Middleware and Web Services
Lecture 9: Web Service Description Language

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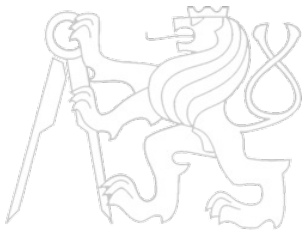

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Overview

- Web Service Description Language
  - *Elements, Types and Messages Definitions*
  - *Interface and Operations*
  - *Binding*
  - *Service and Endpoint*
  - *Description*
- WS-Addressing

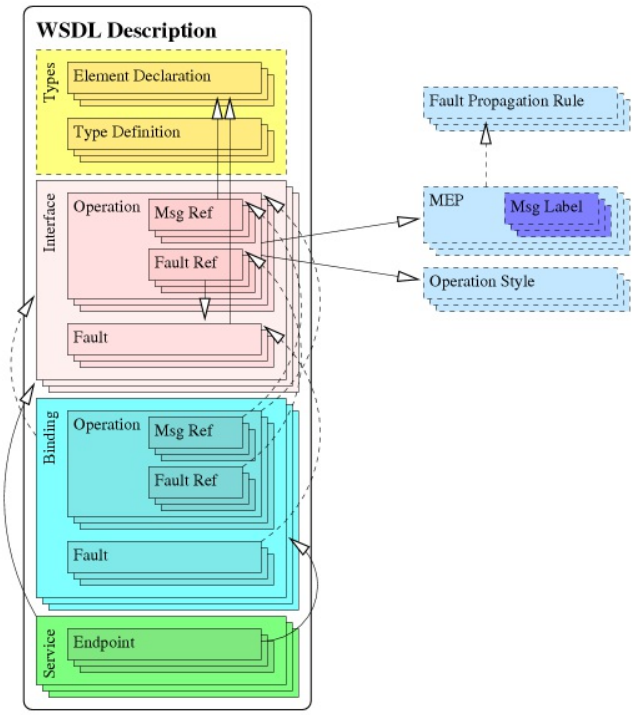
Specifications

- WSDL = Web Service Description Language
  - *A standard that allows to describe Web services explicitly (main aspects)*
  - *A contract between a requester and a provider*
- Specifications
  - *WSDL 1.1 – still widely used*
    - → *Web Service Description Language 1.1*
  - *WSDL 2.0 – An attempt to address several issues with WSDL 1.1*
    - → *SOAP vs. REST, naming, exrpessivity*
    - → *WSDL 2.0 Primer (part 0)*
    - → *WSDL 2.0 Core Language (part 1)*

WSDL Overview and WSDL 1.1 Syntax

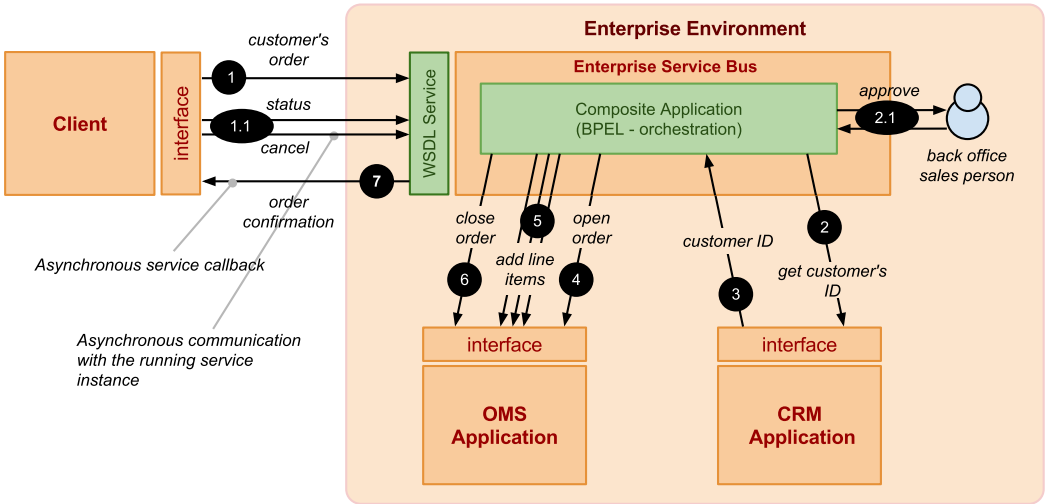
- Components of WSDL
  - *Information model (`types`)*
    - → *Element types, message declarations (XML Schema)*
  - *Set of operations (`portType`)*
    - → *A set of operations is "interface" in the WSDL terminology*
    - → *operation name, input, output, fault*
  - *Binding (`binding`)*
    - → *How messages are transfered over the network using a concrete transport protocol*
    - → *Transport protocols: HTTP, SMTP, FTP, JMS, ...*
  - *Endpoint (`service`)*
    - → *Where the service is physically present on the network*
- Types of WSDL documents
  - ***Abstract WSDL*** *– only information model and a set of operations*
  - ***Concrete WSDL*** *– everything, a concrete service available in the environment*

WSDL Components and Dependencies



Example

- Simple order process example



Top-level Element and Namespaces

- Example

```
1  <?xml version="1.0" encoding="utf-8"?>
2  <definitions
3    xmlns="http://schemas.xmlsoap.org/wsdl/"
4    targetNamespace="http://mimdw.fit.cvut.cz/mdw_examples/ProcessOrder/OrderPrc
5    xmlns:om="xmlns:om="http://mimdw.fit.cvut.cz/mdw-examples/cdm/order"
6    xmlns:tns="http://mimdw.fit.cvut.cz/mdw_examples/ProcessOrder/OrderProcess">
7    name="OrderProcess"
8    ...
9  </definitions>
```

  - `definitions` *is a top-level element*
  - *Any un-prefixed elements will be WSDL 2.1 elements (line 3)*
  - *Target namespace (line 4)*
    - → *a vocabulary for the order service's parts that this WSDL document defines (it is not a XML namespace declaration!)*
    - → `xmlns:tns` *(line 5) is a prefix definition for this namespace*

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Type Definitions

- XML Schema
  - *Only XML Schema in WSDL 1.1*
  - *WSDL 2.0 allows to use other languages too*
- Types for input, output, fault messages
- Single elements at the topmost level
  - *may contain arbitrary structure*
- Could be defined
  - *directly inside the* `types` *element*
  - *externalally by using XML Schema* `import` *mechanism*
    - → *Types to be resued in multiple WSDLs*
    - → *Definitions of Common Data Model*

Elements and Types Definitions Example

```
1  <types>
2      <schema xmlns="http://www.w3.org/2001/XMLSchema"
3          attributeFormDefault="unqualified"
4          elementFormDefault="qualified"
5          xmlns:op="http://mimdw.fit.cvut.cz/mdw-examples/cdm/order"
6          targetNamespace="http://.../mdw_examples/ProcessOrder/OrderProcess">
7
8          <import
9              namespace="http://mimdw.fit.cvut.cz/mdw-examples/cdm/order"
10             schemaLocation="http://.../soa-infra/services/mdw-examples/ProcessOrder/apps/MDW
11         <element name="OrderProcessRequest" type="op:Order"/>
12         <element name="OrderProcessResponse" type="string"/>
13         <element name="StatusRequest" type="op:StatusRequestType"/>
14         <element name="FaultMessage" type="string"/>
15         <complexType name="StatusRequestType">
16             <sequence>
17                 <element name="process-id" type="string"/>
18             </sequence>
19         </complexType>
20         <element name="StatusResponse" type="op:StatusResponseType"/>
21         <complexType name="StatusResponseType">
22             <sequence>
23                 <element name="process-id" type="string"/>
24                 <element name="status" type="string"/>
25             </sequence>
26         </complexType>
27         <!-- [snip] -->
28     </schema>
29 </types>
```

Messages Definitions

- Definitions of messages
  - *Messages flow between a client and a service*
  - *They can be request, response or fault*
  - *Each message has one or more "parts"*
  - *A message part references a single element defined in* `types`
- Example messages definitions for order process
  - *A name can be arbitrary name but a commonly agreed convention is:*

`{ServiceName}{Request|Response|Fault}Message`

```
<message name="OrderProcessRequestMessage">
    <part name="order" element="op:OrderProcessRequest"/>
</message>
<message name="OrderStatusResponseMessage">
    <part name="status" element="op:StatusResponse"/>
<message>
<message name="OrderProcessFaultMessage">
    <part name="text" element="op:FaultMessage"/>
<message>
<message name="OrderProcessResponseMessage">
    <part name="result" element="op:OrderProcessResult"/>
<message>
```


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Defining Interface

- Interface
  - *abstract description of a service*
  - *separation of*
    - → *abstract functionality (interface definition)*
    - → *and concrete details on how and where the functionality is offered*
- WSDL Interface
  - *A set of operations implemented by a service or a client*
    - → *The client may implement the interface for asynchronous callbacks*
- Each operation specifies
  - *references to messages (input, output, fault)*
  - *Exchange pattern*
    - → ***Request-response*** *– the most commonly used pattern*
    - → ***One-way*** *(also called fire-and-fortget) – only request from the client*
    - → ***Solicit-response*** *– response-request*
    - → ***Notification*** *– response-only, used in asynchronous callbacks*

Interface Example (1)

- Order process complex conversation
  1. *The client invokes* `processOrder`.
  2. *The service responses back* ***synchronously*** *with order status.*
  3. *The client gets the status of order processing by invoking synchronous* `getStatus` *operation (this can be invoked serveral times).*
  4. *The service responses back* ***asynchronously*** *by invoking* `processOrderResponse` *– callback on client's interface*
- Interface implemented by the order process service
  - `getStatus` *operation must be executed in the same* ***conversation*** *as* `processOrder` *operation*

```
<portType name="OrderProcess">
    <operation name="processOrder">
        <input message="op:OrderProcessRequestMessage"/>
        <output message="op:OrderStatusResponseMessage"/>
    </operation>
    <operation name="getStatus">
        <input message="op:OrderStatusRequestMessage"/>
        <output message="op:OrderStatusResponseMessage"/>
    <operation>
<portType>
```

Interface Example (2)

- Interface implemented by the client

```
<portType name="OrderProcessCallback">
    <operation name="processOrderResponse">
        <input message="op:OrderProcessResponseMessage"/>
        <fault message="op:OrderProcessFaultMessage"/>
    <operation>
</portType>
```


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Defining a Binding

- Binding is part of a concrete WSDL
  - *A WSDL exposed by a service deployed to application server or ESB*
  - *One binding for one interface (`portType`)*
- "How" messages can be exchanged
  - *one interface may have one or more bindings*
    - → *such as one for SOAP over HTTP and one for SOAP over SMTP*
- Binding specifies
  - *details for every operation and fault in the interface*
    - → *concrete message format and transmission protocol*
    - → *rules for SOAP headers*
      (policies, e.g. ws-addressing for asynchronous communication)
- SOAP binding styles
  - *RPC/encoded*
  - *RPC/literal*
  - *Document/encoded – nobody uses this one*
  - *Document/literal*
  - *Document/literal wrapped*

Binding Example – HTTP Transport

- Binding to SOAP over HTTP

```
1  <binding name="OrderProcessBinding" type="op:OrderProcess">
2      <soap:binding transport="http://schemas.xmlsoap.org/soap/http"/>
3      <PolicyReference xmlns:wsp="http://schemas.xmlsoap.org/ws/2004/09/polic
4          URI="#wsaddr_policy" wsdl:required="false"/>
5      <operation name="processOrder">
6          <soap:operation style="document" soapAction="processOrder"/>
7          <input>
8              <soap:body use="literal"/>
9          </input>
10         <output>
11             <soap:body use="literal"/>
12         </output>
13     </operation>
14     <!-- snip -->
15 </binding>
```

  - *HTTP transport defined by*
    - → *URI `http://schemas.xmlsoap.org/soap/http` of `transport` attribute on `binding` element (line 2)*
  - *A style `document/literal` defined by:*
    - → `style` *attribute of* `soap:operation` *(line 6)*
    - → `use` *attribute of* `soap:body` *(lines 8,11)*

SOAP Binding – RPC/encoded

- WSDL

```
1  <message name="OrderStatusRequestMessage">
2      <part name="process-id" type="xsd:string"/>
3  </message>
4
5  <portType name="OrderProcess">
6      <operation name="getStatus">
7          <input message="OrderStatusRequestMessage"/>
8          <output message="..."/>
9      </operation>
10 </portType>
```

- SOAP Request

```
1  <soap:envelope>
2      <soap:body>
3          <getStatus>
4              <process-id xsi:type="xsd:string">5</process-id>
5          </getStatus>
6      </soap:body>
7  </soap:envelope>
```


SOAP Binding – RPC/literal

- WSDL

```
1  <message name="OrderStatusRequestMessage">
2      <part name="process-id" type="xsd:string"/>
3  </message>
4
5  <portType name="OrderProcess">
6      <operation name="getStatus">
7          <input message="OrderStatusRequestMessage"/>
8          <output message="..."/>
9      </operation>
10 </portType>
```

- SOAP Request

```
1  <soap:envelope>
2      <soap:body>
3          <getStatus>
4              <process-id>5</process-id>
5          </getStatus>
6      </soap:body>
7  </soap:envelope>
```

SOAP Binding – Document/literal

- WSDL

```
1  <types>
2      <schema>
3          <element name="process-id" type="xsd:string"/>
4      </schema>
5  </types>
6
7  <message name="OrderStatusRequestMessage">
8      <part name="payload" element="process-id"/>
9  </message>
10
11 <portType name="OrderProcess">
12     <operation name="getStatus">
13         <input message="OrderStatusRequestMessage"/>
14         <output message="..."/>
15     </operation>
16 </portType>
```

- SOAP Request

```
1  <soap:envelope>
2      <soap:body>
3          <process-id>5</process-id>
4      </soap:body>
5  </soap:envelope>
```


SOAP Binding – Document/literal wrapped

- WSDL

```
1  <types>
2      <schema>
3          <element name="StatusRequest" type="StatusRequestType">
4          <complexType name="StatusRequestType">
5              <element name="process-id" type="xsd:string"/>
6          </complexType>
7      </schema>
8  </types>
9
10 <message name="OrderStatusRequestMessage">
11     <part name="payload" element="StatusRequest"/>
12 </message>
13
14 <portType name="OrderProcess">
15     <operation name="getStatus">
16         <input message="OrderStatusRequestMessage"/>
17         <output message="..."/>
18     </operation>
19 </portType>
```

- SOAP Request

```
1  <soap:envelope>
2      <soap:body>
3          <StatusRequest>
4              <process-id>5</process-id>
5          </StatusRequest>
6      </soap:body>
7  </soap:envelope>
```

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Service

- "Where" the service can be accessed
- Service element specifies
  - *always one interface*
  - *list of endpoint locations to access the service*
    - → *each endpoint references a binding*
    - → *protocols and transmission formats it supports*
- Multiple endpoints
  - *different protocols for the same service*
  - *different security requirements, for example*
    - → *SOAP over HTTPS endpoint*
    - → *SOAP over HTTP endpoint*

Service Element and SOAP Message

- Service element definition

```
<service name="orderprocess_client_ep">
    <port name="OrderProcess_pt" binding="op:OrderProcessBinding">
        <soap:address location="http://mimdw.fit.cvut.cz/soa-infra/services/mdw-examples
    </port>
</service>
```

- Corresponding HTTP request SOAP message example

```
> POST /soa-infra/services/mdw-examples/ProcessOrder/orderprocess_client_ep HTTP/1.1
> User-Agent: curl/7.30.0
> Host: midmdw.fit.cvut.cz
> Accept: */*
> Accept-Encoding: gzip,deflate
> Content-Type: text/xml;charset=UTF-8
> SOAPAction: "getStatus"
> Content-Length: 810

<soap:Envelope xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
    <soap:Header>
    <!-- snip -->
    </soap:Header>
    <soap:Body>
        <ns1:StatusRequest
            xmlns:ns1="http://mimdw.fit.cvut.cz/mdw_examples/ProcessOrder/OrderProcess">
            <ns1:process-id>5</ns1:process-id>
        </ns1:StatusRequest>
    </soap:Body>
</soap:Envelope>
```


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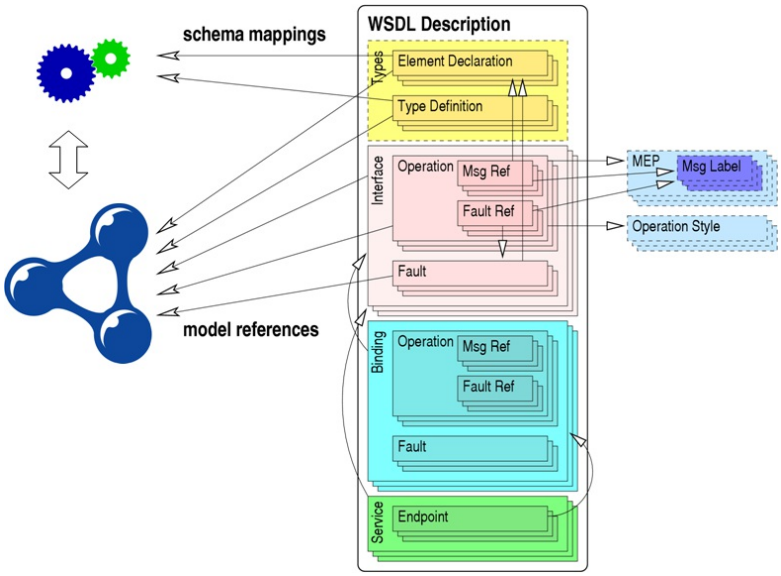
Description

- WSDL does not cover all service descriptions
  - *functionality only as a set of operations*
  - *no order of operations (e.g., a state diagram)*
- Solution
  - *Semantic Annotations for WSDL and XML Schema (SAWSDL)*
    - → *defines links to rich semantic models*
    - → *can be attached to any WSDL component*
  - *Textual description in WSDL documentation element*

```
1  <?xml version="1.0" encoding="utf-8" ?>
2  <definitions>
3    ...
4    <documentation>
5          This document describes an order service. Additional
6          application-level requirements for use of this service --
7          beyond what WSDL is able to describe -- are available
8          at http://company.com/doc/order-documentation.html
9    </documentation>
10   ...
11 </definitions>
```

  - *Additional WS-* specifications, for example*
    - → *WS-Addressing, WS-Reliability, WS-CDL, etc.*

SAWSDL



- SAWSDL extension attributes
  - `modelReference`, `schemaMappingLowering`, `schemaMappingLifting`
  - *SAWSDL W3C Recommendation, 2007*

Example Interface Annotation

- Service classification at `http://example.org/classification`

```xml
<?xml version="1.0" encoding="utf-8"?>
<root xmlns="http://example.org/service-classification-schema">
    <order>
        <book>
            <adventure/>
            <travel/>
        </book>
        <electronics>
            <TV/>
            <computer/>
        </electronics>
    </order>
    <shipment><!-- shipment services --></shipment>
</root>
```

- Example annotation
  - *prefix* `wsdl` *is* `http://www.w3.org/ns/wsdl`
  - *prefix* `sawsdl` *is* `http://www.w3.org/ns/sawsdl`

```xml
<portType name="ProcessOrder"
    sawsdl:modelReference="http://example.org/classification/root/order/electronics"/>
    ...
</portType>
```


Overview

- Web Service Description Language
- WS-Addressing

Overview

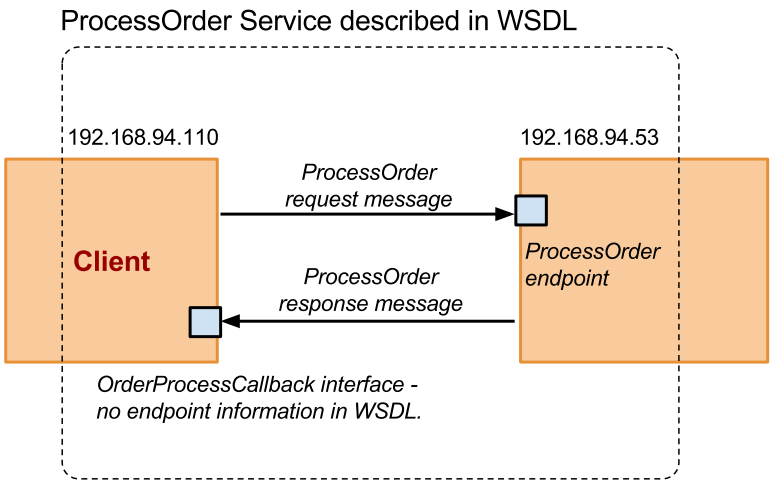
- WS-Addressing
  - *W3C Recommendation, May 2006*
  - *A transport-independent mechanisms for web services to communicate addressing information*
  - *WSDL describes WS-Addressing as a policy attached to a WSDL binding*

```
1  <binding name="OrderProcessBinding" type="op:OrderProcess">
2      <soap:binding transport="http://schemas.xmlsoap.org/soap/http"/>
3      <PolicyReference xmlns:wsp="http://schemas.xmlsoap.org/ws/2004/09/polic
4          URI="#wsaddr_policy" wsdl:required="false"/>
```

- Two main purposes
  1. *Asynchronous communication*
     - *Client sends an endpoint where the server should send a response asynchronously*
  2. *Relating interactions to a conversation*
     - *Client and service communicate conversation ID*

Order Processing Example

- Asynchronous communication via callback, steps:
  - *Client submits an order request*
  - *Service processes the order (CRM, OMS, back-office)*
  - *Service responds asynchronously with an order response message*



ProcessOrder Request Message

- Client sends process order request – `processOrder`
  - *it sends addressing information where the client listens for the callback*
  - *it sends conversation ID (message ID) to start the conversation on the server*

```
> POST /soa-infra/services/mdw-examples/ProcessOrder/orderprocess_client_ep HTTP/1.1
> Host: mimdw.fit.cvut.cz
> Content-Type: text/xml;charset=UTF-8
> SOAPAction: "processOrder"
> Content-Length: 810

<soap:Envelope xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/"
    xmlns:ord="http://mimdw.fit.cvut.cz/mdw-examples/cdm/order">
     <soap:Header xmlns:wsa='http://www.w3.org/2005/08/addressing'>
        <wsa:ReplyTo>
            <wsa:Address>http://192.168.94.110:2233/path/to/service</wsa:Address>
        </wsa:ReplyTo>
        <wsa:MessageID>urn:AXYYBA00531111E3BFACA780A7E5AF64</wsa:MessageID>
     </soap:Header>
     <soap:Body>
        <ord:Order>
            <ord:CustomerId>1</ord:CustomerId>
            <ord:LineItems>
                <ord:item>
                    <ord:label>Apple MacBook Pro</ord:label>
                    <ord:action>ADD</ord:action>
                </ord:item>
            </ord:LineItems>
        </ord:Order>
    </soap:Body>
</soap:Envelope>
```


GetStatus Request Message

- Client sends get status request – `getStatus`
  - *after it invokes* `processOrder` *with conversation ID (message ID)*
  - *it uses the same conversation ID for get status request too*
    - → *the request will be procesessed by the running service instance*

```
> POST /soa-infra/services/mdw-examples/ProcessOrder/orderprocess_client_ep HTTP/1.1
> Host: mimdw.fit.cvut.cz
> Content-Type: text/xml;charset=UTF-8
> SOAPAction: "getStatus"
> Content-Length: 472

<soap:Envelope xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
    <soap:Header xmlns:wsa="http://www.w3.org/2005/08/addressing">
        <wsa:RelatesTo>urn:AXYYBA00531111E3BFACA780A7E5AF64</wsa:RelatesTo>
    </soap:Header>
    <soap:Body>
        <ns1:StatusRequest
            xmlns:ns1="http://mimdw.fit.cvut.cz/mdw_examples/ProcessOrder/OrderProces
            <ns1:process-id>18a9baec2d5ac0a2:64d155de:1425c4185f1:-7ff2</ns1:process-
        </ns1:StatusRequest>
    </soap:Body>
</soap:Envelope>
```