

Web Services Integration – It's All About Standards

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J2EE 1.4 and Web Services

- J2EE 1.4 now contains several Web Services Standards
 - Web Services 1.1
 - JAX-RPC 1.1
 - SAAJ 1.2
 - JAXR 1.0
 - WS-I Basic Profile 1.0

	<i>Client</i>	<i>Web</i>	<i>EJB</i>
EJB 2.1	X	X	X
Servlet 2.4		X	
JSP 2.0		X	
JMS 1.1	X	X	X
JTA 1.0		X	X
JavaMail 1.3	X	X	X
JAF 1.0	X	X	X
JAXP 1.2	X	X	X
Connector 1.5		X	X
Web services 1.1	X	X	X
JAX-RPC 1.1	X	X	X
SAAJ 1.2	X	X	X
JAXR 1.0	X	X	X
J2EE Management 1.0	X	X	X
JMX 1.2	X	X	X
J2EE Deployment 1.1			
JACC 1.0		X	X

Web service-related library support in J2EE 1.4



J2EE 1.4 Web Services

- Web Services are now an integral part of J2EE 1.4
- Support provided via following standards
 - JSR 101 (JAX-RPC)
 - Provides standard programming model for Web Services based on WSDL and SOAP
 - JSR 109 (Enterprise Web Services)
 - Provides standard deployment model for Web Services applications (provider and requestor)
 - WS-I Basic Profile 1.1
 - Promotes Web Services interoperability across J2EE and non-J2EE platforms
 - SAAJ (SOAP with Attachments API for Java) 1.2
 - Allows developers to write applications accessing SOAP messages (JAX-RPC Handlers)
 - JAXR
 - Provides an API for accessing Web Services registries

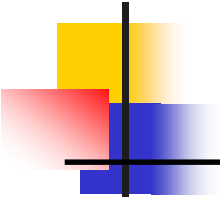




The Web Service Solution

- There are three major parts to a Web Services Solution
 - A Programming model
 - How you write clients to access Web services
 - How you write service implementations
 - How you handle other parts of the SOAP spec (headers, attachments, *etc.*)
 - A deployment model
 - Deployment descriptors to map service implementations to SOAP messages
 - Type mapping for parameters (at least in RPC)
 - An Engine
 - Code to receive SOAP messages and invoke service implementations
 - Code to map Java types to XML





Java Standard Programming and Deployment Model

- Portable Web Services applications (JSR 101) – JAX/RPC
 - Defines the mapping of WSDL to Java and vice versa
 - Defines a client API to invoke a remote Web service
 - Defines a runtime environment for Java Bean as an implementation of a Web service
 - Handler model

- Standard Web Services Deployment Descriptors (JSR 109)
 - JSR109 conceptually enhances JSR101
 - Defines a J2EE compliant deployment/packaging model for Web Services on the server side and for the client
 - New deployment descriptors for Web services
 - Server-side programming model
 - Stateless Session EJB as implementation of a Web service
 - Client-side programming model
 - EJB, Servlet/JSPs, Application Client as client to Web Services
 - J2EE Container required

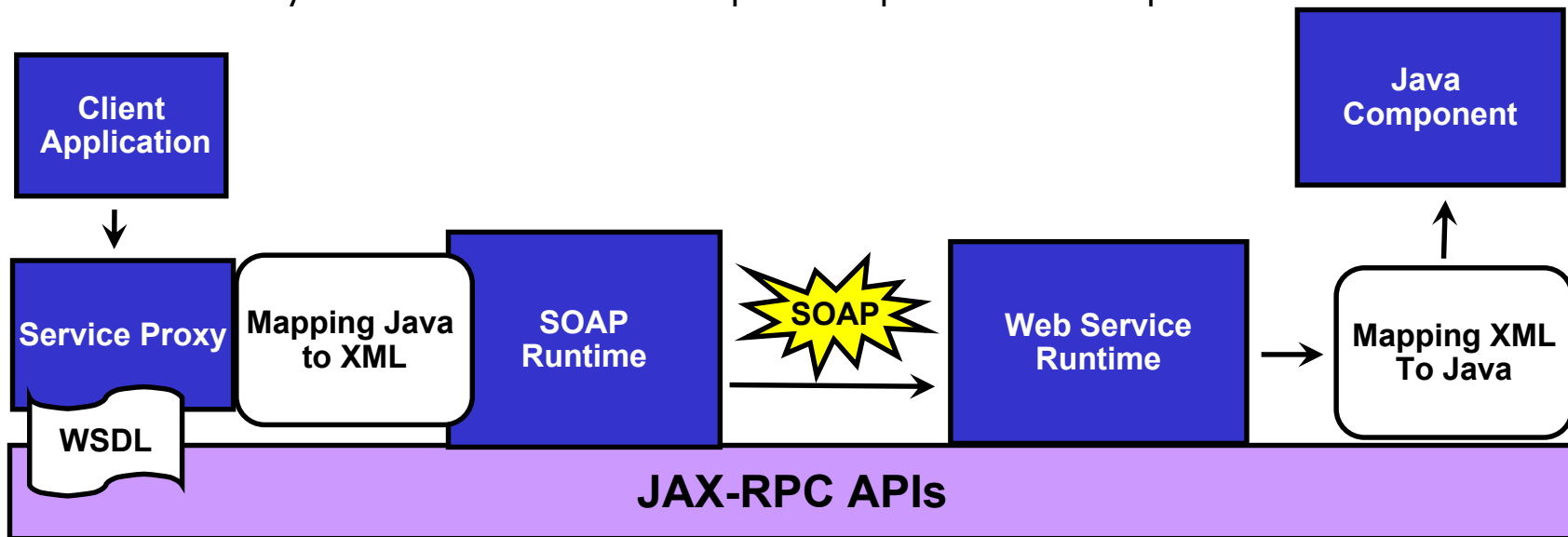
JAX RPC – The Programming Model

- Began as V1.0 (JSR101)
- V1.1 added WS-I Basic Profile support and bug fixes
 - Also released under JSR101
- V1.1 specification published October 14th 2003
 - Required by J2EE 1.4
- Version 2.0 (JSR224)
 - early draft released 23rd July 2004
 - Aims to delegate XML mapping to JAXB 2.0 (JSR222) specification
 - Targets J2SE 1.5
 - The Future...



JAX-RPC Goals

- Java API for XML based Remote Procedure Call (JAX-RPC)
 - formalizes the procedure for invoking Web services in an RPC-like manner
- Defines Client side APIs to access web service
 - as well as server side requirements
- Defines mapping model between WSDL, XML and Java
- Defines a Handler model to the client and the server side
 - Allow your custom code to intercept the request and the response





JAX RPC – Features

- Defines
 - mapping of WSDL/XML to Java and vice versa
 - a client API to invoke a remote web service
 - a runtime environment for Java Bean as an implementation of a web service
 - Handler model
- JAX-RPC is designed for portability of code across multiple vendors
 - Any client or service implementation should be portable across any vendor that supports JAX-RPC

Note, JAX-RPC is meant to be protocol-neutral, but requires support for SOAP over HTTP



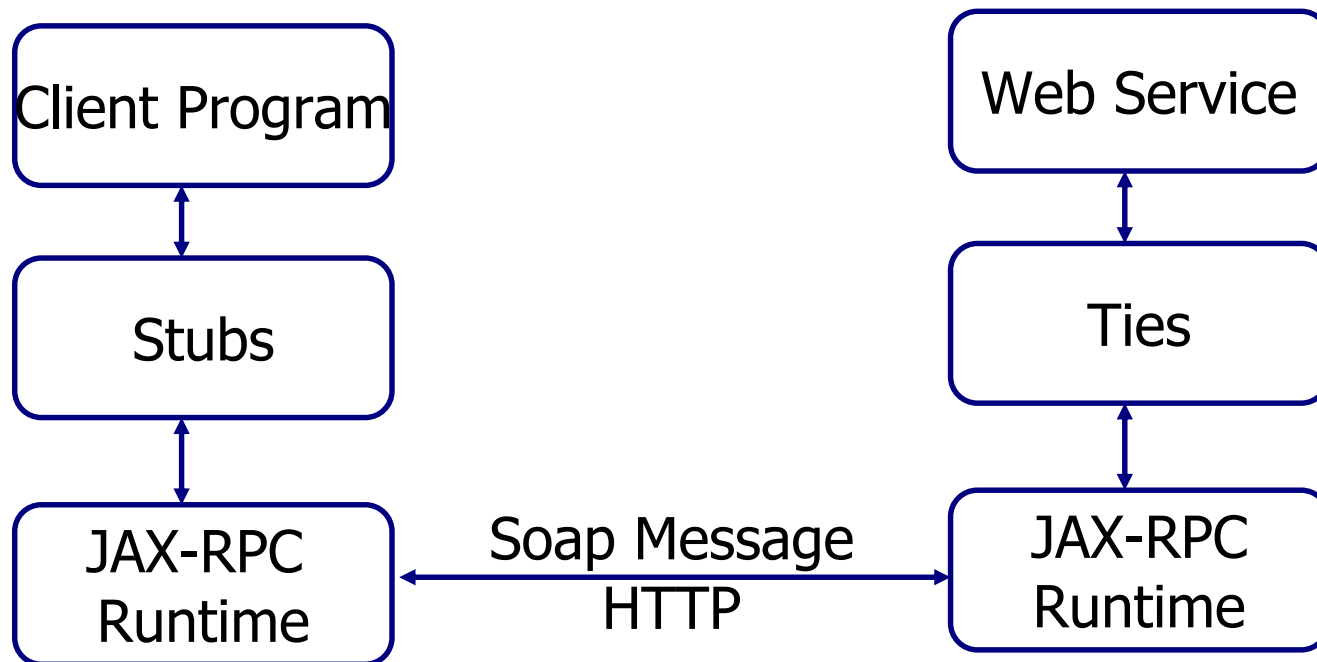


JAX-RPC

- Mappings for WSDL to XML
 - Standard Java Type <--> XML type mapping
 - Standard Java Type <--> WSDL type mapping
 - Standard SOAP binding mapping
- SOAP Manipulation Library
 - JAX-RPC is built on SAAJ (SOAP Attachments API for Java)
 - SAAJ was formerly part of JAXM
 - Provides pattern for sending and receiving SOAP messages with or without attachments, synchronous or asynchronous
- Servlet Container Service Endpoint
 - Standard way to specify servlets that receive SOAP messages
 - Compatible with JSR 109 style deployment descriptors
- Basic Authentication

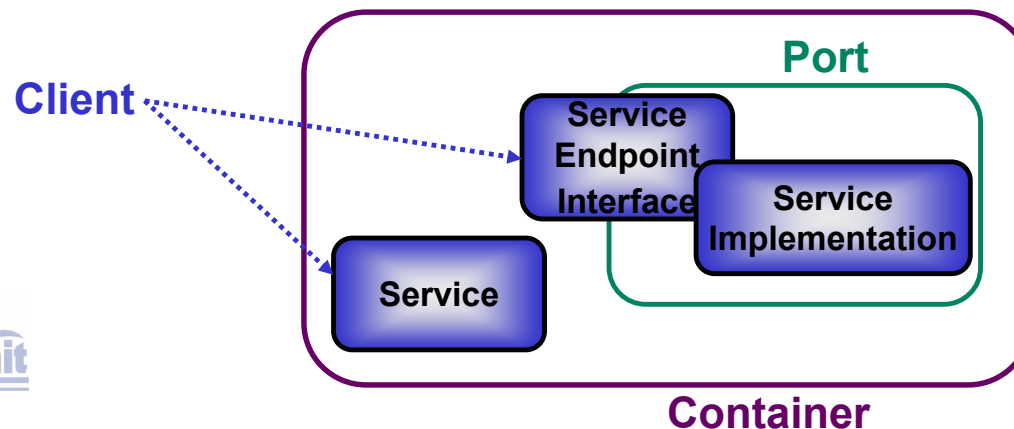
 Colorado Software Summit
■ Handlers

JAX-RPC Working Model



An Architectural View

- JAX-RPC and JSR-109 fit together to form a standard approach for Web service implementation, access and deployment in Java
- Based on a few concepts
 - A **Service Implementation** (either a Java Bean or Stateless Session Bean) implements the methods of a WSDL-Described interface
 - A **Service Endpoint Interface (SEI)** provides a Java "view" of the WSDL-described interface. Clients interact with objects implementing this interface
 - A **Service** mediates access to the **Ports** (acts as a factory for ports)

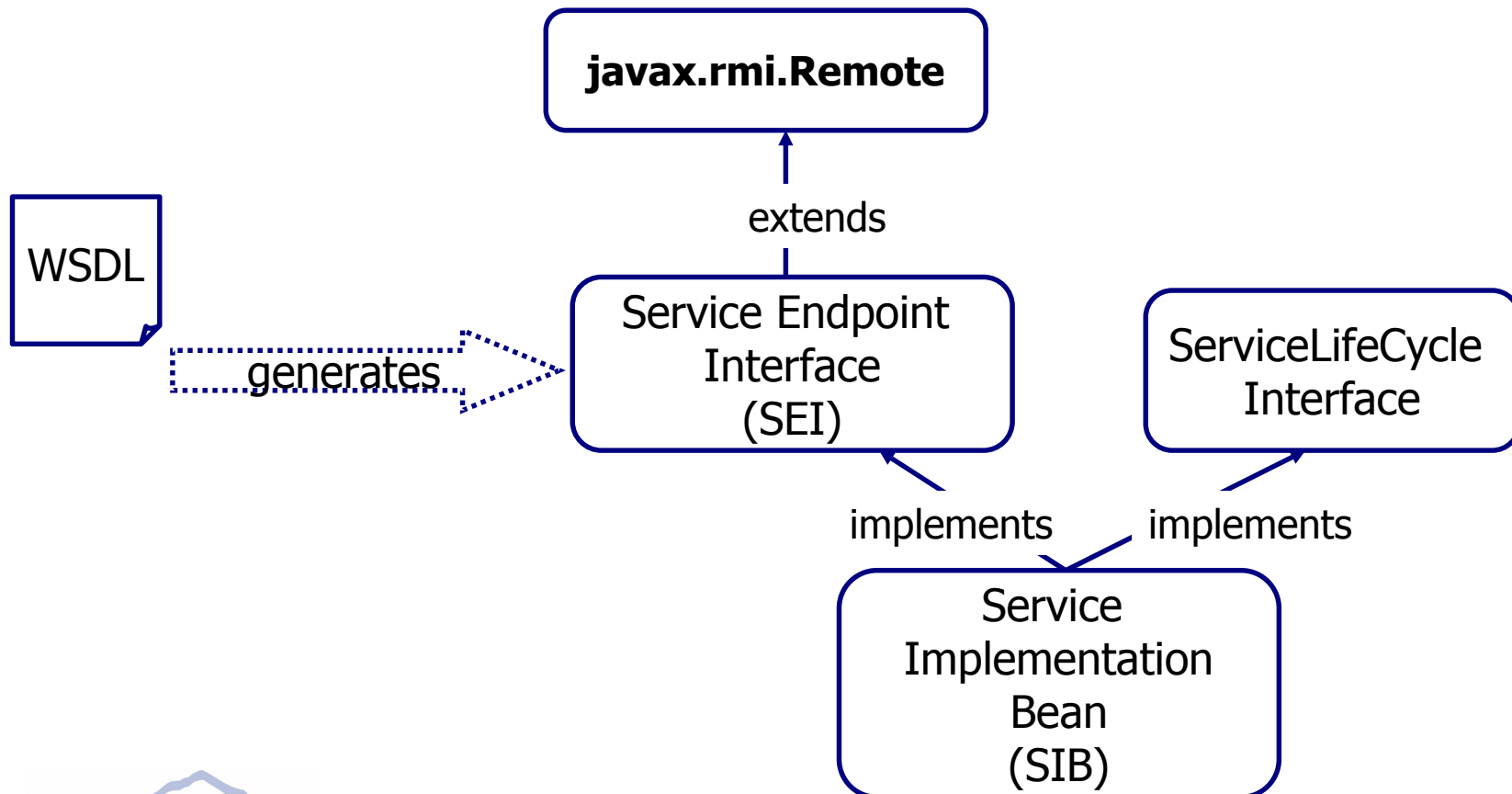




Analogies to EJBs

- The JAX-RPC approach is analogous to the EJB (or RMI) approach in a number of ways
- A **Service Endpoint Interface** (SEI) is analogous to the Remote interface of an EJB
 - Both the Stub and the Service Implementation implement the methods of the SEI
 - If the service implementation is an EJB, it does not directly implement the SEI interface, just as the EJB does not directly implement the remote interface
 - The Service Implementation is thus analogous to the Bean Implementation of an EJB
- Service Factories (and Services) are analogous to the EJB Homes
 - You obtain stubs from them – they are factories of remote objects

Service Implementation Interface Hierarchy





WSDL Document Overview

- **Definition**
 - The root of the WSDL document
 - Contains the definition of one or more services
 - Usually contains attributes
- **Service**
 - Defines the service
- **Messages and PortTypes**
 - Describes the actions available for the service
- **Bindings**
 - How to communicate with the service



WSDL Review

A WSDL document defines Web Service *via*:

Messages

Defines a single interaction with the service

Types

Defines data types used in a message

Operations

Description of an action

Port Types

Describes the set of operations supported by the service.

Bindings

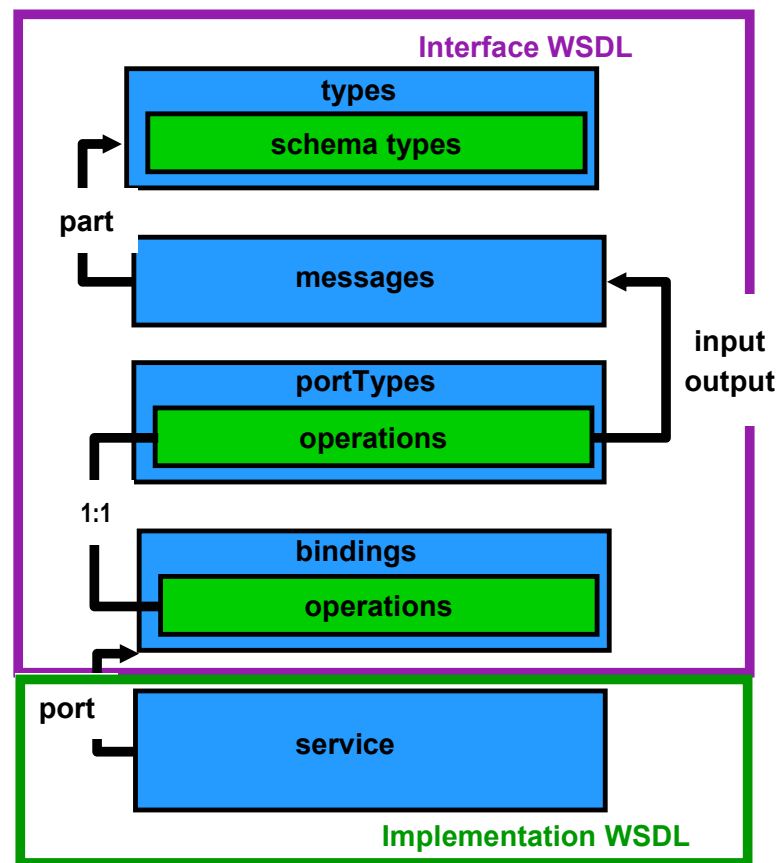
A concrete protocol and data format for a particular port type.

Port

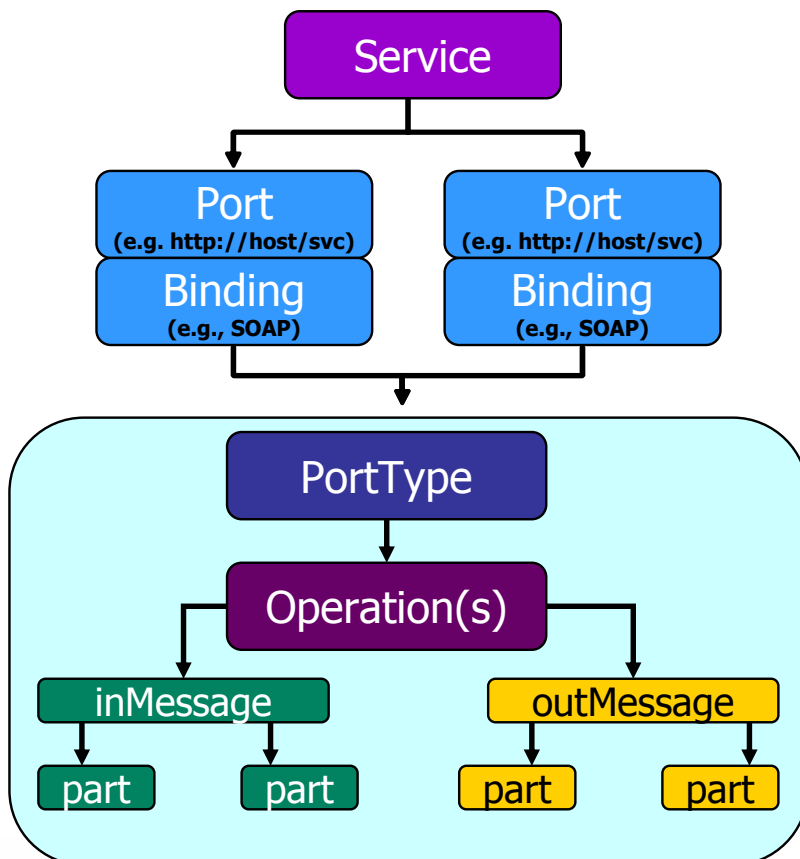
Describes the network address where the service is being hosted.

Service

Ties together all the elements of the service.



WSDL and JAX/RPC



Abstract definition of the service

Service Implementation Bean (SIB)

Client API for invoking services

Service Endpoint Interface (SEI)

Method(s)

Method Parameters

Method Return values

Java Objects



WSDL <-> Java Mapping (JAX-RPC)

- Each WSDL <portType> element is mapped to a Java interface.
 - Called the “Service Endpoint Interface” or SEI.
 - This interface must extend `java.rmi.Remote`.
 - Its package name can be derived from the namespace of the <portType> element and vice versa.
- Each <operation> within the <portType> is mapped to a Java method in the service endpoint interface.
 - Every method must throw `java.rmi.RemoteException`.
- The <message> elements of the <operation> are mapped to parameters and return types of the methods of the service endpoint interface.
- The types in the parts map to Java types
 - Complex types must implement `Serializable`
 - JAX-RPC does not define a pass-by-value semantic thus requiring parameters to be serializable

WSDL Interface <-> Java Interfaces and Classes

```
<?xml version="1.0"?>
<definitions name="StockQuoteService interface" ...>
  <message name="SymbolRequest">
    <part name="return" type="xsd:string"/>
  </message>
  <portType name="StockQuotePortType">
    <operation name="getQuote">
      <input message="tns:SymbolRequest"/>
      <output message="tns:QuoteResponse"/>
    </operation>
  </portType>
  <binding name="StockQuoteServiceBinding" type="tns:StockQuotePortType">
    <soap:binding style="rpc" transport="http://schemas.xmlsoap.org/soap/http"/>
    :
  </binding>
  <service name="StockQuoteService">
    <port name="StockQuotePort" binding="intf:StockQuoteServiceBinding">
      <soap:address location="http://hostname/StockQuote/services/StockQuotePort"/>
    </port>
  </service>
</definitions>
```

WSDL

```
public interface StockQuotePortType
  extends java.rmi.Remote
{
  public float getQuote(java.lang.String in0)
    throws java.rmi.RemoteException;
}
```

Service Endpoint Interface

```
public interface StockQuoteService
  extends javax.xml.rpc.Service
{
  public StockQuote getStockQuotePort()
    throws javax.xml.rpc.ServiceException;
}
```

Service Interface





Service Interface

- Service Interface
 - A java representation of the Web Service
 - Must implement the `javax.xml.rpc.Service` interface
 - Can be used to generate
 - A Stub class
 - A Dynamic Proxy
 - A `javax.xml.rpc.Call` object





Service Interface and SEI

```
package sample;

public interface StockQuoteService extends javax.xml.rpc.Service
{
    public java.lang.String getPurchaseAddress();
    public sample.PurchasePortType getPurchase()
        throws javax.xml.rpc.ServiceException;
    public sample.PurchasePortType getPurchase(java.net.URL portAddress)
        throws javax.xml.rpc.ServiceException;
    public java.lang.String getQuoteAddress();
    public sample.GetQuotePortType getQuote() throws javax.xml.rpc.ServiceException;
    public sample.GetQuotePortType getQuote(java.net.URL portAddress)
        throws javax.xml.rpc.ServiceException;
}
```

Service Interface

```
package sample;

public interface GetQuotePortType extends javax.rmi.Remote
{
    public sample.Price getQuote(sample.Ticker parameter)
        throws java.rmi.RemoteException;
}
```

Service Endpoint Interface



JAX-RPC

Server Programming Model

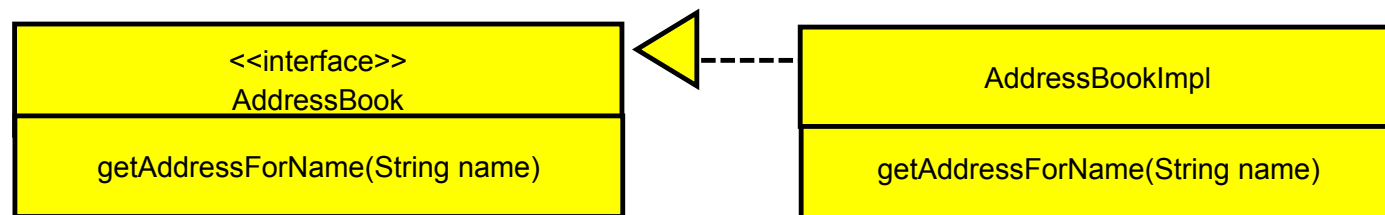
- Port components
 - Service Endpoint Interface (SEI)
 - Service Implementation Bean (SIB)
- Service Implementation Bean
 - Implements the SEI
 - Must be stateless
 - May implement the ServiceLifecycle interface for managing the service's life cycle
- EJB tier (JSR109 defines)
 - SIB must also be a Stateless Session Bean
 - Implementing of the SEI *is not required*
 - Discouraged because SEI methods throw RemoteException
- Web Tier
 - Java Bean implementation



Provider

Implementing a JAX/RPC service

- A Quick example will probably best show how the pieces fit.
- Imagine that we want an AddressBook Web Service
 - Can get Addresses for a person's name
- Begin by creating an implementation (either a Stateless Session Bean or a Java Bean) and then creating an SEI for the exposed methods
 - In our example we will call the SEI AddressBook and the Implementation AddressBookImpl
 - The bean implementation must implement (through the implements keyword) the SEI but EJBs don't have to actually implement the SEI, but it can (but the method signatures must match – much like with EJB's)



Provider



JAX/RPC Server Example

```
public interface AddressBook extends java.rmi.Remote {  
    public Address getAddressForName(String name);  
}
```

Service Endpoint
Interface (SEI)

```
public class AddressBookImpl implements AddressBook {  
    public Address getAddressForName(String name)  
        throws RemoteException {  
        // fill in implementation here  
    }  
}
```

Service Implementation
Bean (SIB)

```
public class Address implements java.io.Serializable {  
    int name;  
    String streetAddress;  
    ...  
    // getters and setters not shown
```

Java classes which are
mapped to XML must
implement Serializable

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JAX-RPC and Encoding

- There are two options for the style of a message and (at least) two for the type encoding used in that message.
 - RPC Style and SOAP Encoding (rpc/encoded)
 - RPC Style and Literal Encoding (rpc/literal)
 - Document Style and SOAP Encoding (doc/encoded)
 - Document Style and Literal Encoding (doc/literal)

Style (SOAP message body format)	Mode (parameter encoding)	JAX-RPC related information
Document (uses a schema to define body format)	Literal (uses XML Schema for each parameter encoding)	Required
Document	Encoded (using SOAP Section 5 encoding)	Optional
RPC (using SOAP Section 7 rules to define body format)	Encoded	Required
RPC	Literal	Optional

Type Mapping

-Primitive Types

XML Schema Type	Java Type
xsd:string	java.lang.String
xsd:integer	java.math.BigInteger
xsd:int	int
xsd:long	long
xsd:short	short
xsd:decimal	java.math.BigDecimal
xsd:float	float
xsd:double	double
xsd:byte	byte
xsd:QName	javax.xml.namespace.QName
xsd:dateTime	java.util.Calendar
xsd:base64Binary	byte[]
xsd:hexBinary	byte[]

- JAX-RPC does not dictate a specific Java mapping for `xsd:anyType` until JAX-RPC 1.1
- XML Schema simple types which map to Java base types map to the Java wrapper classes instead when an element is marked as nillable in the XML Schema.

Example:

```
<xsd:element name="code"
type="xsd:int" nillable="true" />
```

Maps to: *java.lang.Integer*



JAX-RPC 1.1

xsd:unsignedInt	long
xsd:unsignedShort	int
xsd:unsignedByte	short
xsd:date	java.util.Calendar
xsd:time	java.util.Calendar
xsd:anyURI	java.net.URI (J2SE 1.4 only) java.lang.String
xsd:anySimpleType	java.lang.String
xsd:duration	java.lang.String
xsd:gYearMonth	java.lang.String
xsd:gYear	java.lang.String
xsd:gMonthDay	java.lang.String
xsd:gDay	java.lang.String
xsd:gMonth	java.lang.String

xsd:normalizedString	java.lang.String
xsd:token	java.lang.String
xsd:language	java.lang.String
xsd:Name	java.lang.String
xsd:NCName	java.lang.String
xsd:ID	java.lang.String
xsd:NMTOKEN	java.lang.String
xsd:NMTOKENS	java.util.List
xsd:nonPositiveInteger	java.math.BigInteger
xsd:negativeInteger	java.math.BigInteger
xsd:nonNegativeInteger	java.math.BigInteger
xsd:positiveInteger	java.math.BigInteger
xsd:unsignedLong	java.math.BigInteger





SOAP Encoded Type Mapping

SOAP Encoded Simple Type	Java Type
soapenc:string	java.lang.String
soapenc:boolean	java.lang.Boolean
soapenc:float	java.lang.Float
soapenc:double	java.lang.Double
soapenc:decimal	java.math.BigDecimal
soapenc:int	java.lang.Integer
soapenc:short	java.lang.Short
soapenc:byte	java.lang.Byte
soapenc:base64	byte[]

 Note: the SOAP encoded types are all nillable, so they are mapped to the Java wrapper classes



Complex Type Mapping

- XML Arrays
 - XML Arrays are mapped to Java arrays
 - Types of XML Arrays that are mapped
 - Arrays declared using `wsdl:arrayType` or `soapenc:Array`
 - Not recommended by the WS-I Basic Profile
- XML Enumeration
 - Mapped to Java class following enumeration pattern





Complex Type Mapping

- XML Struct / Complex Type
 - xsd:complexType with sequence of elements with simple/complex type
 - xsd:complexType with xsd:all of elements of simple/complex type
 - Mapped to Java classes (called JAX-RPC Value types)
 - with getters and setters to access each element in the complex type
 - must have public default constructor
 - must implement java.io.Serializable
 - not required to be a JavaBean
 - may not implement java.rmi.Remote
 - Notes:
 - no sequencing maintained in Java class
 - if maxOccurs on element > 1, maps to an Array for the element
 - XML element attributes not specified, maps to SOAPElement





Complex Type Mapping

```
<xsd:complexType name = "Book">
  <sequence>
    <element name="author"
      type="xsd:string"
      maxOccurs="10" />
    <element name="price"
      type="xsd:float" />
  </sequence>
</xsd:complexType>
```

XMLSchema Fragment



```
Public class Book {
  private float price;
  private String[] author;

  String[] getAuthor() {.....}
  public setAuthor(String[] author)
  {.....}

  public float getPrice() {.....}
  public void setPrice(float price)
  {.....}
}
```

Java



Enumeration Mapping

```
<simpleType
  name="EyeColorType">
  <restriction base="xsd:string">
    <enumeration
      value="green"/>
    <enumeration
      value="blue"/>
  </restriction>
</simpleType>
```

XMLSchema Fragment

```
public class EyeColorType {
  // Constructor
  protected EyeColorType(String value) { ... }

  public static final String _green = "green";
  public static final String _blue = "blue";
  public static final EyeColorType green =
    new EyeColorType(_green);
  public static final EyeColorType blue =
    new EyeColorType(_blue);

  public String getValue() { ... }
  public static EyeColorType fromValue(String value)
    { ... }

  public boolean equals(Object obj) { ... }
  public int hashCode() { ... }
  // ... Other methods not shown
}
```

Java



JAX-RPC and Literal Encoding

- If JAX-RPC specifies a mapping for the XML type of a message part
 - That mapping is used
- If there is no JAX-RPC mapping for the XML type of the message part
 - An implementer of `javax.xml.soap.SOAPElement` is used
 - `SOAPElement` interface comes from SAAJ and provides a DOM-like API for manipulating SOAP messages
- This is true for document or rpc style





JAX/RPC parameter modes

- *IN type:*
 - An *IN* parameter is passed as a copy. The value of the *IN* parameter is copied before a Web service invocation. The return value is created as a copy and returned to the Web service client.
- *OUT type:*
 - An *OUT* parameter is passed as a copy without any input value to the Web service method. The Web service method fills out the *OUT* parameter and then returns it back to the client.
- *IN OUT type:*
 - An *INOUT* parameter is passed as a copy with an input value to the Web service method. The Web service method uses the input value, process it, fills in the *INOUT* parameter with a new value and returns it back to the client.



Holder Classes

- WSDL allows for “in/out” parameters to operations
 - parts that appear both in the input and output message
 - service client uses the Holder class instance to send the values of either the out or the in/out parameter.
 - The contents of the Holder class are modified by the remote method calls and the service client can use this changed content after the method invocation.
- in/out parameters are mapped to Holder Classes
- Holder classes implement `javax.xml.rpc.Holders.Holder`





Holder Classes

- Holder Classes for primitive types
 - Named according to the following convention:
 - float's holder is `javax.xml.rpc.holders.FloatHolder`
 - float's holder wrapper is
`javax.xml.rpc.holders.FloatWrapperHolder`
- Holder classes are generated for all other XML types
 - For complex XML data types, the name of the Holder class is constructed by
 - appending Holder to the name of the corresponding Java class
 - example: `com.example.holders.BookHolder`.
 - Holder has a field `value` with the type of the mapped Java class
 - Public constructor that sets `value` to the constructor argument



Holder Classes Example – Sample WSDL

```
<xsd:complexType name="Authors">
  <xsd:all>
    <xsd:element name="Authors" type="typens:AuthorArray"/>
  </xsd:all>
</xsd:complexType>

<message name="AuthorPresentRequest">
  <part name="Authors" type="typens:Authors"/>
</message>
<message name="AuthorPresentResponse">
  <part name="return" type="xsd:boolean"/>
  <part name="Authors" type="typens:Authors"/>
</message>
<portType name="AcmeAuthorPresentPortType">
  <operation name="IsAuthorPresent">
    <input message="typens:AuthorPresentRequest"/>
    <output message="typens:AuthorPresentResponse"/>
  </operation>
</portType>
```

You can see that the input and output messages contain an Authors type as a parameter. This is the in/out style of parameter passing.



Holder Classes Example – Mapped Java

Holder class Definition

```
public final class AuthorsHolder implements javax.xml.rpc.holders.Holder {  
    public com.acme.www.Authors value;  
    public AuthorsHolder() {}  
    public AuthorsHolder(com.acme.www.Authors value) {  
        this.value = value; }  
}
```

Java Service Endpoint Interface

```
public interface AcmeAuthorPresentPortType extends java.rmi.Remote {  
    public boolean isAuthorPresent(AuthorsHolder authors) throws  
        java.rmi.RemoteException;  
}
```

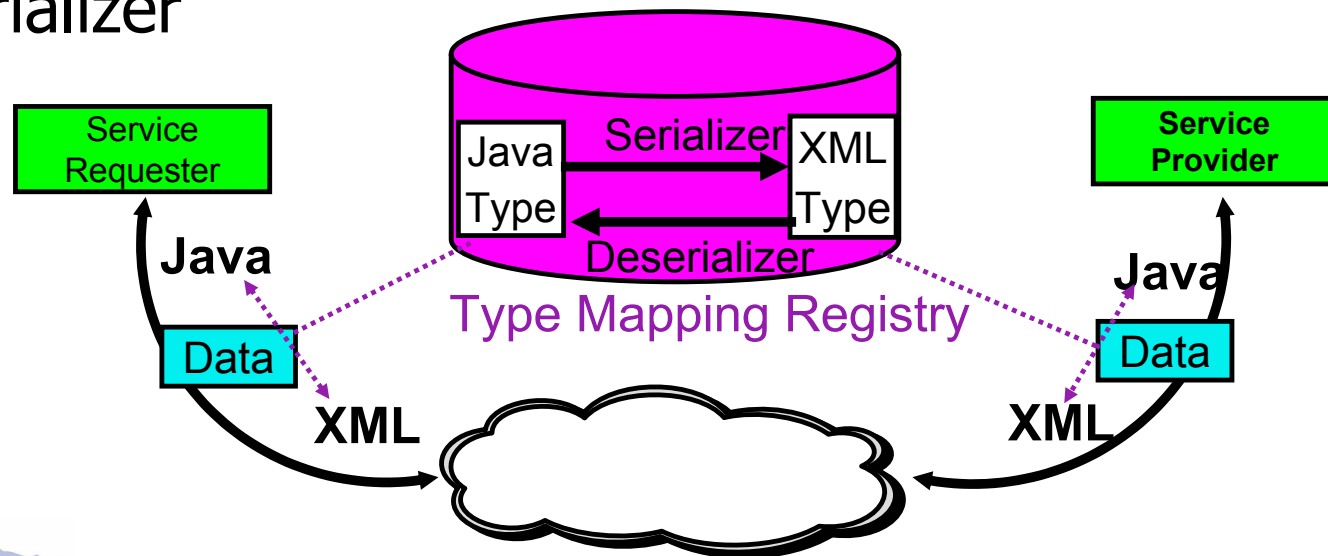


Parameter Mappings

Parameter defined in	Parameter style	Possible JAX-RPC mapping classes	Sample JAX-RPC mapping class
wSDL:input	in	Wrapper classes or JavaBeans	java.lang.Integer
wSDL:output	out	Holder class	IntHolder, StringHolder, etc.
wSDL:input and wSDL:output	inout	Holder class	IntHolder, StringHolder, etc.

JAX-RPC Type Mapping Framework

- TypeMappingRegistry
- TypeMapping
- Serializer
- Deserializer





Type Mapping / Custom Serialization

- JAX-RPC defines interfaces which a vendor may provide implementations for to support custom serializers
- JAX-RPC does not specify the XML processing model to be used
- A vendor would extend the Serializer and Deserializer interfaces to support a specific XML processing mechanism (ex. SAX)



Type Mapping / Custom Serialization

- **TypeMappingRegistry** interface is how you lookup type mapping for a Java class or XML type
- **TypeMapping**
 - Maps between
 - `JavaType (Class)`
 - `XML Type (QName)`
 - `javax.xml.rpc.encoding.SerializerFactory`
 - `javax.xml.rpc.encoding.DeserializerFactory`
- **Serializer**
 - Implements `javax.xml.rpc.encoding.Serializer`
- **Deserializer**
 - Implements `javax.xml.rpc.encoding.Deserializer`
- **Get the registry for a service from**
 - `getTypeMappingRegistry()` on `javax.xml.rpc.Service`





SOAP with Attachments

- MIME Types are mapped to Java types according to WSDL MIME binding
- To create an attachment, pass one of the mapped Java types as a parameter or return value
- You may also pass `javax.activation.DataHandler` to handle types not included in the JAX-RPC mapping (implementation dependent).

MIME Type	Java Type
image/gif	<code>java.awt.Image</code>
image/jpeg	<code>java.awt.Image</code>
text/plain	<code>java.lang.String</code>
multipart/*	<code>javax.mail.internet.MimeMultipart</code>
text/xml application/xml	<code>javax.xml.transform.source</code>



JAX-B (JSR31)

- Java API for XML Binding
 - Initially part of JAXM
- Java data binding facility that compiles an XML schema into one or more Java classes
- Interface oriented
 - binding compiler that binds components of a *source schema* to schema-derived Java *content classes*
 - establish conventions for annotating classes with the necessary metadata.
 - standard way to customize the binding of existing schema's components to Java
- Binding framework – APIs for
 - *unmarshalling* of an XML document into a tree of interrelate instances of both existing and schema-derived classes,
 - *marshalling* of such *content trees* back into XML
 - *validation* of content trees against the constraints expressed in the schema.





JAX-RPC and JAXB

- According to the JAX-RPC 1.1 specification draft
 - You may or may not use JAXB for for converting Java to XML
 - JAXB does however have some impact on type mapping
 - In order to make it possible to use other binding frameworks in JAX-RPC
 - It must be possible to selectively turn the standard JAX-RPC mapping off on a per part basis
 - JAX-RPC tools are required to provide a facility for specifying metadata for this purpose



SOAP Attachments API for Java

- Used in Handler infrastructure to manipulate XML-based SOAP messages (SOAPMessage/SOAPEnvelope/SOAPElement/...)
- Used to render literal XML snippets (SOAPElement)
- Can be used in a stand-alone environment to create SOAP-based messages
 - Including adding Attachments in contained MIME envelope structure



SAAJ 1.1 → 1.2

- The SAAJ 1.1 interfaces are still valid.

f For SAAJ 1.2,

f SAAJ 1.1 interfaces implement DOM.

f Thus the SAAJ tree can now be manipulated with DOM apis.

f Interface `javax.xml.soap.Node` now extends `org.w3c.dom.Node`.

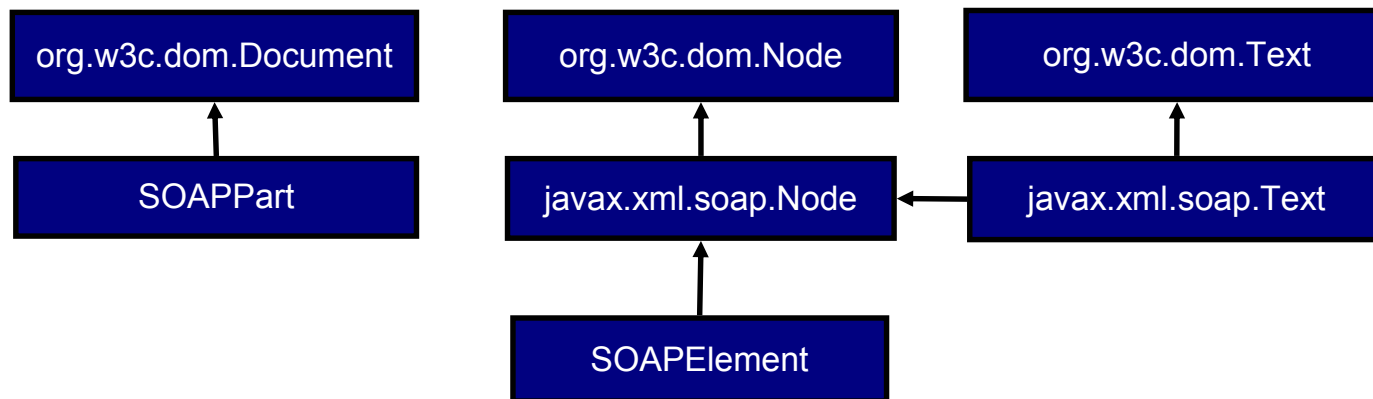
f Interface `javax.xml.soap.SOAPElement` now extends `org.w3c.dom.Element`.

f Abstract class `javax.xml.soap.SOAPPart` now implements `org.w3c.dom.Document`.

f Interface `javax.xml.soap.Text` now extends `org.w3c.dom.Text`.

SAAJ 1.2

- **SAAJ 1.2 contains new APIs and binds the SAAJ APIs to Document Object Model (DOM) APIs**
 - The new APIs focus on ease of use and Java Doc support.
 - The SOAPPart of a SOAP message is now also a level 2 DOM document.
 - An object model is a mechanism for accessing a document





Exception Handling

- JAX-RPC specification addresses Web Service run-time (application and system) exceptions
 - Based on the standard approach to service endpoint interface design and its mapping to `wsdl:fault` elements
 - service-specific exceptions are declared in the `wsdl:fault` element, and these exception types are derived from the `java.lang.Exception` class

```
<wsdl:portType name="Transfer_SEI">
  <wsdl:operation name="transferFunds" parameterOrder="fromAcctId toAcctId
amount">
    <wsdl:input name="transferFundsRequest"
        message="impl:transferFundsRequest"/>
    <wsdl:output name="transferFundsResponse"
        message="impl:transferFundsResponse"/>
    <wsdl:fault name="InsufficientFundsException"
        message="impl:InsufficientFundsException" />
  </wsdl:operation>
</wsdl:portType>
```




JAX-RPC 1.1

- Published October 14, 2003
- Part of J2EE 1.4
- Mainly changes to comply with WS-I BP 1.0
 - *e.g.* mandatory support for rpc/literal
- Plus many clarifications and minor fixes for 1.0 spec
 - *e.g.* <xsd:any/> mapped to SOAPElement
 - *e.g.* requirement to map any element to SOAPElement
 - Attributes on complex types must be mapped to properties of JavaBean class





JAX-RPC 1.1

- New <simpleType> to Java mappings
 - f* new set of primitives
 - f* new mapping for simpleTypes derived by restriction
- Required mapping for <list>.
 - <list> maps to an array.
- Unknown optional types must map to SAAJ SOAPElement
- ServiceFactory.loadService methods
- ServletEndpointContext.isUserInRole method
- WSDL faults can have elements as well as types
- Generated Service.get<Name_of_wsdl:port>
- Additional name collision rules
- One way operations from Java void methods



JAX-RPC Runtime Services

- Provided *via* property interface on Stub and Call interfaces

- HTTP Basic Authentication
 - `javax.xml.rpc.security.auth.username` (String)
 - `javax.xml.rpc.security.auth.password` (String)
 - No other HTTP authentication forms are required

- HTTP Session Management
 - `javax.xml.rpc.session.maintain` (boolean)





JAX-RPC Handlers



Client &
Provider

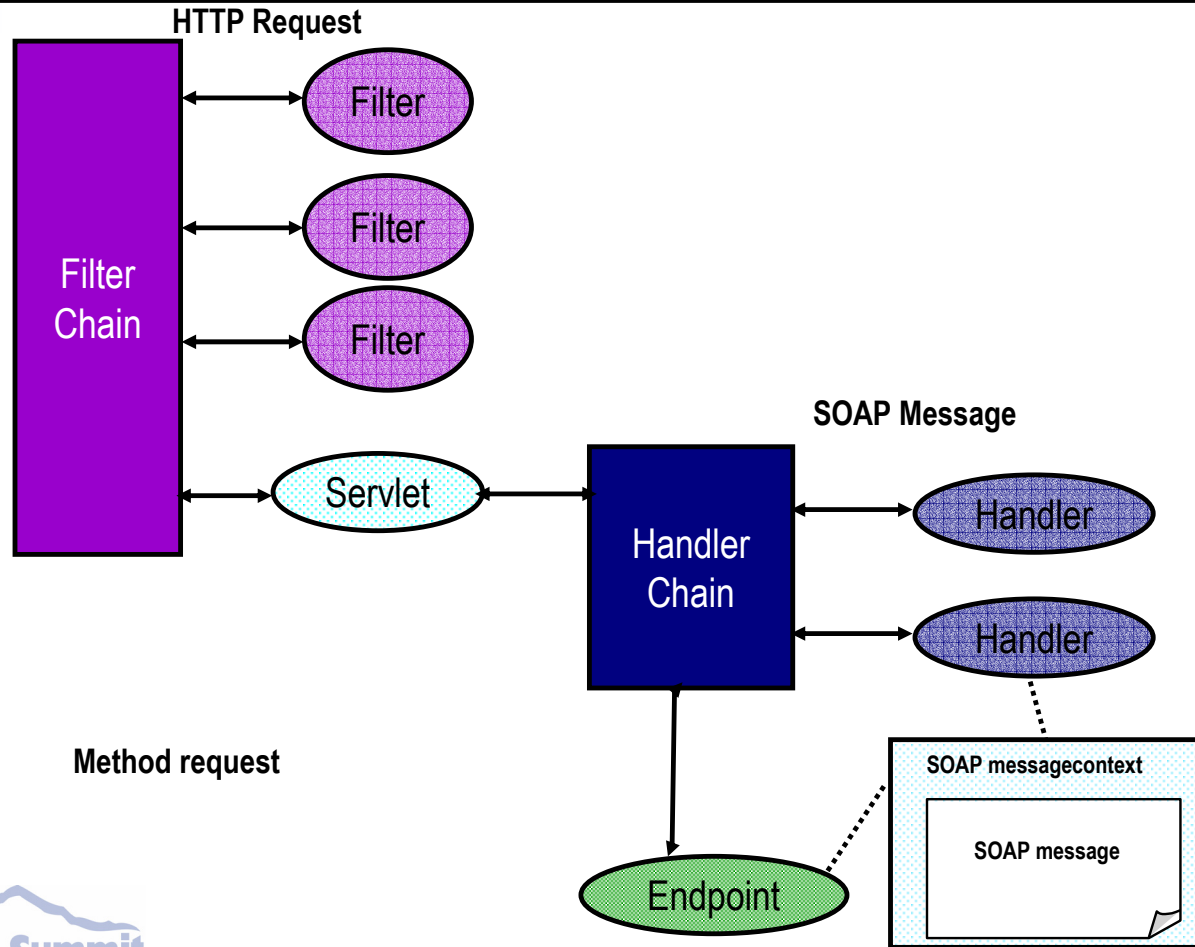
JAX-RPC Handlers

- Provides a mechanism for intercepting the SOAP message and operating on header information
 - Can examine and potentially modify a request before it is processed by a Web Service component.
 - Can examine and potentially modify the response after the component has processed the request
- Conceptually, similar to Servlet 2.3 Filter
- Can be provided for both the client and server
- Handler **MUST NOT CHANGE** SOAP message, Operation name, number of parts in the message, or types of the message parts
 - SOAP Fault is send if Handler does this
- Handlers are configured into 'ordered chains'
 - Client side Handlers run after the Stub/proxy has marshaled the message, but before container services and the transport binding occurs.
 - Server side Handlers run after container services have run including method level authorization, but before demarshalling and dispatching the SOAP message to the endpoint.

■ Handler chains (handlers) are service specific

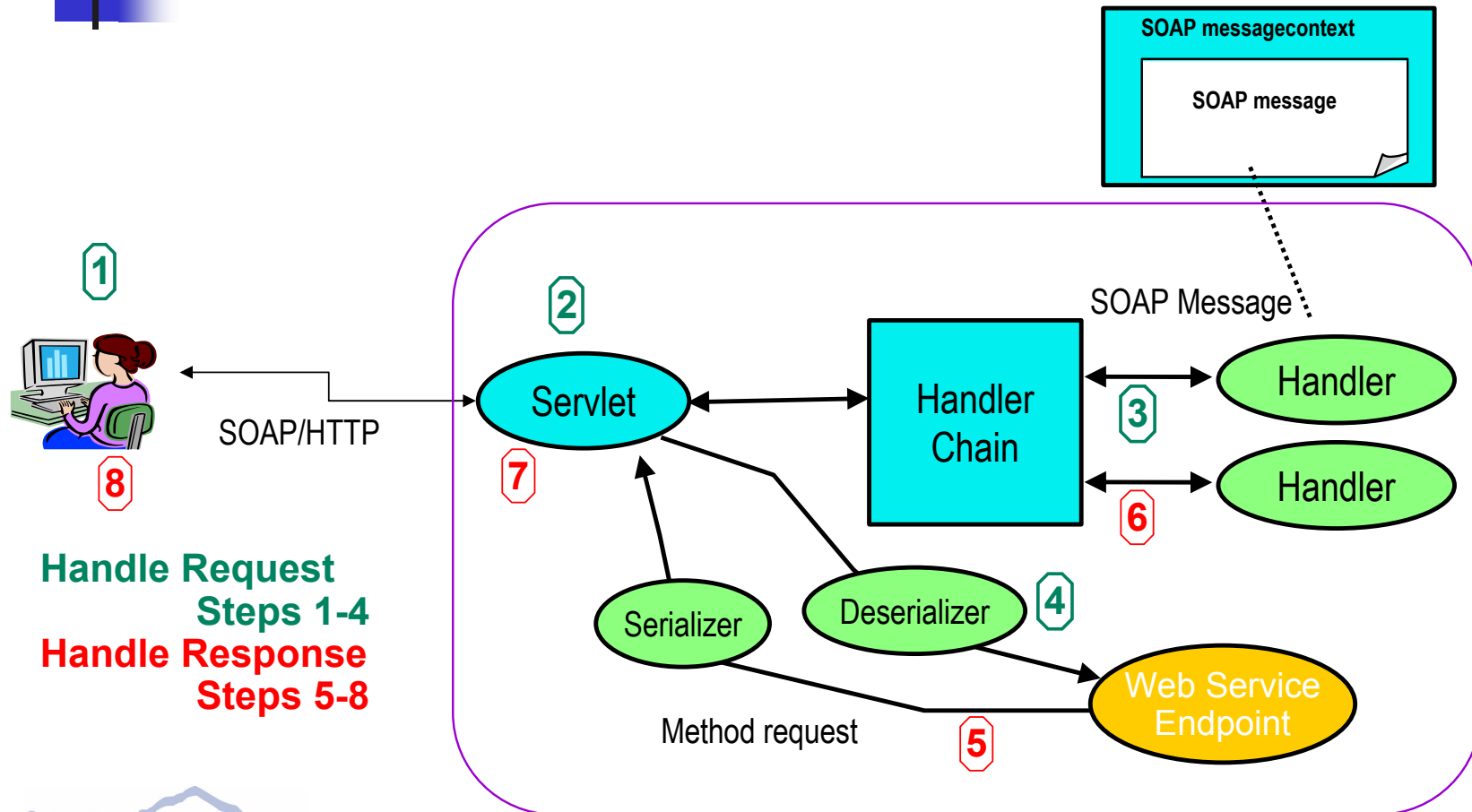


JAX RPC Handler Architecture



Provider

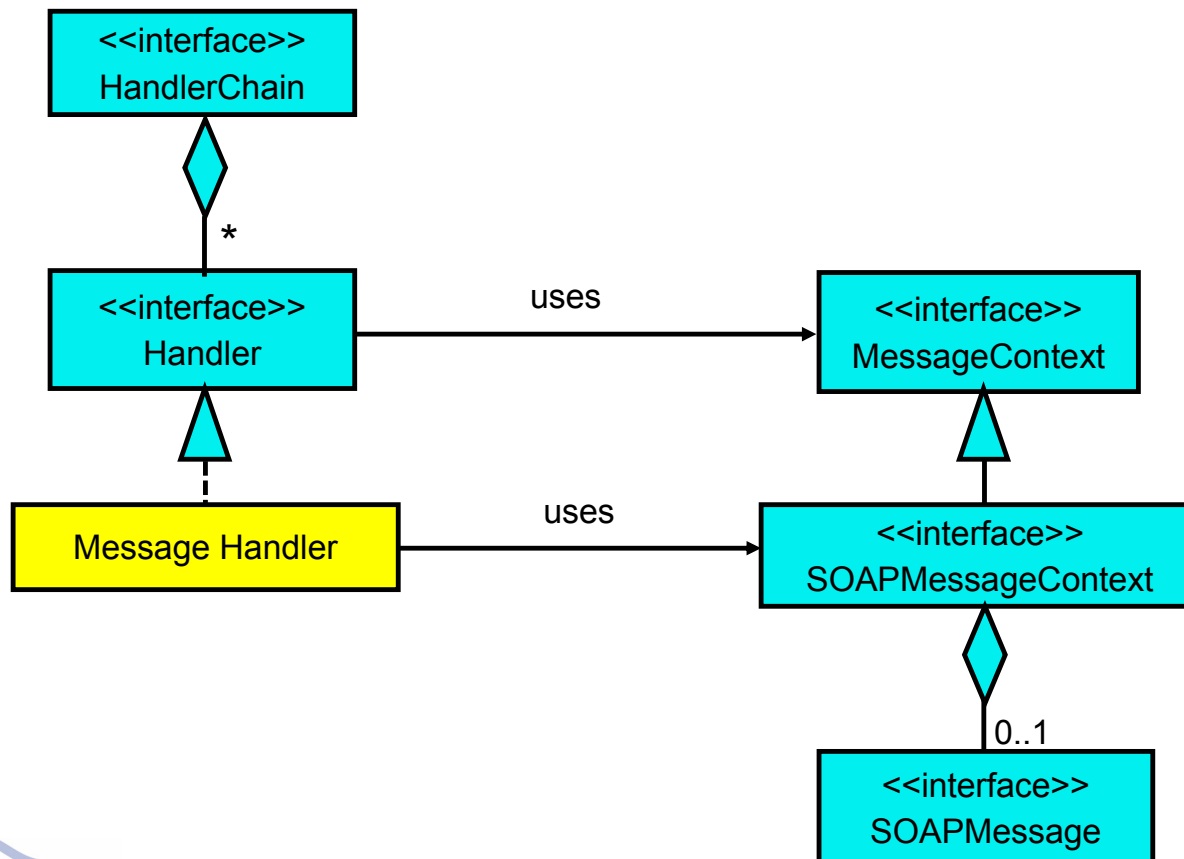
End to End Flow for SOAP/HTTP



Handle Request
Steps 1-4
Handle Response
Steps 5-8



Handler Class Hierarchy





Handler Configuration

- Handlers are configured programmatically *via* `HandlerRegistry`
 - The `HandlerRegistry` is available *via* the `getHandlerRegistry` method on `Service`
 - `HandlerRegistry` has methods to
 - `getHandlerChain`
 - `setHandlerChain`

- J2EE Deployment Descriptor for Handlers (JSR109)



Handler Interface

```
package javax.xml.rpc.handler;  
public interface Handler(){  
    boolean handleRequest(MessageContext ctx);  
    boolean handleResponse(MessageContext ctx);  
    boolean handleFault(MessageContext ctx);  
}
```





Header Handling

- The `handleRequest()` method does the following
 - Return `true` to indicate that the processing of the handler chain should continue
 - Return `false` to indicate that the handler chain is blocked.
 - Processing continues in on the `handleResponse()` method of this handler instance and the handlers backward in the chain
 - Throw a `JAXRPCException` or other `RuntimeException` for a runtime error (in which case the `HandlerChain` will generate a SOAP Fault)
- The `handleResponse()` mechanism is similar, except for the processing false case
 - After blocking (return false), no other handlers will be processed



Handler Chains

- A Handler is associated with a SOAP header block using the qualified name of the outermost element of each header block
- A Handler chain performs the following steps during SOAP processing
 - Identify the set of SOAP actor roles in which this handler chains is to act
 - Identify all mandatory header blocks for this role
 - If one or more of the mandatory blocks are not handled by this node then generate a SOAP MustUnderstand fault
 - Otherwise, process all the header blocks by invoking the chain of handlers
 - If processing is unsuccessful, generate exactly one SOAP fault to propagate to the client



Handler Caveats

- Usually need to be defined in pairs (client, server)
- Client cannot communicate requirements to server handler and vice-versa
 - Not described in WSDL
- Client cannot alter the signature, hence, can't change the operation or type
- Customers need to consider performance issues
 - Cost associated with each Handler



JSR109 – Enterprise Services Programming Model





JSR-109 – Enterprise Web Services

- Often known as 'Web Services for J2EE' or just JSR109
 - Spec actually calls it 'Web Services for J2EE' !
- Began as V1.0 (JSR109)
 - An addition to J2EE 1.3
- V1.1 added WS-I Basic Profile support and bug fixes (JSR 921)
- V1.1 specification released January 23rd 2004
 - Required by J2EE 1.4



JSR-109 – Enterprise Web Services

- Key Web Services Objective
 - Achieve interoperability across heterogeneous platforms and runtimes
- Basically filling the gaps that the JAX-RPC specification left open for use of Web services in a J2EE Application Server
- JSR 109 – Web Services for J2EE
 - Facilitates the building of interoperable Web Services in J2EE
 - Standardization of the the deployment of Web Services in a J2EE container
 - Specifically addresses
 - Client Access to Web Services
 - Web Service Lifecycle
 - Web Service Deployment





JSR 109 – Features

- Basically filling the gaps that the JAX-RPC specification left open for use of web services in a J2EE Application Server
- Standard Web Services Deployment Descriptors
- Defines a J2EE compliant deployment/packaging model for Web Services on the server side and for the client
 - New deployment descriptors for web services
- Server-side programming model
 - Stateless Session EJB as implementation of a web service
 - Entity and Stateful cannot
- Client-side programming model
 - EJB, Servlet/JSPs, Application Client as client to Web Services



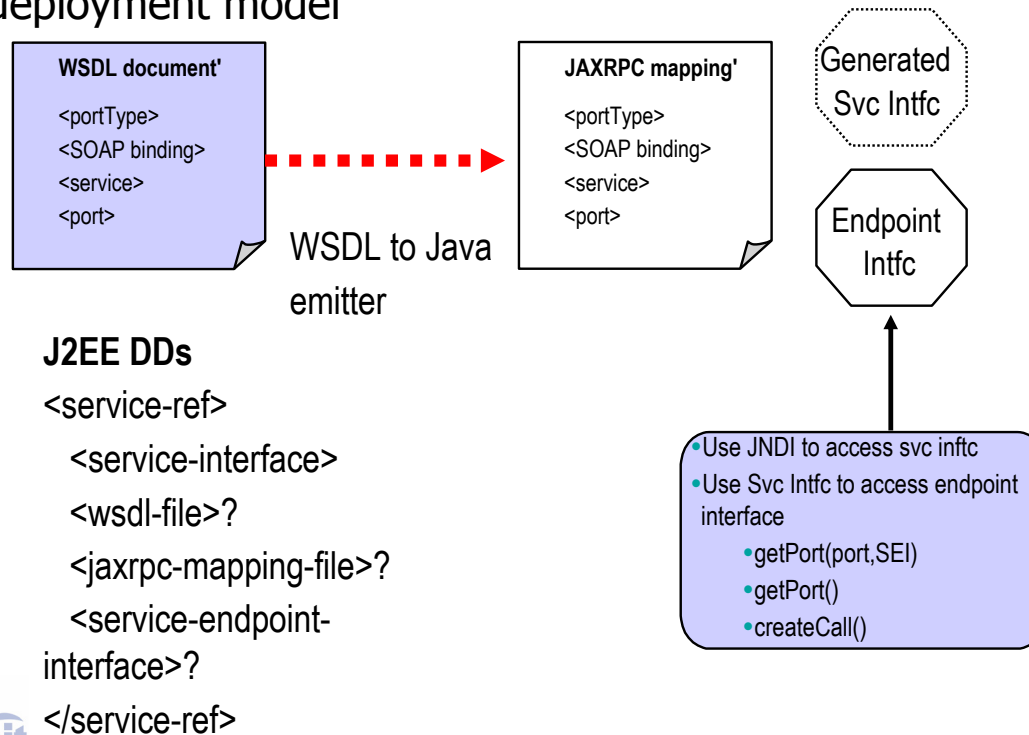


JSR 109 – Features

- J2EE Container required
- The SEI acts like the EJB's remote interface (or it must contain a subset of the remote interface's methods)
- The application server (WebApp for HTTP) must route incoming SOAP requests to the appropriate EJB
- New deployment descriptors are defined
- Integrating Handlers into a J2EE container environment
 - Lifecycle
 - Declaration (deployment descriptors)

Overview

- Defines web services support within a J2EE environment
- Leverages JSR 101 work
- Defines a J2EE programming model
- Defines a deployment model





Service Programming Models





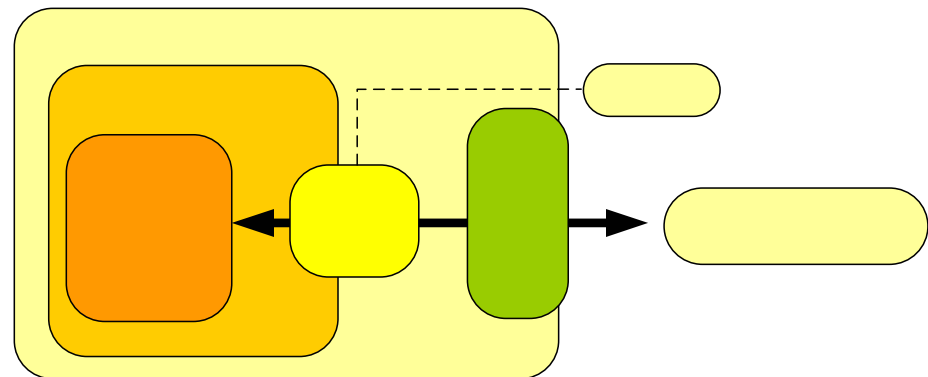
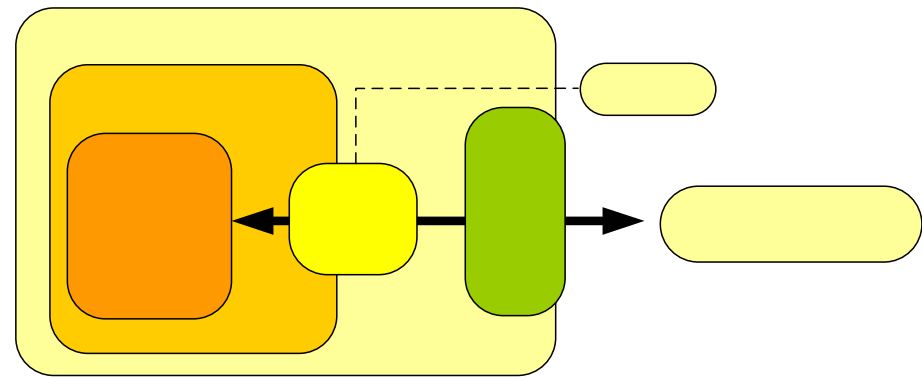
JSR-109 Server Programming Model

- Attempts to standardize the deployment of Web Services
- Defines deployment of
 - Servlet based implementation bean in a Web Container
 - Stateless Session EJB implementation in an EJB container
- Use of the Service Endpoint Interface (SEI) defined by JAX-RPC
 - Defines the method signatures of the Web Service
 - Must follow the Java and WSDL mapping rules defined by JAX-RPC



Server Side Programming

- Port defined the Server view of Web Service
- Port component services the operations defined in WSDL
- Port component has Service Endpoint Interface and Service Implementation that implements the Interface
- Service Implementation can be
 - Stateless Session EJB
 - Java Bean (also referred to as JAX-RPC Service Endpoints)





JSR-109 Service Bean Implementation

- The Service Implementation Bean must
 - Implement all the methods defined by the SEI
 - For EJBs
 - SEI methods must be a subset of the remote interface methods
- The application server (WebApp for HTTP) must route incoming SOAP requests to the appropriate Service Bean Implementation
 - New deployment descriptors are defined
- The Service Implementation Bean and state
 - The container may create and pool multiple instances of the bean to optimize request handling
 - Thus carrying state may be questionable and risky





JSR-109 Service Bean Implementation

- WSDL is used as the contract for the Web Service
- The WSDL to SEI mapping **MUST** follow the Java and WSDL mapping rules defined by JAX-RPC





Service LifeCycle

- LifeCycle is controlled by the associated container
- In general, life cycle phases are
 - Instantiation
 - Initialization
 - Execution
 - Removal

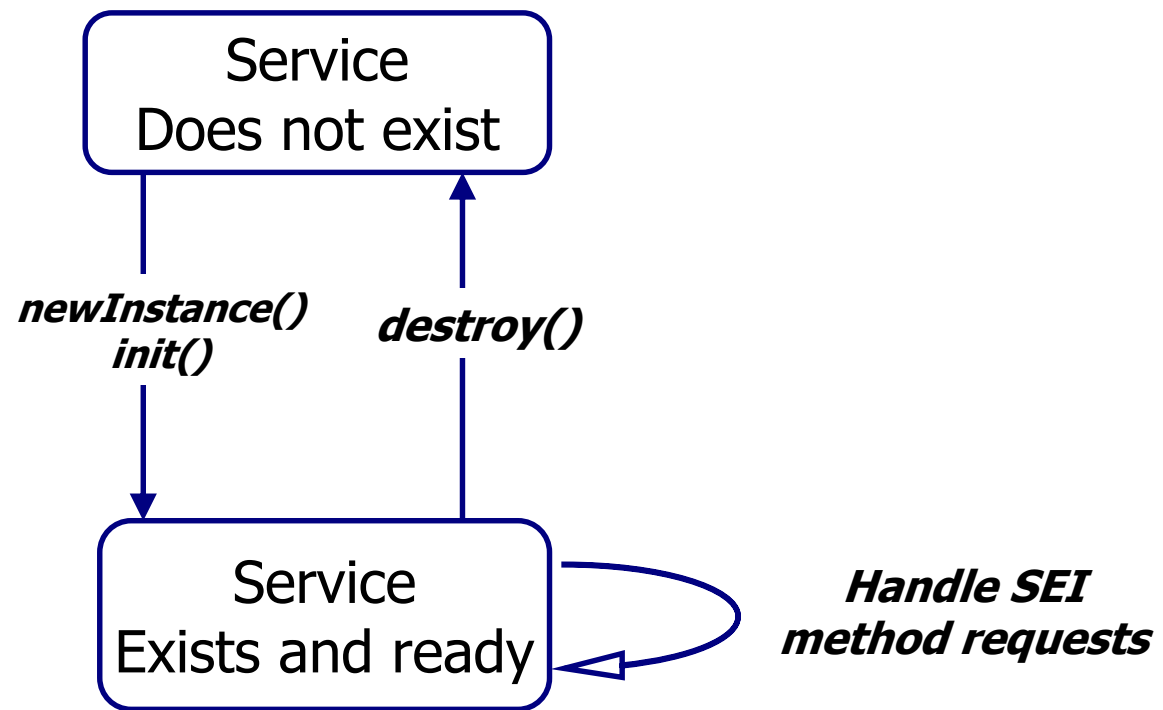




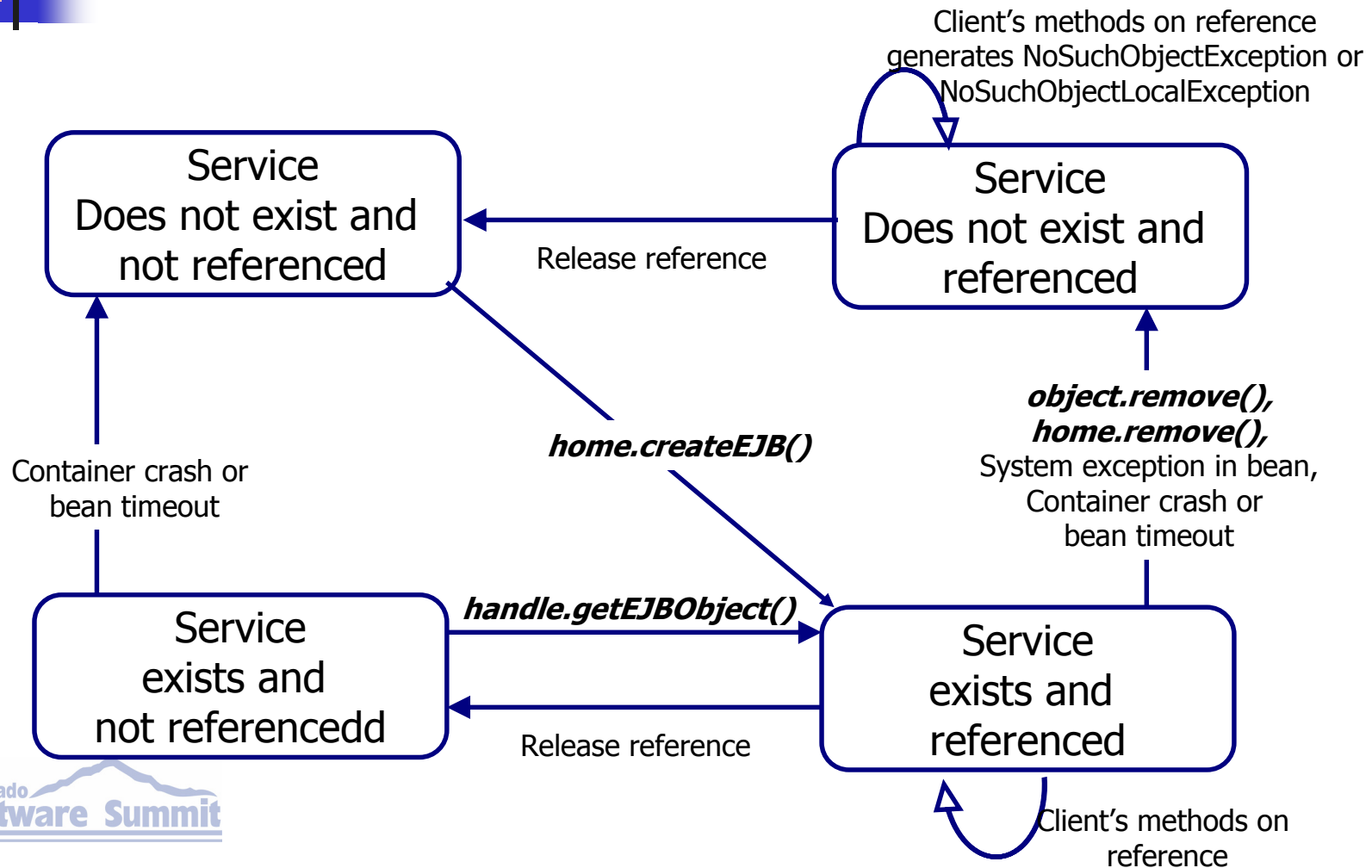
Web Service LifeCycle

- Instantiation
 - Container invokes the bean's *newInstance()* method
- Initialization
 - Container initializes *via* the container specific method
 - Servlet based service – *init()*
 - EJB based service – *setSessionContext()*, *ejbCreate()*
- Execution
- Removal
 - Container removes the service
 - Servlet based service – *destroy()*
 - EJB based service – *ejbRemove()*

Bean Based Implementation



EJB Based Implementation Bean





Server Side Packaging

- Port components (SEI and Implementation)
 - In their respective modules – Web or EJB

- Web Services DD – webservices.xml
 - For EJB, in the Module META-INF directory
 - For Web, in the Module WEB-INF directory

- WSDL and Mapping files
 - Located relative to the module
 - Typically co-located with the module descriptor
 - Referenced in the Deployment Descriptor



Service Deployment Descriptors

- Specify the set of Web service descriptions to be deployed and their dependencies on container resources and services
- Specify any necessary type mappings
- Specify the Java artifact (JavaBean / EJB) implementing the service



Client Programming Models





Types of Client Access to Service

- **Client-Managed Access** (Standalone Java Client)
 - Lookup of service and stub defined by JAX-RPC (not defined by JSR 109)
 - Does not require a J2EE container
 - The client code must know fully-specified URL of the WSDL and therefore the Web service address/endpoint
- **Container-Managed Access** (Web Services for J2EE Client)
 - Lookup of SEI and stub is defined by JSR 109
 - Runs in a J2EE Container and uses J2EE run-time to access/invoke the methods of a Web Service
 - The client code does not know the URL of the target Web service
 - It only has either the SEI or the Port Type and bindings part of the WSDL
 - Can be
 - J2EE Application client
 - Web component (Servlet/JSP)
 - EJB component



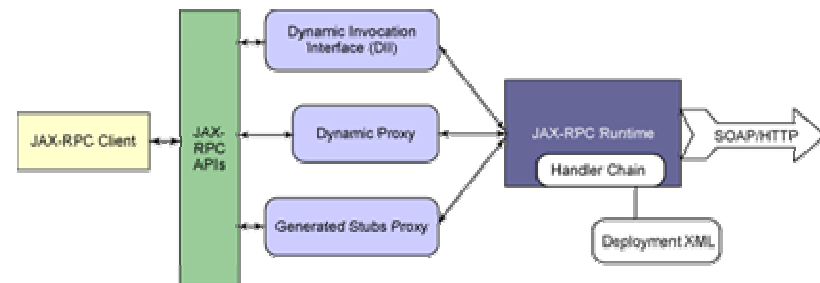
JSR-109 Client Programming Model

- Provides a client view of the Web service in a J2EE environment
- Runtime details are transparent to the client
 - Protocol binding
 - Transport
- A Web Service is invoked much like invoking a method locally



Client Model Invocation Styles

- Three invocation styles:
 - **Static (generated) stub invocation**
 - Java class is statically bound to an SEI, WSDL Port and port component
 - Pretty much as with existing Web Services Implementations
 - **Dynamic Proxy invocation**
 - Java Class is not statically bound to the Web Service *via* a generated Stub
 - A dynamic proxy can be obtained at runtime by providing the SEI
 - Uses the JDK 1.3 Dynamic Proxy feature
 - **Dynamic Call DII invocation**
 - `javax.xml.rpc.Call` object is instantiated and configured to invoke the Web service
 - Used when a client needs dynamic, non-stub based communication with the Web Service





Client Program Flow

- Get Service
- Get stub from the service
- Instantiate and setup the objects which are parameters to the operation
- Use the stub to invoke the remote service operation
- Process return message or fault





JAX-RPC Client Using a Static Stub

- Uses the Service Factory class to create instance of a javax.xml.rpc.Service class

```
Service addressBookService = ServiceFactory.newInstance().createService(  
    new URL("file", "", "Addressbook.wsdl"),  
    new QName("http://addr", "AddressBookService"));
```

- On the Service class, invoke getPort with the Port name, to return an instance of a stub that implements the SEI interface
 - The stub will be generated during deployment and are vendor-specific
 - The stub is the client representation of an instance of the Web Service

```
AddressBook stub = (AddressBook) addressBookService.getPort(  
    new QName("http://addr", "AddressBook"), AddressBook.class);
```

- Client uses the stub to drive the Web Service request to the endpoint that implements the Web service

```
Address response = stub.getAddress();
```





JAX-RPC Client Running in J2EE Container

- Client uses JNDI lookup that returns a Service object
- Using the Service Object, the client gets the stub (that implements the Service Interface)

```
InitialContext initCtx = new InitialContext();  
AddressBookService addressBookService = (AddressBookService)  
    initCtx.lookup("java:com/env/service/AddressBook");  
AddressBook stub =  
addressBookService.getPort(AddressBook.class);
```

- Client uses the stub to drive the Web Service request
Address response = stub.getAddress();





Dynamic Invocation Model

- Implement `javax.xml.rpc.Call`

```
Service service = ServiceFactory.newInstance().createService(null);
```

```
Call call = service.createCall();
```

```
URL u = new URL(
```

```
    "http://localhost:6080/AddressBookService/services/AddressBook");
```

```
call.setTargetEndpointAddress(u);
```

```
call.setProperty(Call.SOAPACTION_USE_PROPERTY, Boolean.TRUE);
```

```
call.setProperty(Call.SOAPACTION_URI_PROPERTY, "getAddress");
```

```
call.setProperty(Call.ENCODINGSTYLE_URI_PROPERTY,
```

```
    "http://schemas.xmlsoap.org/soap/encoding/");
```

```
call.setOperationName(new QName("urn:address-book", "getQuote"));
```

```
call.addParameter("name", XMLType.XSD_STRING, ParameterMode.IN);
```

```
call.setReturnType("urn:address", AddressBook.class);
```

```
Object result = call.invoke(new Object[] {name = "John Doe"});
```

```
return (Address) result;
```





Choosing the Client API to Use

- **Static**
 - These are generated by the tooling
 - Use when you know the service location is unlikely to change
 - You want compile time type checking of use of stub
- **Dynamic Proxy**
 - Dynamic Proxy allows you to use a service endpoint interface without a generated stub class
 - Program to the static SEI, but can change the location of the service endpoint
 - The SEI allows you to retrieve a port and pass in the endpoint URL
- **DII**
 - Use when you need to figure out the service location / signature dynamically
 - Allows late/dynamic binding
 - No service endpoint interface is required



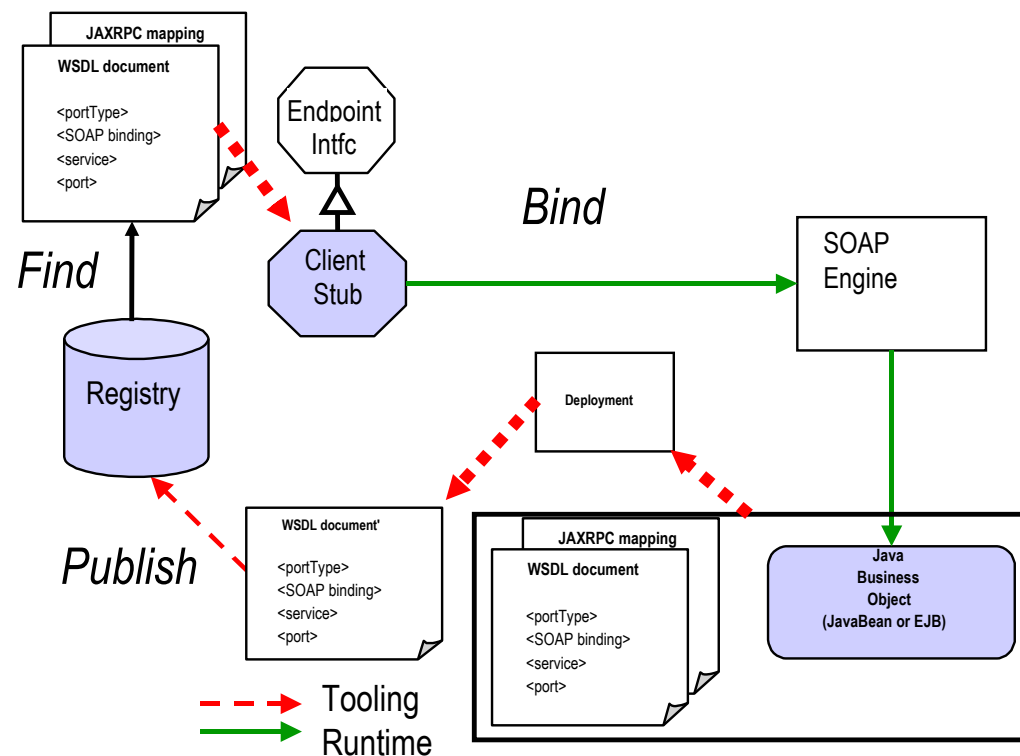


JSR-109 Deployment Descriptors



JSR-109 Deployment

- Defines
 - Set of web service descriptions to be deployed
 - their dependencies on container resources and services
 - Necessary type mappings
 - Specify the Java artifact (JavaBean / EJB) implementing the service





Deployment Descriptors

- Service Deployment Descriptor
 - `webservices.xml`
 - Packaged in same directory as module deployment descriptor
 - `META-INF` for EJB and Application client modules
 - `WEB-INF` for WAR modules
 - Stateless Session Bean Service Implementation defined by `session` element in `ejb-jar.xml`
 - Web container Service Implementation defined by `servlet-class` element in `web.xml`
- Client Deployment Descriptor
 - `webservicesclient.xml`
 - Packaged in same directory as module deployment descriptor
 - `META-INF` for EJB and Application client modules
 - `WEB-INF` for WAR modules
- JAX-RPC Mapping Deployment Descriptor
 - `<service>_mapping.xml`
 - Packaged in same directory as module deployment descriptor
 - `META-INF` for EJB and Application client modules
 - `WEB-INF` for WAR modules



JSR-109 Service Deployment Descriptors

- JSR-109 builds on top of JAX-RPC and defines two deployment descriptors
 - webservices.xml
 - Defines the structural information of the deployed Web services
 - Each WSDL defines service is mapped to a description in webservices.xml
 - JAX-RPC mapping file
 - The name of this file is not dictated by the specification
 - Referenced by the webservices.xml





webservices.xml

- Each description element **MUST** contain
 - Name
 - References the service in the WSDL file
 - WSDL file reference
 - References the WSDL file location in the J2EE module
 - JAX-RPC mapping file reference
 - References the Mapping file in the J2EE module





webservices.xml

```
<webservices>
  <webservice-description>
    <webservice-description-name>ExchangeRateService</webservice-description-name>
    <wsdl-file>WEB-INF/wsdl/Sample.wsdl</wsdl-file>
    <jaxrpc-mapping-file>WEB-INF/Sample_mapping.xml</jaxrpc-mapping-file>
    <port-component>
      <port-component-name>ExchangeRate</port-component-name>
      <wsdl-port>
        <namespaceURI>http://sample</namespaceURI>
        <localpart>ExchangeRate</localpart>
      </wsdl-port>
      <service-endpoint-interface>sample.ExchangeRatePortType</service-endpoint-interface>
      <service-impl-bean>
        <servlet-link>sample_ExchangeRateBindingImpl</servlet-link>
      </service-impl-bean>
    </port-component>
  </webservice-description>
  ...
</webservices>
```



WSDL and webservicexml

```

<wsdl:service name="StockQuoteService">
  <wsdl:port binding="intf:GetQuoteBinding" name="GetQuote">
    <wsdlsoap:address location="http://www.example.com/stockquote/services/getquote"/>
  </wsdl:port>
  <wsdl:port binding="intf:PurchaseBinding" name="Purchase">
    <wsdlsoap:address location="http://www.example.com/stockquote/services/purchase"/>
  </wsdl:port>
</wsdl:service>
<wsdl:service name="ExchangeRateService">
  <wsdl:port binding="intf:ExchangeRateBinding" name="ExchangeRate">
    <wsdlsoap:address location="http://www.example.com/exchangerate/services/getrate"/>
  </wsdl:port>
</wsdl:service>

```

WSDL

```

<webservicex>
  <webservice-description>
    <webservice-description-name>StockQuoteService</webservice-description-name>
    <wsdl-file>WEB-INF/wsdl/Sample.wsdl</wsdl-file>
    <jaxrpc-mapping-file>WEB-INF/Sample_mapping.xml</jaxrpc-mapping-file>
    ...
  </webservice-description>
  <webservice-description>
    <webservice-description-name>ExchangeRateService</webservice-description-name>
    <wsdl-file>WEB-INF/wsdl/Sample.wsdl</wsdl-file>
    <jaxrpc-mapping-file>WEB-INF/Sample_mapping.xml</jaxrpc-mapping-file>
    ...
  </webservice-description>
</webservicex>

```

webservicexml



webservices.xml – Ports

- Port
 - Defines the server view of the service
- Contains
 - Name
 - WSDL port reference
 - Namespace URI
 - WSDL local name of the wsdl:port
 - SEI reference
 - Fully qualified class name of the SEI
 - SIB reference
 - Web Service implementation
 - ✓ Servlet based service – references a servlet element in the web.xml
 - ✓ EJB based service – references an EJB defined in ejb-jar.xml



webservices.xml – Port component

```
<?xml version="1.0" encoding="UTF-8"?>
<wsdl:definitions
  targetNamespace="http://sample"
  .....
```

```
  <wsdl:service name="StockQuoteService">
    <wsdl:port binding="intf:GetQuoteBinding" name="GetQuote">
      <wsdlsoap:address location="http://www.example.com/stockquote/services/getquote"/>
    </wsdl:port>
    <wsdl:port binding="intf:PurchaseBinding" name="Purchase">
      <wsdlsoap:address location="http://www.example.com/stockquote/services/purchase"/>
    </wsdl:port>
  </wsdl:service>
  ...
</wsdl:definitions>
```

WSDL

```
<webservice-description>
  <webservice-description-name>StockQuoteService</webservice-description-name>
  <wsdl-file>WEB-INF/wsdl/Sample.wsdl</wsdl-file>
  <jaxrpc-mapping-file>WEB-INF/Sample_mapping.xml</jaxrpc-mapping-file>
  <port-component>
    <port-component-name>Purchase</port-component-name>
    <wsdl-port>
      <namespaceURI>http://sample</namespaceURI>
      <localpart>Purchase</localpart>
    </wsdl-port>
    ...
  </port-component>
  ...
</webservice-description>
```

webservices.xml





Servlet Based Service Port

```
<servlet>
  <servlet-name>sample_GetQuoteBindingImpl</servlet-name>
  <servlet-class>sample.GetQuoteBindingImpl</servlet-class>
</servlet>
```

web.xml

```
<webservices>
  <webservice-description>
    ...
    <port-component>
      <port-component-name>GetQuote</port-component-name>
      <wsdl-port>
        <namespaceURI>http://sample</namespaceURI>
        <localpart>GetQuote</localpart>
      </wsdl-port>
      <service-endpoint-interface>sample.GetQuotePortType</service-endpoint-interface>
      <service-impl-bean>
        <servlet-link>sample_GetQuoteBindingImpl</servlet-link>
      </service-impl-bean>
    ...
  </webservice-description>
</webservices>
```

webservices.xml

EJB Based Service Port

```
<enterprise-beans>
  <session>
    <ejb-name>GetQuoteBindingImpl</ejb-name>
    <home>sample.GetQuotePortTypeHome</home>
    <remote>sample.GetQuotePortType_RI</remote>
    <ejb-class>sample.GetQuoteBindingImpl</ejb-class>
    <session-type>Stateless</session-type>
    <transaction-type>Container</transaction-type>
  </session>
</enterprise-beans>
```

ejb-jar.xml

```
<webservices>
  <webservice-description>
    ...
    <port-component>
      <port-component-name>GetQuote</port-component-name>
      <wsdl-port>
        <namespaceURI>http://sample</namespaceURI>
        <localpart>GetQuote</localpart>
      </wsdl-port>
      <service-endpoint-interface>sample.GetQuotePortType</service-endpoint-interface>
      <service-impl-bean>
        <ejb-link>GetQuoteBindingImpl</ejb-link>
      </service-impl-bean>
    ...
  </webservice-description>
</webservices>
```

webservices.xml





Handlers

- JSR-109 also standardizes the support for JAX-RPC handlers
- Handlers can
 - Pre-process a request before it is dispatched to a Web Service endpoint
 - Post-process a response before it is sent to the client
 - Access and modify the SOAP Header and content if the SOAP binding protocol is used
 - Handler **MUST NOT CHANGE** SOAP message structure, Operation name, number of parts in the message, or types of the message parts



SOAP Fault is send if Handler does this



Handlers

```

<port-component>
  <port-component-name>GetQuote</port-component-name>
  <wsdl-port>
    <namespaceURI>http://sample</namespaceURI>
    <localpart>GetQuote</localpart>
  </wsdl-port>
  <service-endpoint-interface>sample.GetQuotePortType</service-endpoint-
interface>
  <service-impl-bean>
    <servlet-link>sample_GetQuoteBindingImpl</servlet-link>
  </service-impl-bean>
  <handler>
    <handler-name>sample.ValidationHandler</handler-name>
    <handler-class>sample.ValidationHandler</handler-class>
  </handler>
  <handler>
    <handler-name>sample.LoggingHandler</handler-name>
    <handler-class>sample.LoggingHandler</handler-class>
    <init-param>
      <param-name>level</param-name>
      <param-value>warning</param-value>
      <description>Logging level</description>
    </init-param>
    <soap-header>
      <namespaceURI>http://sample</namespaceURI>
      <localpart>GetQuote</localpart>
    </soap-header>
    <soap-role>LoggingHandler</soap-role>
  </handler>
</port-component>

```

**Validation
Handler**

**Logging
Handler**

webservices.xml



JSR-109 Client Deployment Descriptors

- Similar to service descriptors – two deployment descriptors
 - `webservicesclient.xml`
 - Defines each Web Service referenced by the client
 - `jaxrpcmapping.xml`
 - Defines the JAX-RPC mapping used by the client to access the Web Services





webservicesclient.xml

- Each service referenced by the client is defined by a service-ref which contains
 - Name
 - References the service in the WSDL file
 - Service Interface
 - Fully qualified class name of the Service Interface
 - WSDL file reference
 - References the WSDL file location in the J2EE module
 - JAX-RPC mapping file reference
 - References the Mapping file in the J2EE module





webservicessclient.xml

```
<webservicessclient>
  <service-ref>
    <description>WSDL Service ExchangeRateService</description>
    <service-ref-name>service/ExchangeRateService</service-ref-name>
    <service-interface>sample.ExchangeRateService</service-interface>
    <wsdl-file>WEB-INF/wsdl/Sample.wsdl</wsdl-file>
    <jaxrpc-mapping-file>WEB-INF/Sample_mapping.xml</jaxrpc-mapping-file>
    <service-qname>
      <namespaceURI>http://sample</namespaceURI>
      <localpart>ExchangeRateService</localpart>
    </service-qname>
    <port-component-ref>
      <service-endpoint-interface>sample.ExchangeRatePortType</service-endpoint-interface>
    </port-component-ref>
  </service-ref>
  ...
</webservicessclient>
```





Client Side Handlers

- Client side handlers are associated with service references
 - Server side handlers are associated with port component references
- They can
 - Process a request before it is sent to the service endpoint
 - Process a response before it is returned to the client
- Defined the same way as Service Handlers
 - Additional the port name parameter
 - Port names are used to associate handlers with WSDL ports



Client Side Handlers

```

<webservicessclient>
  <service-ref>
    ...
    <port-component-ref>
      <service-endpoint-interface>sample.PurchasePortType</service-endpoint-interface>
    </port-component-ref>
    <port-component-ref>
      <service-endpoint-interface>sample.GetQuotePortType</service-endpoint-interface>
    </port-component-ref>
    <handler>
      <handler-name>sample.LoggingHandler</handler-name>
      <handler-class>sample.LoggingHandler</handler-class>
      <init-param>
        <param-name>level</param-name>
        <param-value>information</param-value>
        <description>Logging level</description>
      </init-param>
      <soap-header>
        <namespaceURI>http://sample</namespaceURI>
        <localpart>GetQuote</localpart>
      </soap-header>
      <soap-role>LoggingHandler</soap-role>
      <port-name>GetQuote</port-name>
    </handler>
  </service-ref> ...
</webservicessclient>

```



JAX-PRC Mapping

- Mechanism for standardizing the Java ↔ WSDL mappings
- JAX-RPC provides the rules for the mappings
- JSR-109 provides the XML-based deployment descriptor standardized representation
- No standardized name
 - Name determined by the jaxrpc-mapping-file element in webservices.xml or webservicesclient.xml
- File structure matches closely to the WSDL file structure



JAX-RPC Mapping

- `<package-mapping>` element
 - Defines Java package and namespace mapping

```
<java-wsdl-mapping>  
  <package-mapping>  
    <package-type>sample</package-type>  
    <namespaceURI>http://sample</namespaceURI>  
  </package-mapping>  
  ...  
</java-wsdl-mapping>
```

WSDL Service ↔ Service Interface Mapping

```

<wsdl:service name="StockQuoteService">
  <wsdl:port binding="intf:GetQuoteBinding" name="GetQuote">
    <wsdlsoap:address
      location="http://www.example.com/stockquote/services/getquote"/>
    </wsdl:port>
  <wsdl:port binding="intf:PurchaseBinding" name="Purchase">
    <wsdlsoap:address
      location="http://www.example.com/stockquote/services/purchase"/>
    </wsdl:port>
</wsdl:service>

```

WSDL

```

<service-interface-mapping>
  <service-interface>sample.StockQuoteService</service-interface>
  <wsdl-service-name>
    <namespaceURI>http://sample</namespaceURI>
    <localpart>StockQuoteService</localpart>
  </wsdl-service-name>
  <port-mapping>
    <port-name>Purchase</port-name>
    <java-port-name>Purchase</java-port-name>
  </port-mapping>
  <port-mapping>
    <port-name>GetQuote</port-name>
    <java-port-name>GetQuote</java-port-name>
  </port-mapping>
</service-interface-mapping>

```

JAX-RPC Mapping file

WSDL Mappings

```

<wsdl:message name="getQuoteRequest">
  <wsdl:part element="intf:ticker" name="parameter"/>
</wsdl:message>
<wsdl:message name="getQuoteResponse">
  <wsdl:part element="intf:price" name="parameter"/>
</wsdl:message>
...
<wsdl:portType name="GetQuotePortType">
  <wsdl:operation name="getQuote">
    <wsdl:input message="intf:getQuoteRequest" name="getQuoteRequest"/>
    <wsdl:output message="intf:getQuoteResponse" name="getQuoteResponse"/>
  </wsdl:operation>
</wsdl:portType>
...
<wsdl:binding name="GetQuoteBinding" type="intf:GetQuotePortType">
  <wsdlsoap:binding style="document"
transport="http://schemas.xmlsoap.org/soap/http"/>
  <wsdl:operation name="getQuote">
    <wsdlsoap:operation soapAction=""/>
    <wsdl:input name="getQuoteRequest">
      <wsdlsoap:body use="literal"/>
    </wsdl:input>
    <wsdl:output name="getQuoteResponse">
      <wsdlsoap:body use="literal"/>
    </wsdl:output>
  </wsdl:operation>
</wsdl:binding>

```

WSDL

WSDL Bindings Mappings

```

<service-endpoint-interface-mapping>
  <service-endpoint-interface>sample.GetQuotePortType</service-endpoint-interface>
  <wsdl-port-type>
    <namespaceURI>http://sample</namespaceURI>
    <localpart>GetQuotePortType</localpart>
  </wsdl-port-type>
  <wsdl-binding>
    <namespaceURI>http://sample</namespaceURI>
    <localpart>GetQuoteBinding</localpart>
  </wsdl-binding>
  <service-endpoint-method-mapping>
    <java-method-name>getQuote</java-method-name>
    <wsdl-operation>getQuote</wsdl-operation>
    <method-param-parts-mapping>
      <param-position>0</param-position>
      <param-type>sample.Ticker</param-type>
      <wsdl-message-mapping>
        <wsdl-message>
          <namespaceURI>http://sample</namespaceURI>
          <localpart>getQuoteRequest</localpart>
        </wsdl-message>
        <wsdl-message-part-name>parameter</wsdl-message-part-name>
        <parameter-mode>IN</parameter-mode>
      </wsdl-message-mapping>
    </method-param-parts-mapping>
    <wsdl-return-value-mapping>
      <method-return-value>sample.Price</method-return-value>
      <wsdl-message>
        <namespaceURI>http://sample</namespaceURI>
        <localpart>getQuoteResponse</localpart>
      </wsdl-message>
      <wsdl-message-part-name>parameter</wsdl-message-part-name>
    </wsdl-return-value-mapping>
  </service-endpoint-method-mapping>
</service-endpoint-interface-mapping>

```

JAX-RPC Mapping file

Java ↔ XML Mapping





V1.1 – JSR 921

- Maintenance release for JSR109
 - Is part of J2EE 1.4
- No dependency between EJB Remote Interface (RI) and Service Endpoint Interface (SEI) for EJBs exposed as web services
 - JSR109 mandated SEI to include subset of RI
 - SEI and RI both act as remote interfaces to access a J2EE component
 - EJB 2.1 deployment descriptor contains reference to SEI
 - “SEI is a peer to Remote Interface/Local Interface”





V1.1 – JSR 921

- Replaced DTD deployment descriptors with XML Schema deployment descriptors
- J2EE 1.4 changes
- Updated to support WS-I Basic Profile 1.0
- Clarified interoperability requirements
- Support for JAX-RPC handlers for EJB web services now required
 - Was optional in JSR109
- MessageContext accessible in EJB container
- Client DDs merged with normal J2EE DDs





What about Service Discovery?

- Remote Service Discovery must be done by developer
 - Not defined by JSR-109 or JAX-RPC
 - Locate and retrieve WSDL *via*:
 - URL
 - UDDI
 - UDDI4J
 - JAX-R
- From the WSDL pick one of:
 - Service and Port
 - Service and PortType
- Can then use the JAX-RPC client-managed programming model to connect to a particular Web service implementation

Client



JAXR

- JAX-RPC and JSR-109 do not define how to achieve
- Remote Service Discovery
- Developer can locate and retrieve WSDL via URL, UDDI, UDDI4J, **JAX-R**
- Java API for XML Registries (JAX-R)
 - Uniform Standard API for accessing XML registries (including UDDI)
 - J2EE-based standards access to UDDI
 - Organization → businessEntity
 - Service → businessService
 - ServiceBinding → bindingTemplate
 - ExternalLink → discoveryURL
 - Concept/Classification Scheme → tModel



Interoperability WS-I

- Organization focused on promoting interoperability between Web Services
- Main goal is to provide guidance in the standardization of Web Services between different platforms, applications, and programming languages
- Defines profiles, which are a set of different specifications
 - WS-I Basic 1.0 Profile currently available
 - WS-I 1.1 Profile adds support for attachments



WS-I Basic Profile

- HTTP V1.1
 - Specific on HTTP errors and response codes
 - must not require cookie support
- XML 1.0 and XML Schema 1.0
 - May use any construct from Schema 1.0
- SOAP V1.1
 - Use of SOAP encoding disallowed
 - Specific on structure of fault and when to generate faults
 - “Trailers” (element content after soap-env:Body) disallowed
 - Use of SOAPAction, soap-env:actor clarified
- WSDL V1.1 with SOAP Encoding = Literal
 - Exclude use of wsdl:import for XSD files
 - Numerous spec clarifications
 - Only one element in the Body of the element
- UDDI V2.0
 - Established category to identify WS-I conformant entities
 - Models must use WSDL as descriptive language



Summary

- With J2EE 1.4 Web Services is becoming a foundation technology with the addition of
 - Web Services 1.1
 - JAX-RPC 1.1
 - SAAJ 1.2
 - JAXR 1.0
 - WS-I Basic Profile 1.0





Resources

- JSR 101 (JAX-RPC)
 - <http://java.sun.com/xml/jaxrpc/index.html>
- JSR 109
 - <http://jcp.org/jsr/detail/109.jsp>
 - <http://www-106.ibm.com/developerworks/webservices/library/ws-jsr109/index.pdf>
- Introduction to Web Services
 - <http://java.sun.com/webservices/docs/ea2/tutorial/doc/IntroWS.html>
- WS-I Basic Profile
 - <http://www-106.ibm.com/developerworks/webservices/library/ws-basicprof.html?dwzone=webservices>
 - <http://www.ws-i.org/Profiles/BasicProfile-1.0-2004-04-16.html>





Resources – Standards Bodies

- <http://www.w3.org/TR/SOAP/>
- <http://www.w3.org/TR/wsdl>
- <http://www.uddi.org>
- <http://www.WS-I.org>
- <http://xml.apache.org/soap>
- <http://www.xmethods.com>



WSDL <-> Java Mapping

- JSR 101 defines a standardized mapping model from WSDL to Java artifacts
 - WSDL Port Type maps to Java Service Endpoint Interface (SEI)
 - WSDL Service maps to a Java Service Interface
 - WSDL complex elements/parts maps to a Java Bean

