Progress FUSE

FUSE™ Services Framework

Configuring and Deploying Endpoints

Version 2.2.x
April 2009

PROGRESS SOFTWARE

Configuring and Deploying Endpoints

Version 2.2.x

Publication date 17 Jul 2009

Legal Notices

Table of Contents

List of Figures

List of Tables

List of Examples

Chapter 1. FUSE Services Framework Configuration Overview

FUSE Services Framework takes a minimalist approach to requiring configuration. However, it provides a large number of options for providing configuration data.

FUSE Services Framework adopts an approach of zero configuration, or configuration by exception. Configuration is required only if you want to either customize the runtime to exhibit non-default behavior or if you want to activate some of the more advanced features.

FUSE Services Framework supports a number of configuration methods if you want to change the default behavior, enable specific functionality or fine-tune a component's behavior. The supported configuration methods include:

- Spring XML configuration
- WS-Policy statements
- WSDL extensions

Spring XML configuration is, however, the most versatile way to configure FUSE Services Framework and is the recommended approach to use.

FUSE Services Framework Configuration Files

Overview

FUSE Services Framework leverages the Spring framework to inject configuration information into the runtime when it starts up. The XML configuration file used to configure applications is a Spring XML file that contains some FUSE Services Framework specific elements.

Spring framework

Spring is a layered Java/J2EE application framework. FUSE Services Framework leverages the Spring core and uses the principles of *Inversion of Control* and *Dependency Injection*.

For more information on the Spring framework, see http://www.springframework.org. Of particular relevance is Chapter 3 of the Spring reference guide, *The IoC container*[1].

For more information on inversion of control and dependency injection, see http://martinfowler.com/articles/injection.html.

Configuration namespace

The core FUSE Services Framework configuration elements are defined in the http://cxf.apache.org/jaxws namespace. You must add the entry shown in Example 1.1 on page 12 to the `beans` element of your configuration file.

Example 1.1. Namespace

```
<beans ...
  xmlns:jaxws="http://cxf.apache.org/jaxws
  ...>
```

Advanced features, like WS-Addressing and WS-RM, require the use of elements in other namespaces. The SOAP and JMS transports also use elements defined in different namespaces. You must add those namspaces when configuring those features.

Schema location

Spring XML files use the `beans` element's `xsi:schemaLocation` attribute to locate the schemas required to validate the elements used in the document. The `xsi:schemaLocation` attribute is a list of namespaces, and the schema in which the namespace is defined. Each namespace/schema combination is defined as a space delimited pair.

[1] http://static.springframework.org/spring/docs/2.0.x/reference/beans.html

You should add the FUSE Services Framework's configuration schemas to the list of schemas in the attribute as shown in Example 1.2 on page 13.

Example 1.2. Adding the JAX-WS Schema to the Configuration File

```
<beans ...
   xsi:schemaLocation="
http://www.springframework.org/schema/beans
 http://www.springframework.org/schema/beans/spring-beans-
2.0.xsd
http://cxf.apache.org/jaxws
 http://cxf.apache.org/schemas/jaxws.xsd
...">
```

Sample configuration file

Example 1.3 on page 13 shows a simplified example of a FUSE Services Framework configuration file.

Example 1.3. FUSE Services Framework Configuration File

```
<beans xmlns="http://www.springframework.org/schema/beans" ❶
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xmlns:jaxws="http://cxf.apache.org/jaxws" ❷
   ...
   xsi:schemaLocation="
http://www.springframework.org/schema/beans
 http://www.springframework.org/schema/beans/spring-beans-2.0.xsd
http://cxf.apache.org/jaxws ❸
 http://cxf.apache.org/schemas/jaxws.xsd">

<!-- your configuration goes here! --> ❹

</beans>
```

The following describes Example 1.3 on page 13:

❶ A FUSE Services Framework configuration file is actually a Spring XML file. You must include an opening Spring `beans` element that declares the namespaces and schema files for the child elements that are encapsulated by the `beans` element.

❷ Before using the FUSE Services Framework configuration elements, you must declare its namespace in the configuration's root element.

❸ In order for the runtime and the tooling to ensure that your configuration file is valid, you need to add the proper entries to the schema location list.

❹ The contents of the configuration depends on the behavior you want exhibited by the runtime. You can use:

- FUSE Services Framework specific elements
- Plain Spring XML `bean` elements

Making Your Configuration File Available

Overview

You can make the configuration file available to the FUSE Services Framework runtime in one of the following ways:

- Name the configuration file `cxf.xml` and add it your `CLASSPATH`.
- Use one of the following command-line flags to point to the configuration file:
  - `-Dcxf.config.file=myCfgResource`
  - `-Dcxf.config.file.url=myCfgURL`

  This allows you to save the configuration file anywhere on your system and avoid adding it to your `CLASSPATH`. It also means you can give your configuration file any name you want.

  This is a useful approach for portable JAX-WS applications. It is also the method used in most of the FUSE Services Framework samples. For example, in the WS-Addressing sample, located in the *InstallDir*`/samples/ws-addressing` directory, the server start command specifies the `server.xml` configuration file as follows:

```
java -Dcxf.config.file=server.xml  demo.ws_addressing.server.Server
```

Note

In this example, the start command is run from the directory in which the `server.xml` file resides.

- Programmatically, by creating a bus and passing the configuration file location as either a URL or string. For example:

```
(new SpringBusFactory()).createBus(URL myCfgURL)
(new SpringBusFactory()).createBus(String myCfgResource)
```

Chapter 2. Setting Up Your Environment

This chapter explains how to set-up your FUSE Services Framework runtime system environment.

Using the FUSE Services Framework Environment Script

Overview

To use the FUSE Services Framework runtime environment, the host computer must have several environment variables set. These variables can be configured either during installation, or later using the **fuse_env** script, The can also be configured manually.

Running the fuse_env script

The FUSE Services Framework installation process creates a script named **fuse_env**, which captures the information required to set your host's environment variables. Running this script configures your system to use the FUSE Services Framework runtime. The script is located in the *InstallDir*/bin folder.

FUSE Services Framework Environment Variables

Overview

This section describes the following environment variables in more detail:

- CXF_HOME
- JAVA_HOME
- ANT_HOME
- SPRING_CONTAINER_HOME
- CATALINA_HOME
- PATH

Note

You do not have to manually set your environment variables. You can configure them during installation, or you can set them later by running the provided **fuse_env** script.

Environment variables

The environment variables are explained in Table 2.1 on page 19.

Table 2.1. FUSE Services Framework Environment Variables

Variable	Description
CXF_HOME	Specifies the top level of your FUSE Services Framework installation. For example, on Windows, if you install FUSE Services Framework into the C:\FUSE directory, CXF_HOME should be set to C:\FUSE.
JAVA_HOME	Specifies the directory path to your system's JDK.
ANT_HOME	Specifies the directory path to the **ant** utility. The default location is *InstallDir*\tools\ant.
SPRING_CONTAINER_HOME	Specifies the directory path to the Spring container. The default location is CXF_HOME\containers\spring_container.

Variable	Description
CATALINA_HOME	Specifies the location of the Tomcat instance installed with FUSE Services Framework.
PATH	The FUSE Services Framework bin directories are prepended on the PATH to ensure that the proper libraries, configuration files, and utility programs are used.

Customizing your Environment Script

Overview

The **fuse_env** script sets the FUSE Services Framework environment variables using values obtained from the installer. The script checks each one of these settings in sequence, and updates them, where appropriate.

The **fuse_env** script is designed to suit most needs. However, if you want to customize it for your own purposes, note the points described in this section.

Before you begin

You can only run the **fuse_env** script once in any console session. If you run this script a second time, it exits without completing. This prevents your environment from becoming bloated with duplicate information (for example, on your `PATH` and `CLASSPATH`). In addition, if you introduce any errors when customizing the **fuse_env** script, it also exits without completing.

This feature is controlled by the `FUSE_ENV_SET` variable, which is local to the **fuse_env** script. `FUSE_ENV_SET` is set to `true` the first time you run the script in a console; this causes the script to exit when run again.

Environment variables

The following applies to the environment variables set by the **fuse_env** script:

- `JAVA_HOME` defaults to the value obtained from the installer. If you do not manually set this variable before running **fuse_env**, it takes its value from the installer.
- The following environment variables are all set with default values relative to `CXF_HOME`:
  - `ANT_HOME`
  - `SPRING_CONTAINER_HOME`
  - `CATALINA_HOME`

  If you do not set these variables manually, **fuse_env** sets them with default values based on `CXF_HOME`. For example, the default for `ANT_HOME` is `CXF_HOME\tools\ant`.

Chapter 3. Configuring JAX-WS Endpoints

JAX-WS endpoints are configured using one of three Spring configuration elements. The correct element depends on what type of endpoint you are configuring and which features you wish to use. For consumers you use the `jaxws:client` *element. For service providers you can use either the* `jaxws:endpoint` *element or the* `jaxws:server` *element.*

The information used to define an endpoint is typically defined in the endpoint's contract. You can use the configuration element's to override the information in the contract. You can also use the configuration elements to provide information that is not provided in the contract.

Note

When dealing with endpoints developed using a Java-first approach it is likely that the SEI serving as the endpoint's contract is lacking information about the type of binding and transport to use.

You must use the configuration elements to activate advanced features such as WS-RM. This is done by providing child elements to the endpoint's configuration element.

Configuring Service Providers

FUSE Services Framework has two elements that can be used to configure a service provider:

- `jaxws:endpoint`
- `jaxws:server`

The differences between the two elements are largely internal to the runtime. The `jaxws:endpoint` element injects properties into the `org.apache.cxf.jaxws.EndpointImpl` object created to support a service endpoint. The `jaxws:server` element injects properties into the `org.apache.cxf.jaxws.support.JaxWsServerFactoryBean` object created to support the endpoint. The `EndpointImpl` object passes the configuration data to the `JaxWsServerFactoryBean` object. The `JaxWsServerFactoryBean` object is used to create the actual service object. Because either configuration element will configure a service endpoint, you can choose based on the syntax you prefer.

Using the jaxws:endpoint Element

Overview

The `jaxws:endpoint` element is the default element for configuring JAX-WS service providers. Its attributes and children specify all of the information needed to instantiate a service provider. Many of the attributes map to information in the service's contract. The children are used to configure interceptors and other advanced features.

Identifying the endpoint being configured

For the runtime to apply the configuration to the proper service provider, it must be able to identify it. The basic means for identifying a service provider is to specify the class that implements the endpoint. This is done using the `jaxws:endpoint` element's `implementor` attribute.

For instances where different endpoint's share a common implementation, it is possible to provide different configuration for each endpoint. There are two approaches for distinguishing a specific endpoint in configuration:

- a combination of the `serviceName` attribute and the `endpointName` attribute

  The `serviceName` attribute specifies the `wsdl:service` element defining the service's endpoint. The `endpointName` attribute specifies the specific `wsdl:port` element defining the service's endpoint. Both attributes are specified as QNames using the format *`ns`*`:`*`name`*. *`ns`* is the namespace of the element and *`name`* is the value of the element's `name` attribute.

  Tip

  If the `wsdl:service` element only has one `wsdl:port` element, the `endpointName` attribute can be omitted.

- the `name` attribute

  The `name` attribute specifies the QName of the specific `wsdl:port` element defining the service's endpoint. The QName is provided in the format

{*ns*}*localPart*. *ns* is the namespace of the `wsdl:port` element and *localPart* is the value of the `wsdl:port` element's `name` attribute.

Attributes

The attributes of the `jaxws:endpoint` element configure the basic properties of the endpoint. These properties include the address of the endpoint, the class that implements the endpoint, and the `bus` that hosts the endpoint.

Table 3.1 on page 26 describes the attribute of the `jaxws:endpoint` element.

Table 3.1. Attributes for Configuring a JAX-WS Service Provider Using the `jaxws:endpoint` Element

Attribute	Description
`id`	Specifies a unique identifier that other configuration elements can use to refer to the endpoint.
`implementor`	Specifies the class implementing the service. You can specify the implementation class using either the class name or an ID reference to a Spring bean configuring the implementation class. This class must be on the classpath.
`implementorClass`	Specifies the class implementing the service. This attribute is useful when the value provided to the `implementor` attribute is a reference to a bean that is wrapped using Spring AOP.
`address`	Specifies the address of an HTTP endpoint. This value overrides the value specified in the services contract.
`wsdlLocation`	Specifies the location of the endpoint's WSDL contract. The WSDL contract's location is relative to the folder from which the service is deployed.
`endpointName`	Specifies the value of the service's `wsdl:port` element's `name` attribute. It is specified as a QName using the format *ns*`:`*name* where *ns* is the namespace of the `wsdl:port` element.
`serviceName`	Specifies the value of the service's `wsdl:service` element's `name` attribute. It is specified as a QName using the format *ns*`:`*name* where *ns* is the namespace of the `wsdl:service` element.
`publish`	Specifies if the service should be automatically published. If this is set to `false`, the developer must explicitly publish the endpoint as described in "Publishing a Service" in *Developing Applications Using JAX-WS*.
`bus`	Specifies the ID of the Spring bean configuring the bus used to manage the service endpoint. This is useful when configuring several endpoints to use a common set of features.
`bindingUri`	Specifies the ID of the message binding the service uses. A list of valid binding IDs is provided in Appendix A on page 143.

Attribute	Description
name	Specifies the stringified QName of the service's wsdl:port element. It is specified as a QName using the format {*ns*}*localPart*. *ns* is the namespace of the wsdl:port element and *localPart* is the value of the wsdl:port element's name attribute.
abstract	Specifies if the bean is an abstract bean. Abstract beans act as parents for concrete bean definitions and are not instantiated. The default is false. Setting this to true instructs the bean factory not to instantiate the bean.
depends-on	Specifies a list of beans that the endpoint depends on being instantiated before it can be instantiated.
createdFromAPI	Specifies that the user created that bean using FUSE Services Framework APIs, such as Endpoint.publish() or Service.getPort(). The default is false. Setting this to true does the following: • Changes the internal name of the bean by appending .jaxws-endpoint to its id • Makes the bean abstract

In addition to the attributes listed in Table 3.1 on page 26, you might need to use multiple xmlns:*shortName* attributes to declare the namespaces used by the endpointName and serviceName attributes.

Example

Example 3.1 on page 27 shows the configuration for a JAX-WS endpoint that specifies the address where the endpoint is published. The example assumes that you want to use the defaults for all other values or that the implementation has specified values in the annotations.

Example 3.1. Simple JAX-WS Endpoint Configuration

```
<beans ...
  xmlns:jaxws="http://cxf.apache.org/jaxws"
  ...
  schemaLocation="...
    http://cxf.apache.org/jaxws http://cxf.apache.org/schemas/jaxws.xsd
    ...">
  <jaxws:endpoint id="example"
                  implementor="org.apache.cxf.example.DemoImpl"
                  address="http://localhost:8080/demo" />
</beans>
```

Example 3.2 on page 28 shows the configuration for a JAX-WS endpoint whose contract contains two service definitions. In this case, you must specify which service definition to instantiate using the `serviceName` attribute.

Example 3.2. JAX-WS Endpoint Configuration with a Service Name

```
<beans ...
  xmlns:jaxws="http://cxf.apache.org/jaxws"
  ...
  schemaLocation="...
    http://cxf.apache.org/jaxws http://cxf.apache.org/schemas/jaxws.xsd
    ...">
  <jaxws:endpoint id="example2"
                  implementor="org.apache.cxf.example.DemoImpl"
                  serviceName="samp:demoService2"
                  xmlns:samp="http://org.apache.cxf/wsdl/example" />
                  </beans>
```

The `xmlns:samp` attribute specifies the namespace in which the WSDL `service` element is defined.

Using the jaxws:server Element

Overview

The `jaxws:server` element is an element for configuring JAX-WS service providers. It injects the configuration information into the `org.apache.cxf.jaxws.support.JaxWsServerFactoryBean`. This is a FUSE Services Framework specific object. If you are using a pure Spring approach to building your services, you will not be forced to use FUSE Services Framework specific APIs to interact with the service.

The attributes and children of the `jaxws:server` element specify all of the information needed to instantiate a service provider. The attributes specify the information that is required to instantiate an endpoint. The children are used to configure interceptors and other advanced features.

Identifying the endpoint being configured

In order for the runtime to apply the configuration to the proper service provider, it must be able to identify it. The basic means for identifying a service provider is to specify the class that implements the endpoint. This is done using the `jaxws:server` element's `serviceBean` attribute.

For instances where different endpoint's share a common implementation, it is possible to provide different configuration for each endpoint. There are two approaches for distinguishing a specific endpoint in configuration:

- a combination of the `serviceName` attribute and the `endpointName` attribute

  The `serviceName` attribute specifies the `wsdl:service` element defining the service's endpoint. The `endpointName` attribute specifies the specific `wsdl:port` element defining the service's endpoint. Both attributes are specified as QNames using the format *`ns`*`:`*`name`*. *`ns`* is the namespace of the element and *`name`* is the value of the element's `name` attribute.

  Tip

  If the `wsdl:service` element only has one `wsdl:port` element, the `endpointName` attribute can be omitted.

- the `name` attribute

  The `name` attribute specifies the QName of the specific `wsdl:port` element defining the service's endpoint. The QName is provided in the format

{*ns*}*localPart*. *ns* is the namespace of the `wsdl:port` element and *localPart* is the value of the `wsdl:port` element's `name` attribute.

Attributes

The attributes of the `jaxws:server` element configure the basic properties of the endpoint. These properties include the address of the endpoint, the class that implements the endpoint, and the `bus` that hosts the endpoint.

Table 3.2 on page 30 describes the attribute of the `jaxws:server` element.

Table 3.2. Attributes for Configuring a JAX-WS Service Provider Using the `jaxws:server` Element

Attribute	Description
`id`	Specifies a unique identifier that other configuration elements can use to refer to the endpoint.
`serviceBean`	Specifies the class implementing the service. You can specify the implementation class using either the class name or an ID reference to a Spring bean configuring the implementation class. This class must be on the classpath.
`serviceClass`	Specifies the class implementing the service. This attribute is useful when the value provided to the `implementor` attribute is a reference to a bean that is wrapped using Spring AOP.
`address`	Specifies the address of an HTTP endpoint. This value will override the value specified in the services contract.
`wsdlLocation`	Specifies the location of the endpoint's WSDL contract. The WSDL contract's location is relative to the folder from which the service is deployed.
`endpointName`	Specifies the value of the service's `wsdl:port` element's `name` attribute. It is specified as a QName using the format *ns*`:`*name*, where *ns* is the namespace of the `wsdl:port` element.
`serviceName`	Specifies the value of the service's `wsdl:service` element's `name` attribute. It is specified as a QName using the format *ns*`:`*name*, where *ns* is the namespace of the `wsdl:service` element.
`start`	Specifies if the service should be automatically published. If this is set to `false`, the developer must explicitly publish the endpoint as described in "Publishing a Service" in *Developing Applications Using JAX-WS*.
`bus`	Specifies the ID of the Spring bean configuring the bus used to manage the service endpoint. This is useful when configuring several endpoints to use a common set of features.
`bindingId`	Specifies the ID of the message binding the service uses. A list of valid binding IDs is provided in Appendix A on page 143.

Attribute	Description
name	Specifies the stringified QName of the service's wsdl:port element. It is specified as a QName using the format {ns}localPart, where ns is the namespace of the wsdl:port element and localPart is the value of the wsdl:port element's name attribute.
abstract	Specifies if the bean is an abstract bean. Abstract beans act as parents for concrete bean definitions and are not instantiated. The default is false. Setting this to true instructs the bean factory not to instantiate the bean.
depends-on	Specifies a list of beans that the endpoint depends on being instantiated before the endpoint can be instantiated.
createdFromAPI	Specifies that the user created that bean using FUSE Services Framework APIs, such as Endpoint.publish() or Service.getPort(). The default is false. Setting this to true does the following: • Changes the internal name of the bean by appending .jaxws-endpoint to its id • Makes the bean abstract

In addition to the attributes listed in Table 3.2 on page 30, you might need to use multiple xmlns:*shortName* attributes to declare the namespaces used by the endpointName and serviceName attributes.

Example

Example 3.3 on page 31 shows the configuration for a JAX-WS endpoint that specifies the address where the endpoint is published.

Example 3.3. Simple JAX-WS Server Configuration

```
<beans ...
  xmlns:jaxws="http://cxf.apache.org/jaxws"
  ...
  schemaLocation="...
    http://cxf.apache.org/jaxws http://cxf.apache.org/schemas/jaxws.xsd
    ...">
  <jaxws:server id="exampleServer"
                serviceBean="org.apache.cxf.example.DemoImpl"
                address="http://localhost:8080/demo" />
</beans>
```

Adding Functionality to Service Providers

Overview

The `jaxws:endpoint` and the `jaxws:server` elements provide the basic configuration information needed to instantiate a service provider. To add functionality to your service provider or to perform advanced configuration you must add child elements to the configuration.

Child elements allow you to do the following:

- Change the endpoint's logging behavior
- Add interceptors to the endpoint's messaging chain
- Enable WS-Addressing features
- Enable reliable messaging

Elements

Table 3.3 on page 32 describes the child elements that `jaxws:endpoint` supports.

Table 3.3. Elements Used to Configure JAX-WS Service Providers

Element	Description
`jaxws:handlers`	Specifies a list of JAX-WS `Handler` implementations for processing messages. For more information on JAX-WS `Handler` implementations see "Writing Handlers" in *Developing Applications Using JAX-WS*.
`jaxws:inInterceptors`	Specifies a list of interceptors that process inbound requests. For more information see *Developing Interceptors*.
`jaxws:inFaultInterceptors`	Specifies a list of interceptors that process inbound fault messages. For more information see *Developing Interceptors*.
`jaxws:outInterceptors`	Specifies a list of interceptors that process outbound replies. For more information see *Developing Interceptors*.
`jaxws:outFaultInterceptors`	Specifies a list of interceptors that process outbound fault messages. For more information see *Developing Interceptors*.
`jaxws:binding`	Specifies a bean configuring the message binding used by the endpoint. Message bindings are configured using implementations of the `org.apache.cxf.binding.BindingFactory` interface.[a]

Element	Description
`jaxws:dataBinding` [b]	Specifies the class implementing the data binding used by the endpoint. This is specified using an embedded bean definition.
`jaxws:executor`	Specifies a Java executor that is used for the service. This is specified using an embedded bean definition.
`jaxws:features`	Specifies a list of beans that configure advanced features of FUSE Services Framework. You can provide either a list of bean references or a list of embedded beans.
`jaxws:invoker`	Specifies an implementation of the `org.apache.cxf.service.Invoker` interface used by the service. [c]
`jaxws:properties`	Specifies a Spring map of properties that are passed along to the endpoint. These properties can be used to control features like enabling MTOM support.
`jaxws:serviceFactory`	Specifies a bean configuring the `JaxWsServiceFactoryBean` object used to instantiate the service.

[a]The SOAP binding is configured using the `soap:soapBinding` bean.

[b]The `jaxws:endpoint` element does not support the `jaxws:dataBinding` element.

[c]The `Invoker` implementation controls how a service is invoked. For example, it controls whether each request is handled by a new instance of the service implementation or if state is preserved across invocations.

Configuring Consumer Endpoints

Overview

JAX-WS consumer endpoints are configured using the `jaxws:client` element. The element's attributes provide the basic information necessary to create a consumer.

To add other functionality, like WS-RM, to the consumer you add children to the `jaxws:client` element. Child elements are also used to configure the endpoint's logging behavior and to inject other properties into the endpoint's implementation.

Basic Configuration Properties

The attributes described in Table 3.4 on page 34 provide the basic information necessary to configure a JAX-WS consumer. You only need to provide values for the specific properties you want to configure. Most of the properties have sensible defaults, or they rely on information provided by the endpoint's contract.

Table 3.4. Attributes Used to Configure a JAX-WS Consumer

Attribute	Description
`address`	Specifies the HTTP address of the endpoint where the consumer will make requests. This value overrides the value set in the contract.
`bindingId`	Specifies the ID of the message binding the consumer uses. A list of valid binding IDs is provided in Appendix A on page 143.
`bus`	Specifies the ID of the Spring bean configuring the bus managing the endpoint.
`endpointName`	Specifies the value of the `wsdl:port` element's `name` attribute for the service on which the consumer is making requests. It is specified as a QName using the format *`ns`*`:`*`name`*, where *`ns`* is the namespace of the `wsdl:port` element.
`serviceName`	Specifies the value of the `wsdl:service` element's `name` attribute for the service on which the consumer is making requests. It is specified as a QName using the format *`ns`*`:`*`name`* where *`ns`* is the namespace of the `wsdl:service` element.
`username`	Specifies the username used for simple username/password authentication.
`password`	Specifies the password used for simple username/password authentication.
`serviceClass`	Specifies the name of the service endpoint interface(SEI).

Attribute	Description
wsdlLocation	Specifies the location of the endpoint's WSDL contract. The WSDL contract's location is relative to the folder from which the client is deployed.
name	Specifies the stringified QName of the wsdl:port element for the service on which the consumer is making requests. It is specified as a QName using the format {*ns*}*localPart*, where *ns* is the namespace of the wsdl:port element and *localPart* is the value of the wsdl:port element's name attribute.
abstract	Specifies if the bean is an abstract bean. Abstract beans act as parents for concrete bean definitions and are not instantiated. The default is false. Setting this to true instructs the bean factory not to instantiate the bean.
depends-on	Specifies a list of beans that the endpoint depends on being instantiated before it can be instantiated.
createdFromAPI	Specifies that the user created that bean using FUSE Services Framework APIs like Service.getPort(). The default is false. Setting this to true does the following: • Changes the internal name of the bean by appending .jaxws-client to its id • Makes the bean abstract

In addition to the attributes listed in Table 3.4 on page 34, it might be necessary to use multiple xmlns:*shortName* attributes to declare the namespaces used by the endpointName and the serviceName attributes.

Adding functionality

To add functionality to your consumer or to perform advanced configuration, you must add child elements to the configuration.

Child elements allow you to do the following:

- Change the endpoint's logging behavior
- Add interceptors to the endpoint's messaging chain
- Enable WS-Addressing features
- Enable reliable messaging

Table 3.5 on page 36 describes the child element's you can use to configure a JAX-WS consumer.

Table 3.5. Elements For Configuring a Consumer Endpoint

Element	Description
`jaxws:binding`	Specifies a bean configuring the message binding used by the endpoint. Message bindings are configured using implementations of the `org.apache.cxf.binding.BindingFactory` interface.[a]
`jaxws:dataBinding`	Specifies the class implementing the data binding used by the endpoint. You specify this using an embedded bean definition. The class implementing the JAXB data binding is `org.apache.cxf.jaxb.JAXBDataBinding`.
`jaxws:features`	Specifies a list of beans that configure advanced features of FUSE Services Framework. You can provide either a list of bean references or a list of embedded beans.
`jaxws:handlers`	Specifies a list of JAX-WS `Handler` implementations for processing messages. For more information in JAX-WS `Handler` implementations see "Writing Handlers" in *Developing Applications Using JAX-WS*.
`jaxws:inInterceptors`	Specifies a list of interceptors that process inbound responses. For more information see *Developing Interceptors*.
`jaxws:inFaultInterceptors`	Specifies a list of interceptors that process inbound fault messages. For more information see *Developing Interceptors*.
`jaxws:outInterceptors`	Specifies a list of interceptors that process outbound requests. For more information see *Developing Interceptors*.
`jaxws:outFaultInterceptors`	Specifies a list of interceptors that process outbound fault messages. For more information see *Developing Interceptors*.
`jaxws:properties`	Specifies a map of properties that are passed to the endpoint.
`jaxws:conduitSelector`	Specifies an `org.apache.cxf.endpoint.ConduitSelector` implementation for the client to use. A `ConduitSelector` implementation will override the default process used to select the `Conduit` object that is used to process outbound requests.

[a]The SOAP binding is configured using the `soap:soapBinding` bean.

Example

Example 3.4 on page 37 shows a simple consumer configuration.

Example 3.4. Simple Consumer Configuration

```
<beans ...
  xmlns:jaxws="http://cxf.apache.org/jaxws"
  ...
  schemaLocation="...
    http://cxf.apache.org/jaxws http://cxf.apache.org/schemas/jaxws.xsd
    ...">
  <jaxws:client id="bookClient"
                serviceClass="org.apache.cxf.demo.BookClientImpl"
                address="http://localhost:8080/books"/>
  ...
</beans>
```

Chapter 4. Deploying to an OSGi Container

Applications developed using the FUSE Services Framework can be installed into an OSGi container. Once installed the applications can use many of the advanced features.

Introduction to OSGi

Overview

OSGi is a mature, lightweight, component system that solves many challenges associated with medium and large scale development projects. Through the use of bundles complexity is reduced by separating concerns and ensuring dependencies are minimally coupled via well defined interface communication. This also promotes the reuse of components in much the same way that SOA promotes the reuse of services. And, since each bundle effectively is given an isolated environment, and since dependencies are explicitly defined, versioning and dynamic updates are possible. These are just a few of the many benefits of OSGi. Users wishing to learn more should check out http://www.osgi.org/Main/HomePage.

Before you can install an application into an OSGi container, you need to package it into one or more *OSGi bundles*. An OSGi bundle is a JAR that contains extra information that is used by the OSGi container. This extra information specifies the packages this bundle exposes to the other bundles in the container and any packages on which this bundle depends.

Supported containers

FUSE Services Framework applications should work in any OSGi container. However, they are only supported in the following containers:

- FUSE ESB 4.0
- 4.0.0.3
- Equinox 3.4.0

Application packaging

Before you can install an application into an OSGi container it needs to be packaged into one or more OSGi bundles. An OSGi bundle is essentially a standard JAR. Where an OSGi bundle and a plain JAR differ is in the contents of their manifest files. An OSGi bundle's manifest contains a number of properties that specify the following:

- the Java packages which this bundle exposes to other bundles
- the Java packages, and other resources, on which this bundle depends

- the version number of the bundle

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. Once all of a bundle's dependencies are resolved, it moves to the next lifecycle 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 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, at any time, any of the above conditions ceases to be satisfied, the bundle is moved back into the installed state. For example, this can happen if a bundle containing 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 if 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 a bundle containing a JAX-WS service provider, this means 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 if 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 your application must be published during in the starting state. The published endpoints must be stopped during the stopping state.

Packaging and Installing an Application

Overview

There are a number of tools available and the different OSGi containers use varying deployment mechanisms. However, the basic steps to package and deploy applications into an OSGi container are the same:

1. Determine how the application will publish its endpoints.

   In order for your application to be started by the OSGi framework it needs to have logic that instantiates the resources used by the application. For a JAX-WS server application this means that the service provider endpoints need to be created and published. For a JAX-WS client application this means that the object implementing the client's business logic needs to be instantiated. The application may also need some logic to clean up its resources when shutting down.

   There are two ways to get the resources for your application started:

   - rely on Sring-DM to publish the endpoints
   - publish the endpoints in a `BundleActivator` object

2. Decide how you want to bundle the application.

   Depending on the complexity of you application, it may make sense to break your application into several bundles. You will also want to be very deliberate in determining if your application's bundles include any third party libraries.

   Tip

   The best practice is to find OSGi bundles containing all of the third party libraries needed by your application and use the OSGi dependency mechanism to resolve them.

3. Create bundles for each of your application's modules.
4. Install the bundles to the container.

Once your bundles are installed, you can start and stop them using the container's commands. You can also upgrade them in place when needed.

Publishing endpoints using Spring-DM

Spring Dynamic Modules for OSGi Service Platforms(Spring-DM) scans bundles in an OSGi container and automatically creates a Spring application context for any bundles that contains a Spring XML file in its `META-INF/spring` folder. It will inject all of the beans defined in the configuration file into the application context. For JAX-WS server, you would include a `jaxws:endpoint` element for each service provider your application exposes. Spring-DM injects them into the application context and publish the endpoints when the bundle is started.

Before using Spring-DM you must make sure the required bundles are installed into your OSGi container. You must also make sure they are started. FUSE ESB and include support for Spring-DM as part of their default configuration. If your container does not include Spring-DM support you can download it from http://www.springsource.org/osgi.

Important

When using Spring-DM to publish endpoints you must include the following DynamicImport-Package statement in the bundle's manifest:

```
DynamicImport-Package: org.apache.cxf.*
```

This allows the Spring framework to construct the proper FUSE Services Framework objects.

Publishing endpoints in a bundle activator

The `org.osgi.framework .BundleActivator` is an OSGi API used by the OSGi framework when it starts and stops bundles. As shown in Example 4.1 on page 44, it has two methods that need to be implemented.

Example 4.1. Bundle Activator Interface

```
interface BundleActivator
{
  public void start(BundleContext context)
  throws java.lang.Exception;

  public void stop(BundleContext context)
  throws java.lang.Exception;
}
```

The `start()` method is called when the container starts the bundle. This is where you would instantiate and publish any service provider endpoints exposed by a server application. For a client application, this is the method that would instantiate the client's application logic.

The `stop()` method is called when the container stops the bundle. This is where you would stop any endpoints exposed by a server.

When using a bundle activator you need to add the Bundle-Activator property to the bundle's manifest. This property tells the container which class in the bundle to use when activating the bundle.

For more information on publishing service provider endpoints see "Publishing a Service" in *Developing Applications Using JAX-WS*.

Creating bundles

You can hand edit the manifest files for each of your application's bundles and manually assemble them using the standard Java mechanism for creating JARs. Hand editing a manifest is a tedious and error prone process and is not recommended. You should use one of the many tools available for creating OSGi bundles.

The **bnd**[1] tool from Peter Kriens is powerful and freely available. It automates the construction of OSGi bundle manifests by introspecting the contents of the classes being packaged in the bundle. Using the knowledge of the classes contained in the bundle, the tool can calculate the proper values to populate the Import-Packages and the Export-Package properties in the bundle manifest.

The **bnd** tool can be used as an Ant task and is the foundation for the Maven bundle plug-in[2] from Apache Felix.

Required bundles

The FUSE Services Framework core components are included in an OSGi bundle called `org.apache.cxf.cxf-bundle`.

[1] http://www.aqute.biz/Code/Bnd
[2] http://cwiki.apache.org/FELIX/apache-felix-maven-bundle-plugin-bnd.html

Tip

FUSE ESB and install the `org.apache.cxf.cxf-bundle` bundle by default.

Required packages

FUSE Services Framework applications depend on a number of runtime packages. Because of the complex nature of the dependencies in FUSE Services Framework, you cannot rely on 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`
- `META-INF.cxf`
- `META-INF.cxf.osgi`
- `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`

Installing a Sample Application

This section uses the WSDL-first sample included with FUSE Services Framework to walk you through installing an application into an OSGi container. This sample, which is located in *InstallDir*/samples/wsdl-first, is a simple Hello World application that is developed using the JAX-WS APIs.

The sample must be modified so that it can generate an OSGi bundle that contains the proper artifacts. You must make the following changes:

- Set up the **bnd** Ant task.
- Add a build target for packaging your application into an OSGi bundle.
- Create a BND driver file for your application.
- Create a FUSE Services Framework configuration file to publish the endpoint.

Important

You will need to download and install the **bnd** tool to run this example. The instructions in this section assume that bnd-0.0.249.jar is installed in *InstallDir*/lib.

Once you have started the container and built the bundle, you can install it into the running container and see the client make requests against the service. Once you are finished testing the example you can stop the application and uninstall it.

Modifying the Sample

Setting up Ant

Setting up Ant to build your bundle requires the following:

- Setting up the **bnd** task.

  Example 4.2 on page 48 shows the code for adding the **bnd** task to Ant.

  Example 4.2. Adding BND to Ant

  ```
  <taskdef resource="aQute/bnd/ant/taskdef.properties"
              classpath="${cxf.home}/lib/bnd-0.0.249.jar"/>
  ```

- Adding a target to build the bundle using the **bnd** task.

  Example 4.3 on page 48 shows the Ant target used to package the WSDL-first demo into a bundle.

  Example 4.3. Build Targets for Packaging the WSDL-First Demo as an OSGi Bundle

  ```
  <target name="osgi" depends="build">
    <bnd classpath="${build.classes.dir}"
                  eclipse="false"
                  failok="false"
                  exceptions="true"
                  files="wsdl_first.bnd"
                  output="./build"/>
  </target>
  ```

  The `wsdl_first.bnd` file provided as the value to the **bnd** task's `files` property is a BND driver file. The BND driver file controls what is placed in the application's bundle and it defines the properties that are placed in the application bundle's manifest.

The BND file

The **bnd** Ant task uses the BND control file shown in Example 4.4 on page 48.

Example 4.4. OSGi BND Control File

```
Private-Package: demo.hw.server, org.apache.hello_world_soap_http.* ❶
Import-Package: javax.jws, javax.wsdl, META-INF.cxf, 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, * ❷
Include-Resource: META-INF/spring/beans.xml=beans.xml, hello_world.wsdl=wsdl/hello_world.wsdl
  ❸
Bundle-Version: 1.0
Require-Bundle: org.apache.cxf.cxf-bundle
DynamicImport-Package: org.apache.cxf.* ❹
```

The BND control file specifies the following:

❶ The classes implementing the service are to be added to the bundle, but not exported.

❶ The packages listed in "Required packages" on page 46 are imported by the bundle.

❸ The WSDL file and the configuration are copied into the proper places in the bundle.

❹ The `org.apache.cxf.*` packages are dynamically imported for the Spring-DM framework.

Configuration file

For this example, we are going to rely on Spring-DM to publish the endpoint created by the application. Spring-DM requires that a Spring XML file be placed in the bundle's `META-INF/spring` folder. Since FUSE Services Framework configuration files are Spring XML files, we can simply create FUSE Services Framework configuration file similar to the one shown in Example 4.5 on page 49 and have it placed into the proper location in the application's bundle.

Example 4.5. Sample Configuration for an OSGi deployment

```
<beans xmlns="http://www.springframework.org/schema/beans"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xmlns:jaxws="http://cxf.apache.org/jaxws"
 xsi:schemaLocation="
http://www.springframework.org/schema/beans http://www.springframe
work.org/schema/beans/spring-beans.xsd
http://cxf.apache.org/jaxws http://cxf.apache.org/schemas/jaxws.xsd">

    <import resource="classpath:META-INF/cxf/cxf.xml" />
    <import resource="classpath:META-INF/cxf/cxf-extension-soap.xml" />
    <import resource="classpath:META-INF/cxf/cxf-extension-http.xml" />
    <import resource="classpath:META-INF/cxf/cxf-extension-http-jetty.xml" />

    <jaxws:endpoint id="hello_world"
            implementor="demo.hw.server.GreeterImpl"
           wsdlLocation="hello_world.wsdl"
            address="http://localhost:9000/SoapContext/SoapPort"/>
```

```
</beans>
```

The Include-Resource statement in the BND control file shown in Example 4.4 on page 48 instructs BND to copy the configuration file into the bundle's `META-INF/spring` folder.

Running the Sample

Building the bundle

To package the demo into an OSGI bundle enter the following command:

```
>ant osgi
```

When Ant finishes building and packaging the demo you will find the bundle in the `build` folder.

Installing the application

Once you have packaged your application into a bundle, you must install it to a running OSGi container. How you install bundles into your OSGi container will depend on your OSGi container.

Use the **install** command from the FUSE ESB's OSGi command shell to install it into the container as shown in Example 4.6 on page 51.

Example 4.6. Installing HelloWorld to the FUSE ESB Container

```
servicemix osgi> install file:SampleDir/build/wsdl_first.jar
Bundle ID: 134
```

Tip

FUSE ESB has a hot deployment feature that automates the installation and starting of OSGi bundles. Any bundle copied into FUSE ESB's `deploy` folder is automatically installed and started.

Starting the application

Before an application can be used the bundle containing the service implementation must be moved into the active life-cycle state and all of the bundles containing dependencies must be in the resolved, or active, life-cycle state.

In the demo, the bundle contains a Spring configuration file that defines the endpoint to be created by the application. FUSE ESB comes pre-loaded with the Spring-DM extender bundle. The Spring-DM extender bundle creates a Spring `ApplicationContext` for the `jaxws:endpoint` element included in the endpoint bundle's `META-INF/spring` directory. For more information about writing Spring configuration for a service provider see "Configuring Service Providers" on page 24.

When starting the bundle, the container begins trying to resolve all of the bundle's dependencies. Once the endpoint's bundle's dependencies are resolved, the container activates it.

To start the demo from FUSE ESB's **osgi** command shell use the **start** command as shown in Example 4.7 on page 52.

Example 4.7. Starting the HelloWorld OSGi Sample

```
servicemix osgi>install 134
Jan 18, 2009 6:09:35 PM org.apache.cxf.endpoint.ServerImpl initDestination
INFO: Setting the server's publish address to be http://localhost:9000/SoapContext/SoapPort
```

Running the client

Once the endpoint bundle is fully started, the HelloWorld service provider is ready to accept requests from consumers. To test the application you can run the client against the service provider by executing the **ant client** command. Example 4.8 on page 52 shows the expected results.

Example 4.8. Output from HelloWorld

```
Buildfile: build.xml
maybe.generate.code:

compile:

build:

client:
     [java] file:/home/emjohnson/iona/fsf213/samples/wsdl_first_osgi/wsdl/hello_world.wsdl
     [java] Invoking sayHi...
     [java] Server responded with: Bonjour
     [java]
     [java] Invoking greetMe...
     [java] Server responded with: Hello emjohnson
     [java]
     [java] Invoking greetMe with invalid length string, expecting exception...
     [java] Caught expected WebServiceException:
     [java]     Marshalling Error: cvc-maxLength-valid: Value 'Invoking greetMe with invalid length
string, expecting exception...' with length = '67' is not facet-valid with respect to maxLength '30'
 for type 'MyStringType'.
     [java]
     [java] Invoking greetMeOneWay...
     [java] No response from server as method is OneWay
     [java]
     [java] Invoking pingMe, expecting exception...
     [java] Expected exception: PingMeFault has occurred: PingMeFault raised by server
```

```
     [java] FaultDetail major:2
     [java] FaultDetail minor:1

BUILD SUCCESSFUL
Total time: 6 seconds
```

Stopping the application

When you are ready to take the service provider off line you can simply move it from the active state to the resolved state. This will shut down the service provider and free the resources it is using. However, the contents of the application's bundle remain available to other bundles.

To stop a bundle in FUSE ESB you use the **stop** command from the **osgi** command shell.

Tip

Stopped bundles can be easily reactivated using the **start** command.

Uninstalling the application

When you want to completely remove any resources exposed by your application's bundles you need to uninstall the bundles. Once a bundle is uninstalled none of its exported resources are available to bundles in the container. It also cannot be re-started. It must be reinstalled before it can be used again.

To uninstall bundles from the FUSE ESB container you use the **uninstall** command from the **osgi** command shell.

Chapter 5. Deploying to the Spring Container

FUSE Services Framework provides a Spring container into which you can deploy any Spring-based application, including a FUSE Services Framework service endpoint. This chapter outlines how to deploy and manage a FUSE Services Framework service endpoint in the Spring container.

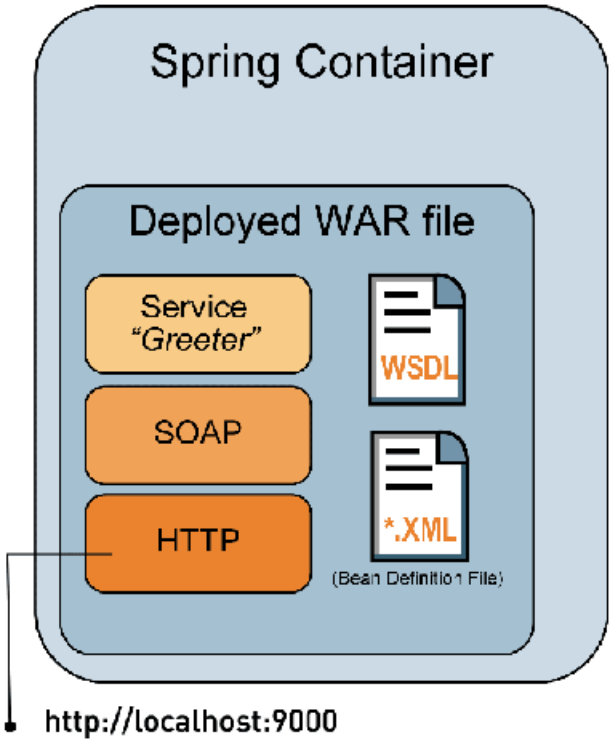
Introduction

Overview

FUSE Services Framework includes a Spring container that is a customized version of the *Spring framework*. The Spring framework is a general purpose environment for deploying and running Java applications. For more information on the framework, see www.springframework.org. This document explains how to deploy and manage FUSE Services Framework service endpoints in the Spring container.

Figure 5.1 on page 57 shows how to access a deployed FUSE Services Framework endpoint in the Spring container.

Figure 5.1. FUSE Services Framework Endpoint Deployed in a Spring Container



You deploy a Web Archive (WAR) file to the Spring container. The WAR file contains all of the files that the Spring container needs to run your application. These include the WSDL file that defines your service, the code that you generated from the WSDL file, including the implementation file, and any libraries that your application requires. It also includes a FUSE Services Framework runtime Spring-based XML configuration file to configure your application.

The Spring container loads each WAR file using a unique class loader. The class loader incorporates a firewall class loader that ensures that any classes

contained in the WAR are loaded before classes in the parent class loader are loaded.

Sample XML

The example XML used in this chapter is taken from the Spring container sample application located in:

InstallDir/samples/spring_container

Most of the samples contained in the *InstallDir*/samples directory can be deployed to the Spring container. After reading this chapter, you can try deploying some of the sample applications to the Spring container. For instructions, see the README.txt files in each sample directory.

Running the Spring Container

Overview

This section explains how to run the Spring container using the **spring_container** command.

Using the spring_container command

The **spring_container** command is located in the *InstallDir*/bin directory, and has the following syntax:

spring_container [-config *spring-config-url*] [-wsdl *container-wsdl-url*] [-h] [-verbose] [[start] | [stop]]

Table 5.1. Spring Container Command Options

-config *spring-config-url*	Specifies the URL or file location of the Spring container configuration file, which is used to launch the Spring container. This flag is optional. By default, the Spring container uses the spring_container.xml file, which is located in the *InstallDir*/containers/spring_container/etc directory. You should only use the -config flag if you are specifying a different configuration file. For example, see "Running Multiple Containers on Same Host" on page 72 .
-wsdl *container-wsdl-url*	Specifies the URL or file location of the Spring container WSDL file. This flag is optional. By default, the Spring container uses the container.wsdl file located in the *InstallDir*/containers/spring_container/etc/wsdldirectory. You should only use the -wsdl flag if you are specifying a different Spring container WSDL file. For example, see "Running Multiple Containers on Same Host" on page 72
-h	Prints usage summary and exits. This flag is optional.
-v	Specifies verbose mode. This flag is optional.
<start|stop>	Starts and stops the Spring container. These flags are required to start and stop the Spring container respectively.

Starting the Spring container

To start the Spring container, run the following command from the *InstallDir*/bin directory:

```
spring_container start
```

If you wish to start more that one container on a single host, see "Running Multiple Containers on Same Host" on page 72.

Stopping the Spring container

To stop the Spring container, run the following command from the *InstallDir*/bin directory:

```
spring_container stop
```

If you are running more than one container on the same host, see "Running Multiple Containers on Same Host" on page 72.

Deploying a FUSE Services Framework Endpoint

Deployment steps

The following steps outline, at a high-level, what you must do to successfully configure and deploy a FUSE Services Framework endpoint to the Spring container:

1. Write a FUSE Services Framework configuration file for your application. See "Configuring your application" on page 61.
2. Build a WAR file that contains the configuration file, the WSDL file that defines your service, and the code that you generated from that WSDL file, including the implementation file, and any libraries that your application requires. See "Building a WAR file" on page 62.
3. Deploy the WAR file in one of the following ways:
   - Copy the WAR file to the Spring container repository. See "Deploying the WAR file to the Spring repository" on page 63.
   - Use the JMX console. See "Managing the Container using the JMX Console" on page 65.
   - Use the Web service interface. See "Managing the Container using the Web Service Interface" on page 68.

Configuring your application

You must write an XML configuration file for your application. The Spring container requires this file to instantiate, configure, and assemble the beans in your application.

Example 5.1 on page 61 shows the `spring.xml` configuration file used in the Spring container sample application. You can use any name for your configuration file, however, it must end with a `.xml` extension. This example file is taken from the *`InstallDir`*`/samples/spring_container` sample application. Most of the samples in the *`InstallDir`*`/samples` directory contain files named`spring.xml`, which configure the samples for deployment to the Spring container.

Example 5.1. Configuration File—spring.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<beans ❶
```

```
    xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:jaxws="http://cxf.apache.org/jaxws"
    xsi:schemaLocation="
        http://cxf.apache.org/jaxws
        http://cxf.apache.org/schemas/jaxws.xsd
        http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans.xsd">
    <jaxws:endpoint id="SoapEndpoint" ❷
        implementor="#SOAPServiceImpl"
        address="http://localhost:9000/SoapContext/SoapPort"
        wsdlLocation="hello_world.wsdl"
        endpointName="e:SoapPort"
        serviceName="s:SOAPService"
        xmlns:e="http://apache.org/hello_world_soap_http"
        xmlns:s="http://apache.org/hello_world_soap_http"/>
    <bean id="SOAPServiceImpl" class="demo.hw.server.GreeterImpl"/> ❸
</beans>
```

The code shown in Example 5.1 on page 61 can be explained as follows:

❶ The Spring `beans` element is required at the beginning of every FUSE Services Framework configuration file. It is the only Spring element that you must be familiar with.

❷ Configures a `jaxws:endpoint` element that defines a service and its corresponding endpoints.

Important

The location of the WSDL file specified in the `wsdlLocation` is relative to the WAR's `WEB_INF/wsdl` folder.

For more information on configuring a FUSE Services Framework `jaxws:endpoint` element, see "Using the jaxws:endpoint Element" on page 25.

❸ Identifies the class that implements the service.

Building a WAR file

To deploy your application to the Spring container you must build a WAR file that has the following structure and contents:

- `META-INF/spring` should include your configuration file. The configuration file must have a `.xml` extension.

- `WEB-INF/classes` should include your Web service implementation class, and any other classes (including the class hierarchy) generated by the **wsdl2java** utility. For details, see wsdl2java in *Tool Reference*.
- `WEB-INF/wsdl` should include the WSDL file that defines the service that you are deploying.
- `WEB-INF/lib` should include any JARs required by your application.

Deploying the WAR file to the Spring repository

The simplest way to deploy a FUSE Services Framework endpoint to the Spring container is to:

1. Start the Spring container by running the following command:

   ```
   InstallDir/bin/spring_container start
   ```

2. Copy the WAR file to the Spring container repository.

   The default location for the repository is *InstallDir*`/containers/spring_container/repository`.

The Spring container automatically scans the repository for newly deployed applications. The default value at which it scans the repository is every `5000` milliseconds.

Using Ant to build a WAR file and deploy to the Spring container

You can use the Apache **ant** utility to build the FUSE Services Framework sample applications. This includes building the WAR files and deploying them to the Spring container. If you want to use the **ant** utility to build your applications, including the WAR file for deployment to the Spring container, see the example `build.xml` file located in the *InstallDir*`/samples/spring_container/wsdl_first` directory.

For more information about the **ant** utility, see http://ant.apache.org/.

Changing the interval at which the Spring container scans its repository

You can change the time interval at which the Spring container scans the repository by changing the `scanInterval` property in the

`spring_container.xml` configuration file. See Example 5.2 on page 69 for more detail.

Changing the default location of the container repository

You can change the Spring container repository location by changing the value of the `containerRepository` property in the `spring_container.xml` configuration file. See Example 5.2 on page 69 for more detail.

Managing the Container using the JMX Console

Overview

You can use the JMX console to deploy and manage applications in the Spring container. The JMX console enables you to deploy applications, as well as stop, start, remove, and list applications that are running in the container. You can also get information on the application's state. The name of the deployed WAR file is the name given to the application.

Using the JMX console

To use the JMX console to manage applications deployed to the Spring container, do the following:

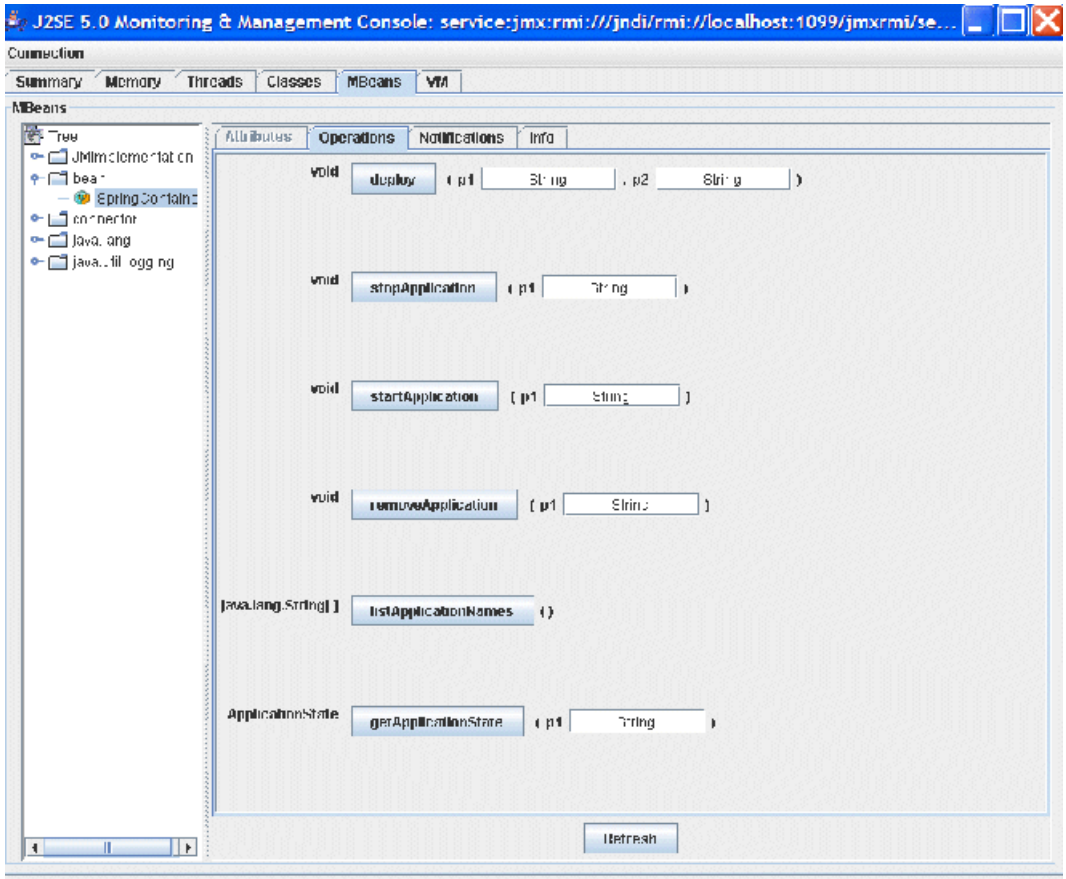
1. Start the JMX console by running the following command from the *InstallDir*`/bin` directory:

Platform	Command
Windows	**`jmx_console_start.bat`**
UNIX	**`jmx_console_start.sh`**

2. Select the **MBeans** tag and expand the **bean** node to view the **SpringContainer** MBean (see Figure 5.2 on page 66).

   The `SpringContainer` MBean is deployed as part of the Spring container. It provides access to the management interface for the Spring Container and can be used to deploy, stop, start, remove and list applications. I can also get information on an application's state.

Figure 5.2. JMX Console—SpringContainer MBean



The operations and their parameters are described in Table 5.2 on page 66.

Table 5.2. JMX Console—SpringContainer MBean Operations

Operation	Description	Parameters
`deploy`	Deploys an application to the container repository. The `deploy` method copies a	`location` — A URL or file location that points to the application to be deployed.

Operation	Description	Parameters
	WAR file from a given URL or file location and puts the copy into the container repository.	`warFileName` — The name of the WAR file as you want it to appear in the container repository.
`stopApplication`	Stops the specified application. It does not remove the application from the container repository.	`name` — Specifies the name of the application that you want to stop. The application name is the same as the WAR file name.
`startApplication`	Starts an application that has previously been deployed and subsequently stopped.	`name` — Specifies the name of the application that you want to start. The application name is the same as the WAR file name.
`removeApplication`	Stops and removes an application. It completely removes an application from the container repository.	`name` — Specifies the name of the application that you want to stop and remove. The application name is the same as the WAR file name.
`listApplicationNames`	Lists all of the applications that have been deployed. The applications can be in one of three states: start, stop, or failed. An application's name is the same as its WAR file name.	None
`getApplicationState`	Reports whether an application is running or not.	`name` — Specifies the name of the application whose state you want to know. The application name is the same as the WAR file name.

Managing the Container using the Web Service Interface

Overview

You can use the Web service interface to deploy and manage applications in the Spring container. The Web service interface is specified in the `container.wsdl` file, which is located in the *`InstallDir`*`/containers/spring_container/etc/wsdl` directory of your installation.

Client tool

FUSE Services Framework does not currently include a client tool for the Web service interface. However, you can write one if you are familiar with Web service development. Please see the `container.wsdl` file and the *Developing Applications Using JAX-WS* for more details.

Changing the port the Web service interface listens on

To change the port that the Web service interface listens on, you must change the port number of the address property in the `spring_container.xml` file, as shown:

```
<jaxws:endpoint id="ContainerService"
                implementor="#ContainerServiceImpl"
               address="http://localhost:2222/AdminContext/Ad
minPort" ...>
```

You do not need to change the `container.wsdl` file.

For more information on the `spring_container.xml` file, see "Spring Container Definition File" on page 69.

Adding a port

If you want to add a port, such as a JMS port or an HTTPS port, add the port details to the `container.wsdl` file.

Spring Container Definition File

Overview

The Spring container is configured in the `spring_container.xml` file located in the following directory of your installation:

InstallDir`/containers/spring_container/etc`

spring_container.xml

The contents of the Spring container configuration file are shown in Example 5.2 on page 69.

Example 5.2. spring_container.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:jaxws="http://cxf.apache.org/jaxws"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:container="http://schemas.iona.com/soa/container-config"
       xsi:schemaLocation="http://www.springframework.org/schema/beans
                           http://www.springframework.org/schema/beans/spring-beans-2.0.xsd

                          http://cxf.apache.org/jaxws
                             http://cxf.apache.org/schemas/jaxws.xsd
                           http://schemas.iona.com/soa/container-config
                           http://schemas.iona.com/soa/container-config.xsd">

   <!-- Bean definition for Container -->
   <container:container id="container" containerRepository="C:\iona\fuse-services-frame
work/containers/spring_container/repository" scanInterval="5000"/> ❶

   <!-- Web Service Container Management -->
   <jaxws:endpoint id="ContainerService" ❷
                   implementor="#ContainerServiceImpl"
                   address="http://localhost:2222/AdminContext/AdminPort"
                   wsdlLocation="/wsdl/container.wsdl"
                   endpointName="e:ContainerServicePort"
                   serviceName="s:ContainerService"
                   xmlns:e="http://cxf.iona.com/container/admin"
                   xmlns:s="http://cxf.iona.com/container/admin"/>

  <bean id="ContainerServiceImpl" class="com.iona.cxf.container.admin.ContainerAdminSer
viceImpl">
    <property name="container">
      <ref bean="container" />
    </property>
  </bean>
```

```
    <!--  JMX Container Management  -->
  <bean id="mbeanServer" class="org.springframework.jmx.support.MBeanServerFactoryBean"> ❸

    <property name="locateExistingServerIfPossible" value="true" />
  </bean>

  <bean id="exporter" class="org.springframework.jmx.export.MBeanExporter">
    <property name="beans">
      <map>
        <entry key="bean:name=SpringContainer" value-ref="container"/>
        <entry key="connector:name=rmi" value-ref="serverConnector"/>
      </map>
    </property>
    <property name="server" ref="mbeanServer"/>
    <property name="assembler" ref="assembler" />
  </bean>

  <bean id="assembler" class="org.springframework.jmx.export.assembler.InterfaceBasedMBean
InfoAssembler">
    <property name="interfaceMappings">
      <props>
        <prop key="bean:name=SpringContainer">com.iona.cxf.container.managed.JMXContain
er</prop>
      </props>
    </property>
  </bean>

  <bean id="serverConnector" class="org.springframework.jmx.support.ConnectorServerFactory
Bean"  depends-on="registry">
    <property name="serviceUrl" value="service:jmx:rmi:///jndi/rmi://local
host:1099/jmxrmi/server"/>
  </bean>

  <bean id="registry" class="org.springframework.remoting.rmi.RmiRegistryFactoryBean">
    <property name="port" value="1099"/>
  </bean>
</beans>
```

The XML shown in Example 5.2 on page 69 does the following:

❶ Defines a bean that encapsulates the logic for the Spring container. This bean handles the logic for deploying user applications that are copied to the specified container repository location. The default container repository location is: *InstallDir*/containers/spring_container/repository. You can

change the repository location by changing the value of the `containerRepository` attribute.

The `scanInterval` attribute sets the time interval at which the repository is scanned. It is set in milliseconds. The default value is set to 5000 milliseconds. Removing this attribute disables scanning.

❷ Defines an application that creates a Web service interface that you can use to manage the Spring container.

The `ContainerServiceImpl` bean contains the server implementation code and the container administration logic.

To change the port on which the Web service interface listens, change the `address` property.

❸ Defines Spring beans that allow you to use a JMX console to manage the Spring container.

For more information, see the JMX chapter of the Spring 2.0.x reference document available at http://static.springframework.org/spring/docs/2.0.x/reference/jmx.html.

Running Multiple Containers on Same Host

Overview

You might want to run more than one instance of a Spring container on a single host. This allows you to load balance between multiple containers and also allows you to separate applications. Setting up multiple Spring containers to run on a single host requires you to modify each container's configuration so that there are no resource clashes.

Procedure

If you want to run more than one Spring container on the same host, you must do the following:

1. Make a copy of the `container.wsdl` file, which is located in the *`InstallDir`*`/containers/spring_container/etc/wsdl` directory.
2. In your new copy, `my_container.wsdl`, change the port on which the Web service interface listens from `2222` to another port by changing the address property as shown below:

```
<service name="ContainerService">
  <port name="ContainerServicePort" binding="tns:ContainerServiceBinding">
  <soap:address location="http://localhost:2222/AdminContext/AdminPort"/>
 </port>
</service>
```

3. Make a copy of the `spring_container.xml` file, which is located in the *`InstallDir`*`/containers/spring_container/etc` directory.
4. Make the following changes to your new copy, *`my_spring_container`*`.xml`:

    1. Container repository location—change the container's `containerRepository` property to point to a new repository.

       For example, you change:

```
<container:container id="container"
      containerRepository="c:\iona\fuse-services-framework/containers/spring_container/re
pository"
       scanInterval="5000"/>
```

       To:

```
<container:container id="container"
     containerRepository="MyNewContainerRepository/spring_container/repository"
     scanInterval="5000"/>
```

2. Change the port on which the Web service interface listens by changing the `address` property as follows:

```
<jaxws:endpoint id="ContainerService"
      implementor="#ContainerServiceImpl"
      address=" http://localhost:2222/AdminContext/AdminPort">
```

3. Change the JMX port from `1099` to a new port as show in the following line:

```
<bean id="serverConnector"
           class="org.springframework.jmx.support.ConnectorServerFactoryBean"
           depends-on="registry">
           <property name="serviceUrl" value="service:jmx:rmi:///jndi/rmi://local
host:1099/jmxrmi/server"/>
</bean>
```

4. Change the RMI registry port from `1099` to a new port as shown in the following snipit:

```
<bean id="registry" class="org.springframework.remot
ing.rmi.RmiRegistryFactoryBean">
  <property name="port" value="1099"/>
 </bean>
```

5. Make a copy of the JMX console launch script, `jmx_console_start.bat`, which is located in the *`InstallDir`*`/bin` directory.

6. Change the following line in the copy of the JMX console launch script to point to the JMX port that is specified above:

```
service:jmx:rmi:///jndi/rmi://localhost:1099/jmxrmi/server
```

7. Start the new container by passing the URL, or file location of its configuration file, `my_spring_container.xml`, to the `start_container` script as follows:

```
InstallDir/bin/spring_container -config my_spring_contain
er.xml start
```

8. To view the new container using the JMX console, run the JMX console launch script created in steps 5 and 6.

9. Stop the new container by passing the URL or file location of its WSDL file, `my_container.wsdl`, to the **spring_container** command.

   For example, if the `my_container.wsdl` file has been saved to the *InstallDir*`/containers/spring_container/wsdl` directory, run the following command:

```
InstallDir/bin/spring_container -wsdl ..\containers\spring_con
tainer\wsdl\my_container.wsdl stop
```

Chapter 6. Deploying to a Servlet Container

FUSE Services Framework endpoints can be deployed into any servlet container. FUSE Services Framework provides a standard servlet adapter that works for most service providers. It is also possible to deploy FUSE Services Framework endpoints using a Spring context or by creating a custom servlet to instantiate the FUSE Services Framework endpoint.

Introduction

Overview

Servlet containers are a common platform for running Web services. The FUSE Services Framework runtime's light weight and plugability make it easy to deploy endpoints into a servlet container. There are several ways to deploy endpoints into a servlet container:

- a FUSE Services Framework provided servlet adapter class
- a custom servlet
- the Spring servlet context listener
- the FUSE Services Framework JCA connector

Note

Not all servlet containers support JCA connectors

Deploying service providers

The preferred way to deploy a service provider into a servlet container is to use the CXF servlet. The CXF servlet only requires a few additional pieces of configuration to deploy a service provider into the servlet container. Much of the additional information is either canned information required deploy the servlet or FUSE Services Framework configuration for the endpoint.

It is also possible to deploy a service provider using any of the other methods.

Deploying service consumers

Service consumers cannot be deployed using the CXF servlet. They can be deployed using either a custom servlet that creates the required proxies or using the FUSE Services Framework JCA adapter.

For more information on using the JCA adapter read *J2EE Integrations*.

Configuring the Servlet Container

Overview

Before you can deploy a FUSE Services Framework endpoint to your servlet container you must make the FUSE Services Framework runtime libraries available to the container. There are two ways to accomplish this:

1. Add the required libraries to the container's shared library folder

   This approach has the advantage of keeping individual WAR files small. It also ensures that all of the FUSE Services Framework servlets are using the same version of the libraries.

2. Add the required libraries to each application's WAR file

   This approach has the advantage of flexibility. Each WAR can contain the versions of the libraries it requires.

Required libraries

FUSE Services Framework endpoints require all of the JAR files in the *`InstallDir`*`/lib` directory except the following:

- `servlet-api*.jar`
- `geronimo-servlet_*.jar`
- `jetty-*.jar`

Tip

The *`InstallDir/modules`* folder contains the FUSE Services Framework libraries broken into component JAR files. Using these component jars can shrink the amount of code that needs to be imported into the servlet environment. However, using the component JAR files requires knowing exactly which FUSE Services Framework components are in use.

Automating servlet container configuration

The FUSE Services Framework samples directory, *`InstallDir`*`/samples`, includes a `common_build.xml` file that contains utilities that automates the configuration of the servlet environment.

One utility is the **copy-war-libs** Ant target. It copies the required libraries to the folder specified in the war-lib. For example, to install the required libraries into a Tomcat 6 installation enter **`ant copy-war-libs -Dwar-lib=`*`CATALINA_HOME`*`\lib`**.

The other utility is the **cxfwar** macro. The macro is used to build the WAR files for all of the FUSE Services Framework samples. Its default result is to make a WAR containing all of the required libraries. This behavior can be changed by setting the without.libs property to `true`.

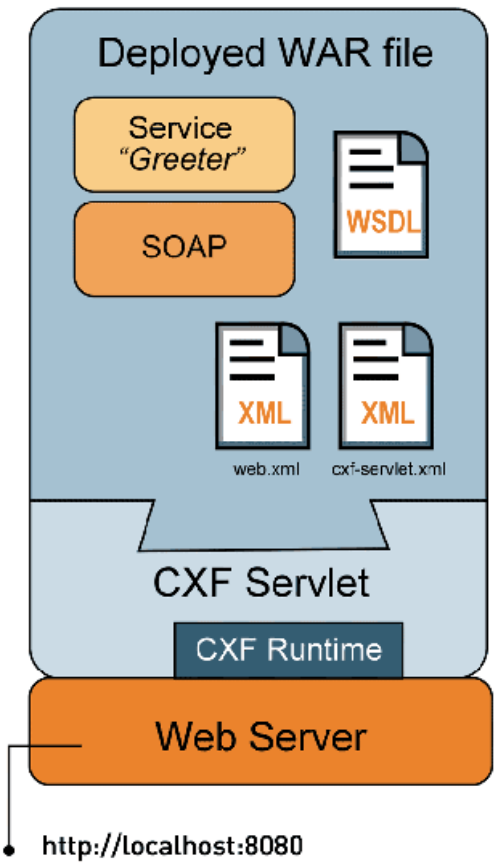
Using the CXF Servlet

Overview

FUSE Services Framework provides a standard servlet, the CXF servlet, which acts as an adapter for the Web service endpoints. The CXF servlet is the easiest method for deploying Web services into a servlet container.

Figure 6.1 on page 79 shows the main components of a FUSE Services Framework endpoint deployed using the CXF servlet.

Figure 6.1. FUSE Services Framework Endpoint Deployed in a Servlet Container



- Deployed WAR file — Service providers are deployed to the servlet container in a Web Archive (WAR) file. The deployed WAR file contains:
  - the compiled code for the service provider being deployed
  - the WSDL file defining the service
  - the FUSE Services Framework configuration file

    This file, called `cxf-servlet.xml`, is standard FUSE Services Framework configuration file that defines all of the endpoints contained in the WAR.
  - the Web application deployment descriptor

    All FUSE Services Framework Web applications using the standard CXF servlet need to load the `org.apache.cxf.transport.servlet.CXFServlet` class.
- CXF servlet — The CXF servlet is a standard servlet provided by FUSE Services Framework. It acts as an adapter for Web service endpoints and is part of the FUSE Services Framework runtime. The CXF servlet is implemented by the `org.apache.cxf.transport.servlet.CXFServlet` class.

Deployment steps

To deploy a FUSE Services Framework endpoint to a servlet container you must:

1. Build a WAR that contains your application and all the required support files.
2. Deploy the WAR file to your servlet container.

Building a WAR

To deploy your application to a servlet container, you must build a WAR file. The WAR file's `WEB-INF` folder should include the following:

- `cxf-servlet.xml` — a FUSE Services Framework configuration file specifying the endpoints that plug into the CXF servlet. When the CXF servlet starts up, it reads the `jaxws:endpoint` elements from this file, and initializes a service endpoint for each one. See "Servlet configuration file" for more information.

- `web.xml` — a standard web application file that instructs the servlet container to load the `org.apache.cxf.transport.servlet.CXFServlet` class.

Tip

A reference version of this file is contained in your *`InstallDir`*`/etc` directory. You can use this reference copy without making changes to it.

- `classes` — a folder including your Web service implementation class and any other classes required to support the implementation.
- `wsdl` — a folder including the WSDL file that defines the service you are deploying.
- `lib` — a folder including any JARs required by your application.

Servlet configuration file

The `cxf-servlet.xml` file is a FUSE Services Framework configuration file that configures the endpoints that plug into the CXF servlet. When the CXF servlet starts up it reads the `jaxws:endpoint` elements in this file and initializes a service endpoint for each one.

Example 6.1 on page 81 shows a simple `cxf-servlet.xml` file.

Example 6.1. CXF Servlet Configuration File

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans" ❶
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance
       xmlns:jaxws="http://cxf.apache.org/jaxws"
       xmlns:soap="http://cxf.apache.org/bindings/soap"
       xsi:schemaLocation="
http://www.springframework.org/schema/beans http://www.springframe
work.org/schema/beans/spring-beans-2.0.xsd
http://cxf.apache.org/bindings/soap http://cxf.apache.org/schemas/configuration/soap.xsd
http://cxf.apache.org/jaxws http://cxf.apache.org/schemas/jaxws.xsd">
    <jaxws:endpoint ❷
        id="hello_world"
        implementor="demo.hw.server.GreeterImpl"
        wsdlLocation="WEB-INF/wsdl/hello_world.wsdl"
        address="/hello_world">
```

```
            <jaxws:features>
                <bean class="org.apache.cxf.feature.LoggingFeature"/>
            </jaxws:features>
    </jaxws:endpoint>
</beans>
```

The code shown in Example 6.1 on page 81 is explained as follows:

❶ The Spring `beans` element is required at the beginning of every FUSE Services Framework configuration file. It is the only Spring element that you need to be familiar with.

❷ The `jaxws:endpoint` element defines a service provider endpoint. The `jaxws:endpoint` element has the following attributes:

- `id` — Sets the endpoint id.
- `implementor` — Specifies the class implementing the service.

Important

This class needs to be included in the WAR's `WEB-INF/classes` folder.

- `wsdlLocation` — Specifies the WSDL file that contains the service definition.

Important

The WSDL file location is relative to the WAR's `WEB-INF/wsdl` folder.

- `address` — Specifies the address of the endpoint as defined in the service's WSDL file that defines service that is being deployed.
- `jaxws:features` — Defines features that can be added to your endpoint.

For more information on configuring a `jaxws:endpoint` element, see "Using the jaxws:endpoint Element" on page 25.

Web application configuration

You must include a `web.xml` deployment descriptor file that instructs the servlet container to load the CXF servlet. Example 6.2 on page 83 shows a `web.xml` file. It is not necessary to change this file. A reference copy is located in the *`InstallDir`*`/etc` directory.

Example 6.2. A web.xml Deployment Descriptor File

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE web-app PUBLIC "-//Sun Microsystems, Inc.//DTD Web Application 2.3//EN" "ht
tp://java.sun.com/dtd/web-app_2_3.dtd">
<web-app>
   <display-name>cxf</display-name>
   <description>cxf</description>
   <servlet>
        <servlet-name>cxf</servlet-name>
        <display-name>cxf</display-name>
        <description>Apache CXF Endpoint</description>
        <servlet-class>org.apache.cxf.transport.servlet.CXFServlet</servlet-class>
        <load-on-startup>1</load-on-startup>
    </servlet>
    <servlet-mapping>
        <servlet-name>cxf</servlet-name>
        <url-pattern>/services/*</url-pattern>
    </servlet-mapping>
    <session-config>
        <session-timeout>60</session-timeout>
    </session-config>
</web-app>
```

Deploying a WAR file to the servlet container

How you deploy your WAR file depends on the servlet container that you are using. For example, to deploy your WAR file to Tomcat, you copy it to the Tomcat `CATALINA_HOME/server/webapp` directory.

Using a Custom Servlet

Overview

In some cases, you might want to write a custom servlet that deploys FUSE Services Framework enabled endpoints. A common reason is to deploy FUSE Services Framework client applications into a servlet container. The CXF servlet does not support deploying pure client applications.

Procedure

The procedure for using a custom servlet is similar to the one for using the default CXF servlet:

1. Implement a servlet that instantiates a FUSE Services Framework enabled endpoint.
2. Package your servlet in a WAR that contains the FUSE Services Framework libraries and the configuration needed for your application.
3. Deploy the WAR to your servlet container.

Differences from using the default servlet

There are a few important differences between using the CXF servlet and using a custom servlet:

- The configuration file is not called `cxf-servlet.xml`.

  The default behavior is similar to that of a regular FUSE Services Framework application. It looks for its configuration in a file called `WEB-INF/classes/cxf.xml`. If you want to locate the configuration in a different file, you can programmatically configure the servlet to load the configuration file.

- Any paths in the configuration file are relative to the servlet's `WEB-INF/classes` folder.

Implementing the servlet

Implementing the servlet is easy. You simply add logic to the servlet's constructor to instantiate the FUSE Services Framework endpoint. Example 6.3 on page 85 shows an example of instantiating a consumer endpoint in a servlet.

Example 6.3. Instantiating a Consumer Endpoint in a Servlet

```
public class HelloWorldServlet extends HttpServlet
{
  private static Greeter port;

  public HelloWorldServlet()
  {
    URL wsdlURL = getClass().getResource("/hello_world.wsdl");

     port = new SOAPService(wsdlURL,
       new QName("http://apache.org/hello_world_soap_http",
       "SOAPService")).getSoapPort();
  }

  ...
  }
```

If you choose not to use the default location for the configuration file, then you must add code for loading the configuration file. To load the configuration from a custom location do the following:

1. Use the `ServletContext` to resolve the file location into a URL.
2. Create a new bus for the application using the resolved URL.
3. Set the application's default bus to the newly created bus.

Example 6.4 on page 85 shows an example of loading the configuration from the `WEB-INF/client.xml` file.

Example 6.4. Loading Configuration from a Custom Location

```
public class HelloWorldServlet extends HttpServlet
{
  public init(ServletConfig cfg)
  {
    URL configUrl=cfg.getServletContext().getResource("WEB-
INF/client.xml");
    Bus bus = new SpringBusFactory().createBus(url);
    BusFactory.setDefaultBus(bus);
  }

  ...
}
```

Depending on what other features you want to use, you might need to add additional code to your servlet. For example, if you want to use WS-Security

in a consumer you must add code to your servlet to load the credentials and add them to your requests.

Building the WAR file

To deploy your application to a servlet container you must build a WAR file that has the following directories and files:

- The `WEB-INF` folder should include a `web.xml` file which instructs the servlet container to load the custom servlet.
- The `WEB-INF/classes` folder should include the following:
  - The implementation class and any other classes (including the class hierarchy) generated by the **wsdl2java** utility
  - The default `cxf.xml` configuration file
  - Other resource files that are referenced by the configuration.
- The `WEB-INF/wsdl` folder should include the WSDL file that defines the service being deployed.
- The `WEB-INF/lib` folder should include any JARs required by the application.

Using the Spring Context Listener

Overview

An alternative approach to instantiating endpoints inside a servlet container is to use the Spring context listener. The Spring context listener provides more flexibility in terms of how an application is wired together. It uses the application's Spring configuration to determine what object to instantiate and loads the objects into the application context used by the servlet container.

The added flexibility adds complexity. The application developer must know exactly what application components need to loaded. They also must know what FUSE Services Framework components need to be loaded. If any component is missing, the application will not not load properly and the desired endpoints will not be created.

Procedure

The following steps are involved in building and packaging a Web application that uses the Spring context listener:

1. Develop the application's business logic.

   Only the service implementation needs to be developed service provider endpoints.

   The business logic for service consumers should be encapsulated in a Java class and not as part of the `main()` method.

2. Update the application's `web.xml` file to load the Spring context listener and the application's Spring configuration.

3. Create a Spring configuration file that explicitly loads all of the application's components and all of the required FUSE Services Framework components.

4. Package the application into a WAR file for deployment.

Configuring the Web application

The servlet container looks in the `WEB-INF/web.xml` file to determine what classes are needed to activate the Web application. When deploying a FUSE Services Framework based application using the Spring context listener, the servlet container needs to load the `org.springframework.web.context.ContextLoaderListener` class. This is specified using the `listener` element and its `listener-class` child.

The `org.springframework.web.context.ContextLoaderListener` class uses a context parameter called *`contextConfigLocation`* to determine the location of the Spring configuration file. The context parameter is configured using the `context-parameter` element. The `context-param` element has two children that specify parameters and their values. The `param-name` element specifies the parameter's name. The `param-value` element specifies the parameter's value.

Example 6.5 on page 88 shows a `web.xml` file that configures the servlet container to load the Spring listener and a Spring configuration file.

Example 6.5. Web Application Configuration for Loading the Spring Context Listener

```
<!DOCTYPE web-app
    PUBLIC "-//Sun Microsystems, Inc.//DTD Web Application 2.3//EN"
        "http://java.sun.com/dtd/web-app_2_3.dtd">
<web-app>
  <context-param> ❶
    <param-name>contextConfigLocation</param-name>
    <param-value>WEB-INF/beans.xml</param-value>
  </context-param>

  <listener> ❷
    <listener-class>org.springframework.web.context.ContextLoaderListener</listener-class>

  </listener>
  ...
</web-app>
```

The XML in Example 6.5 on page 88 does the following:

❶ Specifies that the Spring context listener will load the application's Spring configuration from `WEB-INF/beans.xml`.

❷ Specifies that the servlet container should load the Spring context listener.

Creating the Spring configuration

The Spring configuration file for a application using the Spring context listener is similar to a standard FUSE Services Framework configuration file. It uses all of the same endpoint configuration elements described in "Configuring JAX-WS Endpoints" on page 23. It can also contain standard Spring beans.

The difference between a typical FUSE Services Framework configuration file and a configuration file for using the Spring context listener is that the Spring context listener configuration *must* import the configuration for all of the FUSE Services Framework runtime components used by the endpoint's exposed by

the application. These components are imported into the configuration as resources using an `import` element for each component's configuration.

Example 6.6 on page 89 shows the configuration for a simple consumer endpoint being deployed using the Spring context listener.

Example 6.6. Configuration for a Consumer Deployed into a Servlet Container Using the Spring Context Listener

```
<beans ... >

  <import resource="classpath:META-INF/cxf/cxf.xml" />
  <import resource="classpath:META-INF/cxf/cxf-extension-jaxws.xml" />
  <import resource="classpath:META-INF/cxf/cxf-extension-soap.xml" />
  <import resource="classpath:META-INF/cxf/cxf-extension-http-binding.xml" />
  <import resource="classpath:META-INF/cxf/cxf-servlet.xml" />

  <jaxws:client id="funguy"
                address="http://localhost:9000/funguyTool"
                serviceClass="org.laughs.funGuyImpl" />

</beans>
```

The `import` elements at the beginning of Example 6.6 on page 89 import the required FUSE Services Framework component configuration. The required FUSE Services Framework component configuration files depends on the features being used by the endpoints. At a minimum, an application in a servlet container will need the components shown in Example 6.6 on page 89.

Tip

Importing the `cxf-all.xml` configuration file will automatically import all of the FUSE Services Framework components.

Building the WAR

To deploy your application to a servlet container, you must build a WAR file. The `WEB-INF` folder should include the following:

- `beans.xml` — the Spring configuration file configuring the application's beans.
- `web.xml` — the web application file that instructs the servlet container to load the Spring context listener.
- `classes` — a folder including the Web service implementation class and any other classes required to support the implementation.

- `wsdl` — a folder including the WSDL file that defines the service being deployed.
- `lib` — a folder including any JARs required by the application.

Chapter 7. FUSE Services Framework Logging

This chapter describes how to configure logging in the FUSE Services Framework runtime.

Overview of FUSE Services Framework Logging

Overview

FUSE Services Framework uses the Java logging utility, `java.util.logging`. Logging is configured in a logging configuration file that is written using the standard `java.util.Properties` format. To run logging on an application, you can specify logging programmatically or by defining a property at the command that points to the logging configuration file when you start the application.

Default logging.properties file

FUSE Services Framework comes with a default `logging.properties` file, which is located in your *`InstallDir`*`/etc` directory. This file configures both the output destination for the log messages and the message level that is published. The default configuration sets the loggers to print message flagged with the `WARNING` level to the console. You can either use the default file without changing any of the configuration settings or you can change the configuration settings to suit your specific application.

Logging feature

FUSE Services Framework includes a logging feature that can be plugged into your client or your service to enable logging. Example 7.1 on page 92 shows the configuration to enable the logging feature.

Example 7.1. Configuration for Enabling Logging

```
<jaxws:endpoint...>
  <jaxws:features>
    <bean class="org.apache.cxf.feature.LoggingFeature"/>
  </jaxws:features>
</jaxws:endpoint>
```

For more information, see "Logging Message Content" on page 103.

Where to begin?

To run a simple example of logging follow the instructions outlined in a "Simple Example of Using Logging" on page 94.

For more information on how logging works in FUSE Services Framework, read this entire chapter.

More information on java.util.logging

The `java.util.logging` utility is one of the most widely used Java logging frameworks. There is a lot of information available online that describes how to use and extend this framework. As a starting point, however, the following documents gives a good overview of `java.util.logging`:

- http://java.sun.com/j2se/1.5.0/docs/guide/logging/overview.html
- http://java.sun.com/j2se/1.5.0/docs/api/java/util/logging/package-summary.html

Simple Example of Using Logging

Changing the log levels and output destination

To change the log level and output destination of the log messages in the wsdl_first sample application, complete the following steps:

1. Run the sample server as described in the *Running the demo using java* section of the `README.txt` file in the *`InstallDir`*`/samples/wsdl_first` directory. Note that the **server start** command specifies the default `logging.properties` file, as follows:

Platform	Command
Windows	**`start java -Djava.util.logging.config.file=%CXF_HOME%\etc\logging.properties demo.hw.server.Server`**
UNIX	**`java -Djava.util.logging.config.file=$CXF_HOME/etc/logging.properties demo.hw.server.Server &`**

   The default `logging.properties` file is located in the *`InstallDir`*`/etc` directory. It configures the FUSE Services Framework loggers to print `WARNING` level log messages to the console. As a result, you see very little printed to the console.

2. Stop the server as described in the `README.txt` file.

3. Make a copy of the default `logging.properties` file, name it `mylogging.properties` file, and save it in the same directory as the default `logging.properties` file.

4. Change the global logging level and the console logging levels in your `mylogging.properties` file to `INFO` by editing the following lines of configuration:

```
.level= INFO
java.util.logging.ConsoleHandler.level = INFO
```

5. Restart the server using the following command:

Platform	Command
Windows	`start java -Djava.util.logging.config.file=%CXF_HOME%\etc\mylogging.properties demo.hw.server.Server`
UNIX	`java -Djava.util.logging.config.file=$CXF_HOME/etc/mylogging.properties demo.hw.server.Server &`

Because you configured the global logging and the console logger to log messages of level `INFO`, you see a lot more log messages printed to the console.

Default `logging.properties` File

The default logging configuration file, `logging.properties`, is located in the *`InstallDir`*`/etc` directory. It configures the FUSE Services Framework loggers to print `WARNING` level messages to the console. If this level of logging is suitable for your application, you do not have to make any changes to the file before using it. You can, however, change the level of detail in the log messages. For example, you can change whether log messages are sent to the console, to a file or to both. In addition, you can specify logging at the level of individual packages.

Note

This section discusses the configuration properties that appear in the default `logging.properties` file. There are, however, many other `java.util.logging` configuration properties that you can set. For more information on the `java.util.logging` API, see the `java.util.logging` javadoc at: http://java.sun.com/j2se/1.5/docs/api/java/util/logging/package-summary.html.

Configuring Logging Output

The Java logging utility, `java.util.logging`, uses handler classes to output log messages. Table 7.1 on page 97 shows the handlers that are configured in the default `logging.properties` file.

Table 7.1. Java.util.logging Handler Classes

Handler Class	Outputs to
`ConsoleHandler`	Outputs log messages to the console
`FileHandler`	Outputs log messages to a file

Important

The handler classes must be on the system classpath in order to be installed by the Java VM when it starts. This is done when you set the FUSE Services Framework environment. For details on setting the FUSE Services Framework environment, see "Using the FUSE Services Framework Environment Script" on page 18.

Configuring the console handler

Example 7.2 on page 97 shows the code for configuring the console logger.

Example 7.2. Configuring the Console Handler

```
handlers= java.util.logging.ConsoleHandler
```

The console handler also supports the configuration properties shown in Example 7.3 on page 97.

Example 7.3. Console Handler Properties

```
java.util.logging.ConsoleHandler.level = WARNING ❶
java.util.logging.ConsoleHandler.formatter = java.util.logging.SimpleFormatter ❷
```

The configuration properties shown in Example 7.3 on page 97 can be explained as follows:

❶ The console handler supports a separate log level configuration property. This allows you to limit the log messages printed to the console while the global logging setting can be different (see "Configuring Logging Levels" on page 99). The default setting is `WARNING`.

❷ Specifies the `java.util.logging` formatter class that the console handler class uses to format the log messages. The default setting is the `java.util.logging.SimpleFormatter`.

Configuring the file handler

Example 7.4 on page 98 shows code that configures the file handler.

Example 7.4. Configuring the File Handler

```
handlers= java.util.logging.FileHandler
```

The file handler also supports the configuration properties shown in Example 7.5 on page 98.

Example 7.5. File Handler Configuration Properties

```
java.util.logging.FileHandler.pattern = %h/java%u.log ❶
java.util.logging.FileHandler.limit = 50000 ❷
java.util.logging.FileHandler.count = 1 ❸
java.util.logging.FileHandler.formatter = java.util.logging.XMLFormatter ❹
```

The configuration properties shown in Example 7.5 on page 98 can be explained as follows:

❶ Specifies the location and pattern of the output file. The default setting is your home directory.

❷ Specifies, in bytes, the maximum amount that the logger writes to any one file. The default setting is `50000`. If you set it to zero, there is no limit on the amount that the logger writes to any one file.

❸ Specifies how many output files to cycle through. The default setting is `1`.

❹ Specifies the `java.util.logging` formatter class that the file handler class uses to format the log messages. The default setting is the `java.util.logging.XMLFormatter`.

Configuring both the console handler and the file handler

You can set the logging utility to output log messages to both the console and to a file by specifying the console handler and the file handler, separated by a comma, as shown in Example 7.6 on page 98.

Example 7.6. Configuring Both Console Logging and File Logging

```
handlers= java.util.logging.FileHandler, java.util.logging.ConsoleHandler
```

Configuring Logging Levels

Logging levels

The `java.util.logging` framework supports the following levels of logging, from the least verbose to the most verbose:

- `SEVERE`
- `WARNING`
- `INFO`
- `CONFIG`
- `FINE`
- `FINER`
- `FINEST`

Configuring the global logging level

To configure the types of event that are logged across all loggers, configure the global logging level as shown in Example 7.7 on page 99.

Example 7.7. Configuring Global Logging Levels

```
.level= WARNING
```

Configuring logging at an individual package level

The `java.util.logging` framework supports configuring logging at the level of an individual package. For example, the line of code shown in Example 7.8 on page 99 configures logging at a `SEVERE` level on classes in the `com.xyz.foo` package.

Example 7.8. Configuring Logging at the Package Level

```
com.xyz.foo.level = SEVERE
```

Enabling Logging at the Command Line

Overview

You can run the logging utility on an application by defining a `java.util.logging.config.file` property when you start the application. You can either specify the default `logging.properties` file or a `logging.properties` file that is unique to that application.

Specifying the log configuration file on application start-up

To specify logging on application start-up add the flag shown in Example 7.9 on page 100 when starting the application.

Example 7.9. Flag to Start Logging on the Command Line

```
-Djava.util.logging.config.file=myfile
```

Logging for Subsystems and Services

You can use the `com.xyz.foo.level` configuration property described in "Configuring logging at an individual package level" on page 99 to set fine-grained logging for specified FUSE Services Framework logging subsystems.

FUSE Services Framework logging subsystems

Table 7.2 on page 101 shows a list of available FUSE Services Framework logging subsystems.

Table 7.2. FUSE Services Framework Logging Subsystems

Subsystem	Description
`com.iona.cxf.container`	FUSE Services Framework container
`org.apache.cxf.aegis`	Aegis binding
`org.apache.cxf.binding.coloc`	colocated binding
`org.apache.cxf.binding.http`	HTTP binding
`org.apache.cxf.binding.jbi`	JBI binding
`org.apache.cxf.binding.object`	Java Object binding
`org.apache.cxf.binding.soap`	SOAP binding
`org.apache.cxf.binding.xml`	XML binding
`org.apache.cxf.bus`	FUSE Services Framework bus
`org.apache.cxf.configuration`	configuration framework
`org.apache.cxf.endpoint`	server and client endpoints
`org.apache.cxf.interceptor`	interceptors
`org.apache.cxf.jaxws`	Front-end for JAX-WS style message exchange, JAX-WS handler processing, and interceptors relating to JAX-WS and configuration
`org.apache.cxf.jbi`	JBI container integration classes
`org.apache.cxf.jca`	JCA container integration classes
`org.apache.cxf.js`	JavaScript front-end

Subsystem	Description
`org.apache.cxf.transport.http`	HTTP transport
`org.apache.cxf.transport.https`	secure version of HTTP transport, using HTTPS
`org.apache.cxf.transport.jbi`	JBI transport
`org.apache.cxf.transport.jms`	JMS transport
`org.apache.cxf.transport.local`	transport implementation using local file system
`org.apache.cxf.transport.servlet`	HTTP transport and servlet implementation for loading JAX-WS endpoints into a servlet container
`org.apache.cxf.ws.addressing`	WS-Addressing implementation
`org.apache.cxf.ws.policy`	WS-Policy implementation
`org.apache.cxf.ws.rm`	WS-ReliableMessaging (WS-RM) implementation
`org.apache.cxf.ws.security.wss4j`	WSS4J security implementation

Example

The WS-Addressing sample is contained in the *`InstallDir`*`/samples/ws_addressing` directory. Logging is configured in the `logging.properties` file located in that directory. The relevant lines of configuration are shown in Example 7.10 on page 102.

Example 7.10. Configuring Logging for WS-Addressing

```
java.util.logging.ConsoleHandler.formatter = demos.ws_addressing.common.ConciseFormatter
...
org.apache.cxf.ws.addressing.soap.MAPCodec.level = INFO
```

The configuration in Example 7.10 on page 102 enables the snooping of log messages relating to WS-Addressing headers, and displays them to the console in a concise form.

For information on running this sample, see the `README.txt` file located in the *`InstallDir`*`/samples/ws_addressing` directory.

Logging Message Content

You can log the content of the messages that are sent between a service and a consumer. For example, you might want to log the contents of SOAP messages that are being sent between a service and a consumer.

Configuring message content logging

To log the messages that are sent between a service and a consumer, and vice versa, complete the following steps:

1. Add the logging feature to your endpoint's configuration.
2. Add the logging feature to your consumer's configuration.
3. Configure the logging system log `INFO` level messages.

Adding the logging feature to an endpoint

Add the logging feature your endpoint's configuration as shown in Example 7.11 on page 103.

Example 7.11. Adding Logging to Endpoint Configuration

```
<jaxws:endpoint ...>
  <jaxws:features>
    <bean class="org.apache.cxf.feature.LoggingFeature"/>
  </jaxws:features>
</jaxws:endpoint>
```

The example XML shown in Example 7.11 on page 103 enables the logging of SOAP messages.

Adding the logging feature to a consumer

Add the logging feature your client's configuration as shown in Example 7.12 on page 103.

Example 7.12. Adding Logging to Client Configuration

```
<jaxws:client ...>
   <jaxws:features>
      <bean class="org.apache.cxf.feature.LoggingFeature"/>
    </jaxws:features>
</jaxws:client>
```

The example XML shown in Example 7.12 on page 103 enables the logging of SOAP messages.

Set logging to log INFO level messages

Ensure that the `logging.properties` file associated with your service is configured to log `INFO` level messages, as shown in Example 7.13 on page 104.

Example 7.13. Setting the Logging Level to INFO

```
.level= INFO
java.util.logging.ConsoleHandler.level = INFO
```

Logging SOAP messages

To see the logging of SOAP messages modify the wsdl_first sample application located in the *`InstallDir`*`/samples/wsdl_first` directory, as follows:

1. Add the `jaxws:features` element shown in Example 7.14 on page 104 to the `cxf.xml` configuration file located in the wsdl_first sample's directory:

Example 7.14. Endpoint Configuration for Logging SOAP Messages

```
<jaxws:endpoint name="{http://apache.org/hello_world_soap_http}SoapPort"
                createdFromAPI="true">
  <jaxws:properties>
    <entry key="schema-validation-enabled" value="true" />
  </jaxws:properties>
  <jaxws:features>
    <bean class="org.apache.cxf.feature.LoggingFeature"/>
  </jaxws:features>
</jaxws:endpoint>
```

2. The sample uses the default `logging.properties` file, which is located in the *`InstallDir`*`/etc` directory. Make a copy of this file and name it `mylogging.properties`.

3. In the `mylogging.properties` file, change the logging levels to `INFO` by editing the `.level` and the `java.util.logging.ConsoleHandler.level` configuration properties as follows:

```
.level= INFO
java.util.logging.ConsoleHandler.level = INFO
```

4. Start the server using the new configuration settings in both the `cxf.xml` file and the `mylogging.properties` file as follows:

Platform	Command
Windows	**`start java -Djava.util.logging.config.file=%CXF_HOME%\etc\mylogging.properties demo.hw.server.Server`**
UNIX	**`java -Djava.util.logging.config.file=$CXF_HOME/etc/mylogging.properties demo.hw.server.Server &`**

5. Start the hello world client using the following command:

Platform	Command
Windows	**`java -Djava.util.logging.config.file=%CXF_HOME%\etc\mylogging.properties demo.hw.client.Client .\wsdl\hello_world.wsdl`**
UNIX	**`java -Djava.util.logging.config.file=$CXF_HOME/etc/mylogging.properties demo.hw.client.Client ./wsdl/hello_world.wsdl`**

The SOAP messages are logged to the console.

Chapter 8. Deploying WS-Addressing

FUSE Services Framework supports WS-Addressing for JAX-WS applications. This chapter explains how to deploy WS-Addressing in the FUSE Services Framework runtime environment.

Introduction to WS-Addressing

Overview

WS-Addressing is a specification that allows services to communicate addressing information in a transport neutral way. It consists of two parts:

- A structure for communicating a reference to a Web service endpoint
- A set of Message Addressing Properties (MAP) that associate addressing information with a particular message

Supported specifications

FUSE Services Framework supports both the WS-Addressing 2004/08 specification and the WS-Addressing 2005/03 specification.

Further information

For detailed information on WS-Addressing, see the 2004/08 submission at http://www.w3.org/Submission/ws-addressing/.

WS-Addressing Interceptors

Overview

In FUSE Services Framework, WS-Addressing functionality is implemented as interceptors. The FUSE Services Framework runtime uses interceptors to intercept and work with the raw messages that are being sent and received. When a transport receives a message, it creates a message object and sends that message through an interceptor chain. If the WS-Addressing interceptors are added to the application's interceptor chain, any WS-Addressing information included with a message is processed.

WS-Addressing Interceptors

The WS-Addressing implementation consists of two interceptors, as described in Table 8.1 on page 109.

Table 8.1. WS-Addressing Interceptors

Interceptor	Description
`org.apache.cxf.ws.addressing.MAPAggregator`	A logical interceptor responsible for aggregating the Message Addressing Properties (MAPs) for outgoing messages.
`org.apache.cxf.ws.addressing.soap.MAPCodec`	A protocol-specific interceptor responsible for encoding and decoding the Message Addressing Properties (MAPs) as SOAP headers.

Enabling WS-Addressing

Overview

To enable WS-Addressing the WS-Addressing interceptors must be added to the inbound and outbound interceptor chains. This is done in one of the following ways:

- FUSE Services Framework Features
- RMAssertion and WS-Policy Framework
- Using Policy Assertion in a WS-Addressing Feature

Adding WS-Addressing as a Feature

WS-Addressing can be enabled by adding the WS-Addressing feature to the client and the server configuration as shown in Example 8.1 on page 110 and Example 8.2 on page 110 respectively.

Example 8.1. client.xml—Adding WS-Addressing Feature to Client Configuration

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:jaxws="http://cxf.apache.org/jaxws"
       xmlns:wsa="http://cxf.apache.org/ws/addressing"
       xsi:schemaLocation="
       http://www.springframework.org/schema/beans ht
tp://www.springframework.org/schema/beans/spring-beans.xsd">

    <jaxws:client ...>
        <jaxws:features>
            <wsa:addressing/>
        </jaxws:features>
    </jaxws:client>
</beans>
```

Example 8.2. server.xml—Adding WS-Addressing Feature to Server Configuration

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:jaxws="http://cxf.apache.org/jaxws"
       xmlns:wsa="http://cxf.apache.org/ws/addressing"
       xsi:schemaLocation="
```

```
http://www.springframework.org/schema/beans http://www.spring
framework.org/schema/beans/spring-beans.xsd">

    <jaxws:endpoint ...>
        <jaxws:features>
            <wsa:addressing/>
        </jaxws:features>
    </jaxws:endpoint>
</beans>
```

Configuring WS-Addressing Attributes

Overview

The FUSE Services Framework WS-Addressing feature element is defined in the namespace http://cxf.apache.org/ws/addressing. It supports the two attributes described in Table 8.2 on page 112.

Table 8.2. WS-Addressing Attributes

Attribute Name	Value
`allowDuplicates`	A boolean that determines if duplicate MessageIDs are tolerated. The default setting is `true`.
`usingAddressingAdvisory`	A boolean that indicates if the presence of the `UsingAddressing` element in the WSDL is advisory only; that is, its absence does not prevent the encoding of WS-Addressing headers.

Configuring WS-Addressing attributes

Configure WS-Addressing attributes by adding the attribute and the value you want to set it to the WS-Addressing feature in your server or client configuration file. For example, the following configuration extract sets the `allowDublicates` attribute to `false` on the server endpoint:

```
<beans ... xmlns:wsa="http://cxf.apache.org/ws/addressing"
...>
    <jaxws:endpoint ...>
        <jaxws:features>
            <wsa:addressing allowDuplicates="false"/>
        </jaxws:features>
    </jaxws:endpoint>
</beans>
```

Using a WS-Policy assertion embedded in a feature

In Example 8.3 on page 112 an addressing policy assertion to enable non-anonymous responses is embedded in the `policies` element.

Example 8.3. Using the Policies to Configure WS-Addressing

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:wsa="http://cxf.apache.org/ws/addressing"
       xmlns:wsp="http://www.w3.org/2006/07/ws-policy"
       xmlns:policy="http://cxf.apache.org/policy-config"
```

```
        xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-
utility-1.0.xsd"
        xmlns:jaxws="http://cxf.apache.org/jaxws"
        xsi:schemaLocation="
http://www.w3.org/2006/07/ws-policy http://www.w3.org/2006/07/ws-policy.xsd
http://cxf.apache.org/ws/addressing http://cxf.apache.org/schema/ws/addressing.xsd
http://cxf.apache.org/jaxws http://cxf.apache.org/schemas/jaxws.xsd
http://www.springframework.org/schema/beans http://www.springframe
work.org/schema/beans/spring-beans.xsd">

    <jaxws:endpoint name="{http://cxf.apache.org/greeter_control}GreeterPort"
                    createdFromAPI="true">
        <jaxws:features>
            <policy:policies>
                <wsp:Policy xmlns:wsam="http://www.w3.org/2007/02/addressing/metadata">
                    <wsam:Addressing>
                        <wsp:Policy>
                            <wsam:NonAnonymousResponses/>
                        </wsp:Policy>
                    </wsam:Addressing>
                </wsp:Policy>
            <policy:policies>
        </jaxws:features>
    </jaxws:endpoint>
</beans>
```

Chapter 9. Enabling Reliable Messaging

FUSE Services Framework supports WS-Reliable Messaging(WS-RM). This chapter explains how to enable and configure WS-RM in FUSE Services Framework.

Introduction to WS-RM

Overview

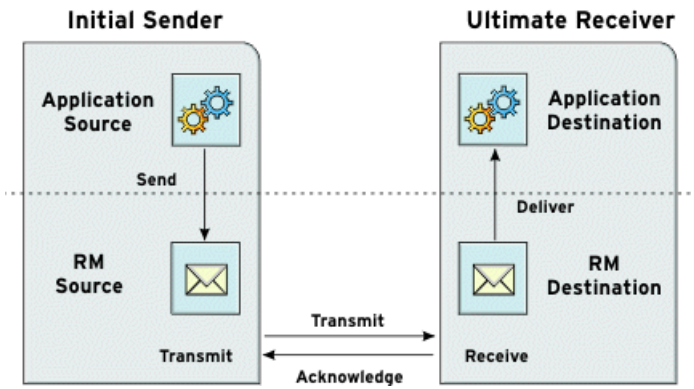
WS-ReliableMessaging (WS-RM) is a protocol that ensures the reliable delivery of messages in a distributed environment. It enables messages to be delivered reliably between distributed applications in the presence of software, system, or network failures.

For example, WS-RM can be used to ensure that the correct messages have been delivered across a network exactly once, and in the correct order.

How WS-RM works

WS-RM ensures the reliable delivery of messages between a source and a destination endpoint. The source is the initial sender of the message and the destination is the ultimate receiver, as shown in Figure 9.1 on page 116.

Figure 9.1. Web Services Reliable Messaging



The flow of WS-RM messages can be described as follows:

1. The RM source sends a `CreateSequence` protocol message to the RM destination. This contains a reference for the endpoint that receives acknowledgements (the `wsrm:AcksTo` endpoint).

2. The RM destination sends a `CreateSequenceResponse` protocol message back to the RM source. This message contains the sequence ID for the RM sequence session.

3. The RM source adds an RM `Sequence` header to each message sent by the application source. This header contains the sequence ID and a unique message ID.
4. The RM source transmits each message to the RM destination.
5. The RM destination acknowledges the receipt of the message from the RM source by sending messages that contain the RM `SequenceAcknowledgement` header.
6. The RM destination delivers the message to the application destination in an exactly-once-in-order fashion.
7. The RM source retransmits a message that it has not yet received an acknowledgement.

   The first retransmission attempt is made after a base retransmission interval. Successive retransmission attempts are made, by default, at exponential back-off intervals or, alternatively, at fixed intervals. For more details, see "Configuring WS-RM" on page 124.

This entire process occurs symmetrically for both the request and the response message; that is, in the case of the response message, the server acts as the RM source and the client acts as the RM destination.

WS-RM delivery assurances

WS-RM guarantees reliable message delivery in a distributed environment, regardless of the transport protocol used. Either the source or the destination endpoint logs an error if reliable delivery can not be assured.

Supported specifications

FUSE Services Framework supports the 2005/02 version of the WS-RM specification, which is based on the WS-Addressing 2004/08 specification.

Further information

For detailed information on WS-RM, see the specification at http://specs.xmlsoap.org/ws/2005/02/rm/ws-reliablemessaging.pdf.

WS-RM Interceptors

Overview

In FUSE Services Framework, WS-RM functionality is implemented as interceptors. The FUSE Services Framework runtime uses interceptors to intercept and work with the raw messages that are being sent and received. When a transport receives a message, it creates a message object and sends that message through an interceptor chain. If the application's interceptor chain includes the WS-RM interceptors, the application can participate in reliable messaging sessions. The WS-RM interceptors handle the collection and aggregation of the message chunks. They also handle all of the acknowledgement and retransmission logic.

FUSE Services Framework WS-RM Interceptors

The FUSE Services Framework WS-RM implementation consists of four interceptors, which are described in Table 9.1 on page 118.

Table 9.1. FUSE Services Framework WS-ReliableMessaging Interceptors

Interceptor	Description
`org.apache.cxf.ws.rm.RMOutInterceptor`	Deals with the logical aspects of providing reliability guarantees for outgoing messages. Responsible for sending the `CreateSequence` requests and waiting for their `CreateSequenceResponse` responses. Also responsible for aggregating the sequence properties—ID and message number—for an application message.
`org.apache.cxf.ws.rm.RMInInterceptor`	Responsible for intercepting and processing RM protocol messages and `SequenceAcknowledgement` messages that are piggybacked on application messages.
`org.apache.cxf.ws.rm.soap.RMSoapInterceptor`	Responsible for encoding and decoding the reliability properties as SOAP headers.

Interceptor	Description
`org.apache.cxf.ws.rm.RetransmissionInterceptor`	Responsible for creating copies of application messages for future resending.

Enabling WS-RM

The presence of the WS-RM interceptors on the interceptor chains ensures that WS-RM protocol messages are exchanged when necessary. For example, when intercepting the first application message on the outbound interceptor chain, the `RMOutInterceptor` sends a `CreateSequence` request and waits to process the original application message until it receives the `CreateSequenceResponse` response. In addition, the WS-RM interceptors add the sequence headers to the application messages and, on the destination side, extract them from the messages. It is not necessary to make any changes to your application code to make the exchange of messages reliable.

For more information on how to enable WS-RM, see "Enabling WS-RM" on page 120.

Configuring WS-RM Attributes

You control sequence demarcation and other aspects of the reliable exchange through configuration. For example, by default FUSE Services Framework attempts to maximize the lifetime of a sequence, thus reducing the overhead incurred by the out-of-band WS-RM protocol messages. To enforce the use of a separate sequence per application message configure the WS-RM source's sequence termination policy (setting the maximum sequence length to `1`).

For more information on configuring WS-RM behavior, see "Configuring WS-RM" on page 124.

Enabling WS-RM

Overview

To enable reliable messaging, the WS-RM interceptors must be added to the interceptor chains for both inbound and outbound messages and faults. Because the WS-RM interceptors use WS-Addressing, the WS-Addressing interceptors must also be present on the interceptor chains.

You can ensure the presence of these interceptors in one of two ways:

- Explicitly, by adding them to the dispatch chains using Spring beans
- Implicitly, using WS-Policy assertions, which cause the FUSE Services Framework runtime to transparently add the interceptors on your behalf.

Spring beans—explicitly adding interceptors

To enable WS-RM add the WS-RM and WS-Addressing interceptors to the FUSE Services Framework bus, or to a consumer or service endpoint using Spring bean configuration. This is the approach taken in the WS-RM sample that is found in the *InstallDir*/samples/ws_rm directory. The configuration file, ws-rm.cxf, shows the WS-RM and WS-Addressing interceptors being added one-by-one as Spring beans (see Example 9.1 on page 120).

Example 9.1. Enabling WS-RM Using Spring Beans

```
<?xml version="1.0" encoding="UTF-8"?>
❶<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xsi:schemaLocation="http://www.springframework.org/schema/
   beans http://www.springframework.org/schema/beans/spring-beans.xsd">
❷   <bean id="mapAggregator" class="org.apache.cxf.ws.addressing.MAPAggregator"/>
   <bean id="mapCodec" class="org.apache.cxf.ws.addressing.soap.MAPCodec"/>
❸   <bean id="rmLogicalOut" class="org.apache.cxf.ws.rm.RMOutInterceptor">
        <property name="bus" ref="cxf"/>
   </bean>
   <bean id="rmLogicalIn" class="org.apache.cxf.ws.rm.RMInInterceptor">
        <property name="bus" ref="cxf"/>
   </bean>
   <bean id="rmCodec" class="org.apache.cxf.ws.rm.soap.RMSoapInterceptor"/>
   <bean id="cxf" class="org.apache.cxf.bus.CXFBusImpl">
❹       <property name="inInterceptors">
          <list>
              <ref bean="mapAggregator"/>
              <ref bean="mapCodec"/>
              <ref bean="rmLogicalIn"/>
```

```
                <ref bean="rmCodec"/>
            </list>
        </property>
❺       <property name="inFaultInterceptors">
            <list>
                <ref bean="mapAggregator"/>
                <ref bean="mapCodec"/>
                <ref bean="rmLogicalIn"/>
                <ref bean="rmCodec"/>
            </list>
        </property>
❻       <property name="outInterceptors">
            <list>
                <ref bean="mapAggregator"/>
                <ref bean="mapCodec"/>
                <ref bean="rmLogicalOut"/>
                <ref bean="rmCodec"/>
            </list>
        </property>
❼       <property name="outFaultInterceptors">
            <list>
                <ref bean="mapAggregator">
                <ref bean="mapCodec"/>
                <ref bean="rmLogicalOut"/>
                <ref bean="rmCodec"/>
            </list>
        </property>
    </bean>
</beans>
```

The code shown in Example 9.1 on page 120 can be explained as follows:

❶ A FUSE Services Framework configuration file is a Spring XML file. You must include an opening Spring `beans` element that declares the namespaces and schema files for the child elements that are encapsulated by the `beans` element.

❷ Configures each of the WS-Addressing interceptors—`MAPAggregator` and `MAPCodec`. For more information on WS-Addressing, see "Deploying WS-Addressing" on page 107.

❸ Configures each of the WS-RM interceptors—`RMOutInterceptor`, `RMInInterceptor`, and `RMSoapInterceptor`.

❹ Adds the WS-Addressing and WS-RM interceptors to the interceptor chain for inbound messages.

❺ Adds the WS-Addressing and WS-RM interceptors to the interceptor chain for inbound faults.

❻ Adds the WS-Addressing and WS-RM interceptors to the interceptor chain for outbound messages.
❼ Adds the WS-Addressing and WS-RM interceptors to the interceptor chain for outbound faults.

WS-Policy framework—implicitly adding interceptors

The WS-Policy framework provides the infrastructure and APIs that allow you to use WS-Policy. It is compliant with the November 2006 draft publications of the Web Services Policy 1.5—Framework[1] and Web Services Policy 1.5—Attachment[2] specifications.

To enable WS-RM using the FUSE Services Framework WS-Policy framework, do the following:

1. Add the policy feature to your client and server endpoint. Example 9.2 on page 122 shows a reference bean nested within a `jaxws:feature` element. The reference bean specifies the `AddressingPolicy`, which is defined as a separate element within the same configuration file.

Example 9.2. Configuring WS-RM using WS-Policy

```
<jaxws:client>
    <jaxws:features>
      <ref bean="AddressingPolicy"/>
    </jaxws:features>
</jaxws:client>
<wsp:Policy wsu:Id="AddressingPolicy" xmlns:wsam="http://www.w3.org/2007/02/address
ing/metadata">
    <wsam:Addressing>
      <wsp:Policy>
        <wsam:NonAnonymousResponses/>
      </wsp:Policy>
    </wsam:Addressing>
</wsp:Policy>
```

2. Add a reliable messaging policy to the `wsdl:service` element—or any other WSDL element that can be used as an attachment point for policy or policy reference elements—to your WSDL file, as shown in Example 9.3 on page 123.

[1] http://www.w3.org/TR/2006/WD-ws-policy-20061117/
[2] http://www.w3.org/TR/2006/WD-ws-policy-attach-20061117/

Example 9.3. Adding an RM Policy to Your WSDL File

```
<wsp:Policy wsu:Id="RM"
   xmlns:wsp="http://www.w3.org/2006/07/ws-policy"
   xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-utility-
1.0.xsd">
    <wsam:Addressing xmlns:wsam="http://www.w3.org/2007/02/addressing/metadata">
        <wsp:Policy/>
    </wsam:Addressing>
    <wsrmp:RMAssertion xmlns:wsrmp="http://schemas.xmlsoap.org/ws/2005/02/rm/policy">
        <wsrmp:BaseRetransmissionInterval Milliseconds="10000"/>
    </wsrmp:RMAssertion>
</wsp:Policy>
...
<wsdl:service name="ReliableGreeterService">
    <wsdl:port binding="tns:GreeterSOAPBinding" name="GreeterPort">
        <soap:address location="http://localhost:9020/SoapContext/GreeterPort"/>
        <wsp:PolicyReference URI="#RM" xmlns:wsp="http://www.w3.org/2006/07/ws-policy"/>
    </wsdl:port>
</wsdl:service>
```

Configuring WS-RM

You can configure WS-RM by:

- Setting FUSE Services Framework-specific attributes that are defined in the FUSE Services Framework WS-RM manager namespace, http://cxf.apache.org/ws/rm/manager.
- Setting standard WS-RM policy attributes that are defined in the `http://schemas.xmlsoap.org/ws/2005/02/rm/policy` namespace.

Configuring FUSE Services Framework-Specific WS-RM Attributes

Overview

To configure the FUSE Services Framework-specific attributes, use the `rmManager` Spring bean. Add the following to your configuration file:

- The http://cxf.apache.org/ws/rm/manager namespace to your list of namespaces.
- An `rmManager` Spring bean for the specific attribute that your want to configure.

Example 9.4 on page 125 shows a simple example.

Example 9.4. Configuring FUSE Services Framework-Specific WS-RM Attributes

```
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:wsrm-mgr="http://cxf.apache.org/ws/rm/manager"
     xsi:schemaLocation="http://www.springframework.org/schema/beans http://www.springframe
work.org/schema/beans/spring-beans.xsd
 http://cxf.apache.org/ws/rm/manager http://cxf.apache.org/schemas/configuration/wsrm-man
ager.xsd">
...
<wsrm-mgr:rmManager>
<!--
  ...Your configuration goes here
-->
</wsrm-mgr:rmManager>
```

Children of the rmManager Spring bean

Table 9.2 on page 125 shows the child elements of the `rmManager` Spring bean, defined in the http://cxf.apache.org/ws/rm/manager namespace.

Table 9.2. Children of the rmManager Spring Bean

Element	Description
`RMAssertion`	An element of type RMAssertion
`deliveryAssurance`	An element of type DeliveryAssuranceType that describes the delivery assurance that should apply
`sourcePolicy`	An element of type SourcePolicyType that allows you to configure details of the RM source

Element	Description
`destinationPolicy`	An element of type DestinationPolicyType that allows you to configure details of the RM destination

Example

For an example, see "Maximum unacknowledged messages threshold" on page 133.

Configuring Standard WS-RM Policy Attributes

Overview

You can configure standard WS-RM policy attributes in one of the following ways:

- "RMAssertion in rmManager Spring bean"
- "Policy within a feature"
- "WSDL file"
- "External attachment"

WS-Policy RMAssertion Children

Table 9.3 on page 127 shows the elements defined in the http://schemas.xmlsoap.org/ws/2005/02/rm/policy namespace:

Table 9.3. Children of the WS-Policy RMAssertion Element

Name	Description
`InactivityTimeout`	Specifies the amount of time that must pass without receiving a message before an endpoint can consider an RM sequence to have been terminated due to inactivity.
`BaseRetransmissionInterval`	Sets the interval within which an acknowledgement must be received by the RM Source for a given message. If an acknowledgement is not received within the time set by the `BaseRetransmissionInterval`, the RM Source will retransmit the message.
`ExponentialBackoff`	Indicates the retransmission interval will be adjusted using the commonly known exponential backoff algorithm (Tanenbaum). For more information, see *Computer Networks*, Andrew S. Tanenbaum, Prentice Hall PTR, 2003.
`AcknowledgementInterval`	In WS-RM, acknowledgements are sent on return messages or sent stand-alone. If a return message is not available to send an acknowledgement, an RM Destination can wait for up to the acknowledgement interval before sending a

Name	Description
	stand-alone acknowledgement. If there are no unacknowledged messages, the RM Destination can choose not to send an acknowledgement.

More detailed reference information

For more detailed reference information, including descriptions of each element's sub-elements and attributes, please refer to http://schemas.xmlsoap.org/ws/2005/02/rm/wsrm-policy.xsd.

RMAssertion in rmManager Spring bean

You can configure standard WS-RM policy attributes by adding an `RMAssertion` within a FUSE Services Framework `rmManager` Spring bean. This is the best approach if you want to keep all of your WS-RM configuration in the same configuration file; that is, if you want to configure FUSE Services Framework-specific attributes and standard WS-RM policy attributes in the same file.

For example, the configuration in Example 9.5 on page 128 shows:

- A standard WS-RM policy attribute, `BaseRetransmissionInterval`, configured using an `RMAssertion` within an `rmManager` Spring bean.
- An FUSE Services Framework-specific RM attribute, `intraMessageThreshold`, configured in the same configuration file.

Example 9.5. Configuring WS-RM Attributes Using an RMAssertion in an rmManager Spring Bean

```
<beans xmlns:wsrm-policy="http://schemas.xmlsoap.org/ws/2005/02/rm/policy"
       xmlns:wsrm-mgr="http://cxf.apache.org/ws/rm/manager"
...>
<wsrm-mgr:rmManager id="org.apache.cxf.ws.rm.RMManager">
    <wsrm-policy:RMAssertion>
        <wsrm-policy:BaseRetransmissionInterval Milliseconds="4000"/>
    </wsrm-policy:RMAssertion>
    <wsrm-mgr:destinationPolicy>
        <wsrm-mgr:acksPolicy intraMessageThreshold="0" />
    </wsrm-mgr:destinationPolicy>
</wsrm-mgr:rmManager>
</beans>
```

Policy within a feature

You can configure standard WS-RM policy attributes within features, as shown in Example 9.6 on page 129.

Example 9.6. Configuring WS-RM Attributes as a Policy within a Feature

```
<xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:wsa="http://cxf.apache.org/ws/addressing"
       xmlns:wsp="http://www.w3.org/2006/07/ws-policy"
       xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-
utility-1.0.xsd"
       xmlns:jaxws="http://cxf.apache.org/jaxws"
       xsi:schemaLocation="
http://www.w3.org/2006/07/ws-policy http://www.w3.org/2006/07/ws-policy.xsd
http://cxf.apache.org/ws/addressing http://cxf.apache.org/schema/ws/addressing.xsd
http://cxf.apache.org/jaxws http://cxf.apache.org/schemas/jaxws.xsd
http://www.springframework.org/schema/beans http://www.springframe
work.org/schema/beans/spring-beans.xsd">
    <jaxws:endpoint name="{http://cxf.apache.org/greeter_control}GreeterPort" created
FromAPI="true">
        <jaxws:features>
               <wsp:Policy>
                   <wsrm:RMAssertion xmlns:wsrm="http://schem
as.xmlsoap.org/ws/2005/02/rm/policy">
                     <wsrm:AcknowledgementInterval Milliseconds="200" />
                   </wsrm:RMAssertion>
                   <wsam:Addressing xmlns:wsam="http://www.w3.org/2007/02/address
ing/metadata">
                      <wsp:Policy>
                           <wsam:NonAnonymousResponses/>
                      </wsp:Policy>
                   </wsam:Addressing>
              </wsp:Policy>
        </jaxws:features>
    </jaxws:endpoint>
</beans>
```

WSDL file

If you use the WS-Policy framework to enable WS-RM, you can configure standard WS-RM policy attributes in a WSDL file. This is a good approach if you want your service to interoperate and use WS-RM seamlessly with consumers deployed to other policy-aware Web services stacks.

For an example, see "WS-Policy framework—implicitly adding interceptors" on page 122 where the base retransmission interval is configured in the WSDL file.

External attachment

You can configure standard WS-RM policy attributes in an external attachment file. This is a good approach if you cannot, or do not want to, change your WSDL file.

Example 9.7 on page 130 shows an external attachment that enables both WS-A and WS-RM (base retransmission interval of 30 seconds) for a specific EPR.

Example 9.7. Configuring WS-RM in an External Attachment

```
<attachments xmlns:wsp="http://www.w3.org/2006/07/ws-policy" xmlns:wsa="ht
tp://www.w3.org/2005/08/addressing">
    <wsp:PolicyAttachment>
        <wsp:AppliesTo>
           <wsa:EndpointReference>
                <wsa:Address>http://localhost:9020/SoapContext/GreeterPort</wsa:Address>
            </wsa:EndpointReference>
        </wsp:AppliesTo>
        <wsp:Policy>
            <wsam:Addressing xmlns:wsam="http://www.w3.org/2007/02/addressing/metadata">
                <wsp:Policy/>
            </wsam:Addressing>
          <wsrmp:RMAssertion xmlns:wsrmp="http://schemas.xmlsoap.org/ws/2005/02/rm/policy">

                <wsrmp:BaseRetransmissionInterval Milliseconds="30000"/>
            </wsrmp:RMAssertion>
        </wsp:Policy>
    </wsp:PolicyAttachment>
</attachments>/
```

WS-RM Configuration Use Cases

Overview

This subsection focuses on configuring WS-RM attributes from a use case point of view. Where an attribute is a standard WS-RM policy attribute, defined in the http://schemas.xmlsoap.org/ws/2005/02/rm/policy namespace, only the example of setting it in an `RMAssertion` within an `rmManager` Spring bean is shown. For details of how to set such attributes as a policy within a feature; in a WSDL file, or in an external attachment, see "Configuring Standard WS-RM Policy Attributes" on page 127.

The following use cases are covered:

- "Base retransmission interval"
- "Exponential backoff for retransmission"
- "Acknowledgement interval"
- "Maximum unacknowledged messages threshold"
- "Maximum length of an RM sequence"
- "Message delivery assurance policies"

Base retransmission interval

The `BaseRetransmissionInterval` element specifies the interval at which an RM source retransmits a message that has not yet been acknowledged. It is defined in the http://schemas.xmlsoap.org/ws/2005/02/rm/wsrm-policy.xsd schema file. The default value is 3000 milliseconds.

Example 9.8 on page 131 shows how to set the WS-RM base retransmission interval.

Example 9.8. Setting the WS-RM Base Retransmission Interval

```
<beans xmlns:wsrm-policy="http://schemas.xmlsoap.org/ws/2005/02/rm/policy
...>
<wsrm-mgr:rmManager id="org.apache.cxf.ws.rm.RMManager">
    <wsrm-policy:RMAssertion>
        <wsrm-policy:BaseRetransmissionInterval Milliseconds="4000"/>
    </wsrm-policy:RMAssertion>
```

```
</wsrm-mgr:rmManager>
</beans>
```

Exponential backoff for retransmission

The `ExponentialBackoff` element determines if successive retransmission attempts for an unacknowledged message are performed at exponential intervals.

The presence of the `ExponentialBackoff` element enables this feature. An exponential backoff ratio of `2` is used by default.

Example 9.9 on page 132 shows how to set the WS-RM exponential backoff for retransmission.

Example 9.9. Setting the WS-RM Exponential Backoff Property

```
<beans xmlns:wsrm-policy="http://schemas.xmlsoap.org/ws/2005/02/rm/policy
...>
<wsrm-mgr:rmManager id="org.apache.cxf.ws.rm.RMManager">
    <wsrm-policy:RMAssertion>
        <wsrm-policy:ExponentialBackoff="4"/>
    </wsrm-policy:RMAssertion>
</wsrm-mgr:rmManager>
</beans>
```

Acknowledgement interval

The `AcknowledgementInterval` element specifies the interval at which the WS-RM destination sends asynchronous acknowledgements. These are in addition to the synchronous acknowledgements that it sends on receipt of an incoming message. The default asynchronous acknowledgement interval is `0` milliseconds. This means that if the `AcknowledgementInterval` is not configured to a specific value, acknowledgements are sent immediately (that is, at the first available opportunity).

Asynchronous acknowledgements are sent by the RM destination only if both of the following conditions are met:

- The RM destination is using a non-anonymous `wsrm:acksTo` endpoint.
- The opportunity to piggyback an acknowledgement on a response message does not occur before the expiry of the acknowledgement interval.

Example 9.10 on page 133 shows how to set the WS-RM acknowledgement interval.

Example 9.10. Setting the WS-RM Acknowledgement Interval

```
<beans xmlns:wsrm-policy="http://schemas.xmlsoap.org/ws/2005/02/rm/policy
...>
<wsrm-mgr:rmManager id="org.apache.cxf.ws.rm.RMManager">
    <wsrm-policy:RMAssertion>
        <wsrm-policy:AcknowledgementInterval Milliseconds="2000"/>
    </wsrm-policy:RMAssertion>
</wsrm-mgr:rmManager>
</beans>
```

Maximum unacknowledged messages threshold

The `maxUnacknowledged` attribute sets the maximum number of unacknowledged messages that can accrue per sequence before the sequence is terminated.

Example 9.11 on page 133 shows how to set the WS-RM maximum unacknowledged messages threshold.

Example 9.11. Setting the WS-RM Maximum Unacknowledged Message Threshold

```
<beans xmlns:wsrm-mgr="http://cxf.apache.org/ws/rm/manager
...>
<wsrm-mgr:reliableMessaging>
    <wsrm-mgr:sourcePolicy>
        <wsrm-mgr:sequenceTerminationPolicy maxUnacknowledged="20" />
    </wsrm-mgr:sourcePolicy>
</wsrm-mgr:reliableMessaging>
</beans>
```

Maximum length of an RM sequence

The `maxLength` attribute sets the maximum length of a WS-RM sequence. The default value is `0`, which means that the length of a WS-RM sequence is unbound.

When this attribute is set, the RM endpoint creates a new RM sequence when the limit is reached, and after receiving all of the acknowledgements for the previously sent messages. The new message is sent using a newsequence.

Example 9.12 on page 133 shows how to set the maximum length of an RM sequence.

Example 9.12. Setting the Maximum Length of a WS-RM Message Sequence

```
<beans xmlns:wsrm-mgr="http://cxf.apache.org/ws/rm/manager
...>
```

```
<wsrm-mgr:reliableMessaging>
    <wsrm-mgr:sourcePolicy>
        <wsrm-mgr:sequenceTerminationPolicy maxLength="100" />
    </wsrm-mgr:sourcePolicy>
</wsrm-mgr:reliableMessaging>
</beans>
```

Message delivery assurance policies

You can configure the RM destination to use the following delivery assurance policies:

- `AtMostOnce` — The RM destination delivers the messages to the application destination only once. If a message is delivered more than once an error is raised. It is possible that some messages in a sequence may not be delivered.
- `AtLeastOnce` — The RM destination delivers the messages to the application destination at least once. Every message sent will be delivered or an error will be raised. Some messages might be delivered more than once.
- `InOrder` — The RM destination delivers the messages to the application destination in the order that they are sent. This delivery assurance can be combined with the `AtMostOnce` or `AtLeastOnce` assurances.

Example 9.13 on page 134 shows how to set the WS-RM message delivery assurance.

Example 9.13. Setting the WS-RM Message Delivery Assurance Policy

```
<beans xmlns:wsrm-mgr="http://cxf.apache.org/ws/rm/manager
...>
<wsrm-mgr:reliableMessaging>
    <wsrm-mgr:deliveryAssurance>
        <wsrm-mgr:AtLeastOnce />
    </wsrm-mgr:deliveryAssurance>
</wsrm-mgr:reliableMessaging>
</beans>
```

Configuring WS-RM Persistence

Overview

The FUSE Services Framework WS-RM features already described in this chapter provide reliability for cases such as network failures. WS-RM persistence provides reliability across other types of failure such as an RM source or an RM destination crash.

WS-RM persistence involves storing the state of the various RM endpoints in persistent storage. This enables the endpoints to continue sending and receiving messages when they are reincarnated.

FUSE Services Framework enables WS-RM persistence in a configuration file. The default WS-RM persistence store is JDBC-based. For convenience, FUSE Services Framework includes Derby for out-of-the-box deployment. In addition, the persistent store is also exposed using a Java API. To implement your own persistence mechanism, you can implement one using this API with your preferred DB *Developing Applications Using JAX-WS*.

Important

WS-RM persistence is supported for oneway calls only, and it is disabled by default.

How it works

FUSE Services Framework WS-RM persistence works as follows:

- At the RM source endpoint, an outgoing message is persisted before transmission. It is evicted from the persistent store after the acknowledgement is received.
- After a recovery from crash, it recovers the persisted messages and retransmits until all the messages have been acknowledged. At that point, the RM sequence is closed.
- At the RM destination endpoint, an incoming message is persisted, and upon a successful store, the acknowledgement is sent. When a message is successfully dispatched, it is evicted from the persistent store.

- After a recovery from a crash, it recovers the persisted messages and dispatches them. It also brings the RM sequence to a state where new messages are accepted, acknowledged, and delivered.

Enabling WS-persistence

To enable WS-RM persistence, you must specify the object implementing the persistent store for WS-RM. You can develop your own or you can use the JDBC based store that comes with FUSE Services Framework.

The configuration shown in Example 9.14 on page 136 enables the JDBC-based store that comes with FUSE Services Framework.

Example 9.14. Configuration for the Default WS-RM Persistence Store

```
<bean id="RMTxStore" class="org.apache.cxf.ws.rm.persistence.jdbc.RMTxStore"/>
<wsrm-mgr:rmManager id="org.apache.cxf.ws.rm.RMManager">
    <property name="store" ref="RMTxStore"/>
</wsrm-mgr:rmManager>
```

Configuring WS-persistence

The JDBC-based store that comes with FUSE Services Framework supports the properties shown in Table 9.4 on page 136.

Table 9.4. JDBC Store Properties

Attribute Name	Type	Default Setting
driverClassName	String	`org.apache.derby.jdbc.EmbeddedDriver`
userName	String	null
passWord	String	null
url	String	`jdbc:derby:rmdb;create=true`

The configuration shown in Example 9.15 on page 136 enables the JDBC-based store that comes with FUSE Services Framework, while setting the driverClassName and url to non-default values.

Example 9.15. Configuring the JDBC Store for WS-RM Persistence

```
<bean id="RMTxStore" class="org.apache.cxf.ws.rm.persistence.jdbc.RMTxStore">
    <property name="driverClassName" value="com.acme.jdbc.Driver"/>
    <property name="url" value="jdbc:acme:rmdb;create=true"/>
</bean>
```

Chapter 10. Enabling High Availability

This chapter explains how to enable and configure high availability in the FUSE Services Framework runtime.

Introduction to High Availability

Overview

Scalable and reliable applications require high availability to avoid any single point of failure in a distributed system. You can protect your system from single points of failure using *replicated services*.

A replicated service is comprised of multiple instances, or *replicas*, of the same service. Together these act as a single logical service. Clients invoke requests on the replicated service, and FUSE Services Framework delivers the requests to one of the member replicas. The routing to a replica is transparent to the client.

HA with static failover

FUSE Services Framework supports high availability (HA) with static failover in which replica details are encoded in the service WSDL file. The WSDL file contains multiple ports, and can contain multiple hosts, for the same service. The number of replicas in the cluster remains static as long as the WSDL file remains unchanged. Changing the cluster size involves editing the WSDL file.

Enabling HA with Static Failover

Overview

To enable HA with static failover, you must do the following:

1. "Encode replica details in your service WSDL file"
2. "Add the clustering feature to your client configuration"

Encode replica details in your service WSDL file

You must encode the details of the replicas in your cluster in your service WSDL file. Example 10.1 on page 139 shows a WSDL file extract that defines a service cluster of three replicas.

Example 10.1. Enabling HA with Static Failover—WSDL File

```
❶<wsdl:service name="ClusteredService">
❷    <wsdl:port binding="tns:Greeter_SOAPBinding" name="Replica1">
       <soap:address location="http://localhost:9001/SoapContext/Replica1"/>
    </wsdl:port>

❸    <wsdl:port binding="tns:Greeter_SOAPBinding" name="Replica2">
       <soap:address location="http://localhost:9002/SoapContext/Replica2"/>
    </wsdl:port>

❹    <wsdl:port binding="tns:Greeter_SOAPBinding" name="Replica3">
       <soap:address location="http://localhost:9003/SoapContext/Replica3"/>
    </wsdl:port>

</wsdl:service>
```

The WSDL extract shown in Example 10.1 on page 139 can be explained as follows:

❶ Defines a service, `ClusterService`, which is exposed on three ports:

1. `Replica1`
2. `Replica2`
3. `Replica3`

❷ Defines `Replica1` to expose the `ClusterService` as a SOAP over HTTP endpoint on port `9001`.

❸ Defines `Replica2` to expose the `ClusterService` as a SOAP over HTTP endpoint on port `9002`.

❹ Defines `Replica3` to expose the `ClusterService` as a SOAP over HTTP endpoint on port `9003`.

Add the clustering feature to your client configuration

In your client configuration file, add the clustering feature as shown in Example 10.2 on page 140.

Example 10.2. Enabling HA with Static Failover—Client Configuration

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:jaxws="http://cxf.apache.org/jaxws"
       xmlns:clustering="http://cxf.apache.org/clustering"
         xsi:schemaLocation="http://cxf.apache.org/jaxws
         http://cxf.apache.org/schemas/jaxws.xsd
         http://www.springframework.org/schema/beans
         http://www.springframework.org/schema/beans/spring-beans.xsd">

    <jaxws:client name="{http://apache.org/hello_world_soap_http}Replica1"
                  createdFromAPI="true">
        <jaxws:features>
            <clustering:failover/>
        </jaxws:features>
    </jaxws:client>

    <jaxws:client name="{http://apache.org/hello_world_soap_http}Replica2"
                  createdFromAPI="true">
        <jaxws:features>
            <clustering:failover/>
        </jaxws:features>
    </jaxws:client>

    <jaxws:client name="{http://apache.org/hello_world_soap_http}Replica3"
                  createdFromAPI="true">
        <jaxws:features>
            <clustering:failover/>
        </jaxws:features>
    </jaxws:client>

</beans>
```

Configuring HA with Static Failover

Overview

By default, HA with static failover uses a sequential strategy when selecting a replica service if the original service with which a client is communicating becomes unavailable, or fails. The sequential strategy selects a replica service in the same sequential order every time it is used. Selection is determined by FUSE Services Framework's internal service model and results in a deterministic failover pattern.

Configuring a random strategy

You can configure HA with static failover to use a random strategy instead of the sequential strategy when selecting a replica. The random strategy selects a random replica service each time a service becomes unavailable, or fails. The choice of failover target from the surviving members in a cluster is entirely random.

To configure the random strategy, add the configuration shown in Example 10.3 on page 141 to your client configuration file.

Example 10.3. Configuring a Random Strategy for Static Failover

```
<beans ...>
❶     <bean id="Random" class="org.apache.cxf.clustering.RandomStrategy"/>

    <jaxws:client name="{http://apache.org/hello_world_soap_http}Replica3"
                  createdFromAPI="true">
        <jaxws:features>
            <clustering:failover>
❷                <clustering:strategy>
                    <ref bean="Random"/>
                 </clustering:strategy>
            </clustering:failover>
        </jaxws:features>
    </jaxws:client>
</beans>
```

The configuration shown in Example 10.3 on page 141 can be explained as follows:

❶ Defines a `Random` bean and implementation class that implements the random strategy.

❷ Specifies that the random strategy is used when selecting a replica.

Appendix A. FUSE Services Framework Binding IDs

Table A.1. Binding IDs for Message Bindings

Binding	ID
CORBA	http://cxf.apache.org/bindings/corba
HTTP/REST	http://apache.org/cxf/binding/http
SOAP 1.1	http://schemas.xmlsoap.org/wsdl/soap/http
SOAP 1.1 w/ MTOM	http://schemas.xmlsoap.org/wsdl/soap/http?mtom=true
SOAP 1.2	http://www.w3.org/2003/05/soap/bindings/HTTP/
SOAP 1.2 w/ MTOM	http://www.w3.org/2003/05/soap/bindings/HTTP/?mtom=true
XML	http://cxf.apache.org/bindings/xformat

Index

L

M

P

R

S

U

W