Chapter 5
Describing Web services

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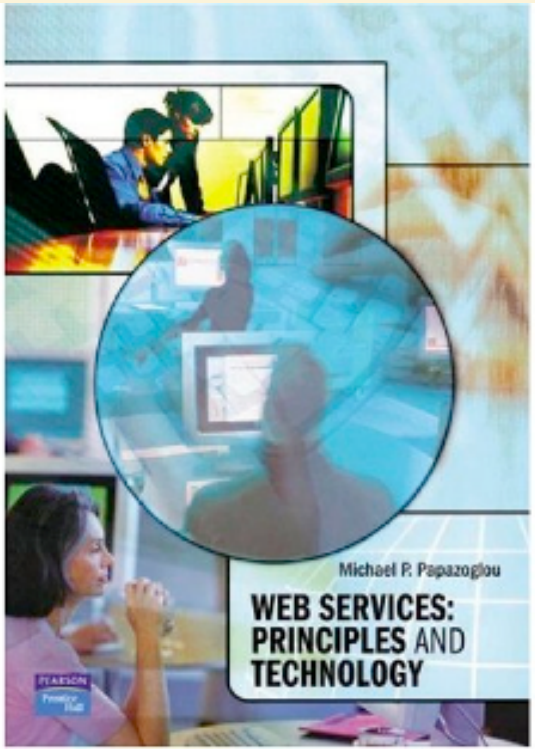

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Topics

- *Why is a service description needed?*
- *Web Service Description Language*

Why is a Service description needed?

- Web services must be defined in a consistent manner to be discovered and used by other services and applications. Web service consumers must determine the precise XML interface of a web service:
  - XML Schema alone cannot describe important additional details involved in communicating with a Web service.
- **Service description** reduces the amount of required common understanding and custom programming and integration:
  - It is a machine understandable standard describing the operations of a Web service.
  - It specifies the wire format and transport protocol that the Web service uses to expose this functionality.
  - It can also describe the payload data using a type system.
- **Service description + SOAP infrastructure** isolates all technical details, e.g., machine- and implementation language-specific elements, away from the service requestor's application and the service provider's Web service.

Topics

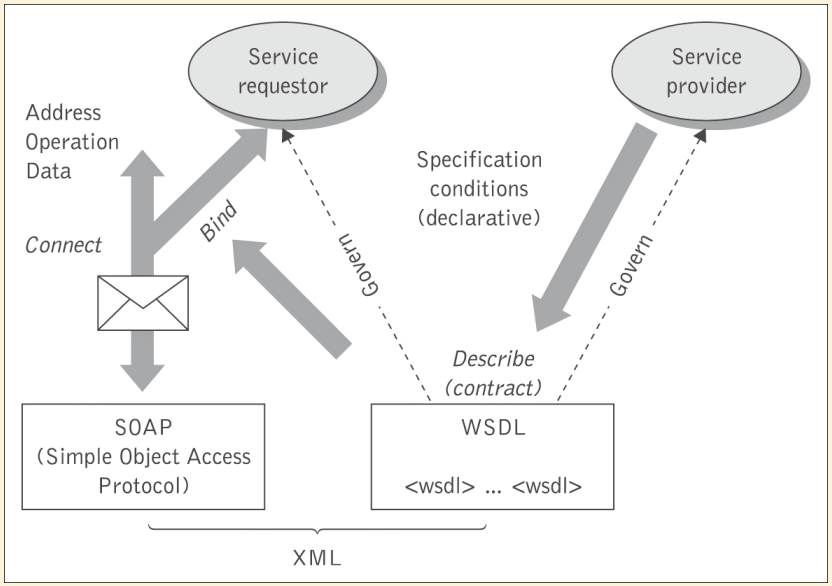
- *Why is a service description needed?*
- *Web Service Description Language*

Web Services Description Language

- The web services description language (WSDL) is the XML-based service representation language used to describe the details of the complete interfaces exposed by Web services and thus is the means to accessing a Web service.
  - For instance, neither the service requestor nor the provider should be aware of each other's technical infrastructure, programming language, or distributed object framework (if any).

WSDL as a contract

- A Web service description in WSDL is an XML document that describes the mechanics of interacting with a particular Web service.
- It is inherently intended to constrain both the service provider and the service requestor that make use of that service. This implies that **WSDL represents a "contract" between the service requestor and the service provider**
- WSDL is platform and language independent and is used primarily (but not exclusively) to describe SOAP-enabled services. Essentially, WSDL is used to describe precisely
  - ***what*** a service does, i.e., the operations the service provides,
  - ***where*** it resides, i.e., details of the protocol-specific address, e.g., a URL, and
  - ***how*** to invoke it, i.e., details of the data formats and protocols necessary to access the service's operations.



Characteristics of WSDL

- Operations and messages are described abstractly.
- Defines bindings to message formats and protocols:
  - Endpoints defined by binding concrete network protocol and message format to abstract operations and messages.
  - Can describe any endpoint regardless of the underlying network protocol or message format.
  - Defines how to locate the endpoint for the service:
    - Example: URLs for HTTP.
- Defines extensible SOAP and HTTP extensions.

Structure of WSDL documents

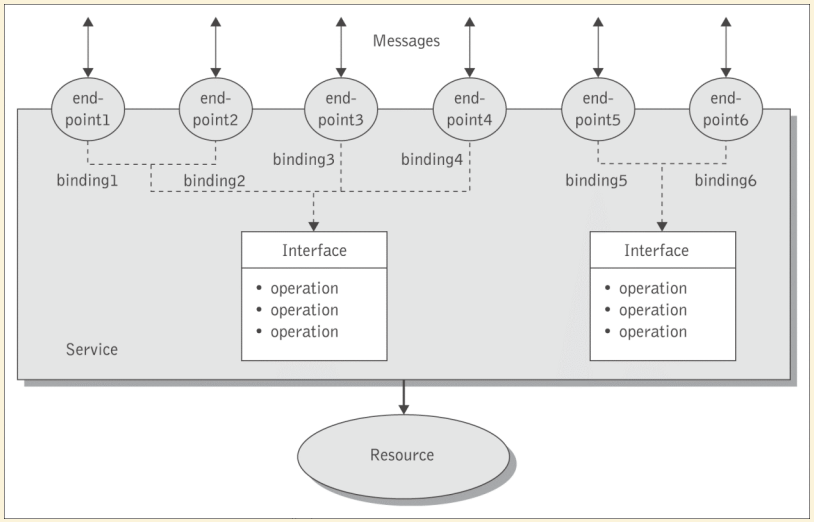
- WSDL documents can be separated into distinct sections:
  - The ***service-interface definition*** describes the general Web service interface structure. This contains all the operations supported by the service, the operation parameters, and abstract data types.
  - The ***service implementation part*** binds the abstract interface to a concrete network address, to a specific protocol, and to concrete data structures.
    - A web service client may bind to such an implementation and invoke the service in question.
- This enables each part to be defined separately and independently, and **reused** by other parts.
- The combination of these two parts contains **sufficient information** to describe to the service requestor how to invoke and interact with the Web service at a provider's site.
  - Using WSDL, a requestor can locate a web service and invoke any of the publicly available operations.

WSDL document content

- Abstract (interface) definitions
  - <types> data type definitions
  - <message> operation parameters
  - <operation> abstract description of service actions
  - <portType> set of operation definitions
- Concrete (implementation) definitions
  - <binding> operation bindings
  - <port> association of an endpoint with a binding
  - <service> location/address for each binding
- Also:
  - <import> used to reference other XML documents

Web Service Interface Definition

- WSDL specifies a grammar and syntax that describes Web services as a collection of communicating endpoints.
  - A complete WSDL definition contains all of the information necessary to invoke a web service.
- The data being exchanged between the **endpoints** are specified as part of messages and every kind of processing activity allowed at an endpoint is considered as an operation.
- WSDL is layered top of the XML schema and provides the means to group messages into operations and operations into interfaces.
  - Collections of permissible operations at an endpoint are grouped together into **port types.**
  - WSDL also provides a way to define **bindings** for each interface and protocol combination along with the endpoint address for each one.



```
<wsdl:definitions name="PurchaseOrderService"
    targetNamespace="http://supply.com/PurchaseService/wsdl"
    xmlns:tns="http://supply.com/ PurchaseService/wsdl"
    xmlns:xsd="http://www.w3.org/2001/XMLSchema"
    xmlns:soapbind="http://schemas.xmlsoap.org/wsdl/soap/"
    xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/">
  <wsdl:types>
    <xsd:schema
      targetNamespace="http://supply.com/PurchaseService/wsdl"
      <xsd:complexType name="CustomerInfoType">
          <xsd:sequence>
              <xsd:element name="CusNamer" type="xsd:string"/>
              <xsd:element name="CusAddress" type="xsd:string"/>
           </xsd:sequence>
      </xsd:complexType>
      <xsd:complexType name="POType">
          <xsd:sequence>
              <xsd:element name="PONumber" type="integer"/>
              <xsd:element name="PODate" type="string"/>
          </xsd:sequence>
       </xsd:complexType>
       <xsd:complexType name="InvoiceType">
          <xsd:all>
              <xsd:element name="InvPrice" type="float"/>
              <xsd:element name="InvDate" type="string"/>
          </xsd:all>
       </xsd:complexType>
    </xsd:schema>
  </wsdl:types>
  <wsdl:message name="POMessage">
      <wsdl:part name="PurchaseOrder" type="tns:POType"/>
      < wsdl:part name="CustomerInfo" type="tns:CustomerInfoType"/>
  </wsdl:message>
  <wsdl:message name="InvMessage">
      <wsdl:part name="Invoice" type="tns:InvoiceType"/>
  </wsdl:message>
  <wsdl:portType name="PurchaseOrderPortType">
      <wsdl:operation name="SendPurchase">
          <wsdl:input message="tns:POMessage"/>
          <wsdl:output message="tns:InvMessage"/>
       </wsdl:operation>
  </wsdl:portType>
</wsdl:definitions>
```

Abstract data type definitions

Data that is sent

Data that is returned

Port type with one operation

An operation with request (input) & response (output) message

Listing 1: Example of WSDL interface definition

<types> element

- The WSDL **<types>** element serves as a container that contains all abstract data types that define a Web service interface.
- A <type> element in WSDL is comparable to a data type in Java or C++.
  - WSDL uses a few primitive data types that XML schema definition (XSD) defines, e.g., **int, float, long, short, string, boolean**, and allows developers to either use them directly or build complex data types based on those primitive ones before using them in messages.
  - The data types and elements defined in the <types> element are used by message definitions when declaring the parts (payloads) of messages.
  - Any complex data type that the service uses must be defined using a <types> element.
- Listing 1 illustrates two complex types : **POType** and **InvoiceType**.

<message> element

- The **<message>** element describes the payload of a message used by a web service. A message consists of <part> elements, which are linked to <types> elements.
- In Listing 1, the PurchaseOrder service defines two <message> elements to describe the parameters and return values of that service.
  - POMessage (also below) describes the input parameters of the service, while
  - InvMessage represents the return (output) parameters.

```
<!-- message elements that describe input and output parameters for the
    PurchaseOrderService -->
<!--input message  -->
<wsdl:message name="POMessage">
      <wsdl:part name="PurchaseOrder" type="tns:POType"/>
      <wsdl:part name="CustomerInfo" type="tns:CustomerInfoType"/>
</wsdl:message>
<! -- outputput message  -->
<wsdl:message name="InvMessage">
      <wsdl:part name="Invoice" type="tns:InvoiceType"/>
</wsdl:message>
```

RPC-style message

```
<!-- message element that describes input and output parameters -->
<wsdl:message name="POMessage">
      <wsdl:part name="PurchaseOrder" element="tns:PurchaseOrder"/>
</wsdl:message>
```

Document-style message

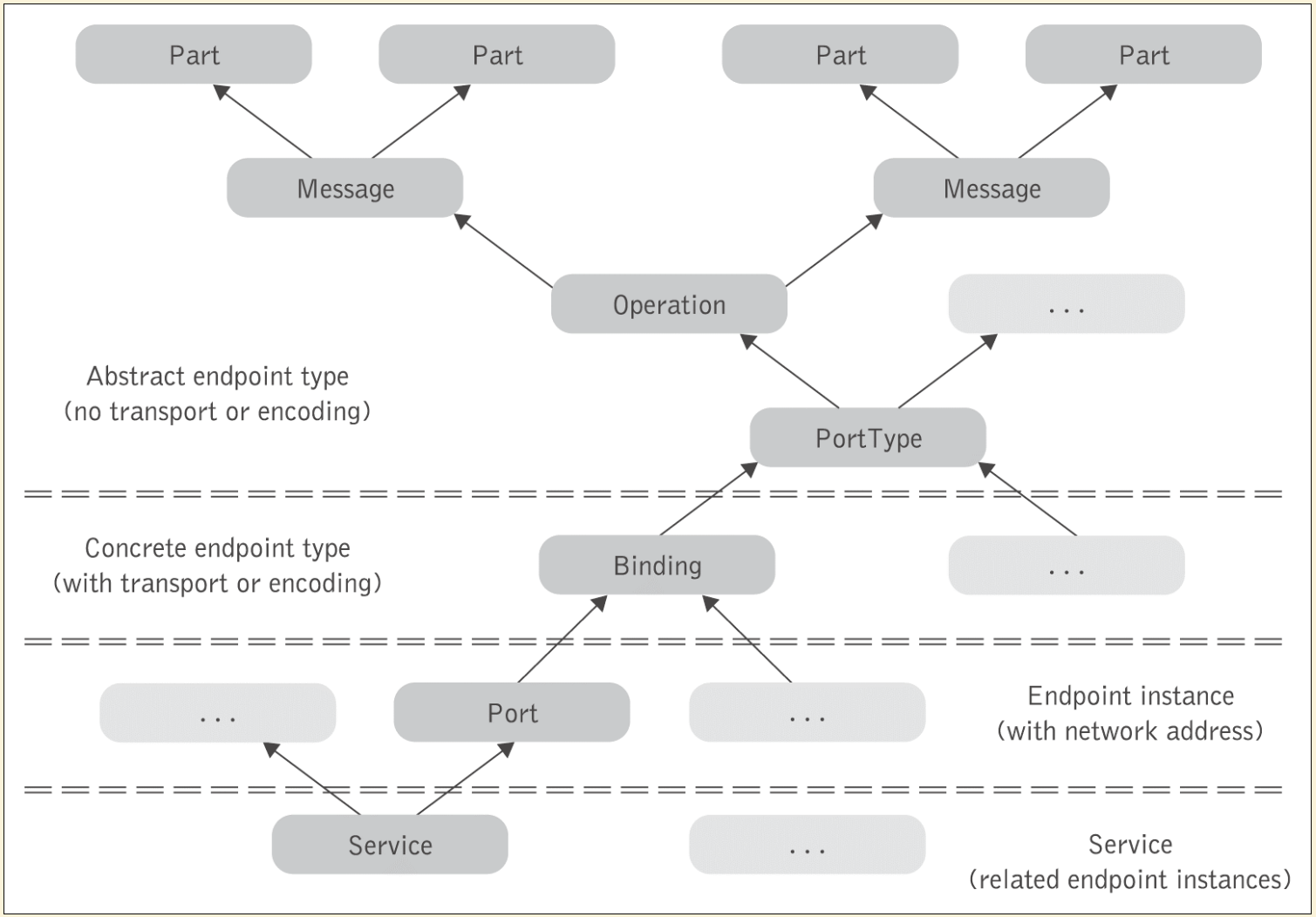
<portType>, <operation> elements

- A **<portType>** element defines an abstract type and its operations but not an implementation. A <portType> element is a logical grouping of **<operations>** in a Web service.
  - It describes the kinds of operations that a Web service supports – the messaging mode and payloads – without specifying the Internet protocol or physical address used.
  - The <portType> element is central to a WSDL description; the rest of the elements in the definition are essentially details that the <portType> element depends upon.
- Operations in WSDL represent the methods exposed by the service: they include the name of the method and the input and output parameters.
  - A typical <operation> element is composed of at most one <input> or <output> element and any number of <fault> elements.
- The WSDL example in Listing 1 contains a <portType> named PurchaseOrderPortType that supports a single <operation> called SendPurchase.

WSDL Implementation

- The purpose of WSDL is to specify a Web service abstractly **and then to define how the WSDL developer will reach the implementation of these services**.
- The service implementation part of WSDL contains the elements **<binding>**, **<port>,** and **<service>** and describes how a particular service interface is implemented by a given service provider.
- The service implementation describes
  - **where** the service is located, or more precisely;
  - **which network address** the message must be sent to in order to invoke the web service;
  - a **WSDL service element**.
- A service implementation document can contain references to more than one service interface document by means of <import> elements.

WSDL Elements Hierarchy



```
<wsdl:definitions> . …
   <import namespace="http://supply.com/PurchaseService/wsdl"
    location="http://supply.com PurchaseService/wsdl/PurchaseOrder-interface.wsdl"/>
 <!--  location of WSDL PO interface from Listing-1-->
 <!-- wsdl:binding states a serialisation protocol for this service -->
 <!--  type attribute must match name of portType element in Listing-1-->
 <wsdl:binding name="PurchaseOrderSOAPBinding"
                  type="tns:PurchaseOrderPortType">

   <!-- leverage off soapbind:binding synchronous style -->
   <soapbind:binding style="rpc"
                        transport="http://schemas.xmlsoap.org/soap/http/"/>

   <wsdl:operation name="SendPurchase">

    <!-- again bind to SOAP -->
    <soapbind:operation
      soapAction="http://supply.com/ PurchaseService/wsdl/ SendPurchase" style="rpc"/>

    <!-- furthur specify that the messages in the wsdl:operation use SOAP -->
     <wsdl:input>
       <soapbind:body  use="literal"
        namespace="http://supply.com/PurchaseService/wsdl"/>
     </wsdl:input>
     <wsdl:output>
       <soapbind:body  use="literal"
        namespace="http://supply.com/ PurchaseService/wsdl"/>
     </wsdl:output>

  </wsdl:operation>
 </wsdl:binding>

 <wsdl:service name="PurchaseOrderService">
   <wsdl:port  name="PurchaseOrderPort" binding="tns:PurchaseOrderSOAPBinding">
     <!-- give the binding a network endpoint address or URI of service  -->
     <soapbind:address location="http://supply.com:8080/PurchaseOrderService"/>
   </wsdl:port>
 </wsdl:service>
</wsdl:definitions>
```

Bind an abstract operation to this implementation and

map the abstract input and output messages to these concrete messages

Service name

Network address of service

Listing 2: Example of WSDL implementation

<binding>, <port>, <service> elements

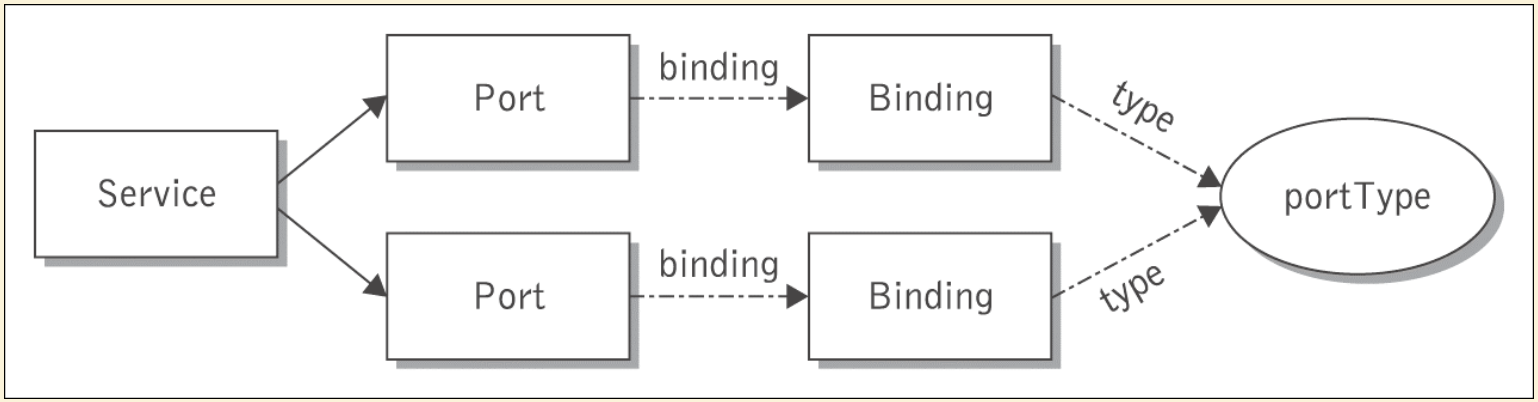
- The central element of the implementation description is the **<binding> element**. This element specifies how the client and Web service should exchange messages. The client uses this information to access the Web service.
- A <binding> element contains information of how the elements in an abstract service interface (<portType> element) are converted into concrete representation in a particular combination of
  - concrete protocols, e.g., SOAP or HTTP,
  - messaging styles, e.g., RPC or documents styles, and
  - formatting (encoding) styles, e.g., literal or SOAP encoding.
- A **<port> element** defines the location of a web service and we can think of it as the URL where the service can be found. A <port> associates an endpoint, for instance, a network address location or URL, with a specific WSDL <binding> element.
  - It is possible for two or more <port> elements to assign different URLs to the same <binding> element. This might be, for instance, useful for load balancing or fail-over purposes.
- A **<service> element** contains a collection (usually one) of WSDL <port> elements. Each <service> element is named, and each name must be unique among all services in a WSDL document.

Mapping the SendPurchase operation to an RPC-style SOAP message

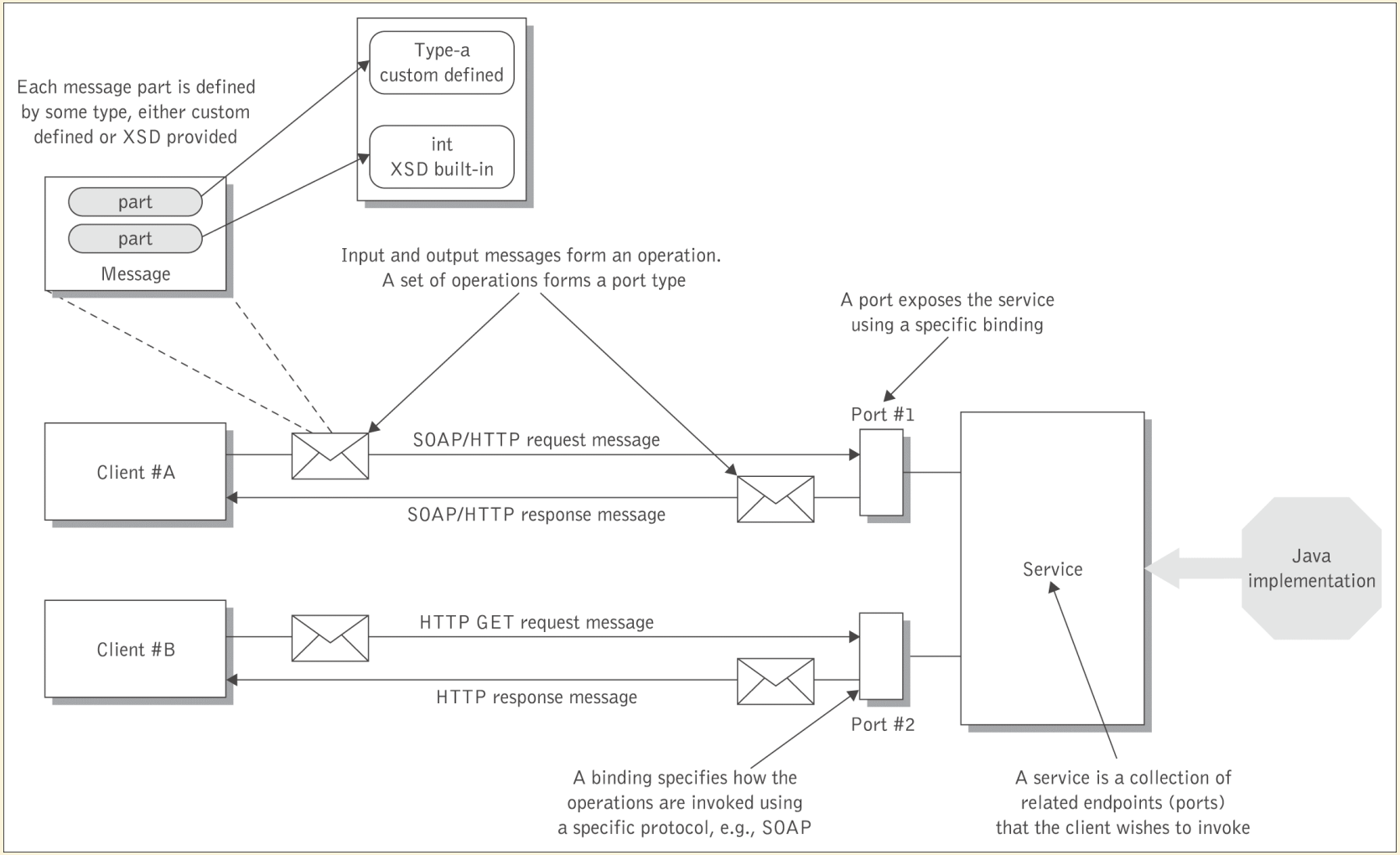
```
<wsdl:message name="POMessage">
      <wsdl:part name="PurchaseOrder" type="tns:POType"/>
      < wsdl:part name="CustomerInfo" type="tns:CustomerInfoType"/>
</wsdl:message>
<wsdl:message name="InvMessage">
      <wsdl:part name="Invoice" type="tns:InvoiceType"/>
</wsdl:message>

<wsdl:portType name="PurchaseOrderPortType">
      <wsdl:operation name="SendPurchase">
            <wsdl:input message="tns:POMessage"/>
            <wsdl:output message="tns:InvMessage"/>
      </wsdl:operation>
</wsdl:portType>

<wsdl:binding name="POMessageSOAPBinding"
                type="tns:PurchaseOrderPortType">

  <soapbind:binding style="rpc"
        transport="http://schemas.xmlsoap.org/soap/http/"/>
  <wsdl:operation name="SendPurchase">

  <soapbind:operation  style="rpc"
            soapAction="http://supply.com/ PurchaseService/wsdl/ SendPurchase"/>

    <wsdl:input>
       <soapbind:body  use="literal"
        namespace="http://supply.com/PurchaseOrderService/wsdl"/>
     </wsdl:input>
     <wsdl:output>
       <soapbind:body  use="literal"
        namespace="http://supply.com/ PurchaseOrderService/wsdl"/>
     </wsdl:output>
  </wsdl:operation>
</wsdl:binding>
```

```
<?xml version= "1.0"  encoding= "UTF-8" ?>
<soap:Envelope
xmlns:soapbind="http://schemas.xmlsoap.org/soap/envelope"
  xmlns:tns="http://supply.com/ PurchaseService/wsdl ">
    <soap:Body>
      <tns:SendPurchase>
        <POtype>
          <PONumber> 223451 </PONumber>
          <PODate> 10/28/2004 </PODate>
        </POtype>
          ……
      <tns:SendPurchase>
    </soap:Body>
</soap:Envelope>
```

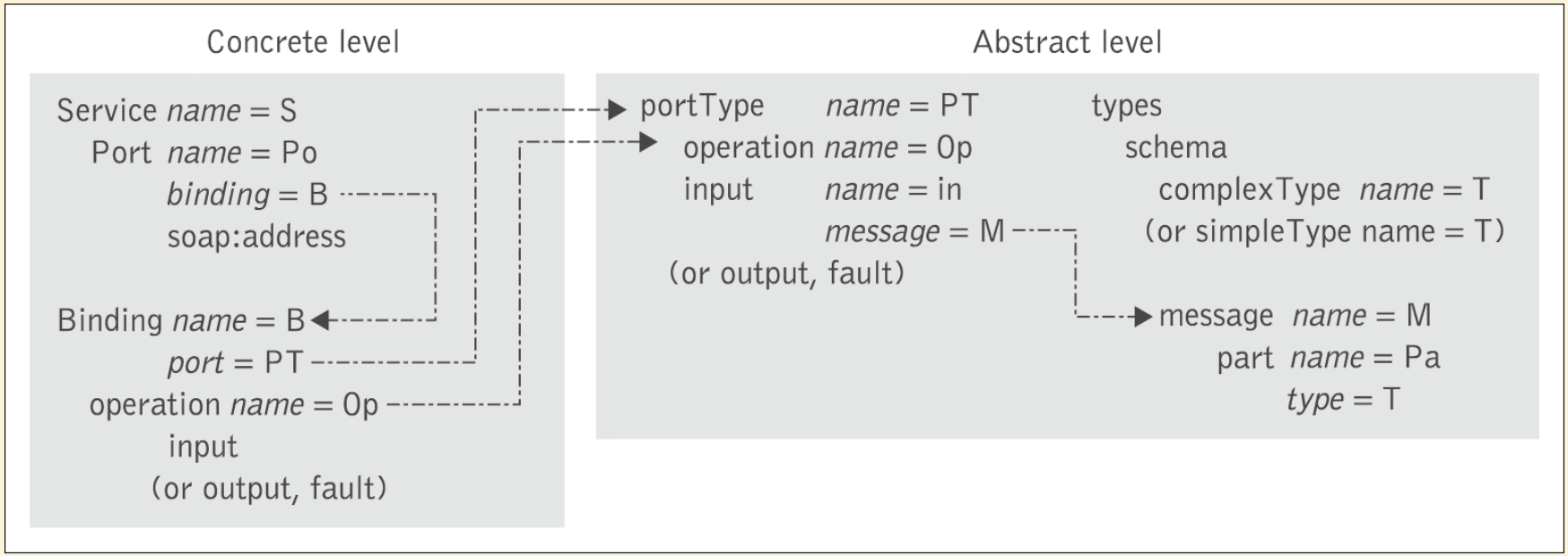
Connecting the service interface with the service implementation



Elements of WSDL as part of requestor–service interaction

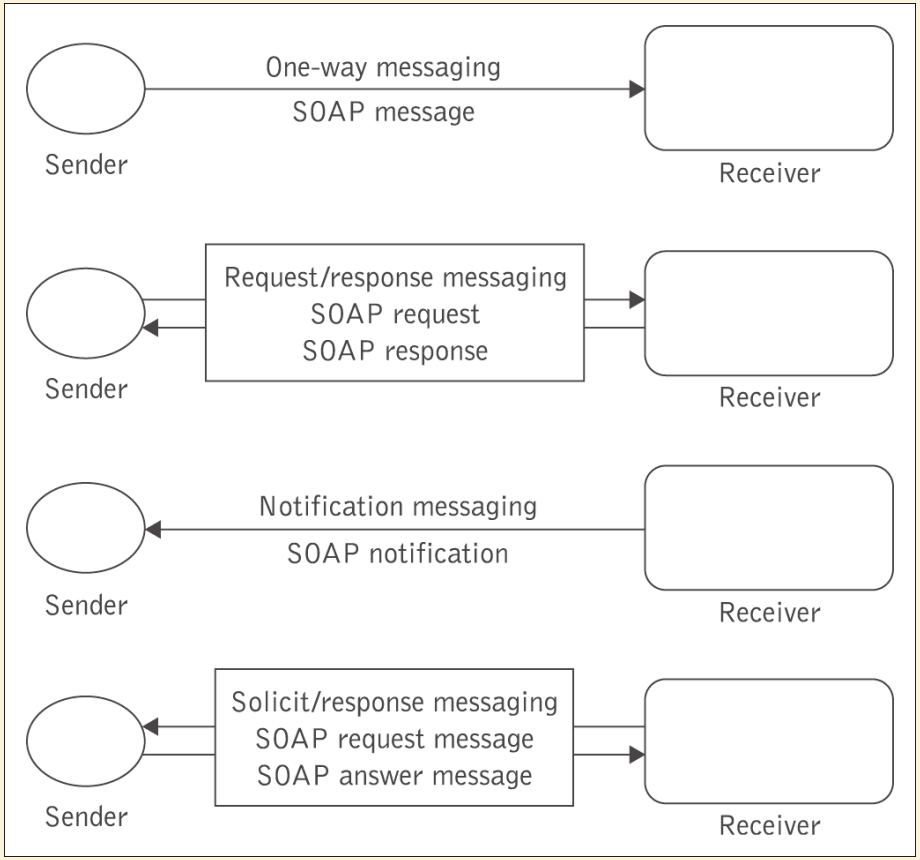


Connecting the abstract and concrete levels of a Web service.



WSDL Message Exchange Patterns

- WSDL interfaces support four common types of operations that represent possible combinations of input and output messages
- The WSDL operations correspond to the incoming and outgoing versions of two basic operation types:
  - an incoming single message passing operation and its outgoing counterpart ("one-way" and "notification" operations),
  - the incoming and outgoing versions of a synchronous two-way message exchange ("request/response" and "solicit response").
- Any combination of incoming and outgoing operations can be included in a single WSDL interface:
  - these four types of operations provide support for both push and pull interaction models at the interface level.



One-way operation

- A one-way operation is an operation in which the service endpoint receives a message, but does not send a response.
  - An example of a one-way operation might be an operation representing the submission of an order to a purchasing system. Once the order is sent, no immediate response is expected.
  - This message exchange pattern is typically thought of as asynchronous messaging. In an RPC environment, a one-way operation represents a procedure call to which no return value is assigned.
  - A one-way message defines only an input message. It requires no output message and no fault. Next to the request/response message exchange pattern, this is the most popular message exchange pattern employed today.

```
<!-- portTyepe element describes the abstract interface of a Web service -->
<wsdl:portType name="SubmitPurchaseOrder_PortType">
     <wsdl:operation name="SubmitPurchaseOrder">
          <wsdl:input name="order" message="tns:SubmitPurchaseOrder_Message"/>
     </wsdl:operation>
</wsdl:portType>
```

Request/response operation

- A request/response operation is an operation in which the service end point receives a message and returns a message in response.
- If an <operation> element is declared with a single <input> element followed by a single <output> element, it defines a request/response operation. By listing the <input> tag first, the <operation> indicates that the Web service receives a message that is sent by the client. Listing the <output> tag second indicates that the Web service should respond to the message.

```
<!-- portTyepe element describes the abstract interface of a Web service -->
<wsdl:portType name="PurchaseOrder_PortType">
     <wsdl:operation name="SendPurchase">
          <wsdl:input message="tns:POMessage"/>
          <wsdl:output message="tns:InvMessage"/>
     </wsdl:operation>
</wsdl:portType>
```

Notification operation

- A notification operation is an operation in which the service endpoint sends a message to a client, but it does not expect to receive a response.
- This type of messaging is used by services that need to notify clients of events.
  - Notification is when a <portType> element contains an <output> tag, but no <input> message definitions.
- Here the client (subscriber) has registered with the Web service to receive messages (notifications) about an event.
  - An example of this could be a service model in which events are reported to the service and where the endpoint periodically reports its status.
    - No response is required in this case, as most likely the status data is assembled and logged and not acted upon immediately.

Solicit/response operation

- A solicit/response operation is an operation in which the service endpoint sends a message and expects to receive an answering message in response.
- This is the opposite of the request/response operation since the service endpoint is initiating the operation (soliciting the client), rather than responding to a request.
- Solicit/response is similar to notification messaging, except that the client is expected to respond to the Web service.
- With this type of messaging the <portType> element first declares an <output> tag and then a <input> message definition – exactly the reverse of a request/response operation.
  - An example of this operation might be a service that sends out order status to a client and receives back a receipt.