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Web Services Descriptions and SOAP messages

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OVERVIEW

Goals –

- **To be able to understand**
  - **WSDL definition for a standard SOAP binding**
  - **A soap message**

- **Structure**
  - SOAP Messages
  - General Structure of WSDL
  - Details of abstract Service Definition
  - Details of Physical Service Definition - Core
  - Physical Service Definition - Extensions

"SOAP" what it is

- **Name**
  - Originally – Simple Object Access Protocol
  - Temporarily – Service Oriented Architecture Protocol ?
  - Now (SOAP 1.2) – Not an acronym
- **Purpose**
  - A extensible protocol to enable the exchange of
    - structured and typed information
    - between peers
    - in a decentralised, distributed environment
- **Status**
  - SOAP 1.2 – http:www.w3.org/TR/soap12-part0
    - W3C recommendation, June 2003
  - **SOAP 1.1** – http://www.w3.org/TR/NOTE-SOAP-20000508
    - W3C submission May 2000 – but that's what people use currently

Main Architectural Features

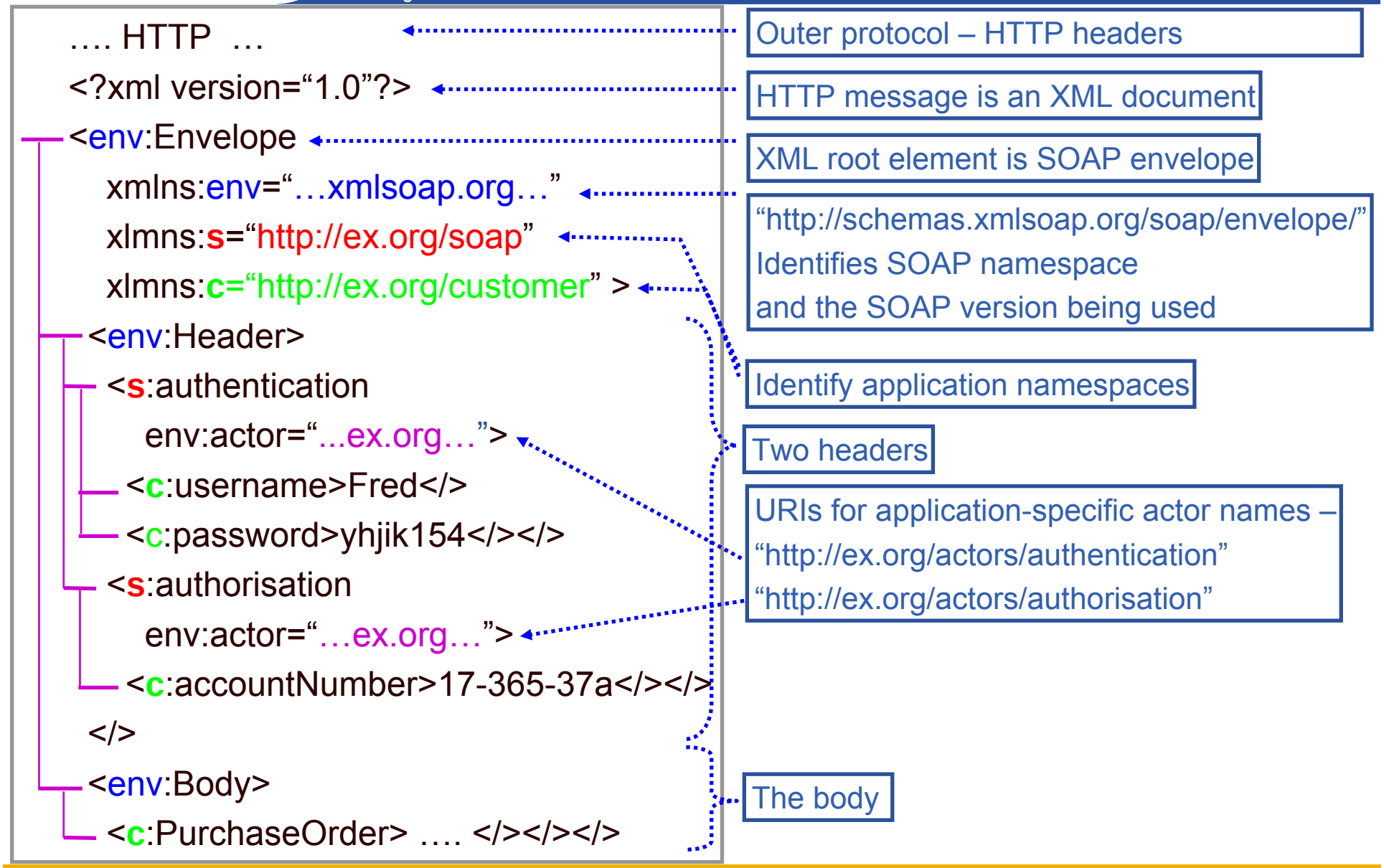
- **XML based**
- **Higher order Protocol –**
  - Built on some underlying protocol - binding
    - Extensibility – can define binding for any underlying protocol
    - Usually HTTP – a specific standard extension
- **Single Message Protocol**
  - Defines standard for a single message communication
  - Multi-message conversations require a means to associate one message with another
    - Via underlying protocol (e.g. use of same connection)
    - Via the application (specific message-id information as part of the soap message)
- **Multi-stage message processing –**
  - The soap Processing model

Message Structure

Each SOAP message will have:

- **Outer layer(s) for underlying protocols**
  - Only consider HTTP
- **Envelope (XML root element)**
- **Header (optional)**
  - Multiple header blocks/entries
  - For different purposes – factorisation
  - For different processing stages
    - Actors
- **Body (mandatory)**
  - The payload
  - Zero or more XML elements
  - May be a Fault element
    - Specific fault reporting standard

XML Message Representation



Types

- Simple value in a SOAP message will have a type as in Schemas standard, which defines their lexical form
- Soap provides two compound types
  - Se:Struct – components are uniquely named
  - Se:Array – components are identified by position
- Array is of type SEnc:Array or some derivative thereof
- Can specify shape and component type using attribute SEnc:arrayType

```
<element name="A" type="SEnc:Array"/>
```

Schema

```
<A SEnc:arrayType="xsd:integer [2,3] [2]">
    <A1>
        <n>111</n> <n>112</n> <n>113</n>
        <n>121</n> <n>122</n> <n>123</n>
    </>
    <A2>
        <n>211</n> <n>112</n> <n>213</n>
        <n>221</n> <n>122</n> <n>223</n>
    </> </>
```

Message

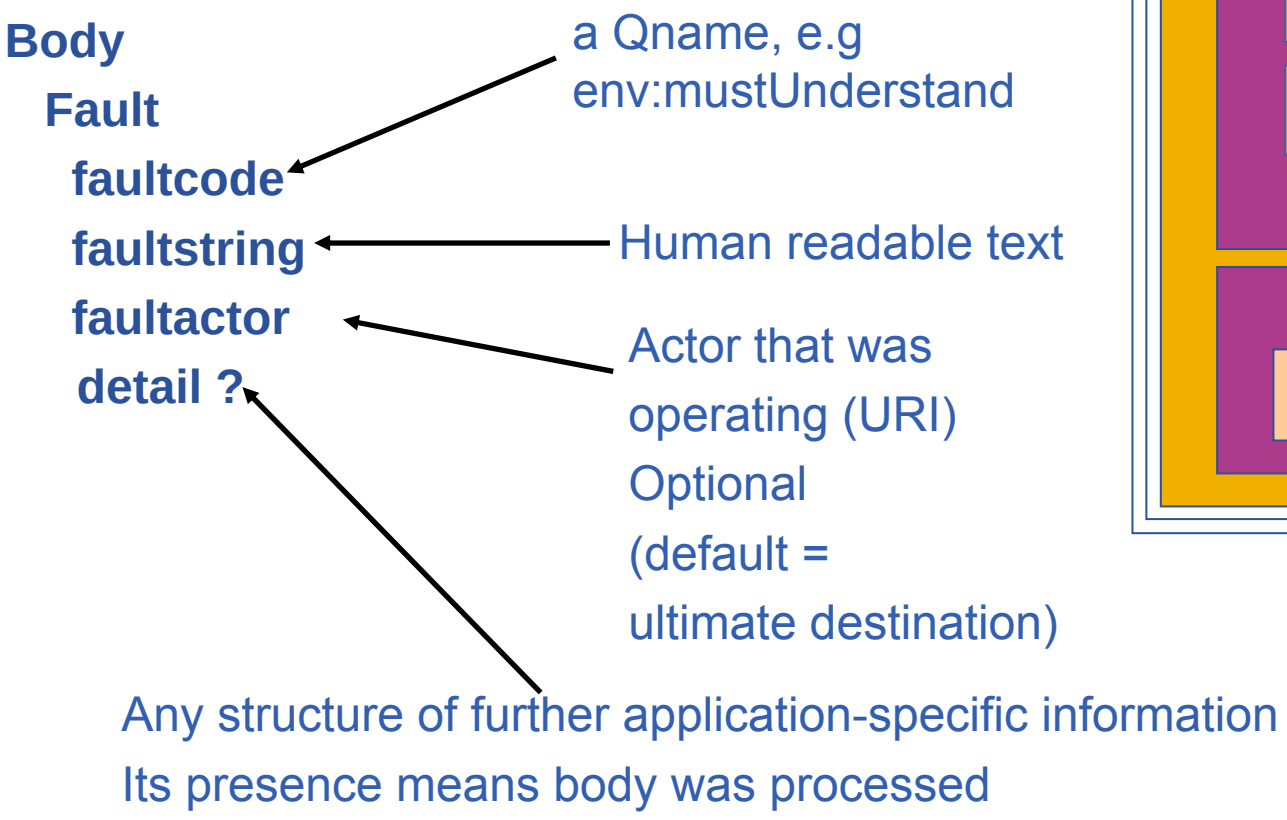
- **[2] - An array of 2 elements -**
- **[2,3] Each is a 2 x 3 array of**
- **Xsd:integer – standard schema type**

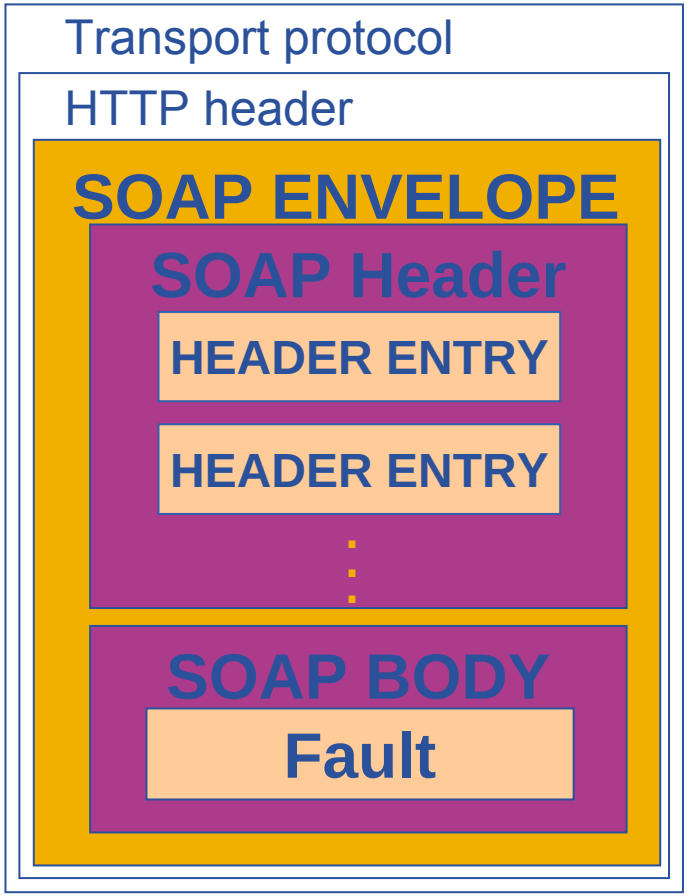
SOAP Faults

Faults reported in the body – single element

Zero or more header entries –

for detail error information pertaining to original header entries





Fault Message Example

```
<env:Envelope … >
  <env:Body >
    <env:Fault>
      <env:faultcode>env:Server</>
      <env:faultstring>Server Error</></>
      <env:detail
            xlmns:f="http://ex.org/faults"
            env:encodingStyle="…">
        <f:faultdetail1>
          <f:faultcode>129</>
          <f:excuse> not my fault really </> </>
        <f:faultdetail2> …. </></></></></></></>
```

Standard error code

Explanation

Application-specific Error code

Explanation

The Standard Fault Codes

- **env:VersionMismatch**
  - Un-recognised namespace for the env:Envelope
- **env:MustUnderstand**
  - A mandatory header entry was not understood
- **env:Client**
  - It's your fault (e.g. wrong info. In body); re-send won't work.
  - Must have detail element
- **env:Server**
  - It's our fault (e.g an upstream processing node not responding).
  - Might succeed if sent later.
  - Can have detail element

WSDL

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  - General Structure of WSDL
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  - Details of Physical Service Definition - Core
  - Physical Service Definition - Extensions

What is WSDL ?

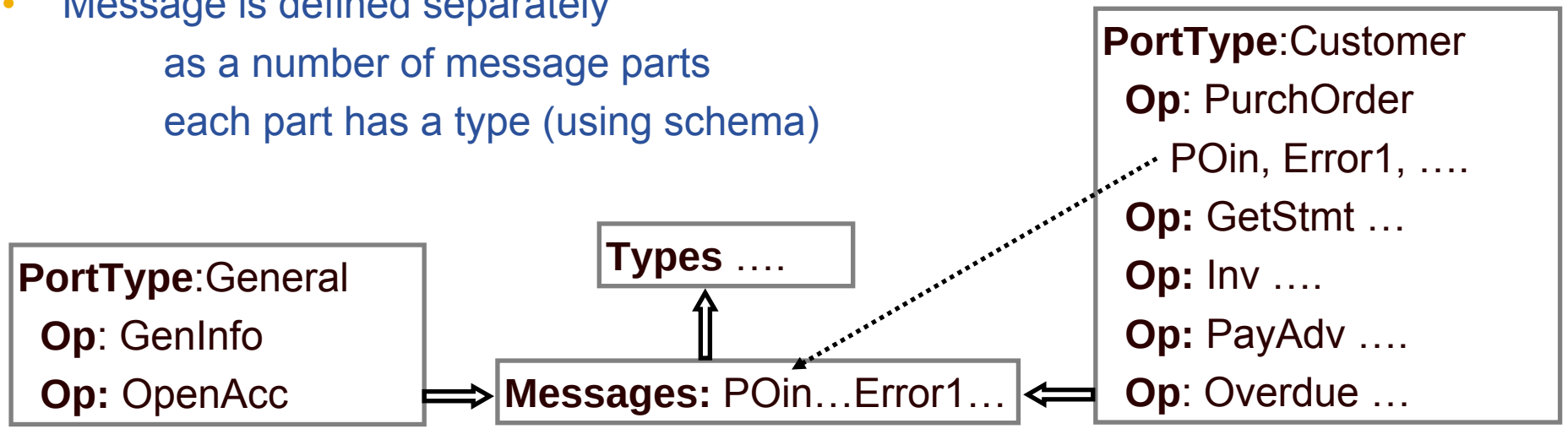
- **An XML format**
- **For describing network services**
  - Operates either on
    - Documents
    - Procedure calls
  - Describes the **exposed** interface –
    what the consumer sees of the service
  - Constitutes a contract with the client
    - Provides a specification of what is offered by the service provider which can be relied on by the service consumer
- **Supports Separation of concerns**
    - abstract structure – operations and messages
    - binding to a specific underlying protocol
    - definition of a particular deployed service
  - To allow common definition and re-combination
- **Here using WSDL 1.1 – a W3C submission (March 2001)**
  - 2.0 – is a last call working draft (Aug 2004) – many differences

Services Structure Example

- **Example**
- **Company Provides two types of Service (PortTypes)**
  - General Service
    - Get general information (GenInfo)
    - Open an Account (OpenAcc)
  - Customers Service (being a “Customer” = having an account)
    - Purchase Order (PurchOrder)
    - Invoice (Inv)
    - Payment Advice (PayAdv)
    - Get Statement (GetStmt)
    - Notify overdue payment (Overdue)
- **Both over two kinds of binding**
  - Web - HTTP
  - Email - SMTP

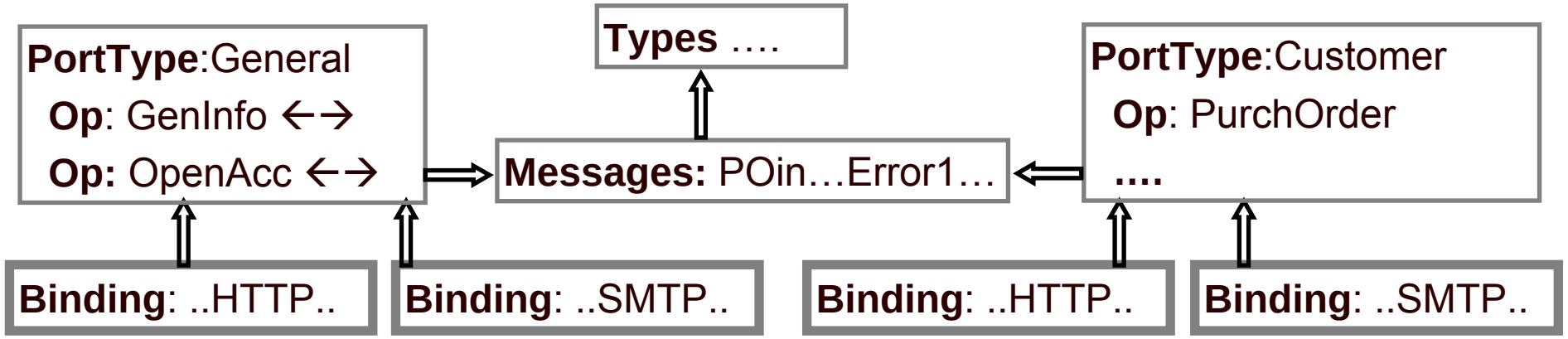
Abstract Definition - PortTypes

- Start with PortType = Interface
- Set of operations
- For each operation, a number of messages – input; output; faults
- Message is defined separately
  - as a number of message parts
  - each part has a type (using schema)



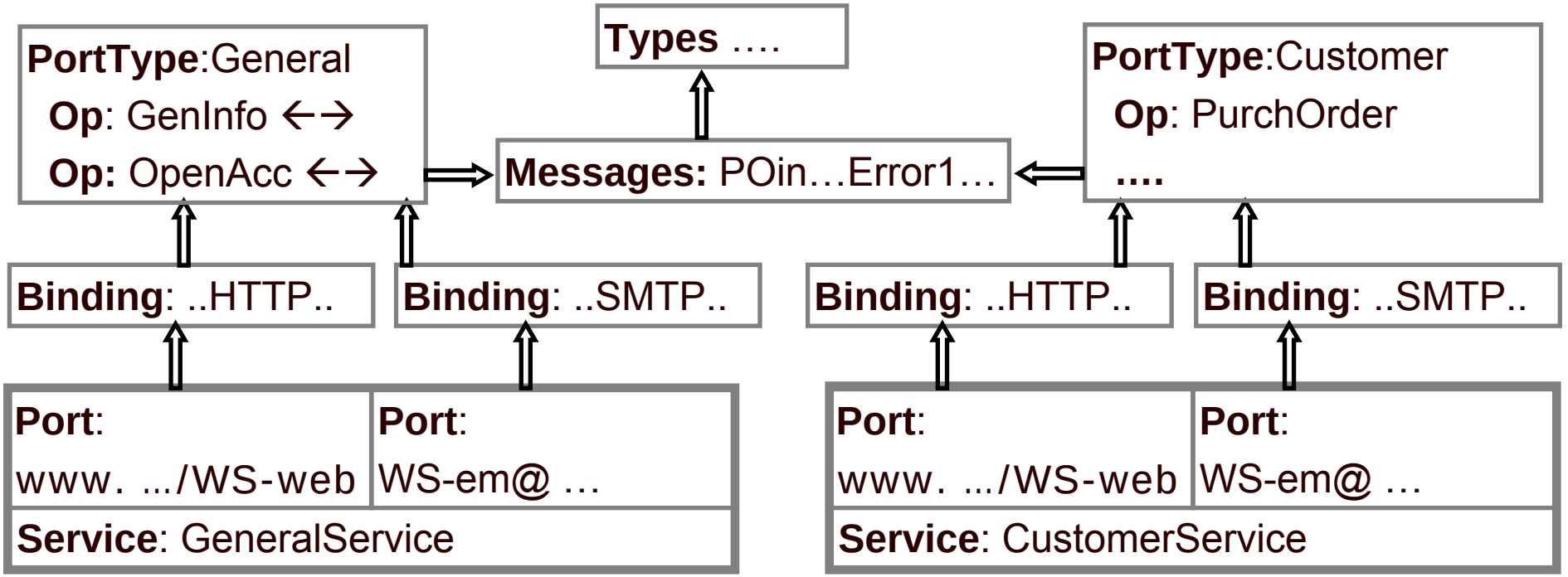
Physical Definition - Binding

- **Binding –**
  - A binding of a portType to a communication protocol for using it
  - Specifies
    - The portType
    - The underlying protocol(s)
    - How the logical structure is represented using the underlying protocol
  - Here two bindings for each PortType – web, e-mail



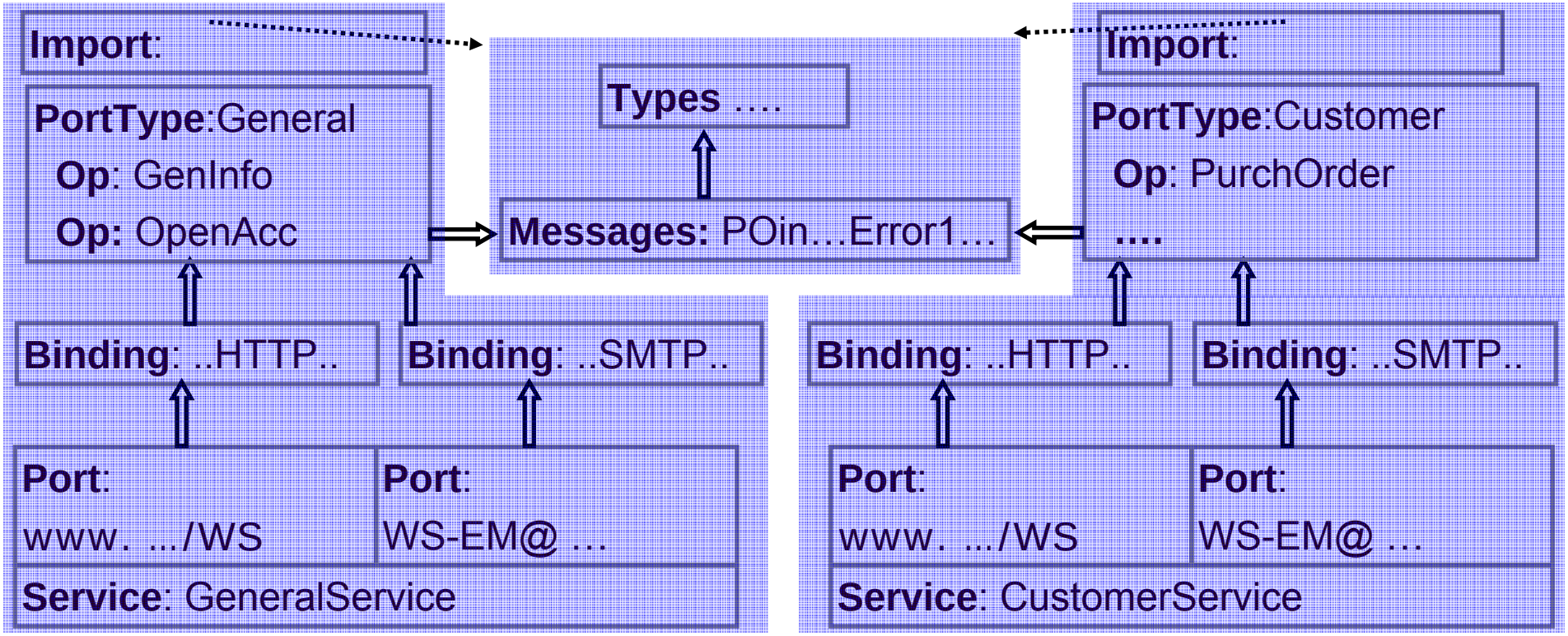
Physical Definition - Service

- **Service – defines one or more ports, each with**
  - Location – URL – here sharing of locations
  - Binding and thus portType
    - The interface provided by the port
    - how it is realised over a particular protocol
  - Here one service for each portType – there are alternatives ….

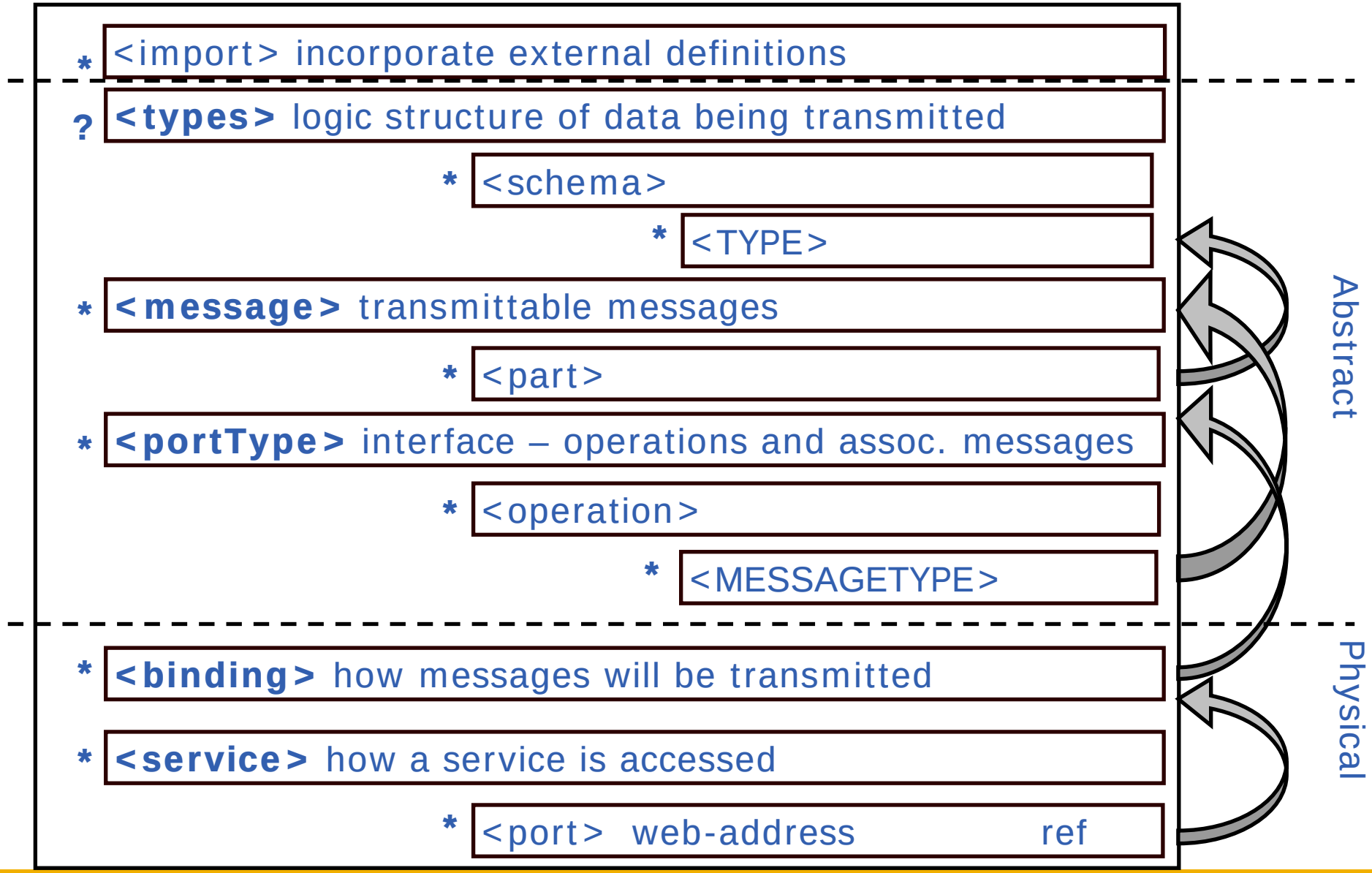


Partitioning of WSDL

- Could put all definitions in one WSDL file – that's what is produced by JAX
- For hand-crafted WSDL, could spread over multiple files, e.g. -
  - one WSDL file per service –
    - Gives control over publication use – CustomerService not in public registry
    - Different services may have semi-independent development
  - common message and type definitions – may be shared between interfaces



Structure


* <import> incorporate external definitions
? <types> logic structure of data being transmitted
* <schema>
* <TYPE>
* <message> transmittable messages
* <part>
* <portType> interface – operations and assoc. messages
* <operation>
* <MESSAGETYPE>
* <binding> how messages will be transmitted
* <service> how a service is accessed
* <port> web-address ref
Abstract
Physical

Bureaucracy

```
<?xml version="1.0" encoding="UTF-8"?>
<wsdl:definitions  name="CustServWSDL"
    wsdl:targetNamespace ="HTTP://ex.org/wsdl/Cust"
    xmlns:w="HTTP://ex.org/wsdl/Cust"
    xmlns:wsdl="…xmlsoap.org/wsdl/"
    xmlns:soap ="…xmlsoap.org/wsdl/soap/" …
        xmlns:y="Y" …
        xmlns:t="T" … …>
  <import namespace="Y" location="Yloc">….
  <types>
    <wsdl:schema targetNameSpace="T"> …</>
    ….    </>
  <wsdl:message> …. </>….
  <wsdl:portType> …. </> …
  <wsdl:binding> ….    </> ….
  <wsdl:service> ….   </> ….
</>
```

An XML document

Root – WSDL Defn.

Name – optional, Lightweight documentation

targetNameSpace, for internal naming Define prefix

Use definitions for: wsdl; its SOAP extension; …

Namespaces prefixes for imported schemas/wsdls

Namespaces prefixes for local schemas

Declaration of multiple – messages, portTypes …

ABSTRACT SERVICE DEFINITION

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Types and Messages

TYPES –

- **Each type is for one or more message parts**
- **Need a target namespace, as for any Schema**
- **A prefix for use in message parts**

```
<?xml version="1.0" encoding="UTF-8" ?>
<wsdl: definitions ….
  xmlns:m = "…/mytypes/serviceA" >
 <wsdl: types>
  <xsd: schema …
  targetNamespace= "…/mytypes/serviceA" >
   <xs:complexType name="PreludeT">
    <xs:sequence>
     <xs:element name="Account" type="xs:string"/>
     <xs:element name="Date" type="xs:date"/>
    </></>
   <xs:complexType name="POentriesT"> ….  </>
 ……</></>
```

Types
Schema
PreludeT
Account
Date
POentriesT …
…..

Message: POin
Part: Prelude
Part: POentries
Message: GetStmtIn
Part: Prelude
Message: Error1
….
…

Types and Messages

Message

- **Has a name – so message can be referenced by a portType definition**
- **Consists of one or more parts,**
  - Each part is a logical unit, e.g. a parameter
    - No parts in WSDL 2.0
  - Has a name so that it can be referenced by a Binding definition
    - E.g to put one part in a header and the other part in the body
  - Has a type –
    - a Schema type definition or a Schema element definition
    - a standard type – from an imported Schema

```
<wsdl:message name="POin">
   <part name="Prelude" type="t:PreludeT">
   <part name= "POentries" type="t:accInfoT">
    </>
<wsdl:message name="OverdueIn">
   <part name="excuse" type="xs:string"></>
```

Input message for the purchase order operation

Defined type – the namespace of the in-line schema

Input (response) message for the Overdue Payment operation

standard type

PortTypes

PORTTYPE – an interface comprising a set of operations

- Organisation of functionality into portTypes and operations is similar to O-O design
- A portType is a coherent unit of exposed functionality – operations make sense together
  - E.g. Currency conversion might be a service used in processing customer transaction
  - But would not expect a convertCurrency operation for this service
- But … larger granularity than O-O
- … Deployment considerations
  - Split between General and Customer may be that say General has a wider range of available bindings/locations
- Each operation declares a number of messages which can be communicated as the interface to the operation
- These messages conform to one of four message exchange patterns – input/output sequencing ….

PortType:Customer
Op: PurchOrder
In: POin
Out: POout
Fault: Error1
….
Op: Overdue
….
Op: Inv
….
….

PortType:General
Op: GenInfo
….
Op: OpenAcc
….

Message Exchange Patterns

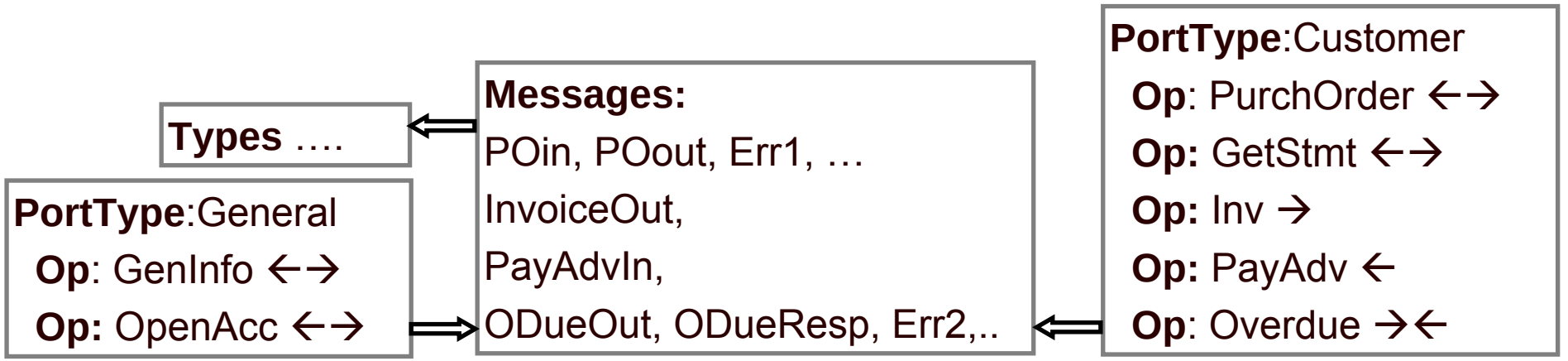
Four patterns

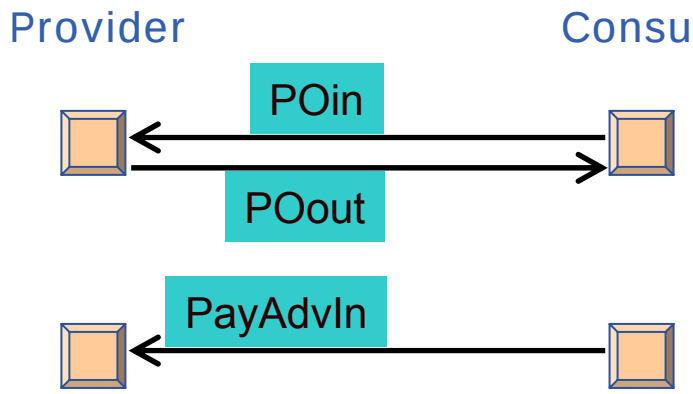
←→ IN then OUT	Request/Response – most usual
→ OUT	Notify *
← IN	One-way
→← OUT then IN	Solicit/Response *

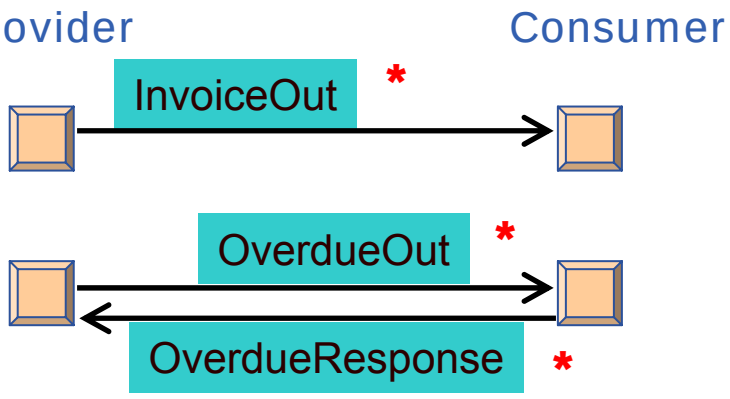
* Reversed roles

Service Provider
  proactive = client

Service Consumer
  reactive = server







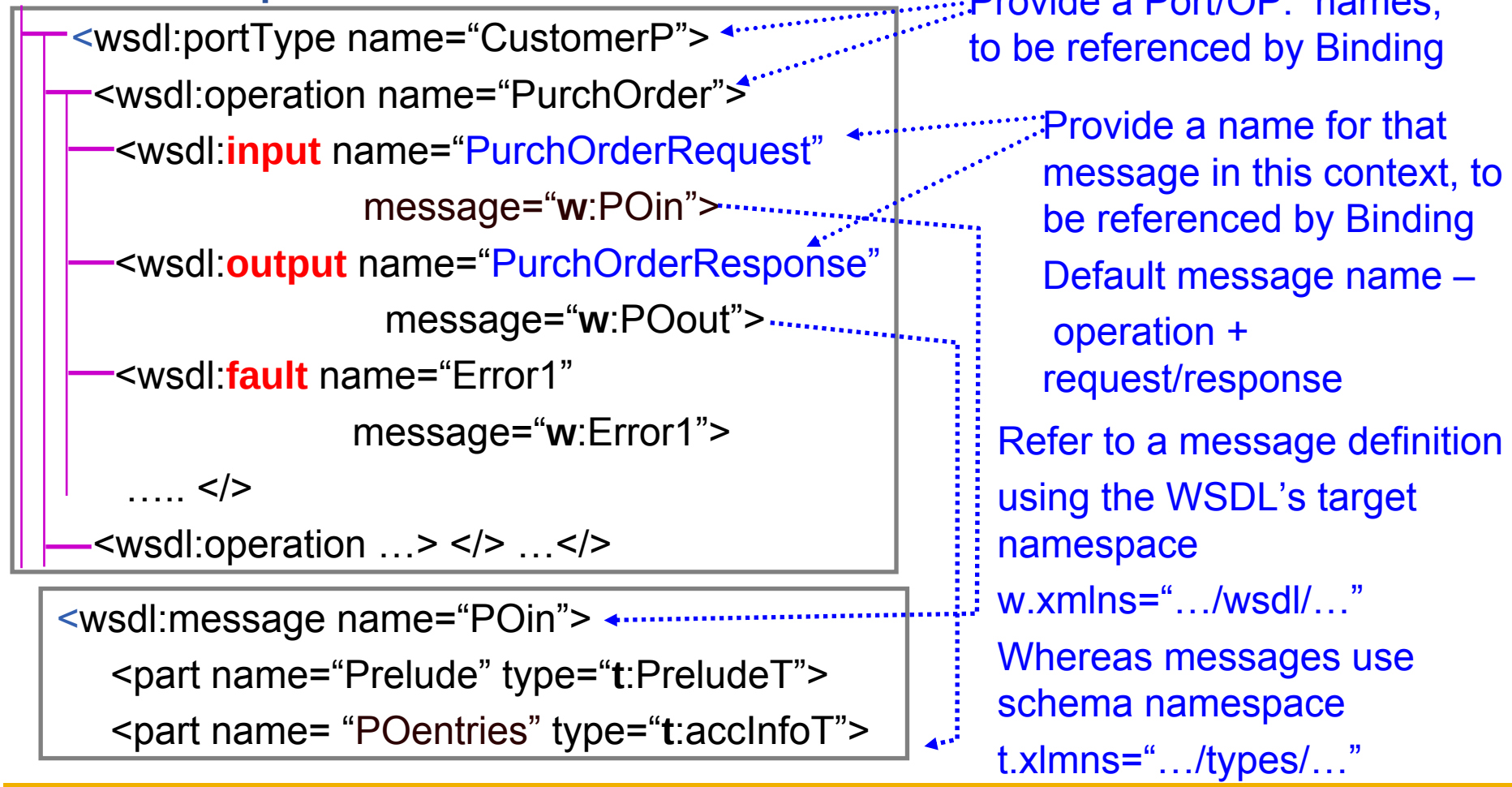
Message Exchange Patterns

- **Message exchange pattern is determined by sequence of message declarations**
  - ←→ Request-Response – **input output fault***
  - →← Solicit-Response – **output input fault***
  - → Notify – **output**
  - ← One-way (Request) – **input**
- **Single message patterns can't have fault message**
- **(in WSDL 2.0 this is explicit and more general – named patterns)**

PortType:Customer
- **Op**: PurchOrder
  - **In**: POin
  - **Out**: POout
  - **Fault**: Error1 …
- **Op:** Overdue
  - **Out**: OverdueOut
  - **In**: OverdueIn
  - Fault: ErrorThreat
- **Op:** Inv
  - **Out:** InvOut
- **Op**: PayAdv
  - **In:** PayAdvIn

Request - Response

- **Message to service provider; reply to service consumer; possible fault messages**
- **A logical pattern, Binding might be e.g. An HTTP request/response or two HTTP requests**



Solicit - Response

- **Message from service provider to consumer; reply from consumer to provider; possible fault messages**

```
<wsdl:portType name="CustomerP">
   …
   <wsdl:operation name="Overdue">
     <wsdl:output name="OverdueSolicit" message="w:OverdueOut">
     <wsdl:input name="OverdueResponse" message="w:OverdueIn">
     <wsdl:fault name="Threat" message="w:ErrorThreat">
   ….. </>
  <wsdl:operation …> </> …</>
```

Default message name –
operation + solicit/response

Single Messages

- **Notify**
  - Message from service provider to consumer, with no reply
  - Example – “Invoice”
    - Send an invoice
- **One-way - Request with no reply**
  - Message from service consumer to provider
  - Example – “payment advice”
    - Company gets notification from customer that a payment has been made

```
<wsdl:portType name=“CustomerP”>
   …..
   <wsdl:operation name=“Inv”>
     <wsdl:output name=“Inv” message=“w:InvOut”> </>
   <wsdl:operation name=“w:PayAdv”>
     <wsdl:input name=“PayAdv” message=“w:PayAdvIn”> </>
 </>
```

Default message name – operation name

PHYSICAL SERVICE DEFINITION

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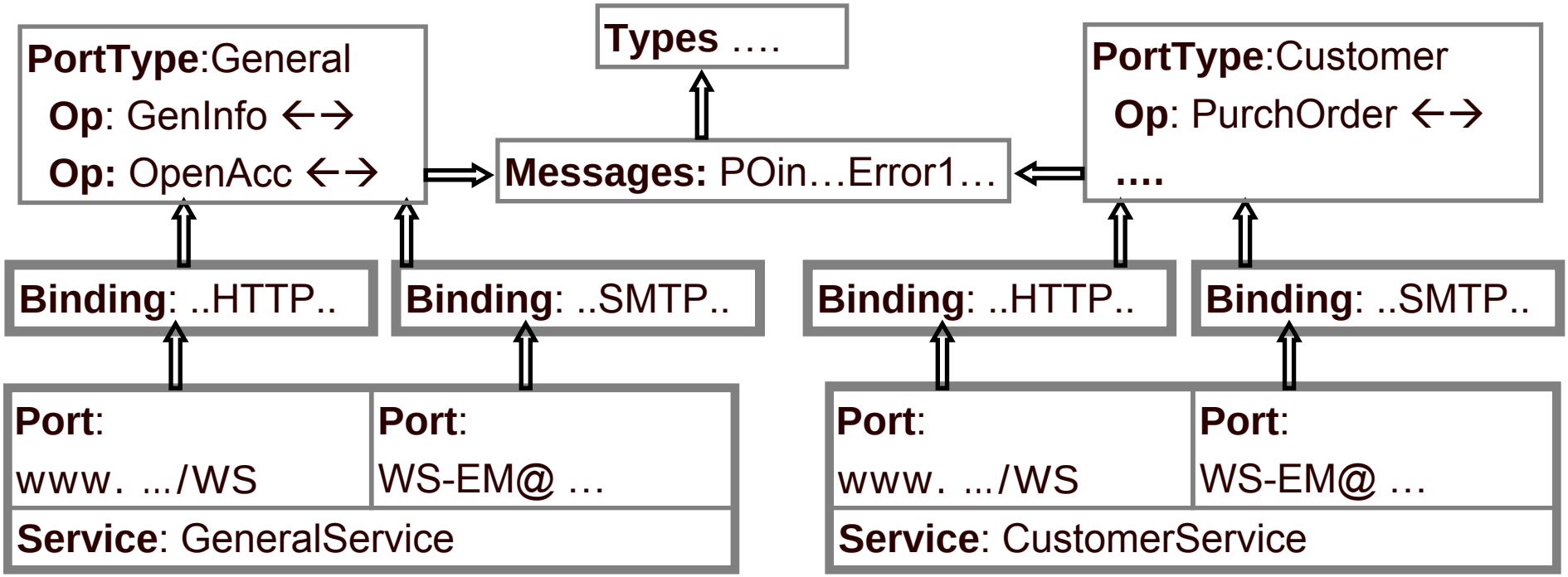
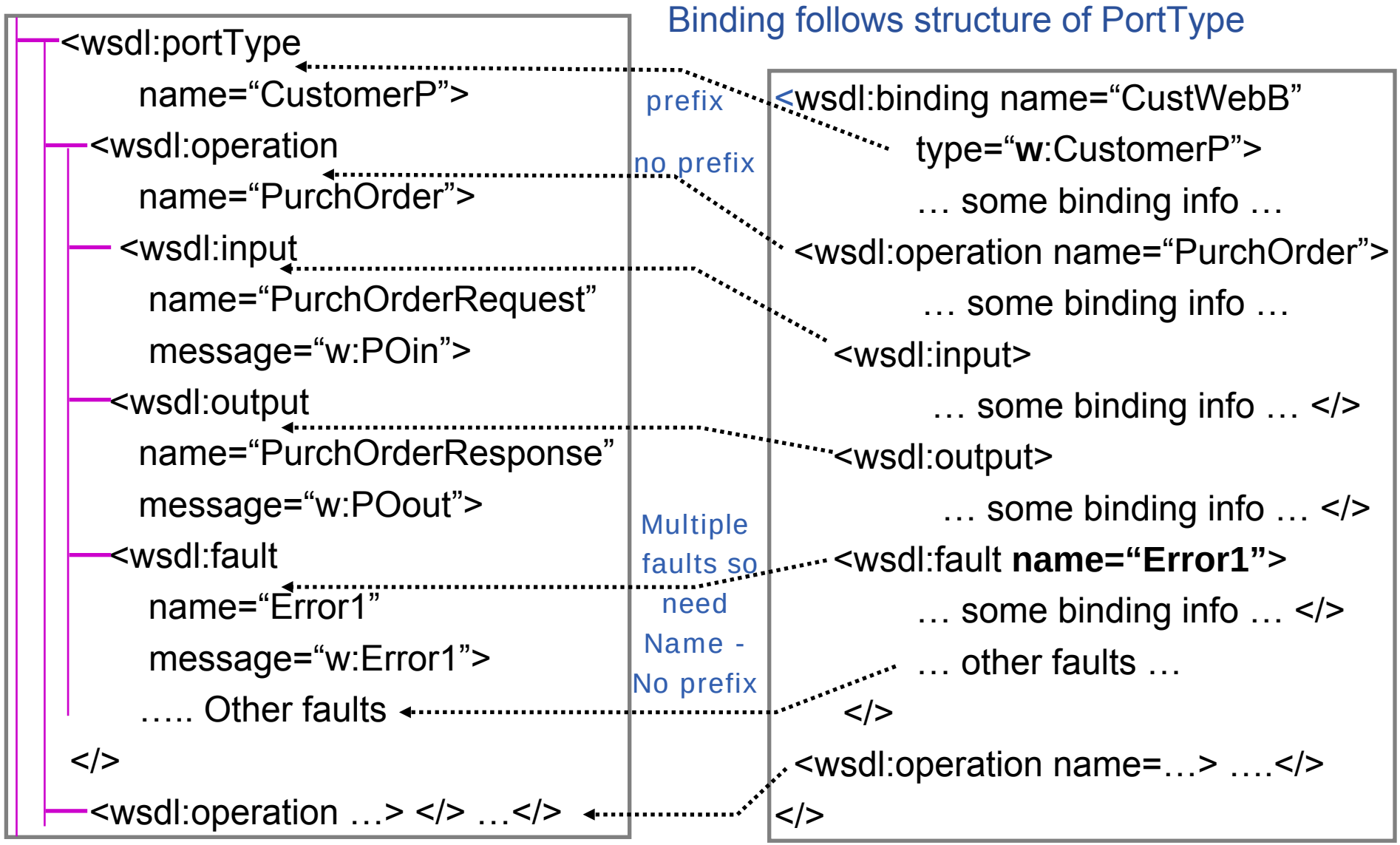
BINDING - General

- **A Binding defines**
  - A particular PortType – named as its "type"
  - Particular message format and communication protocol details
    - By extensibility point
    - A standard extension is SOAP binding
  - A binding name, for use in service definition

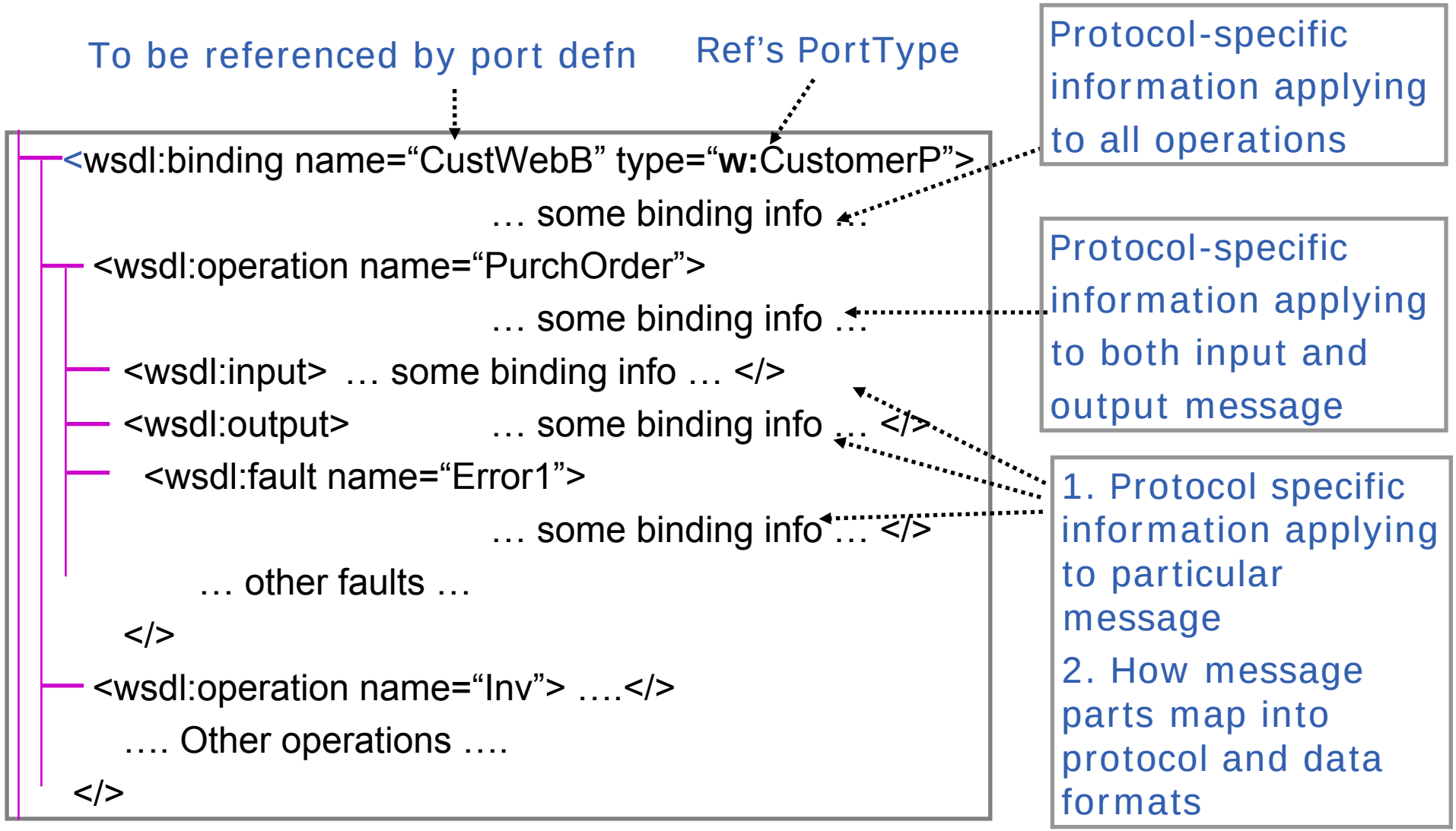


Structure of Binding Element



Protocol Specific Information

- Binding definition is framework for extension points – a bit intangible



SERVICE DEFINITION

- Can have multiple services in one WSDL definition document
- Each Service can have multiple ports, each bound to a binding
- For WSDL 2.0 – all ports of a service must have the same portType
  - Can have different portTypes in WSDL 1.1 –
    consumer may need all functionalities for the service to be useful
- Two ports having the same portType means same semantics
- Gives the location, a URL –
  - this is a SOAP extension of WSDL, not WSDL core

```
<wsdl:binding name="CustEmailB"
              type= "w:CustomerP"> … </>
<wsdl:binding name="CustWebB"
              type= "w:CustomerP"> … </>

<wsdl:service name="CustomerService">
   <wsdl:port name="CustWebSP" binding="w:CustWebB">
      <soap:address location= "http://www.ex.org/WS">
   <wsdl:port name="CustEmailSP" binding="w:CustEmailB">
      <soap:address location="mailto:WS-EM@www.ex.org">
```

WSDL STANDARD EXTENSIONS

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BINDING Extensions

- **There are a number of defined bindings to be used in the extension points**
  - **SOAP – identifying the SOAP 1.1 standards**
    - Transport
      - *Over **HTTP***
      - *Over SMTP*
      - *….*
    - Style
      - ***RPC***
      - ***Document***
    - Use
      - ***Literal***
      - ***Encoded***
  - HTTP
  - MIME
- **SOAP over HTTP is most commonly used**
  - all we will deal with here

The Soap Binding Extension

```
<wsdl:binding name="CustWebB" type="w:CustomerP">
  <soap:binding  style="document"
     transport="http://schemas.xmlsoap.org/soap/http" >
  <wsdl:operation name="PurchOrder"> … </>
  <wsdl:operation name="…">…</> ….
 </>
```

PORT LEVEL

Replaces an ANY extension point in general definition

soap:binding element means

Using SOAP standards. Message structure is

<soap:envelope>

<soap:header>…</>

<soap:body>…</>

style=… - Default for all operations;

= "rpc" – body is parameters/return

= "document" – body is one document

Optional

default = "document"

Transport=

URI to identify some protocol

Optional

The Soap Binding Extension

```
<wsdl:binding name="CustWebB" type="w:CustomerP">
  <soap:binding   style="document"
      transport="http://schemas.xmlsoap.org/soap/http" >
  <wsdl:operation name="PurchOrder">
    <soap:operation
          soapAction="http://ex.org/PO"
              style="rpc">
     <wsdl:input> … </> …. </>
  <wsdl:operation name="…">…</> …. </>
```

PORT LEVEL

OPERATION LEVEL

Replaces an ANY extension point in general definition

soapAction =
URI, the value for the HTTP header "SOAPaction"
Mandatory for SOAP/HTTP
For "document" style gives the operation
For JAX-RPC – empty, ""

style =
Over-rides port-level style

The Soap Binding Extension

```
<wsdl:binding name="CustWebB" type="w:CustomerP">
  <soap:binding   style="document"
      transport="http://schemas.xmlsoap.org/soap/http" >
  <wsdl:operation name="PurchOrder">
    <soap:operation
            soapAction="http://ex.org/PO"
                style="rpc">
    <wsdl:input>
      <soap:body use="encoded"
          encodingStyle="http://.../encoding/"
          namespace="http://ex.org/wsdl/Cust" /></>
        …. </>
  <wsdl:operation name="…">…</> …. </>
```

PORT LEVEL

OPERATION LEVEL

MESSAGE LEVEL

Namespace=

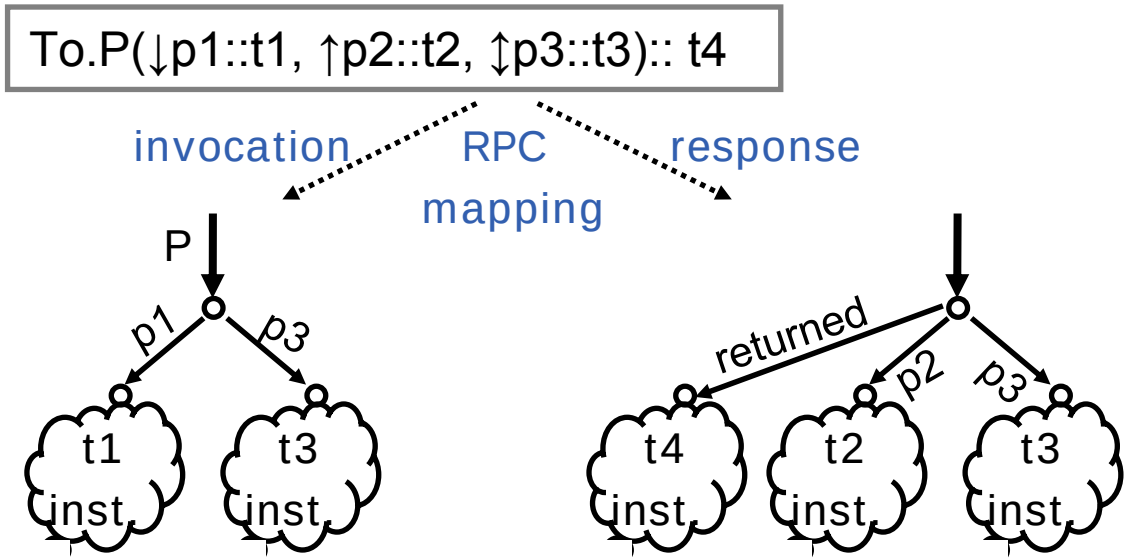
the namespace to be used for validating the outermost elements

Use = "Encoded" : each message part references a type – an abstract type encoded using the scheme(s) identified by encodingStyle

Use = "literal" : each message part ref's a type or element which gives the concrete format

encodingStyle = ".." a URI list to identify encoding scheme(s)
Soap-encoding is http://schemas.xmlsoap.org/soap/encoding

RPC vs Document



- **RPC**
  - Hint that this is best dealt with as a procedure call (/return)
  - Message parts are parameters which are wrapped as one component of Body
  - As in the SOAP RPC standard
- **Document**
  - This is a document to be processed – message parts are directly in body
  - Wrapped convention – single message part – looks like RPC style

RPC vs Document

```
<wsdl:message name="POin">
    <part name=prelude  type=…>
    <part name=POentries  type=…>
</>
```

```
<wsdl:message name="POout">
    <part name=Result  type=…>
    <part name=delivSched  type=…>
</>
```

```
<wsdl:operation name="PurchOrder">
      <wsdl:input name="PurchOrderRequest" message="w:POin">
      <wsdl:output name="PurchOrderResponse" message="w:POout">
```

```
<env:Body>
  <PurchOrderRequest>
    <Prelude> … </>
    <POentries> … </></></></>
```

⟹

```
<env:Body>
  <PurchOrderResponse>
    <Result> … </>
    <delivSched> … </></></></>
```

RPC Actual messages

```
<env:Body>
  <Prelude> … </>
  <POentries> … </></></></>
```

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```
<env:Body>
  <Result> … </>
  <delivSched> … </></></></>
```

Document Actual messages

Summary

WSDL

- **Defines abstract structure of service interactions**
  - Including logical content of messages exchanged
- **Defines binding – how the messages are carried and represented**
  - Standard binding is for SOAP over HTTP
    - Message is an XML document, with a particular structure
    - Using particular types
- **Defines Service as a number of ports, each being address and binding**

- **A site where you can obtain WSDL definitions of services and see what SOAPmessages are produced - http://xmethods.com/**

The End

THE END