RFC 241 – Features

Draft

48 Pages

Abstract

OSGi is regularly used as a platform for running applications comprised of a large number of bundles, configurations and other artifacts. However it is lacking a developer friendly mechanism to define such applications. This RFC aims at describing a technical solution to address this challenge.

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This document can be downloaded from the OSGi Alliance design repository at https://github.com/osgi/design
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0.5 Terminology and Document Conventions

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY" and "OPTIONAL" in this document are to be interpreted as described in 10.1.

`Source code is shown in this typeface.`

0.6 Revision History

The last named individual in this history is currently responsible for this document.

Revision	Date	Comments
Initial	February 2019	David Bosschaert, initial version.
0.1	May 2019	David Bosschaert, feedback from the Berlin F2F
0.2	June 2019	David Bosschaert, feedback from the Chicago F2F
0.3	September 2019	David Bosschaert, additional changes, introduce transient extensions.
0.4	October 2019	David Bosschaert, feedback from Sofia F2F
0.5	January 2020	David Bosschaert, add Javadoc for proposed API

1 Introduction

OSGi has become a platform capable of running large applications for a variety of purposes, including rich client applications, server-side systems and cloud and container based architectures. As these applications are generally based on many bundles, describing each bundle individually in the application definition becomes unwieldy once the number of bundles reaches a certain level.

Furthermore, OSGi has no mechanism to describe other elements of the application definition, such as configuration or custom artifacts.

The requirements for a higher level to describe OSGi applications that encapsulates the details of the various components that the application is built up from are described in RFP 188. They are also available in this document. This RFC aims to describe the technical solution for the requirements identified in RFP 188. It allows the description of an entire OSGi-based application based on reusable components and includes everything related to this application, including configuration, framework properties, capabilities, requirements and custom artifacts.

2 Application Domain

When developing large enterprise applications it is often the case that very few people know the role of every bundle or configuration item in the application. To keep the architecture understandable a grouping mechanism is needed that allows for the representation of parts of the application into larger entities that keep reasoning about the application manageable. In such a domain members of teams spread across the organization will need to be able to both develop new parts for the application as well as make tweaks or enhancements to their respective parts such as adding configuration and resources or changing one or more bundles relevant to their part of the application.

The higher level constructs that define the application should be reusable in different contents, for example if one team has developed a component to handle job processing, different applications should be able to use it, and if needed tune its configuration or other aspects so that it works in each setting without having to know each and every detail, bundle etc that the job processing component is built up from.

This RFP aims solving the problem of defining (large) applications in OSGi in a way that's easy for humans and teams.

2.1 Relation to existing OSGi specifications

2.1.1 Subsystems Specification

While some might say that subsystems were designed for the purposes outlined in this RFP, subsystems are rather a possible way to implement the runtime realization of some aspects of the features. Subsystems are lacking authoring support and don't provide an architect-friendly design-time source format. Additionally, subsystems are limited to bundles, features often additionally declare configuration, custom content and

custom metadata. Experience has shown that while subsystems work, authors of large systems find it difficult to work directly with these.

2.1.2 Deployment Admin Specification

The Deployment Admin specification also defines a deployable application format. These deployables are somewhat limited in that multiple deployment admin applications cannot have overlapping bundles, making this specification not very useful as many applications share certain dependencies. Additionally, the Deployment Admin specification does not define a format to architect features.

2.1.3 Application Admin Specification

The Application Admin Specification allows the deployment and management of Applications in OSGi. This specification is primarily aimed at UI-based applications. While this application provides a run-time API for deployment and management of applications, it does not provide a way to model features and applications for a systems architect.

2.2 Relation to existing Open Source solutions

A number of existing solutions exist both in Open Source as well as in closed source. From the Open Source space Apache Karaf Features are popular, as well as Eclipse Features. Additionally Apache Felix Bundle Archives provide a mechanism that could be used to deploy features.

Apache Sling Features provide a way to design and run features using JSON.

Bnd provides a mechanism to create an application runfile from a set of seed bundles, matching requirements against capabilities provided through one or more repositories.

Knowledge of the existing solutions is used to influence the requirements in this document.

2.3 Roles

The following section outlines roles involved in the creation of Feature-based OSGi applications. Note that different roles may be performed by the same individual.

Bundle Developer – A Bundle Developer writes OSGi bundle code. The Bundle Developer typically has a small scope and focuses on individual bundles or a small number of bundles that provide a cohesive piece of functionality.

Feature Developer – A Feature Developer creates OSGi features by collecting multiple bundles together to create higher level components.

Application Architect – The Application Architect designs a product by putting a number of high-level components together in a document. She defines the interaction between components in the product, and the external interactions of the product.

Application Assembler – The Application Assembler takes the input from the Application Architect and maps it to available features and configuration. He creates a high-level feature representing the application from existing features with added configuration.

Application Deployer/Administrator – The Application Deployer takes the feature created by the Application Assembler and turns it into a runnable application. He does this by mapping all requirements to capabilities and by resolving all version ranges to a specific version. He sets configuration to integrate with external systems such as databases, external microservices and others. He then runs the application on his infrastructure.

Quality Engineer – A Quality Engineer needs to test an application before it's released. The QE may also be asked to ensure that the application still works when one or more individual bundles or features, configuration or other resources are replaced with different ones.

2.4 Terminology + Abbreviations

Feature – A feature combines a number of bundles together to provide a logical piece of functionality. Features may also depend on other features, configuration and other artifacts.

Complete Feature – A complete feature has no unresolved dependencies and has all required configuration provided. A complete feature is still a regular feature and can be used everywhere a regular feature can. However some tools or scenarios may require complete features; these cannot operate on features that are not complete.

Feature Management Agent – An entity which is capable of consuming feature models, to produce a representation for a runtime context, see also Management Agent as defined in the OSGi Core Specification.

3 Problem Description

OSGi has no support for describing large applications. Application developers need to come up with their own way to do this. When applications are getting larger and are developed by multiple teams this becomes a challenge, especially in cases where the application is composed of multiple features each of which are groups of bundles, configuration, metadata and other artifacts.

4 Requirements

This specification should meet the following requirements:

- FM010 – The feature model should be described through a text format which is easily consumable by both humans and machines, that can be edited with common editors and support text-based diff operations.
- FM020 – A feature must be described through a single file.
- FM040 – The feature model language must support comments.
- FM050 – The feature model may support more than one text-based definition language where the language used can be easily inferred, for example from the file extension.
- FM060 – The feature model should provide support for long and multi-line values without creating files that become hard to handle.
- FM070 – A feature must have a version.
- FM080 – A feature must have a unique identifier, which contains the version.

- FM090 – A feature identifier must be mappable to Apache Maven coordinates.
- FM100 – It must be possible to specify the bundles belonging to the feature, including version.
- FM111 – It must be possible to identify a bundle using repository coordinates, for example for a Maven repository.
- FM120 – The feature model must allow the specification of the order in which the bundles inside the feature are started. This should be relative to when the feature itself is started.
- FM130 – It must be possible to define whether a bundle is always enabled in a feature or conditionally enabled.
- FM140 – It must be possible to associate any additional metadata like a hash with a bundle.
- FM150 – It must be possible to specify the OSGi configurations for a feature.
- FM160 – Both normal OSGi configurations as well as factory configurations must be supported. The feature model must support all data types supported by the OSGi Configuration Admin specification.
- FM170 – The OSGi configuration resource format as defined in the OSGi Configurator Specification must be supported.
- FM180 – It must be possible to associate an OSGi configuration with a bundle within a feature. If the bundle is not enabled then the associated configuration also does not get installed.
- FM190 – It must be possible to define framework launch properties in a feature.
- FM195 – it must be possibe to define system properties in a feature.
- FM200 – The feature model must be extensible to allow other artifacts than bundles.
- FM211 – It must be possible to identify artifacts in a feature using repository coordinates, for example for a Maven repository.
- FM220 – It must be possible to associate any additional metadata like a hash with an artifact.
- FM230 – It must be possible to define whether an artifact always enabled in a feature or conditionally enabled.
- FM260 – A feature must be able to specify additional requirements and capabilities that extend the requirements and capabilities from the contained artifacts.
- FM270 – A feature must be able to use another feature as a prototype.
- FM280 – A feature must be able to depend on other features through the requirements/capabilities model based on the feature contents. The feature model must be able to deal with circular dependencies. However, there must be no way of explicitly requiring a feature from another feature.
- FM290 – The feature model must describe how several features are aggregated to build a higher level feature. This description must include all parts of the feature model (bundles, configurations, framework properties etc.). The process should be general for extensions, which means it should describe how extensions are aggregated without requiring the model implementation to know the type of extension.
- FM300 – It must be possible to declare that a feature is transitively closed, this defines a ‘Complete Feature’.

- FM305 – The solution may define a packaging format for features, including their contents.
- FM310 – When features are aggregated, to create a higher level feature, and a clash is detected wrt their contents, a conflict resolution mechanism must be defined.
- FM340 – The feature model must calculate the startup order of bundles for an aggregated feature respecting the dependencies between features and their contents.
- FM350 – The feature model must support variables to be used for configurations and framework properties, avoiding the need to repeat the same value several times, and to allow late binding.
- FM400 – It must be possible to specify the framework implementation to launch as part of the feature model.
- FM430 – The feature model must support additional, optional information about the feature like a human readable title, a description, vendor and licensing information.
- FM440 – The feature model must use a semantically versioned descriptor format so that if the format evolves in the future users can state in feature model files what version they are written for.
- FM500 – All artifacts need the ability to establish trust and detect tampering, for example via signing.
- FM510 – The feature model should support conditionally including bundles, based on system properties and/or capabilities.
- FM520 – It should be possible to specify classpath, module-path and JVM/System properties in a feature file.

5 Technical Solution

5.1 Feature Model

The central concept of this specification is the Feature Model. Each Feature defined using the Feature Model has a unique ID which includes a version. It can hold a number of entities, including a list of bundles, configurations, capabilities, requirements and others. Features are extensible, so a Feature can also hold any number of custom entities which are related to the Feature.

Features may have dependencies on other Features. Features inherit the capabilities and requirements from all bundles listed in the Feature, and can also have additional capabilities and requirements on the Feature level.

Once created, a Feature is immutable. Its definition cannot be modified. However another Feature with a different identity can be created which is based on a given Feature using the prototype mechanism.

Additionally it’s possible to record caching related information in a Feature through transient extensions, however this cached content is not significant for the definition of the Feature.

5.1.1 Identifiers in the Feature Model

Identifiers used throughout this specification are defined using the Maven Identifier model. They are composed of the following parts:

- Group ID
- Artifact ID
- Version
- Type (optional)
- Classifier (optional)

For more information see https://maven.apache.org/pom.html.

The format used to specify identifiers is as follows:

```
group-id ':' artifact-id [ ':' [type] [ ':' classifier ] ] ':' version
```

5.1.2 Feature Model Identifier

Each Feature has a unique identifier. Apart from providing a persistent handle to the Feature it also provides enough information to find the Feature in an artifact repository. This identifier is defined using the format described in section 5.1.1.

As Features are immutable, a given Feature ID always refers to the same Feature Model.

5.1.3 Bundles

Features often list a number of bundles that provide the functionality provided by the Feature. Bundles are listed by referencing them so that they can be resolved from a repository. Bundles can have metadata associated with them, such as the relative start order of the bundle in the Feature. Custom metadata can also be provided. A single Feature can provide multiple versions of the same bundle, if desired.

Bundles are referenced using the identifier format described in section 5.1.1. This means that Bundles are referenced using their Maven coordinates.

5.1.4 Configurations

Features support configuration using the OSGi Configurator syntax.

It is an error to define the same PID (or Factory PID) twice in a single feature model.

5.1.5 Framework properties

When a Feature is launched in an OSGi framework it may be necessary to specify Framework properties. These can be provided in the Framework Properties section of the Feature Model.

If a Feature Management Agent is not able to set the Framework properties it may fail.

5.1.6 Variables

Configurations and Framework Properties support late binding of values. This enables setting these items through a Management Agent, for example to specify a database user name or other information that may be variable between runtimes.

5.1.7 Prototype

If a Feature is similar to another Feature, it can use the other Feature as its prototype. Entities can be removed from the prototype and additional entities can be added in the resulting Feature. Prototypes can be used to create variants of existing Features. The newly created Features must have a different ID than the prototype they're based on.

5.2 Extensibility

Features are extensible. This means that custom content can be provided inside the Feature Model. The custom content can be used to store extra metadata in the Feature, or to define additional processing associated with the Feature. Extensions can be handled through plugins or external tools at various times in the Feature lifecycle.

Extension content can be provided in the following types:

- TEXT: the content is provided as plain text.
- JSON: the content is specified as custom JSON.
- ARTIFACTS: the content declares a list of artifacts, similar to the bundles listed in the Feature. The artifacts are expressed as Identifiers, see section 5.1.1.

Custom extensions can declare whether they need to be handled during processing. Extensions are optional by default, if the extension requires that it must be handled by a plugin during processing it can declare itself as *mandatory*. In this case, if no plugin is present to handle the extension, the entity processing the Feature should fail.

Additionally, information can be cached in Feature Model extensions using *transient* extensions. These extensions can store previously computed information to speed up later execution. Tools are permitted to enhance an existing Feature Model with transient extensions. Transient extensions are not part of the defining part of a Feature Model and adding or removing them does not alter the Feature Model definition.

5.2.1 Extension naming

To avoid name clashes, namespacing should be used for extensions. The typical reverse-dns dotted format similar to what is used for Java Packages is recommended.

Extensions without a namespace, i.e. without dots in their name, are reserved for OSGi specifications.

5.3 Aggregation

Multiple Features can be combined together into a larger Feature. This can be useful to assemble a runtime or application out of a number of smaller features, or to have all dependencies satisfied within a single Feature. A Feature which does not have any unsatisfied dependencies in the context of listed capabilities and Framework version is said to be *complete* see section 5.3.2.

When multiple Feature Models are aggregated, this must be recorded in the resulting Feature Model using the aggregate-origins extension:

```
"aggregate-origins|ARTIFACTS:false": {[
  "a:b:1", "c:d:2"
]}
```

The aggregate-origins extension should preserve the order in which Features were aggregated.

5.3.1 Merging Features

During aggregation conflict resolution may be necessary and merge strategies are needed. For example when multiple Features declare the same bundle in different versions or when multiple Features declare the same configuration PID. Additionally the aggregation process provides an opportunity for tooling to validate Features and/or the aggregation result. For example to see if the resulting aggregate is complete, or other.

Plugins can be provided that act on the merging of extensions. They can implement custom merging strategies, or otherwise act on the extensions. The operational details of these extensions are outside of the scope of this specification.

5.3.2 Feature Completeness

Feature Completeness is recorded by tooling in an extension called requirements-complete, with as context, the environmental capabilities, OSGi framework and other artifacts as provided:

```
"requirements-complete|JSON:false": {
  "environment-capabilities”: [“osgi.ee(version=1.11)”,”...java packages...”],
  "framework": ["org.osgi:core:6.0.0"],
  "provided-bundles": ["org.osgi:logging:1.1“]
}
```

5.4 Feature Descriptor

The Feature Model is commonly described using a Feature JSON file.

5.4.1 Example Feature Model

```
{
    "#": "A key that starts with a hash is a comment",
    "id": "org.foo.bar:my.app:1.0",

    "title": "A title for the feature. (optional)",
    "description": "A description for the feature. (optional)",
    "vendor": "The feature vendor, for example 'Apache Software Foundation'. (optional)",
    "license": "The license of this feature file, for example 'ASL-2'. (optional)",
    "location": "The location might be the location of the feature file or any other means
identifying where the object is defined. (optional)",

    "# A complete feature has no external dependencies": "(optional)",
    "complete": true,

    "# A final feature cannot be used as a prototype for another feature": "(optional)",
    "final": false,

    "# variables": "used in configuration and framework properties are substituted at launch time.",
    "variables": {
        "cfgvar": "somedefault",
        "org.abc.xyz": "1.2.3"
    },

    "# A prototype is another feature that is used as a prototype for this one ":
    "# Bundles, configurations and framework properties can be removed from the ",
    "# prototype. Bundles with the same artifact ID defined in the feature override ":
    "# bundles with this artifact ID in the Prototype",
    "prototype":
        {
            "id": "org.foo:some-other-feature:1.2.3",
            "removals": {
                "#": "Configurations, bundles and framework properties from the prototype can be
removed.",
                "configurations": [],
                "bundles": [],
                "framework-properties": []
            }
        },
```

```
    "# Requirements over and above the requirements in the bundles.": "",
    "requirements": [
        {
            "namespace": "osgi.contract",
            "directives": {
                "filter": "(&(osgi.contract=JavaServlet)(version=3.1))"
            }
        }
    ],

    "# Capabilities over and above the capabilities provided by the bundles referenced ":
    "# by the feature.",
    "capabilities": [
        {
            "namespace": "osgi.implementation",
            "attributes": {
                "osgi.implementation": "osgi.http",
                "version:Version": "1.1"
            },
            "directives": {
                "uses":
"javax.servlet,javax.servlet.http,org.osgi.service.http.context,org.osgi.service.http.whiteboard"
            }
        },
        {
            "namespace": "osgi.service",
            "attributes": {
                "objectClass:List<String>": "org.osgi.service.http.runtime.HttpServiceRuntime"
            },
            "directives": {
                "uses": "org.osgi.service.http.runtime,org.osgi.service.http.runtime.dto"
            }
        }
    ],

    "# Framework properties to be provided to the running OSGi Framework":"",
    "framework-properties": {
        "foo": 1,
        "org.osgi.framework.storage": "${tempdir}",
        "org.apache.felix.scr.directory": "launchpad/scr"
    },

    "# The bundles that are part of the feature. Bundles are referenced using Maven ":
    "# coordinates and can have additional metadata associated with them. Bundles can ",
    "# specified as either a simple string (the Maven coordinates of the bundle) or ":
    "# as an object with 'id' and additional metadata.",
    "bundles": [
        {
            "id": "org.foo.bar:util-bundle:2.2.0",
            "hash": "4632463464363646436",

            "#": "This is the relative start order inside the feature",
            "start-order": 5
        },
        {
            "id": "org.foo.bar:application-bundle:2.0.0",
            "start-order": 10
        },
        {
            "id": "org.foo.bar:another-bundle:2.1.0",

            "#": "OSGi start level is also supported",
            "start-level": 20
        },
        "org.foo.bar:foo-xyz:1.2.3"
    ],

    "# The configurations are specified following the format defined by the OSGi Configurator ":
    "# specification: https://osgi.org/specification/osgi.cmpn/7.0.0/service.configurator.html ",
    "# Variables declared in the variables section can be used for late binding of variables, ":
    "# they can be specified with the Launcher, or the default from the variables section is used.",
    "# Factory configurations can be specified using the named factory syntax, which separates ":
```

```
    "# The factory PID and the name with a tilde '~'",
    "configurations": {
        "my.pid": {
            "foo": 5,
            "something-enabled": false,
            "bar": "${cfgvar}",

            "# The tempdir variable is not specified at the variables section.":
            "# It needs to be provided at launch, otherwise the launch will stop.",
            "tempdir": "${tempdir}",


            "number:Integer": 7
        },
        "my.factory.pid~name": {
           "a.value":"yeah"
        }
    },
    "sql-init|TEXT:true": {
        "# create some database tables for this feature",
        "CREATE TABLE FOO (...)",
        "CREATE TABLE BAR (...)"
    },
    "my-metadata|JSON:false": {
        "scm-location": "git@github.com:myorg/myproj.git"
    }
}
```

6 Data Transfer Objects

RFC 185 defines Data Transfer Objects as a generic means for management solutions to interact with runtime entities in an OSGi Framework. DTOs provides a common, easily serializable representation of the technology.

For all new functionality added to the OSGi Framework the question should be asked: would this feature benefit from a DTO? The expectation is that in most cases it would.

The DTOs for the design in this RFC should be described here and if there are no DTOs being defined an explanation should be given explaining why this is not applicable in this case.

This section is optional and could also be provided in a separate RFC.

7 Javadoc

OSGi Javadoc

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Package org.osgi.feature

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Interface Artifact

org.osgi.feature

All Known Subinterfaces:
Bundle, Feature

`public interface` **`Artifact`**

An Artifact is an entity with an ID.

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Method Detail

getID

ArtifactID **getID**()

Get the artifact's ID.

Returns:
The ID of this artifact.

Class ArtifactID

org.osgi.feature

```
java.lang.Object
  └ org.osgi.feature.ArtifactID
```

```
public class ArtifactID
extends Object
```

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ArtifactID

```
public ArtifactID(String groupId,
                  String artifactId,
                  String version)
```

~~ArtifactID~~

```
public ArtifactID(String groupId,
                  String artifactId,
                  String version,
                  String type,
                  String classifier)
```

Method Detail

fromMavenID

```
public static ArtifactID fromMavenID(String mavenID)
```

~~getGroupId~~

```
public String getGroupId()
```

getArtifactId

```
public String getArtifactId()
```

getVersion

```
public String getVersion()
```

getType

```
public String getType()
```

getClassifier

```
public String getClassifier()
```

hashCode

```
public int hashCode()
```

Overrides:

`hashCode` in class `Object`

---

equals

```
public boolean equals(Object obj)
```

Overrides:

`equals` in class `Object`

---

toString

```
public String toString()
```

Overrides:

`toString` in class `Object`

Interface BuilderFactory

org.osgi.feature

```
public interface BuilderFactory
```

The Builder Factory can be used to obtain builders for the various entities.

Method Summary		Page
BundleBuilder	**newBundleBuilder**(ArtifactID id) Obtain a new builder for Bundle objects.	20
ConfigurationBuilder	**newConfigurationBuilder**(String pid) Obtain a new builder for Configuration objects.	20
ConfigurationBuilder	**newConfigurationBuilder**(String factoryPid, String name) Obtain a new builder for Factory Configuration objects.	20
ExtensionBuilder	**newExtensionBuilder**(String name, Extension.Type type, Extension.Kind kind) Obtain a new builder for Feature objects.	21
FeatureBuilder	**newFeatureBuilder**(ArtifactID id) Obtain a new builder for Feature objects.	21
MergeContextBuilder	**newMergeContextBuilder**() Obtain a new builder for MergeContext objects.	21

Method Detail

newBundleBuilder

```
BundleBuilder newBundleBuilder(ArtifactID id)
```

Obtain a new builder for Bundle objects.

Parameters:
`id` - The artifact ID for the bundle object being built.
Returns:
The builder.

---

newConfigurationBuilder

```
ConfigurationBuilder newConfigurationBuilder(String pid)
```

Obtain a new builder for Configuration objects.

Parameters:
`pid` - The persistent ID for the Configuration being built.
Returns:
The builder.

---

newConfigurationBuilder

```
ConfigurationBuilder newConfigurationBuilder(String factoryPid,
                                             String name)
```

Obtain a new builder for Factory Configuration objects.

Parameters:
`factoryPid` - The factory persistent ID for the Configuration being built.
`name` - The name of the configuration being built. The PID for the configuration will be the factoryPid + '~' + name
Returns:
The builder.

---

newFeatureBuilder

```
FeatureBuilder newFeatureBuilder(ArtifactID id)
```

Obtain a new builder for Feature objects.

Parameters:
`id` - The artifact ID for the feature object being built.
Returns:
The builder.

---

newExtensionBuilder

```
ExtensionBuilder newExtensionBuilder(String name,
                                     Extension.Type type,
                                     Extension.Kind kind)
```

Obtain a new builder for Feature objects.

Parameters:
`name` - The extension name.
`type` - The type of extension: JSON, Text or Artifacts.
`kind` - The kind of extension: Mandatory, Optional or Transient.
Returns:
The builder.

---

newMergeContextBuilder

```
MergeContextBuilder newMergeContextBuilder()
```

Obtain a new builder for MergeContext objects.

Returns:
The builder.

Interface Bundle

org.osgi.feature

All Superinterfaces:
Artifact

```
public interface Bundle
extends Artifact
```

A Bundle which is part of a feature.

ThreadSafe

Method Summary		Page
Map<String,Object>	**getMetadata**() Get the metadata for this bundle.	22

Methods inherited from interface org.osgi.feature.Artifact
getID

Method Detail

getMetadata

```
Map<String,Object> getMetadata()
```

Get the metadata for this bundle.

Returns:
The metadata.

Interface BundleBuilder

org.osgi.feature

```
public interface BundleBuilder
```

A builder for Feature Model `Bundle` objects.

NotThreadSafe

Method Summary		Page
BundleBuilder	**addMetadata**(String key, Object value) Add metadata for this Bundle.	23
BundleBuilder	**addMetadata**(Map<String,Object> md) Add metadata for this Bundle by providing a map.	23
Bundle	**build**() Build the Bundle object.	23

Method Detail

addMetadata

```
BundleBuilder addMetadata(String key,
                          Object value)
```

Add metadata for this Bundle.

Parameters:
`key` - Metadata key.
`value` - Metadata value.
Returns:
This builder.

---

addMetadata

```
BundleBuilder addMetadata(Map<String,Object> md)
```

Add metadata for this Bundle by providing a map. All metadata in the map is added to any previously provided metadata.

Parameters:
`md` - The map with metadata.
Returns:
This builder.

---

build

```
Bundle build()
```

Build the Bundle object. Can only be called once on a builder. After calling this method the current builder instance cannot be used any more.

Returns:

The Bundle.

Interface Configuration

org.osgi.feature

```
public interface Configuration
```

Represents an OSGi Configuration in the Feature Model.

ThreadSafe

Method Summary		Page
String	**getFactoryPid**() Get the Factory PID from the configuration, if any.	25
String	**getPid**() Get the PID from the configuration.	25
Map<String,Object>	**getValues**() Get the configuration key-value map.	25

Method Detail

getPid

```
String getPid()
```

Get the PID from the configuration.

Returns:
The PID.

---

getFactoryPid

```
String getFactoryPid()
```

Get the Factory PID from the configuration, if any.

Returns:
The Factory PID, or `null` if there is none.

---

getValues

```
Map<String,Object> getValues()
```

Get the configuration key-value map.

Returns:
The key-value map.

Interface ConfigurationBuilder

org.osgi.feature

```
public interface ConfigurationBuilder
```

A builder for Feature Model Configuration objects.

NotThreadSafe

Method Summary		Page
ConfigurationBuilder	**addValue**(String key, Object value) Add a configuration value for this Configuration object.	26
ConfigurationBuilder	**addValues**(Map<String,Object> cfg) Add a map of configuration values for this Configuration object.	26
Configuration	**build**() Build the Configuration object.	26

Method Detail

addValue

```
ConfigurationBuilder addValue(String key,
                              Object value)
```

Add a configuration value for this Configuration object. If a value with the same key was previously provided the previous value is overwritten.

Parameters:
`key` - The configuration key.
`value` - The configuration value. Acceptable data types are: TODO list

Returns:
This builder.

---

addValues

```
ConfigurationBuilder addValues(Map<String,Object> cfg)
```

Add a map of configuration values for this Configuration object. All values will be added to any previously provided configuration values.

Returns:
This builder.

---

build

```
Configuration build()
```

Build the Configuration object. Can only be called once on a builder. After calling this method the current builder instance cannot be used any more.

Returns:

The Configuration.

Interface ConflictResolver

org.osgi.feature

Type Parameters:

`T` - The type of entity this conflict resolver is used for.
`R` - The type of the result of the resolution.

```
public interface ConflictResolver
```

Interface implemented by a callback that can resolve merge conflicts.

ThreadSafe

Method Summary		Page
R	**resolve**(Feature f1, T o1, Feature f2, T o2) Resolve this conflict between o1 and o2.	28

Method Detail

resolve

```
R resolve(Feature f1,
          T o1,
          Feature f2,
          T o2)
```

Resolve this conflict between o1 and o2.

Parameters:

`f1` - The first feature model.
`o1` - The first conflicting object.
`f2` - The second feature model
`o2` - The second conflicting object.

Returns:

The resolution of the conflict.

Interface Extension

org.osgi.feature

```
public interface Extension
```

A Feature Model Extension. Extensions can contain either Text, JSON or a list of Artifacts.

Extensions are of one of the following kinds:

- Mandatory: this extension must be processed by the runtime
- Optional: this extension does not have to be processed by the runtime
- Transient: this extension contains transient information such as caching data that is for optimization purposes. It may be changed or removed and is not part of the feature's identity.

ThreadSafe

Nested Class Summary		Page
static enum	Extension.Kind	31
static enum	Extension.Type	32

Method Summary		Page
List<ArtifactID>	getArtifacts() Get the Artifacts from this extension.	30
String	getJSON() Get the JSON from this extension.	30
Extension.Kind	getKind() Get the extension kind.	30
String	getName() Get the extension name.	29
String	getText() Get the Text from this extension.	30
Extension.Type	getType() Get the extension type.	29

Method Detail

getName

```
String getName()
```

Get the extension name.

Returns:
The name.

---

getType

```
Extension.Type getType()
```

Get the extension type.

Returns:
The type.

---

getKind

`Extension.Kind` **`getKind`**`()`

Get the extension kind.

Returns:
The kind.

---

getJSON

`String` **`getJSON`**`()`

Get the JSON from this extension.

Returns:
The JSON, or `null` if this is not a JSON extension.

---

getText

`String` **`getText`**`()`

Get the Text from this extension.

Returns:
The Text, or `null` if this is not a Text extension.

---

getArtifacts

`List<ArtifactID>` **`getArtifacts`**`()`

Get the Artifacts from this extension.

Returns:
The Artifacts, or `null` if this is not an Artifacts extension.

Enum Extension.Kind

org.osgi.feature

```
java.lang.Object
  └java.lang.Enum<Extension.Kind>
      └org.osgi.feature.Extension.Kind
```

All Implemented Interfaces:

Comparable<Extension.Kind>, Serializable

Enclosing class:

Extension

```
public static enum Extension.Kind
extends Enum<Extension.Kind>
```

Enum Constant Summary	Page
MANDATORY	31
OPTIONAL	31
TRANSIENT	31

Method Summary		Page
static Extension.Kind	valueOf(String name)	31
static Extension.Kind[]	values()	31

Enum Constant Detail

MANDATORY

```
public static final Extension.Kind MANDATORY
```

OPTIONAL

```
public static final Extension.Kind OPTIONAL
```

TRANSIENT

```
public static final Extension.Kind TRANSIENT
```

Method Detail

values

```
public static Extension.Kind[] values()
```

valueOf

```
public static Extension.Kind valueOf(String name)
```

Enum Extension.Type

org.osgi.feature

```
java.lang.Object
  └java.lang.Enum<Extension.Type>
      └org.osgi.feature.Extension.Type
```

All Implemented Interfaces:

Comparable<Extension.Type>, Serializable

Enclosing class:

Extension

```
public static enum Extension.Type
extends Enum<Extension.Type>
```

Enum Constant Summary	Page
ARTIFACTS	32
JSON	32
TEXT	32

Method Summary		Page
static Extension.Type	valueOf(String name)	32
static Extension.Type[]	values()	32

Enum Constant Detail

JSON

```
public static final Extension.Type JSON
```

TEXT

```
public static final Extension.Type TEXT
```

ARTIFACTS

```
public static final Extension.Type ARTIFACTS
```

Method Detail

values

```
public static Extension.Type[] values()
```

valueOf

```
public static Extension.Type valueOf(String name)
```

Interface ExtensionBuilder

org.osgi.feature

```
public interface ExtensionBuilder
```

A builder for Feature Model `Extension` objects.

NotThreadSafe

Method Summary		Page
ExtensionBuilder	**addArtifact**(String groupId, String artifactId, String version) Add an Artifact to the extension.	34
ExtensionBuilder	**addArtifact**(String groupId, String artifactId, String version, String at, String classifier) Add an Artifact to the extension.	34
ExtensionBuilder	**addArtifact**(ArtifactID aid) Add an Artifact to the extension.	34
ExtensionBuilder	**addText**(String text) Add text to the extension.	33
Extension	**build**() Build the Extension.	34
ExtensionBuilder	**setJSON**(String json) Add JSON in String form to the extension.	33

Method Detail

addText

ExtensionBuilder **addText**(String text)

Add text to the extension. Can only be called for extensions of type .

Parameters:
`text` - The text to be added.
Returns:
This builder.

---

setJSON

ExtensionBuilder **setJSON**(String json)

Add JSON in String form to the extension. Can only be called for extensions of type .

Parameters:
`json` - The JSON to be added.
Returns:
This builder.

---

addArtifact

```
ExtensionBuilder addArtifact(ArtifactID aid)
```

Add an Artifact to the extension. Can only be called for extensions of type .

Parameters:
`aid` - The ArtifactID of the artifact to add.
Returns:
This builder.

---

addArtifact

```
ExtensionBuilder addArtifact(String groupId,
                             String artifactId,
                             String version)
```

Add an Artifact to the extension. Can only be called for extensions of type .

Parameters:
`groupId` - The Group ID of the artifact to add.
`artifactId` - The Artifact ID of the artifact to add.
`version` - The Version of the artifact to add.
Returns:
This builder.

---

addArtifact

```
ExtensionBuilder addArtifact(String groupId,
                             String artifactId,
                             String version,
                             String at,
                             String classifier)
```

Add an Artifact to the extension. Can only be called for extensions of type .

Parameters:
`groupId` - The Group ID of the artifact to add.
`artifactId` - The Artifact ID of the artifact to add.
`version` - The Version of the artifact to add.
`at` - The type indicator of the artifact to add.
`classifier` - The classifier of the artifact to add.
Returns:
This builder.

---

build

```
Extension build()
```

Build the Extension. Can only be called once on a builder. After calling this method the current builder instance cannot be used any more.

Returns:
The Extension.

Interface Feature

org.osgi.feature

All Superinterfaces:
Artifact

```
public interface Feature
extends Artifact
```

The Feature Model Feature.

ThreadSafe

Method Summary		Page
List<Bundle>	**getBundles**() Get the bundles.	37
Map<String,Configuration>	**getConfigurations**() Get the configurations.	37
String	**getDescription**() Get the description.	36
Map<String,Extension>	**getExtensions**() Get the extensions.	37
String	**getLicense**() Get the license.	36
String	**getLocation**() Get the location.	36
String	**getTitle**() Get the title.	35
Map<String,String>	**getVariables**() Get the variables.	37
String	**getVendor**() Get the vendor.	36
boolean	**isComplete**() Get whether the feature is complete or not.	36
boolean	**isFinal**() Get whether the feature is final or not.	36

Methods inherited from interface org.osgi.feature.Artifact
getID

Method Detail

getTitle

```
String getTitle()
```

Get the title.

Returns:
The title.

---

getDescription

`String` **`getDescription`**`()`

Get the description.

Returns:
The description.

---

getVendor

`String` **`getVendor`**`()`

Get the vendor.

Returns:
The vendor.

---

getLicense

`String` **`getLicense`**`()`

Get the license.

Returns:
The license.

---

getLocation

`String` **`getLocation`**`()`

Get the location.

Returns:
The location.

---

isComplete

`boolean` **`isComplete`**`()`

Get whether the feature is complete or not.

Returns:
Completeness value.

---

isFinal

`boolean` **`isFinal`**`()`

Get whether the feature is final or not.

Returns:
Final value.

---

getBundles

`List<Bundle> **getBundles**()`

Get the bundles.

Returns:
The bundles.

---

getConfigurations

`Map<String,Configuration> **getConfigurations**()`

Get the configurations.

Returns:
The configurations.

---

getExtensions

`Map<String,Extension> **getExtensions**()`

Get the extensions.

Returns:
The extensions.

---

getVariables

`Map<String,String> **getVariables**()`

Get the variables.

Returns:
The variables.

Interface FeatureBuilder

org.osgi.feature

```
public interface FeatureBuilder
```

A builder for Feature Models.

NotThreadSafe

Method Summary		Page
FeatureBuilder	**addBundles**(Bundle... bundles) Add Bundles to the Feature.	40
FeatureBuilder	**addConfigurations**(Configuration... configs) Add Configurations to the Feature.	40
FeatureBuilder	**addExtensions**(Extension... extensions) Add Extensions to the Feature	40
FeatureBuilder	**addVariable**(String key, String defaultValue) Add a variable to the Feature.	40
FeatureBuilder	**addVariables**(Map<String,String> variables) Add a map of variables to the Feature	41
Feature	**build**() Build the Feature.	41
FeatureBuilder	**setComplete**(boolean complete) Set the Feature Complete flag.	39
FeatureBuilder	**setDescription**(String description) Set the Feature Description.	40
FeatureBuilder	**setFinal**(boolean isFinal) Set the Feature is Final flag.	39
FeatureBuilder	**setLicense**(String license) Set the License.	39
FeatureBuilder	**setLocation**(String location) Set the Location.	39
FeatureBuilder	**setTitle**(String title) Set the Feature Title.	38
FeatureBuilder	**setVendor**(String vendor) Set the Vendor.	39

Method Detail

setTitle

FeatureBuilder **setTitle**(String title)

Set the Feature Title.

Parameters:

`title` - The Title.

Returns:
This builder.

---

setVendor

`FeatureBuilder` **`setVendor`**`(String vendor)`

Set the Vendor.

Parameters:
`vendor` - The Vendor.
Returns:
This builder.

---

setLicense

`FeatureBuilder` **`setLicense`**`(String license)`

Set the License.

Parameters:
`license` - The License.
Returns:
This builder.

---

setLocation

`FeatureBuilder` **`setLocation`**`(String location)`

Set the Location.

Parameters:
`location` - The Location.
Returns:
This builder.

---

setComplete

`FeatureBuilder` **`setComplete`**`(boolean complete)`

Set the Feature Complete flag.

Parameters:
`complete` - If the feature is complete.
Returns:
This builder.

---

setFinal

`FeatureBuilder` **`setFinal`**`(boolean isFinal)`

Set the Feature is Final flag.

Parameters:
`isFinal` - If the feature is final.

Returns:
This builder.

---

setDescription

`FeatureBuilder` **`setDescription`**`(String description)`

Set the Feature Description.

Parameters:
`description` - The description.
Returns:
This builder.

---

addBundles

`FeatureBuilder` **`addBundles`**`(Bundle... bundles)`

Add Bundles to the Feature.

Parameters:
`bundles` - The Bundles to add.
Returns:
This builder.

---

addConfigurations

`FeatureBuilder` **`addConfigurations`**`(Configuration... configs)`

Add Configurations to the Feature.

Parameters:
`configs` - The Configurations to add.
Returns:
This builder.

---

addExtensions

`FeatureBuilder` **`addExtensions`**`(Extension... extensions)`

Add Extensions to the Feature

Parameters:
`extensions` - The Extensions to add.
Returns:
This builder.

---

addVariable

```
FeatureBuilder addVariable(String key,
                           String defaultValue)
```

Add a variable to the Feature. If a variable with the specified key already exists it is replaced with this one.

Parameters:
`key` - The key.
`defaultValue` - The default value.
Returns:
This builder.

---

addVariables

`FeatureBuilder` **`addVariables`**`(Map<String,String> variables)`

Add a map of variables to the Feature

Parameters:
`variables` - to be added.
Returns:
This builder.

---

build

`Feature` **`build`**`()`

Build the Feature. Can only be called once on a builder. After calling this method the current builder instance cannot be used any more.

Returns:
The Feature.

Interface FeatureService

org.osgi.feature

```
public interface FeatureService
```

The Feature Service is the primary entry point for interacting with the feature model.

ThreadSafe

Method Summary		Page
BuilderFactory	**getBuilderFactory**() Get a factory which can be used to build feature model entities.	42
Feature	**mergeFeatures**(ArtifactID targetID, Feature f1, Feature f2, MergeContext ctx) Merge two features into a new feature.	43
Feature	**readFeature**(Reader jsonReader) Read a Feature from JSON	42
void	**writeFeature**(Feature feature, Writer jsonWriter) Write a Feature Model to JSON	42

Method Detail

getBuilderFactory

```
BuilderFactory getBuilderFactory()
```

Get a factory which can be used to build feature model entities.

Returns:
A builder factory.

---

readFeature

```
Feature readFeature(Reader jsonReader)
            throws IOException
```

Read a Feature from JSON

Parameters:
`jsonReader` - A Reader to the JSON input
Returns:
The Feature represented by the JSON
Throws:
`IOException` - When reading fails

---

writeFeature

```
void writeFeature(Feature feature,
                  Writer jsonWriter)
           throws IOException
```

Write a Feature Model to JSON

Parameters:
`feature` - the Feature to write.
`jsonWriter` - A Writer to which the Feature should be written.
Throws:
`IOException` - When writing fails.

---

mergeFeatures

```
Feature mergeFeatures(ArtifactID targetID,
                      Feature f1,
                      Feature f2,
                      MergeContext ctx)
```

Merge two features into a new feature.

Parameters:
`targetID` - The ID of the new feature.
`f1` - The first feature
`f2` - The second feature
`ctx` - The merge context to use for the merge operation.
Returns:
The merged feature.

Interface MergeContext

org.osgi.feature

```
public interface MergeContext
```

Context provided by the caller for the merge operation.

Method Summary		Page
List<Bundle>	**handleBundleConflict**(Feature f1, Bundle b1, Feature f2, Bundle b2) If two merged features both contain the same bundle, same group ID and artifact ID but different version, this method is called to resolve what to do.	44
Configuration	**handleConfigurationConflict**(Feature f1, Configuration c1, Feature f2, Configuration c2) If two merged features both contain the same configuration PID, this method is called to perform the merge operation.	44
Extension	**handleExtensionConflict**(Feature f1, Extension e1, Feature f2, Extension e2) If two merged features both contain an extension with the same IF, this method is called to perform the merge operation.	45

Method Detail

handleBundleConflict

```
List<Bundle> handleBundleConflict(Feature f1,
                                  Bundle b1,
                                  Feature f2,
                                  Bundle b2)
```

If two merged features both contain the same bundle, same group ID and artifact ID but different version, this method is called to resolve what to do.

Parameters:

`f1` - The first feature.
`b1` - The first bundle.
`f2` - The second feature.
`b2` - The second bundle.

Returns:

Return a list of bundles that should be used in this case. This could be one or both of the provided bundles, or a different bundle altogether.

---

handleConfigurationConflict

```
Configuration handleConfigurationConflict(Feature f1,
                                          Configuration c1,
                                          Feature f2,
                                          Configuration c2)
```

If two merged features both contain the same configuration PID, this method is called to perform the merge operation.

Parameters:

`f1` - The first feature.

`c1` - The first configuration.
`f2` - The second feature.
`c2` - The second configuration.

Returns:

The merged configuration to use.

---

handleExtensionConflict

```
Extension handleExtensionConflict(Feature f1,
                                  Extension e1,
                                  Feature f2,
                                  Extension e2)
```

If two merged features both contain an extension with the same IF, this method is called to perform the merge operation.

Parameters:

`f1` - The first feature.
`e1` - The first extension.
`f2` - The second feature.
`e2` - The second extension.

Returns:

The merged extension.

Interface MergeContextBuilder

org.osgi.feature

```
public interface MergeContextBuilder
```

A builder for MergeContext objects.

NotThreadSafe

Method Summary		Page
MergeContext	**build**() Build the Merge Context.	47
MergeContextBuilder	**bundleConflictHandler**(ConflictResolver<Bundle,List<Bundle>> bh) Set the Bundle Conflict Resolver.	46
MergeContextBuilder	**configConflictHandler**(ConflictResolver<Configuration,Configuration> ch) Set the Configuration Conflict Resolver.	46
MergeContextBuilder	**extensionConflictHandler**(ConflictResolver<Extension,Extension> eh) Set the Extension Conflict Resolver.	46

Method Detail

bundleConflictHandler

MergeContextBuilder **bundleConflictHandler**(ConflictResolver<Bundle,List<Bundle>> bh)

Set the Bundle Conflict Resolver.

Parameters:
bh - The Conflict Resolver.
Returns:
This builder.

---

configConflictHandler

MergeContextBuilder **configConflictHandler**(ConflictResolver<Configuration,Configuration> ch)

Set the Configuration Conflict Resolver.

Parameters:
ch - The Conflict Resolver.
Returns:
This builder.

---

extensionConflictHandler

MergeContextBuilder **extensionConflictHandler**(ConflictResolver<Extension,Extension> eh)

Set the Extension Conflict Resolver.

Parameters:
`eh` - The Conflict Resolver.
Returns:
This builder.

---

build

`MergeContext` **`build`**`()`

Build the Merge Context. Can only be called once on a builder. After calling this method the current builder instance cannot be used any more.

Returns:
The Merge Context.

Please include Javadoc of any new APIs here, once the design has matured. Instructions on how to export Javadoc for inclusion in the RFC can be found here: https://www.osgi.org/members/RFC/Javadoc

8 Considered Alternatives

For posterity, record the design alternatives that were considered but rejected along with the reason for rejection. This is especially important for external/earlier solutions that were deemed not applicable.

9 Security Considerations

Description of all known vulnerabilities this may either introduce or address as well as scenarios of how the weaknesses could be circumvented.

10 Document Support

10.1 References

[1]. Bradner, S., Key words for use in RFCs to Indicate Requirement Levels, RFC2119, March 1997.

[2]. Software Requirements & Specifications. Michael Jackson. ISBN 0-201-87712-0

Add references simply by adding new items. You can then cross-refer to them by chosing <Insert><Cross Reference><Numbered Item> and then selecting the paragraph. ***STATIC REFERENCES (I.E. BODGED) ARE NOT ACCEPTABLE, SOMEONE WILL HAVE TO UPDATE THEM LATER, SO DO IT PROPERLY NOW.***

10.2 Author's Address

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10.3 Acronyms and Abbreviations

10.4 End of Document