

IBM Cúram Social Program Management
Version 7.0.2

Cúram Web Services Guide



Note

Before using this information and the product it supports, read the information in [“Notices” on page 48](#)

Edition

This edition applies to IBM® Cúram Social Program Management v7.0.2 and to all subsequent releases unless otherwise indicated in new editions.

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Chapter 1. Integrating with External Applications through Web Services

Use this information to develop Cúram web services. You can make business logic available as web services. Details are provided on how to secure web services.

Introduction

Purpose

The purpose of this guide is to provide instructions on how to connect IBM Cúram Social Program Management to external applications that have a web service interface, how to make business logic available as web services and how to secure those web services.

Audience

This guide is intended for developers that are responsible for the interoperability between enterprise applications using web services. It covers all aspects of IBM Cúram Social Program Management web service development including modeling, building, securing, deploying, and troubleshooting.

Prerequisites

The reader should be familiar with web service concepts and their underlying technologies, including modeling and developing in an IBM Cúram Social Program Management environment.

IBM Cúram Social Program Management web services are based on Apache Axis2.

Related concepts

[Web services glossary](#)

[Cúram Server Developer](#)

Related information

[Cúram Modeling Reference](#)

Using Web Services

Overview of Web Services

The term web services describes a standardized way of integrating web-based applications. They allow different applications from different sources to communicate with each other and because all communication is in XML, web services are not tied to any one operating system or programming language. This application-to-application communication is performed using XML to tag the data, using:

- SOAP (Simple Object Access Protocol: A lightweight XML-based messaging protocol) to transfer the data;
- WSDL (Web Services Description Language) to describe the services available;
- UDDI (Universal Description, Discovery and Integration) to list what services are available.

Web services can be considered in terms of the direction of flow, outbound/accessing and inbound/implementing, which are supported by the IBM Cúram Social Program Management infrastructure for development and deployment as described below:

Outbound Web Service Connector

An outbound web service connector allows the IBM Cúram Social Program Management application to access external applications that have exposed a web service interface. The WSDL file used to describe this interface is used by the web service connector functionality in IBM Cúram Social Program Management to generate the appropriate client code (stubs) to connect to the web service. This means developers can focus on the business logic to handle the data for the web service. See [“Outbound Web Service Connectors” on page 5](#) for details on developing outbound web service connectors.

Inbound Web Service

Some functionality within the IBM Cúram Social Program Management application can be exposed to other internal or external applications within the network. This can be achieved using an inbound web service. The IBM Cúram Social Program Management infrastructure will generate the necessary deployment artifacts and package them for deployment. Once the application EAR file is deployed any application that wishes to communicate with the IBM Cúram Social Program Management application will have to implement the appropriate functionality based on the WSDL for the web service. The infrastructure relies on the web service class to be modeled and it utilizes Axis2 tooling in the generation step for inbound web services. See [“Inbound Web Services” on page 10](#) for details on developing IBM Cúram Social Program Management inbound web services.

Web Service Platforms

The platform (also called stack) supported for web services is Apache Axis2.

There are other web service platforms available besides Axis2 that you might adapt for use with IBM Cúram Social Program Management. However, some of the benefits of Axis2 web services include:

- Axis2 provides significant improvements in flexibility due to the new architecture and improved performance. Performance improvements come from a change in XML parser changes by using the StAX API, which gives greater speed than SAX event-based parsing that is used in the previous web services implementation.
- New message types available - This third generation of web service support makes new message exchange patterns (MEPs) available. Rather than just in-out processing, in-only (also known as "fire-and-forget") and other MEPs are now available.
- Support for new and updated standards such as SOAP (1.2 and 1.1) and WSDL (2.0 and 1.1).

Types of web services

Web services are categorized in a number of ways, one of the main groupings is the web service style and use, which determines the way web service operation parameters are handled. The following table summarizes the Axis2 offerings in this area.

The *style* option (define by the WSDL specification) determines the structure of the SOAP message payload, which is the contents of the `<soap:body>` element.

- Document (also referred to as document-oriented web services, or DOWS). The contents of the web service payload are defined by the schema in the `<wsdl:type>` and is sent as a self-contained document. This style is flexible and can process parameters and return data, or by using IBM Rational® Software Architect modeling, can be a W3C Document that is passed as an argument and return value. Document is assumed to be the default style if not specified.
- RPC: The contents of the payload must conform to the rules specified in the SOAP specification, that is, `<soap:body>` and can contain one element only. The element is named after the operation. Also, all parameters must be represented as subelements of this wrapper element. Typically, subelements would be parameters and return values.

Regardless of the choice of style the contents of the SOAP message payload could look the same for a SOAP message regardless of whether document or RPC style is specified in the WSDL. This is because of the freedom available in the case of the document style.

The *use* option determines the serialization rules that are used by the web service client and server to interpret the payload of the SOAP message.

- Literal. The type definitions are self-defining, following an XML schema definition in `<wsdl:types>` by using either the *element* or *type* attribute.
- Encoded: The rules to encode and interpret the payload application data are in a list of URIs specified by the *encodingStyle* attribute, from the most to least restrictive. The most common encoding is SOAP encoding, which specifies how objects, arrays, and so on, must be serialized into XML.

The style and use options for a web service are specified in the WSDL `<wsdl:binding>` section (see <http://www.w3.org/TR/wsdl> and <http://www.w3.org/TR/wsdl20>) as attributes and control the content and function of the resulting SOAP (see <http://www.w3.org/TR/soap11> and <http://www.w3.org/TR/soap12>) message.

The following WSDL fragment illustrates the context for these settings, where the different values for the options are separated by the pipe (|) character:

```
<wsdl:binding name="myService" ... >
  <soap:binding transport="..." style="document|rpc"/>
  <wsdl:operation name="myOperation">
    <soap:operation soapAction="urn:op2" style="document"/>
    <wsdl:input>
      <soap:body use="literal|encoded"
        encodingStyle="uri-list" ... />
    </wsdl:input>
    <wsdl:output>
      <soap:body use="literal|encoded"
        encodingStyle="uri-list" ... />
    </wsdl:output>
  </wsdl:operation>
</wsdl:binding>
```

The *encoded* use option is discouraged by the Web Services Interoperability Organization (WS-I) and the Document/Literal is the preferred choice for web service style and use.

Within the context of the Document/Literal style, use pairing is the concept of "wrapped" and "unwrapped". This pairing is not a specific style or use, but a pattern that is characterized by a single part definition, each part definition in the WSDL references an element, not a type as in RPC (it's these referenced elements that serve as the "wrappers"), the input wrapper element must be defined as a complex type that is a sequence of elements, the input wrapper name must have the same name as the operation, the output wrapper name must have the same name as the operation with "Response" appended to it, and, the style must be "document" in the WSDL binding section. Based on the capabilities of Apache Axis2 only the "wrapped" pattern is supported¹. However, it is not supported by WSDL 2.0. The following WSDL fragment illustrates this pattern by using a simple web service that multiplies two numbers and returns the results.

¹ Because only the Document/Literal-wrapped pattern for Axis2 is supported, turning this off via `doclitBare` set to `true` in the `services.xml` descriptor file is not supported.

```

...
<wsdl:types>
  ...
  <xs:element name="simpleMultiply">
    <xs:complexType>
      <xs:sequence>
        <xs:element
          minOccurs="0"
          name="args0"
          type="xs:float"/>
        <xs:element
          minOccurs="0"
          name="args1"
          type="xs:float"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="simpleMultiplyResponse">
    <xs:complexType>
      <xs:sequence>
        <xs:element
          minOccurs="0"
          name="return" type="xs:float"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</wsdl:types>
...
<wsdl:message name="simpleMultiplyRequest">
  <wsdl:part name="parameters"
    element="ns:simpleMultiply"/>
</wsdl:message>
<wsdl:message name="simpleMultiplyResponse">
  <wsdl:part name="parameters"
    element="ns:simpleMultiplyResponse"/>
</wsdl:message>
...
<wsdl:operation name="simpleMultiply">
  <wsdl:input message="ns:simpleMultiplyRequest"
    wsaw:Action="urn:simpleMultiply"/>
  <wsdl:output message="ns:simpleMultiplyResponse"
    wsaw:Action="urn:simpleMultiplyResponse"/>
</wsdl:operation>
...
<wsdl:operation name="simpleMultiply">
  <soap:operation soapAction="urn:simpleMultiply"
    style="document"/>
  <wsdl:input>
    <soap:body use="literal"/>
  </wsdl:input>
  <wsdl:output>
    <soap:body use="literal"/>
  </wsdl:output>
</wsdl:operation>
</wsdl:operation>
...

```

The following table shows the various style and use combinations that are supported in IBM Cúram Social Program Management.

Style/Use	Cúram with Axis2
RPC/Literal	-
Document/Encoded	Not supported (not WS-I compliant)
Document/Literal (wrapped)	Supported

Of the supported style and use combinations, there are a number of relative strengths and weaknesses to be considered when defining your web services:

Style/Use	Strengths	Weaknesses
Document/Literal (wrapped)	<ul style="list-style-type: none"> • WS-I compliant • No type encoding information • Can validate in a standard way • Operation name in SOAP message 	<ul style="list-style-type: none"> • Very complex WSDL
RPC/Literal (Axis2 only)	<ul style="list-style-type: none"> • WS-I compliant • WSDL is straightforward • Operation name is included in the WSDL • No type encoding information 	<ul style="list-style-type: none"> • Hard to validate the message
RPC/Encoded (legacy only)	<ul style="list-style-type: none"> • WSDL is straightforward • Operation name is included in the WSDL 	<ul style="list-style-type: none"> • Not WS-I compliant

Web Services Security

Web service security is an important consideration in your planning, implementation, and runtime support of web services to ensure your valuable and sensitive enterprise data remains safe. This security is implemented entirely by the facilities that are integrated with Axis2, which includes WS-Security, wss4j, and so on. However, with the support of web services with Axis2 there is the option (recommended and on by default) of requiring that clients of inbound web services provide credentials using IBM Cúram Social Program Management custom SOAP headers.

Summary

The basics of Apache Axis2 web services have been introduced and how IBM Cúram Social Program Management web services correspond to this web service functionality. As the basis for the latest generation of web service standards, Axis2 brings improved architecture, performance, and standards support to your web services.

The following chapters provide the details necessary to enable access to web services externally deployed (outbound) and model, build, customize, secure, and deploy business logic as a web service (inbound).

Outbound Web Service Connectors

Overview

A IBM Cúram Social Program Management outbound web service connector allows the application to access external applications that have exposed a web service interface. The WSDL file used to describe this interface is used by the web service connector functionality in IBM Cúram Social Program Management to generate the appropriate client code (stubs) to connect to the web service.

This topic shows how to create new IBM Cúram Social Program Management outbound web services:

- Include the WSDL file in your components file system;
- Add the WSDL file location to the outbound web services file;
- Generate the web service stubs;
- Create a client and invoke the web service.

Getting Started

The process for building outbound connectors is briefly:

Include the WSDL file(s) in your components file system

You must have a WSDL file in order to generate client stubs. Once you have the necessary WSDL file(s) you need to store it within the file system of your `EJBServer/components/custom` directory as shown in [“Getting Started” on page 6](#). These WSDL files will be referenced in the following step.

Add the WSDL file location(s) to the component `ws_outbound.xml` file

For each component you wish to have outbound web service connectors built you must place a `ws_outbound.xml` file in the `EJBServer/components/custom/axis` directory. The format of this file is described in [“Adding the WSDL File Location to the Outbound Web Services File” on page 7](#).

Generate stubs

You are now ready to generate the web service stubs by invoking the following build script: `build wsconnector2`

Create a client and invoke the web service

To invoke the web service you must create and build a client (e.g. a Java™ main program) that utilizes the generated stubs to prepare arguments, call the web service, and process the return results.

Each of the above steps is explained in more detail in the sections that follow. To better understand the process just outlined the following illustrates the structure of directories and files used.

```

+ EJBServer
  + build
    + svr
      + wsc2
        + <service_name>
          - <service_name>.wsdl           - where modeled service
                                         WSDL files are built to
      + jav
        + src
          + wsconnector                 - default location for
                                         generated stub source;
                                         override with property
                                         axis2.java.outdir
        + wsconnector                 - default location for
                                         compiled stub code;
                                         override, with axis2.
                                         extra.wsdl2java.args
                                         property
    + components
      + custom
        + axis
          - ws_outbound.xml           - where you identify
                                         your WSDL files as
                                         below
          + <service_name>
            + <service_name>.wsdl     - where you might copy a
                                         WSDL file as pointed to
                                         by ws_outbound.xml

```

Figure 1: File System Usage For Outbound Web Services

Building an Outbound Web Service Connector

Including the WSDL File in Your Components File System

Once you have the WSDL file(s) representing the service you wish to access place them in the file system (usually under source control). You should place the WSDL file(s) in the custom folder under the location represented by your SERVER_DIR environment variable (and that location is specified in `ws_outbound.xml`, below). Placing your WSDL within this structure will ensure your web services are isolated from IBM Cúram Social Program Management -shipped web services. This is shown in [“Getting Started”](#) on page 6. The base name of the (root) WSDL file must use the service name.

Adding the WSDL File Location to the Outbound Web Services File

Once your WSDL file(s) is in your file system you need to create (if not already in existence) a `ws_outbound.xml` file in your component axis directory and update it. The recommended location for this file is: `components/custom/axis/ws_outbound.xml`.

In that file you identify the location of the WSDL file(s); for example:

```

<?xml version="1.0" encoding="UTF-8"?>
<services>
  <service name="SomeService"
    location=
      "components/custom/axis/SomeService/SomeService.wsdl"/>
</services>

```

Figure 2: Sample `ws_outbound.xml` File

In the `ws_outbound.xml` file there is one service entity for each web service, specifying the service name (matching the WSDL file base name) and location (relative to the SERVER_DIR environment variable).

Generating the Web Service Stubs

The generation of the web service stubs is based on the contents of the `ws_outbound.xml` files as specified by your component structure - the setting of the `COMPONENT_ORDER` environment variable and any files in your components/`custom/axis` directories. See the example file system structure in [“Getting Started”](#) on page 6.

When you invoke the IBM Cúram Social Program Management build script:

```
build wsconnector2
```

each WSDL file identified by the `ws_outbound.xml` files is used to generate the stub source code, which is compiled to produce executable code. The generated source is located in the `EJBServer/build/svr/wsc2/jav/src/wsconnector` directory and any compiled Java code is located in the `EJBServer/build/svr/wsc2/jav/wsconnector` directory.

By default the client stubs are generated with Axis2 data bindings(ADB); however, you can generate some or all of your stubs using XMLBeans bindings. To generate all stubs using XMLBeans bindings run the `wsconnector2` Ant target with the argument: `-Daxis2.extra.wsd12java.args="-d xmlbeans"`.

Sometimes not all clients are suitable for the same binding; so, you can override the ADB default selectively by adding the `extraWsd12javaArgs="-d xmlbeans"` attribute to the service definition(s) in the `ws_outbound.xml` file; for example:

```
<service name="SomeService"
        location="components/custom/axis/SomeService/SomeService.wsdl"
        extraWsd12javaArgs="-d xmlbeans"
/>
```

Figure 3: Sample `ws_outbound.xml` service with XMLBeans override

Creating a Client and Invoking the Web Service

Invoking the web service and utilizing the generated code depends on your development environment; but, for example, it might include the following steps, assuming the web service has already been deployed and tested:

1. Copy or reference the generated source and class files; e.g. reference in Eclipse;
2. Code your client; e.g. Java main program. Typically your steps here will include:
 - Instantiate the generated stub class;
 - Optionally, increase the client timeout threshold (especially for a client that might run first after the application server starts);
 - Setup the credentials in the custom SOAP header (see [“Custom SOAP Headers”](#) on page 22 for more details);
 - Call the stub methods to instantiate objects and set their values for passing to the service;
 - Invoke the service operation;
 - Check the response;
3. Build and test.

Typically the generated stub code provides a number of options to invoke the web service. Following are some sample code fragments to help illustrate that.

The following fragment calls a service named `simpleAdd` in class `WebServiceTest` for which the external tooling generates `WebServiceTestStub` and related classes:

```

final WebServiceTestStub stub =
    new WebServiceTestStub();

// Set client timeout for slow machines.
ServiceClient client = stub._getServiceClient();
client.getOptions().setProperty(
    HTTPConstants.SO_TIMEOUT, new Integer(180000));
client.getOptions().setProperty(
    HTTPConstants.CONNECTION_TIMEOUT, new Integer(180000));

// test string and primitive data types
final WebServiceTestStub.SimpleAdd service =
    new WebServiceTestStub.SimpleAdd();
final int i = 20;
final int j = 30;
service.setArgs0(i);
service.setArgs1(j);

final WebServiceTestStub.SimpleAddResponse
    simpleAddResponse = stub.simpleAdd(service);
final long sum = simpleAddResponse.get_return();

client.cleanupTransport(); // Call when done with the service
                           // to avoid exhausting connection pool.
client.cleanup();         // Call when done with the client.

```

Figure 4: Sample Web Service Client

Sometimes, while the generated code is convenient, you need a little more control over your client environment. The following example illustrates how you might call an in-only service using a "hand-built" SOAP message, which in this case takes a simple String argument as input:

```

final TestWSStub stub =
    new TestWSStub();

// Get client from stub
ServiceClient client;
client = stub._getServiceClient();

/*
 * Define SOAP using string
 */
final String xml = " <rem:testString "
    + "xmlns:rem=\"http://remote.testmodel.util.curam\"> "
    + " <rem:testString>"
    + " My test string!"
    + "</rem:testString>"
    + " </rem:testString>";

final ByteArrayInputStream xmlStream =
    new ByteArrayInputStream(xml.getBytes());
final StAXBuilder builder = new StAXOMBuilder(xmlStream);
final OMElement oe = builder.getDocumentElement();

// Send the message
client.fireAndForget(oe); // API for In-Only processing
Thread.sleep(10000);     // Required for fireAndForget()
client.cleanupTransport(); // Call when done with the service
                           // to avoid exhausting connection pool.
client.cleanup();         // Call when done with the client.

```

Figure 5: Sample Web Service Client Using Generated Stub and Custom Code

Note: Later versions of Axis2 JavaDoc indicate that unless your client sets the `callTransportCleanup` property to true (not recommended for performance reasons) on the `org.apache.axis2.client.Options` object that you must call the

`org.apache.axis2.client.ServiceClient.cleanupTransport()` API after processing the response.

Inbound Web Services

Overview

An inbound web service is IBM Cúram Social Program Management application functionality that is exposed to other internal or external applications within the network. This topic describes the infrastructure for supporting these services and the steps necessary to exploit it.

This topic shows you how to create new IBM Cúram Social Program Management inbound web services:

- Model and implement an inbound web service;
- Build and package web services;
- Provide security data for web services;
- Provide web service customizations.

Getting Started

The process for developing inbound web services is briefly:

Model your web service and provide implementation code

You need to define the classes (WS Inbound) and operations in Rational Software Architect that you will be implementing to provide the functionality you wish to expose as web services.

As with any IBM Cúram Social Program Management process class you need to provide the implementation for the classes and operations you model as per the *Cúram Modeling Reference Guide*.

Build your web services and the web services EAR file

The IBM Cúram Social Program Management build system will build and package your web services. Use the server and EAR file build targets as described in the *Cúram Server Developer's Guide* and the deployment guide appropriate to your platform.

Provide security data for your web services

By default your web services are not accessible until you: a) Provide security data (see [“Providing Security Data for Web Services”](#) on page 15) that defines the service class and operation and which security group(s) can access them; and b) Your clients must then provide credentials appropriate to those security definitions (see [“Custom SOAP Headers”](#) on page 22 (unless you choose to disable this security functionality; see [“Custom Credential Processing”](#) on page 16).

Each of the above steps is explained in more detail in the sections that follow. To better understand the process just outlined the following illustrates the structure of directories and files used.

+ EJBServer	
+ build	
+ svr	
+ gen	- where the generator places ws_inbound.xml property files
+ wsc2	- where modeled service WSDL files are generated
- <service_name>.wsdl	
+ components	
+ custom	
+ axis	
+ <service_name>	- where you might place a custom ws_inbound.xml property file
- ws_inbound.xml	- where you might place a custom services.xml descriptor file
- services.xml	- where optional schema validation code would go
+ source	- where you might place optional schema
+ schemas	- where you must place custom receiver code
+ webservice	

Figure 6: File System Usage For Inbound Web Services

Modeling and Implementing an Inbound Web Service

See *Working with the IBM Cúram Social Program Management Model in Rational Software Architect* for more information on using the Rational Software Architect tool with the Cúram model. Based on your design decisions you will need to model the necessary classes and operations and set the appropriate properties in the Cúram model. As per the normal IBM Cúram Social Program Management development process documented in the *Cúram Server Developers Guide* you must also code your web service implementation classes.

When you model your web services consider:

- The web service binding style - Document (recommended, default) or RPC;
- The web service binding use - Literal or Encoded;

Note: Not all combinations of binding style and use are supported; see [“Types of web services” on page 2](#) for more information.

- Whether the service is processing struct and domain types or a W3C Document.

Creating Inbound Web Service Classes

In Rational Software Architect to add an Axis2 inbound web service class to a package, select Add Class, WS Inbound from the right-click context menu and name the class.

Note: In IBM Cúram Social Program Management web service names are based on the class name specified in the Rational Software Architect model and must be unique within the environment.

If you require passing and returning a W3C Document instead of IBM Cúram Social Program Management domain types or structs you must:

1. In the **Curam** properties tab for the WS Inbound class, select the WS_Is_XML_Document property (if passing W3C Documents providing schema validation is an optional activity and is detailed in [“Providing schema validation” on page 19](#));
2. Select True as the value from the drop down.

By default the web service style for the class is document, which is defined in the WS_Binding_Style property as "0 - Unspecified". If you require the RPC binding style:

1. In the **Curam** properties tab, select the `WS_Binding_Style` property;
2. Select " 2 - RPC " as the value from the drop down.

You can also set the value explicitly to " 1 - Document ", but the generator defaults the " 0 - Unspecified " value to be document.

The class properties above will apply uniformly to all operations of the web service class; so, you need to plan your design to account for this. That is, a class can contain W3C Document operations or operations that use native data types or IBM Cúram Social Program Management structs, but not both. Similarly the binding style (`WS_Binding_Style`) will be applied to all operations of a class when passed as an argument to the Java2WSDL tool; so, any requirement for operations with a different binding style in generated WSDL would need to be handled in a separate modeled class.

Adding Operations to Inbound Web Service Classes

In Rational Software Architect, operations are added to Axis2 inbound web service classes using the right-click context menu. To add an operation to an inbound web service class:

1. Select Operation from the right-click context menu and choose Default.
2. In the Create 'default' Operation Wizard, name the operation, and select its return type.

The following are issues with Axis2 that are relevant to you when modeling inbound web services:

- Certain method names on inbound web services do not operate as expected because, when handling an inbound web service call, Java reflection is used to find and start methods in your application. The Axis2 reflection code identifies methods by name only (that is, not by signature). This identification means that unexpected behavior can occur if your web service interface contains a method with the same name as an inherited method. Each inbound web service in your application causes a facade bean, that is, a stateless session bean to be generated.

So, in addition to your application methods, this class also contains methods that are inherited from `javax.ejb.EjbObject`, and possibly others generated by your application server tooling. For example: `remove`, `getEJBHome`, `getHandle`.

This limitation is logged with Apache in JIRA [AXIS2-4802](#). Currently, the only workaround is to ensure that your inbound web service does not contain any methods whose names conflict with those that are in `javax.ejb.EjbObject`.

Adding Arguments and Return Types to Inbound Web Service Operations

Arguments and return types are added to inbound web service operations in the same manner as they are added to process and facade classes. However, they are only relevant for classes that don't specify support for W3C Documents (`WS_Is_XML_Document` property). For more information on how to add arguments and return types to process classes refer to the relevant sections of: *Working with the Cúram Model in Rational Software Architect*.

Note: When modeling a web service struct aggregation within Rational Software Architect graphical mode, Rational Software Architect automatically adds an aggregation label. This causes the WSDL to be generated incorrectly. Remove this label in the model before building and the WSDL will generate correctly.

Processing of Lists

An operation is said to use IBM Cúram Social Program Management lists if its return value or any of its parameters utilize a struct which aggregates another struct using 'multiple' cardinality.

In the UML metamodel, it is possible to model a `<<WS_Inbound>>` operation that uses parameters containing lists (i.e., a struct that aggregates another struct(s) as a list). All operations that are visible as a web service are normally also visible to the web client.

However the web client does not support the following:

- List parameters.
- Non-struct parameters (i.e. parameters which are domain definitions).

- Non-struct operation return types.

In these cases the web client ignores the operations that it does not support, but these operations can be used for Axis2 inbound web services.

Data Types

The IBM Cúram Social Program Management data types except Blob (SVR_BLOB) can be used in Axis2 inbound web service operations. The mappings between IBM Cúram Social Program Management and WSDL data types are shown in the following table:

Cúram data type	WSDL data type
SVR_BOOLEAN	xsd:boolean
SVR_CHAR	xsd:string
SVR_INT8	xsd:byte
SVR_INT16	xsd:short
SVR_INT32	xsd:int
SVR_INT64	xsd:long
SVR_STRING	xsd:string
SVR_DATE	xsd:string (Format: yyyyymmdd)
SVR_DATETIME	xsd:string (Format: yyyyymmddThmmss)
SVR_FLOAT	xsd:float
SVR_DOUBLE	xsd:double
SVR_MONEY	xsd:float

In conjunction with the supported data types shown in “Data Types” on page 13, only the related XML schema types that map to primitive Java types and `java.lang.String` are supported for inbound web services. For example, "xsd:boolean" and "xsd:long" that map to the boolean and long Java types, respectively, and "xsd:string" that maps to `java.lang.String` are supported. All other XML schema types that do not map to a Java primitive type or to `java.lang.String` are not supported. An example of such an unsupported XML schema type is "xsd:anyURI", which maps to `java.net.URI`. This limitation applies to inbound web services only and is due to the fact that inbound web services are generated based on what can be represented in a Cúram model. Outbound web services are not affected by this issue. For more details on related modeling topics consult the documents: *Working with the Cúram Model in Rational Software Architect* and *Cúram Server Modeling Guide*.

Note: Passing or returning the "raw" IBM Cúram Social Program Management data types (i.e., "Date", "DateTime", "Money") as an attribute to an Axis2 web service is restricted. IBM Cúram Social Program Management data types must be wrapped inside a struct before passing them as attributes to a web service.

Building and Packaging Web Services

This section discusses the targets (`websphereWebServices` and `weblogicWebServices`) for building the web services EAR file.

The steps in this build process are:

1. Package global WAR file directories: lib, conf, modules;
2. Iterate over the web service directories in build/svr/gen/wsc2 (one directory per web service class) created by the generator:
 - Process the properties in the following order: custom, generator, defaults (see [“Inbound Web Service Properties File”](#) on page 15 for more information);
 - Generate the services.xml descriptor file, unless a custom services.xml has been provided (see [“Deployment Descriptor File”](#) on page 15 for more information);
 - Package the web service directory.

The following properties and customizations are available:

- Generation of the webservices2.war can be turned off by setting property: disable.axis2.build;
- You can specify an alternate location for the build to read in additional or custom Axis2 module files by setting the axis2.modules.dir property that will contain all the .mar files and the modules.list file to be copied into the WEB-INF\modules directory;
- You can include additional, external content into the webservices.war by either of the following properties:
 - axis2.include.location - that points to a directory containing a structure mapping to the the Axis2 WAR file directory structure;
 - axis2.include.zip - that points to a zip file containing a structure mapping to the Axis2 WAR file directory structure.

In conjunction with either of the two properties above, setting the axis2.include.overwrite property will cause these contents to override the IBM Cúram Social Program Management -packaged content in the WAR file. This capability is for including additional content into your WAR file. An example of how you might use this would be to include the sample Version service to enable Axis2 to successfully validate the environment (see [“Axis2 Environment Validation”](#) on page 42).

For example, to include the sample Version web service for IBM WebSphere® Application Server you need to create a directory structure that maps to the webservices2.war file and includes the structure of Version.aar file as is shipped in the Axis2 binary distribution: axis2-1.5.1-bin/repository/services/version.aar. That structure would look like this:

```
+ WEB-INF
  + services
    + Version
      + META-INF
        - ./services.xml
      + sample
        + axisversion
          - ./Version.class
```

Then, if the location of the Version directory were in C:\Axis2-includes, you would specify the following property value at build time: -Daxis2.include.location=C:\Axis2-includes. Alternatively, you could package the above file structure into a zip file and specify the -Daxis2.include.zip property instead. In both cases the file structure specified would be overlaid onto the file structure (depending on the value of axis2.include.overwrite) and packaged into the webservice2.war WAR file. (For Oracle WebLogic Server the above would be changed to replace the contents of the Version directory with a Version.aar file, which is a compressed file.)

- You can set global, default web services credentials at build time via the following properties set in your Bootstrap.properties file:
 - curam.security.credentials.ws.username - the username used when executing inbound web service calls;
 - curam.security.credentials.ws.password - the password used when executing inbound web service calls. This password must be encrypted.

The above credentials must exist on the 'Users' table, must be enabled, and should be assigned the appropriate security role.

Default credentials can streamline your development and testing processes, but should not be used in a production environment when working with sensitive data and/or processes.

Providing Security Data for Web Services

In IBM Cúram Social Program Management web services are not automatically associated with a security group. This is to ensure that web services are not vulnerable to a security breach. You have to provide security data in order to make your web service usable. As part of your development process you need to ensure that the appropriate security database entries are created. For instance:

```
INSERT INTO SecurityGroupSid (groupname, sidname)
values ('WEBSERVICESGROUP', 'ServiceName.anOperation');
```

The contents of the IBM Cúram Social Program Management security tables are explained further in the *Cúram Security Guide*.

Providing web service customizations

Providing customizations at build-time impacts the security and behavior of your web service at run time. With the default configuration the web services EAR file build performs the following tasks:

- Assign the appropriate IBM Cúram Social Program Management message receiver for struct and domain types, for argument and operation return values, or for W3C Documents. This assignment is based on how you set the `WS_Is_XML_Document` property in Rational Software Architect for the "WS Inbound" (stereotype: `<<wsinbound>>`) class.
- Expect the web service client to pass a custom SOAP header with authentication credentials to start the web service.

To change the default behaviors, you require a custom receiver. For more information, see [“Customizing Receiver Runtime Functionality”](#) on page 16. You might also need to customize the following

- Implementing web services security (Apache Rampart). For more information, see [“Secure Web Services”](#) on page 21.
- Providing external, non- IBM Cúram Social Program Management functionality such as the Apache Axis2 Monitor. For more information, see [“Including the Axis2 SOAP Monitor in Your Web Services WAR File”](#) on page 46.
- Providing other custom parameters for the deployment descriptor (`services.xml`), for example: `doclitBare`, `mustUnderstand`. For more information, see the Apache Axis2 documentation for more information ([Apache Axis2 Configuration Guide](#)).

To effectively customize your web services you need to know how IBM Cúram Social Program Management processes web services at build time, which is explained in the following sections.

Inbound Web Service Properties File

Based on the web service classes modeled with Rational Software Architect the generator creates a folder in the `build/svr/gen/wsc2` directory for each web service class modeled. This is shown in [“Getting Started”](#) on page 10. (This maps closely to how Axis2 expects services to be packaged for deployment.) In that folder a properties file, `ws_inbound.xml`, is generated.

To provide a custom `ws_inbound.xml` file we suggest you start with the generated copy that you will find in the `build/svr/gen/wsc2/<service_name>` directory after an initial build. Place your custom `ws_inbound.xml` file in your `components/custom/axis/<service_name>` directory (usually under source control). During the build the `ws_inbound.xml` files are processed to allow for a custom file first, overriding generated and default values. See [“Inbound Web Service Properties - ws_inbound.xml”](#) on page 37 for details of the property settings in this file.

Deployment Descriptor File

Each web service class requires its own deployment descriptor file (`services.xml`). The build automatically generates a suitable deployment descriptor for the defaults as per [“Inbound Web Service](#)

Properties - ws_inbound.xml” on page 37. The format and contents of the services.xml are defined by Axis2; see the *Apache Axis2 Configuration Guide* (<http://axis.apache.org/axis2/java/core/docs/axis2config.html>) for more information.

To provide a custom services.xml file we suggest you start with the generated copy that you will find in the build/svr/wsc2/<service_name> directory after an initial build of the web services WAR/EAR file. This is illustrated in “Getting Started” on page 10. Place your custom services.xml file in your components/custom/axis/<service_name> directory (usually under source control). (See “Deployment Descriptor File - services.xml” on page 38 for details of the contents of this file.) During the build the services.xml files are packaged into the web services WAR file (webservices2.war) as per Axis2 requirements; that is, using this file system structure: WEB-INF/services/<service_name>/META-INF/services.xml (see the *Apache Axis2 User's Guide - Building Services* <http://axis.apache.org/axis2/java/core/docs/userguide-building-services.html>).

Customizing Receiver Runtime Functionality

The default receivers provided with IBM Cúram Social Program Management should be sufficient for most cases; but, you can provide overrides for the following functionality:

- Credentials processing;
- Accessing the SOAP Message;
- Application server-specific provider URL and context factory parameters;
- SOAP factory provider for W3C Document processing.

These are explained in more detail in the following sections.

Custom Credential Processing

You might need to customize credentials processing, for example, if you want to obtain or validate credentials externally before passing them to the receiver for authentication.

By default, IBM Cúram Social Program Management web services are built to expect the client to provide credentials using a custom SOAP header. These credentials are then used in starting the service class operation. The default processing flow is as follows:

- Unless *curamWSClientMustAuthenticate* is set to *false* in the services.xml descriptor for the service, the SOAP message is checked for a header and if present these credentials are used. If the SOAP header is not present, then the invocation of the service fails.
- If *curamWSClientMustAuthenticate* is set to *false* the services.xml *jndiUser* and *jndiPassword* parameters are used.
- If there are no *jndiUser* and *jndiPassword* parameters in the services.xml descriptor file, default credentials are used.

However, there is no security data generated for web services. In this case, the defaults credentials on their own are not adequate to enable access to the service. For more information on providing this data, see “Providing Security Data for Web Services” on page 15.

If you require your own credential processing you must code your own `getAxis2Credentials(MessageContext)` method, extending `curam.util.connectors.axis2.CuramMessageReceiver`, to provide these parameters. This method takes a `MessageContext` object as an input parameter and returns a `java.util.Properties` object that contains the Axis2 parameter name and value. For example:

```

public Properties getAxis2Credentials(
    final MessageContext messageContextIn) {

    final Properties loginCredentials = new Properties();

    String sUser = null;
    String sPassword = null;

    <Your processing here...>

    if (sUser != null) {
        loginCredentials.put(
org.apache.axis2.rpc.receivers.ejb.EJBUtil.EJB_JNDI_USERNAME,
        sUser);
    }

    if (sPassword != null) {
        loginCredentials.put(
org.apache.axis2.rpc.receivers.ejb.EJBUtil.EJB_JNDI_PASSWORD,
        sPassword);
    }

    return loginCredentials;
}

```

Figure 7: Sample getAxis2Credentials Method

See [“Building Custom Receiver Code” on page 19](#) on how to specify and build this custom class for this method.

You can use the runtime properties `curam.security.credentials.ws.username` and `curam.security.credentials.ws.password (encrypted)` to specify default web services credentials. Using runtime properties might not be appropriate in a secure production environment; but, could be a useful, for instance, in development for simulating functions that would ultimately be provided by an external security system. For more information on encrypted passwords, see the *Cúram Security Guide*.

Accessing the SOAP Message

If you require access to the SOAP message extending the Curam receiver class can allow you to do this as shown in the following example:

```

package webservice;

import org.apache.axis2.AxisFault;
import org.apache.axis2.context.MessageContext;
import org.apache.log4j.Logger;

/**
 * Sample SOAP message access.
 */
public class CustomReceiverInOutAccessSOAPMsg
    extends curam.util.connectors.axis2.CuramMessageReceiver {

    /** Class logger. */
    private final Logger log =
        Logger.getLogger(CustomReceiverInOutAccessSOAPMsg.class);

    /**
     * Access the SOAP message and invoke
     * Curam receiver invokeBusinessLogic.
     *
     * @param messageContextIn Input MessageContext.
     * @param messageContextOut Output MessageContext.
     *
     * @throws AxisFault based on called method.
     */
    @Override
    public void invokeBusinessLogic(final MessageContext messageContextIn,
        final MessageContext messageContextOut) throws AxisFault {
        if (messageContextIn != null) {
            final org.apache.axiom.soap.SOAPEnvelope inEnv =
                messageContextIn.getEnvelope();
            if (inEnv != null) {
                // Insert custom SOAP processing here.
                log.debug("Sample access of SOAP message: " + inEnv.toString());
            }
        }

        super.invokeBusinessLogic(messageContextIn, messageContextOut);
    }
}

```

Figure 8: Sample Custom Receiver to Access the SOAP Message

Note, the invocation of `super.invokeBusinessLogic()` must be made.

See [“Building Custom Receiver Code” on page 19](#) on how to specify and build this custom class.

Custom Application Server-Specific Parameters

The `app_webservices2.xml` script will generate correct application server-specific provider URL and context factory parameters; however, you may find it convenient if you are supporting multiple environments to derive one or more of these values in your own custom code.

If so, you can provide your own `getProviderURL()` and/or `getContextFactoryName()` method(s) by overriding class `curam.util.connectors.axis2.CuramMessageReceiver`. Both methods return a string representing the provider URL and context factory name, respectively. See [“Building Custom Receiver Code” on page 19](#) on how to specify and build this custom class for these methods.

Custom SOAP Factory

Generally, the default SOAP factory, `org.apache.axiom.soap.SOAPFactory`, should be adequate for processing your web services that process W3C Documents. But, if necessary you can override this behavior by providing your own `getSOAPFactory(MessageContext)` method. This method takes a `MessageContext` object as an input parameter and returns an `org.apache.axiom.soap.SOAPFactory`.

Building Custom Receiver Code

For any of the above cases of providing custom receiver code you must:

- Extend the appropriate class (e.g. `public class MyReceiver extends curam.util.connectors.axis2.CuramMessageReceiver`). (See [“Deployment Descriptor File” on page 15](#) for the list of receiver classes and their usage.)
- Specify a package name of webservice in your custom Java program (e.g.: `package webservice;`).
- Place your custom source code in your components `source/webservice` directory (e.g. `components/mycomponents/source/webservice`). The server build target will then build and package this custom receiver code.
- Create a custom `services.xml` descriptor file for each service class to be overridden by your custom behavior. See [“Deployment Descriptor File” on page 15](#) and [“Building Custom Receiver Code” on page 19](#) below.

```
<messageReceivers>
  <messageReceiver
    mep="http://www.w3.org/2004/08/wsdl/in-out"
    class="webservice.MyReceiver"/>
</messageReceivers>
```

Figure 9: Sample services.xml Descriptor File Entry for a Custom Receiver

The webservices build (implemented in `app_webservices2.xml`) will package these custom artifacts into a WAR file.

Providing schema validation

When using web services that pass and return a W3C Document object, you might want to use schema validation to verify the integrity of the document you are processing. Whether you choose to use schema validation might depend on factors such as:

- The CPU cost of performing such validation, which depends on the volume of transactions your system encounters.
- The source of the Documents being passed to your web service, whether that is under your control or public.

The steps for validating an XML Document in an inbound web service are as follows:

1. Include the schema document in the application ear by storing it somewhere within directory `SERVER_DIR/components/**/webservices/**/*xsd`.
2. Provide code within the implementation code of the BPO method that loads the schema file, and passes it into the infrastructure validator class along with the `org.w3c.Document` class to be validated.

The code example ([“Providing schema validation” on page 19](#)) illustrates how validation can be implemented.

```

import curam.util.exception.AppException;
import curam.util.exception.InformationalException;
import curam.util.webservices.DOWSValidator;
import java.io.InputStream;
import org.w3c.dom.Document;

. . .

/**
 * A sample XML document web service.
 */
public org.w3c.dom.Document
myWebServiceOperation(final org.w3c.dom.Document docIn)
throws AppException, InformationalException {

    // DOWSValidator is the SDEJ infrastructure class for
    // validating org.w3c.Document classes in web services.
    final curam.util.webservices.DOWSValidator validator =
        new curam.util.webservices.DOWSValidator();

    try {
        // The following is used only for error reporting
        // purposes by DOWSValidator. In your code you can
        // provide a relevant value to help identify the schema
        // in the event of an error.
        final String schemaURL = "n/a";

        // Load the schema file from the .ear file.
        // For example, the source location of
        // 'test1.xsd' was
        // SERVER_DIR/components/custom/webservices.

        final InputStream schemaStream =
            getClass().getClassLoader().
                getResourceAsStream("schemas/test1.xsd");

        // if schema file is in
        // SERVER_DIR/components/custom/webservices/test/test1.xsd
        schemaStream =
            getClass().getClassLoader().
                getResourceAsStream("schemas/test/test1.xsd");

        // Invoke the validator.
        validator.validateDocument(docIn, schemaStream,
            schemaURL);

    } catch (Exception e) {
        // Schema validation failed. Throw an exception.
        AppException ae = new
            AppException(SOME_MESSAGES.ERR_SCHEMA_VALIDATION_ERROR,
                e);
    }

    // normal BPO logic goes here.
    // ...

    return result;
}

```

Figure 10: Sample Illustrating Schema Validation

Secure Web Services

Overview

Web service security is an important part of your web services implementation. Existing web service security is described in this chapter. For Rampart and Axis2 web services security you will learn about:

- Using custom SOAP headers with Axis2 and encrypting them;
- Using and setting up Rampart;
- Using HTTPS/SSL to secure web service network traffic.

The following can be used to secure your web services:

- IBM Cúram Social Program Management modeling requirements for using secure web services.
- Coding password callback handlers (also applicable to Axis2 if your policy specifies a password callback handler).
- Setting up the client environment.
- Creating keystore files (also applicable to Axis2 if your environment requires these steps for supporting HTTPS/SSL).

Axis2 Security and Rampart

Rampart is the security module of Axis2. With the Rampart module you can secure web services for authentication (but see below), integrity (signature), confidentiality (encryption/decryption) and non-repudiation (timestamp). Rampart secures SOAP messages according to specifications in WS-Security, using the WS-Security Policy language.

The only specific restriction placed on the use of web service security for IBM Cúram Social Program Management applications is that Rampart Authentication cannot be used. This is due to the requirements of IBM Cúram Social Program Management receivers (this authentication is typically coded in the service code itself, which would be moot by that point as these receivers would have already performed authentication). However, custom SOAP headers provide similar functionality (see [“Custom SOAP Headers”](#) on page 22 for more details).

WS-Security can be configured using the Rampart WS-Security Policy language. The WS-Security Policy language is built on top of the WS-Policy framework and defines a set of policy assertions that can be used in defining individual security requirements or constraints. Those individual policy assertions can be combined using policy operators defined in the WS-Policy framework to create security policies that can be used to secure messages exchanged between a web service and a client.

WS-security can be configured without any IBM Cúram Social Program Management infrastructure changes using Rampart and WS-Security Policy definitions. A WS-Security Policy document can be embedded in a custom `services.xml` descriptor (see [“Deployment Descriptor File”](#) on page 15). WS-Policy and WS-SecurityPolicy can also be directly associated with the service definition by being embedded within a WSDL document.

Encryption generally incurs costs (e.g. CPU overhead) and this is a concern when using WS-Security. However, there are ways to help minimize these costs and one of these is to set the WS-SecurityPolicy appropriate for each individual operation, message, or even parts of the message for a service, rather than applying a single WS-SecurityPolicy to the entire service (for example, see [“Encrypting Custom SOAP Headers”](#) on page 24). To apply such a strategy you need to have a clear grasp of your requirements and exposures. Questions you might consider as you plan your overall security strategy and implementation: Can some services bypass encryption if they are merely providing data that is already available elsewhere publicly? Are multiple levels of encryption necessary; for instance, do you really need both Rampart encryption and HTTP/SSL encryption?

Custom SOAP Headers

Credential checking is enforced in IBM Cúram Social Program Management for web service invocations based on the default expectation that a client invoking a web service will provide a custom SOAP header. This topic was introduced in [“Providing web service customizations”](#) on [page 15](#) insofar as you need to plan specific customizations if you choose to bypass this security checking. By default, the provided receivers for Axis2 expect the client invocation of each web service to provide a custom SOAP header that contains credentials for authenticating IBM Cúram Social Program Management access to the web service. This section explains how your clients can provide these SOAP headers.

The following is an example of the IBM Cúram Social Program Management custom SOAP header in the context of the SOAP message:

```
<?xml version='1.0' encoding='UTF-8'?>
  <soapenv:Envelope
    xmlns:soapenv="http://www.w3.org/2003/05/soap-envelope">
    <soapenv:Header>
      <curam:Credentials
        xmlns:curam="http://www.curamsoftware.com">
        <Username>testerID</Username>
        <Password>password</Password>
      </curam:Credentials>
    </soapenv:Header>
    <soapenv:Body>
      <!-- SOAP message body data here. -->
    </soapenv:Body>
  </soapenv:Envelope>
```

Figure 11: Example Custom SOAP Header

The following is a sample client method for creating custom SOAP headers:

```

import org.apache.axis2.client.ServiceClient;
import javax.xml.namespace.QName;
import org.apache.axiom.om.OMAbstractFactory;
import org.apache.axiom.om.OMElement;
import org.apache.axiom.om.OMFactory;
import org.apache.axiom.om.OMNode;
import org.apache.axiom.om.OMNamespace;
import org.apache.axiom.soap.SOAPFactory;
import org.apache.axiom.soap.SOAPHeaderBlock;

...

/**
 * Create custom SOAP header for web service credentials.
 *
 * @param serviceClient Web service client
 * @param userName      User name
 * @param password      Password
 */
void setCuramCredentials(final ServiceClient serviceClient,
    final String userName, final String password)

    // Setup and create the header
    final SOAPFactory factory =
        OMAbstractFactory.getSOAP12Factory();
    final OMNamespace ns =
        factory.createOMNamespace("http://www.curamsoftware.com",
            "curam");
    final SOAPHeaderBlock header =
        factory.createSOAPHeaderBlock("Credentials", ns);
    final OMFactory omFactory = OMAbstractFactory.getOMFactory();

    // Set the username.
    final OMNode userNameNode =
        omFactory.createOMElement(new QName("Username"));
    ((OMElement) userNameNode).setText(userName);
    header.addChild(userNameNode);

    // Set the password.
    final OMNode passwordNode =
        omFactory.createOMElement(new QName("Password"));
    ((OMElement) passwordNode).setText(password);
    header.addChild(passwordNode);

    serviceClient.addHeader(header);
}

```

Figure 12: Sample Method to Create Custom SOAP Headers

Then a call to the above method would appear as:

```

// Set the credentials for the web service:
MyWebServiceStub stub =
    new MyWebServiceStub();
setCuramCredentials(stub._getServiceClient(),
    "system", "password");

```

By default, the client failing to provide this custom header will cause the service to not be invoked. And, of course, incorrect or invalid credentials will cause an authentication error. The following is an example of failing to provide the necessary custom SOAP header:

```

<soapenv:Envelope xmlns:
  soapenv="http://www.w3.org/2003/05/soap-envelope">
  <soapenv:Body>
    <soapenv:Fault>
      <soapenv:Code>
        <soapenv:Value
          >soapenv:Receiver</soapenv:Value>
        </soapenv:Code>
      <soapenv:Reason>
        <soapenv:Text xml:lang="en-US">
          No authentication data.
        </soapenv:Text>
      </soapenv:Reason>
      <soapenv:Detail/>
    </soapenv:Fault>
  </soapenv:Body>
</soapenv:Envelope>

```

warning: Potential Security Vulnerability

Be aware that by default custom SOAP headers containing credentials for authentication pass on the wire in plain-text! This is an unsecure situation and you must encrypt this traffic to prevent your credentials from being vulnerable and your security from being breached. See [“Encrypting Custom SOAP Headers”](#) on page 24 and/or [“Securing web service network traffic with HTTPS/SSL”](#) on page 35 on how you might rectify this.

For example, this is what the custom SOAP header looks like in the SOAP message with the credentials visible:

```

<?xml version='1.0' encoding='UTF-8'?>
<soapenv:Envelope
  xmlns:soapenv="http://www.w3.org/2003/05/soap-envelope">
  <soapenv:Header>
    <curam:Credentials
      xmlns:curam="http://www.curamsoftware.com">
      <Username>tester</Username>
      <Password>password</Password>
    </curam:Credentials>
  </soapenv:Header>
  <soapenv:Body>
    ...
  </soapenv:Body>
</soapenv:Envelope>

```

Figure 13: Sample Custom SOAP Header

Encrypting Custom SOAP Headers

Since SOAP data (e.g. the headers above in [“Custom SOAP Headers”](#) on page 22) travels across the wire, by default, as plain text, using Rampart to encrypt your IBM Cúram Social Program Management custom SOAP headers is one way to help ensure the security of these credentials. Of course, you should plan a security strategy and implementation for all of your web services and related data based on your overall, enterprise-wide requirements, environment, platforms, etc. The information in this section is just one small part of your overall security picture.

There is additional information on coding your web service clients for Rampart security in [“Using Rampart With Web Services”](#) on page 26 that will help provide context for the following.

The steps to encrypt these headers are:

1. Add the following to your client descriptor file:

```

<encryptionParts>
  {Element}{http://www.curamsoftware.com}Credentials
</encryptionParts>

```

(See [“Defining the Axis2 Security Configuration”](#) on page 27 for more information on the contents of this file.)

Or, add the following to your Rampart policy file:

```
<sp:EncryptedElements
  xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/"
  xmlns:sp=
    "http://schemas.xmlsoap.org/ws/2005/07/securitypolicy">
  <sp:XPath xmlns:curam="http://www.curamsoftware.com" >
    /soapenv:Envelope/soapenv:Header/curam:Credentials/Password
  </sp:XPath>
</sp:EncryptedElements>
```

(See [“Defining the Axis2 Security Configuration”](#) on page 27 for more information on the contents of this file.)

2. Engage and invoke Rampart in your client code as per [“Using Rampart With Web Services”](#) on page 26.

With WS-Security applied as per above the credentials portion of the wsse:Security header will be encrypted in the SOAP message as shown in this example below, which you can contrast with [Figure 13](#) on page 24:

In the following example encryptedParts was used to encrypt the IBM Cúram Social Program Management credentials.

```

...
<?xml version='1.0' encoding='UTF-8'?>
  <soapenv:Envelope
    xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/"
    xmlns:wsa="http://www.w3.org/2005/08/addressing"
    xmlns:xenc="http://www.w3.org/2001/04/xmlenc#">
    <soapenv:Header>
      <wsse:Security
        xmlns:wsse="http://docs.oasis-open.org/wss/
          2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd"
        soapenv:mustUnderstand="1">
      <xenc:EncryptedKey
        Id="EncKeyId-A5ACA637487ECDA81713059750729855">
        <xenc:EncryptionMethod
          Algorithm="http://www.w3.org/2001/04/xmlenc#rsa-1_5" />
        <ds:KeyInfo
          xmlns:ds="http://www.w3.org/2000/09/xmldsig#">
        <wsse:SecurityTokenReference>
          .....
        </wsse:SecurityTokenReference>
        </ds:KeyInfo>
        <!-- Credential data is then encoded in sections
          that follow as illustrated -->
        <xenc:EncryptedData Id="EncDataId-3"
          Type="http://www.w3.org/2001/04/xmlenc#Element">
        <xenc:EncryptionMethod
          Algorithm="http://www.w3.org/
            2001/04/xmlenc#aes128-cbc" />
        <ds:KeyInfo
          xmlns:ds="http://www.w3.org/2000/09/xmldsig#">
        <wsse:SecurityTokenReference
          xmlns:wsse="http://..oasis-
            200401-wss-wssecurity-secext-1.0.xsd">
        <wsse:Reference
          URI="#EncKeyId-A5ACA637444e87ECDA81713059750729855"/>
        </wsse:SecurityTokenReference>
        </ds:KeyInfo>
        <xenc:CipherData>
        <xenc:CipherValue>
          eZFRrk6VSncadAnYCjyVD=</xenc:CipherValue>
        </xenc:CipherData>
        </xenc:EncryptedData>
        <wsa:Action>urn:simpleXML</wsa:Action>
      </soapenv:Header>

```

Figure 14: Example Encrypted Custom SOAP Header

Using Rampart With Web Services

There are a number of parts to Rampart security, as indicated in [“Overview” on page 21](#), and covering these in detail is outside the scope of this document. However, the following gives a high-level view on using Rampart with your IBM Cúram Social Program Management Axis2 web services.

These are the steps for using web services security with Axis2:

1. Define configuration data and parameters for your client and server environments;
2. Provide the necessary data and code specified in your configuration;
3. Code a client to identify and process the configuration.

There is a lot of flexibility in how you fulfill the above steps and the following sections will show some possible ways of doing this.

Defining the Axis2 Security Configuration

While the necessary configuration will depend on what security features you choose to use the overall set of activities will be similar regardless. On the client side you can define the security configuration via a client Axis2 descriptor file (`axis2.xml`), Rampart policy file, or programmatically (deprecated). On the server side you can define the security configuration via the service descriptor file (`services.xml`) or via a Rampart policy embedded in the service WSDL.

The following examples show the client and server configurations in the context of a client Axis2 descriptor and Rampart policy files and the server configuration via the context of the service descriptor file.

Client configuration:

```
<axisconfig name="AxisJava2.0">
  <module ref="rampart" />

  <parameter name="InflowSecurity">
    <action>
      <items>Signature Encrypt</items>
      <signaturePropFile>
        client-crypto.properties
      </signaturePropFile>
      <passwordCallbackClass>
        webservice.ClientPWCallback
      </passwordCallbackClass>
      <signatureKeyIdentifier>
        DirectReference
      </signatureKeyIdentifier>
    </action>
  </parameter>

  <parameter name="OutflowSecurity">
    <action>
      <items>Signature Encrypt</items>

      <encryptionUser>admin</encryptionUser>
      <user>tester</user>

      <passwordCallbackClass>
        webservice.ClientPWCallback
      </passwordCallbackClass>

      <signaturePropFile>
        client-crypto.properties
      </signaturePropFile>
      <signatureKeyIdentifier>
        DirectReference
      </signatureKeyIdentifier>

      <encryptionParts>
        {Element}{http://www.curamssoftware.com}Credentials
      </encryptionParts>

    </action>
  </parameter>
  ...

```

Figure 15: Sample Client Descriptor Settings (Fragment)

Server configuration:

```

<serviceGroup>
  <service name="SignedAndEncrypted">
    ...
    <module ref="rampart" />
    <parameter name="InflowSecurity">
      <action>
        <items>Signature Encrypt</items>
        <passwordCallbackClass>
          webservice.ServerPWCallback
        </passwordCallbackClass>
        <encryptionUser>admin</encryptionUser>
        <user>tester</user>
        <signaturePropFile>
          server-crypto.properties
        </signaturePropFile>
        <signatureKeyIdentifier>
          DirectReference
        </signatureKeyIdentifier>
      </action>
    </parameter>

    <parameter name="OutflowSecurity">
      <action>
        <items>Signature Encrypt</items>
        <encryptionUser>admin</encryptionUser>
        <user>tester</user>
        <passwordCallbackClass>
          webservice.ServerPWCallback
        </passwordCallbackClass>
        <signaturePropFile>
          server-crypto.properties
        </signaturePropFile>
        <signatureKeyIdentifier>
          DirectReference
        </signatureKeyIdentifier>
      </action>
    </parameter>

    ...
  </service>
</serviceGroup>

```

Figure 16: Sample Server Security Settings (services.xml Fragment)

All Rampart clients must specify a configuration context that at a minimum identifies the location of the Rampart and other modules. The following example illustrates this and includes a client Axis2 descriptor file. Later code examples will utilize this same structure assuming it is located in the C:\Axis2\client directory.

```

modules/
  addressing-1.3.mar
  rahas-1.5.mar
  rampart-1.5.mar
conf/
  client-axis2.xml

```

Figure 17: Axis2 Client File System Structure

The equivalent specification to the parameters in “Defining the Axis2 Security Configuration” on page 27 and “Defining the Axis2 Security Configuration” on page 27 via a Rampart policy file would be as follows:

(policy.xml Fragment)

```
...
<ramp:RampartConfig
  xmlns:ramp="http://ws.apache.org/rampart/policy">
  <ramp:user>beantester</ramp:user>
  <ramp:encryptionUser>curam</ramp:encryptionUser>
  <ramp:passwordCallbackClass>
    webservice.ClientPWCallback
  </ramp:passwordCallbackClass>

  <ramp:signatureCrypto>
    <ramp:crypto
      provider="org.apache.ws.security.components.crypto.Merlin">
      <ramp:property
        name="org.apache.ws.security.crypto.merlin.keystore.type">
        JKS
      </ramp:property>
      <ramp:property
        name="org.apache.ws.security.crypto.merlin.file">
        client.keystore
      </ramp:property>
      <ramp:property
        name=
        "org.apache.ws.security.crypto.merlin.keystore.password">
        password
      </ramp:property>
    </ramp:crypto>
  </ramp:signatureCrypto>
  <ramp:encryptionCrypto>
    <ramp:crypto
      provider="org.apache.ws.security.components.crypto.Merlin">
      <ramp:property
        name="org.apache.ws.security.crypto.merlin.keystore.type">
        JKS
      </ramp:property>
      <ramp:property
        name="org.apache.ws.security.crypto.merlin.file">
        client.keystore
      </ramp:property>
      <ramp:property
        name=
        "org.apache.ws.security.crypto.merlin.keystore.password">
        password
      </ramp:property>
    </ramp:crypto>
  </ramp:encryptionCrypto>
</ramp:RampartConfig>
...
```

Figure 18: Sample Rampart Policy

Providing the Security Data and Code

The example configurations in [“Defining the Axis2 Security Configuration” on page 27](#) specify an encryption property file and password call back routine, which would be used in the process of encrypting your web service data.

The value of signaturePropFile specifies the name of the signature crypto property file to use. This file contains the properties used for signing and encrypting the SOAP message. An example server crypto property file is shown below in [“Providing the Security Data and Code” on page 29](#). When using a Rampart policy file, as shown in [“Defining the Axis2 Security Configuration” on page 27](#), these property files are not used as the policy itself contains the equivalent settings.

```
org.apache.ws.security.crypto.provider=
org.apache.ws.security.components.crypto.Merlin
org.apache.ws.security.crypto.merlin.keystore.type=jks
org.apache.ws.security.crypto.merlin.keystore.password=password
org.apache.ws.security.crypto.merlin.file=server.keystore
```

Figure 19: Example Rampart server-crypto.properties File

The client-crypto.properties file would have similar properties as above, but with client-specific values:

```
org.apache.ws.security.crypto.provider=
org.apache.ws.security.components.crypto.Merlin
org.apache.ws.security.crypto.merlin.keystore.type=jks
org.apache.ws.security.crypto.merlin.keystore.password=password
org.apache.ws.security.crypto.merlin.file=client.keystore
```

The creation of the keystore file and the related properties are discussed in [“Keystore File Creation”](#) on page 35.

When configuring a secure web service the server signature property file and keystore file (server-crypto.properties and server.keystore) must be placed in the %SERVER_DIR%/project/config/wss/ directory so that the build will package them and they will be available on the classpath at execution time.

The password callback handlers specified in the passwordCallbackClass parameter entities.

Coding the Client

The following code snippets illustrate what's needed to add to the basic client examples in [“Creating a Client and Invoking the Web Service”](#) on page 8 to utilize the preceding security illustrations.

To utilize a client axis2.xml descriptor file you would need to make the following API call where C:/Axis2/client also contains the Axis2 modules directory as indicated in [“Defining the Axis2 Security Configuration”](#) on page 27:

```
final ConfigurationContext ctx =
    ConfigurationContextFactory.
    createConfigurationContextFromFileSystem(
        // Looks for modules, etc. here:
        "C:/Axis2/client",
        // Axis2 client descriptor:
        "C:/Axis2/client/conf/client-axis2.xml");
```

Figure 20: Identifying Axis2 Client Rampart Configuration

To utilize a Rampart policy file you would need to create a context as above, but the client Axis2 descriptor is not necessary in this example, just the Axis2 modules directory:

```
final ConfigurationContext ctx =
    ConfigurationContextFactory.
    createConfigurationContextFromFileSystem(
        // Looks for modules, etc. here:
        "C:/Axis2/client",
        null);
```

When not utilizing an Axis2 configuration that specifies the necessary modules (as shown in [“Defining the Axis2 Security Configuration”](#) on page 27) you will need to explicitly engage the necessary module(s) prior to invoking the service. The specific modules required will depend on the security features and configuration you are using; for example:

```
client.engageModule("rampart");
```

Failing to do this will result in a server-side error; e.g.:

```
org.apache.rampart.RampartException:  
Missing wsse:Security header in request
```

To utilize a Rampart policy you would need to create a policy object and set it in the service options properties:

```
final org.apache.axiom.om.impl.builder.StAXOMBuilder builder =  
    new StAXOMBuilder("C:/Axis2/client/policy.xml");  
final org.apache.neethi.Policy policy =  
    org.apache.neethi.PolicyEngine.  
        getPolicy(builder.getDocumentElement());  
options.setProperty(  
    org.apache.rampart.RampartMessageData.KEY_RAMPART_POLICY,  
    loadPolicy(policy);
```

Note: Any number of client coding errors, policy specification errors, configuration errors, etc. can manifest in the client and/or the server. Often an error in the client cannot be debugged without access to the log4j trace from the server. For instance, the error when the proper module(s) has not been engaged (discussed earlier) may appear in the client as:

```
OMException in getSOAPBuilder  
org.apache.axiom.om.OMException:  
com.ctc.wstx.exc.WstxUnexpectedCharException:  
Unexpected character 'E' (code 69) in prolog; expected '<'  
at [row,col {unknown-source}]: [1,1]
```

Here is an example that combines the fragments above, illustrating providing an IBM Cúram Social Program Management custom SOAP header and using Rampart to encrypt it:

```
import wsconnector.MyServiceStub;
import java.io.File;
import java.net.URL;
import org.apache.axiom.om.impl.builder.StAXOMBuilder;
import org.apache.axiom.om.OMAbstractFactory;
import org.apache.axiom.om.OMElement;
import org.apache.axiom.om.OMFactory;
import org.apache.axiom.om.OMNamespace;
import org.apache.axis2.addressing.EndpointReference;
import org.apache.axis2.client.Options;
import org.apache.axis2.client.ServiceClient;
import org.apache.axis2.context.ConfigurationContext;
import org.apache.axis2.context.ConfigurationContextFactory;
import org.apache.axis2.transport.http.HTTPConstants;
import org.apache.neethi.Policy;
import org.apache.neethi.PolicyEngine;
import org.apache.rampart.RampartMessageData;

...

/**
 * Invoke a web service with encrypted credentials.
 */
public void webserviceClient() {

    final String serviceName = "myService";
    final String operationName = "myOperation";

    // Instantiate the stub.
    final MyServiceStub stub =
        new MyServiceStub();

    // Get the end point of the service and convert it to a URL
    final Options options = stub._getServiceClient().getOptions();
    final EndpointReference eprTo = options.getTo();
    final URL urlOriginal = new URL(eprTo.getAddress());

    // Use that URL,
    // plus our service name to construct a new end point.
    final URL urlNew = new URL(
        urlOriginal.getProtocol(),
        urlOriginal.getHost(),
        urlOriginal.getPort(),
        "/CuramWS2/services/" + serviceName);
    final EndpointReference endpoint =
        new EndpointReference(urlNew.toString());

    // Load configuration.
    final ConfigurationContext ctx = ConfigurationContextFactory.
        createConfigurationContextFromFileSystem(
            "C:/Axis2/client", // Looks for modules, etc. here.
            null); // Configuration provided via API engaging rampart.

    final ServiceClient client = new ServiceClient(ctx, null);

    // Set the credentials - illustrated as an example earlier
    setCuramCredentials(client, "tester", "password");

    // Set the operation in the endpoint.
    options.setAction("urn:" + operationName);
    options.setTo(endpoint);
}
```

The following shows an equivalent technique for setting the security parameters programmatically, although it is deprecated, it would replace the block of code commented "Load the Rampart policy file" in "Coding the Client" on page 30, above as well as the related policy file:

```
final OutflowConfiguration outConfig =
    new OutflowConfiguration();
outConfig.setActionItems("Signature Encrypt");
outConfig.setUser("tester");
outConfig.
    setPasswordCallbackClass("my.test.ClientPWCallback");
outConfig.
    setSignaturePropFile("client-crypto.properties");
outConfig.setSignatureKeyIdentifier(
    WSSHandlerConstants.BST_DIRECT_REFERENCE);
outConfig.setEncryptionKeyIdentifier(
    WSSHandlerConstants.ISSUER_SERIAL);
outConfig.setEncryptionUser("admin");

final InflowConfiguration inConfig =
    new InflowConfiguration();
inConfig.setActionItems("Signature Encrypt");
inConfig.
    setPasswordCallbackClass("my.test.ClientPWCallback");
inConfig.setSignaturePropFile("client-crypto.properties");

//Set the rampart parameters
options.setProperty(WSSHandlerConstants.OUTFLOW_SECURITY,
    outConfig);
options.setProperty(WSSHandlerConstants.INFLOW_SECURITY,
    inConfig);
```

Figure 22: Sample Client Code (Deprecated) for Setting the Client Security Configuration

Here is an sample working axis2 client descriptor that provides the functionality to send a soap request message using Rampart, with UserNameToken, wsse-Timestamp, Signing, Encryption:

Use the following code snippet in the axis2 java client to load the axis2 client descriptor.

```
ConfigurationContext ctx = ConfigurationContextFactory
.createConfigurationContextFromFileSystem(
"base directory under which the axis2 modules are present",
// pass the absolute path of your client axis2 descriptor, as this is very
important.
"absolute path of your client-axis2.xml");
```

Sample client-axis2.xml

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

```
<axisconfig name="AxisJava2.0">
```

```
    <ref="rampart" />
```

```
    <parameter name="OutflowSecurity">
```

```
        <action>
```

```
            <items>UsernameToken Timestamp Signature Encrypt</items>
```

```
            <!-- encryption user is the certificate alias , that is
present in keystore -->
```

```
            <encryptionUser>verisignsecondarycacert</encryptionUser>
```

```
            <!-- the username that is passed in username token-->
```

```
                <user>scmca</user>
```

```
            <!-- the client password callback class ,
manipulated-->
            where at runtime, the username and password can be
```

```
<passwordCallbackClass>curam.mm.verification.service.impl.MMClientPWCallback
</passwordCallbackClass>
```

```
    <!-- the client crypto property file that provides the keystore
related information for the axis2 client engine-->
```

```
    <signaturePropFile>client-crypto.properties</signaturePropFile>
```

```
    <signatureKeyIdentifier>DirectReference</signatureKeyIdentifier>
```

```
    </action>
```

```
</parameter>
```

```
    <parameter name="InflowSecurity">
```

```
        <action>
```

```
            <items>Signature Encrypt</items>
```

```
            <signaturePropFile>client-crypto.properties</signaturePropFile>
```

```
            <passwordCallbackClass>
```

```
                curam.mm.verification.service.impl.MMClientPWCallback</
passwordCallbackClass>
```

```
            <signatureKeyIdentifier>DirectReference</signatureKeyIdentifier>
```

```
            </action>
```

```
</parameter>
```

```
    <!-- ===== -->
```

```
    <!-- Message Receivers -->
```

```
    <!-- ===== -->
```

```
    <!--This is the Default Message Receiver for the system ,
if you want to have MessageReceivers for -->
```

```
    <!--all the other MEP implement it and add the correct entry
to here , so that you can refer from-->
```

```
    <!--any operation -->
```

```
    <!--Note : You can override this for particular
service by adding the same element with your requirement-->
```

```
    <messageReceivers>
```

```
class="org.apache.axis2.receivers.RawXMLINOnlyMessageReceiver"/>
```

Securing web service network traffic with HTTPS/SSL

HTTPS/SSL might be a part of your web services security strategy. Details about setting up HTTPS/SSL are beyond the scope of this document. However, the use of HTTPS/SSL can be established in either of the following ways:

- Application server environment - Setting up this environment is specific to your particular application server, but essentially involves exporting the appropriate server certificates and making them available to your client environment.
- Rampart WS-Security policy - There are a number of web articles that cover this subject in more detail.

For client access the end point needs to reflect the protocol and port change, which can be done dynamically at run time. Client code such as the following example, can change the endpoint:

```
// stub is a previously obtained service stub.
// nHttpsPort is an integer identifying the HTTPS port of
// your application server.
// serviceName is a String identifying the service name.

ServiceClient client = stub._getServiceClient();

// Get the end point of the service and convert it to a URL

final Options options = stub._getServiceClient().getOptions();
final EndpointReference eprTo = options.getTo();
final URL urlOriginal = new URL(eprTo.getAddress());

// Use that URL, plus our service name to construct
// a new end point.

final URL urlNew = new URL("https", urlOriginal.getHost(),
nHttpsPort, "/CuramWS2/services/" + serviceName);
client.setTargetEPR(new EndpointReference(urlNew.toString()));
```

Figure 24: Example of Dynamically Changing the Web Service End Point

Your client needs to identify the keystore and password that contains the necessary certificates, for example:

```
System.setProperty("javax.net.ssl.trustStore",
    "C:/keys/server.jks");
System.setProperty("javax.net.ssl.trustStorePassword",
    "password");
```

Otherwise, client coding for HTTPS is similar to that of HTTP.

Note: In a WebSphere environment the SSL socket classes are not available by default and you might experience this error:

```
org.apache.axis2.AxisFault: java.lang.ClassNotFoundException:
    Cannot find the specified class
    com.ibm.websphere.ssl.protocol.SSLSocketFactory
```

Resolve this error with code like the following:

```
Security.setProperty("ssl.SocketFactory.provider",
    "com.ibm.jsse2.SSLSocketFactoryImpl");
Security.setProperty("ssl.ServerSocketFactory.provider",
    "com.ibm.jsse2.SSLServerSocketFactoryImpl");
```

Keystore File Creation

This section describes how to create the `server.keystore` and `client.keystore` keystore files for secure web service configuration:

- Generate the server keystore in file `server.keystore`:

```
%JAVA_HOME%/bin/keytool -genkey -alias curam-sv -dname "CN=localhost, OU=Dev, O=Curam, L=Dublin, ST=Ireland, C=IRL" -keyalg RSA -keypass password -storepass password -keystore server.keystore
```
- Export the certificate from the keystore to an external file `server.cer`:

```
%JAVA_HOME%/bin/keytool -export -alias curam-sv -storepass password -file server.cer -keystore server.keystore
```
- Generate the client keystore in file `client.keystore`:

```
%JAVA_HOME%/bin/keytool -genkey -alias beantester -dname "CN=Client, OU=Dev, O=Curam, L=Dublin, ST=Ireland, C=IRL" -keyalg RSA -keypass password -storepass password -keystore client.keystore
```
- Export the certificate from the client keystore to external file `client.cer`:

```
%JAVA_HOME%/bin/keytool -export -alias beantester -storepass password -file client.cer -keystore client.keystore
```
- Import server's certificate into the client's keystore:

```
%JAVA_HOME%/bin/keytool -import -v -trustcacerts -alias curam -file server.cer -keystore client.keystore -keypass password -storepass password
```
- Import client's certificate into the server's keystore:

```
%JAVA_HOME%/bin/keytool -import -v -trustcacerts -alias curam -file client.cer -keystore server.keystore -keypass password -storepass password
```

Web services glossary

document-oriented web services (DOWS)

There is no formal, industry-accepted definition for DOWS, it is generally accepted that these are defined by the use of `style="document"` attribute in the WSDL binding section. In the context of Cúram the concept of DOWS also includes the option to model Cúram operations (web services) to process XML documents directly.

inbound web services

Inbound web services refers to web services that you implement and are accessed by external clients.

outbound web services

Outbound web services refers to web services that you would access, hosted externally.

SOA

Service-Oriented Architecture

As defined by IBM (<http://www-01.ibm.com/software/solutions/soa/>): "Service Oriented Architecture (SOA) is a business-centric IT architectural approach that supports integrating your business as linked, repeatable business tasks, or services." Typically, web services take a significant role in a SOA implementation.

SOAP

Simple Object Access Protocol

SOAP is an XML-based protocol for processing web services over HTTP. For a more comprehensive definition see: <http://www.w3.org/TR/soap/>.

stub

A stub refers to the Java code that's generated at build time by the Cúram scripts by invoking Axis2 tooling; they are stubs in that the code does not stand alone: you must code a Java main program, or provide some other context, where you instantiate its various objects and call their methods to invoke (outbound) the web service, process results, etc.

WSDL

Web Services Description Language

WSDL is an XML-based format for describing web services. For a more comprehensive definition see: <http://www.w3.org/TR/wsdl>.

WS-I (Web Services Interoperability Organization)

The WS-I is part of OASIS (Organization for the Advancement of Structured Information Standards) standards organization and as their website (<http://www.oasis-ws-i.org/>) their mission is to advance: "... Best Practices for Web services standards across platforms, operating systems, and programming languages."

Inbound Web Service Properties - ws_inbound.xml

Property Settings

The following details the name/value pairs in the `ws_inbound.xml` property file, which are used to build `services.xml` descriptor files for a web service. These files are generated by default, but can also be customized as described in [“Providing web service customizations”](#) on page 15.

These are the default properties produced by the IBM Cúram Social Program Management generator:

classname

The fully qualified name of the web service class, from the Rational Software Architect model. This property should never be overridden and should always be provided by the generator.

ws_binding_style

The web service binding style, based on the Rational Software Architect class property `WS_Binding_Style`. Values: `document` (default) or `rpc`.

ws_is_xml_document

Indicator of a service class whose operations process W3C Documents, based on the Rational Software Architect class property `WS_Is_XML_Document` property. This property should always be determined by the generator. Values: `true` or `false` (default).

An example `ws_inbound.xml` property file that the generator would create is shown in [“Property Settings”](#) on page 37.

```
<curam_ws_inbound>
  <classname>my.util.component_name.remote.WSClass</classname>
  <ws_binding_style>document</ws_binding_style>
  <ws_is_xml_document>>false</ws_is_xml_document>
</curam_ws_inbound>
```

Figure 25: Sample Generated ws_inbound.xml Properties File

The following are the properties that can be provided and/or customized via a custom `ws_inbound.xml` property file:

ws_binding_style

The web service binding style. This property has no direct dependency on the Rational Software Architect model. It is used for passing the corresponding argument to the Apache Axis2 Java2WSDL tool. See also the description of the `ws_binding_use` property below.

Values: `document` (default) or `rpc`.

ws_binding_use

The web service binding use. It is used for passing the corresponding argument to the Axis2 Java2WSDL tool.

Values: `literal` (default) or `encoded`.

ws_service_username

A username (see `ws_service_password` below) to be used for authentication by the IBM Cúram Social Program Management receiver. Not set by default as the default is to utilize a custom SOAP header for

specifying authentication credentials. If specified, results in the corresponding descriptor parameter in `services.xml` being set.

Values: A valid Cúram user.

ws_service_password

A password (see `ws_service_username` above) to be used for authentication by the Cúram receiver. Not set by default as the default is to utilize a custom SOAP header for specifying authentication credentials. If specified, results in the corresponding Axis2 descriptor parameter in `services.xml` being set.

Values: A valid password for the corresponding Cúram user.

ws_client_must_authenticate

An indicator as to whether custom SOAP headers are to be used for IBM Cúram Social Program Management web service client authentication. Should not be specified with `ws_service_username` and `ws_service_password` (above), but if specified this setting overrides, causing the credentials in those properties to be ignored. If specified, results in the corresponding Axis2 descriptor parameter in `services.xml` being set.

Values: `true` (default) or `false`.

ws_disable

An indicator as to whether this web service should be processed by the build system for generating and packing the service into the WAR file. Typically you would use this to temporarily disable a service from being built and thus exposed.

Values: `true` or `false` (default).

An example, custom `ws_inbound.xml` property file is shown in [“Property Settings” on page 37](#).

```
<curam_ws_inbound>
  <ws_binding_style>document</ws_binding_style>
  <ws_client_must_authenticate>>false</ws_client_must_authenticate>
  <ws_service_username>beantester</ws_service_username>
  <ws_service_password>password</ws_service_password>
</curam_ws_inbound>
```

Figure 26: Sample Custom `ws_inbound.xml` Properties File

When providing a custom `ws_inbound.xml` properties file place the file in your `components/custom/axis/<service_name>` directory (the `<service_name>` and class name must match). During the build the properties files are combined based on the following precedence order:

- Your custom `ws_inbound.xml` properties file;
- The generated `ws_inbound.xml` properties file;
- The default values for the properties.

Deployment Descriptor File - `services.xml`

Descriptor File Contents

Each web service class requires its own Axis2 deployment descriptor file (`services.xml`). The Cúram build automatically generates a suitable deployment descriptor for the default settings described in [“Inbound Web Service Properties File” on page 15](#) and [“Inbound Web Service Properties - `ws_inbound.xml`” on page 37](#). The format and contents of the `services.xml` are defined by Axis2; see the *Apache Axis2 Configuration Guide* (<http://axis.apache.org/axis2/java/core/docs/axis2config.html>) for more information.

Based on the settings from the `ws_inbound.xml` property file(s) the `app_webservices2.xml` script generates a `services.xml` file for each web service class. This descriptor file contains a number of parameters that are used at runtime to define and identify the web service and its behavior.

An example `services.xml` descriptor file that would be generated is shown in [“Descriptor File Contents”](#) on page 38.

```

<serviceGroup>
  <service name="ServiceName">

    <!-- Generated by app_webservices2.xml -->
    <description>
      Axis2 web service descriptor
    </description>

    <messageReceivers>
      <messageReceiver
        mep="http://www.w3.org/2004/08/wsdl/in-out"
        class=
          "curam.util.connectors.axis2.CuramXmlDocMessageReceiver"/>
      <messageReceiver
        mep="http://www.w3.org/2004/08/wsdl/in-only"
        class=
          "curam.util.connectors.axis2.CuramInOnlyMessageReceiver"/>
    </messageReceivers>

    <parameter
      name="remoteInterfaceName">
      my.package.remote.ServiceName</parameter>
    <parameter
      name="ServiceClass" locked="false">
      my.package.remote.ServiceNameBean</parameter>
    <parameter
      name="homeInterfaceName">
      my.package.remote.ServiceNameHome</parameter>
    <parameter
      name="beanJndiName">
      curamejb/ServiceNameHome</parameter>

    <parameter
      name="curamWSCClientMustAuthenticate">
      true</parameter>

    <parameter
      name="providerUrl">
      iiop://localhost:2809</parameter>
    <parameter
      name="jndiContextClass">
      com.ibm.websphere.naming.WsnInitialContextFactory
    </parameter>

    <parameter
      name="useOriginalwsdl">
      false</parameter>
    <parameter
      name="modifyUserWSDLPortAddress">
      false</parameter>

    <!--
    NOTE: For any In-Only services (i.e. returning void) you must
    explicitly code those operation names here as per:
    http://issues.apache.org/jira/browse/AXIS2-4408
    For example:
      <operation name="insert">
        <messageReceiver
          class="curam.util.connectors.axis2.
            CuramInOnlyMessageReceiver"/>
      </operation>
    -->

  </service>
</serviceGroup>

```

Figure 27: Sample Generated services.xml Descriptor File

The following lists the mapping of the `services.xml` parameters to the settings in your build environment:

messageReceiver

Specifies the appropriate receiver class for the MEPs of the service. For Cúram there are three available settings/classes:

- `curam.util.connectors.axis2.CuramXmlDocMessageReceiver` - For service classes that process W3C Documents as arguments and return values.
- `curam.util.connectors.axis2.CuramMessageReceiver` - For service classes that process Cúram classes and use the in-out MEP.
- `curam.util.connectors.axis2.CuramInOnlyMessageReceiver` - For service classes that process Cúram classes and use the in-only MEP.

This value is set by the `app_webservices2.xml` script as per the description above. (Required)

remoteInterfaceName, ServiceClass, homeInterfaceName, beanJndiName

Specify the class names and JNDI name required by the receiver code for invoking the service via the facade bean.

These values are set by the `app_webservices2.xml` script based on the generated classname value in the `ws_inbound.xml` properties file. (Required)

curamWSCClientMustAuthenticate, jndiUser, jndiPassword

Specify credential processing and credentials for accessing the operations of the web service class.

These are set by the `app_webservices2.xml` script based on the corresponding properties in `ws_inbound.xml` (see “Inbound Web Service Properties File” on page 15). Default for `curamWSCClientMustAuthenticate` is `true`, but can be overridden at runtime by custom receiver code. (Optional)

providerUrl, jndiContextClass

Specify the application server-specific connection parameters.

These values are set by the `app_webservices2.xml` script based on your `AppServer.properties` settings for your `as.vendor`, `curam.server.port`, and `curam.server.host` properties. Can be set at runtime by custom receiver code. (Optional)

useOriginalwsdl, modifyUserWSDLPortAddress

Specify the processing and handling of WSDL at runtime.

These are explicitly set to `false` by the `app_webservices2.xml` script due to symptoms reported in, for instance, Apache Axis2 JIRA: [AXIS2-4541](#). (Required for proper WSDL handling.)

Troubleshooting

Introduction

This appendix discusses some techniques for troubleshooting Axis2 web services. It covers:

- Initial server validation and troubleshooting
- Tools and techniques for troubleshooting Axis2 errors
- Avoid use of *anyType*

You have modeled your web services, developed your server code, built and deployed your application and web service EAR files. You are now ready to begin testing and finally delivering your web service.

Axis2 represents a complex set of software and third-party products, especially when viewed from the perspective of running in an application server environment. While the IBM Cúram Social Program Management environment simplifies many aspects of web service development, the final steps of testing and debugging your services can prove daunting. The various tips and techniques that are outlined are not

new or comprehensive, but are here to help you consider options and ways of increasing your effectiveness.

Initial Server Validation and Troubleshooting

Because web services process through many layers, one effective technique for more quickly identifying and resolving problems is to keep the server and client side of your service testing separate. Once deployed you want to first focus your testing on the server side to ensure everything works properly and then introduce your client development and testing so that you know where to focus to resolve errors.

If this is your first deployment of a web service, did the application server and deployed application EAR/WAR files start without errors? If not, investigate and resolve these errors.

If your application starts successfully the next step is to ensure that your service is available. This is done differently for Axis2. But, in general, it involves entering the web service URL with the `?wsdl` argument to verify that your service can be accessed. Details for validating the Axis2 environment are in the sections following.

Axis2 Environment Validation

In order to use the Axis2 web app, it must first be downloaded from Apache. Please follow the instructions outlined in [“Including the Axis2 Admin Application in Your Web Services WAR File”](#) on page 45 for details on including this application in your environment. Axis2 provides an initial validation step that is provided by its built-in validation check. You invoke this by entering the URL for your Axis2 web service application as defined by your web services application root context and application server port configuration. For instance, this might look like: `http://localhost:9099/CuramWS2/axis2-web/index.jsp`. This page brings up the "Welcome!" page with an option to validate your environment, which you should select. Out of the box, the only error you should see on the resultant page is in the "Examining Version Service" section where it warns you about not having the sample Apache Axis2 version web service. You can rectify this error (which is not really an error, but a nice sanity check) by including that service as external content when you build your Axis2 web services WAR/EAR file; see [“Building and Packaging Web Services”](#) on page 13 for more information on doing this.

Having successfully validated your Axis2 environment you should click the "Back Home" link on that page and select the Services link on the "Welcome!" page. The resulting "Available services" page will list all available services (classes) and their operations. If there is any invalid service (e.g. due to a missing implementation class) it will be flagged here in more detail and you need to use the diagnostics provided to resolve any errors. For all valid services selecting a service name link from the "Available services" page will generate and display the WSDL for that service. This verifies your deployed service(s) and it should now be available for invocation.

To Be Aware Of

- On the "Available services" page you might see the operation "setSessionContext", which you did not model and code. This behavior is an aspect of the issue that is described in [“Modeling and Implementing an Inbound Web Service”](#) on page 11 and in the *Cúram Release Notes*. It has no impact and can be ignored.
- The WSDL generated from the "Available services" links is not equivalent to the WSDL generated by the Axis2 Java2WSDL tool. Use the Java2WSDL tool to develop outbound web services. You can find the Java2WSDL tool in the `build/src/wsc` directory of your development environment after a web services EAR file build.
- Axis2 has capabilities for checking, investigating your environment using its external administration web application (the "Administration" link on the "Welcome!" page). See [“Including the Axis2 Admin Application in Your Web Services WAR File”](#) on page 45 for details on including this application in your environment. If you don't explicitly build/include this application, the functionality is not available.

Using an External Client to Validate and Troubleshoot

Begin validating the service on the server side first by using an external client because unless the web service class exists, deployment is set up properly. A client failure might not be clearly distinguishable. To keep the path length and areas you might have to investigate for possible errors as small as possible. Use

a known, working client to start your service. Common areas of failure that a known, working external client can help validate include: service packaging, receiver processing, security configuration, and implementation processing. An example of an external client you might use is the freely available soapUI client (www.soapui.org), which is relatively easy and fast to set up and begin using. While a detailed treatment of soapUI is beyond the scope of this document the following is an outline of the steps you would use, which are similar for Axis2:

- Download, install, and start soapUI.
- When validating your service(s) (above) save the generated WSDL.
- In soapUI select the File menu -> New soapUI Project and in this dialog specify the location of your saved WSDL and click OK. This creates and opens a new soapUI project from where you can invoke your web services.
- From the soapUI tree control, expand your newly created project and expand the "Soap12Binding" or "Soap11Binding". Under this tree branch you will see your service operations and under each operation a "Request 1" (default name) request. Double-clicking the request opens a request editor. In the left pane you must code your SOAP message (e.g. parameters, etc.) and a template is provided for doing this. In the right pane is where the result is displayed. Once you've coded your SOAP message click the right green arrow/triangle in the tool bar to execute the service. If you've coded the SOAP message correctly the service output will be displayed in the right pane. However, if an error occurs there will be error information in this pane. In the event of an error verify your SOAP message syntax and content; also see ["Using an External Client to Validate and Troubleshoot"](#) on page 42 for some further techniques for resolving and addressing these.

Note: For Axis2 you must keep in mind the default security behavior and that you must include the custom SOAP header credentials in your request. This would look something like this:

```
<soap:Envelope
  xmlns:soap="http://www.w3.org/2003/05/soap-envelope"
  xmlns:rem="http://remote.my.package">
  <soap:Header>
    <curam:Credentials
      xmlns:curam="http://www.curamsoftware.com">
      <Username>beantester</Username>
      <Password>password</Password>
    </curam:Credentials>
  </soap:Header>
  <soap:Body>
  ...
  </soap:Body>
</soap:Envelope>
```

Note: For Axis2 the first access of a web service may timeout due to the large number of jar files and processing done at first initialization. This can easily be mitigated in a Java client (e.g. see ["Creating a Client and Invoking the Web Service"](#) on page 8), but for soapUI you can just re-invoke the service and the subsequent request will likely not timeout; otherwise, see ["Tools and Techniques for Troubleshooting Axis2 Errors"](#) on page 43 for further techniques for resolving and addressing general web services errors.

Tools and Techniques for Troubleshooting Axis2 Errors

The following highlight possible tools and techniques you might use in troubleshooting errors with Axis2 web services, but is not an exhaustive list. Also, the tools available might vary by operating system and application server environment.

When trying to understand why a service fails, consider the following:

- To debug axis2 soap request / response messages effectively, add the following as JVM Arguments in Eclipse (for axis2 java clients) or pass this in websphere console JVM Process definition VM Arguments.

or as JAVA_OPTS for weblogic, and it requires a server restart if applied in application server. Please use this only for debugging purpose.

```
-Dorg.apache.commons.logging.Log=org.apache.commons.logging.impl.SimpleLog
-Dorg.apache.commons.logging.simplelog.showdatetime=true
-Dorg.apache.commons.logging.simplelog.log.httpclient.wire=debug
-
Dorg.apache.commons.logging.simplelog.log.org.apache.commons.httpclient=debug
```

This java system property enables console logging of the soap request sent and soap response received. this is another alternative to using soap monitor.

- Use a monitoring tool (Apache TCPMon or SOAP Monitor) to view the SOAP message traffic. It's easier to setup TCPMon (download from <http://ws.apache.org/commons/tcpmon>, unzip, & run; also available within soapUI), but it requires changing your client end points or your server port. Once setup, SOAP Monitor doesn't require any client or server changes, but does require special build steps for your WAR/EAR files. Apache ships SOAP Monitor as an Axis2 module and see [“Including the Axis2 SOAP Monitor in Your Web Services WAR File” on page 46](#) on how to include this in your built Axis2 environment.
- Look at the failure stack trace and investigate any messages there. Try to understand where in the processing the error occurred. Here is an example Apache log4j properties file that would log verbosely in a C:\Temp\axis2.log file, you can adjust these settings to suit your requirements.

```
# Set root category
log4j.rootCategory=DEBUG, CONSOLE, LOGFILE

# Set the enterprise logger priority to FATAL
log4j.logger.org.apache.axis2.enterprise=FATAL
log4j.logger.de.hunsicker.jalopy.io=FATAL
log4j.logger.httpclient.wire.header=FATAL
log4j.logger.org.apache.commons.httpclient=FATAL

# CONSOLE is set to be a ConsoleAppender using a PatternLayout.
log4j.appender.CONSOLE=org.apache.log4j.ConsoleAppender
log4j.appender.CONSOLE.layout=org.apache.log4j.PatternLayout
log4j.appender.CONSOLE.layout.ConversionPattern=[%p] %m%n

# LOGFILE is set to be a File appender using a PatternLayout.
log4j.appender.LOGFILE=org.apache.log4j.FileAppender
log4j.appender.LOGFILE.File=c:/temp/axis2.log
log4j.appender.LOGFILE.Append=true
log4j.appender.LOGFILE.layout=org.apache.log4j.PatternLayout
log4j.appender.LOGFILE.layout.ConversionPattern=
%d [%t] %-5p %c %x - %m%n
```

You need to place the log4j.properties somewhere in the classpath of the Axis2 WAR file.

- Check the application server logs for more information.
- Turn on log4j tracing for Axis2, as this will most likely give you the most detailed picture of the web service processing or error at the time of the failure. This can be quite voluminous so use it with care.
- Turn on the IBM Cúram Social Program Management application log4j trace as this will also help to give you further context for the failure.
- Consider remote debugging the service running on the application server using Eclipse. Consult your application server-specific documentation for setting up this kind of an environment. Remember that if you are setting breakpoints in this kind of environment that timeouts in the client and/or server are a high probability and appropriate steps should be taken; for the client see [“Creating a Client and Invoking the Web Service” on page 8](#) and for the server consult your application server-specific documentation for setting timer values.

Note: Application verbose tracing (`trace_verbose`) is the highest level of logging available for tracing with web services. This is because the SDEJ employs a proxy wrapper object for ultra verbose (`trace_ultra_verbose`) tracing in order to provide detailed logging. Due to the fact that the SDEJ uses reflection for forwarding a web service request to the underlying process class, the use of a proxy wrapper object is not compatible with the web services infrastructure.

Avoid Use of 'anyType'

Avoid using *anyType* within your WSDL because it makes interoperability difficult, since both service platforms and any client platforms must be able to map, or serialize/deserialize the underlying object.

WSDL is typically generated with *anyType* when the underlying data type (for example, object) cannot be resolved.

You might find with Axis2 that your WSDL works with *anyType* because some vendors/platforms map it to, for instance, *java.lang.Object*, which allows it, if it's XML-compliant, to be processed into a SOAP message, and allows processing from XML to a Java object.

Generate your WSDL as early as possible, checking it for the use of *anyType*. In your development focus on implementing the overall web service structure first and implement the actual service functionality last. For instance, code your web service operations as stubs that merely echo back with minimal processing the input parameters to ensure they can be processed successfully from end to end.

Axis2 Exceptions

Exceptions in web services are returned back to the client as an `AxisFault` exception with the message string from the original exception retained whenever possible. For instance, client code might look like this:

```
// Processing
...
} catch (final AxisFault a) {
    System.out.println(a.getMessage());
}
```

The structure and contents of the fault SOAP message will vary depending on whether the request is a SOAP 1.1 or SOAP 1.2 request.

Also, you need to ensure that, depending on the context of the web service client, the web service provides a meaningful exception message. Otherwise, it may not be possible for the handler of the `AxisFault` exception to react appropriately. However, sometimes failures occur unexpectedly and it will be necessary to resolve them in conjunction with the application server logs and/or the log4j output from Cúram and/or Axis2.

Including the Axis2 Admin Application in Your Web Services WAR File

Introduction

This appendix shows you how to setup your Axis2 web services build to include the Axis2 Admin web application, which provides useful functionality for working with your Axis2 environment.

warning: The dynamic functionality of Axis2 (e.g. hot deployment) isn't intended for production application server environments such as WebSphere Application Server and WebLogic Server and this functionality should not be attempted in these environments.

Steps for Building

Do not use Axis2 to dynamically modify a production environment. However Axis2 is useful for validating settings, viewing services, and modules. To build your EAR file to include this application:

- Download the Axis2 binary distribution (<http://axis.apache.org/axis2/java/core/download.cgi>) corresponding to the supported Apache Axis2 version and unload it to your hard disk. For example, C:\Downloads\Axis2).
- Create a location on your disk to contain the necessary Axis2 artifacts, for example:

```
cd C:\
mkdir Axis2-includes
```

- Put the class files AdminAgent.class and AxisAdminServlet.class in the C:\Downloads\Axis2\webapp\WEB-INF\classes\org\apache\axis2\webapp\ into a JAR file that you place into the WEB-INF\lib directory in your newly created C:\Axis2-includes location. For example:

```
mkdir C:\Axis2-includes\WEB-INF\lib
cd C:\Downloads\Axis2\webapp\WEB-INF\classes
jar -uvf C:\Axis2-includes\WEB-INF\lib\WebAdmin.jar
org/apache/axis2/webapp/
```

- Additionally, you might want to add a custom axis2.xml descriptor file to a WEB-INF\conf folder to change the default credentials. You can copy the existing included axis2.xml file to this example location:

```
mkdir C:\Axis2-includes\WEB-INF\conf
copy %CURAMSDEJ%\ear\webservices2\Axis2\conf\axis2.xml
C:\Axis2-includes\WEB-INF\conf
```

- Then, change the existing *userName* and *password* parameters, for example:

```
<parameter name="userName">restricted</parameter>
<parameter name="password">special</parameter>
```

- To secure the username and password, the axis2.xml file must be secured in your development and deployed environments without access in the runtime environment to the Axis2 configuration.
- Use the following properties when you start your web services ear target (see [“Building and Packaging Web Services”](#) on page 13):

```
-Daxis2.include.overwrite=true
-Daxis2.include.location=C:\Axis2-includes
```

- On deployment, access the Administration link using the Axis2 "Welcome!" page menu. For example: <http://localhost:9082/CuramWS2/axis2-web/index.jsp>.

Including the Axis2 SOAP Monitor in Your Web Services WAR File

Introduction

This appendix shows you how to setup your Axis2 web services build to include the Axis2 SOAP Monitor module in your Axis2 web services WAR file. The SOAP Monitor provides the ability to view SOAP message requests and responses, which can be useful in debugging.

Steps for Building

The SOAP Monitor module is included with the binary distribution of Axis2 and its module (soapmodule.mar) is included in the packaging of the webservices2.war lib directory during the

build. The `web.xml` file that is included with the `webservices2.war` has the necessary entries to support the SOAP Monitor. Beyond this the following additional steps are needed to enable this functionality:

1. Create a location on your disk to contain the necessary Axis2 artifacts, for example:

```
cd C:\
mkdir Axis2-includes
```

2. As indicated in the Axis2 documentation, you must place the SOAPMonitor applet classes at the root of the WAR file. For example:

```
cd C:\Axis2-includes
jar -xvf %CURAMSDEJ%\ear\webservices2\Axis2\modules\soapmonitor.mar
org/apache/axis2/soapmonitor/applet/
```

3. Then, use the following properties when you start your web services ear target (*websphereWebServices* or *weblogicWebServices*):

```
-Daxis2.include.override=true
-Daxis2.include.location=C:\Axis2-includes
```

4. The included `axis2.xml` file defines the necessary SOAP Monitor phase elements, but to be functional the following entry needs to be added (similarly to other *module* entries):

```
<module ref="soapmonitor"/>
```

This change can be made to the EAR file before deployment or for WebSphere in the deployed file system.

5. To access the SOAPMonitor, use a URL, for example: `http://localhost:9082/CuramWS2/SOAPMonitor`.
6. Unfortunately the applet does not give much information if there is an issue. If you see the error:

```
"The SOAP Monitor is unable to communicate with the server."
```

Ensure that there is not a port conflict; the default as set in `web.xml` is 5001. If so, change that port.

7. This default port can be changed by setting `soap.monitor.port = <port number>` in the `AppServer.properties`

Exclude Soap Monitor

Excluding Soap Monitor from being packed into the `webservices2.war`.

Soap Monitor can be excluded from the deployed EAR file by setting the following property in the `AppServer.properties`.

1. `exclude.soapmonitor = true`

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