Ambientes de Desenvolvimento Avançados

http://www.dei.isep.ipp.pt/~jtavares/ADAV/ADAV.htm

Aula 18

Engenharia Informática

2004/2005

José António Tavares
jrt@isep.ipp.pt

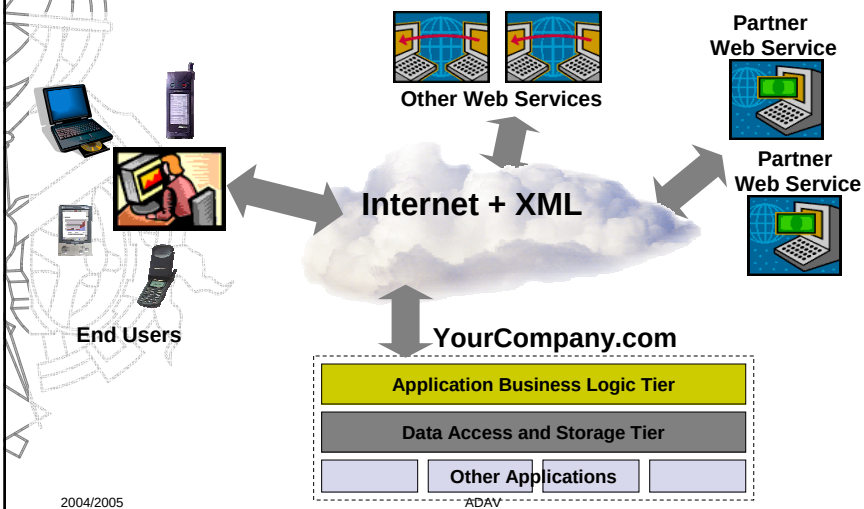
Web services standards

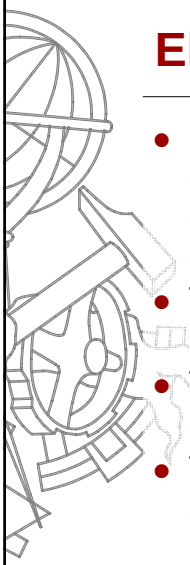
Wiring Standards

- Wiring is the fabric that connects electrical components;
- Plumbing is essentially the same whether it is for gas or water systems;
- Standards on this level are important for components to be connectable at all;
- Software component wiring and the emerging world of XML-based standards – promise of an universal adapter.

Web Services Overview

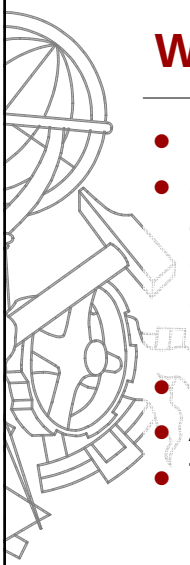
Application Model





Elements of the Web Service

- Description of the Service
  - UDDI
  - WSDL
  - WSCL
- The Wiring
  - SOAP
- The Host
  - Web Server
- The Actual Service
  - The Service Code



Web Server Issues

- Handles the requests and invokes the functions
- Since HTTP is used, SOAP invocations can be as a result of a
  - Get request
  - Post Request
  - Or a SOAP request (mime type SOAP)
- IIS 5.0 (.NET implementation)
- Apache (SOAP Module Built by IBM)
- Tomcat (Java Server)

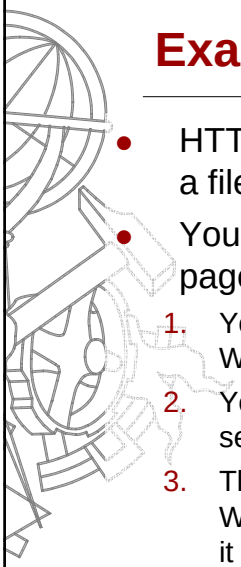
Hosting Environments for Web Services

- Microsoft .NET
- IBM Websphere
- Apache Axis - http://xml.apache.org/axis

Web Services Standards Stack

Directory: Publish & Find Services:	UDDI
Description: Formal Service Descriptions:	WSDL
Wire Format: Service Interactions:	SOAP
Universal Data Format:	XML
Ubiquitous Communications:	Internet

Simple, Open, Broad Industry Support



Examining HTTP

- HTTP is a protocol for requesting and receiving a file from a Web server.
- Your Web browser uses HTTP to access Web pages. How does this work?
  1. You enter http://www.yahoo.com/games.htm into your Web browser
  2. Your Web browser makes a request to Yahoo's Web server for the file games.htm.
  3. The Web server then sends back this file and your Web browser renders the HTML in the file, displaying it in the browser.

HTTP Requests

- An HTTP request, in its simplest form, looks like the following:

```
GET /filename HTTP/1.1
```

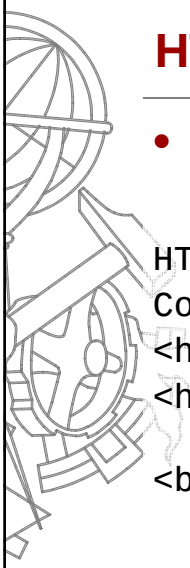
- So, if we wanted to get www.yahoo.com/games.htm, the Web browser makes a connection to Yahoo's Web server on (typically) port 80 and then sends the command:

```
GET /games.htm HTTP 1.1
```

HTTP Response

- When the Web server receives the request, it replies with an *HTTP response*, which has the following format:

```
HTTP/1.1 STATUS_CODE
Content-type: content_type
Contents of requested file…
```

HTTP Response

- For example, the Yahoo Web server, after receiving the HTTP request for /games.htm, might respond with:

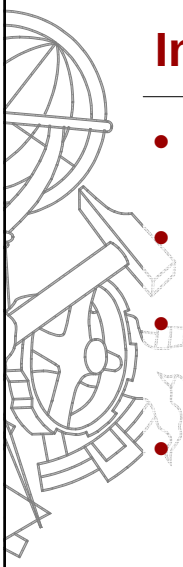
```
HTTP/1.1 200 OK
Content-type: text/html
<html>
<head><title>Yahoo
 Games!</title></head>
<body>
   …
```

HTTP Request/Response

Web Services Standards Stack

Directory: Publish & Find Services:	UDDI
Description: Formal Service Descriptions:	WSDL
Wire Format: Service Interactions:	SOAP
Universal Data Format:	XML
Ubiquitous Communications:	Internet

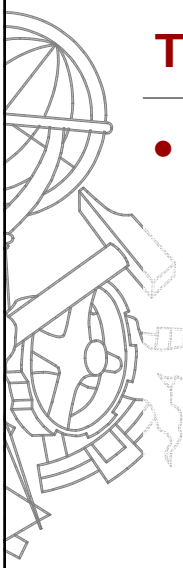
Simple, Open, Broad Industry Support



Introduction to XML

- XML stands for e**X**tensible **M**arkup **L**anguage.

  http://www.w3.org/TR/REC-xml/
- XML is a way of specifying *self-describing* data in a *human-readable* format.
- XML's structure is like that of HTML – it consists of nested tags, or *elements*. Elements can contain text data, attributes, and other elements.
- XML is ideal for describing *hierarchical* data.



The Components of XML

- XML document can be comprised of the following components:
  - A Root Element (*required*)
  - Elements
    - Attributes

An Example XML Document

```
<?xml version="1.0" encoding="UTF-8" ?>
<books>
   <!-- Each book is represented by a <book> element -->
   <book price="34.95">
      <title>Teach Yourself ASP 3.0 in 21 Days</title>
      <authors>
         <author>Mitchell</author>
         <author>Atkinson</author>
      </authors>
      <year>1999</year>
   </book>
</books>
```


An Example XML Document

- All XML Documents must have precisely one *root element*.
- The first element in the XML document is referred to as the root element.
- For the books example, the root element is <books>:

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

An Example XML Document

- XML documents can contain an arbitrary number of *elements* within the root element. Elements have a *name*, can have an arbitrary number of attributes, and can contain either text content or further elements.
- The generic syntax of an element is given as:

```
<elementName attribute1="value1" …
    attributeN="valueN">
        text content or further elements
</elementName>
```


An Example XML Document

- For example, in the books XML document, the <book> element contains an attribute named price and three *child elements*: <title>, <authors>, and <year>.

```
<book price="34.95">
    <title>…</title>
    <authors>
        …
    </authors>
    <year>…</year>
</book>
```

An Example XML Document

- The <title> and <year> elements contain text content.

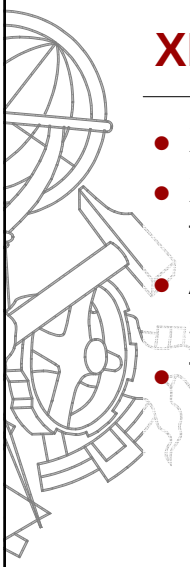
```
<title>Teach Yourself ASP 3.0 in 21 Days</title>

<year>1999</year>
```


An Example XML Document

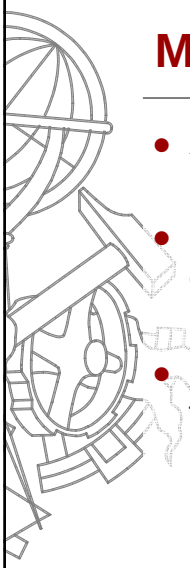
- The <authors> element contains two <author> child elements. The <author> elements contain text content, specifying the author(s) of the book:

```
<authors>
        <author>Mitchell</author>
        <author>Atkinson</author>
</authors>
```



XML Formatting Rules

- XML is case sensitive.
- XML Documents must adhere to specific formatting rules.
- An XML document that adheres to such rules is said to be *well-formed*.
- These formatting rules are presented over the next few slides.



Matching Tags

- XML elements must consist of both an *opening tag* and a *closing tag*.
- For example, the element <book> has an opening tag - <book> - and must also have a matching closing tag - </book>.
- For elements with no contents, you can use the following shorthand notation:

```
<elementName optionalAttributes />
```

Elements Must be Properly Nested

- Examples of properly nested elements:

```
<book price="39.95">
        <title>XML and ASP.NET</title>
</book>
```

- Example of improperly nested elements:

```
<book price="39.95">
        <title>XML and ASP.NET
</book> </title>
```


Attribute Values Must Be Quoted

- Recall that elements may have an arbitrary number of attributes, which are denoted as:

```
<elementName attribute1="value1" ...
  attributeN="valueN"> … </elementName>
```

- Note that the attribute values *must be delimited by quotation marks*. That is, the following is malformed XML:

```
<book price=39.95> … </book>
```

Illegal Characters for Text Content

- Recall that elements can contain text content or other elements. For example, the <title> element contains text, providing the title of the book:

```
<title>XML for ASP.NET</title>
```

- There are five characters that cannot appear within the text content: <, >, &, ", and '.

Replacing the Illegal Characters with Legal Ones

- If you need to use any of those four illegal characters in the text portion of an element, replace them with their equivalent legal value:

Replace This	With This
<	<
>	>
&	&
"	"
'	'

Namespaces

- Element names in an XML document can be invented by the XML document's creator.
- Due to this naming flexibility, when computer programs work with different XML documents there may be *naming conflicts*.
- For example, appending two XML documents together that use the same element name for different data representations leads to a naming conflict.

Naming Conflicts

- For example, if the following two XML documents were to be merged, there would be a naming conflict:

```
<bug>
  <date>2003-05-22</date>
  <description>The button, when clicked,
raises a GPF exception.</description>
</bug>
```

```
<bug>
  <genus>Homoptera</genus>
  <species>Pseudococcidae</species>
</bug>
```

Solving Name Conflicts with Namespaces

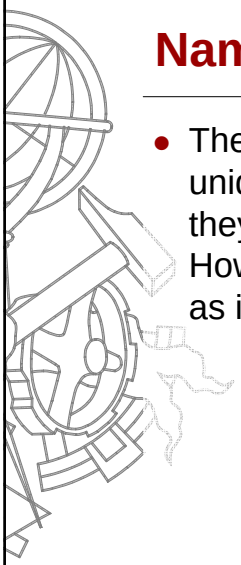
- A namespace is a *unique* name that is "prefixed" to each element name to uniquely identify it.
- To create namespaces, use the xmlns attribute:

```
<namespace-prefix:elementName xmlns:namespace-
  prefix="namespace">

E.g.:
<animal:bug xmlns:animal="http://www.bugs.com/">
```

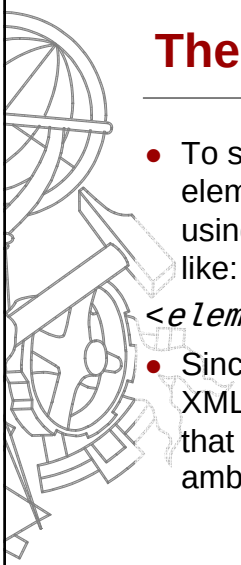

Namespaces

- Note that the xmlns namespace attribute contains two parts:
  1. The *namespace-prefix* and,
  2. The namespace value.
- The namespace-prefix can be any name. The namespace-prefix is then used to prefix element names to indicate that the element belongs to a particular namespace.
- The namespace for an element automatically transfers to its children elements, unless explicitly specified otherwise.



Namespaces

- The namespace value must be a globally unique string. Typically, URLs are used since they are unique to companies/developers. However, *any* string value will suffice, so long as it is unique.



The Default Namespace

- To save typing in the namespace-prefix for every element, a *default namespace* can be specified using xmlns *without* the *namespace-prefix* part, like:

```
<elementName xmlns="namespace">
```

- Since messages to Web services are XML-formatted (as we'll see in a bit), it is important that namespaces are used to remove any ambiguity between potential naming conflicts.

Defining XML Document Structure

- Relational databases employ *schemas*, which explicitly define the structure and properties of the data a table can hold.
- XML allows for its structure to be defined using either one of two technologies:
  1. DTDs (**D**ocument **T**ype **D**efinition)
  2. XSD (**X**ML **S**chema **D**efinition)
- XSD is the method used to define the structure of the XML messages passed to and from a Web service.

XML Schemas (XSD)

- XSD files are XML-formatted files themselves, and define the structure of some other XML document.
- This technology is useful with Web services, because it provides a means for the Web service and client to both know the structure of the message being passed to and from.

XSD Example

- Given the following XML document:

```
<books>
  <book>
    <title>ASP.NET Data Web Controls</title>
    <author>Mitchell</author>
    <year>2003</year>
  </book>
</books>
```


XSD Example

- We can describe the previous XML file with the following XSD file:

```
<xsd:schema xmlns:xsd="…">
  <xsd:element name="books">
    <xsd:complexType>
      <xsd:element name="book">
        <xsd:complexType>
          <xsd:element name="title" type="xsd:string" />
          <xsd:element name="author" type="xsd:string" />
          <xsd:element name="year" type="xsd:integer" />
        </xsd:complexType>
      </xsd:element>
    </xsd:complexType>
  </xsd:element>
</xsd:schema>
```

For More XSD Information…

- A mastery of XSD is not required for this course.
- However, if you are interested, you can learn more at:
  - http://www.w3schools.com/schema
  - http://datawebcontrols.com/classes/xmlfornet/Session2.zip (*presentation on XML schemas from the XML for .NET class*)

Web Services Standards Stack

Directory: Publish & Find Services:	UDDI
Description: Formal Service Descriptions:	WSDL
Wire Format: Service Interactions:	SOAP
Universal Data Format:	XML
Ubiquitous Communications:	Internet

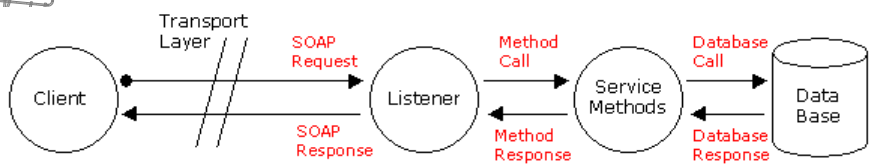
Simple, Open, Broad Industry Support

What is SOAP?

- **SOAP** – (**S**imple **O**bject **A**ccess **P**rotocol)
  http://www.w3c.org/TR/soap

- SOAP is an XML-based messaging protocol.
- simple one-way messaging
- performing RPC-style (Remote Procedure Call) request-response dialogues
- Not tied to any particular operating system or programming language

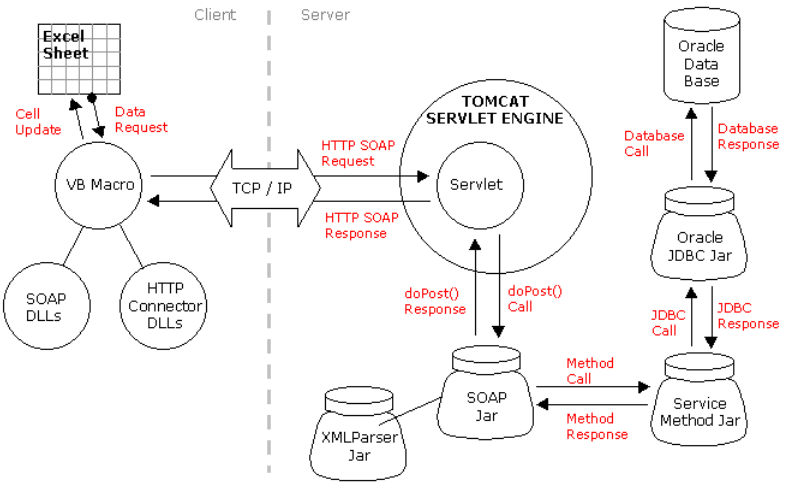
What is SOAP?



The SOAP developer's approach

- encapsulate the database request logic for the service in a method
- the service method, decodes the incoming SOAP request

What is SOAP?



SOAP Messages

- A valid SOAP Message is a well-formed XML document
- It should use the SOAP Envelope and SOAP Encoding namespaces and have the following form:
  - An XML Declaration
  - A SOAP Envelope
    - A SOAP Header
    - A SOAP Body

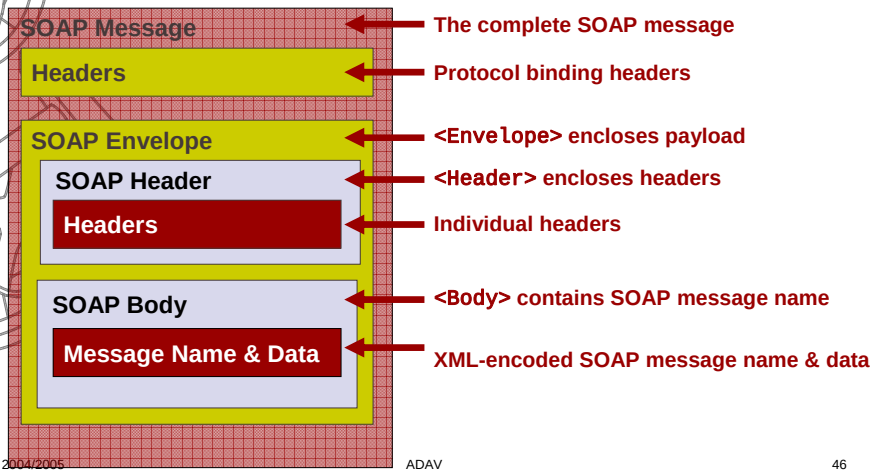
SOAP Messages

- A SOAP-encoded RPC dialogue contains both
  - a request message
  - a response message.

Method Signature

```
int doubleAnInteger ( int numberToDouble );
```


Message Structure



- A SOAP message is an XML document – it has a mandatory SOAP envelope, an optional SOAP header, and a mandatory SOAP body.
- The envelope is the top element of the XML document representing the message.
- The header is a generic mechanism for adding features to a SOAP message in a decentralized manner without prior agreement between the communicating parties.
- SOAP defines a few attributes that can be used to indicate who should deal with a feature and whether it is optional or mandatory.
- The Body is a container for mandatory information intended for the ultimate recipient of the message.
- SOAP defines one element for the body, which is the Fault element used for reporting errors**.**

SOAP Messages

Request

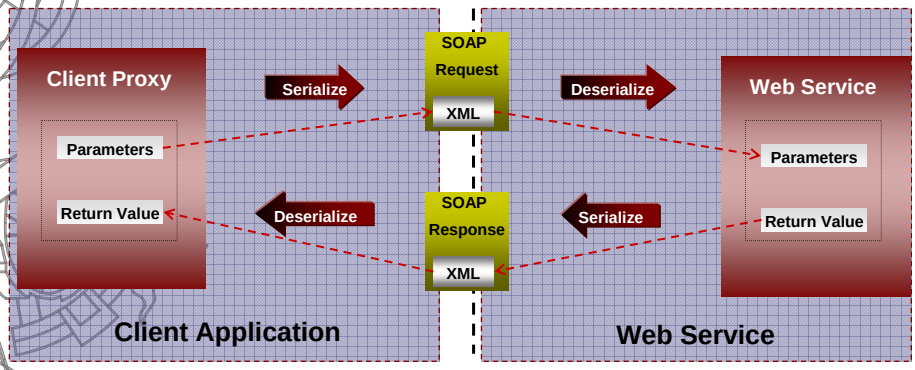
```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<SOAP-ENV:Envelope
   SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
   xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
   xmlns:SOAP-ENC="http://schemas.xmlsoap.org/soap/encoding/"
   xmlns:xsi="http://www.w3.org/1999/XMLSchema-instance"
   xmlns:xsd="http://www.w3.org/1999/XMLSchema">
   <SOAP-ENV:Body>
      <ns1:doubleAnInteger  xmlns:ns1="urn:MySoapServices">
            <param1 xsi:type="xsd:int">123</param1>
      </ns1:doubleAnInteger>
   </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

SOAP Messages

Response

```
<?xml version="1.0" encoding="UTF-8" ?>
<SOAP-ENV:Envelope
      xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
      xmlns:xsi="http://www.w3.org/1999/XMLSchema-instance"
      xmlns:xsd="http://www.w3.org/1999/XMLSchema">
  <SOAP-ENV:Body>
      <ns1:doubleAnIntegerResponse xmlns:ns1="urn:MySoapServices“
      SOAP-ENV:encodingStyle=
                  "http://schemas.xmlsoap.org/soap/encoding/">
            <return xsi:type="xsd:int">246</return>
      </ns1:doubleAnIntegerResponse>
  </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```


How it works



An Example

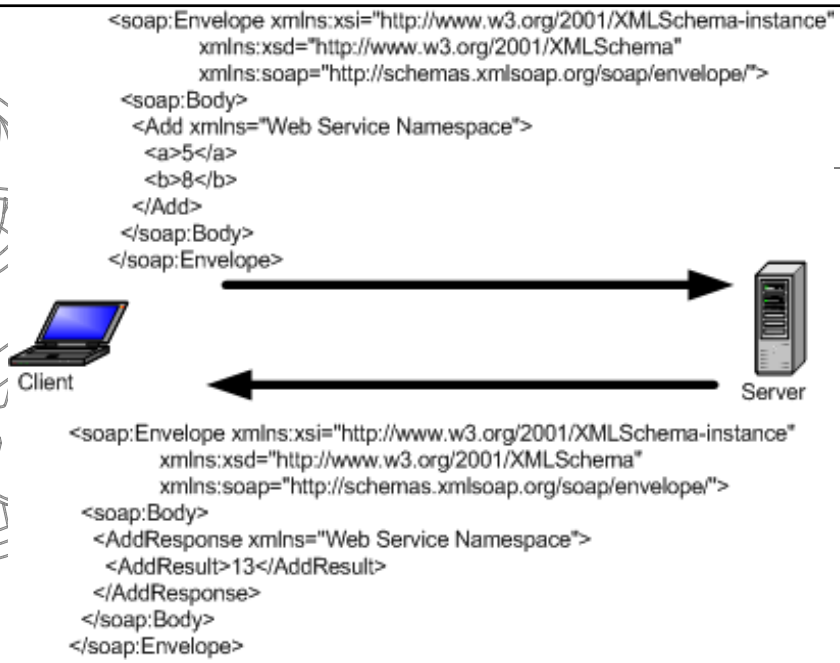
- Imagine that we had a Web service with an `Add()` method, that took two integer inputs and returned their sum.
- Let's look at what the request and response SOAP messages would look like if `Add(5,8)` was called from the client…

The Request SOAP Message

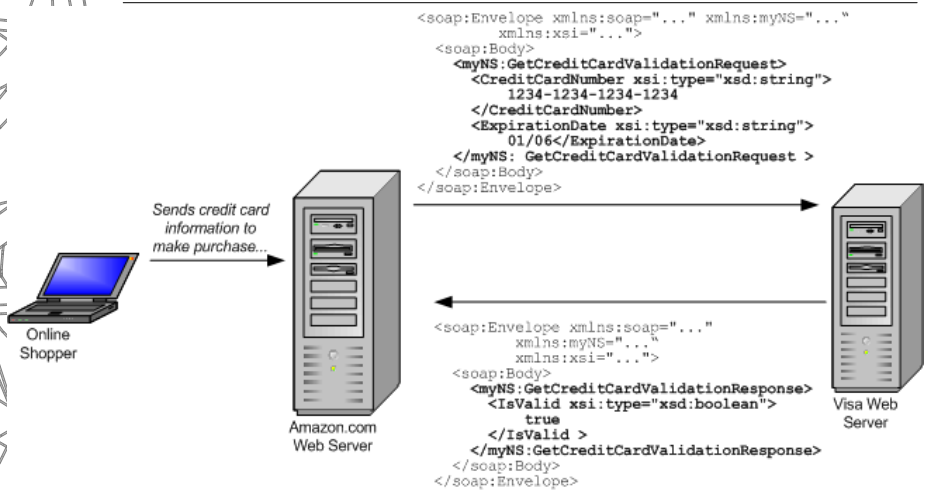
```
<soap:Envelope namespace>
  <soap:Body>
    <Add xmlns="Web Service Namespace">
      <a>5</a>
      <b>8</b>
    </Add>
  </soap:Body>
</soap:Envelope>
```

The Response SOAP Message

```
<soap:Envelope namespaces>
  <soap:Body>
    <AddResponse xmlns="Web Service Namespace">
      <AddResult>13</AddResult>
    </AddResponse>
  </soap:Body>
</soap:Envelope>
```

SOAP Interaction
Other Example




```
<soap:Envelope xmlns:soap="..." xmlns:myNS="..."
               xmlns:xsi="...">
  <soap:Body>
    <myNS:GetCreditCardValidationRequest>
      <CreditCardNumber xsi:type="xsd:string">
          1234-1234-1234-1234
      </CreditCardNumber>
      <ExpirationDate xsi:type="xsd:string">
          01/06</ExpirationDate>
    </myNS: GetCreditCardValidationRequest >
  </soap:Body>
</soap:Envelope>
```

```
<soap:Envelope xmlns:soap="..."
               xmlns:myNS="..."
               xmlns:xsi="...">
  <soap:Body>
    <myNS:GetCreditCardValidationResponse>
      <IsValid xsi:type="xsd:boolean">
          true
      </IsValid >
    </myNS:GetCreditCardValidationResponse>
  </soap:Body>
</soap:Envelope>
```


SOAP Example

- WS Calculadora

Web Services Standards Stack

Directory: Pblish & Find Services:	UDDI
Description: Formal Service Descriptions:	WSDL
Wire Format: Service Interactions:	SOAP
Universal Data Format:	XML
Ubiquitous Communications:	Internet

Simple, Open, Broad Industry Support

WSDL

- **WSDL** - **W**eb **S**ervices **D**escription **L**anguage
- XML schema for describing Web Services
  1. Service interface definition
     - Abstract semantics for Web Service
  2. Service implementation definition
     - Concrete end points and network addresses where Web Service can be invoked
- Clear delineation between abstract and concrete messages

http://www.w3c.org/TR/wsdl

WSDL - Overview

- WSDL is a simple XML grammar for describing how to communicate with a Web service
  - It defines the messages (both abstract and concrete) that are sent to and from a service
  - It defines logical collections of messages (“port type”, “interface”)
  - It defines how a given “port type” is bound to particular wire protocols
  - It defines where the service is located

WSDL - Overview

```
<definitions>
  <types>  <!-- XML Schema -->  </types>
  <message name=“getQuote_In” />
  <message name=“getQuote_Out” />
  <portType name=“StockQuoteServiceInterface”>
    <operation name=“getQuote”>
      <input message=“getQuote_In” />
      <output message=“getQuote_Out” />
    </operation>
  </portType>
  <binding name=“StockQuoteServiceBinding” type=“StockQuoteServiceInterface”>
    <soap:binding transport=“http://schemas.xmlsoap.org/soap/http” />
    ...
  </binding>
  <service name=“StockQuoteService”>
    <port name=“StockQuoteServicePort” binding=“StockQuoteServiceBinding”>
      <soap:address location=“http://www.acme.com/services/stockquote” />
    </port>
  </service>
</definitions>
```

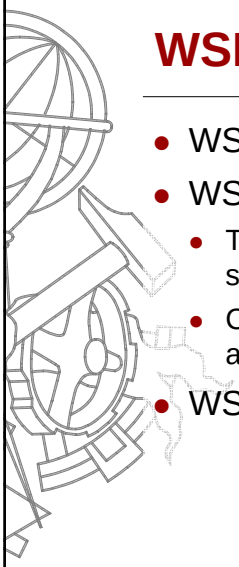
Definition of data types

Definition of messages

Definition of port type

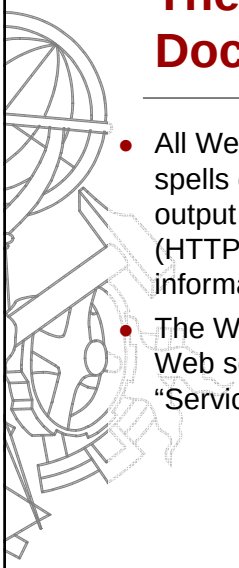
Definition of the bindings

Definition of the service



WSDL Overview

- WSDL is extensible.
- WSDL was created by IBM and Microsoft
  - The intent was to create something that worked, not something that was complete
  - Creating a formal Web Services “data model” was *not* a priority
- WSDL is RDF-compatible (*not* RDF-compliant)

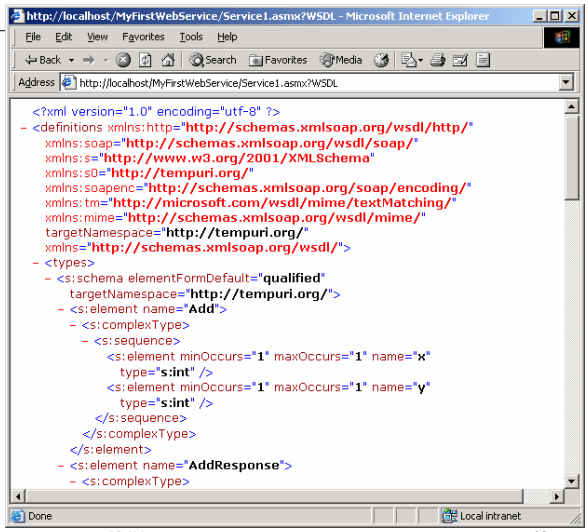


The Web Service’s WSDL Document

- All Web services contain a WSDL file that very precisely spells out the Web service’s methods, their input and output parameters, how the Web service can be invoked (HTTP-GET/HTTP-POST/SOAP), and other such information.
- The Web service description page contains a link to the Web service’s WSDL file (go to the first page and click the “Service Description” link)

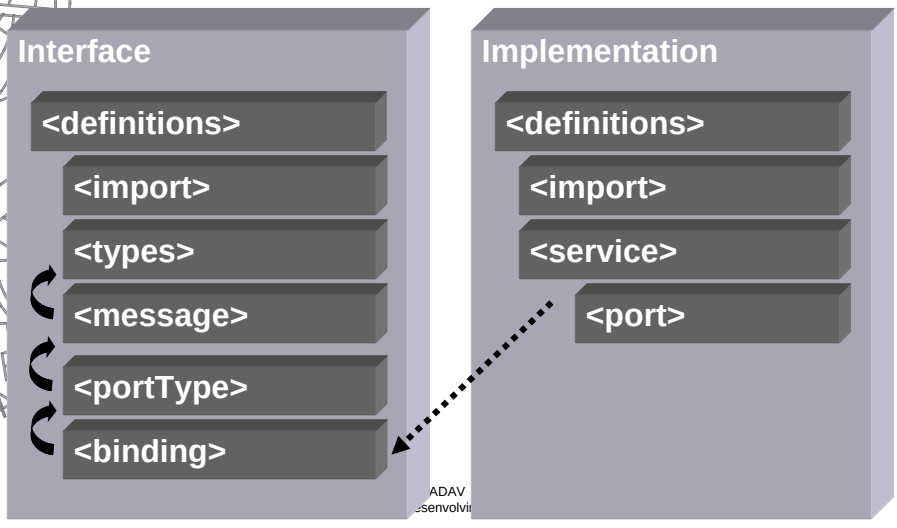
Web Service's WSDL Document

- The WSDL document is an XML-formatted document.

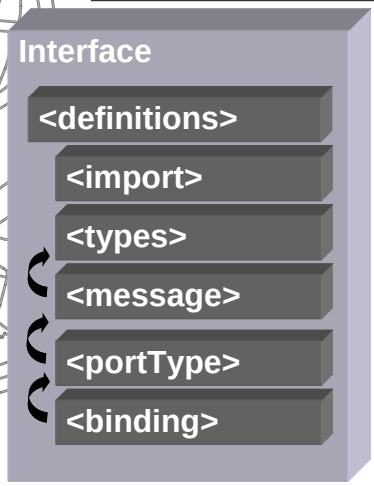


WSDL

WSDL Schema



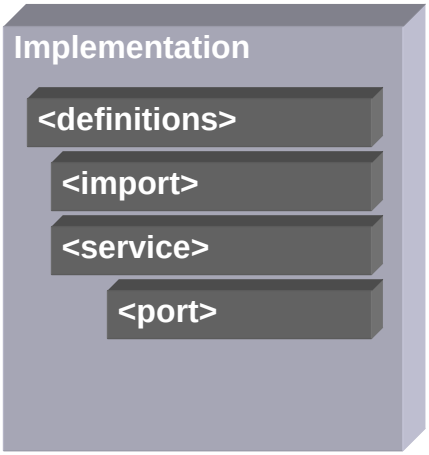
WSDL
WSDL Schema

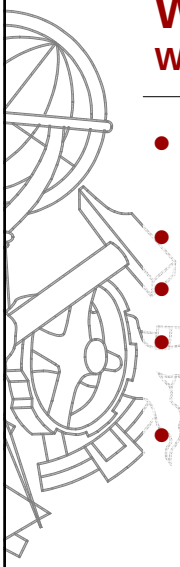


- **<definitions>**
  are root node of WSDL
- **<import>**
  allows other entities for inclusion
- **<types>**
  are data definitions - xsd
- **<message>**
  defines parameters of a Web Service function
- **<portType>**
  defines input and output operations
- **<binding>**
  specifies how each message is sent over the wire

WSDL
WSDL Schema

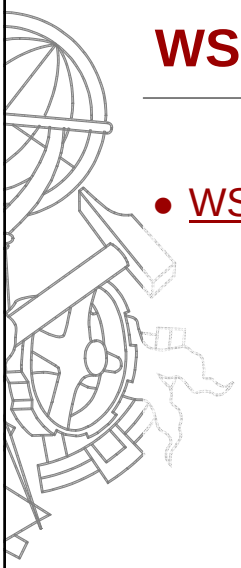
- **<service>**
  specifies details about the implementation
- **<port>**
  contains the address itself





WSDL
WSDL Elements

- Open – allows for other namespaces and thus highly extensible
- Ability to import other schemas & WSDL
- Provides “recipe” for Web Services
- Provides both interface and implementation details
- Allows for separation of the two



WSDL Example

- WSDL do WS Calculadora

Web Services Standards Stack

Directory: Pblish & Find Services:	UDDI
Description: Formal Service Descriptions:	WSDL
Wire Format: Service Interactions:	SOAP
Universal Data Format:	XML
Ubiquitous Communications:	Internet

Simple, Open, Broad Industry Support

What is UDDI?

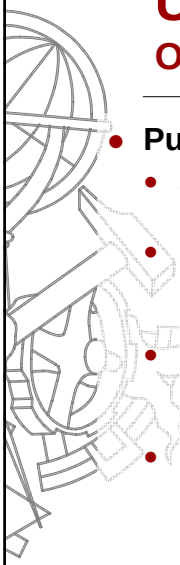
- UDDI is a project started by Microsoft, IBM, and Ariba and is being publicly launched September 6th.
- The goal of UDDI is to accelerate the adoption of B2B commerce by providing businesses with a standard way to programmatically describe their own Web Services while making it easier to discover the Web Service capabilities of their trading partners and customers.
- UDDI does this through a set of specifications for service description and through the shared operation of a Business Registry on the web.
- UDDI is based on XML and SOAP and is a core component of Microsoft's .NET strategy.
- Over 30 companies, including Sun Microsystems, have joined the project.

UDDI
Overview

- **UDDI** = **U**niversal **D**escription, **D**iscovery, and **I**ntegration
  http://www.uddi.org
- Industry Initiative to address discovery
  - A registration database for Web Services
- Specifications
  - Schema for service providers and descriptions
  - API for publishing and searching
  - Developed on industry standards (XML, HTTP, TCP/IP, SOAP)
  - Applies to both XML and non-XML services
- Implementation
  - Public and private instances of specification

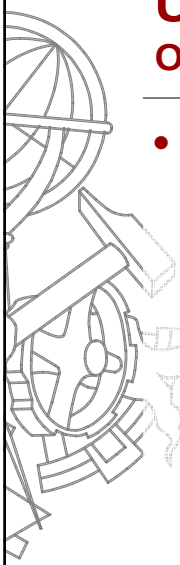
UDDI
Overview

- A number of companies (Microsoft, IBM, HP, etc.) run global UDDI Business Registries, which are a database of Web services.
- These directories can be searched via a Web site interface. For example, see: http://uddi.microsoft.com/ or https://uddi.ibm.com/ubr/registry.html



UDDI
Overview

- **Publishing activities**
  - All interactions that involve publishing require an authenticated connection.
  - Before you can start publishing data to a UDDI registry, you must first have visited the registry web site and selected a specific *UDDI Operator* that you'll use to manage your data.
  - Once you have selected an operator (there are many operators, each which manage a portion of the overall data), you'll sign up for publishing credentials.
  - You'll need these credentials (typically a user name and password pair) to connect to the UDDI publishing server before using any of the UDDI publishing API.



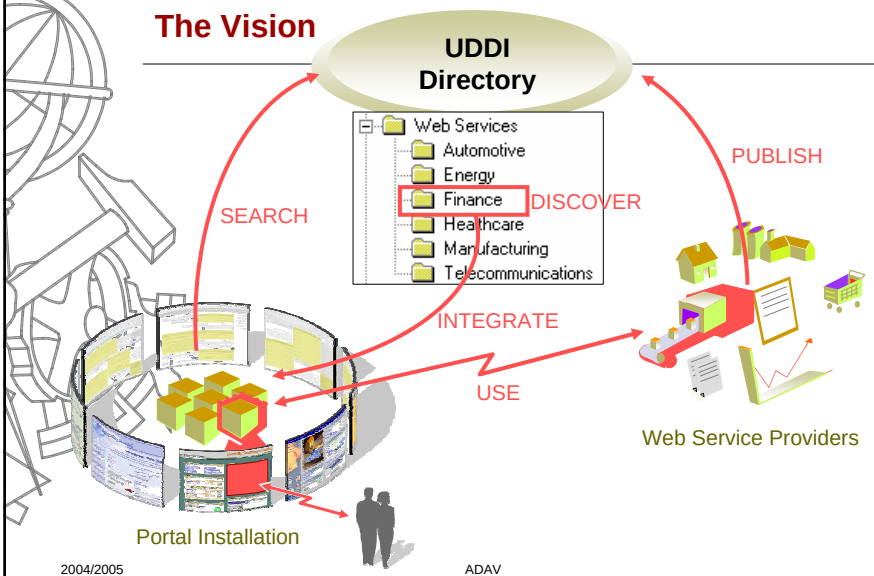
UDDI
Overview

- **Registering your organization**
  - One of the first tasks is to register your master organization information.
  - This is simply data about your business or organization, including the name of the organization, and optional description and contact information.
  - Several of the objects provided in the SDK are useful for registering data about your organization.

UDDI
Overview

- **Registering software that uses .Net services**
  - The main purpose of the UDDI registry is to let others know you exist and that you have .Net services exposed that can be used to interact with your business.
  - Common examples of these services will be for business document interchange – for documents such as purchase orders, invoices, shipping notices, etc.
  - Depending on the tools and products you use to manage your exposed services, you'll want to use the UDDI registry to advertise technical information about your service.

UDDI
The Vision

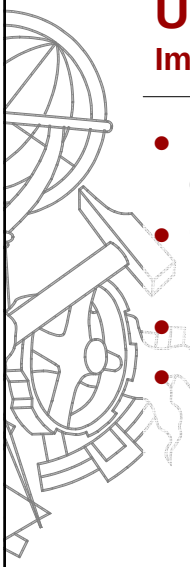


SOAP Workflow

UDDI

Providers, Services And Bindings

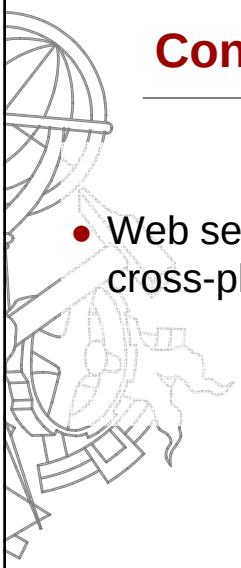
- Providers
  - Examples: Accounting Department, Corporate Application Server
  - Name, Description, Contact Information
  - Categorization and Identification Information
- Services
  - Examples: Purchase Order services, Payroll services
  - Name, Description(s)
  - Categorization Information
- Bindings
  - Description(s), access points, parameters
  - Examples: Access Point (http://...) for Web Service



UDDI

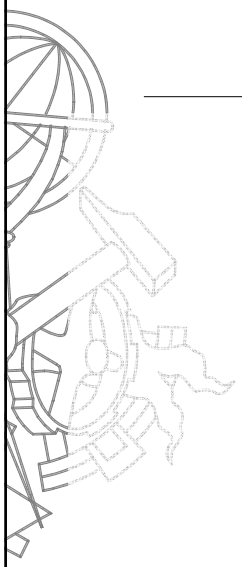
Important UDDI Features

- Neutral in terms of protocols – as a registry, it can contain pointers to *anything*
- Can search by business, service, Web Service (tModel), binding
- Usage of Globally Unique Identifiers (GUIDs)
- Specification allows public and private nodes



Conclusion

- Web services standards are the future of cross-platform interop



Questões

?