IRIS Web Services Workshop II

Session 2
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Outline

- From XML-RPC to SOAP + WSDL
  - – Web services background and compatibility
  - – SOAP and WSDL basics
- Introduction to Axis
  - – JAX-RPC background
  - – Developing SOAP clients using Axis
  - – TCPMonitor

Historical background

- Many different ways to expose applications:
  - – Direct socket connection (custom data formats)
  - – Remote Procedure Call (RPC)
  - – CORBA cross-language calls (or DCOM, or RMI)
- All have drawbacks for interoperability
  - – Especially in terms of coupling
- XML seems ideal as a way around problems
  - – Cross-platform and cross-language
  - – Wide variety of tools available

XML web services

- Mostly use HTTP because of firewalls
- Exposing applications using XML:
  - – Direct XML exchange via HTTP
  - – SOAP wrapper with WSDL description
  - – HTTP GET queries with XML response (REST)
- All are seeing common use

Direct XML exchange

- Typically uses HTTP transport
- POST operation for two-way exchange:
  - – Request XML document as POST data
  - – Response XML document returned directly
  - – Both directions use customized XML formats
    - Industry- or company-specific
- Requires custom handling (security, etc.)
- Common approach for 6+ years

Direct XML example

- Aircraft parts catalog viewer application
  - – Equivalent of two bookshelves full of manuals (for each individual plane)
  - – “Smart” Java applet-based browser client
  - – Web server software interfaces to database
  - – XML data sent in both directions
  - – Images referenced in XML, not embedded
  - – Developed in 1999

SOAP/WSDL XML

- SOAP defines wrapper for content
  - – Both wrapper (envelope) and content are XML
  - – Envelope allows for added-value functions
    - Security, routing, transactional support, etc.
- WSDL gives standard service descriptions
  - – Operations, data structures, addresses, etc.
  - – Allows automatic client code generation
- Widespread use for last 4+ years (.Net, etc.)

SOAP Example

- Amazon SOAP web service interface:
  - – Provides SOAP services for full range of services
  - – WSDL definition allows easy client generation
    - Defines set of operations supported by service
    - Defines XML format for all request and responses
  - – Advantage to developers is ease of use
    - Frameworks generate client interface from WSDL
    - Services exposed to application as method calls

REST XML

- ***RE**presentational **S**tate **T**ransfer*
  - Way of looking at the Web as resources (2000)
    - GET to retrieve the representation of a resource, DELETE to remove, POST/PUT for updating or creating
  - Can also be applied to HTTP XML web services
  - More hand development than SOAP/WSDL
    - But simpler resulting code – no framework needed
- Requires custom handling (security, etc.)
- Specialized use over last 3+ years

REST example

- Amazon REST web service interface:
  - Provides XML output for full range of services
  - Request very similar to web browser requests
  - Advantage to developers is simplicity
    - No SOAP framework is required
  - Currently gets more use than SOAP version
    - But not necessarily a typical use case...

Focus for this workshop

- Focus on SOAP/WSDL services
  - Widespread industry backing (MS, IBM, Sun, ...)
  - Client code generation makes for easy use
  - Supports (relatively) easy interface versioning
  - Other protocols being layered on top of SOAP
- Most widely used approach at present

RPC with XML

- XML-RPC the simple form of XML web services
  - Remote calls with XML encoding
  - Less efficient than binary, but much more convenient
- Developed by Dave Winer of Userland
  - In cooperation with Microsoft (SOAP)
  - Publicly released while SOAP still in development
- Largely “self-describing”

XML-RPC structure

```
POST /RPC2 HTTP/1.0
User-Agent: Frontier/5.1.2 (WinNT)
Host: betty.userland.com
Content-Type: text/xml
Content-length: 181


<?xml version="1.0"?>
<methodCall>
   <methodName>examples.getStateName</methodName>
   <params>
      <param>
         <value><i4>41</i4></value>
         </param>
      </params>
   </methodCall>
```

Why not use XML-RPC?

- Limited expressiveness:
  - Only a few data types
  - Handles nested structure trees, but not graphs
- Not very “XMLish”
  - Rigid format doesn't allow for general XML
  - In-band type information bulky and redundant
- Microsoft wanted more...

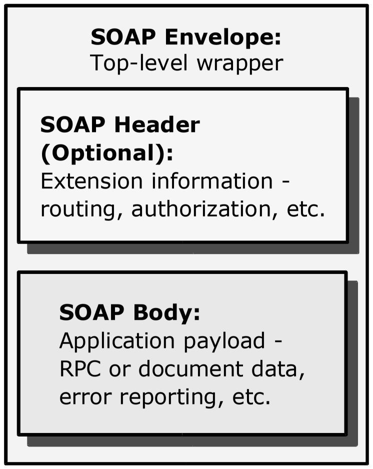
SOAP basics

- SOAP a more-complex version of this:
  - More sophisticated encoding scheme
  - Namespaces to keep components clear
- Microsoft-sponsored effort for 1.0
- IBM joined in promoting as standard in 1.1
- Basis for .NET marketing campaign
- What most people mean by “web services”

What is SOAP?

- Defines wrapper for application data
- Actual data format can vary:
  - Specification defines one encoding (mapping between XML and application objects)
  - Applications can define own encodings
  - Increasingly common to just use XML directly
- Actual connection can vary:
  - Usually request-response pattern
  - Usually HTTP transport (but can be anything)

SOAP Message Structure



SOAP Envelope:
Top-level wrapper

SOAP Header (Optional):
Extension information - routing, authorization, etc.

SOAP Body:
Application payload - RPC or document data, error reporting, etc.

- Envelope is wrapper for content, but no useful information
- Optional header can contain control information
- Body contains actual data in XML form
- Attachments can hold other types of data (binary, unencoded text, etc.)

The WSDL additive

- ***W***eb ***S***ervices ***D***escription ***L***anguage
- Based on abstract definitions and bindings:
  - – **types** – types defined for use in messages
  - – **messages** – the data being exchanged
  - – **port types** – collections of operations
  - – **binding** – concrete protocol and data format
  - – **service** – a collection of bound ports at address
- Gives a comprehensive definition of service

```
<wsdl:definitions targetNamespace="http://www.sosnoski.com/person/types"
 xmlns:impl="http://www.sosnoski.com/person/types"
 xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/" ...>
 <wsdl:types>
  <schema ...>
   ...
  </schema>
 </wsdl:types>
 <wsdl:message name="getAllPersonsResponse">
  <wsdl:part element="impl:getAllPersonsResponse" name="parameters"/>
 </wsdl:message>
 ...
 <wsdl:portType name="Person">
  <wsdl:operation name="getPerson">
   ...
  </wsdl:operation>
  ...
 </wsdl:portType>
 <wsdl:binding name="personSoapBinding" type="impl:Person">
  ...
 </wsdl:binding>
 <wsdl:service name="PersonService">
  <wsdl:port binding="impl:personSoapBinding" name="person">
   <wsdlsoap:address location="http://localhost:8080/axis/services/person"/>
  </wsdl:port>
 </wsdl:service>
</wsdl:definitions>
```

Types

- Types section optionally defines structures for exchange (with embedded schema definitions)

```
<wsdl:types>
 <schema ...>
  <element name="getPerson">
   <complexType>
    <sequence>
     <element name="index" type="xsd:int"/>
    </sequence>
   </complexType>
  </element>
  ...
 </schema>
</wsdl:types>
```

Messages

- Each message represents one interaction
  - One or more “parts” in message
  - Describes the content to be sent in an operation
  - Can make use of type definitions (or schema types)

```
<wsdl:message name="getAllPersonsResponse">
 <wsdl:part element="impl:getAllPersonsResponse"
   name="parameters"/>
</wsdl:message>
<wsdl:message name="getPersonResponse">
 <wsdl:part element="impl:getPersonResponse"
  name="parameters"/>
</wsdl:message>
```

Port types

- Abstract operation definitions
- Messsage(s) involved in each operation

```
<wsdl:portType name="Person">
 <wsdl:operation name="getPerson">
  <wsdl:input message="impl:getPersonRequest"
   name="getPersonRequest"/>
  <wsdl:output message="impl:getPersonResponse"
   name="getPersonResponse"/>
  <wsdl:fault message="impl:NoPersonException"
   name="NoPersonException"/>
 </wsdl:operation>
 ...
 </wsdl:portType>
```

Bindings

- Protocol-specific binding data for port type
  - SOAP communication style, usage, transport

```
<wsdl:binding name="personSoapBinding" type="impl:Person">
 <wsdlsoap:binding style="document"
  transport="http://schemas.xmlsoap.org/soap/http"/>
 <wsdl:operation name="getPerson">
  <wsdlsoap:operation soapAction=""/>
  <wsdl:input name="getPersonRequest">
   <wsdlsoap:body use="literal"/>
  </wsdl:input>
  ...
 </wsdl:operation>
</wsdl:binding>
```

Service and port definition

- Service gives name for a set of ports
- Each port definition specifies a single address for a binding
- Can be multiple ports, multiple addresses

```
<wsdl:service name="PersonService">
 <wsdl:port binding="impl:personSoapBinding" name="person">
  <wsdlsoap:address
   location="http://localhost:8080/axis/services/person"/>
 </wsdl:port>
</wsdl:service>
```

SOAP Body

- Message payload container
- Three commonly-used formats:
  - RPC encoded – defined by SOAP specification
  - Document literal – XML message with format determined by schema
  - Wrapped – document literal variation, with call parameters as children of root element
- Service defines the format to use (WSDL)

RPC encoded SOAP

- ***R***emote ***P***rocedure ***C***all – like CORBA or RMI
  - Call parameters and result encoded in body
    - encodingStyle defines the rules for conversions
    - Messages may include xsi:type information, or not
  - Encoding allows for graphs of objects (multiRefs)
- Optionally used by .NET – but not in future...
- Usually abbreviated rpc/enc

Document literal

- An XML document is passed each way
- Flexible, but less automatic for code:
  - Working with XML documents (but may still map to method calls behind the scenes)
  - Requires code at each end to convert to data
- Equivalent to direct XML exchange embedded in SOAP
- Usually abbreviated doc/lit

Wrapped

- Microsoft approach for easy service interface:
  - Given a call with parameters "a", "b" and "c"
    - Define a top-level element with children "a", "b" and "c"
    - Pass the element as document literal SOAP body
    - Uses Microsoft encoding scheme
  - Preferred .NET approach
- Represented as doc/lit
- Limited by the encoding

rpc/enc sample

```
<soapenv:Body>
 <ns1:handleQuery
   soapenv:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
   xmlns:ns1="urn:axis.sosnoski.com">
    <in0 href="#id0"/>
 </ns1:handleQuery>
 <multiRef id="id0" soapenc:root="0" xsi:type="ns2:Query"
   soapenv:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
   xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/"
   xmlns:ns2="http://seismic.sosnoski.com">
    <maxDateTime xsi:type="xsd:dateTime">2001-07-02T04:33:22.610Z...
    <maxDepth xsi:type="soapenc:float" xsi:nil="true"/>
    <maxLatitude xsi:type="soapenc:float">152.46613</maxLatitude>
    <maxLongitude xsi:type="soapenc:float">78.09824</maxLongitude>
    <maxMagnitude xsi:type="soapenc:float" xsi:nil="true"/>
    <minDateTime xsi:type="xsd:dateTime">2001-05-04T02:31:00.601Z...
    <minDepth xsi:type="soapenc:float" xsi:nil="true"/>
    <minLatitude xsi:type="soapenc:float">-48.434654</minLatitude>
    <minLongitude xsi:type="soapenc:float">-91.997185</minLongitude>
    <minMagnitude xsi:type="soapenc:float" xsi:nil="true"/>
 </multiRef>
```

doc/lit sample

```
<SOAP:Envelope xmlns:SOAP="http://schemas.xmlsoap.org/soap/envelope/">
  <SOAP:Body>
     <qk:search-params xmlns:qk="http://www.sosnoski.com/quakes">
        <qk:min-date>2001-05-04T02:31:00.601</qk:min-date>
        <qk:max-date>2001-07-02T04:33:22.61</qk:max-date>
        <qk:min-long>-91.997185</qk:min-long>
        <qk:max-long>78.09824</qk:max-long>
        <qk:min-lat>-48.434654</qk:min-lat>
        <qk:max-lat>152.46613</qk:max-lat>
     </qk:search-params>
  </SOAP:Body>
</SOAP:Envelope>
```

rpc/enc issues

- Like database schema generation from code
  - Automatic conversion does not allow tuning
  - Some code structures can't be used (hashmaps, etc.)
  - Okay for small, standalone applications
  - Distributed applications need cleaner structure
- doc/lit gives better control
  - doc/lit schemas XML equivalent of DBA
  - Can use cleaner and more compact XML structure

SOAP in Java

- Java API for XML-based RPC
  - “Portable and interoperable” web services in Java
  - Makes web services look like RMI
  - Converts to and from Java objects (limited)
- Now available as 1.1.X release (JWSDP 1.X)
- Unfortunately very difficult to use

Apache Axis SOAP

- Successor to Apache SOAP (itself originally based on IBM SOAP4J):
- Tools for WSDL to Java and Java to WSDL generation
- Automatic WSDL generation for deployed services
- JAX-RPC compatibility
- Currently at 1.2.1, 1.3 in progress

Building Axis clients

- Person sample service demonstration
  - Supplied *person.wsdl* defines the service
  - Supplied *build.xml* takes care of (most) work
    - **clean** deletes generated code and class files
    - **generate-java** generates and organizes code
    - **build-client** compiles client code
    - **from-wsdl** does all the above
    - **run** runs the client with test data
    - **tcpmon** runs TCPMonitor program
    - **run-monitored** runs client using TCPMonitor

How it works

- Code generation to *client/gen* directory
- Supplied *Test.java* program in *client/impl* tree
- Compile first generated classes, then supplied code, to *client/bin*
- Run directly from there

Exercise 1a

- Run the same demonstration on your system
  - Build the client
  - Run without TCPMonitor
  - Start TCPMonitor (in separate console window)
  - Run with TCPMonitor
- Now modify this to work with supplied seismic.wsdl

Seismic service

- Web service for retrieving seismic events
  - Get count of events in database
  - Retrieve by date, latitutude, and longitude ranges
  - Retrieve by “similarity” to quake of interest

Exercise 1b

- Now modify to build client for *seismic.wsdl*
  - Copy the whole directory first!
  - Change “person” name to “seismic” name (including package for *Test.java*)
  - Try the initial **generate-java** step
  - Compare generated classes to those from example
  - Modify the *Test.java* code to use the appropriate class, and implement the *getQuakeCount()* and *findQuakes()* operations

Hints

- The query parameters used in **test** should return 3 QuakeSets, containing 9 total quakes
- Java code for parameters:

```
TimeZone utc = TimeZone.getTimeZone("UTC");
SimpleDateFormat format =
    new SimpleDateFormat("yyyy-MM-dd'/'HH:mm:ss");
Calendar mndate = new GregorianCalendar(utc);
mndate.setTime(format.parse(args[3]));
...
Float mnlat = new Float(args[5]);
...
```

Exercise 2

- Now try doing the same thing for the Amazon Web Service aws.wsdl
- You'll need to register with Amazon for an id to actually use this
- Check details at http://www.amazon.com/webservices
- Will demonstrate in workshop, if time available