current date (optionally using a format)
- **`shell:each`** executes a closure on a list of arguments
- **`shell:echo`** echoes and prints arguments to stdout
- **`shell:edit`** calls a text editor on the current file or URL
- **`shell:env`** displays or sets the value of a shell session variable
- **`shell:exec`** executes a system command
- **`shell:grep`** prints lines matching the given pattern
- **`shell:head`** displays the first line of the input
- **`shell:history`** prints the commands history
- **`shell:if`** allows you to use conditions (if, then, else blocks) in script
- **`shell:info`** prints various information about the current Karaf instance

- **`shell:java`** executes a Java application
- **`shell:less`** file pager
- **`shell:logout`** disconnects shell from current session
- **`shell:more`** is a file pager
- **`shell:new`** creates a new Java object
- **`shell:printf`** formats and prints arguments
- **`shell:sleep`** sleeps for a bit then wakes up
- **`shell:sort`** writes sorted concatenation of all files to stdout
- **`shell:source`** executes commands contained in a script
- **`shell:stack-traces-print`** prints the full stack trace in the console when the execution of a command throws an exception
- **`shell:tac`** captures the STDIN and returns it as a string
- **`shell:tail`** displays the last lines of the input
- **`shell:threads`** prints the current thread
- **`shell:watch`** periodically executes a command and refresh the output
- **`shell:wc`** prints newline, words, and byte counts for each file
- **`shell:while`** loop while the condition is true

You don't have to use the fully qualified name of the command, you can directly use the command name as long as it is unique. So you can use 'head' instead of 'shell:head'

Again, you can find details and all options of these commands using **`help`** command or **`--help`** option.

31.2.3.7. Scripting

The Apache Karaf Console supports a complete scripting language, similar to bash or csh on Unix.

The **each** (**`shell:each`**) command can iterate in a list:

```
karaf@root()> list = [1 2 3]; each ($list) { echo $it }
1
2
3
```

NOTE

The same loop could be written with the **shell:while** command:

```
karaf@root()> a = 0 ; while { %((a+=1) <= 3) } { echo $a }
1
2
3
```

You can create the list yourself (as in the previous example), or some commands can return a list too.

We can note that the console created a "session" variable with the name **list** that you can access with **$list**.

The **$it** variable is an implicit one corresponding to the current object (here the current iterated value from the list).

When you create a list with **[]**, Apache Karaf console creates a Java ArrayList. It means that you can use methods available in the ArrayList objects (like get or size for instance):

```
karaf@root()> list = ["Hello" world]; echo ($list get 0) ($list get 1)
Hello world
```

We can note here that calling a method on an object is directly using **(object method argument)**. Here **($list get 0)** means **$list.get(0)** where **$list** is the ArrayList.

The **class** notation will display details about the object:

```
karaf@root()> $list class
...
ProtectionDomain     ProtectionDomain  null
 null
 <no principals>
 java.security.Permissions@6521c24e (
 ("java.security.AllPermission" "<all permissions>" "<all actions>")
)


Signers              null
SimpleName           ArrayList
TypeParameters       [E]
```

You can "cast" a variable to a given type.

```
karaf@root()> ("hello world" toCharArray)
[h, e, l, l, o,  , w, o, r, l, d]
```

If it fails, you will see the casting exception:

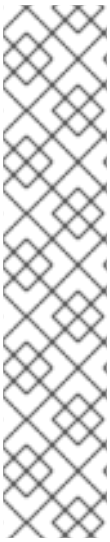
```
karaf@root()> ("hello world" toCharArray)[0]
Error executing command: [C cannot be cast to [Ljava.lang.Object;
```

You can "call" a script using the **shell:source** command:

```
karaf@root> shell:source script.txt
True!
```

where **script.txt** contains:

```
foo = "foo"
if { $foo equals "foo" } {
  echo "True!"
}
```



NOTE

The spaces are important when writing script. For instance, the following script is not correct:

```
if{ $foo equals "foo" } ...
```

and will fail with:

```
karaf@root> shell:source script.txt
Error executing command: Cannot coerce echo "true!"() to any of
[]
```

because a space is missing after the **if** statement.

As for the aliases, you can create init scripts in the **etc/shell.init.script** file. You can also named you script with an alias. Actually, the aliases are just scripts.

See the Scripting section of the developers guide for details.

31.2.4. Security

The Apache Karaf console supports a Role Based Access Control (RBAC) security mechanism. It means that depending of the user connected to the console, you can define, depending of the user's groups and roles, the permission to execute some commands, or limit the values allowed for the arguments.

Console security is detailed in the Security section of this user guide.

CHAPTER 32. PROVISIONING

Apache Karaf supports the provisioning of applications and modules using the concept of Karaf Features.

32.1. APPLICATION

An application consists of all modules, configuration, and transitive applications required for a feature.

32.2. OSGI

Apache Karaf natively supports the deployment of OSGi applications.

An OSGi application is a set of OSGi bundles. An OSGi bundles is a regular jar file, with additional metadata in the jar MANIFEST.

In OSGi, a bundle can depend to other bundles. So, it means that to deploy an OSGi application, most of the time, you have to firstly deploy a lot of other bundles required by the application.

So, you have to find these bundles first, install the bundles. Again, these "dependency" bundles may require other bundles to satisfy their own dependencies.

More over, typically, an application requires configuration (see the [Configuration section|configuration] of the user guide). So, before being able to start your application, in addition of the dependency bundles, you have to create or deploy the configuration.

As we can see, the provisioning of an application can be very long and fastidious.

32.3. FEATURE AND RESOLVER

Apache Karaf provides a simple and flexible way to provision applications.

In Apache Karaf, the application provisioning is an Apache Karaf "feature".

A feature describes an application as:

- a name
- a version
- a optional description (eventually with a long description)
- a set of bundles
- optionally a set configurations or configuration files
- optionally a set of dependency features

When you install a feature, Apache Karaf installs all resources described in the feature. It means that it will automatically resolves and installs all bundles, configurations, and dependency features described in the feature.

The feature resolver checks the service requirements, and install the bundles providing the services matching the requirements. The default mode enables this behavior only for "new style" features repositories (basically, the features repositories XML with schema equal or greater to 1.3.0). It doesn't

apply for "old style" features repositories (coming from Karaf 2 or 3).

You can change the service requirements enforcement mode in **etc/org.apache.karaf.features.cfg** file, using the **serviceRequirements** property.

```
serviceRequirements=default
```

The possible values are:

- disable: service requirements are completely ignored, for both "old style" and "new style" features repositories
- default: service requirements are ignored for "old style" features repositories, and enabled for "new style" features repositories.
- enforce: service requirements are always verified, for "old style" and "new style" features repositories.

Additionally, a feature can also define requirements. In that case, Karaf can automatically additional bundles or features providing the capabilities to satisfy the requirements.

A feature has a complete lifecycle: install, start, stop, update, uninstall.

32.4. FEATURES REPOSITORIES

The features are described in a features XML descriptor. This XML file contains the description of a set of features.

A features XML descriptor is named a "features repository". Before being able to install a feature, you have to register the features repository that provides the feature (using **feature:repo-add** command or FeatureMBean as described later).

For instance, the following XML file (or "features repository") describes the **feature1** and **feature2** features:

```
<features xmlns="http://karaf.apache.org/xmlns/features/v1.3.0">
  <feature name="feature1" version="1.0.0">
    <bundle>...</bundle>
    <bundle>...</bundle>
  </feature>
  <feature name="feature2" version="1.1.0">
    <feature>feature1</feature>
    <bundle>...</bundle>
  </feature>
</features>
```

We can note that the features XML has a schema. Take a look on [Features XML Schema section|provisioning-schema] of the user guide for details. The **feature1** feature is available in version **1.0.0**, and contains two bundles. The **<bundle/>** element contains a URL to the bundle artifact (see [Artifacts repositories and URLs section|urls] for details). If you install the **feature1** feature (using **feature:install** or the FeatureMBean as described later), Apache Karaf will automatically installs the two bundles described. The **feature2** feature is available in version **1.1.0**, and contains a reference to the **feature1** feature and a bundle. The **<feature/>** element contains the name of a feature. A specific feature version can be defined using the **version** attribute to the **<feature/>** element (**<feature version="1.0.0">feature1</feature>**). If the **version**

attribute is not specified, Apache Karaf will install the latest version available. If you install the `feature2` feature (using `feature:install` or the FeatureMBean as described later), Apache Karaf will automatically installs `feature1` (if it's not already installed) and the bundle.

A feature repository is registered using the URL to the features XML file.

The features state is stored in the Apache Karaf cache (in the **KARAF_DATA** folder). You can restart Apache Karaf, the previously installed features remain installed and available after restart. If you do a clean restart or you delete the Apache Karaf cache (delete the **KARAF_DATA** folder), all previously features repositories registered and features installed will be lost: you will have to register the features repositories and install features by hand again. To prevent this behaviour, you can specify features as boot features.

32.5. BOOT FEATURES

You can describe some features as boot features. A boot feature will be automatically install by Apache Karaf, even if it has not been previously installed using `feature:install` or FeatureMBean.

Apache Karaf features configuration is located in the `etc/org.apache.karaf.features.cfg` configuration file.

This configuration file contains the two properties to use to define boot features:

- `featuresRepositories` contains a list (comma-separated) of features repositories (features XML) URLs.
- `featuresBoot` contains a list (comma-separated) of features to install at boot.

32.6. FEATURES UPGRADE

You can update a release by installing the same feature (with the same SNAPSHOT version or a different version).

Thanks to the features lifecycle, you can control the status of the feature (started, stopped, etc).

You can also use a simulation to see what the update will do.

32.7. OVERRIDES

Bundles defined in features can be overridden by using a file etc/overrides.properties. Each line in the file defines one override. The syntax is: <bundle-uri>[;range="[min,max)"] The given bundle will override all bundles in feature definitions with the same symbolic name if the version of the override is greater than the version of the overridden bundle and the range matches. If no range is given then compatibility on the micro version level is assumed.

So for example the override mvn:org.ops4j.pax.logging/pax-logging-service/1.8.5 would overide pax-logging-service 1.8.3 but not 1.8.6 or 1.7.0.

32.8. FEATURE BUNDLES

32.8.1. Start Level

By default, the bundles deployed by a feature will have a start-level equals to the value defined in the **etc/config.properties** configuration file, in the **karaf.startlevel.bundle** property.

This value can be "overrided" by the **start-level** attribute of the **<bundle/>** element, in the features XML.

```
  <feature name="my-project" version="1.0.0">
    <bundle start-level="80">mvn:com.mycompany.myproject/myproject-
dao</bundle>
    <bundle start-level="85">mvn:com.mycompany.myproject/myproject-
service</bundle>
  </feature>
```

The start-level attribute insure that the **myproject-dao** bundle is started before the bundles that use it.

Instead of using start-level, a better solution is to simply let the OSGi framework know what your dependencies are by defining the packages or services you need. It is more robust than setting start levels.

32.8.2. Simulate, Start and stop

You can simulate the installation of a feature using the **-t** option to **feature:install** command.

You can install a bundle without starting it. By default, the bundles in a feature are automatically started.

A feature can specify that a bundle should not be started automatically (the bundle stays in resolved state). To do so, a feature can specify the **start** attribute to false in the **<bundle/>** element:

```
  <feature name="my-project" version="1.0.0">
    <bundle start-level="80"
start="false">mvn:com.mycompany.myproject/myproject-dao</bundle>
    <bundle start-level="85"
start="false">mvn:com.mycompany.myproject/myproject-service</bundle>
  </feature>
```

32.8.3. Dependency

A bundle can be flagged as being a dependency, using the **dependency** attribute set to true on the **<bundle/>** element.

This information can be used by resolvers to compute the full list of bundles to be installed.

32.9. DEPENDENT FEATURES

A feature can depend to a set of other features:

```
  <feature name="my-project" version="1.0.0">
    <feature>other</feature>
    <bundle start-level="80"
start="false">mvn:com.mycompany.myproject/myproject-dao</bundle>
    <bundle start-level="85"
start="false">mvn:com.mycompany.myproject/myproject-service</bundle>
```

```
  </feature>
```

When the **my-project** feature will be installed, the **other** feature will be automatically installed as well.

It's possible to define a version range for a dependent feature:

```
<feature name="spring-dm">
  <feature version="[2.5.6,4)">spring</feature>
  ...
</feature>
```

The feature with the highest version available in the range will be installed.

If a single version is specified, the range will be considered open-ended.

If nothing is specified, the highest available will be installed.

To specify an exact version, use a closed range such as **[3.1,3.1]**.

32.9.1. Feature prerequisites

Prerequisite feature is special kind of dependency. If you will add **prerequisite** attribute to dependant feature tag then it will force installation and also activation of bundles in dependant feature before installation of actual feature. This may be handy in case if bundles enlisted in given feature are not using pre installed URL such **wrap** or **war**.

32.10. FEATURE CONFIGURATIONS

The **<config/>** element in a feature XML allows a feature to create and/or populate a configuration (identified by a configuration PID).

```
<config name="com.foo.bar">
  myProperty = myValue
</config>
```

The **name** attribute of the **<config/>** element corresponds to the configuration PID (see the [Configuration section|configuration] for details).

The installation of the feature will have the same effect as dropping a file named **com.foo.bar.cfg** in the **etc** folder.

The content of the **<config/>** element is a set of properties, following the key=value standard.

32.11. FEATURE CONFIGURATION FILES

Instead of using the **<config/>** element, a feature can specify **<configfile/>** elements.

```
<configfile finalname="/etc/myfile.cfg" override="false">URL</configfile>
```

Instead of directly manipulating the Apache Karaf configuration layer (as when using the **<config/>** element), the **<configfile/>** element takes directly a file specified by a URL, and copy the file in the location specified by the **finalname** attribute.

If not specified, the location is relative from the **KARAF_BASE** variable. It's also possible to use variable like ${karaf.home}, ${karaf.base}, ${karaf.etc}, or even system properties.

For instance:

```
<configfile finalname="${karaf.etc}/myfile.cfg"
override="false">URL</configfile>
```

If the file is already present at the desired location it is kept and the deployment of the configuration file is skipped, as a already existing file might contain customization. This behaviour can be overriden by **`override`** set to true.

The file URL is any URL supported by Apache Karaf (see the [Artifacts repositories and URLs|urls] of the user guide for details).

32.11.1. Requirements

A feature can also specify expected requirements. The feature resolver will try to satisfy the requirements. For that, it checks the features and bundles capabilities and will automatically install the bundles to satisfy the requirements.

For instance, a feature can contain:

```
<requirement>osgi.ee;filter:=&amp;quot;(&amp;amp;(osgi.ee=JavaSE)(!
(version&amp;gt;=1.8)))&amp;quot;</requirement>
```

The requirement specifies that the feature will work by only if the JDK version is not 1.8 (so basically 1.7).

The features resolver is also able to refresh the bundles when an optional dependency is satisfy, rewiring the optional import.

32.12. COMMANDS

32.12.1. `feature:repo-list`

The **`feature:repo-list`** command lists all registered features repository:

```
karaf@root()> feature:repo-list
Repository               | URL
-------------------------------------------------------------------------
---------------
org.ops4j.pax.cdi-0.12.0 | mvn:org.ops4j.pax.cdi/pax-cdi-
features/0.12.0/xml/features
org.ops4j.pax.web-4.1.4  | mvn:org.ops4j.pax.web/pax-web-
features/4.1.4/xml/features
standard-4.0.0           |
mvn:org.apache.karaf.features/standard/4.0.0/xml/features
enterprise-4.0.0         |
mvn:org.apache.karaf.features/enterprise/4.0.0/xml/features
spring-4.0.0             |
mvn:org.apache.karaf.features/spring/4.0.0/xml/features
```

Each repository has a name and the URL to the features XML.

Apache Karaf parses the features XML when you register the features repository URL (using **`feature:repo-add`** command or the FeatureMBean as described later). If you want to force Apache Karaf to reload the features repository URL (and so update the features definition), you can use the **`-r`** option:

```
karaf@root()> feature:repo-list -r
Reloading all repositories from their urls

Repository               | URL
-------------------------------------------------------------------------
---------------
org.ops4j.pax.cdi-0.12.0 | mvn:org.ops4j.pax.cdi/pax-cdi-
features/0.12.0/xml/features
org.ops4j.pax.web-4.1.4  | mvn:org.ops4j.pax.web/pax-web-
features/4.1.4/xml/features
standard-4.0.0           |
mvn:org.apache.karaf.features/standard/4.0.0/xml/features
enterprise-4.0.0         |
mvn:org.apache.karaf.features/enterprise/4.0.0/xml/features
spring-4.0.0             |
mvn:org.apache.karaf.features/spring/4.0.0/xml/features
```

32.12.2. `feature:repo-add`

To register a features repository (and so having new features available in Apache Karaf), you have to use the **`feature:repo-add`** command.

The **`feature:repo-add`** command requires the **`name/url`** argument. This argument accepts:

- a feature repository URL. It's an URL directly to the features XML file. Any URL described in the [Artifacts repositories and URLs section|urls] of the user guide is supported.
- a feature repository name defined in the **`etc/org.apache.karaf.features.repos.cfg`** configuration file.

The **`etc/org.apache.karaf.features.repos.cfg`** defines a list of "pre-installed/available" features repositories:

```
################################################################################
######
#
#    Licensed to the Apache Software Foundation (ASF) under one or more
#    contributor license agreements.  See the NOTICE file distributed with
#    this work for additional information regarding copyright ownership.
#    The ASF licenses this file to You under the Apache License, Version
2.0
#    (the "License"); you may not use this file except in compliance with
#    the License.  You may obtain a copy of the License at
#
#       http://www.apache.org/licenses/LICENSE-2.0
#
#    Unless required by applicable law or agreed to in writing, software
#    distributed under the License is distributed on an "AS IS" BASIS,
```

```
#    WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
implied.
#    See the License for the specific language governing permissions and
#    limitations under the License.
#
##########################################################################
######

#
# This file describes the features repository URL
# It could be directly installed using feature:repo-add command
#
enterprise=mvn:org.apache.karaf.features/enterprise/LATEST/xml/features
spring=mvn:org.apache.karaf.features/spring/LATEST/xml/features
cellar=mvn:org.apache.karaf.cellar/apache-karaf-cellar/LATEST/xml/features
cave=mvn:org.apache.karaf.cave/apache-karaf-cave/LATEST/xml/features
camel=mvn:org.apache.camel.karaf/apache-camel/LATEST/xml/features
camel-extras=mvn:org.apache-extras.camel-extra.karaf/camel-
extra/LATEST/xml/features
cxf=mvn:org.apache.cxf.karaf/apache-cxf/LATEST/xml/features
cxf-dosgi=mvn:org.apache.cxf.dosgi/cxf-dosgi/LATEST/xml/features
cxf-xkms=mvn:org.apache.cxf.services.xkms/cxf-services-xkms-
features/LATEST/xml
activemq=mvn:org.apache.activemq/activemq-karaf/LATEST/xml/features
jclouds=mvn:org.apache.jclouds.karaf/jclouds-karaf/LATEST/xml/features
openejb=mvn:org.apache.openejb/openejb-feature/LATEST/xml/features
wicket=mvn:org.ops4j.pax.wicket/features/LATEST/xml/features
hawtio=mvn:io.hawt/hawtio-karaf/LATEST/xml/features
pax-cdi=mvn:org.ops4j.pax.cdi/pax-cdi-features/LATEST/xml/features
pax-jdbc=mvn:org.ops4j.pax.jdbc/pax-jdbc-features/LATEST/xml/features
pax-jpa=mvn:org.ops4j.pax.jpa/pax-jpa-features/LATEST/xml/features
pax-web=mvn:org.ops4j.pax.web/pax-web-features/LATEST/xml/features
pax-wicket=mvn:org.ops4j.pax.wicket/pax-wicket-
features/LATEST/xml/features
ecf=http://download.eclipse.org/rt/ecf/latest/site.p2/karaf-features.xml
decanter=mvn:org.apache.karaf.decanter/apache-karaf-
decanter/LATEST/xml/features
```

You can directly provide a features repository name to the **`feature:repo-add`** command. For install, to install Apache Karaf Cellar, you can do:

```
karaf@root()> feature:repo-add cellar
Adding feature url mvn:org.apache.karaf.cellar/apache-karaf-
cellar/LATEST/xml/features
```

When you don't provide the optional **`version`** argument, Apache Karaf installs the latest version of the features repository available. You can specify a target version with the **`version`** argument:

```
karaf@root()> feature:repo-add cellar 4.0.0.RC1
Adding feature url mvn:org.apache.karaf.cellar/apache-karaf-
cellar/4.0.0.RC1/xml/features
```

Instead of providing a features repository name defined in the **`etc/org.apache.karaf.features.repos.cfg`** configuration file, you can directly provide the features repository URL to the **`feature:repo-add`** command:

```
karaf@root()> feature:repo-add mvn:org.apache.karaf.cellar/apache-karaf-
cellar/4.0.0.RC1/xml/features
Adding feature url mvn:org.apache.karaf.cellar/apache-karaf-
cellar/4.0.0.RC1/xml/features
```

By default, the **feature:repo-add** command just registers the features repository, it doesn't install any feature. If you specify the **-i** option, the **feature:repo-add** command registers the features repository and installs all features described in this features repository:

```
karaf@root()> feature:repo-add -i cellar
```

32.12.3. feature:repo-refresh

Apache Karaf parses the features repository XML when you register it (using **feature:repo-add** command or the FeatureMBean). If the features repository XML changes, you have to indicate to Apache Karaf to refresh the features repository to load the changes.

The **feature:repo-refresh** command refreshes the features repository.

Without argument, the command refreshes all features repository:

```
karaf@root()> feature:repo-refresh
Refreshing feature url mvn:org.ops4j.pax.cdi/pax-cdi-
features/0.12.0/xml/features
Refreshing feature url mvn:org.ops4j.pax.web/pax-web-
features/4.1.4/xml/features
Refreshing feature url
mvn:org.apache.karaf.features/standard/4.0.0/xml/features
Refreshing feature url
mvn:org.apache.karaf.features/enterprise/4.0.0/xml/features
Refreshing feature url
mvn:org.apache.karaf.features/spring/4.0.0/xml/features
```

Instead of refreshing all features repositories, you can specify the features repository to refresh, by providing the URL or the features repository name (and optionally version):

```
karaf@root()> feature:repo-refresh
mvn:org.apache.karaf.features/standard/4.0.0/xml/features
Refreshing feature url
mvn:org.apache.karaf.features/standard/4.0.0/xml/features
```

```
karaf@root()> feature:repo-refresh cellar
Refreshing feature url mvn:org.apache.karaf.cellar/apache-karaf-
cellar/LATEST/xml/features
```

32.12.4. feature:repo-remove

The **feature:repo-remove** command removes a features repository from the registered ones.

The **feature:repo-remove** command requires a argument:

- the features repository name (as displayed in the repository column of the **`feature:repo-list`** command output)
- the features repository URL (as displayed in the URL column of the **`feature:repo-list`** command output)

```
karaf@root()> feature:repo-remove karaf-cellar-4.0.0.RC1
```

```
karaf@root()> feature:repo-remove mvn:org.apache.karaf.cellar/apache-
karaf-cellar/LATEST/xml/features
```

By default, the **`feature:repo-remove`** command just removes the features repository from the registered ones: it doesn't uninstall the features provided by the features repository.

If you use **`-u`** option, the **`feature:repo-remove`** command uninstalls all features described by the features repository:

```
karaf@root()> feature:repo-remove -u karaf-cellar-4.0.0.RC1
```

32.12.5. `feature:list`

The **`feature:list`** command lists all available features (provided by the different registered features repositories):

```
Name                          | Version                          |
Required | State       | Repository               | Description
--------------------------------------------------------------------------
--------------------------------------------------------------------------
-----------------------------
pax-cdi                       | 0.12.0                           |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Provide CDI support
pax-cdi-1.1                   | 0.12.0                           |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Provide CDI 1.1 support
pax-cdi-1.2                   | 0.12.0                           |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Provide CDI 1.2 support
pax-cdi-weld                  | 0.12.0                           |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Weld CDI support
pax-cdi-1.1-weld              | 0.12.0                           |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Weld CDI 1.1 support
pax-cdi-1.2-weld              | 0.12.0                           |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Weld CDI 1.2 support
pax-cdi-openwebbeans          | 0.12.0                           |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | OpenWebBeans CDI support
pax-cdi-web                   | 0.12.0                           |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Web CDI support
pax-cdi-1.1-web               | 0.12.0                           |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Web CDI 1.1 support
...
```

If you want to order the features by alphabetical name, you can use the **`-o`** option:

```
karaf@root()> feature:list -o
Name                          | Version                          |
```

```
Required | State       | Repository               | Description
-------------------------------------------------------------------
-------------------------------------------------------------------
----------------------------
deltaspike-core               | 1.2.1                              |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Apache Deltaspike core support
deltaspike-data               | 1.2.1                              |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Apache Deltaspike data support
deltaspike-jpa                | 1.2.1                              |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Apache Deltaspike jpa support
deltaspike-partial-bean       | 1.2.1                              |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Apache Deltaspike partial bean
support
pax-cdi                       | 0.12.0                             |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Provide CDI support
pax-cdi-1.1                   | 0.12.0                             |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Provide CDI 1.1 support
pax-cdi-1.1-web               | 0.12.0                             |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Web CDI 1.1 support
pax-cdi-1.1-web-weld          | 0.12.0                             |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Weld Web CDI 1.1 support
pax-cdi-1.1-weld              | 0.12.0                             |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Weld CDI 1.1 support
pax-cdi-1.2                   | 0.12.0                             |
| Uninstalled | org.ops4j.pax.cdi-0.12.0 | Provide CDI 1.2 support
...
```

By default, the **`feature:list`** command displays all features, whatever their current state (installed or not installed).

Using the **`-i`** option displays only installed features:

```
karaf@root()> feature:list -i
Name             | Version | Required | State   | Repository     |
Description
-------------------------------------------------------------------
-----------------------------------------
aries-proxy      | 4.0.0   |          | Started | standard-4.0.0 | Aries
Proxy
aries-blueprint | 4.0.0   | x        | Started | standard-4.0.0 | Aries
Blueprint
feature          | 4.0.0   | x        | Started | standard-4.0.0 |
Features Support
shell            | 4.0.0   | x        | Started | standard-4.0.0 | Karaf
Shell
shell-compat     | 4.0.0   | x        | Started | standard-4.0.0 | Karaf
Shell Compatibility
deployer         | 4.0.0   | x        | Started | standard-4.0.0 | Karaf
Deployer
bundle           | 4.0.0   | x        | Started | standard-4.0.0 | Provide
Bundle support
config           | 4.0.0   | x        | Started | standard-4.0.0 | Provide
OSGi ConfigAdmin support
diagnostic       | 4.0.0   | x        | Started | standard-4.0.0 | Provide
Diagnostic support
instance         | 4.0.0   | x        | Started | standard-4.0.0 | Provide
```

```
Instance support
jaas            | 4.0.0   | x        | Started | standard-4.0.0 | Provide
JAAS support
log             | 4.0.0   | x        | Started | standard-4.0.0 | Provide
Log support
package         | 4.0.0   | x        | Started | standard-4.0.0 | Package
commands and mbeans
service         | 4.0.0   | x        | Started | standard-4.0.0 | Provide
Service support
system          | 4.0.0   | x        | Started | standard-4.0.0 | Provide
System support
kar             | 4.0.0   | x        | Started | standard-4.0.0 | Provide
KAR (KARaf archive) support
ssh             | 4.0.0   | x        | Started | standard-4.0.0 | Provide
a SSHd server on Karaf
management      | 4.0.0   | x        | Started | standard-4.0.0 | Provide
a JMX MBeanServer and a set of MBeans in
wrap            | 0.0.0   | x        | Started | standard-4.0.0 | Wrap
URL handler
```

32.12.6. `feature:install`

The **`feature:install`** command installs a feature.

It requires the **`feature`** argument. The **`feature`** argument is the name of the feature, or the name/version of the feature. If only the name of the feature is provided (not the version), the latest version available will be installed.

```
karaf@root()> feature:install eventadmin
```

We can simulate an installation using **`-t`** or **`--simulate`** option: it just displays what it would do, but it doesn't do it:

```
karaf@root()> feature:install -t -v eventadmin
Adding features: eventadmin/[4.0.0,4.0.0]
No deployment change.
  Managing bundle:
    org.apache.felix.metatype / 1.0.12
```

You can specify a feature version to install:

```
karaf@root()> feature:install eventadmin/4.0.0
```

By default, the **`feature:install`** command is not verbose. If you want to have some details about actions performed by the **`feature:install`** command, you can use the **`-v`** option:

```
karaf@root()> feature:install -v eventadmin
Adding features: eventadmin/[4.0.0,4.0.0]
No deployment change.
Done.
```

If a feature contains a bundle which is already installed, by default, Apache Karaf will refresh this bundle. Sometime, this refresh can cause issue to other running applications. If you want to disable the auto-refresh of installed bundles, you can use the **-r** option:

```
karaf@root()> feature:install -v -r eventadmin
Adding features: eventadmin/[4.0.0,4.0.0]
No deployment change.
Done.
```

You can decide to not start the bundles installed by a feature using the **-s** or **--no-auto-start** option:

```
karaf@root()> feature:install -s eventadmin
```

32.12.7. `feature:start`

By default, when you install a feature, it's automatically installed. However, you can specify the **-s** option to the **feature:install** command.

As soon as you install a feature (started or not), all packages provided by the bundles defined in the feature will be available, and can be used for the wiring in other bundles.

When starting a feature, all bundles are started, and so, the feature also exposes the services.

32.12.8. `feature:stop`

You can also stop a feature: it means that all services provided by the feature will be stop and removed from the service registry. However, the packages are still available for the wiring (the bundles are in resolved state).

32.12.9. `feature:uninstall`

The **feature:uninstall** command uninstalls a feature. As the **feature:install** command, the **feature:uninstall** command requires the **feature** argument. The **feature** argument is the name of the feature, or the name/version of the feature. If only the name of the feature is provided (not the version), the latest version available will be installed.

```
karaf@root()> feature:uninstall eventadmin
```

The features resolver is involved during feature uninstallation: transitive features installed by the uninstalled feature can be uninstalled themselves if not used by other feature.

32.13. DEPLOYER

You can "hot deploy" a features XML by dropping the file directly in the **deploy** folder.

Apache Karaf provides a features deployer.

When you drop a features XML in the deploy folder, the features deployer does: * register the features XML as a features repository * the features with **install** attribute set to "auto" will be automatically installed by the features deployer.

For instance, dropping the following XML in the deploy folder will automatically install feature1 and feature2, whereas feature3 won't be installed:

```
<?xml version="1.0" encoding="UTF-8"?>
<features name="my-features"
xmlns="http://karaf.apache.org/xmlns/features/v1.3.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xsi:schemaLocation="http://karaf.apache.org/xmlns/features/v1.3.0
http://karaf.apache.org/xmlns/features/v1.3.0">

    <feature name="feature1" version="1.0" install="auto">
        ...
    </feature>

    <feature name="feature2" version="1.0" install="auto">
        ...
    </feature>

    <feature name="feature3" version="1.0">
        ...
    </feature>

</features>
```

32.14. JMX FEATUREMBEAN

On the JMX layer, you have a MBean dedicated to the management of the features and features repositories: the FeatureMBean.

The FeatureMBean object name is: **`org.apache.karaf:type=feature,name=*`**.

32.14.1. Attributes

The FeatureMBean provides two attributes:

- **`Features`** is a tabular data set of all features available.
- **`Repositories`** is a tabular data set of all registered features repositories.

The **`Repositories`** attribute provides the following information:

- **`Name`** is the name of the features repository.
- **`Uri`** is the URI to the features XML for this repository.
- **`Features`** is a tabular data set of all features (name and version) provided by this features repository.
- **`Repositories`** is a tabular data set of features repositories "imported" in this features repository.

The **`Features`** attribute provides the following information:

- **`Name`** is the name of the feature.

- **`Version`** is the version of the feature.
- **`Installed`** is a boolean. If true, it means that the feature is currently installed.
- **`Bundles`** is a tabular data set of all bundles (bundles URL) described in the feature.
- **`Configurations`** is a tabular data set of all configurations described in the feature.
- **`Configuration Files`** is a tabular data set of all configuration files described in the feature.
- **`Dependencies`** is a tabular data set of all dependent features described in the feature.

32.14.2. Operations

- **`addRepository(url)`** adds the features repository with the **`url`**. The **`url`** can be a **`name`** as in the **`feature:repo-add`** command.
- **`addRepository(url, install)`** adds the features repository with the **`url`** and automatically installs all bundles if **`install`** is true. The **`url`** can be a **`name`** like in the **`feature:repo-add`** command.
- **`removeRepository(url)`** removes the features repository with the **`url`**. The **`url`** can be a **`name`** as in the **`feature:repo-remove`** command.
- **`installFeature(name)`** installs the feature with the **`name`**.
- **`installFeature(name, version)`** installs the feature with the **`name`** and **`version`**.
- **`installFeature(name, noClean, noRefresh)`** installs the feature with the **`name`** without cleaning the bundles in case of failure, and without refreshing already installed bundles.
- **`installFeature(name, version, noClean, noRefresh)` ` installs the feature with the `name`** and **`version`** without cleaning the bundles in case of failure, and without refreshing already installed bundles.
- **`uninstallFeature(name)`** uninstalls the feature with the **`name`**.
- **`uninstallFeature(name, version)`** uninstalls the feature with the **`name`** and **`version`**.

32.14.3. Notifications

The FeatureMBean sends two kind of notifications (on which you can subscribe and react):

- When a feature repository changes (added or removed).
- When a feature changes (installed or uninstalled).

CHAPTER 33. REMOTE

Apache Karaf supports a complete remote mechanism allowing you to remotely connect to a running Apache Karaf instance. More over, you can also browse, download, and upload files remotely to a running Apache Karaf instance.

Apache Karaf embeds a complete SSHd server.

33.1. SSHD SERVER

When you start Apache Karaf, it enables a remote console that can be accessed over SSH.

This remote console provides all the features of the "local" console, and gives a remote user complete control over the container and services running inside of it. As the "local" console, the remote console is secured by a RBAC mechanism (see the Security section of the user guide for details).

In addition of the remote console, Apache Karaf also provides a remote filesystem. This remote filesystem can be accessed using a SCP/SFTP client.

33.1.1. Configuration

The configuration of the SSHd server is stored in the **`etc/org.apache.karaf.shell.cfg`** file:

```
################################################################################
######
#
#    Licensed to the Apache Software Foundation (ASF) under one or more
#    contributor license agreements.  See the NOTICE file distributed with
#    this work for additional information regarding copyright ownership.
#    The ASF licenses this file to You under the Apache License, Version
2.0
#    (the "License"); you may not use this file except in compliance with
#    the License.  You may obtain a copy of the License at
#
#       http://www.apache.org/licenses/LICENSE-2.0
#
#    Unless required by applicable law or agreed to in writing, software
#    distributed under the License is distributed on an "AS IS" BASIS,
#    WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
implied.
#    See the License for the specific language governing permissions and
#    limitations under the License.
#
################################################################################
######

#
# These properties are used to configure Karaf's ssh shell.
#

#
# Via sshPort and sshHost you define the address you can login into Karaf.
#
sshPort = 8101
sshHost = 0.0.0.0
```

```
#
# The sshIdleTimeout defines the inactivity timeout to logout the SSH
session.
# The sshIdleTimeout is in milliseconds, and the default is set to 30
minutes.
#
sshIdleTimeout = 1800000

#
# sshRealm defines which JAAS domain to use for password authentication.
#
sshRealm = karaf

#
# The location of the hostKey file defines where the private/public key of
the server
# is located. If no file is at the defined location it will be ignored.
#
hostKey = ${karaf.etc}/host.key

#
# Role name used for SSH access authorization
# If not set, this defaults to the ${karaf.admin.role} configured in
etc/system.properties
#
# sshRole = admin

#
# Self defined key size in 1024, 2048, 3072, or 4096
# If not set, this defaults to 4096.
#
# keySize = 4096

#
# Specify host key algorithm, defaults to RSA
#
# algorithm = RSA

#
# Defines the completion mode on the Karaf shell console. The possible
values are:
# - GLOBAL: it's the same behavior as in previous Karaf releases. The
completion displays all commands and all aliases
#           ignoring if you are in a subshell or not.
# - FIRST: the completion displays all commands and all aliases only when
you are not in a subshell. When you are
#          in a subshell, the completion displays only the commands local
to the subshell.
# - SUBSHELL: the completion displays only the subshells on the root
level. When you are in a subshell, the completion
#             displays only the commands local to the subshell.
# This property define the default value when you use the Karaf shell
console.
# You can change the completion mode directly in the shell console, using
```

```
shell:completion command.
#
completionMode = GLOBAL
```

The **etc/org.apache.karaf.shell.cfg** configuration file contains different properties to configure the SSHd server:

- **sshPort** is the port number where the SSHd server is bound (by default, it's 8101).
- **sshHost** is the address of the network interface where the SSHd server is bound. The default value is 0.0.0.0, meaning that the SSHd server is bound on all network interfaces. You can bind on a target interface providing the IP address of the network interface.
- **hostKey** is the location of the **host.key** file. By defaut, it uses **etc/host.key**. This file stores the public and private key pair of the SSHd server.
- **sshRole** is the default role used for SSH access. The default value is the value of **karaf.admin.role** property defined in **etc/system.properties**. See the [Security section|security] of this user guide for details.
- **keySize** is the key size used by the SSHd server. The possible values are 1024, 2048, 3072, or 4096. The default value is 1024.
- **algorithm** is the host key algorithm used by the SSHd server. The possible values are DSA or RSA. The default value is DSA.

The SSHd server configuration can be changed at runtime:

- by editing the **etc/org.apache.karaf.shell.cfg** configuration file
- by using the **config:*** commands

At runtime, when you change the SSHd server configuration, you have to restart the SSHd server to load the changes. You can do it with:

```
karaf@root()> bundle:restart -f org.apache.karaf.shell.ssh
```

The Apache Karaf SSHd server supports key/agent authentication and password authentication.

33.1.2. Console clients

33.1.2.1. System native clients

The Apache Karaf SSHd server is a pure SSHd server, similar to OpenSSH daemon.

It means that you can use directly a SSH client from your system.

For instance, on Unix, you can directly use OpenSSH:

```
~$ ssh -p 8101 karaf@localhost
Authenticated with partial success.
Authenticated with partial success.
Authenticated with partial success.
Password authentication
Password:
```

```
        __ __                  ____
       / //_/____ _____ _____ / __/
      / ,<  / __ `/ ___/ __ `/ /_
     / /| |/ /_/ / /  / /_/ / __/
    /_/ |_|\__,_/_/   \__,_/_/

  Apache Karaf (4.0.0)

Hit '<tab>' for a list of available commands
and '[cmd] --help' for help on a specific command.
Hit 'system:shutdown' to shutdown Karaf.
Hit '<ctrl-d>' or type 'logout' to disconnect shell from current session.

karaf@root()>
```

On Windows, you can use Putty, Kitty, etc.

If you don't have SSH client installed on your machine, you can use Apache Karaf client.

33.1.2.2. ssh : ssh command

Apache Karaf itself provides a SSH client. When you are on the Apache Karaf console, you have the **ssh : ssh** command:

```
karaf@root()> ssh:ssh --help
DESCRIPTION
        ssh:ssh

        Connects to a remote SSH server

SYNTAX
        ssh:ssh [options] hostname [command]

ARGUMENTS
        hostname
                The host name to connect to via SSH
        command
                Optional command to execute

OPTIONS
        --help
                Display this help message
        -p, --port
                The port to use for SSH connection
                (defaults to 22)
        -P, --password
                The password for remote login
        -q
                Quiet Mode. Do not ask for confirmations
        -l, --username
                The user name for remote login
```

Thanks to the **ssh : ssh** command, you can connect to another running Apache Karaf instance:

```
karaf@root()> ssh:ssh -p 8101 karaf@192.168.134.2
```

```
Connecting to host 192.168.134.2 on port 8101
Connecting to unknown server. Add this server to known hosts ? (y/n)
Storing the server key in known_hosts.
Connected
        __ __                  ____
       / //_/____ _____ _____ / __/
      / ,<  / __ `/ ___/ __ `/ /_
     / /| |/ /_/ / /  / /_/ / __/
    /_/ |_|\__,_/_/   \__,_/_/

  Apache Karaf (4.0.0)

Hit '<tab>' for a list of available commands
and '[cmd] --help' for help on a specific command.
Hit 'system:shutdown' to shutdown Karaf.
Hit '<ctrl-d>' or type 'logout' to disconnect shell from current session.

karaf@root()>
```

When you don't provide the **command** argument to the **ssh:ssh** command, you are in the interactive mode: you have a complete remote console available, where you can type commands, etc.

You can also provide directly a command to execute using the **command** argument. For instance, to remotely shutdown a Apache Karaf instance:

```
karaf@root()> ssh:ssh -p 8101 karaf@localhost system:shutdown -f
Connecting to host localhost on port 8101
Connected
```

As the **ssh:ssh** command is a pure SSH client, so it means that you can connect to a Unix OpenSSH daemon:

```
karaf@root()> ssh:ssh user@localhost
Connecting to host localhost on port 22
Connecting to unknown server. Add this server to known hosts ? (y/n)
Storing the server key in known_hosts.
Agent authentication failed, falling back to password authentication.
Password: Connected
Last login: Sun Sep  8 19:21:12 2013
user@server:~$
```

33.1.2.3. Apache Karaf client

The **ssh:ssh** command requires to be run into a running Apache Karaf console.

For commodity, the **ssh:ssh** command is "wrapped" as a standalone client: the **bin/client** Unix script (**bin\client.bat** on Windows).

```
bin/client --help
Apache Karaf client
  -a [port]     specify the port to connect to
  -h [host]     specify the host to connect to
  -u [user]     specify the user name
  --help        shows this help message
```

```
  -v            raise verbosity
  -r [attempts] retry connection establishment (up to attempts times)
  -d [delay]    intra-retry delay (defaults to 2 seconds)
  -b            batch mode, specify multiple commands via standard input
  -f [file]     read commands from the specified file
  [commands]    commands to run
If no commands are specified, the client will be put in an interactive
mode
```

For instance, to connect to local Apache Karaf instance (on the default SSHd server 8101 port), you can directly use **bin/client** Unix script (**bin\client.bat** on Windows) without any argument or option:

```
bin/client
Logging in as karaf
343 [pool-2-thread-4] WARN
org.apache.sshd.client.keyverifier.AcceptAllServerKeyVerifier - Server at
/0.0.0.0:8101 presented unverified key:
        __ __                  ____
       / //_/____ _____ _____ / __/
      / ,<  / __ `/ ___/ __ `/ /_
     / /| |/ /_/ / /  / /_/ / __/
    /_/ |_|\__,_/_/   \__,_/_/

  Apache Karaf (4.0.0)

Hit '<tab>' for a list of available commands
and '[cmd] --help' for help on a specific command.
Hit 'system:shutdown' to shutdown Karaf.
Hit '<ctrl-d>' or type 'logout' to disconnect shell from current session.

karaf@root()>
```

When you don't provide the **command** argument to the **bin/client** Unix script (**bin\client.bat** on Windows), you are in the interactive mode: you have a complete remote console available, where you can type commands, etc.

You can also provide directly a command to execute using the **command** argument. For instance, to remotely shutdown a Apache Karaf instance:

```
bin/client "system:shutdown -f"
Logging in as karaf
330 [pool-2-thread-3] WARN
org.apache.sshd.client.keyverifier.AcceptAllServerKeyVerifier - Server at
/0.0.0.0:8101 presented unverified key:
```

As the Apache Karaf client is a pure SSH client, you can use to connect to any SSHd daemon (like Unix OpenSSH daemon):

```
bin/client -a 22 -h localhost -u user
Logging in as user
353 [pool-2-thread-2] WARN
org.apache.sshd.client.keyverifier.AcceptAllServerKeyVerifier - Server at
localhost/127.0.0.1:22 presented unverified key:
Password:
Welcome to Ubuntu 13.10 (GNU/Linux 3.11.0-13-generic x86_64)
```

```
 * Documentation:  https://help.ubuntu.com/

Last login: Tue Dec  3 18:18:31 2013 from localhost
```

33.1.2.4. Logout

When you are connected to a remote Apache Karaf console, you can logout using:

- using CTRL-D key binding. Note that CTRL-D just logout from the remote console in this case, it doesn't shutdown the Apache Karaf instance (as CTRL-D does when used on a local console).
- using **`shell:logout`** command (or simply **`logout`**)

33.1.3. Filsystem clients

Apache Karaf SSHd server also provides complete fileystem access via SSH. For security reason, the available filesystem is limited to **KARAF_BASE** directory.

You can use this remote filesystem with any SCP/SFTP compliant clients.

33.1.3.1. Native SCP/SFTP clients

On Unix, you can directly use **`scp`** command to download/upload files to the Apache Karaf filesystem. For instance, to retrieve the **`karaf.log`** file remotely:

```
~$ scp -P 8101 karaf@localhost:/data/log/karaf.log .
Authenticated with partial success.
Authenticated with partial success.
Authenticated with partial success.
Password authentication
Password:
karaf.log
```

As you have access to the complete **KARAF_BASE** directory, you can remotely change the configuration file in the **`etc`** folder, retrieve log files, populate the **`system`** folder.

On Windows, you can use WinSCP to access the Apache Karaf filesystem.

It's probably easier to use a SFTP complient client.

For instance, on Unix system, you can use **`lftp`** or **`ncftp`**:

```
$ lftp
lftp :~> open -u karaf sftp://localhost:8101
Password:
lftp karaf@localhost:~> ls
-rw-r--r--   1 jbonofre jbonofre    27754 Oct 26 10:50 LICENSE
-rw-r--r--   1 jbonofre jbonofre     1919 Dec  3 05:34 NOTICE
-rw-r--r--   1 jbonofre jbonofre     3933 Aug 18  2012 README
-rw-r--r--   1 jbonofre jbonofre   101041 Dec  3 05:34 RELEASE-NOTES
drwxr-xr-x   1 jbonofre jbonofre     4096 Dec  3 12:51 bin
drwxr-xr-x   1 jbonofre jbonofre     4096 Dec  3 18:57 data
drwxr-xr-x   1 jbonofre jbonofre     4096 Dec  3 12:51 demos
```

```
drwxr-xr-x   1 jbonofre jbonofre     4096 Dec  3 13:02 deploy
drwxr-xr-x   1 jbonofre jbonofre     4096 Dec  3 17:59 etc
drwxr-xr-x   1 jbonofre jbonofre     4096 Dec  3 13:02 instances
drwxr-xr-x   1 jbonofre jbonofre     4096 Dec  3 13:02 lib
-rw-r--r--   1 jbonofre jbonofre        0 Dec  3 13:02 lock
drwxr-xr-x   1 jbonofre jbonofre     4096 Dec  3 12:51 system
lftp karaf@localhost:/>
```

You can also use graphic client like **filezilla**, **gftp**, **nautilus**, etc.

On Windows, you can use **filezilla**, **WinSCP**, etc.

33.1.3.2. Apache Maven

Apache Karaf **system** folder is the Karaf repository, that use a Maven directory structure. It's where Apache Karaf looks for the artifacts (bundles, features, kars, etc).

Using Apache Maven, you can populate the **system** folder using the **deploy:deploy-file** goal.

For instance, you want to add the Apache ServiceMix facebook4j OSGi bundle, you can do:

```
mvn deploy:deploy-file -Dfile=org.apache.servicemix.bundles.facebook4j-
2.0.2_1.jar -DgroupId=org.apache.servicemix.bundles -
DartifactId=org.apache.servicemix.bundles.facebook4j -Dversion=2.0.2_1 -
Dpackaging=jar -Durl=scp://localhost:8101/system
```

NOTE

If you want to turn Apache Karaf as a simple Maven repository, you can use Apache Karaf Cave.

33.2. JMX MBEANSERVER

Apache Karaf provides a JMX MBeanServer.

This MBeanServer is available remotely, using any JMX client like **jconsole**.

You can find details on the [Monitoring section|monitoring] of the user guide.

CHAPTER 34. BUILDING WITH MAVEN

Abstract

Maven is an open source build system which is available from the Apache Maven project. This chapter explains some of the basic Maven concepts and describes how to set up Maven to work with Red Hat JBoss Fuse. In principle, you could use any build system to build an OSGi bundle. But Maven is strongly recommended, because it is well supported by Red Hat JBoss Fuse.

CHAPTER 35. MAVEN DIRECTORY STRUCTURE

35.1. OVERVIEW

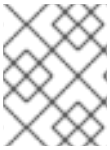
One of the most important principles of the Maven build system is that there are **standard locations** for all of the files in the Maven project. There are several advantages to this principle. One advantage is that Maven projects normally have an identical directory layout, making it easy to find files in a project. Another advantage is that the various tools integrated with Maven need almost **no** initial configuration. For example, the Java compiler knows that it should compile all of the source files under `src/main/java` and put the results into `target/classes`.

35.2. STANDARD DIRECTORY LAYOUT

Example 35.1, “Standard Maven Directory Layout” shows the elements of the standard Maven directory layout that are relevant to building OSGi bundle projects. In addition, the standard locations for Blueprint configuration files (which are **not** defined by Maven) are also shown.

Example 35.1. Standard Maven Directory Layout

```
ProjectDir/
    pom.xml
    src/
        main/
            java/
                ...
            resources/
                META-INF/

                OSGI-INF/
                    blueprint/
                        *.xml
        test/
            java/
            resources/
    target/
        ...
```



NOTE

It is possible to override the standard directory layout, but this is **not** a recommended practice in Maven.

35.3. POM.XML FILE

The `pom.xml` file is the Project Object Model (POM) for the current project, which contains a complete description of how to build the current project. A `pom.xml` file can be completely self-contained, but frequently (particular for more complex Maven projects) it can import settings from a *parent POM* file.

After building the project, a copy of the `pom.xml` file is automatically embedded at the following location in the generated JAR file:

```
META-INF/maven/groupId/artifactId/pom.xml
```

35.4. SRC AND TARGET DIRECTORIES

The **src/** directory contains all of the code and resource files that you will work on while developing the project.

The **target/** directory contains the result of the build (typically a JAR file), as well as all all of the intermediate files generated during the build. For example, after performing a build, the **target/classes/** directory will contain a copy of the resource files and the compiled Java classes.

35.5. MAIN AND TEST DIRECTORIES

The **src/main/** directory contains all of the code and resources needed for building the artifact.

The **src/test/** directory contains all of the code and resources for running unit tests against the compiled artifact.

35.6. JAVA DIRECTORY

Each **java/** sub-directory contains Java source code (***.java** files) with the standard Java directory layout (that is, where the directory pathnames mirror the Java package names, with **/** in place of the **.** character). The **src/main/java/** directory contains the bundle source code and the **src/test/java/** directory contains the unit test source code.

35.7. RESOURCES DIRECTORY

If you have any configuration files, data files, or Java properties to include in the bundle, these should be placed under the **src/main/resources/** directory. The files and directories under **src/main/resources/** will be copied into the root of the JAR file that is generated by the Maven build process.

The files under **src/test/resources/** are used only during the testing phase and will **not** be copied into the generated JAR file.

35.8. BLUEPRINT CONTAINER

OSGi R4.2 defines a Blueprint container. Red Hat JBoss Fuse has built-in support for the Blueprint container, which you can enable simply by including Blueprint configuration files, **OSGI-INF/blueprint/*.xml**, in your project. For more details about the Blueprint container, see Chapter 20, *OSGi Services*.

CHAPTER 36. PREPARING TO USE MAVEN

36.1. OVERVIEW

This section gives a brief overview of how to prepare Maven for building Red Hat JBoss Fuse projects and introduces the concept of Maven coordinates, which are used to locate Maven artifacts.

36.2. PREREQUISITES

In order to build a project using Maven, you must have the following prerequisites:

- **Maven installation** — Maven is a free, open source build tool from Apache. You can download the latest version from the Maven download page.
- **Network connection** — whilst performing a build, Maven dynamically searches external repositories and downloads the required artifacts on the fly. By default, Maven looks for repositories that are accessed over the Internet. You can change this behavior so that Maven will prefer searching repositories that are on a local network.

NOTE

Maven can run in an offline mode. In offline mode Maven only looks for artifacts in its local repository.

36.3. ADDING THE RED HAT MAVEN REPOSITORIES

In order to access artifacts from the Red Hat Maven repositories, you need to add them to Maven's `settings.xml` file. Maven looks for your `settings.xml` file in the `.m2` directory of the user's home directory. If there is not a user specified `settings.xml` file, Maven will use the system-level `settings.xml` file at `M2_HOME/conf/settings.xml`.

To add the Red Hat repositories to Maven's list of repositories, you can either create a new `.m2/settings.xml` file or modify the system-level settings. In the `settings.xml` file, add `repository` elements for the Red Hat repositories as shown in Adding the Red Hat JBoss Fuse Repositories to Maven.

Adding the Red Hat JBoss Fuse Repositories to Maven

```
<?xml version="1.0"?>
<settings>

  <profiles>
    <profile>
      <id>extra-repos</id>
      <activation>
        <activeByDefault>true</activeByDefault>
      </activation>
      <repositories>
       <repository>
            <id>redhat-ga-repository</id>
            <url>https://maven.repository.redhat.com/ga</url>
            <releases>
                <enabled>true</enabled>
```

```
            </releases>
            <snapshots>
                <enabled>false</enabled>
            </snapshots>
        </repository>
        <repository>
            <id>redhat-ea-repository</id>

<url>https://maven.repository.redhat.com/earlyaccess/all</url>
            <releases>
                <enabled>true</enabled>
            </releases>
            <snapshots>
                <enabled>false</enabled>
            </snapshots>
        </repository>
        <repository>
          <id>jboss-public</id>
          <name>JBoss Public Repository Group</name>

<url>https://repository.jboss.org/nexus/content/groups/public/</url>
        </repository>
      </repositories>
      <pluginRepositories>
        <pluginRepository>
            <id>redhat-ga-repository</id>
            <url>https://maven.repository.redhat.com/ga</url>
            <releases>
                <enabled>true</enabled>
            </releases>
            <snapshots>
                <enabled>false</enabled>
            </snapshots>
        </pluginRepository>
        <pluginRepository>
            <id>redhat-ea-repository</id>

<url>https://maven.repository.redhat.com/earlyaccess/all</url>
            <releases>
                <enabled>true</enabled>
            </releases>
            <snapshots>
                <enabled>false</enabled>
            </snapshots>
        </pluginRepository>
        <pluginRepository>
          <id>jboss-public</id>
          <name>JBoss Public Repository Group</name>

<url>https://repository.jboss.org/nexus/content/groups/public</url>
        </pluginRepository>
      </pluginRepositories>
    </profile>
  </profiles>

  <activeProfiles>
```

```
    <activeProfile>extra-repos</activeProfile>
  </activeProfiles>

</settings>
```

36.4. ARTIFACTS

The basic building block in the Maven build system is an *artifact*. The output of an artifact, after performing a Maven build, is typically an archive, such as a JAR or a WAR.

36.5. MAVEN COORDINATES

A key aspect of Maven functionality is the ability to locate artifacts and manage the dependencies between them. Maven defines the location of an artifact using the system of *Maven coordinates*, which uniquely define the location of a particular artifact. A basic coordinate tuple has the form, **{*groupId*, *artifactId*, *version*}**. Sometimes Maven augments the basic set of coordinates with the additional coordinates, *packaging* and *classifier*. A tuple can be written with the basic coordinates, or with the additional *packaging* coordinate, or with the addition of both the *packaging* and *classifier* coordinates, as follows:

```
groupId:artifactId:version
groupId:artifactId:packaging:version
groupId:artifactId:packaging:classifier:version
```

Each coordinate can be explained as follows:

groupdId

Defines a scope for the name of the artifact. You would typically use all or part of a package name as a group ID — for example, **`org.fusesource.example`**.

artifactId

Defines the artifact name (relative to the group ID).

version

Specifies the artifact's version. A version number can have up to four parts: **`n.n.n.n`**, where the last part of the version number can contain non-numeric characters (for example, the last part of **`1.0-SNAPSHOT`** is the alphanumeric substring, **`0-SNAPSHOT`**).

packaging

Defines the packaged entity that is produced when you build the project. For OSGi projects, the packaging is **`bundle`**. The default value is **`jar`**.

classifier

Enables you to distinguish between artifacts that were built from the same POM, but have different content.

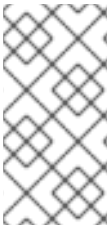
The group ID, artifact ID, packaging, and version are defined by the corresponding elements in an artifact's POM file. For example:

```
<project ... >
  ...
  <groupId>org.fusesource.example</groupId>
  <artifactId>bundle-demo</artifactId>
  <packaging>bundle</packaging>
```

```
  <version>1.0-SNAPSHOT</version>
  ...
</project>
```

For example, to define a dependency on the preceding artifact, you could add the following **dependency** element to a POM:

```
<project ... >
  ...
  <dependencies>
    <dependency>
      <groupId>org.fusesource.example</groupId>
      <artifactId>bundle-demo</artifactId>
      <version>1.0-SNAPSHOT</version>
    </dependency>
  </dependencies>
  ...
</project>
```



NOTE

It is **not** necessary to specify the **bundle** package type in the preceding dependency, because a bundle is just a particular kind of JAR file and **jar** is the default Maven package type. If you do need to specify the packaging type explicitly in a dependency, however, you can use the **type** element.

CHAPTER 37. MAVEN INDEXER PLUGIN

The Maven Indexer Plugin is required for the Maven plugin to enable it to quickly search Maven Central for artifacts.

To Deploy the Maven Indexer plugin use the following commands:

Deploy the Maven Indexer Plugin

1. In the Container perspective go to the Karaf console and enter the following command to install the Maven Indexer plugin:

   ```
   features:install hawtio-maven-indexer
   ```

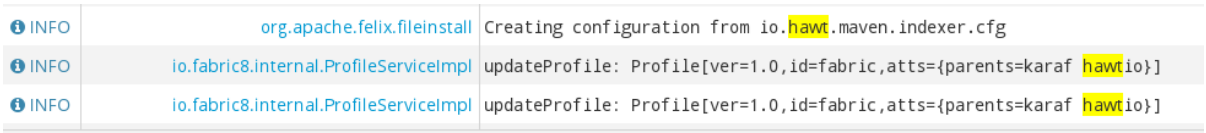
   In the Fabric perspective go to the Karaf console and add the feature to a profile:

   ```
   fabric:profile-edit --features hawtio-maven-indexer jboss-fuse-full
   ```

2. For both perspectives, the rest of the commands are the same. Enter the following commands to configure the Maven Indexer plugin:

   ```
   config:edit io.hawt.maven.indexer
   config:proplist
   config:propset repositories 'https://maven.oracle.com'
   config:proplist
   config:update
   ```

3. Wait for the Maven Indexer plugin to be deployed. This may take a few minutes. Look out for messages like those shown below to appear on the log tab.

When the Maven Indexer plugin has been deployed, use the following commands to add further external Maven repositories to the Maven Indexer plugin configuration:

```
config:edit io.hawt.maven.indexer
config:proplist
config:propset repositories external repository
config:proplist
config:update
```

CHAPTER 38. SECURITY

Apache Karaf provides an advanced and flexible security system, powered by JAAS (Java Authentication and Authorization Service) in an OSGi compliant way.

It provides a dynamic security system.

The Apache Karaf security framework is used internally to control the access to:

- the OSGi services (described in the developer guide)
- the console commands
- the JMX layer
- the WebConsole

Your applications can also use the security framework (see the developer guide for details).

38.1. REALMS

Apache Karaf is able to manage multiple realms. A realm contains the definition of the login modules to use for the authentication and/or authorization on this realm. The login modules define the authentication and authorization for the realm.

The **`jaas:realm-list`** command list the current defined realms:

```
karaf@root()> jaas:realm-list
Index | Realm Name | Login Module Class Name
-------------------------------------------------------------------------
-------------
1     | karaf      |
org.apache.karaf.jaas.modules.properties.PropertiesLoginModule
2     | karaf      |
org.apache.karaf.jaas.modules.publickey.PublickeyLoginModule
```

You can see that the Apache Karaf provides a default realm named **`karaf`**.

This realm has two login modules:

- the **`PropertiesLoginModule`** uses the **`etc/users.properties`** file as backend for users, groups, roles and password. This login module authenticates the users and returns the users' roles.
- the **`PublickeyLoginModule`** is especially used by the SSHd. It uses the **`etc/keys.properties`** file. This file contains the users and a public key associated to each user.

Apache Karaf provides additional login modules (see the developer guide for details):

- JDBCLoginModule uses a database as backend
- LDAPLoginModule uses a LDAP server as backend
- SyncopeLoginModule uses Apache Syncope as backend

- OsgiConfigLoginModule uses a configuration as backend
- Krb5LoginModule uses a Kerberos Server as backend
- GSSAPILdapLoginModule uses a LDAP server as backend but delegate LDAP server authentication to an other backend (typically Krb5LoginModule)

You can manage an existing realm, login module, or create your own realm using the **`jaas:realm-manage`** command.

38.1.1. Users, groups, roles, and passwords

As we saw, by default, Apache Karaf uses a PropertiesLoginModule.

This login module uses the **`etc/users.properties`** file as storage for the users, groups, roles and passwords.

The initial **`etc/users.properties`** file contains:

```
################################################################################
######
#
#    Licensed to the Apache Software Foundation (ASF) under one or more
#    contributor license agreements.  See the NOTICE file distributed with
#    this work for additional information regarding copyright ownership.
#    The ASF licenses this file to You under the Apache License, Version
2.0
#    (the "License"); you may not use this file except in compliance with
#    the License.  You may obtain a copy of the License at
#
#       http://www.apache.org/licenses/LICENSE-2.0
#
#    Unless required by applicable law or agreed to in writing, software
#    distributed under the License is distributed on an "AS IS" BASIS,
#    WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
implied.
#    See the License for the specific language governing permissions and
#    limitations under the License.
#
################################################################################
######

#
# This file contains the users, groups, and roles.
# Each line has to be of the format:
#
# USER=PASSWORD,ROLE1,ROLE2,...
# USER=PASSWORD,_g_:GROUP,...
# _g_\:GROUP=ROLE1,ROLE2,...
#
# All users, grousp, and roles entered in this file are available after
Karaf startup
# and modifiable via the JAAS command group. These users reside in a JAAS
domain
# with the name "karaf".
```

```
#
karaf = karaf,_g_:admingroup
_g_\:admingroup = group,admin,manager,viewer
```

We can see in this file, that we have one user by default: **karaf**. The default password is **karaf**.

The **karaf** user is member of one group: the **admingroup**.

A group is always prefixed by ***g:***. An entry without this prefix is an user.

A group defines a set of roles. By default, the **admingroup** defines **group**, **admin**, **manager**, and **viewer** roles.

It means that the **karaf** user will have the roles defined by the **admingroup**.

38.1.1.1. Commands

The **jaas:*** commands manage the realms, users, groups, roles in the console.

38.1.1.1.1. jaas:realm-list

We already used the **jaas:realm-list** previously in this section.

The **jaas:realm-list** command list the realm and the login modules for each realm:

```
karaf@root()> jaas:realm-list
Index | Realm Name | Login Module Class Name
------------------------------------------------------------------------
-------------
1     | karaf      |
org.apache.karaf.jaas.modules.properties.PropertiesLoginModule
2     | karaf      |
org.apache.karaf.jaas.modules.publickey.PublickeyLoginModule
```

We have here one realm (**karaf**) containing two login modules (**PropertiesLoginModule** and **PublickeyLoginModule**).

The **index** is used by the **jaas:realm-manage** command to easily identify the realm/login module that we want to manage.

38.1.1.1.2. jaas:realm-manage

The **jaas:realm-manage** command switch in realm/login module edit mode, where you can manage the users, groups, and roles in the login module.

To identify the realm and login module that you want to manage, you can use the **--index** option. The indexes are displayed by the **jaas:realm-list** command:

```
karaf@root()> jaas:realm-manage --index 1
```

Another way is to use the **--realm** and **--module** options. The **--realm** option expects the realm name, and the **--module** option expects the login module class name:

```
karaf@root()> jaas:realm-manage --realm karaf --module
```

```
org.apache.karaf.jaas.modules.properties.PropertiesLoginModule
```

38.1.1.1.3. `jaas:user-list`

When you are in edit mode, you can list the users in the login module using the **`jaas:user-list`**:

```
karaf@root()> jaas:user-list
User Name | Group      | Role
--------------------------------
karaf     | admingroup | admin
karaf     | admingroup | manager
karaf     | admingroup | viewer
```

You can see the user name and the group by role.

38.1.1.1.4. `jaas:user-add`

The **`jaas:user-add`** command adds a new user (and the password) in the currently edited login module:

```
karaf@root()> jaas:user-add foo bar
```

To "commit" your change (here the user addition), you have to execute the **`jaas:update`** command:

```
karaf@root()> jaas:update
karaf@root()> jaas:realm-manage --index 1
karaf@root()> jaas:user-list
User Name | Group      | Role
--------------------------------
karaf     | admingroup | admin
karaf     | admingroup | manager
karaf     | admingroup | viewer
foo       |            |
```

On the other hand, if you want to rollback the user addition, you can use the **`jaas:cancel`** command.

38.1.1.1.5. `jaas:user-delete`

The **`jaas:user-delete`** command deletes an user from the currently edited login module:

```
karaf@root()> jaas:user-delete foo
```

Like for the **`jaas:user-add`** command, you have to use the **`jaas:update`** to commit your change (or **`jaas:cancel`** to rollback):

```
karaf@root()> jaas:update
karaf@root()> jaas:realm-manage --index 1
karaf@root()> jaas:user-list
User Name | Group      | Role
--------------------------------
karaf     | admingroup | admin
karaf     | admingroup | manager
karaf     | admingroup | viewer
```

38.1.1.1.6. `jaas:group-add`

The **`jaas:group-add`** command assigns a group (and eventually creates the group) to an user in the currently edited login module:

```
karaf@root()> jaas:group-add karaf mygroup
```

38.1.1.1.7. `jaas:group-delete`

The **`jaas:group-delete`** command removes an user from a group in the currently edited login module:

```
karaf@root()> jaas:group-delete karaf mygroup
```

38.1.1.1.8. `jaas:group-role-add`

The **`jaas:group-role-add`** command adds a role in a group in the currently edited login module:

```
karaf@root()> jaas:group-role-add mygroup myrole
```

38.1.1.1.9. `jaas:group-role-delete`

The **`jaas:group-role-delete`** command removes a role from a group in the currently edited login module:

```
karaf@root()> jaas:group-role-delete mygroup myrole
```

38.1.1.1.10. `jaas:update`

The **`jaas:update`** command commits your changes in the login module backend. For instance, in the case of the PropertiesLoginModule, the **`etc/users.properties`** will be updated only after the execution of the **`jaas:update`** command.

38.1.1.1.11. `jaas:cancel`

The **`jaas:cancel`** command rollback your changes and doesn't update the login module backend.

38.1.2. Passwords encryption

By default, the passwords are stored in clear form in the **`etc/users.properties`** file.

It's possible to enable encryption in the **`etc/org.apache.karaf.jaas.cfg`** configuration file:

```
################################################################################
######
#
#    Licensed to the Apache Software Foundation (ASF) under one or more
#    contributor license agreements.  See the NOTICE file distributed with
#    this work for additional information regarding copyright ownership.
```

```
#    The ASF licenses this file to You under the Apache License, Version
2.0
#    (the "License"); you may not use this file except in compliance with
#    the License.  You may obtain a copy of the License at
#
#       http://www.apache.org/licenses/LICENSE-2.0
#
#    Unless required by applicable law or agreed to in writing, software
#    distributed under the License is distributed on an "AS IS" BASIS,
#    WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
implied.
#    See the License for the specific language governing permissions and
#    limitations under the License.
#
##############################################################################
######

#
# Boolean enabling / disabling encrypted passwords
#
encryption.enabled = false

#
# Encryption Service name
#   the default one is 'basic'
#   a more powerful one named 'jasypt' is available
#       when installing the encryption feature
#
encryption.name =

#
# Encryption prefix
#
encryption.prefix = {CRYPT}

#
# Encryption suffix
#
encryption.suffix = {CRYPT}

#
# Set the encryption algorithm to use in Karaf JAAS login module
# Supported encryption algorithms follow:
#   MD2
#   MD5
#   SHA-1
#   SHA-256
#   SHA-384
#   SHA-512
#
encryption.algorithm = MD5

#
# Encoding of the encrypted password.
# Can be:
#   hexadecimal
```

```
#   base64
#
encryption.encoding = hexadecimal
```

If the **encryption.enabled** property is set to true, the password encryption is enabled.

With encryption enabled, the password are encrypted at the first time an user logs in. The encrypted passwords are prefixed and suffixed with **\{CRYPT\}**. To re-encrypt the password, you can reset the password in clear (in **etc/users.properties** file), without the **\{CRYPT\}** prefix and suffix. Apache Karaf will detect that this password is in clear (because it's not prefixed and suffixed with **\{CRYPT\}**) and encrypt it again.

The **etc/org.apache.karaf.jaas.cfg** configuration file allows you to define advanced encryption behaviours:

- the **encryption.prefix** property defines the prefix to "flag" a password as encrypted. The default is **\{CRYPT\}**.
- the **encryption.suffix** property defines the suffix to "flag" a password as encrypted. The default is **\{CRYPT\}**.
- the **encryption.algorithm** property defines the algorithm to use for encryption (digest). The possible values are **MD2**, **MD5**, **SHA-1**, **SHA-256**, **SHA-384**, **SHA-512**. The default is **MD5**.
- the **encryption.encoding** property defines the encoding of the encrypted password. The possible values are **hexadecimal** or **base64**. The default value is **hexadecimal**.

38.1.3. Managing authentication by key

For the SSH layer, Karaf supports the authentication by key, allowing to login without providing the password.

The SSH client (so bin/client provided by Karaf itself, or any ssh client like OpenSSH) uses a public/private keys pair that will identify himself on Karaf SSHD (server side).

The keys allowed to connect are stored in **etc/keys.properties** file, following the format:

```
user=key,role
```

By default, Karaf allows a key for the karaf user:

```
#
karaf=AAAAB3NzaC1kc3MAAACBAP1/U4EddRIpUt9KnC7s5Of2EbdSPO9EAMMeP4C2USZpRV1A
IlH7WT2NWPq/xfW6MPbLm1Vs14E7gB00b/JmYLdrmVClpJ+f6AR7ECLCT7up1/63xhv4O1fnxq
imFQ8E+4P208UewwI1VBNaFpEy9nXzrith1yrv8iIDGZ3RSAHHAAAAFQCXYFCPFSMLzLKSuYKi
64QL8Fgc9QAAAIEA9+GghdabPd7LvKtcNrhXuXmUr7v6OuqC+VdMCz0HgmdRWVeOutRZT+ZxBx
CBgLRJFnEj6EwoFhO3zwkyjMim4TwWeotUfI0o4KOuHiuzpnWRbqN/C/ohNWLx+2J6ASQ7zKTx
vqhRkImog9/hWuWfBpKLZl6Ae1UlZAFMO/7PSSoAAACBAKKSU2PFl/qOLxIwmBZPPIcJshVe7b
VUpFvyl3BbJDow8rXfskl8wO63OzP/qLmcJM0+JbcRU/53JjTuyk31drV2qxhIOsLDC9dGCWj4
7Y7TyhPdXh/0dthTRBy6bqGtRPxGa7gJov1xm/UuYYXPIUR/3x9MAZvZ5xvE0kYXO+rx,admin
```

NOTE

For security reason, this key is disabled. We encourage to create the keys pair per client and update the **etc/keys.properties** file.

The easiest way to create key pair is to use OpenSSH.

You can create a key pair using:

```
ssh-keygen -t dsa -f karaf.id_dsa -N karaf
```

You have now the public and private keys:

```
-rw-------  1 jbonofre jbonofre    771 Jul 25 22:05 karaf.id_dsa
-rw-r--r--  1 jbonofre jbonofre    607 Jul 25 22:05 karaf.id_dsa.pub
```

You can copy in the content of the **karaf.id_dsa.pub** file in the **etc/keys.properties**:

```
karaf=AAAAB3NzaC1kc3MAAACBAJLj9vnEhu3/Q9Cvym2jRDaNWkATgQiHZxmErCmiLRuD5Klf
v+HT/+8WoYdnvj0YaXFP80phYhzZ7fbIO2LRFhYhPmGLa9nSeOsQlFuX5A9kY1120yB2kxSIZI
0fU2hy1UCgmTxdTQPSYtdWBJyvO/vczoX/8I3FziEfss07Hj1NAAAAFQD1dKEzkt4e7rBPDokP
OMZigBh4kwAAAIEAiLnpbGNbKm8SNLUEc/fJFswg4G4VjjngjbPZAjhkYe4+H2uYmynry6V+GO
TS2kaFQGZRf9XhSpSwfdxKtx7vCCaoH9bZ6S5Pe0voWmeBhJXi/Sww8f2stpitW2Oq7V7lDdDG
81+N/D7/rKDD5PjUyMsVqc1n9wCTmfqmi6XPEw8AAACAHAGwPn/Mv7P9Q9+JZRWtGq+i4pL1zs
1OluiStCN9e/Ok96t3gRVKPheQ6IwLacNjC9KkSKrLtsVyepGA+V5j/N+Cmsl6csZilnLvMUTv
L/cmHDEEhTIQnPNrDDv+tED2BFqkajQqYLgMWeGVqXsBU6IT66itZlYtrq4v6uDQG/o=,admin
```

and specify to the client to use the **karaf.id_dsa** private key:

```
bin/client -k ~/karaf.id_dsa
```

or to ssh

```
ssh -p 8101 -i ~/karaf.id_dsa karaf@localhost
```

38.1.4. RBAC

Apache Karaf uses the roles to control the access to the resources: it's a RBAC (Role Based Access Control) system.

The roles are used to control:

- access to OSGi services
- access to the console (control the execution of the commands)
- access to JMX (MBeans and/or operations)
- access to the WebConsole

38.1.4.1. OSGi services

The details about OSGi services RBAC support is explained in the developer guide.

38.1.4.2. Console

Console RBAC supports is a specialization of the OSGi service RBAC. Actually, in Apache Karaf, all console commands are defined as OSGi services.

The console command name follows the **scope:name** format.

The ACL (Access Lists) are defined in **etc/org.apache.karaf.command.acl.<scope>.cfg** configuration files, where **<scope>** is the commands scope.

For instance, we can define the ACL to the **feature:*** commands by creating a **etc/org.apache.karaf.command.acl.feature.cfg** configuration file. In this **etc/org.apache.karaf.command.acl.feature.cfg** configuration file, we can set:

```
list = viewer
info = viewer
install = admin
uninstall = admin
```

Here, we define that **feature:list** and **feature:info** commands can be executed by users with **viewer** role, whereas the **feature:install** and **feature:uninstall** commands can only be executed by users with **admin** role. Note that users in the admin group will also have viewer role, so will be able to do everything.

Apache Karaf command ACLs can control access using (inside a given command scope):

- the command name regex (e.g. **name = role**)
- the command name and options or arguments values regex (e.g. **name[/.[0-9][0-9][0-9]+./] = role** to execute name only with argument value above 100)

Both command name and options/arguments support exact matching or regex matching.

By default, Apache Karaf defines the following commands ACLs:

- **etc/org.apache.karaf.command.acl.bundle.cfg** configuration file defines the ACL for **bundle:*** commands. This ACL limits the execution of **bundle:*** commands for system bundles only to the users with **admin** role, whereas **bundle:*** commands for non-system bundles can be executed by the users with **manager** role.
- **etc/org.apache.karaf.command.acl.config.cfg** configuration file defines the ACL for **config:*** commands. This ACL limits the execution of **config:*** commands with **jmx.acl.***, **org.apache.karaf.command.acl.***, and **org.apache.karaf.service.acl.*** configuration PID to the users with **admin** role. For the other configuration PID, the users with the **manager** role can execute **config:*** commands.
- **etc/org.apache.karaf.command.acl.feature.cfg** configuration file defines the ACL for **feature:*** commands. Only the users with **admin** role can execute **feature:install** and **feature:uninstall** commands. The other **feature:*** commands can be executed by any user.
- **etc/org.apache.karaf.command.acl.jaas.cfg** configuration file defines the ACL for **jaas:*** commands. Only the users with **admin** role can execute **jaas:update** command. The other **jaas:*** commands can be executed by any user.

- **etc/org.apache.karaf.command.acl.kar.cfg** configuration file defines the ACL for **kar:*** commands. Only the users with **admin** role can execute **kar:install** and **kar:uninstall** commands. The other **kar:*** commands can be executed by any user.

- **etc/org.apache.karaf.command.acl.shell.cfg** configuration file defines the ACL for **shell:*** and "direct" commands. Only the users with **admin** role can execute **shell:edit**, **shell:exec**, **shell:new**, and **shell:java** commands. The other **shell:*** commands can be executed by any user.

You can change these default ACLs, and add your own ACLs for additional command scopes (for instance **etc/org.apache.karaf.command.acl.cluster.cfg** for Apache Karaf Cellar, **etc/org.apache.karaf.command.acl.camel.cfg** from Apache Camel, ...).

You can fine tuned the command RBAC support by editing the **karaf.secured.services** property in **etc/system.properties**:

```
#
# By default, only Karaf shell commands are secured, but additional
services can be
# secured by expanding this filter
#
karaf.secured.services = (&(osgi.command.scope=*)
(osgi.command.function=*))
```

38.1.4.3. JMX

Like for the console commands, you can define ACL (AccessLists) to the JMX layer.

The JMX ACL are defined in **etc/jmx.acl<ObjectName>.cfg** configuration file, where **<ObjectName>** is a MBean object name (for instance **org.apache.karaf.bundle** represents **org.apache.karaf;type=Bundle** MBean).

The **etc/jmx.acl.cfg** is the most generic configuration file and is used when no specific ones are found. It contains the "global" ACL definition.

JMX ACLs can control access using (inside a JMX MBean):

- the operation name regex (e.g. **operation* = role**)

- the operation arguments value regex (e.g. **operation(java.lang.String, int)[/([1-4])?[0-9]/,/.*/] = role**)

By default, Apache Karaf defines the following JMX ACLs:

- **etc/jmx.acl.org.apache.karaf.bundle.cfg** configuration file defines the ACL for the **org.apache.karaf:type=bundle** MBean. This ACL limits the **setStartLevel()**, **start()**, **stop()**, and **update()** operations for system bundles for only users with **admin** role. The other operations can be performed by users with the **manager** role.

- **etc/jmx.acl.org.apache.karaf.config.cfg** configuration file defines the ACL for the **org.apache.karaf:type=config** MBean. This ACL limits the change on **jmx.acl***, **org.apache.karaf.command.acl***, and **org.apache.karaf.service.acl*** configuration PIDs for only users with **admin** role. The other operations can be performed by users with the **manager** role.

- **etc/jmx.acl.org.apache.karaf.security.jmx.cfg** configuration file defines the ACL for the **org.apache.karaf:type=security,area=jmx** MBean. This ACL limits the invocation of the **canInvoke()** operation for the users with **viewer** role.
- **etc/jmx.acl.osgi.compendium.cm.cfg** configuration file defines the ACL for the **osgi.compendium:type=cm** MBean. This ACL limits the changes on **jmx.acl***, **org.apache.karaf.command.acl***, and **org.apache.karaf.service.acl*** configuration PIDs for only users with **admin** role. The other operations can be performed by users with the **manager** role.
- **etc/jmx.acl.java.lang.Memory.cfg** configuration file defines the ACL for the core JVM Memory MBean. This ACL limits the invocation of the **gc** operation for only users with the **manager** role.
- **etc/jmx.acl.cfg** configuration file is the most generic file. The ACLs defined here are used when no other specific ACLs match (by specific ACL, it's an ACL defined in another MBean specific **etc/jmx.acl.*.cfg** configuration file). The **list()**, **get()**, **is()** operations can be performed by users with the **viewer** role. The **set()** and all other **()** operations can be performed by users with the **admin** role.

38.1.4.4. WebConsole

The Apache Karaf WebConsole is not available by default. To enable it, you have to install the **webconsole** feature:

```
karaf@root()> feature:install webconsole
```

The WebConsole doesn't support fine grained RBAC like console or JMX for now.

All users with the **admin** role can logon the WebConsole and perform any operations.

38.1.5. SecurityMBean

Apache Karaf provides a JMX MBean to check if the current user can invoke a given MBean and/or operation.

The **canInvoke()** operation gets the roles of the current user, and check if one the roles can invoke the MBean and/or the operation, eventually with a given argument value.

38.1.5.1. Operations

- **canInvoke(objectName)** returns **true** if the current user can invoke the MBean with the **objectName**, **false** else.
- **canInvoke(objectName, methodName)** returns **true** if the current user can invoke the operation **methodName** on the MBean with the **objectName**, **false** else.
- **canInvoke(objectName, methodName, argumentTypes)** returns **true** if the current user can invoke the operation **methodName** with the array of arguments types **argumentTypes** on the MBean with **objectName**, **false** else.
- **canInvoke(bulkQuery)** returns a tabular data containing for each operation in the **bulkQuery** tabular data if **canInvoke** is **true** or **false**.

38.1.6. Security providers

Some applications require specific security providers to be available, such as [BouncyCastle|http://www.bouncycastle.org].

The JVM imposes some restrictions about the use of such jars: they have to be signed and be available on the boot classpath.

One way to deploy those providers is to put them in the JRE folder at **`$JAVA_HOME/jre/lib/ext`** and modify the security policy configuration (**`$JAVA_HOME/jre/lib/security/java.security`**) in order to register such providers.

While this approach works fine, it has a global effect and requires you to configure all your servers accordingly.

Apache Karaf offers a simple way to configure additional security providers: * put your provider jar in **`lib/ext`** * modify the **`etc/config.properties`** configuration file to add the following property

```
org.apache.karaf.security.providers = xxx,yyy
```

The value of this property is a comma separated list of the provider class names to register.

For instance, to add the bouncycastle security provider, you define:

```
org.apache.karaf.security.providers =
org.bouncycastle.jce.provider.BouncyCastleProvider
```

In addition, you may want to provide access to the classes from those providers from the system bundle so that all bundles can access those.

It can be done by modifying the **`org.osgi.framework.bootdelegation`** property in the same configuration file:

```
org.osgi.framework.bootdelegation = ...,org.bouncycastle*
```