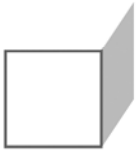




**CHAPTER 5**  
**WEB SERVICES DESCRIPTION  
LANGUAGE**



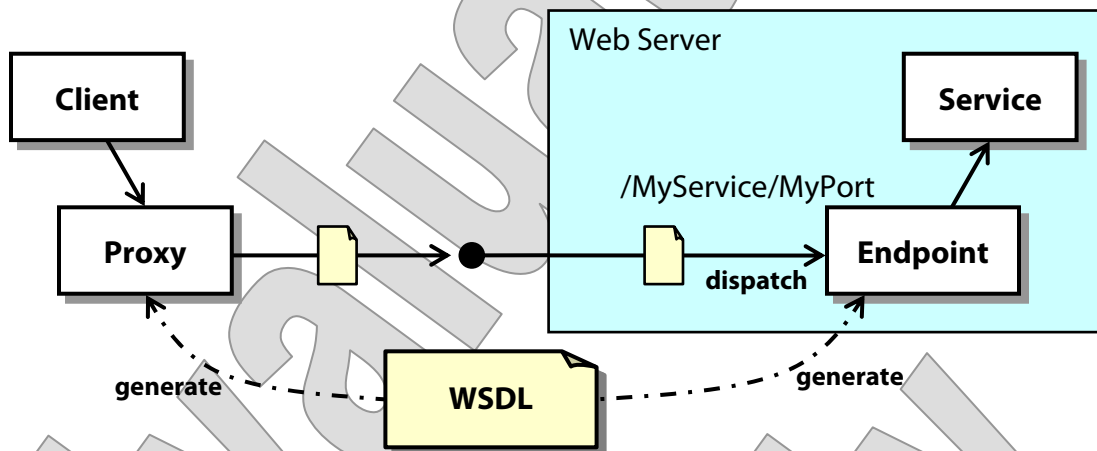
## OBJECTIVES

*After completing “Web Services Description Language,” you will be able to:*

- Explain the importance of providing full metadata for a web service, and how WSDL accomplishes this.
- Describe the WSDL model for creating one’s own
  - Abstract service models
  - Concrete service models
- Write WSDL documents to describe message and service types.
- Create bindings for a service description to a specific protocol, such as SOAP.
- Generate client code for a WSDL-described service.

## Metadata for Web Services

- As we discussed earlier, web services do not live by SOAP alone.
- Service **description** is a critical element of the architecture; there are several key benefits:
  - Developers can **understand the contract** in which their software will play a part – service, client, or intermediary.
  - One can **generate code** for either service or client development that handles the grunt-work of SOAP messaging:



- It's possible to **validate** message content at runtime – though this is not necessarily something we'd want to do for each request and response, for performance reasons.
- Metadata enables **dynamic invocation** and reception of messages, by general-purpose intermediaries or possibly as part of a rapid-application-development tool that helps users build composite applications from a set of available services.

## Web Services Description Language

---

- Broad consensus has formed around the **Web Services Description Language**, or **WSDL**, as the best means of providing the metadata necessary to web services and SOAs.
- WSDL is an XML vocabulary for describing web services.
- A WSDL descriptor defines:
  - **Message types** and their valid content
  - **Operations**, which can include one or more possible message types, in a scenario such as one message type for a request and one for a response
  - Service **interfaces**, essentially compositions of operations
  - Service **implementations** – or perhaps “defines” is the wrong verb for this one; let’s say WSDL “identifies” service implementations, which naturally will be written in some other language
  - **Bindings** between interfaces and implementations – in fact the choice of SOAP/HTTP is considered part of this binding, as the interface is not protocol-specific

## WSDL Namespaces

---

- The WSDL specification defines several namespaces for use in descriptors.
- The primary WSDL namespace URI is shown below; the common prefix is `wsdl:`, although descriptor documents often set this namespace as the default.

`http://schemas.xmlsoap.org/wsdl/`

- Remember the warning from the SOAP chapter about the importance of that trailing slash ...

- Each **binding** of WSDL to a possible messaging protocol is given its own namespace:

- The SOAP binding namespace, commonly prefixed **soap:**

`http://schemas.xmlsoap.org/wsdl/soap/`

- The HTTP binding namespace, commonly prefixed **http:**

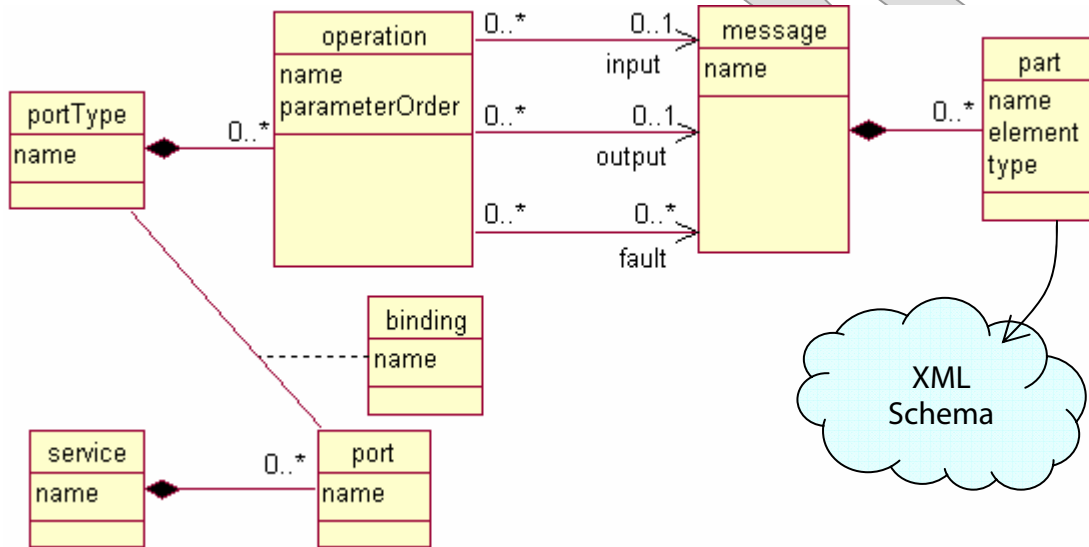
`http://schemas.xmlsoap.org/wsdl/http/`

- The MIME binding namespace, commonly prefixed **mime:**

`http://schemas.xmlsoap.org/wsdl/mime/`

## The Description Model

- WSDL is an XML vocabulary that uses seven main element types to describe a Web service:



- There are components to define an **abstract model** of behavior:
  - A `<portType>` is a named interface to a set of `<operation>`s.
  - Each `<operation>` describes a messaging scenario in terms of `<input>`, `<output>`, and `<fault>` messages.
  - Those `<message>` definitions comprise `<part>`s, which in turn use XML Schema global element and type definitions to fully explain the model of expected message content.
- Then other components can define the **concrete model**:
  - The `<service>` component identifies a web service proper.
  - A service as envisioned by WSDL can offer multiple `<port>`s (though in practice almost all services are single-port).
  - A `<port>` is guaranteed to implement a given `<portType>`, in a specific way that is described by a `<binding>`.

## A WSDL Document

**EXAMPLE**

- Here is a simple WSDL document – find this in **Examples/Math/JAX-WS/Step2/Service/WSDL/Math.wsdl**:

```
<definitions name="Math"><!-- Namespaces elided.-->
  <types/>
  <message name="Math.Request" >
    <part name="x" type="xsd:double"/>
    <part name="y" type="xsd:double"/>
  </message>
  <message name="Math.Response">
    <part name="return" type="xsd:double"/>
  </message>

  <portType name="Calculator">
    <operation name="Add" parameterOrder="x y">
      <input message="tns:Math.Request"/>
      <output message="tns:Math.Response"/>
    </operation>
    ...
  </portType>

  <!-- We'll look at the binding later. -->

  <service name="Math">
    <port name="Calculator"
      binding="tns: CalculatorBinding">
      <soap:address
        location="SERVER_WILL_COMPLETE"
      />
    </port>
  </service>

</definitions>
```

## WSDL and XML Schema

---

- A WSDL descriptor is not a W3C XML Schema document.
- But it has a close relationship with XML Schema.
  - A WSDL can embed an XML Schema, using its `<types>` component, and elements and types defined in that schema can be used in message `<part>`s.
  - A schema so embedded may also **import** other schema.
- WSDL also follows a number of patterns from XML Schema, and really is of a similar nature.
  - Both are **metamodels**: i.e. models for defining other models.
  - Both can be said to **populate a namespace** with type information: WSDL models govern web-service messaging interactions, and XML Schema models govern the XML content of a specific document or message.
  - Both WSDL's `<definitions>` and Schema's `<schema>` components have **targetNamespace** attributes

## Associations Between Components

---

- Another XML Schema pattern followed by WSDL is the use of both **composition** and **association** to connect components.
  - A `<portType>` is **composed** of `<operation>`s: it has direct child elements that represent the operations it offers.
  - An `<operation>` is **associated** with a `<message>`: it identifies the message by name and that name is matched to the unique name of a message component.
- You may notice something odd about the way names are matched, though – refer back to **Math.wsdl** to see this:
  - The **message** attribute used by an operation's `<input>` component to identify the message will include a namespace prefix.
  - The corresponding `<message>`'s **name** attribute will not.
- This is the rationale:
  - When **defining** a component, we're implicitly populating the WSDL's **target namespace**.
  - When **identifying** another component for association, however, there is **no implicit namespace** – nor should there be.
  - One WSDL must populate one namespace, but it might refer to components from many namespaces.
  - This is why, even though it may seem redundant in many cases, attributes that seek to identify other components must be **qualified names**.

## The portType and operation Components

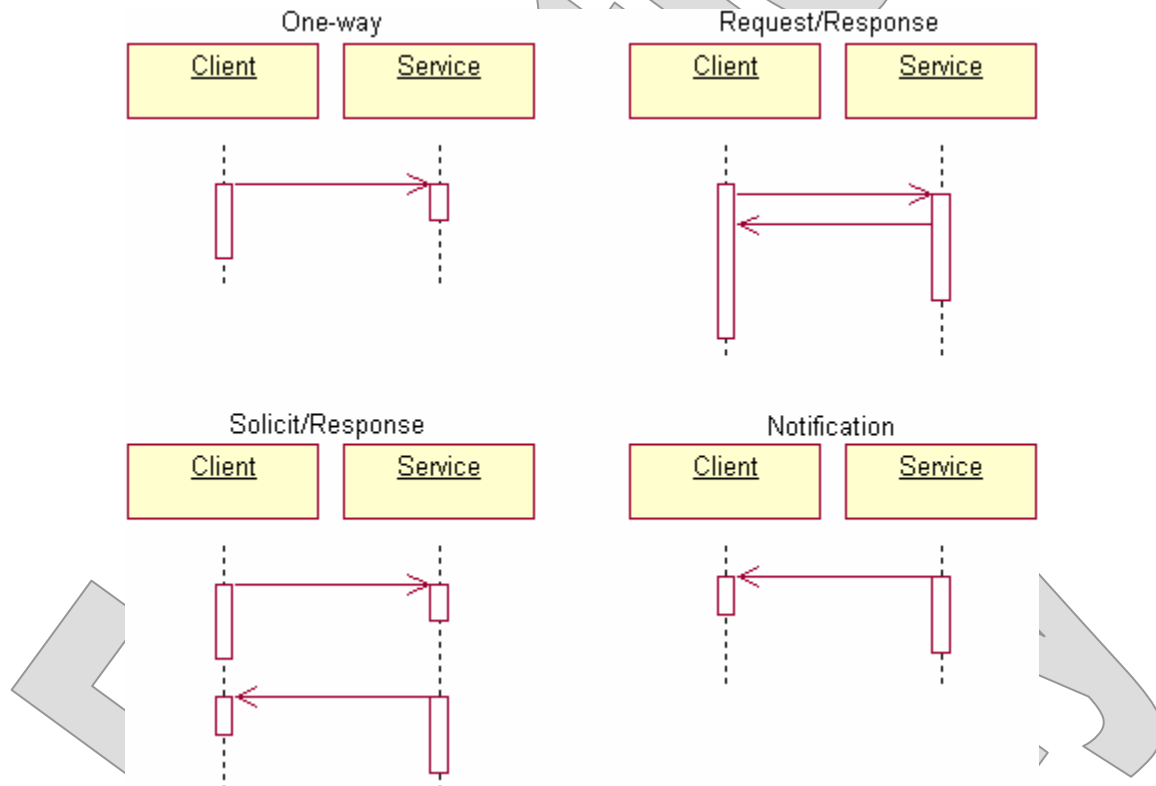
---

- A `<portType>` includes any number of `<operation>`s, and it has a name – that’s really the whole content model.
- `<operation>` is where the interesting stuff happens; it holds:
  - An optional `<input>` message
  - An optional `<output>` message
  - Zero-to-many `<fault>` messages
- As `<portType>` indicates an interface, `<operation>` is a method on that interface.
- Each input, output, or fault component identifies a `<message>`.
  - Each can also carry its own unique **name**, but this is rarely done for input and output since they are unique by type.
  - Faults are almost always named, even if there’s only one.
- Consider a hypothetical method in a programming language:  

```
double calculateMedian (double[] values);
```
- “calculateMedian” would be the name of a corresponding WSDL operation, and it would have input and output messages.
  - One or more faults would correspond to exception signatures.
- `<operation>` also has a `parameterOrder` attribute: this is a hint to processors – especially code generators – as to how the multiple parts of input and output messages might be arranged into a method signature.
  - We’ll consider this again when we look at mapping WSDL to Java.

## Operation Modes

- You've noticed that both input and output messages are optional.
- WSDL defines four **operation modes**, each of which indicates a different combination of input and output messages and different synchronization characteristics between them.



- The latter two are not intuitive, and they imply that the “client” can receive requests and is somehow registered with or known to the service.
- These two are really second-class citizens in the WSDL specification.
  - Bindings are only defined for **request/response** and **one-way**, and that’s where most tools put their effort as well.

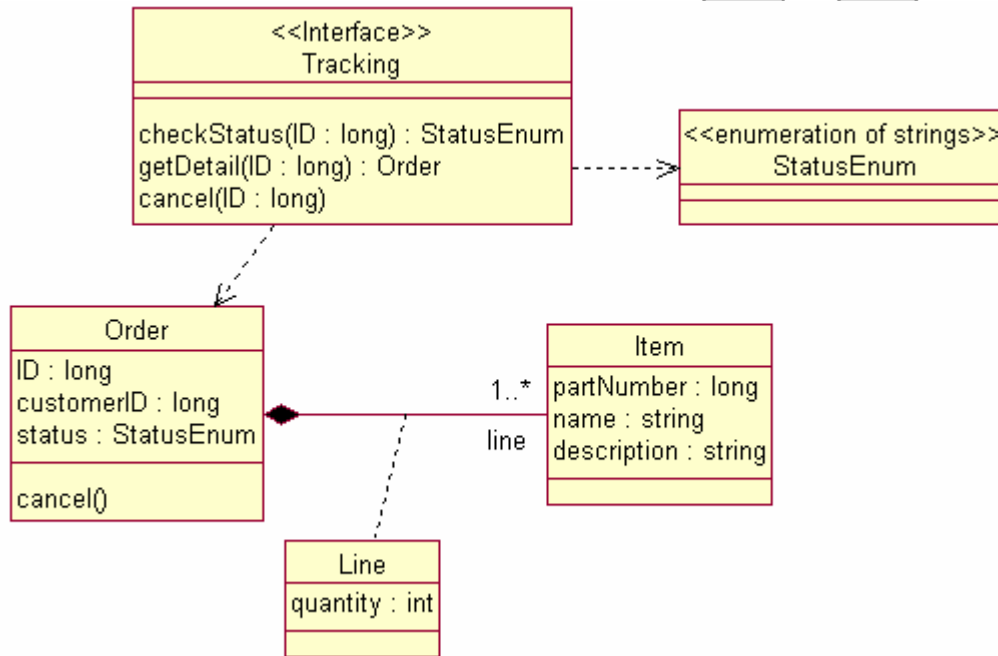
## The message and part Components

---

- The `<message>` element defines the exact information that's expected in a single message – whatever direction that message might travel, whatever it might be expected to mean.
  - Notice that inputs and outputs on multiple `<operation>`s can (re)use a given `<message>` definition.
- A `<message>` may have zero to many `<part>`s.
  - The total message content is understood to include the content models of each of the parts, in sequence.
- Each `<part>` has a **name** and must define its content in one of two ways:
  - Using a **type** attribute to identify an XML Schema complex type – in this case the part **name** may appear in the actual message
  - Using an **element** attribute to identify a global element definition – in this case we're identifying an element with its own name and type, so the part's **name** is irrelevant to the message content

## The Order-Tracking Service

- We'll look now at a new case study: an application that tracks information about product orders:



- The **Tracking** interface acts as a façade over a domain model:
  - **Orders** are composed of one or more **Lines**, each of which in turn defines some quantity of an **Item**.
  - An **Order** also has **status**, which is of an enumerated type.
  - The service is mostly concerned with checking order status and information, but has one mutator method that allows a customer to cancel an order, which of course changes the status field.
- In upcoming labs you'll build various pieces of this service – starting in this chapter, with its WSDL descriptor.

## Validating WSDL

---

- For our labs in this chapter we will need a WSDL-to-Java code generator.
- For this purpose we'll use the **wscmpile** tool that comes with the Java EE SDK.
- In fact this is a JAX-RPC compiler, not a JAX-WS compiler.
- The chapter's first lab really only needs a tool that can validate the WSDL descriptor, to help assure you're building the abstract model correctly.
- The second lab really will need generated code, to support a pre-written JAX-WS client. There, we'll start with **wscmpile** but then switch over to **wsimport**, which is the JAX-WS equivalent.
- At times during these labs, you'll run a script **validate.bat** that invokes **wscmpile**:

```
wscmpile -gen:client -keep -d Build config.xml
```

- This will result in some code generation as a by-product.
- Feel free to review this code, of course, but know that we'll be using a different tool, starting in the next chapter, that generates different code.

## An Abstract Model for Order Tracking

LAB 5A

**Suggested time: 30 minutes**

In this lab you will build the abstract WSDL model of messages for the Tracking service. For now, you will simply validate your descriptor; in a later lab you will use your completed descriptor to generate proxy classes which can be used by a prepared client application to invoke a prepared web service.

Detailed instructions are found at the end of the chapter.

Evaluation Only

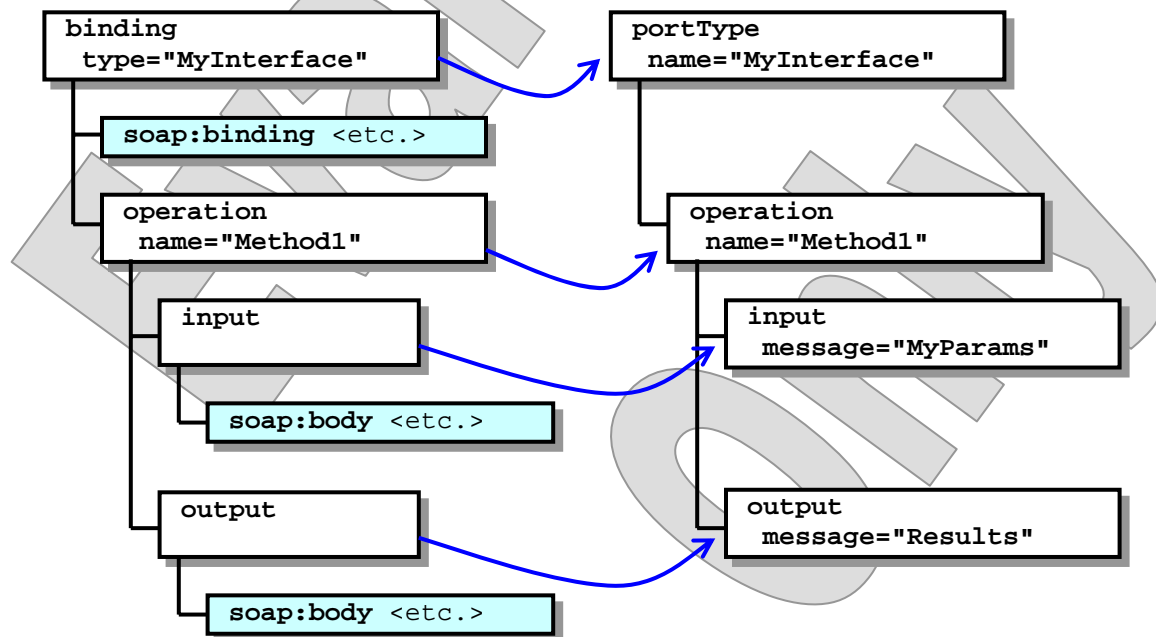
## Making it Real

---

- These abstract models are nice, but when do we get to define an actual running service?
- We'll look at the concrete-model components now, starting with `<service>`, which has a name and a collection of `<port>`s.
- A `<port>` promises to implement a `<portType>`, which is identified by way of a `<binding>`.
- `<port>` and `<binding>` are both in the WSDL namespace – they are standard WSDL components – but they usually rely on **extensibility elements** to say what they really need to say.
- The WSDL vocabulary allows the inclusion of elements from non-WSDL namespaces at various points in a descriptor.
  - These are called **extensibility elements**.
- The WSDL 1.1 specification defines bindings for a few common protocols – SOAP, HTTP, and MIME attachments – and others are possible.
- Each defined binding will occupy its own namespace.
  - Common usage is to set the WSDL namespace as the default and then use prefixes for the namespaces of various binding elements.
  - This leads to names such as **soap:binding** that, at first blush, may seem to be from the SOAP envelope namespace itself.
  - Remember that namespace prefixes can be assigned at the author's choice to any namespace URIs; SOAP is just an awfully common token in web services.

## The binding Component

- One WSDL component, the `<binding>`, exists just for the purpose of extending the abstract service model by playing host to various extensibility elements.
  - A `<port>` refers to a `<binding>`.
  - That `<binding>`, in turn, refers to a `<portType>`.
- The `<binding>`'s children are `<operation>`s – but these do not define new operations on the referenced port type.
  - Rather, each contains enough information to precisely **identify** an operation already defined in the port type.
  - These child elements are then combined with extensibility elements to **add** information specific to a target protocol.



## The SOAP Binding

---

- For SOAP-based services, the WSDL descriptor will include elements specific to SOAP messaging, which **bind** the abstract semantic definitions described thus far to a concrete SOAP implementation.
- Extensibility elements in this binding are:
  - `<soap:binding>`, which extends the abstract binding by defining the specific SOAP transport (for instance, SOAP over HTTP), and the messaging style as either “document” (the default) or “rpc”
  - `<soap:operation>`, which extends the abstract operation with attributes such as the related SOAP action URI
  - `<soap:body>`, which can extend an abstract message type by defining “encoded” or “literal” use, encoding rules, namespaces, and other attributes
  - `<soap:fault>`, which extends abstract fault messages the same way `<soap:body>` extends input and output messages
  - `<soap:address>`, which can be used to assign a real URI to an abstract component such as a service
- Remember that the WS-I BP requires
  - Only literal use, meaning schema rather than encoding schemes
  - Document or RPC style is fine, but it must be consistent over the whole port/type – no mixing and matching at the operation level

## Binding for the Math Model

**EXAMPLE**

- Here's the rest of the **Math.wsdl** from our earlier example:

```
<binding name="CalculatorBinding"
         type="tns:Calculator">
  <soap:binding
    style="rpc"
    transport=
      "http://schemas.xmlsoap.org/soap/http"
  />
  <operation name="Add">
    <input>
      <soap:body
        use="literal"
        namespace=".../WS/Math"
      />
    </input>
    <output>
      <soap:body
        use="literal"
        namespace=".../WS/Math"
      />
    </output>
  </operation>
  ...
```

- The binding reifies the abstract model as follows:
  - It identifies **SOAP over HTTP** as the messaging transport.
  - It says that all operations will be **RPC-style** – we'll talk about the practical impact of this in a moment.
  - It identifies the **namespace** in which the operation element is understood to exist.

## Document vs. RPC Style

---

- We've discussed the differences between document-style and RPC-style services already, but more in the abstract: you know it when you see it.
- In WSDL's SOAP binding, each style implies different arrangement of elements in the actual SOAP message – this is an entirely practical matter.
- In RPC style, the conformant SOAP message will have a single body element which represents the operation itself.
  - The element name will be that of the WSDL `<operation>`.
  - The namespace is defined by the corresponding `<soap:body>` element's `namespace` attribute.
- So, the conformant SOAP request for the **Add** operation as defined in the **Math.wsdl** would look like this:

```
<soap-env:Envelope ... >
  <soap-env:Body>
    <math:Add>
      <x>6.0</x>
      <y>3</y>
    </math:Add>
  </soap-env:Body>
</soap-env:Envelope>
```

- In a document-style binding of the same abstract model, the `<math:Add>` element would disappear, and the `<x>` and `<y>` elements would be direct children of the SOAP body.
  - Or we'd re-express this same model, using a different message type supported by an XML schema complex type – we'll try this later.

## The HTTP Binding

---

- **Strictly as an example of WSDL's extensibility, we'll survey the HTTP GET/POST binding.**
  - This binding can be used to describe interactions with a web application or service using HTTP GET/POST requests.
  - It is more aptly used with REST-based web services than with those that use SOAP.
- **HTTP extensibility elements are:**
  - `<http:binding>`, which identifies the HTTP binding itself and indicates which verb, GET or POST, is to be used
  - `<http:operation>`, which can define a URI relative to the address (below) for each abstract operation
  - `<http:address>`, which identifies the service location as a URI
  - `<http:urlEncoded>` and `<http:urlReplacement>`, which define two mutually-exclusive means of encoding the abstract message parts into the CGI string for GET requests
- **The HTTP binding also uses parts of the MIME binding, to define message parts that travel as attachments.**
- **We will not consider non-SOAP bindings any further in this course.**

## Dynamic Invocation

**EXAMPLE**

- In the next few chapters we'll be looking at JAX-WS, which of course relies on a WSDL compiler to generate Java code.
  - That code is then **statically bound** to a specific WSDL model.
- WSDL also enables **dynamic binding**, and as a rough illustration of this capability we'll now try out a dynamic web-services client application, found in **Examples/Dynamic**.
- This application reads a WSDL descriptor and dynamically populates choosers based on the components it finds there.
  - The user can select a **service**, and per service a **port**, and per port an **operation**.
  - The application then **populates** an area of the **GUI** with input controls based on the chosen operation's message signature. (The application can only handle input of single-value types.)
  - The user can enter argument values and **send a message** that should be valid according to the WSDL.
  - The **response** is interpreted into another dynamically-built GUI.
- The application is actually rather low-tech: it uses JAXP to parse the WSDL descriptor as XML, and SAAJ to perform SOAP messaging.
  - But it gives an idea what more ambitious APIs such as JAXB and JAX-WS can do (and JAX-WS does have some dynamic invocation capabilities).

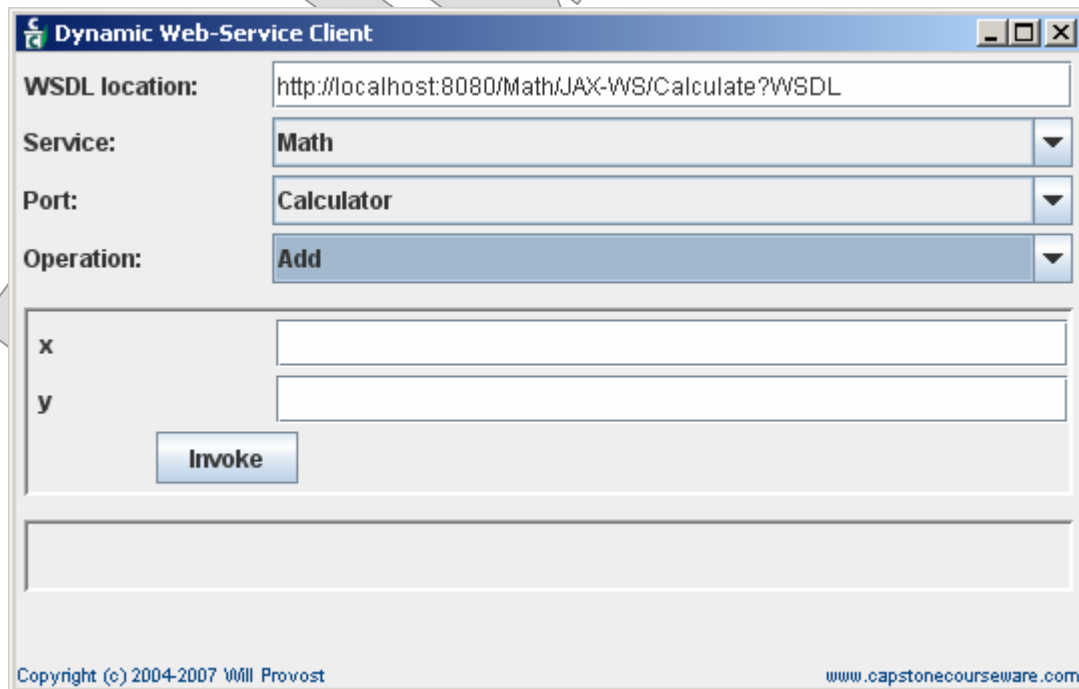
## Dynamic Invocation

**EXAMPLE**

- We'll need some target services, so if you haven't already built these, run **asant** from each of the following directories:
  - Examples/Math/JAX-WS/Step2/Service
  - Examples/Ellipsoid/JAX-WS/Service
- Run the dynamic client application using the **run** script.
- Enter the URI for the Math service descriptor, and hit TAB.

`http://localhost:8080/Math/JAX-WS/Calculate?WSDL`

- The application will pause while it downloads the WSDL file, and then will populate the combo boxes with information on available services, ports, and operations:



The screenshot shows a Java Swing window titled "Dynamic Web-Service Client". The window contains the following fields and controls:

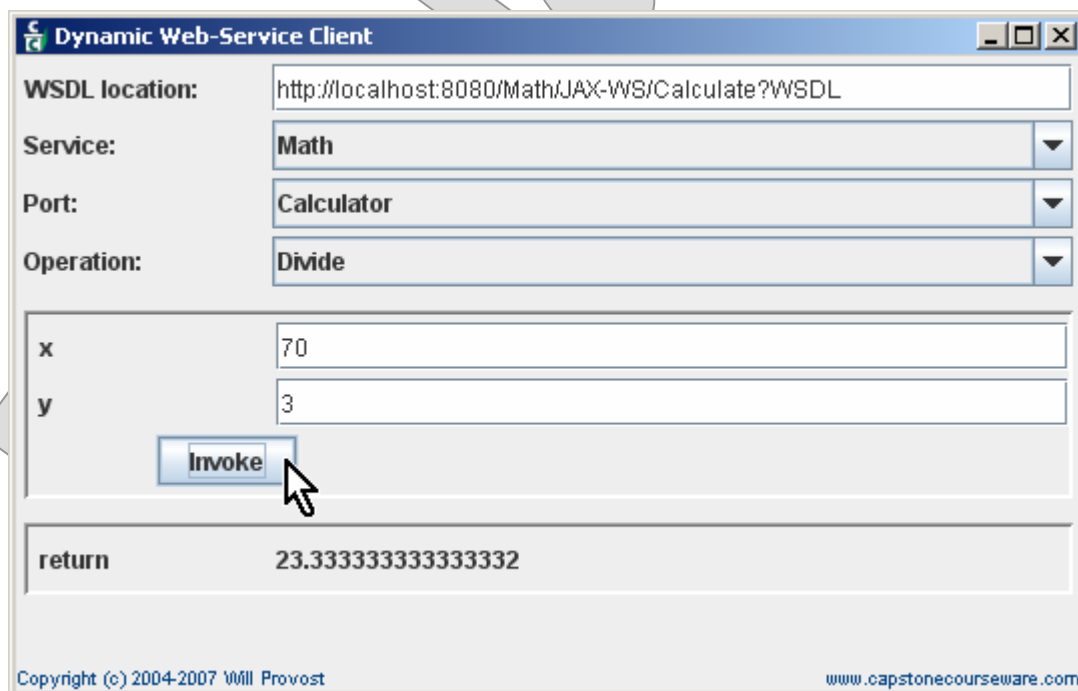
- WSDL location:** A text input field containing the URL `http://localhost:8080/Math/JAX-WS/Calculate?WSDL`.
- Service:** A dropdown menu with "Math" selected.
- Port:** A dropdown menu with "Calculator" selected.
- Operation:** A dropdown menu with "Add" selected.
- x:** An empty text input field.
- y:** An empty text input field.
- Invoke:** A button located below the input fields.

At the bottom of the window, there is a copyright notice: "Copyright (c) 2004-2007 Will Provost" and a website URL: "www.capstonecourseware.com".

## Dynamic Invocation

**EXAMPLE**

- Tab through the combo boxes, choosing whichever operation you like in the third one.
- Whenever you select from this combo box, the GUI will be populated with text fields labeled appropriately for the request message parts – in this case **x** and **y** arguments.
- You can enter values in these text fields and click the **Invoke** button.
  - When the service has responded, the result will appear in another addition to the GUI:



- You can also see the raw SOAP messages that were exchanged on your behalf by the application – these are echoed to the console.

## Dynamic Invocation

**EXAMPLE**

- Now we'll try the Ellipsoid service.
  - Enter the URI for the WSDL file, as shown below, and hit TAB.  
`http://localhost:8080/Ellipsoid/JAX-WS/Classify?WSDL`
  - Here you have no choice of service, port, or operation, but the input and output GUI sections do adjust to the different semantics for the **classify** operation.

The screenshot shows a window titled "Dynamic Web-Service Client". The "WSDL location" field contains the URL `http://localhost:8080/Ellipsoid/JAX-WS/Classify?WSDL`. The "Service" dropdown is set to "EllipsoidService", the "Port" dropdown is set to "EllipsoidUtility", and the "Operation" dropdown is set to "classify". Below these fields are three input fields labeled "a", "b", and "c", each containing the value "3". An "Invoke" button is positioned below the input fields, with a mouse cursor pointing to it. The "result" field displays the output "sphere". At the bottom of the window, the copyright information "Copyright (c) 2004-2007 Will Provost" and the website "www.capstonecourseware.com" are visible.

## A Concrete Model for Order Tracking

LAB 5B

**Suggested time: 30 minutes**

In this lab you will complete the WSDL document from Lab 5A by adding concrete information on service, port, and SOAP/HTTP binding. You will again validate your descriptor, and then you will use it in a full Ant build of the client application, using it to generate proxy classes on which a pre-written client application will depend for its SOAP messaging.

Detailed instructions are found at the end of the chapter.

Evaluation Only

## Publishing WSDL Descriptors

---

- How can potential clients find our service?
  - A WSDL is essential, but then where can clients find that?
- There are a few options, from simple to SOA-ambitious.
- WSDL documents are often published on a **website** alongside the services that they describe.
- A consensus has emerged recently on where to locate a service's WSDL document(s): simply add “?WSDL” to the service URI.

`http://localhost:8080/Tracking/Track?WSDL`

- Application servers implement this automatically – and they fix up the **location** attribute of the SOAP address component while they're at it, so that generated client proxies will find the service without help from the hand-written client software.
- There's a bit of a **chicken-and-egg problem** here, though: how would a client know the service URI, unless they'd see the WSDL?
- This address will also fall under any **security constraints** that you set on the service URI itself – you can't force authentication and authorization over the service endpoint without effectively hiding the WSDL, too.
- So it is sometimes good to deploy the WSDL in duplicate, at a sibling path such as the following:

`http://localhost:8080/Tracking/WSDL/Tracking.wsdl`

- In proper SOAs, WSDL addresses will also be published in UDDI repositories, naming services, and the like.

## SUMMARY

- **WSDL is the consensus solution to the problem of web-service description.**
  - It relies on XML Schema to express precise models for the content of individual messages.
  - It adds its own type information describing the service as a whole, including messaging scenarios (operations) and protocol specifics (bindings) that are gathered into service descriptions.
- **A WSDL description often becomes the “document of record” for a web service or system of services and client software.**
- **Again, it defines a contract, and this allows multiple parties to carry out their part of a larger business collaboration with confidence that**
  - The other roles are being filled
  - All parties will be able to interoperate when they need to
- **It’s a business question, rather than a technical question, who writes or owns the WSDL and who simply uses it.**
  - Several scenarios are possible, and we’ll be visiting many of them in the upcoming chapters.

# An Abstract Model for Order Tracking

**LAB 5A**

In this lab you will build the abstract WSDL model of messages for the Tracking service. For now, you will simply validate your descriptor; in a later lab you will use your completed descriptor to generate proxy classes which can be used by a prepared client application to invoke a prepared web service.

**Lab workspace:** Labs/Lab05A

**Backup of starter code:** Examples/Tracking/Step1/Client

**Answer folder(s):** Examples/Tracking/Step2/Client

**Files:** WSDL/OrderTracking.wsdl  
WSDL/OrderTracking.xsd

## Instructions:

1. Open the starter file **OrderTracking.wsdl**. The `<types>` section has already been written, and its schema imports the external document **OrderTracking.xsd** that defines the simple and complex domain types shown earlier. The **Tracking** service interface has not yet been defined, however.
2. Analyze the **Tracking** interface as depicted below and decide what SOAP message types you will need to describe. Note that each method on the interface will become an `<operation>`, and each operation will require a request message type and a response message type (that is, an `<input>` and an `<output>` message). So, you will define six message types at a maximum; remember, too, that message types can be reused by multiple operations. How many distinct message types do you see?

```

<<Interface>>
Tracking

checkStatus(ID : long) : StatusEnum
getDetail(ID : long) : Order
cancel(ID : long)

```

3. Clearly, since all three methods take a single **long** parameter, we will need a message type to carry this information. Define a `<message>` element with the name "OrderID". Give it a single `<part>` element as a child, with the name "ID" and the type **xs:long**.

**An Abstract Model for Order Tracking****LAB 5A**

4. The **checkStatus** method returns a status indicator; we will need a response message type to carry this information. Right after the `<types>` section, define a `<message>` called “Status” with a single part called “Status” whose type is **order:StatusEnum**.
5. Finally, the **getDetail** method returns a whole **Order**. Define a `<message>` called “Order” with a single part called “Order” whose type is **order:Order**.
6. Save the file and try validating at this point, by running the **validate** script.

**validate**

```
warning: WSDL document does not define any services
```

The warning message is normal – they’re right, after all, you haven’t defined any services! But **wscmpile** still has validated the abstract model you’ve written so far.

7. Now we have the fundamental message types defined; let’s move up a level and define the **Tracking** interface as a whole. This means creating a `<portType>` component, with the name “Tracking”.
8. For each of the three methods, define an `<operation>` element as a child of the `<portType>`. Give it the name of the corresponding method, and give it child elements `<input>` and `<output>`, each with a `<message>` attribute identifying the correct in or out message type. (Remember to provide the proper namespace prefix for each of the message names; the target namespace for the WSDL descriptor is **order**.)
9. Validate again, and fix any errors reported, until the tool runs cleanly.
10. One last thought: does the **cancel** operation really need an output message?

We could go either way here. Since no value will be returned, let’s make the operation one-way by removing the `<output>` component. This means that there will be no SOAP response to this request. We could also define an empty `<message>` – this is legal in WSDL, and it would mean that a SOAP response could be expected by the client, and the result element would be empty. Practically speaking this would also mean that the caller would block waiting for the service’s response, where for a one-way operation it would “fire and forget.”

11. With that last change made, compare your completed WSDL to the answer version.

## A Concrete Model for Order Tracking

**LAB 5B**

In this lab you will complete the WSDL document from Lab 5A by adding concrete information on service, port, and SOAP/HTTP binding. You will again validate your descriptor, and then you will use it in a full Ant build of the client application, using it to generate proxy classes on which a pre-written client application will depend for its SOAP messaging.

<b>Lab workspace:</b>	<b>Labs/Lab05B</b>
<b>Backup of starter code:</b>	<b>Examples/Tracking/Step2/Client</b>
<b>Target service:</b>	<b>Examples/Tracking/Step3/Service</b>
<b>Answer folder(s):</b>	<b>Examples/Tracking/Step3/Client</b>
<b>Files:</b>	<b>WSDL/OrderTracking.wsdl src/org/biz/Tracker.java</b>

### Instructions:

1. If you didn't do this in the previous demo, build the Tracking service now by running **asant** from the target service directory shown above.
2. Now, in the lab directory itself, open the starter file **OrderTracking.wsdl**. This is the completed version from the previous lab, and so includes the XML Schema and the abstract model: `<message>`, `<operation>`, and `<portType>` components.
3. Now you must describe the concrete service model using SOAP over HTTP. This means creating a `<binding>` component; call it "TrackingBinding".
4. The binding's **type** attribute identifies the port type that's being bound to a specific protocol implementation; set this to **order:Tracking**. (Note again the use of the namespace prefix to refer to a previously-defined type. However, note also that the child `<operation>` elements you're about to define will not need this prefix. The idea is that the binding has already qualified description to a certain port type, and so the operations within this binding can be named locally and reference child `<operation>`s of that port type.)
5. As the first child of the binding element, add a `<soap:binding>` element. (The **soap:** namespace prefix is already defined for this descriptor.) Give this element a **transport** attribute that identifies the HTTP transport by the URI shown below:

`http://schemas.xmlsoap.org/soap/http`

6. Set the attribute **style** to "rpc".

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7. As the second child of the binding element, add an `<operation>` with the name “checkStatus”. Give this both `<input>` and `<output>` child elements, and for each of these declare a single child element of the name `<soap:body>`. The body will define **use** as “literal”, and the **namespace** for the operation element – copy this URI from the **targetNamespace** for the WSDL descriptor itself, found at the top of the document.
8. Create an `<operation>` element for **getDetail**: other than the operation name, the content will be identical to the one you’ve just created for **checkStatus**.
9. Create a third `<operation>` element for **cancel**. This too is similar to **checkStatus**, except that as a one-way operation it will need no `<output>` binding.

This completes the binding descriptor; you now have described a concrete SOAP/HTTP messaging model.

10. Lastly you have to identify the service itself: create a `<service>` element with the name “TrackingService”. Its one child element will be a `<port>` element with the name “Tracking” and a **binding** attribute identifying **order:TrackingBinding**.
11. As a child of this `<port>` element, create a `<soap:address>` element, whose **location** attribute has this value:

```
http://LOCALHOST:8080/Tracking/Track
```

12. Validate your WSDL and fix any errors; the “no services defined” warning that you saw in the previous lab should go away now as well.
13. Now we’ll try to get this li'l descriptor into action. Take a quick look at the pre-built client code in **Tracker.java**, and note that it connects to the service through a **Track** class. This proxy implements the web service interface so that it has one Java method for each operation.

```
Tracking service = new TrackingService ().getTracking ();
```

Don’t go looking for **TrackingService.java** or **Tracking.java** – they doesn’t exist yet! They will be generated just in time, as part of the Ant build you’re about to do.

14. Run **asant**; you might want to take a look now in **build/classes/org/biz/ws** to see the generated Java classes (some of which you’ll recognize as pure XML-to-Java products under JAXB).

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15. Try the client application and you should see results as follows:

```
run check 2
BACK_ORDERED
run detail 2
Order details:
  ID:          2
  Customer ID: 3456
  Status:      BACK_ORDERED
              100 Darjeeling
              25 Lapsang Souchong
run cancel 2
Order canceled.
run check 2
CANCELED
```

You can also try these commands through the SOAPSniffer – just add the adjusted URL as an extra command-line argument:

```
run check 2 http://localhost:8079/Tracking/Track
BACK_ORDERED
```

**Optional Steps**

16. Try running the **Dynamic** application as in the demo, pointing it at the URI shown below:

```
http://localhost:8080/Tracking/Track?WSDL
```

Not all operations will work, and this shows the limitations of this little Java client application – it can only handle single-value parts, so it can't show a full order as returned by the **getDetail** operation.

