Lecture 8 : SOA and Web Services

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This Week

RMI and EJB also have the interoperability issue, and also coupling cause these has tight coupling

- RMI, EJB and many other distributed computing frameworks suffer form many disadvantages.
- This week we'll look at Service Oriented Architecture which is an architecture proposed to solve many of these disadvantages
- Also we'll look at SOAP and REST as Web Service implementations

Issues with Traditional RPC

- The RPC frameworks we have discussed so far share a few common issues that tend to inter-relate
  - Tight coupling between client and server
  - Security problems:
    - Trust,
    - Firewalls
    - The Internet
  - Limited/non-existent interoperability between frameworks

google map has low coupling because it can integrate to any project

Issue: Coupling

- Client and server in RPC are typically viewed as two parts in one (distributed) application
  - Stubs/Skeletons are generated from the same IDL file / interface
  - Marshalling/Serialization is technology dependent
  - Implicitly creates a coupling between client and server

Issue: Trust and Firewall Security

must think how to secure the data in server. cause we don;t know if the client is trustable of not. so we need to secure the data

- Trust issues:
  - The server shares it's information with the client
  - The client can compromise the server
- Firewall security: The RPC frameworks advocate assigning each server component with its own port
  - Follows good network protocol design - each different service has its own port (e.g. ftp = port 21, http = port 80)
  - Firewalls are then configured to block access to dangerous/risky ports to minimise the risk of attacks

Issue: Internet Security

- When the RPC is only internal to a corporate network, setup and security is less of an issue
  - Physical + login security cuts out most attack vectors
- But what if we must communicate over the Internet?
  - Need to open a ‘hole’ in the firewall at the *gateway*, one hole for each server component inside the network
  - Network administrators are *very* reluctant to do this!
    -

Issue: Interoperability

- Most RPC frameworks don’t interoperate with other frameworks
  - Almost entirely down to incompatible communication protocols and message formats
    - E.g. IIOP for CORBA vs. MSRPC for DCOM,
  - Each protocol is tailored to the features of the framework it was designed for
  - Presently, RPC became well-understood enough to define stable protocol and message format standards

Software Architectures

- "The software architecture of a program or computing system is the structure or structures of the system, which include software components and the relationships among them."

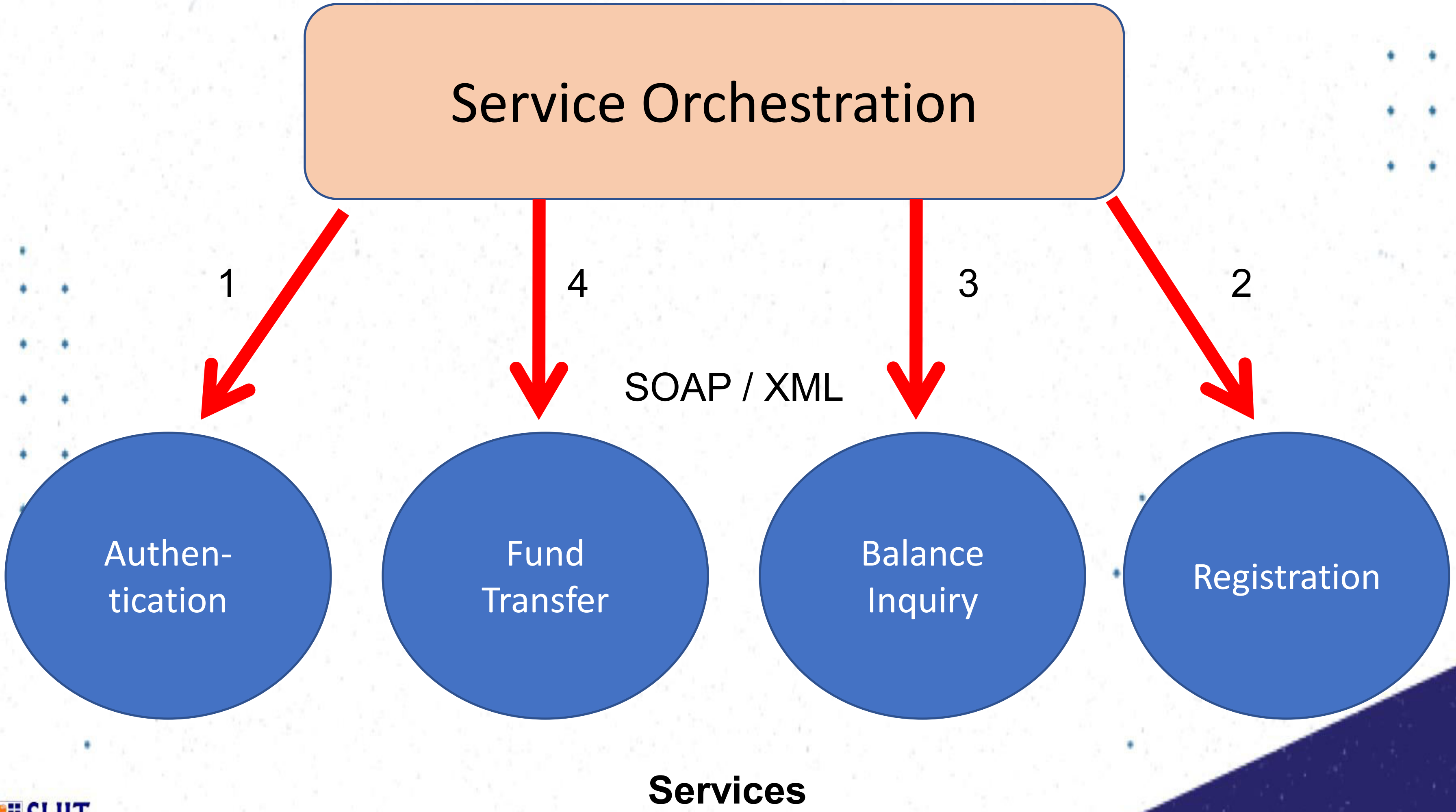
- In other words, software architecture describes the system's components and the way they interact at a high level.

- Service-oriented architecture is a special kind of software architecture that has several unique characteristics

What is SOA?

- Service-oriented architecture (SOA) is an architectural style where existing or new functionalities are grouped into atomic services.
- SOA is commonly thought as an architecture that builds **loosely coupled**, **interoperable, Standard based** components called services.
- They typically implement functionalities most humans would recognize as a service
  - Filling out an online application for an account
  - Viewing an online bank statement
  - Placing an online book or airline ticket order.

What is SOA?


Service Orchestration
1
4
3
2
SOAP / XML
Authen-tication
Fund Transfer
Balance Inquiry
Registration
Services

What is SOA?

- They have no calls to each other embedded in them.
- Instead of services embedding calls to each other in their source code, protocols are defined which describe how one or more services can talk to each other.
- This architecture then relies on a business process expert to link and sequence services, in a process known as **orchestration**, to meet a new or existing business system requirement.

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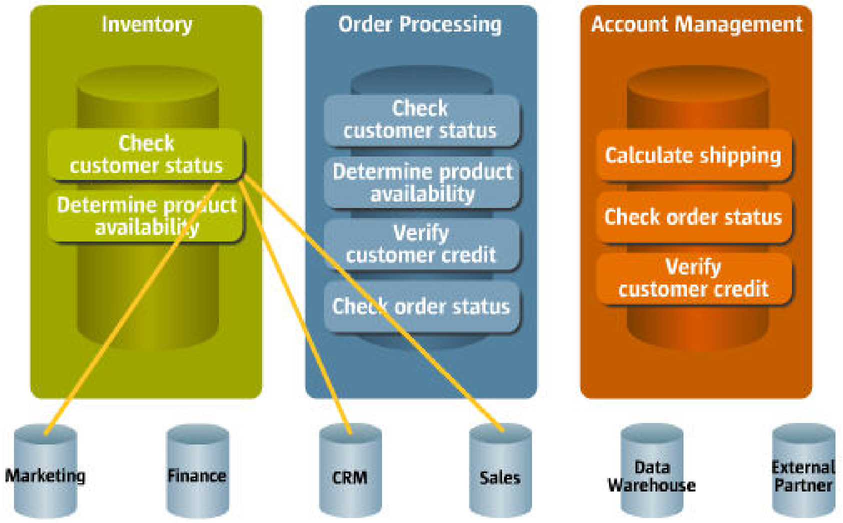
same function we have to duplicate in traditional ds like RMI, EJ

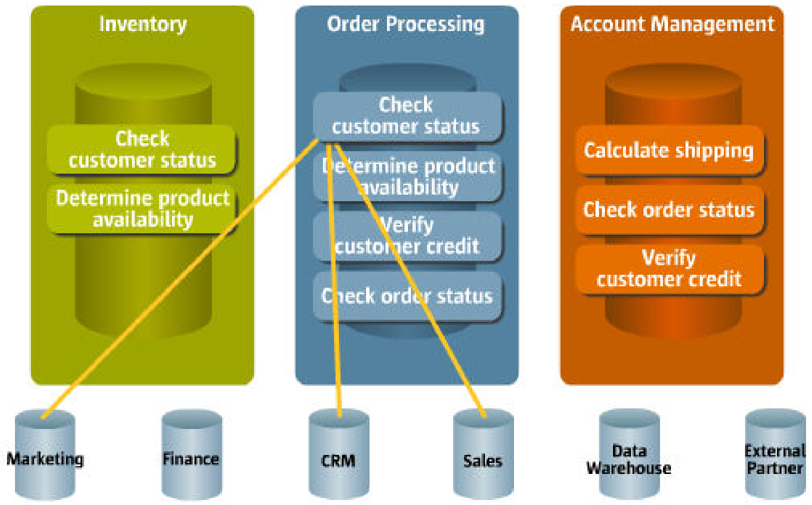
Traditional Distributed Systems

in traditional we have to duplicate our function.because we have functions separately in different sub systems.

- Functions are duplicated



Inventory Processing needs checking customer status



Order Processing also needs checking customer status

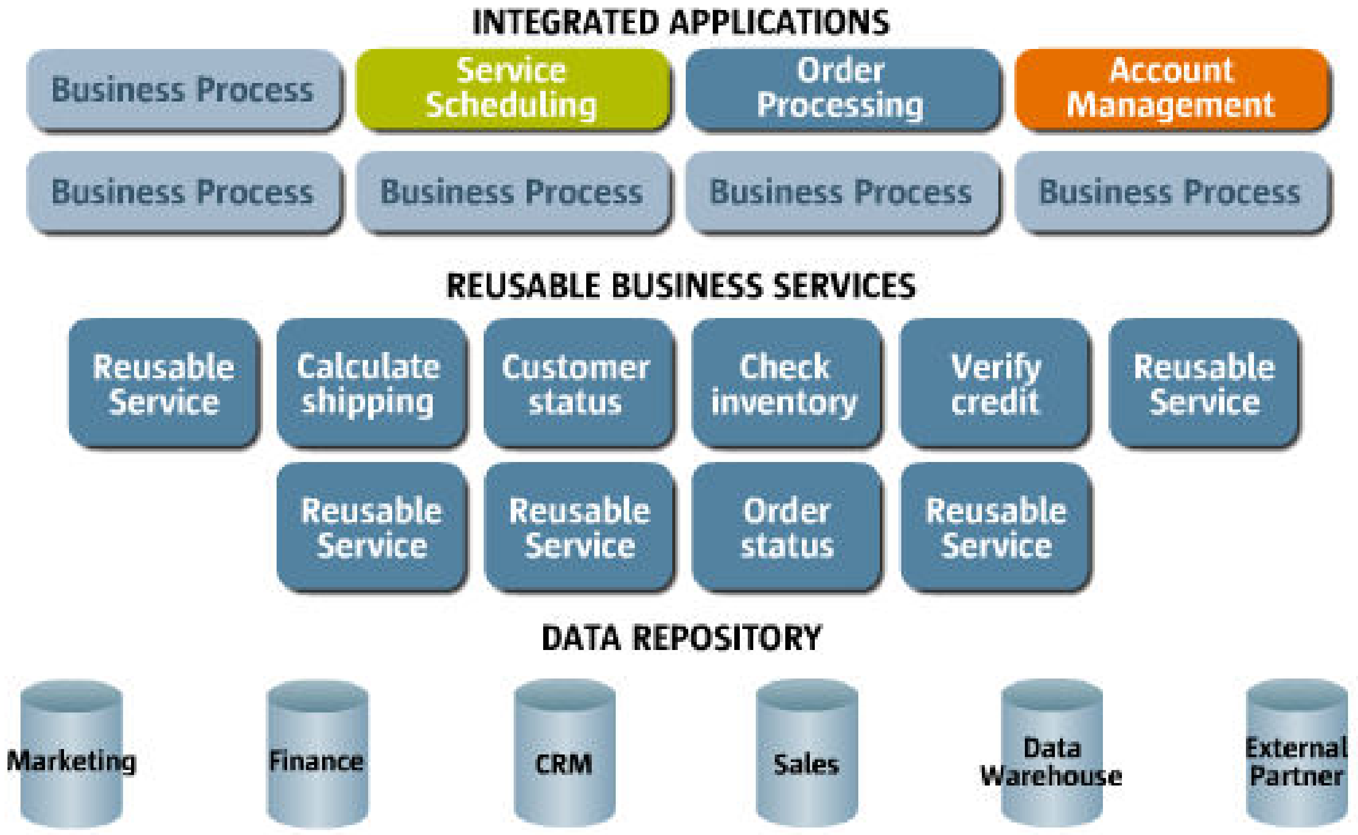
Traditional Distributed Systems

- Low reusability
  - If you try to reuse lot of cross references between sub-systems.

like waterfall. even for new function we must statrt from the beginning

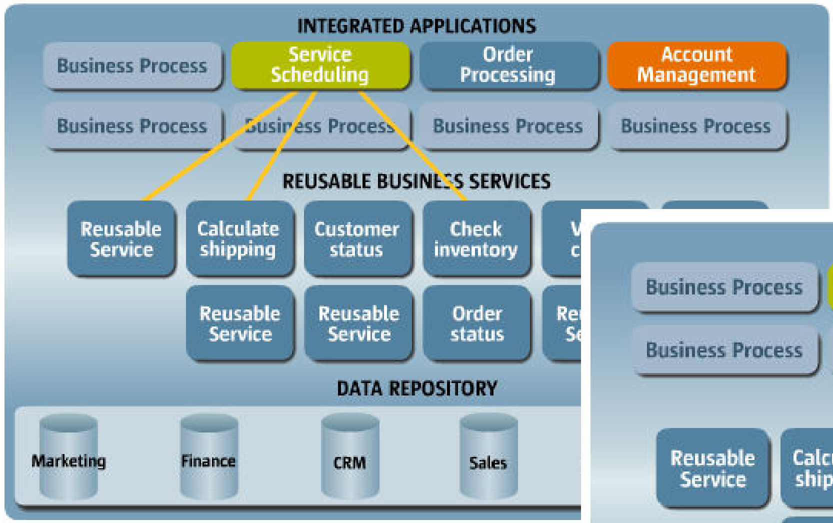
- Adding a new function is difficult
  - Develop everything from the beginning
- Function inconsistency
  - Development of "Checking customer status" can be different from sub-systems to sub-system.

SOA Style



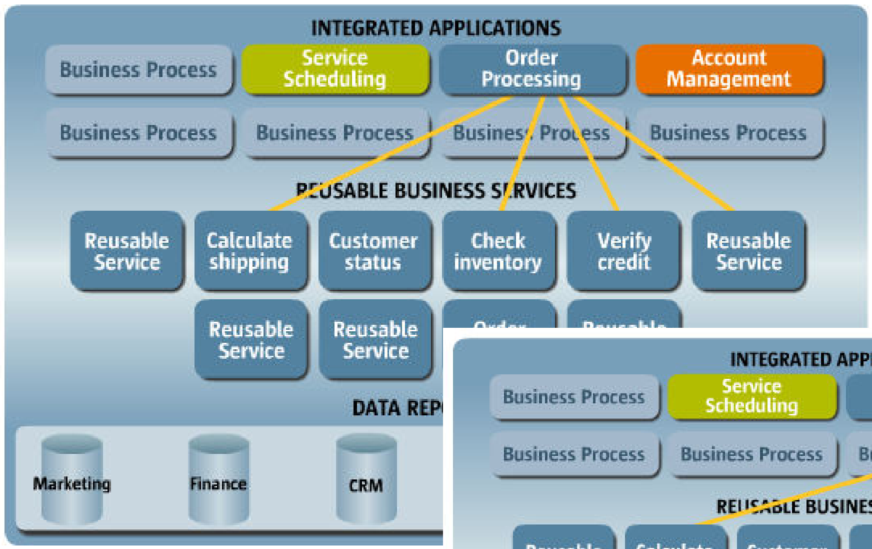
New ERP System is a reusable collection of services, that can be composed into Integrated Applications.

SOA Style

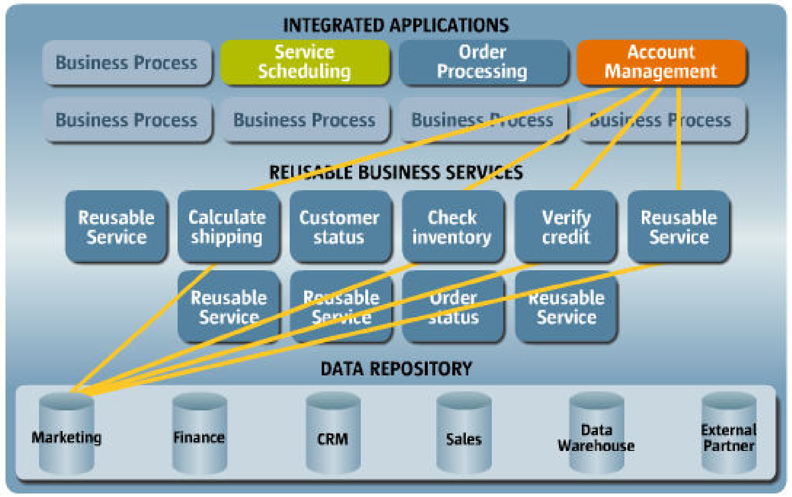


Service Scheduling Application

these are low coupled interoaple and security. can only access the relevent services from the business layer



Order Processing Application



Management Report

Generation Application

SOA

- What distinguishes SOA from other architectures is loosely coupling.
- In loosely coupled systems the client of a service is essentially independent of the service.
- The way a client communicate with the service is not dependent of the service implementation.
- The client communicates with service according to a specified, well-defined interface.

What Happens in SOA?

- Traditional
  - Services and service processing logic is mixed up in the code.
- SOA
  - Try to separate business process and services
  - Example : Data access layer detach the data management functionality out of application programs. Similarly we try to detach business process and the services.

Why SOA?

micro service architecture kiynne SOA vala tavat variant ekak

- Accommodate rapid changes to the IT landscape in relation to the changes in the Business environments.
- Promotes reuse of services across multiple business process automations.
- Simple dynamic interfacing of services.
- The services can be discovered and interfaces can be changed without major changes to applications.

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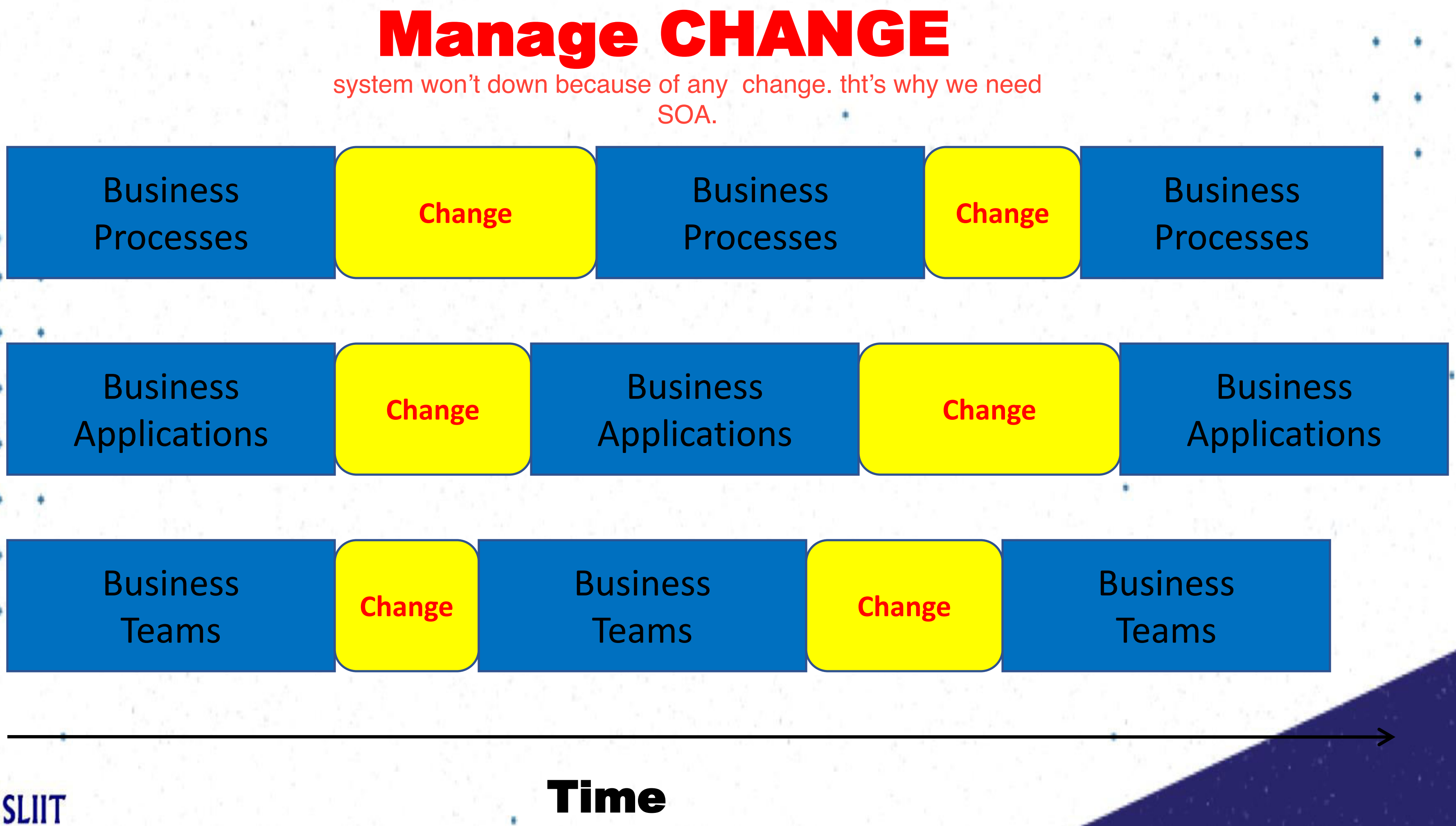
Why SOA for Businesses



Characteristics of SOA

- Loose Coupling - client can discover server's supported protocols/formats and negotiate communication semantics
- Reusable – similar to objected-orientation
- Autonomous - runs independently of other systems
- Stateless - no ongoing commitment between client & service
- Composable - one service can contain another
- Standards-based - interoperability among SOA services
- Contract-based – i.e. uses interfaces
- Fine-grained - services should be small (higher cohesion)
    - Reusable, modular - another way of saying 'fine-grained'
- Encapsulation - information hiding
- Heterogeneous – technologies, platforms, applications, etc.
- Location transparent

Implementing SOA

- SOA can be implemented using many technologies:
  - Web services
  - RPC
    - CORBA
    - DCOM
  - SOAP simple object access protocol
  - WCF (Windows Communication Foundations) Part of .NET framework.
  - REST (Web API)

Where to Use SOA?

- SOA is most useful for what it was designed for:
  - When crossing *platform* boundaries
  - When crossing *trust* boundaries

- Business logic that change frequently and highly reusable is more eligible for SOA.
  - E.g. Payment requests, Balance inquiries

Where *NOT* to Use SOA

- SOA isn't applicable everywhere. It's poor for:
  - **Non-distributed applications**
  - Applications with a **short deployed lifetime**
  - **Asynchronous communication** between servers

    we don't need to wait untill the response back
  - **Interactive GUI applications**
  - A **homogenous application environment**

A Web Service

- A service that is accessible over a web protocol
- Well defined interface - protocols define the interaction
between the client and the server

Why Web Services?

- A Service accessible over a web URL!
    - Reusable functionality
    - Business to business integration
    - Information sharing
    - Business process automation

- Innovation - offer different services

Perform Web Service Invocation

What will you learn?

- Service Invocation

Hands-on

1 - Go to http://openweathermap.org/

2 - Read the documentation

3 - Signup and get a key

4 - Try to read weather by giving longitude and latitude

http://api.openweathermap.org/data/2.5/weather?lat=35&lon=139&APPID=your_key

5 - Try to read weather in Colombo

Web Services Everywhere!

- Grid computing
  - SETI@home
- Cloud computing
  - IaaS - AWS
  - SaaS APIs - Salesforce APIs, Netsuite APIs, PeopleHR API
- Google Maps APIs

Web Services & SOAP

SOAP

SOAP is a protocol which is used to interchange data between applications which are built on different programming languages.

The SOAP building blocks consist of a SOAP Message. Each SOAP message consists of an envelope element, a header, and a body element

What does it stand for?

- Simple Object Access Protocol

What is it?

- Two versions - SOAP 1.1 and SOAP 1.2
- SOAP 1.2 became a W3C recommendation in 2003

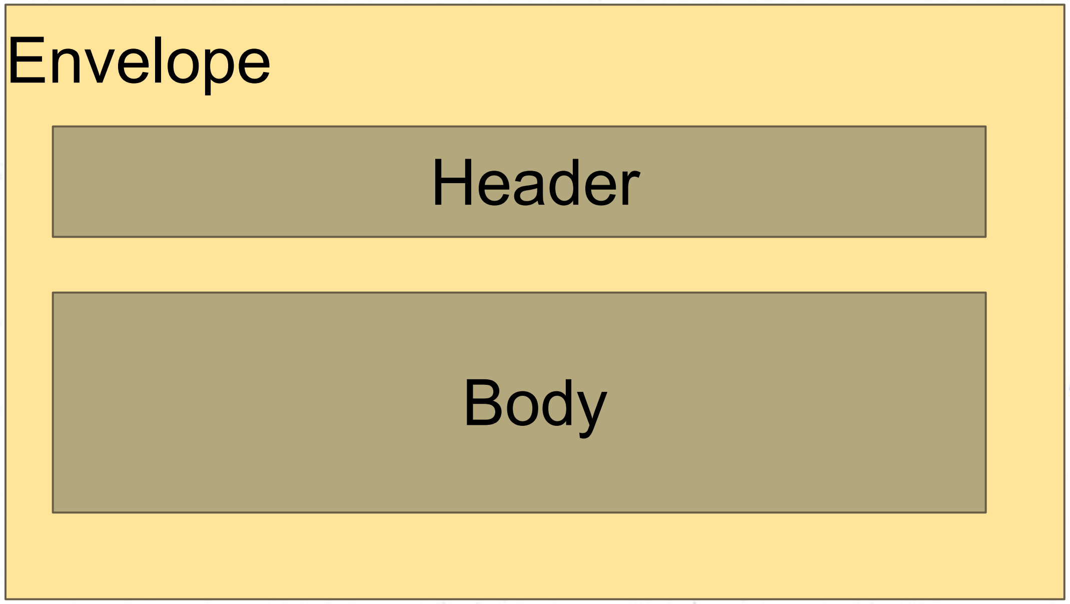
Who/where/when?

- Initiated by IBM, Microsoft

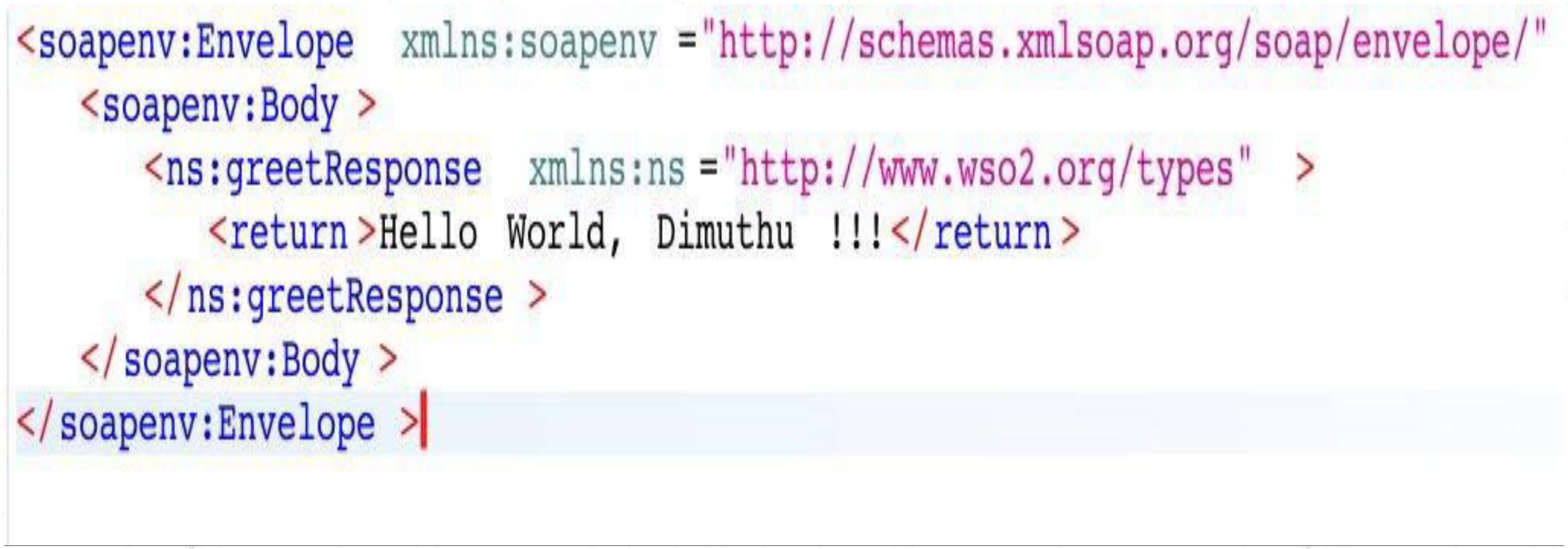
Sopa vala purpose eka eka standard ekkt anuva message ek send krn ek. meka use krnne XML. xmpl open message format ekk unata eke kisima standard ekk na ne. mm liyn XML ekk tava kenekt read krnn amaru venn puluvn. ekt visadumak lesa tama SOAP avill tiyenne. mek saralavam krnne XML message eka kisiyam srandard ekkt anuva liyna eka.

SOAP Basics

- Relies on XML and defines a message structure
- Can run on any protocol HTTP, SMTP

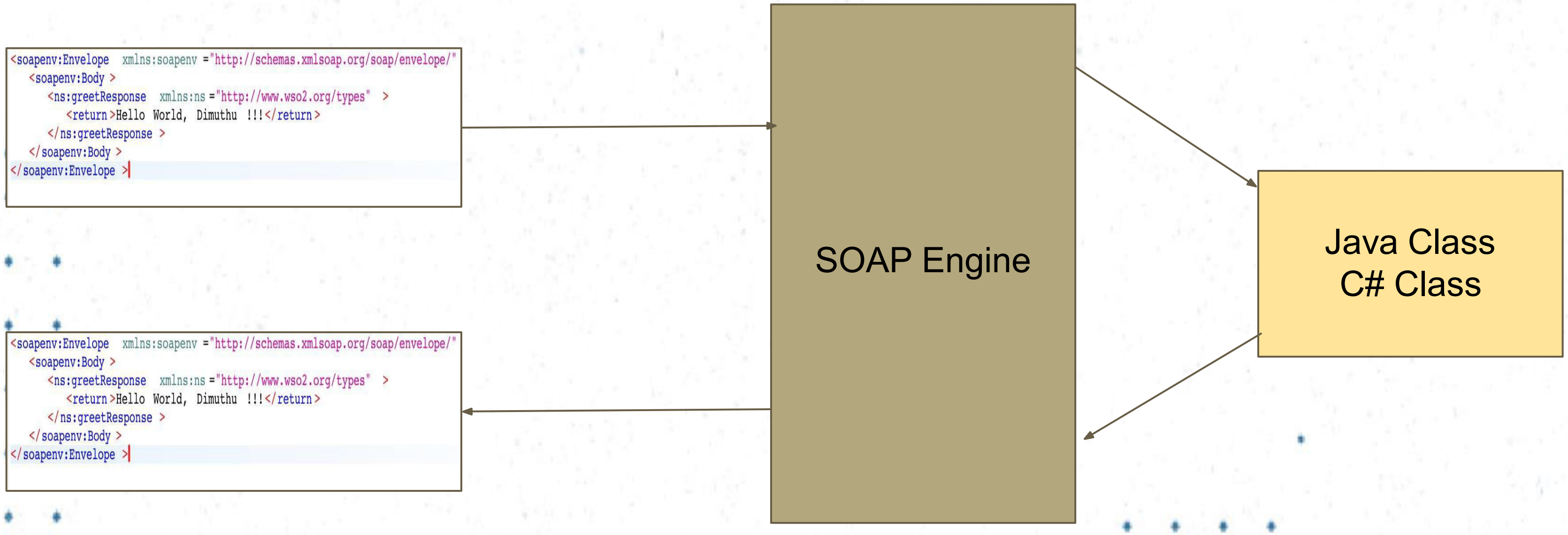


Sample SOAP Message



```
<soapenv:Envelope  xmlns:soapenv ="http://schemas.xmlsoap.org/soap/envelope/"
   <soapenv:Body >
      <ns:greetResponse  xmlns:ns ="http://www.wso2.org/types"  >
         <return >Hello World, Dimuthu !!!</return >
      </ns:greetResponse >
   </soapenv:Body >
</soapenv:Envelope >
```

SOAP Engine



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      </ns:greetResponse >
   </soapenv:Body >
</soapenv:Envelope >
```

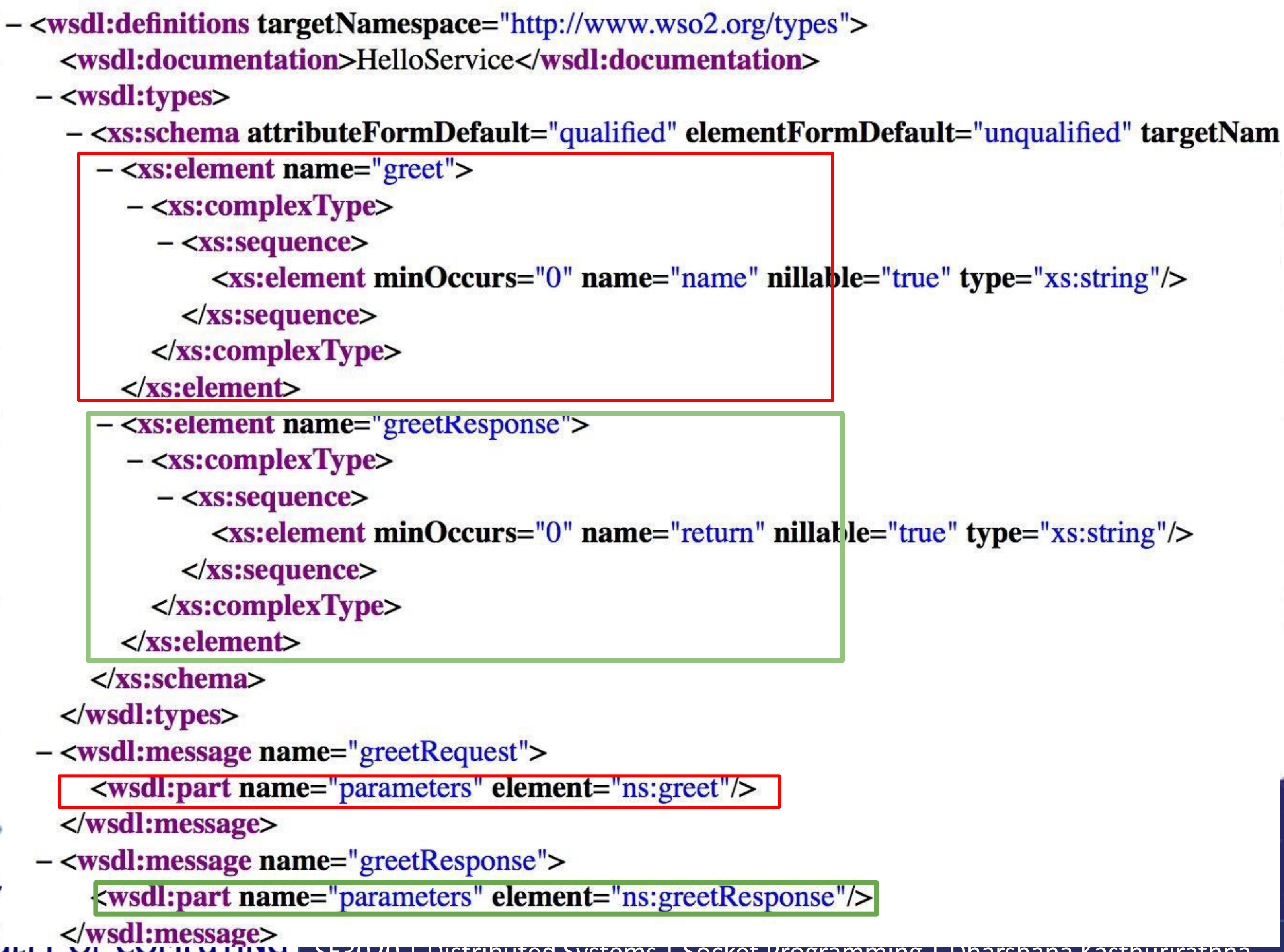
WSDL

SOAP service ekk interface ek describe krnn tama WSDL ek use krnne. It define what are the input messages are supported, what are the communication type are supported, what are the data type are supported

- Web Service Description Language - WSDL1.1 & 2.0
- Describes a web service using XML
  - Uses XML Schema
  - Input message
  - Output message
  - Transports
  - Versions

https://www.w3schools.com/xml/xml_wsdl.asp

SOAP and WSDL - A strong marriage



```
– <wsdl:definitions targetNamespace="http://www.wso2.org/types">
    <wsdl:documentation>HelloService</wsdl:documentation>
  – <wsdl:types>
    – <xs:schema attributeFormDefault="qualified" elementFormDefault="unqualified" targetNam
      – <xs:element name="greet">
        – <xs:complexType>
          – <xs:sequence>
              <xs:element minOccurs="0" name="name" nillable="true" type="xs:string"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      – <xs:element name="greetResponse">
        – <xs:complexType>
          – <xs:sequence>
              <xs:element minOccurs="0" name="return" nillable="true" type="xs:string"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:schema>
    </wsdl:types>
  – <wsdl:message name="greetRequest">
      <wsdl:part name="parameters" element="ns:greet"/>
    </wsdl:message>
  – <wsdl:message name="greetResponse">
      <wsdl:part name="parameters" element="ns:greetResponse"/>
    </wsdl:message>
```

Perform SOAP Service Invocation

What will you learn?

- Service Invocation
- Self contained functionality
- Service interface

WS* Specifications

- WSDL 2.0
- WS Security
- WS Addressing
- WS Policy
- WS Trust

REST

REST

What does it stand for?

- REpresentational State Transfer

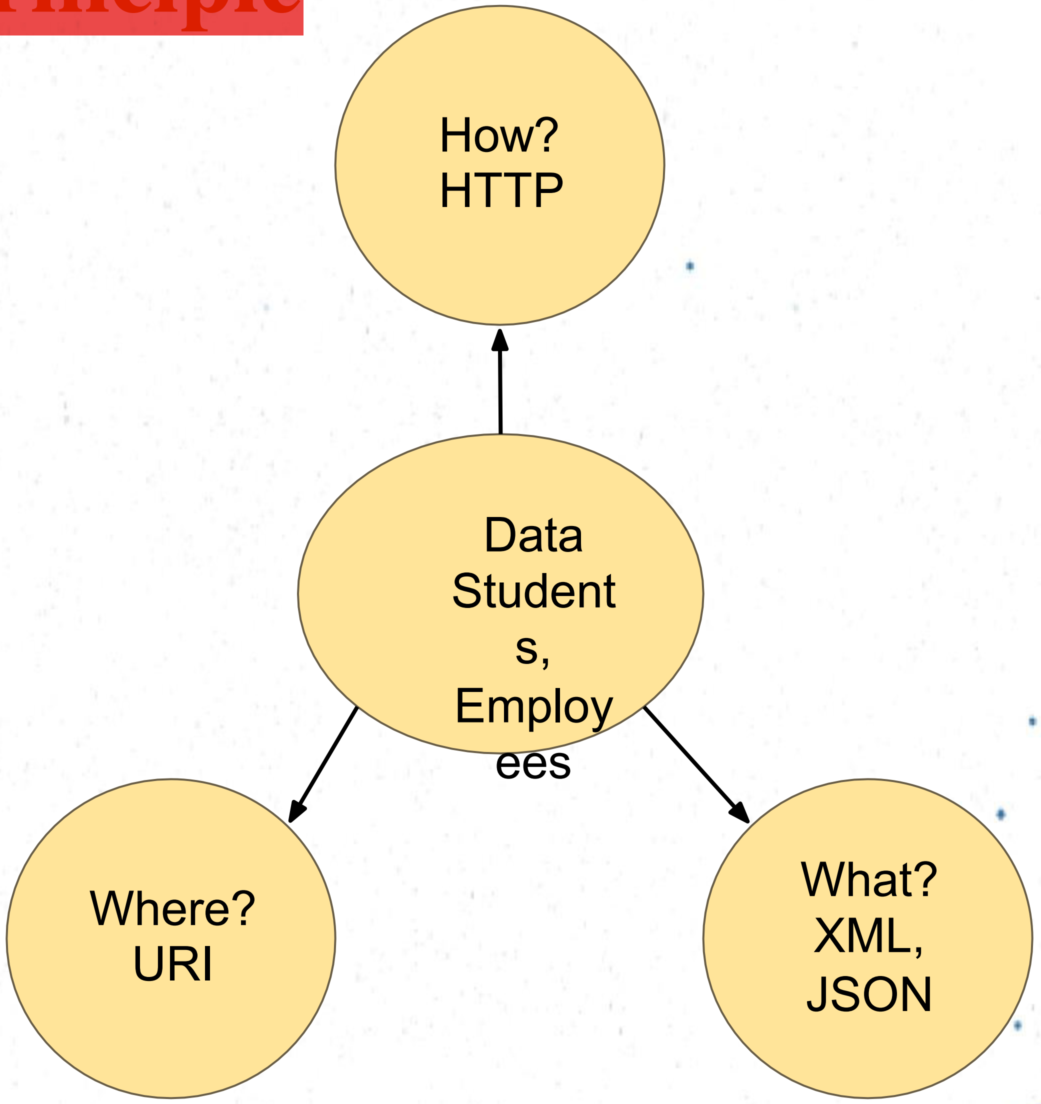
What is it?

- Architectural pattern - not a standard

Who/where/when?

- Roy Fielding in 2001

REST Principle



Stateless

- No state stored on the server
- Every HTTP request executes in complete isolation
- Simpler to design and evolve
- Easier to scale

REST - Methods

- Defines the action taken with a URL
- Proper RESTful services expose all four

HTTP Method	Action	Example
POST	Create	http://wso2.com/general/dbusers/user/
GET	Read	http://wso2.com/general/dbusers/users http://wso2.com/general/dbusers/user/sam
PUT	Update or Create	http://wso2.com/general/dbusers/user/sam
DELETE	Delete	http://wso2.com/general/dbusers/user/sam

URIs - Addressability

- Name, address and version of resource
- Self-descriptive
- Unique URIs are exposed for every resource from RESTful system
    - URI per resource
- URIs are discoverable by clients

Data Representation

- Can be
  - XML, JSON, HTML
- Content negotiation based on HTTP headers
  - Accept or Content-Type
- Query parameters
  - GET /v1/employees/123?format=json
- URI exention
  - GET /v1/employees/123.xml

An Example REST

- In http://ip-api.com/json/[ip_address] service
- Get the location of an Ip Address
- Content type - Application/JSON
- Send HTTP GET

REST Implementation

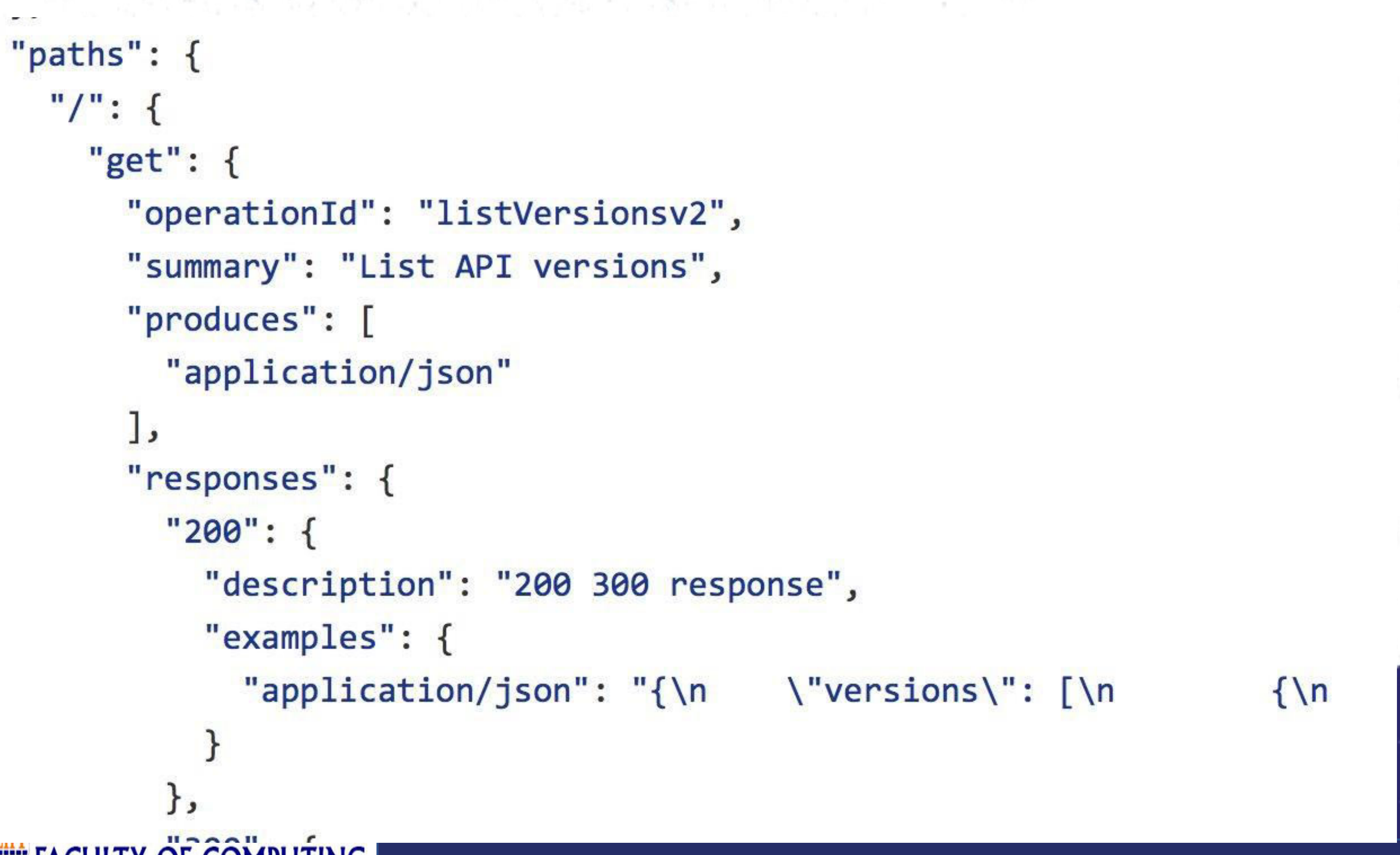
REST - Interface Description

- Swagger- Also known as OpenAPI specification

○ Interface description language for describing, producing, consuming and visualizing RESTful web services

- YAML based
- Allows both humans and machines to understand
- Goal - Update client and documentation at the same time as the server

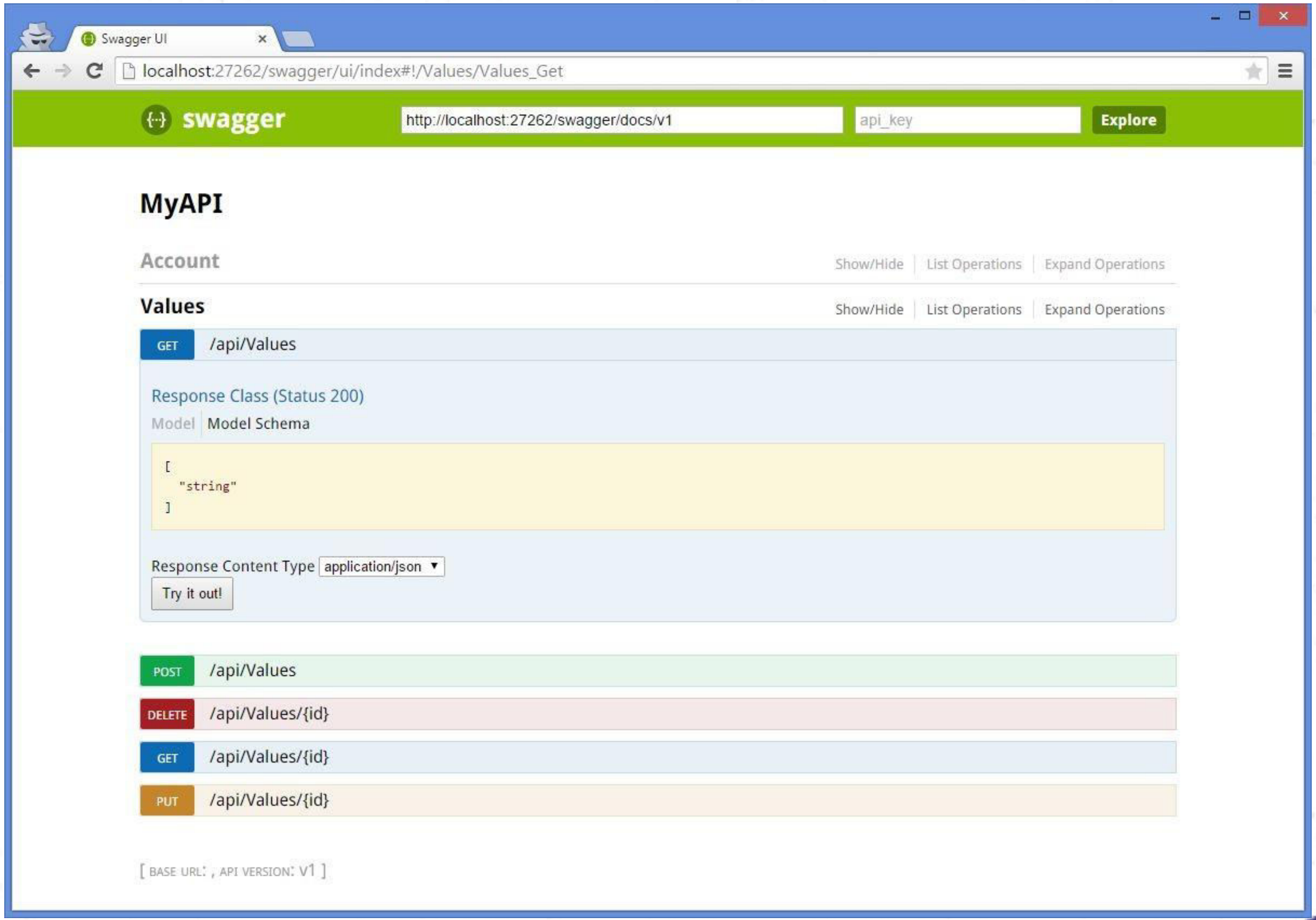
Swagger



```
"paths": {
  "/": {
    "get": {
      "operationId": "listVersionsv2",
      "summary": "List API versions",
      "produces": [
        "application/json"
      ],
      "responses": {
        "200": {
          "description": "200 300 response",
          "examples": {
            "application/json": "{\n    \"versions\": [\n        {\n
          }
        },
```

Swagger

!



localhost:27262/swagger/ui/index#!/Values/Values_Get

swagger http://localhost:27262/swagger/docs/v1 api_key Explore

MyAPI

Account — Show/Hide | List Operations | Expand Operations

Values — Show/Hide | List Operations | Expand Operations

GET /api/Values

Response Class (Status 200)

Model | Model Schema

```
[
  "string"
]
```

Response Content Type application/json

Try it out!

POST /api/Values

DELETE /api/Values/{id}

GET /api/Values/{id}

PUT /api/Values/{id}

[BASE URL: , API VERSION: v1]

Web APIs

Web APIs

What is it?

- Not a standard. Not an architecture pattern. Just a "term".
- Concentrating on the **accessibility** of services.
  - Secured (access controlled), open and monitored services
- A business capability delivered over the Internet to internal/external consumers

API = Service + Security + Documentation

Consuming REST Services - AJAX

HTTP use krnne synchronous communication ekk

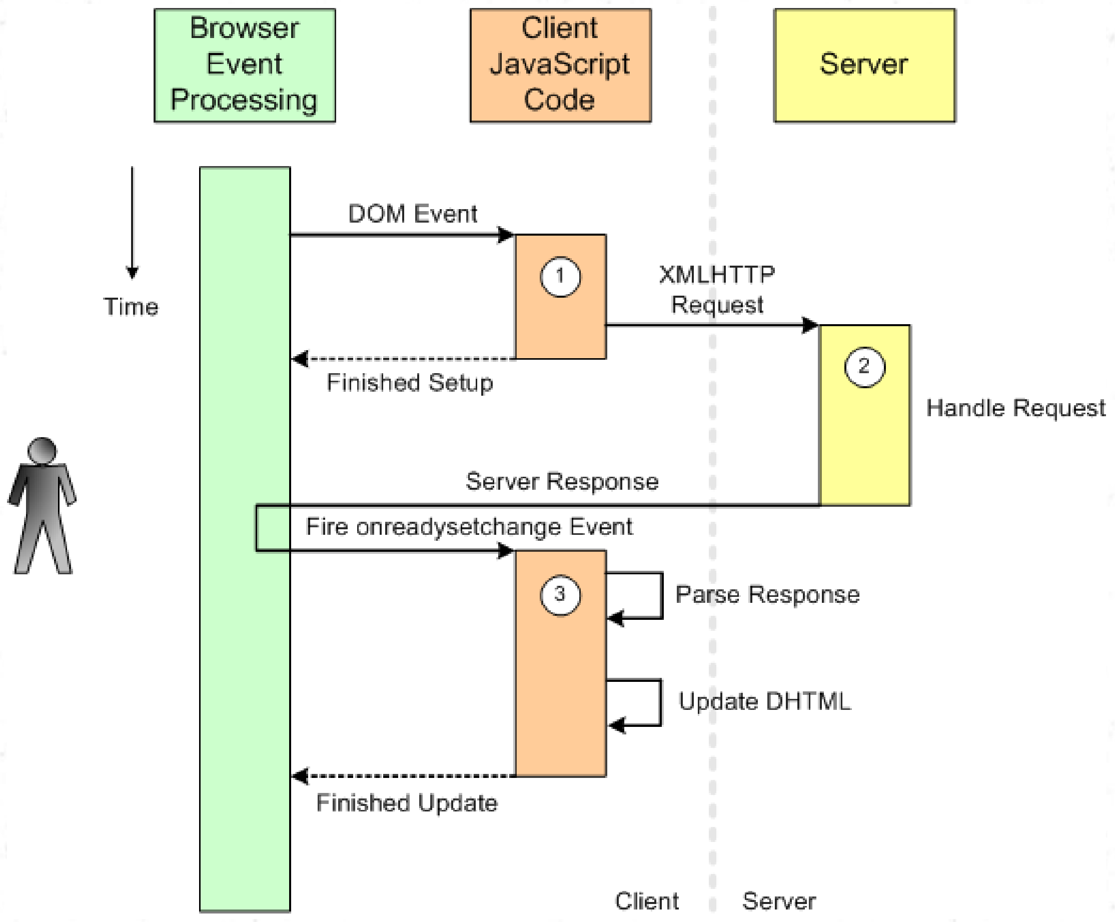
Api samnya HTTP request valin vada krddi assume apit oni yam part ekk update krnn ehidi venne sampurna application ekkm update ven eka. but AJAX ekk vada krddi adal part ek vitrk asynchronously update krnva

EX:- hitann apita user

Ajax

- Ajax stands for Asynchronous JavaScript And XML
  - Convergence of a few disparate technologies that together facilitate rich Web browser GUIs via client-side scripting
    - Term 'Ajax' was coined to describe their use together
  - **JavaScript**: scripting language (ie: interpreted on the fly at run-time) for client-side processing in Web browsers
  - **Asynchronous**: Built-in browser support for sending *arbitrary* messages *asynchronously* to a server via JavaScript
  - **XML**: General-purpose data document format; Web browsers have built-in XML parsers for rendering HTML

Ajax Sequence Diagram



XMLHttpRequest Class

- Methods of XMLHttpRequest object:
  - **open** - sets the URL for submitting (sending) the request to
  - **setRequestHeader** - Add/set headers, usually just Content-Type
  - **send** - accepts the text of the message contents and sends it
- Properties of XMLHttpRequest object:
  - **onreadystatechange** - pointer to completion callback function. Called every time the readyState changes. Note: lower case!
  - **readyState** - Callback state (see previous slide)
  - **status** - Call success/failure (200=success, others are error codes)
  - **responseText** - Raw message text from server
  - **responseXML** - XML parser object attached to responseText

Ajax + Web Service Example (SOAP 1.2)

```
function AddRPCAsync_SOAP12(onCompletionFn) {
   req = null;
   if (window.XMLHttpRequest != undefined)
      req = new XMLHttpRequest();                      ← Firefox and compatible
   else
      req = new ActiveXObject("Microsoft.XMLHTTP");    ← Internet Explorer

   req.onreadystatechange = onCompletionFn;
   req.open("POST", "http://localhost/WebServices/Calculator.asmx", true); ← No .asxm/Add here!
   req.setRequestHeader("Content-Type", "application/soap+xml");      ← Set up header(s)

   req.send("<?xml version=\"1.0\" encoding=\"utf-8\"?> \
          <soap12:Envelope xmlns:xsi=\"http://www.w3.org/2001/XMLSchema-instance\"
                           xmlns:xsd=\"http://www.w3.org/2001/XMLSchema\"
                           xmlns:soap12=\"http://www.w3.org/2003/05/soap-envelope\"> \
            <soap12:Body> \
              <Add xmlns=\"http://www.curtin.edu.au/SPD361/\"> \
                <operand1>8</operand1> \
                <operand2>4</operand2> \
              </Add> \
            </soap12:Body> \
          </soap12:Envelope>");
}
function AddRPC_SOAP_OnCompletion() {                 ← Same as SOAP 1.1
  if (req.readyState == 4) {
    if (req.status == 200) {
      var ndResult = req.responseXML.documentElement.getElementsByTagName("AddResult")[0];
      alert(ndResult.childNodes[0].nodeValue);       ← Access result (<AddResponse>) via DOM
    }
    else
      alert("Asynchronous call failed. ResponseText was:\n" + req.responseText);
  req = null;
}
```

Calling a REST services with AJAX + JQUERY

```
$.ajax({
type: "GET",
dataType: "jsonp",
url: "http://localhost:8080/restws/json/product/get",
success: function(data){
        alert(data);
}
error: function(data);
        alert('error');
});
```

AJAX in JQuery

- $.get(url [, data] [, success(data,textStatus, jqXHR){})

```
$.get( "ajax/test.html", function( data ) {
  $( ".result" ).html( data );
  alert( "Load was performed." );
});
```

- $.post(url [, data] [, success(data,textStatus, jqXHR){})

```
$.post( "ajax/test.html", postdata, function( data ) {
  $( ".result" ).html( data );
});
```

- $.getJSON(url [, data] [, success(data,textStatus, jqXHR){})
  - Use an AJAX get request to get JSON data

REST and SOAP Implement SOA

Summary

- Service Oriented Architecture
- Web Services
- REST
- APIs & Microservices

Reuse

SOA vala main purpose ek reusability ve

Many technologies for implementing a SOA.

None is perfect.

All achieve data sharing, modularity, agility, reuse and innovation!

Questions?