

Middleware and Web Services

Lecture 8: SOAP and REST

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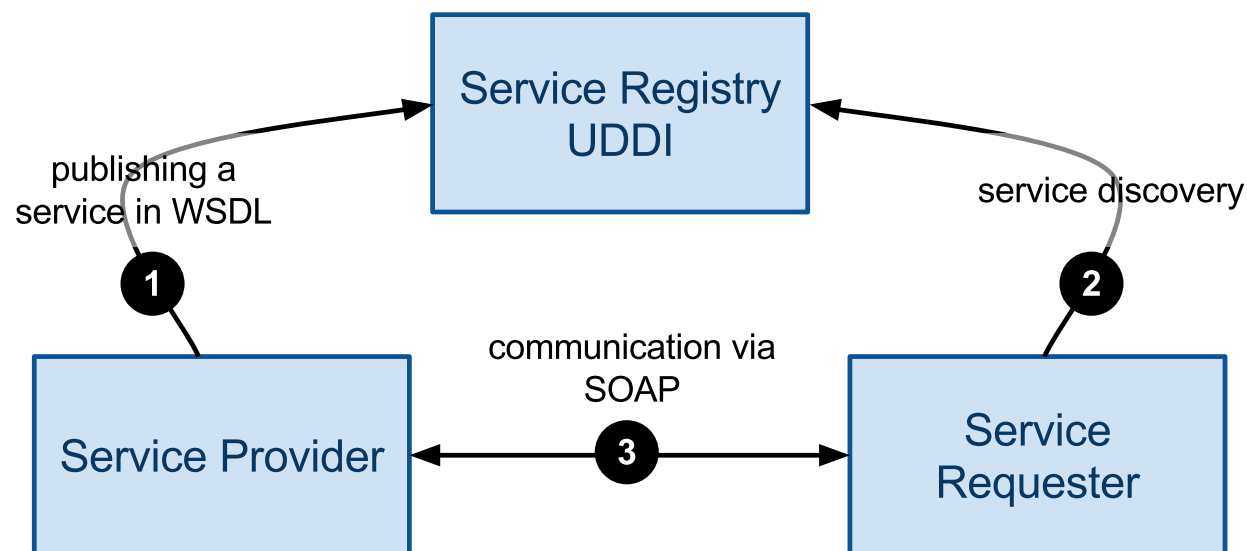
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Overview

- SOAP
 - *Message Path*
- Representational State Transfer
- SOAP and REST Comparision

Web Service Architecture

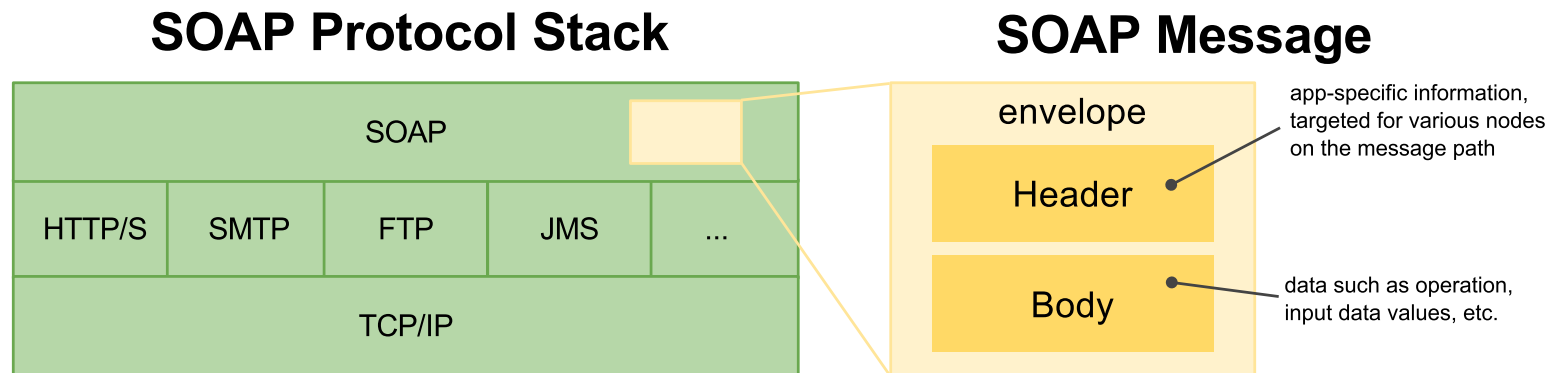
- WSDL, SOAP and UDDI



- *Realization of SOA*
- *Message-Oriented view*
 - *SOAP messaging (header, body)*
 - *types of messages – input, output, fault*

SOAP Protocol

- SOAP defines a messaging framework



- *XML-based protocol*
- *a layer over transport protocols*
 - *binding to HTTP, SMTP, JMS, ...*
- *involves multiple nodes (message path)*
 - *sender, receiver, intermediary*

SOAP Message

- Envelope
 - *A container of a message*
- Header
 - *Metadata – describe a message, organized in header blocks*
 - *routing information*
 - *security measures implemented in the message*
 - *reliability rules related to delivery of the message*
 - *context and transaction management*
 - *correlation information (request and response message relation)*
 - *WS extensions (WS-*) utilize the message header*
- Body (payload)
 - *Actual contents of the message, XML formatted*
 - *Contains also faults for exception handling*
- Attachment
 - *Data that cannot be serialized into XML such as binary data*

Endpoint

- SOAP service endpoint definition



- *Endpoint* – a network address used for communication
- *Communication* – request-response, SOAP messages over a communication (application) protocol
- *Synchronous communication* – only service defines endpoint
- *Asynchronous communication* – service and client define endpoints

Service Invocation Example (1)

- Example service implementation
 - *A service that evaluates an expression*
 - *Uses SOAP over HTTP*
 - *We can use standard HTTP tools to invoke the service*
- SOAP request message

`evaluate-input.xml`

```
1 <soap:Envelope xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
2   <soap:Body>
3     <ns1:evaluateRequest
4       xmlns:ns1="http://xmlns.oracle.com/mdw_examples/Evaluate/evaluate"
5       <ns1:x>12</ns1:x>
6       <ns1:y>18</ns1:y>
7     </ns1:evaluateRequest>
8   </soap:Body>
9 </soap:Envelope>
```

- Invoking the service using `curl`

```
1 curl -s -X POST --header "Content-Type: text/xml; charset=UTF-8" \
2 --header "SOAPAction: \"evaluate\"" --data @evaluate-input.xml \
3 http://mimdw.fit.cvut.cz/soa-infra/services/mdw-examples/Evaluate/evaluate_client_
```

Service Invocation Example (2)

- Invocation result

```
1  * About to connect() to mimdw.fit.cvut.cz port 80 (#0)
2  *   Trying 147.32.233.55... connected
3  * Connected to sb.vitvar.com (147.32.233.55) port 80 (#0)
4  > POST /soa-infra/services/mdw-examples/Evaluate/evaluate_client_ep HTTP/1.1
5  > User-Agent: curl/7.19.7 (x86_64-redhat-linux-gnu) libcurl/7.19.7 NSS/3.14.0.0 z1
6  > Host: mimdw.fit.cvut.cz
7  > Accept: */*
8  > Content-Type: text/xml; charset=UTF-8
9  > SOAPAction: "evaluate"
10 > Content-Length: 302
11 >
12 } [data not shown]
13 < HTTP/1.1 200 OK
14 < Date: Sun, 17 Nov 2013 11:24:59 GMT
15 < Server: Oracle-Application-Server-11g
16 < Content-Length: 569
17 < X-ORACLE-DMS-ECID: 004upqiWhdD0zkwVlybQ8A0005uX0004Y^
18 < SOAPAction: ""
19 < X-Powered-By: Servlet/2.5 JSP/2.1
20 < Content-Type: text/xml; charset=UTF-8
21 < Content-Language: en
```


Service Invocation Example (3)

- SOAP response message

```
1  <?xml version="1.0"?>
2  <env:Envelope xmlns:env="http://schemas.xmlsoap.org/soap/envelope/"
3      xmlns:wsa="http://www.w3.org/2005/08/addressing">
4      <env:Header>
5          <wsa:MessageID>urn:E42018C04F7A11E3BFD5D1953058407C</wsa:MessageID>
6      </env:Header>
7      <env:Body>
8          <evaluateResponse
9              xmlns="http://xmlns.oracle.com/mdw_examples/Evaluate/evaluate">
10             <result>30</result>
11          </evaluateResponse>
12      </env:Body>
13  </env:Envelope>
```

Client Implementation

- WSDL – Web Service Description Language
 - *definitions for the client to know how to communicate with the service*
 - *which operations it can use*
 - *data formats for input (request), output (response) and fault messages*
 - *how to serialize the data as payloads of a communication protocol (binding)*
 - *where the service is physically present on the network*
- Clients' environments
 - *Clients implemented in a language such as Java*
 - *Tools to generate service API for the client, e.g. WSDL2Java*
 - *Can be written manually too, e.g. our example in bash*
 - *Clients reside on the middleware, e.g. on an Enterprise Service Bus*
 - *They provide added values in end-to-end communication, proxy services, SOAP intermediaries*

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- Representational State Transfer
- SOAP and REST Comparision

SOAP Node

- A program that services use to transmit SOAP messages
 - *Element of SOAP messaging infrastructure*
 - *Realized by a SOAP communication server*
 - *Every vendor has its own implementation*
 - *Must conform to SOAP standard*
 - *Sometimes causes vendor interoperability problem*
- SOAP node types
 - **SOAP sender** – *a node that transmits a message*
 - **SOAP receiver** – *a node that received a message*
 - **SOAP intermediary** – *a node that receives and transmits a message and optionally processes the message*
 - **initial SOAP sender** – *the first node transmitting the message*
 - **ultimate SOAP receiver** – *the last node receiving the message*

Message Path

- A path from a service requester to a service consumer over a number of SOAP nodes.

$S \rightarrow (I)^* \rightarrow R$, where

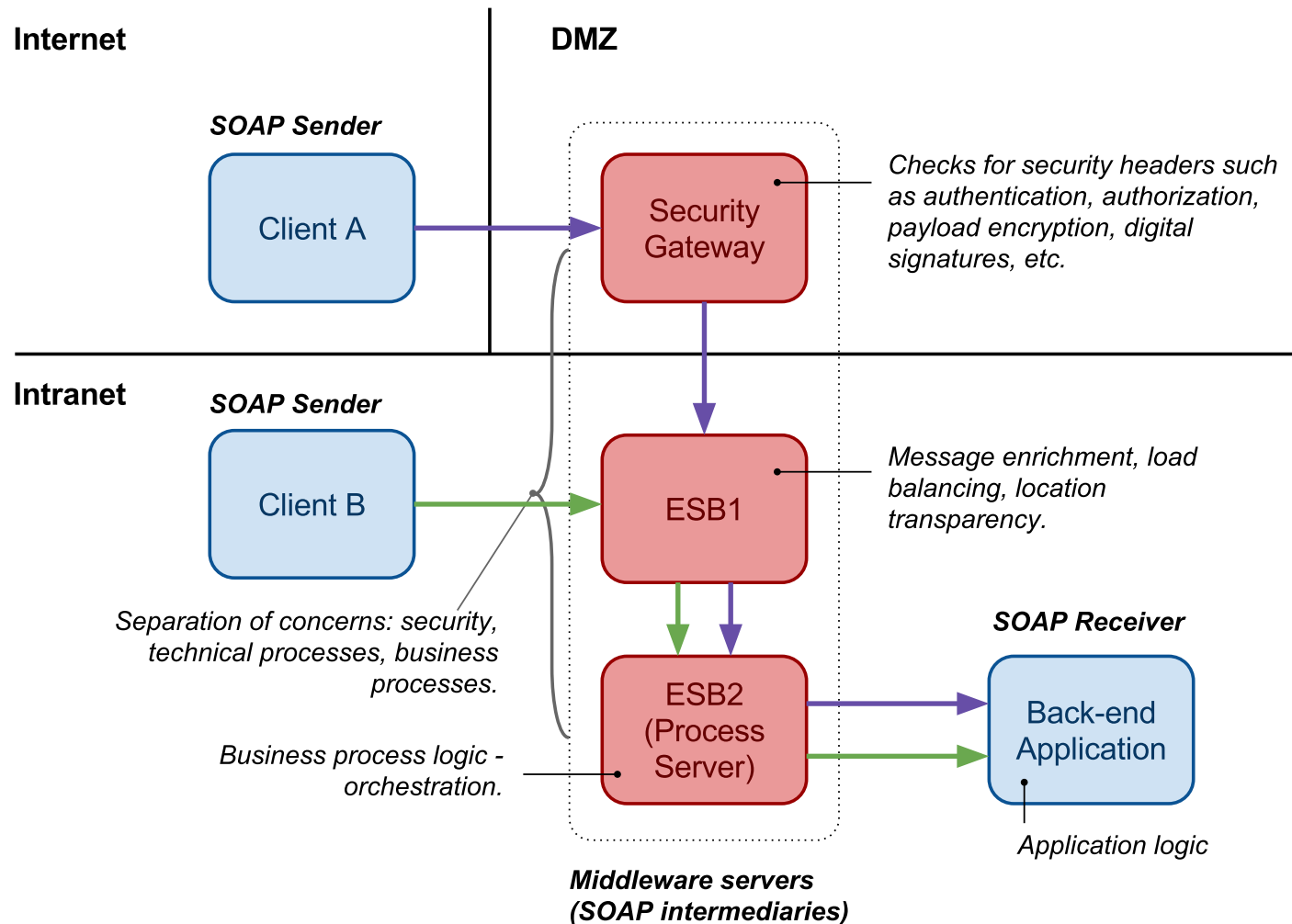
S is an initial sender,

I is an intermediary,

R is an ultimate receiver.

- A path may have zero or more intermediaries
 - **Passive intermediary** – such as a load balancing server
 - only forwards the message, does not rewrite headers
 - **Active intermediary** – such as a policy enforcement server
 - May modify headers

SOAP Message Paths Example



SOAP Message Example 1

- Client A → Security Gateway
 - *Client needs to authenticate with a username and a password*

```
1  <s:envelope
2    xmlns:tns="http://company.com/2011/wsd1/order"
3    xmlns:s="http://schemas.xmlsoap.org/soap/envelope/">
4    <s:header>
5      <wss:security
6        xmlns:wss="http://schemas.xmlsoap.org/ws/2002/04/secext"
7        s:mustUnderstand="1">
8        <wss:UsernameToken>
9          <wss:username>username</wsse:Username>
10         <wss:password Type="#PasswordText">pswd</wsse:Password>
11        </wss:UsernameToken>
12      </wss:security>
13    </s:header>
14    <s:body>
15      <tns:getOrderStatus xmlns:m="http://company.com/2011/schemas/order">
16        <m:orderId>2345</m:orderId>
17        <m:customerId>2234</m:customerId>
18      </tns:getOrderStatus>
19    </s:body>
20  </s:envelope>
```

SOAP Message Example 2

- Client B → Proxy Server
 - *Client directly invokes a proxy service without authentication*

```
1  <s:envelope
2      xmlns:tns="http://company.com/2011/wsd1/order"
3      xmlns:s="http://schemas.xmlsoap.org/soap/envelope/">
4      <s:header/>
5      <s:body>
6          <tns:getOrderStatus xmlns:m="http://company.com/2011/schemas/order">
7              <m:orderId>2345</m:orderId>
8              <m:customerId>2234</m:customerId>
9          </tns:getOrderStatus>
10     </s:body>
11 </s:envelope>
```


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REST

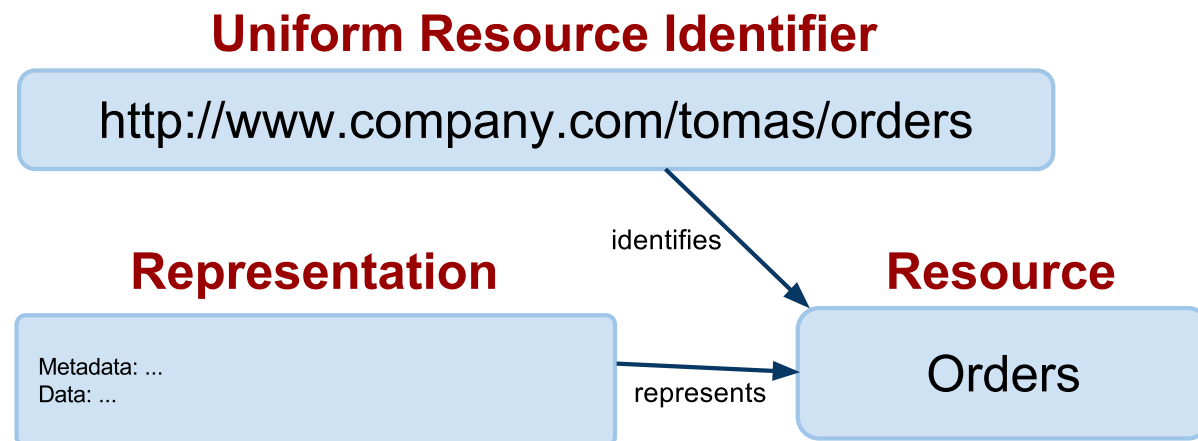
- REST
 - *Representational State Transfer*
- Architecture Style
 - Roy Fielding – co-author of HTTP
 - He coined REST in his PhD thesis [🔗](#).
 - The thesis abstracts from HTTP technical details
 - HTTP is one of the REST implementation → **RESTful**
 - REST is a leading programming model for Web APIs
- REST (RESTful) proper design
 - people break principles often
 - See REST Anti-Patterns [🔗](#) for some details.
- REST and Web Service Architecture
 - REST is a realization of WSA resource-oriented model

REST Core Principles

- REST architectural style defines constraints
 - *if you follow them, they help you to achieve a good design, interoperability and scalability.*
- Constraints
 - *Client/Server*
 - *Statelessness*
 - *Cacheability*
 - *Layered system*
 - *Uniform interface*
- Guiding principles
 - *Identification of resources*
 - *Representations of resources and self-descriptive messages*
 - *Hypermedia as the engine of application state (HATEOAS)*

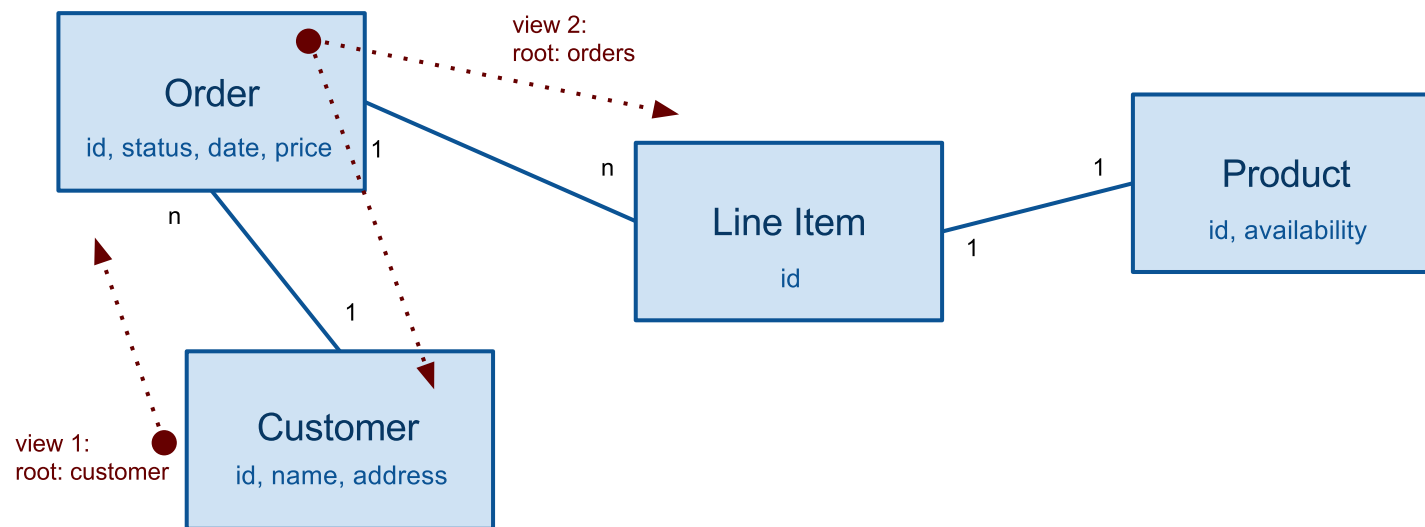
Resource

- A resource can be anything such as
 - *A real object: car, dog, Web page, printed document*
 - *An abstract thing such as address, name, etc. → RDF*
- A resource in REST
 - *A resource corresponds to one or more entities of a data model*
 - *A representation of a resource can be conveyed in a message electronically (information resource)*
 - *A resource has an identifier (URI) and a representation (XML, JSON, ...) and a client can apply an access to it (use HTTP methods)*



Resources over Entities

- Application's data model
 - *Entities and properties that the app uses for its data*



- URI identifies a resource within the app's data model
 - **path** – a "view" on the data model
 - data model is a graph
 - URI identifies a resource using a path in a tree with some root

Examples of Views

- View 1
 - *all customers*: `/customers`
 - *a particular customer*: `/customers/{customer-id}`
 - *All orders of a customer*: `/customers/{customer-id}/orders`
 - *A particular order*: `/customers/{customer-id}/orders/{order-id}`
- View 2
 - *all orders*: `/orders`
 - *All orders of a customer*: `/orders/{customer-id}`
 - *A particular order*: `/orders/{customer-id}/{order-id}`
- Various views represented by **URL path**

Uniform Interface

- Finite set of operations
 - *They are not dependent on the domain semantics*
 - *They only define how to manipulate with resources*
- RESTful service – HTTP methods
 - *GET – reads a resource (+ HEAD, OPTIONS)*
 - *PUT – updates or creates a resource (+ PATCH)*
 - *POST – creates a new resource*
 - *DELETE – deletes a resource*
- HTTP methods' properties
 - *a method is **safe***
 - *It does not change the application state (it does not modify the data)*
 - *GET, OPTIONS, HEAD*
 - *Results can be cached by intermediaries (e.g. proxy servers)*
 - *a method is **idempotent***
 - *Every method invocation will always have the same effect*
 - *GET, PUT, DELETE*

Examples

- Operation **getCustomerOrder(customerId, orderId)**
 - *Retrieves a representation of the order resource that belongs to a particular customer*

```
1 | > GET /customers/{customerId}/orders/{orderId}
```

- Operation **openOrder(customerId)**
 - *Creates a new order for a customer*

```
1 | > POST /customers/{customerId}/orders
2 | < Location: /customers/{customerId}/orders/{orderId}
3 |
4 | > GET /customers/{customerId}/orders/{orderId}
```

- Operation **addLineItem(customerId, orderId)**
 - *Adds a new item to the order*

```
1 | > POST /customers/{customerId}/orders/{orderId}
2 | < Location: /customers/{customerId}/orders/{orderId}/items/{itemId}
3 |
4 | > GET /customers/{customerId}/orders/{orderId}/items/{itemId}
```

- Operation **closeOrder(customerId, orderId)**
 - *Closes the order (i.e., changes a state of the order resource)*

```
1 | > PUT /customers/{customerId}/orders/{orderId}
2 | > <status>CLOSED</status>
```


Examples – evaluate operation

- Example REST implementation of the SOAP service **evaluate**
- Operation **evaluate(n1, n2)**
 - *Evaluates expression such that the result is **n1+n2***

```
1 > POST /evaluate/additions/  
2 > <parameters>  
3 > <n1>{n1}</n1>  
4 > <n2>{n2}</n2>  
5 > </parameters>  
6 < Location: /evaluations/additions/{n1}+{n2}  
7  
8 > GET /evaluations/additions/{n1}+{n2}
```

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SOAP vs. REST

- SOAP uses input and output messages in operations
- REST uses resources and defines access on them
- SOAP can use more protocols
- REST uses HTTP
 - *Practically, most of the SOAP implementations use SOAP over HTTP*
- Operations in SOAP are domain-specific
- HTTP operations are independent on domain semantics
 - *REST operations' semantics is defined by HTTP method + resource semantics*
- SOAP uses XML and XML Schema
- REST can use many representation formats
 - *For example, XML, JSON, YAML, etc.*
- SOAP is defined by WSDL
- REST is described in text or HTML
- Client libraries can be generated from WSDL
- REST vendor provides client libraries

SOAP vs. REST

- SOAP clients must hard-code service's public process
- REST clients can follow links in hypertext for application states
- SOAP services are used for inter/intra-enterprise integration
- REST services are used for Web APIs for integration on the Web