Web Services

27696-54919-01

Web Services

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Topics

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- Definition
- Architecture
- RPC
- XML based Web Services
- REST based Web Services

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Web Services

Web service is:

- A service available on the internet, that uses standard protocols for integration
  - Service
  - Internet [HTTP]
  - Standard protocols

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Architecture

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- Web App Architecture
  - What is a service
  - 2 tier model
  - 3 tier model
  - N tier model
- XML for transferring data
  - Well formed
  - Validation and types with Schema (XSD)
  - XML Binding - JAXB
  - XML vs. JSON
- MVC Model 2
- Moving to single page applications
  - The problem with views
  - AJAX for browsers
  - Future internet clients

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What is a service?

- A model, provided by vendor, that allows clients to communicate and interact.
- May be self-descriptive since a contract is needed.

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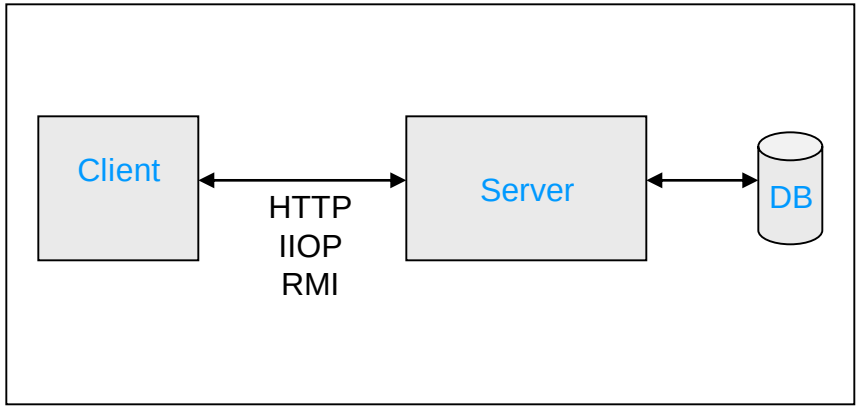
2 Tier Model

- Tier 1 – container
- Tier 2 – DB or any other 3rd party
- Containers are focusing on communication
  - Web containers – HTTP→ CGI
  - RMI containers – Java connectors
  - IIOP containers – IDL connectors



- Disadvantages
  - No infrastructure services
  - Problematic when moving to large scales

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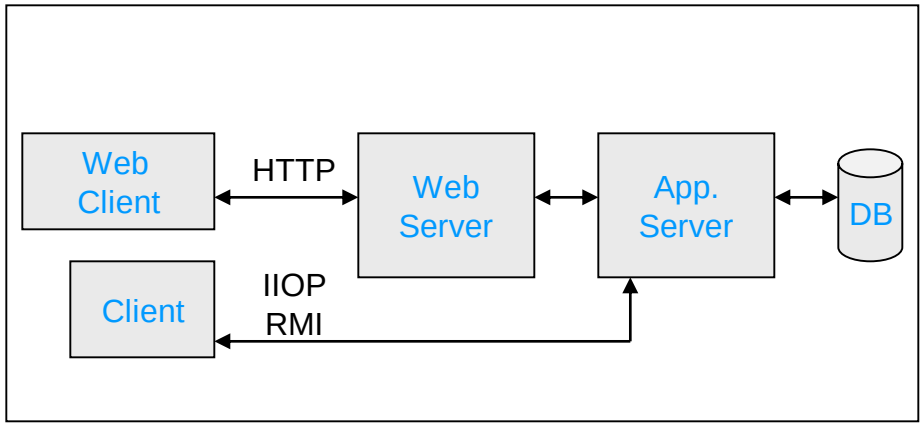
3 Tier Model

- Tier 1 – Web server
- Tier 2 – Business server
- Tier 3 – DB or any other 3rd party
- Business server provides infrastructural services
  - Development focuses on service implementation
  - Highly scalable
  - Support various protocols



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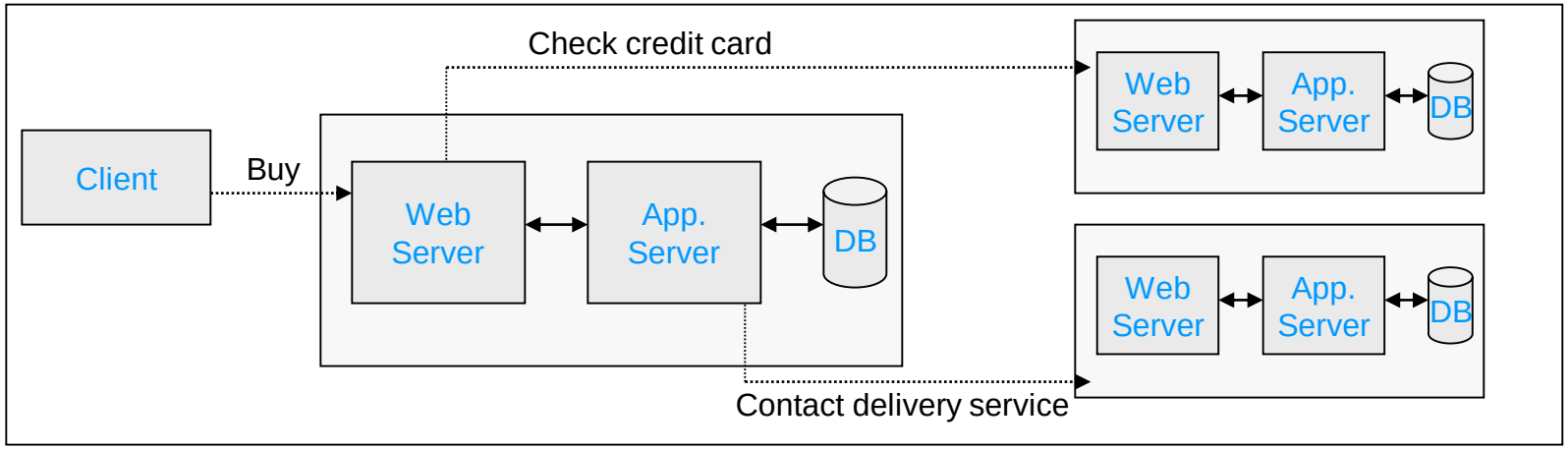
N Tier Model

- 2, 3 tier systems interaction
- Client request might be handled by multiple systems
- One system must effectively interact with another
- B2B / EAI / SOA …



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XML for transferring data

- HTML for applications. Describes plain data rather then how to present it
  - Application that 'understands' the data – can present it if needed…
- Present and future devices will consume mostly data – not view
- We can do much more with this

  than we can do with that:

```
<people>
    <person>
        <name> David </name>
        <age> 20 </age>
    </person>
    ….
</people>
```

```
<table>
    <tr>
        <td> David </td>
        <td> 20 </td>
    </tr>
    ….
</table>
```


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XML for transferring data

- Well formed
  - Set of basic syntax rules
    - Including:
      - Closing tags
      - Attribute values inside quotes
      - Case sensitive
      - Correct element nesting…
  - Part of W3C XML standard
  - XML parsers must not parse any non well-formed data
  - Saves checks and manipulations for small & tiny devices
  - For browsers & micro-browsers - XHTML

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XML for transferring data

- Validation and types
  - XML structure is described via XSD (Schema)
  - W3C standard
  - XSD Schema defines:
    - Element name & content
    - Attributes
    - Simple and complex types
  - Since XSD defines primitives (xsd:integer, xsd:date….) – objects can be described as well…

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XML for transferring data

Schema example:

```
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
      <xsd:element name="People">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element name="Person" type="PersonType" maxOccurs="unbounded"/>
            </xsd:sequence>
        </xsd:complexType>
    </xsd:element>
    <xsd:complexType name="PersonType">
        <xsd:sequence>
                <xsd:element name="Name" type="xsd:string"/>
                <xsd:element name="Age" type="AgeType"/>
                <xsd:element name="BirthDate" type="xsd:date" minOccurs="0"/>
        </xsd:sequence>
        <xsd:attribute name="gender" type="GenderType" use="required"/>
    </xsd:complexType>
    <xsd:simpleType name="AgeType">
        <xsd:restriction base="xsd:nonNegativeInteger">
                <xsd:minInclusive value="0"/>
                <xsd:maxInclusive value="120"/>
        </xsd:restriction>
    </xsd:simpleType>
    <xsd:simpleType name="GenderType">
        <xsd:restriction base="xsd:string">
                <xsd:enumeration value="M"/>
                <xsd:enumeration value="F"/>
        </xsd:restriction>
    </xsd:simpleType>
</xsd:schema>
```


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XML for transferring data

XML example:

```
<?xml version="1.0"?>
<People xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
                xsi:noNamespaceSchemaLocation="PeopleSchema.xsd">
                <Person gender="M">
                                <Name>Bill</Name>
                                <Age>35</Age>
                                <BirthDate>1984-04-13</BirthDate>
                </Person>
                <Person gender="F">
                                <Name>Dana</Name>
                                <Age>47</Age>
                                <BirthDate>1961-11-03</BirthDate>
                </Person>
                <Person gender="F">
                                <Name>Amy</Name>
                                <Age>23</Age>
                                <BirthDate>1991-04-15</BirthDate>
                </Person>
                <Person gender="M">
                                <Name>David</Name>
                                <Age>13</Age>
                                <BirthDate>2000-07-02</BirthDate>
                </Person>
</People>
```


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XML vs. JSON

What is JSON?

- Java Script Object Notation
- Also self-descriptive text based protocol
- Used for marshalling and un-marshalling Jscript objects

```
{
 “people”: [
            { “name": “David“,  “age": “20“},
            { “name": “Dana“,  “age": “25“},
            { “name": “Eve“,  age": “30“},
 ]
}
```


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XML vs. JSON

Why is it an alternative for XML ?

- Better for small applications (like client side apps)
  - No parsers are needed
  - Contracts are less critical
  - Light integration
- Jscript and Android developers prefers it
  - Got popular APIs for binding, handling & presenting JSON based data

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XML vs. JSON

- JAXB supports JSON as well
  - Root class is denoted with @XMLRootElement
  - No schema is needed – all adjustments are done with JAXB annotations
- JSON has no strong standards as XML (yet..)

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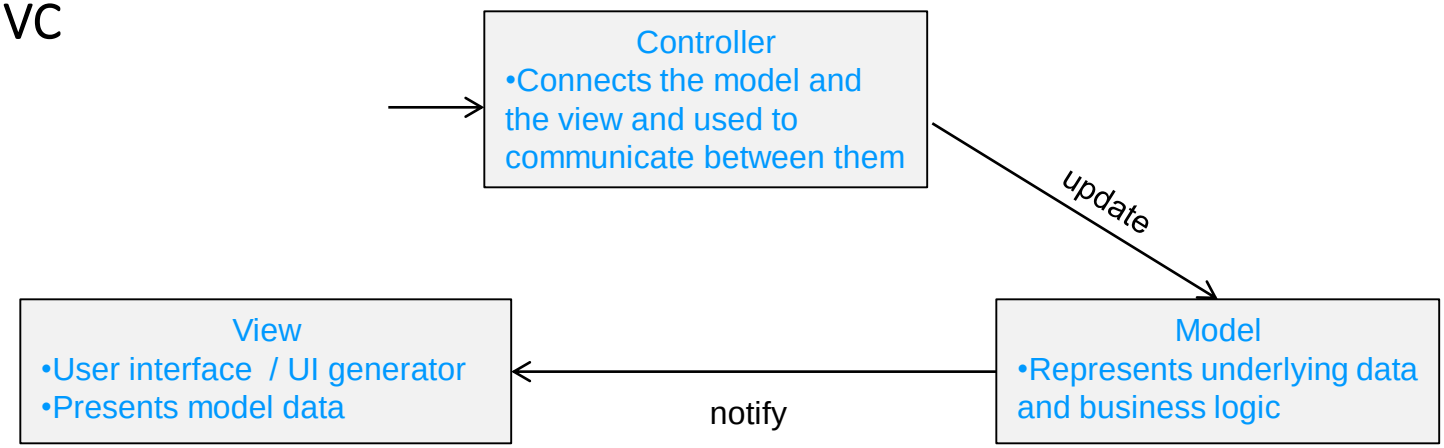
MVC Model 2

- Classic MVC



  – Designed to separate client flow and interaction from business model that serves the client request and from the final output.

- **Traditional MVC** as used in web modules – MVC Model 2

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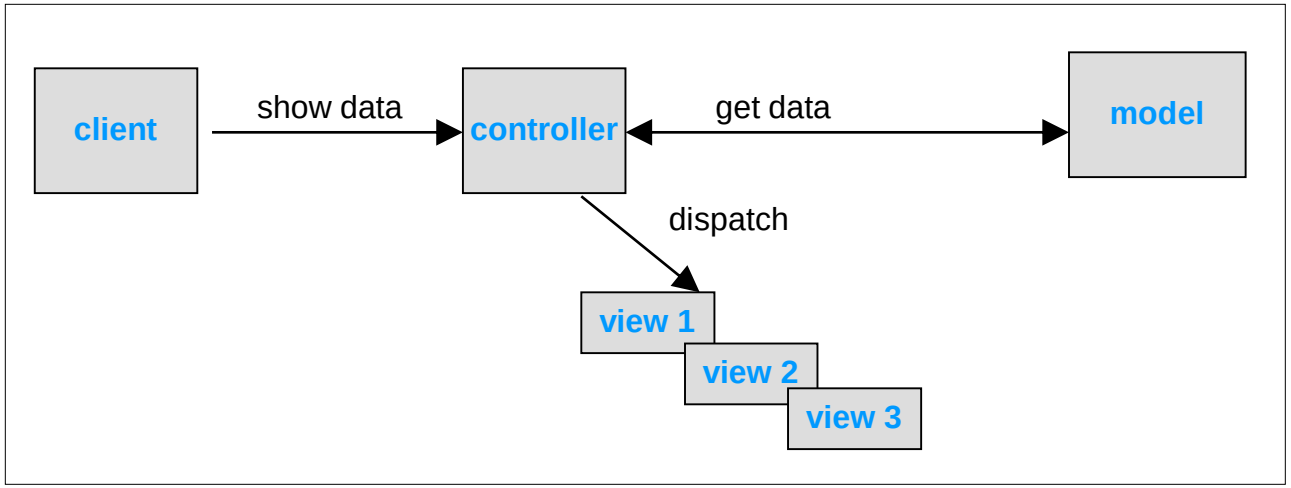
- Service To Work - MVC Model 2



  - Better since:
    - View and model communicated through value objects
    - Trivial server side code is embedded in views
  - But, views are still a mix of server & client code...

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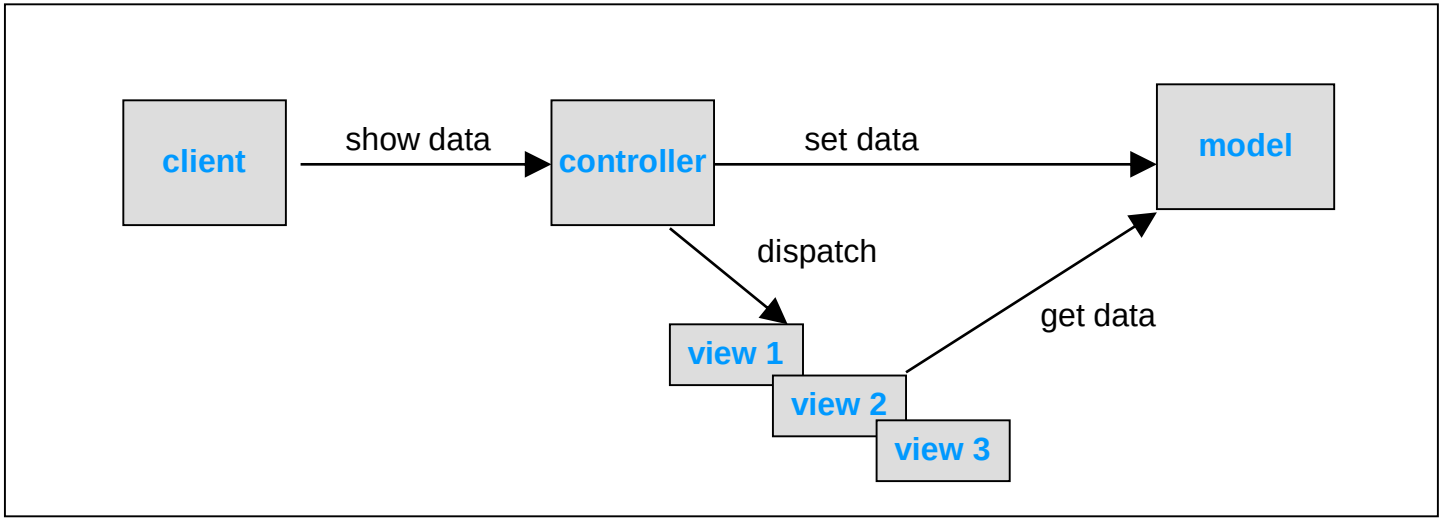
- Dispatcher View model



  - Here, views are used also for 'controlling'
  - Tightly coupling between views and model
  - Can be considered for very simple modules

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The problem with views

Mixing server side code in view causes some serious problems:

- Value objects embedded in HTML
  - It is never just HTML…(CSS, Jscript…)
  - What if client requires something else than HTML ??

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The problem with views

- List of web frameworks that should help:

  Echo, Cocoon, Millstone, OXF, Struts, SOFIA, Tapestry, WebWork, RIFE, Spring MVC, Canyamo, Maverick, Jpublish, JATO, Folium, Jucas, Verge, Niggle, Bishop, Barracuda, Action Framework, Shocks, TeaServlet, wingS, Expresso, Bento, jStatemachine, jZonic, OpenEmcee, Turbine, Scope, Warfare, JWAA, Jaffa, Jacquard, Macaw, Smile, MyFaces, Chiba, Jbanana, Jeenius, Jwarp, Genie, Melati, Dovetail, Cameleon, Jformular, Xoplon, Japple, Helma, Dinamica, WebOnSwing, Nacho, Cassandra, Baritus, Stripes, Click, GWT, Apache Wicket

- So many… means that:
  - none is really good enough…
  - maybe problems can't be solved with MVC model 2

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The problem with views

- AJAX – bigger than it seems…
- AJAX technology encourages web modules to ‘talk’ using XML / JSON rather than HTML

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Introduction to AJAX

Asynchronous Jscript And XML

- AJAX is based on *XMLHttpRequest* Object
  - Is an interface implemented by a scripting engine
  - Allows scripts to perform HTTP client functionality
  - W3C standard

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Introduction to AJAX

Classic way of interacting in web applications:

- Page by page
- Each page links or submits to another
- Static or dynamic content produced by the server
- Client side manipulation are done on downloaded data
- Most of client state is kept on server side

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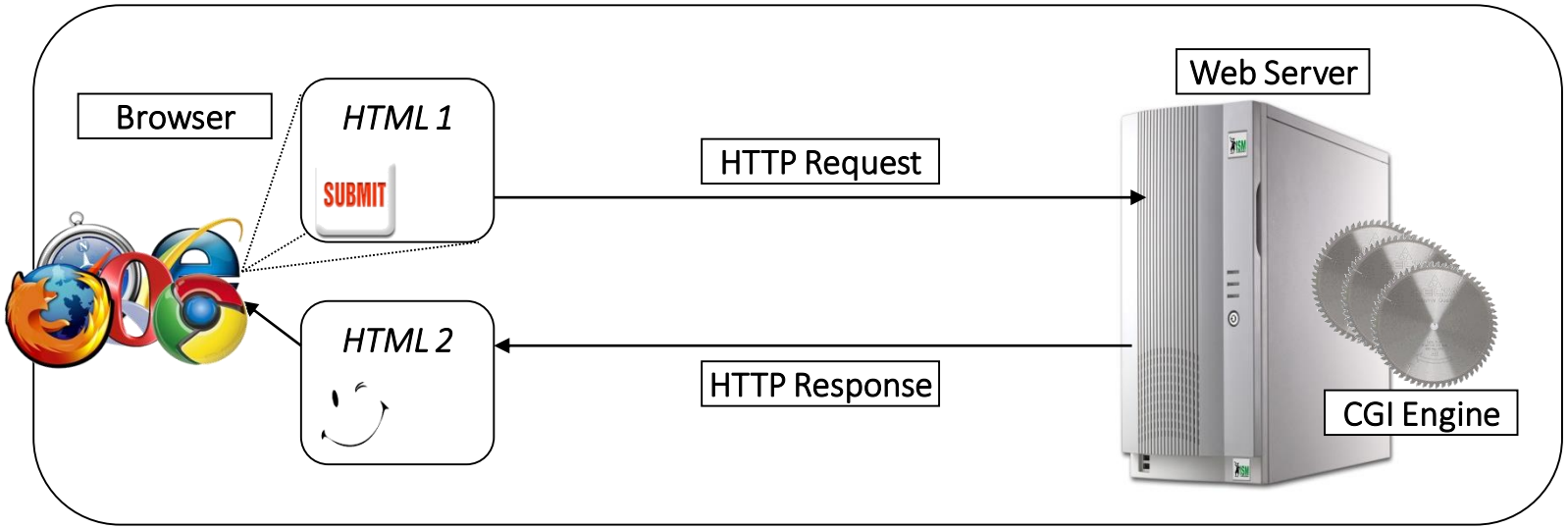
Introduction to AJAX

View of classic architecture



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Introduction to AJAX

AJAX way of interaction:

- Same page generates request(s) & processes responses
- Dynamic content handled also by the client
- Client downloads only the data he needs
- Client is notified asynchronously regarding data receiving

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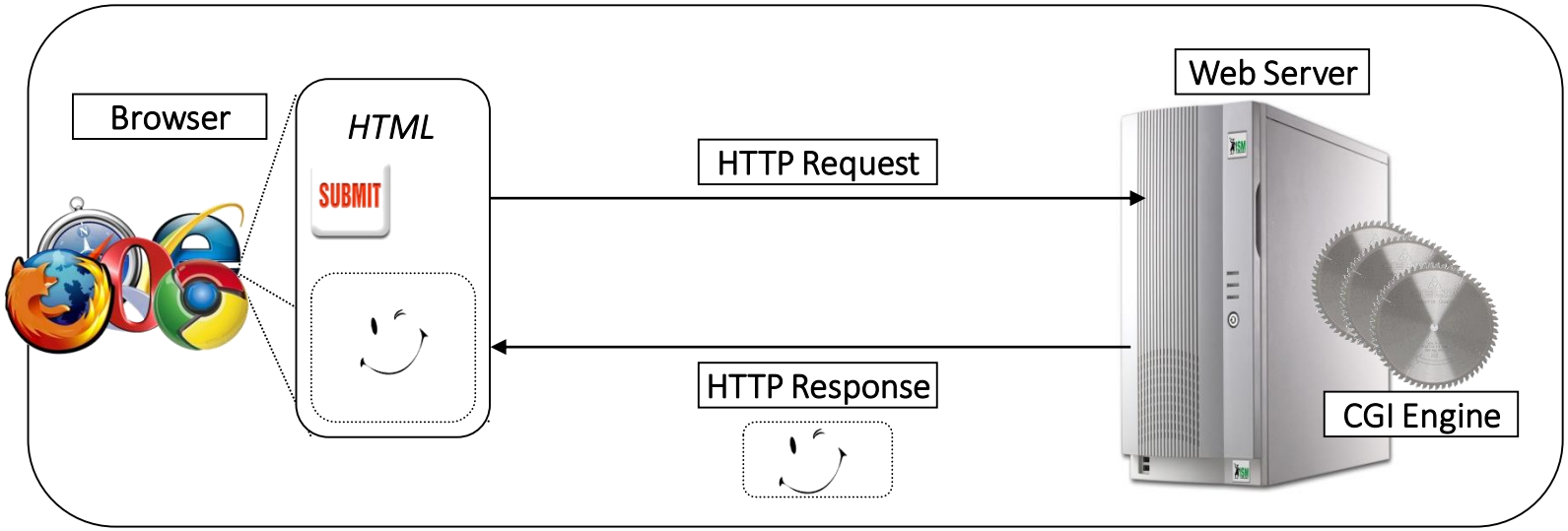
Introduction to AJAX

View of AJAX architecture



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Introduction to AJAX

url – the address of this ajax call. May target a Servlet or JSP. May send parameters just like any HTTP request

When a response is received stateCange() function will be asynchronously called

open() - Setting request data format:

- method (GET/POST)
- url
- asynchronous call – true enables it & is the default value

Send method takes a DOM Object.
DOM object hosts XML documents and Fragments available via DOM API.
Null value is also permitted, usually when string values are sent as a request header.

stateChange() method will be called asynchronously. Will be explained later.

```
function generateRequest()
{
    var url="http://localhost:8080/ajax";
    url+="?command=doIt";
    xmlhttp.onreadystatechange=stateChange;
    xmlhttp.open("GET",url,true);
    xmlhttp.send(null);
}

function stateChange()
{
    if (xmlhttp.readyState==4)
        // ...some code here...
    else
        alert("Problem retrieving XML data")
 }
...
```


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Moving to single page applications

Using AJAX, web modules can focus on transferring data rather than view

- Client receives a single HTML loaded with Jscript functions & callbacks
- Jscript caller functions sends request data
- Jscript callback processes response and renders it to page
- Finally!
  - web modules input & output can be based on structured, self descriptive text formats
  - Future non-HTML clients may use the same modules & data

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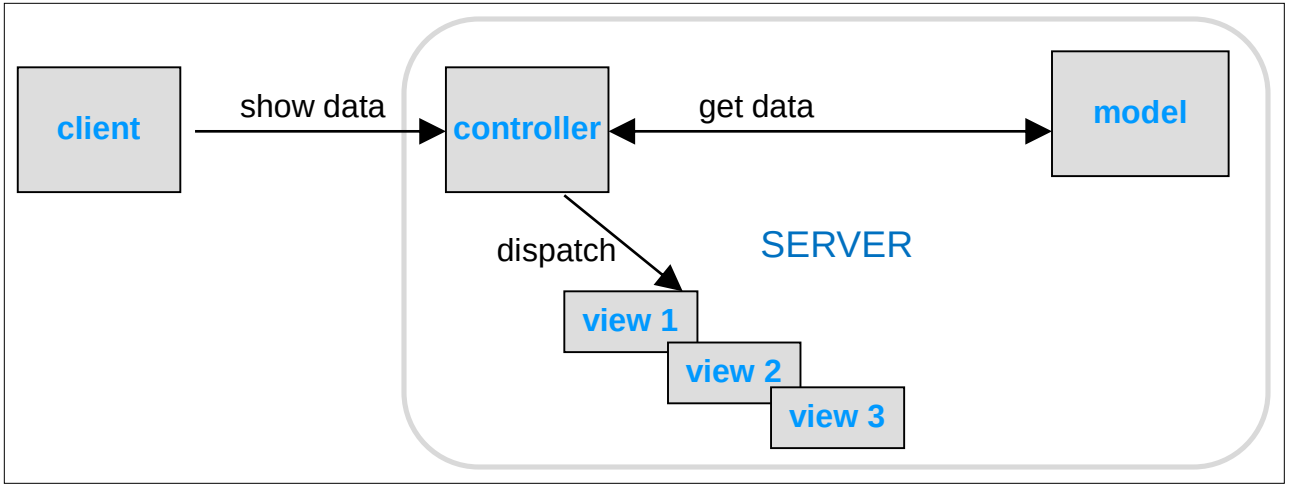
Moving to single page applications

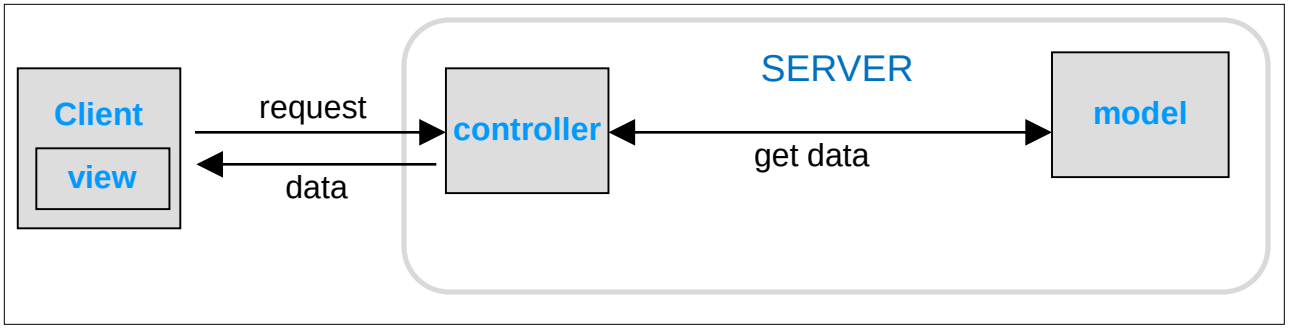
- MVC Model 2

Views are generated on server side



- The 'new' MVC

Views are handled by the client. Communication between client and server is based on data



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Future internet clients

- Why is it so important to ‘talk’ via XML/JSON and not ‘draw’ HTMLs ?
- Internet is much more than visiting web-sites…
- Future client of the internet are not going to use keyboards and screens…

  HTML might be irrelevant

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Future internet clients

- Phones & voice over IP networks
- Smart cards
- Chips
- Nanotechnology

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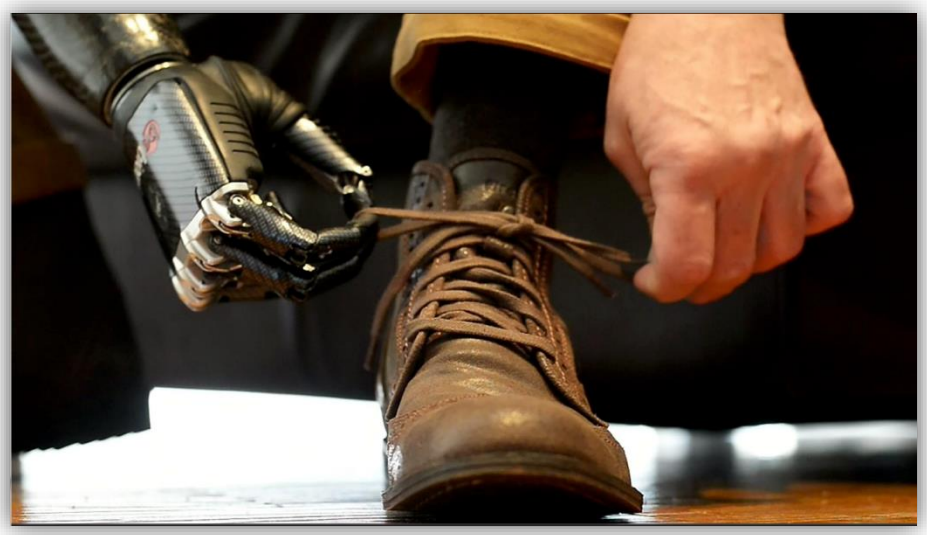
Future internet clients

But the new ultimate client is US

- No hardware, no UI – just us
- Ability to share data directly from & to our brains



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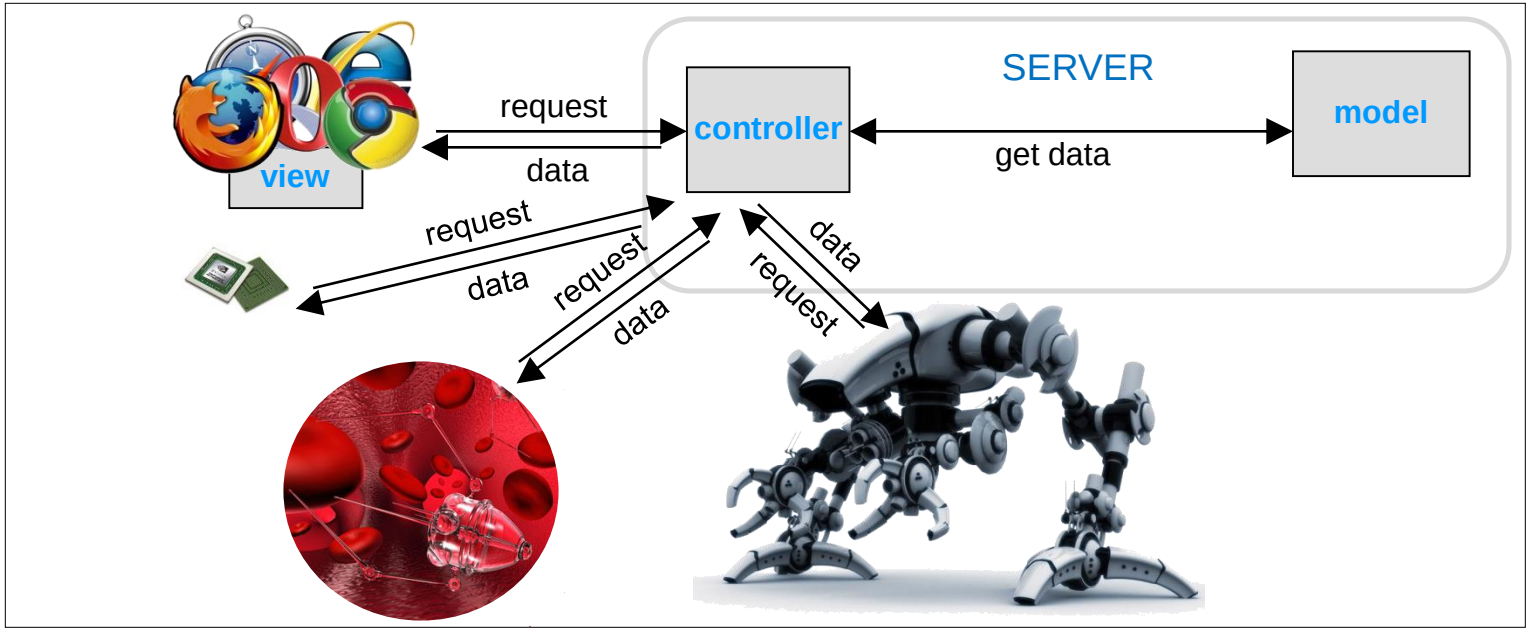
Future internet clients

The ‘new’ MVC



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RPC

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- Architecture & terms
- RPC in Java & JEE
- RPC Framework requirements
- XML for RPC – Web services

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Architecture & Terms

Remote Procedure Call

- Client invokes method on a Remote Object over a network
- Client obeys a contract which is the Remote Interface
- Remote object is a resource
- Remote method is a service

- In order to communicate both client & server uses sockets
  - Socket communication is determined according to the remote interface
  - Stub - Client side socket
  - Skeleton – server side socket that is used as a proxy to the remote object

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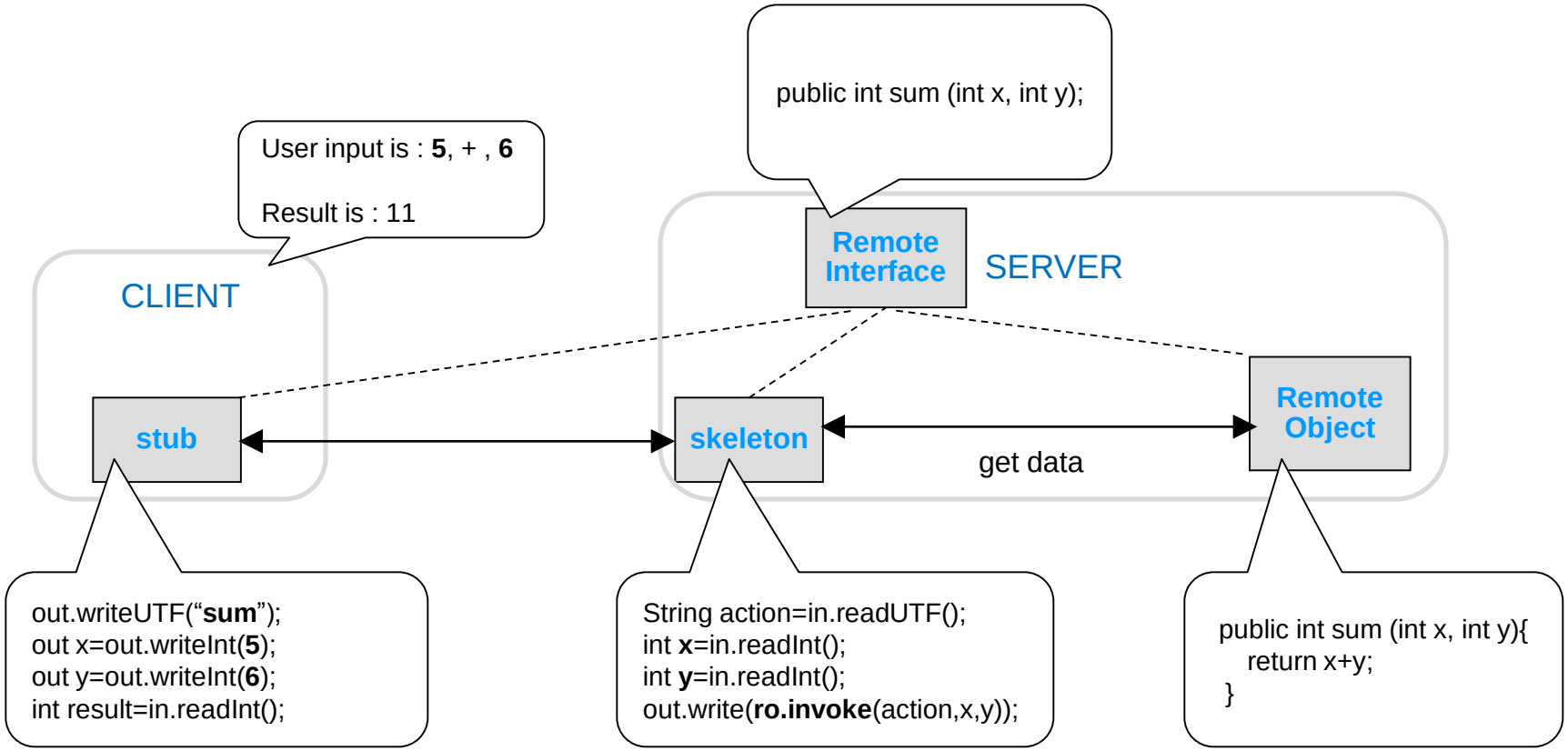
Architecture & Terms



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XML for RPC – Web Services

- Main goal of XML is for application integration
- If the contract is in XML format it can be:
  - describing services written in any language
  - used by any client
- If the stubs & skels will 'talk' via XML:
  - each may be written in a different language
  - xsd types can be used to describe primitives & objects

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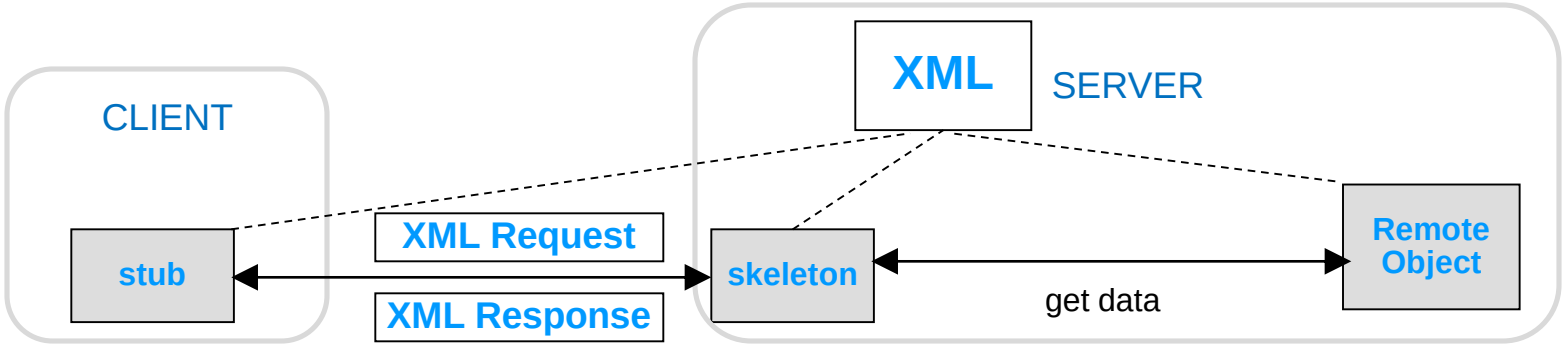
XML for RPC – Web Services



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XML based Web Services

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XML based RPC

- WSDL
  - Role
  - Structure
- SOAP
  - Role
  - Structure
  - SOAP over HTTP
  - SOAP action
- JAX-WS
  - Creating a Java service
  - Publishing & testing
  - Using wsimport for generating clients
  - JEE support

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XML based Web Services

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XML based RPC

- Uses XML standard for contracts
- Uses XML to call remote objects and get response
- XML may be transferred over HTTP
- XML may be passed trough TCP/IP directly
- For asynchronous services (service that result with void)
  - XML can be sent as JMS text message

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XML based Web Services

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WSDL

WSDL - stands for Web Services Description Language

- Describes a resource & its services
- Specifies the location
- Details types and structure used to interact with the services
- Provides information regarding binding style for generating stubs
  - Inner classes
  - Separate classes

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XML based Web Services

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WSDL Structure

- Types

  - types are used to specify complex parameters format

- Part
- Message

  - parts are used to specify the message parameters
  - message is an operation signature.
    for input - output mode, two messages are required

- Port Type
- Operation

  - port is used for defining message flow (operation)
  - operation defines input & output messages

- Binding
- Service

  a link between a service and the SOAP message that generated.
  specifies:
  - SOAP Action name
  - input & output encoding
  - SOAP version in use

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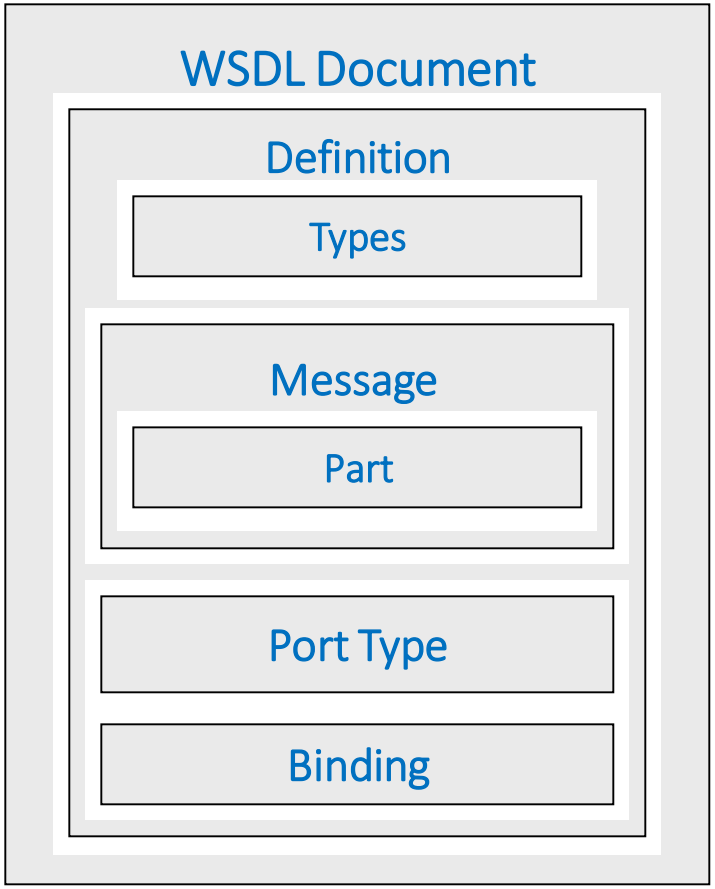
WSDL Structure



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WSDL Example

This WSDL defines the following service:
- client sends a stoke symbol in string format
- client gets the stoke value in float format

```
<?xml version="1.0"?>
<definitions name="StockQuote"
          targetNamespace="http://example.com/stockquote.wsdl"
          xmlns:tns="http://example.com/stockquote.wsdl"
          xmlns:xsd1="http://example.com/stockquote.xsd"
          xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
          xmlns="http://schemas.xmlsoap.org/wsdl/">

< types>
   <schema targetNamespace="http://example.com/stockquote.xsd"
         xmlns="http://www.w3.org/2000/10/XMLSchema">
       <element name="TradePriceRequest">
           <complexType>
              <all> <element name="tickerSymbol" type="string"/> </all>
           </complexType>
       </element>
       <element name="TradePrice">
           <complexType>
              <all><element name="price" type="float"/></all>
           </complexType>
        </element>
     </schema>
</types>…
```

String

Float

Types – defines the request & response parameters format

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XML based Web Services

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WSDL Example

```
<message name="GetLastTradePriceInput">
    <part name="body" element="xsd1:TradePriceRequest"/>
</message>

<message name="GetLastTradePriceOutput">
    <part name="body" element="xsd1:TradePrice"/>
</message>

<portType name="StockQuotePortType">
   <operation name="GetLastTradePrice">
       <input message="tns:GetLastTradePriceInput"/>
       <output message="tns:GetLastTradePriceOutput"/>
   </operation>
</portType>
```

String

Float

Message – defines a message infrastructure (parts)

Port Type – defines operation as a messages flow

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WSDL Example

```
<binding name="StockQuoteSoapBinding" type="tns:StockQuotePortType">
    <soap:binding style="document" transport="http://schemas.xmlsoap.org/soap/http"/>
        <operation name="GetLastTradePrice">
            <soap:operation soapAction="http://example.com/GetLastTradePrice"/>
            <input>  <soap:body use="literal"/>  </input>
            <output> <soap:body use="literal"/> </output>
        </operation>
</binding>

<service name="StockQuoteService">
    <documentation>My first service</documentation>
    <port name="StockQuotePort" binding="tns:StockQuoteSoapBinding">
        <soap:address location="http://example.com/stockquote"/>
    </port>
</service>

</definitions>
```

Binding – sets up the SOAP structure for a pre-defined operation

Service – specifies the WS name and address for SOAP messaging

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SOAP

- Simple Object Access Protocol
- W3C Standard
- Defines a standard way to wrap RPC requests & responses
- Supports exceptions description (Faults)
- Will usually be sent over HTTP
- Can be unidirectional & bidirectional
- Can be synchronous & asynchronous
- SOAP Gateway is needed (skeletons in WEB tier)

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XML based Web Services

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Soap structure

- SOAP Envelope
- SOAP Head
- SOAP Body
- SOAP Element
- SOAP Fault
- SOAP Attachment

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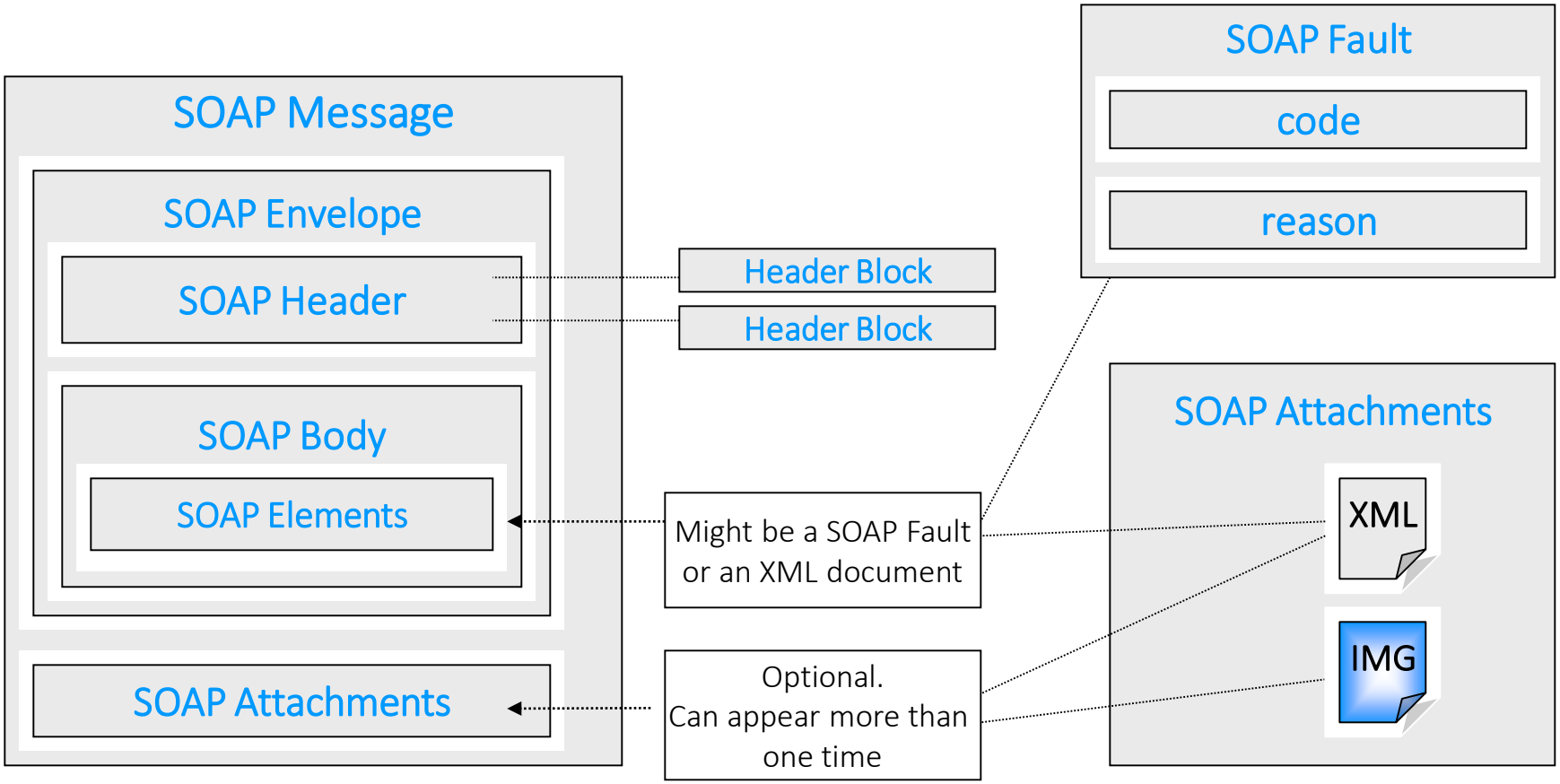
Soap structure schema



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SOAP over HTTP Request example

```
HTTP 1.0 POST
Host: www.stockquoteserver.com
Content-Type: text/xml; charset="utf-8"
Content-Length: nnnn
SOAPAction: "Some-URI“
```

POST method - allows great amount of data upload

SOAP Header that provides another checking mechanism

```
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
                   SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
      <SOAP-ENV:Body>
            <m:GetLastTradePrice xmlns:m="Some-URI">
                  <symbol>DIS</symbol>
            </m:GetLastTradePrice>
      </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```


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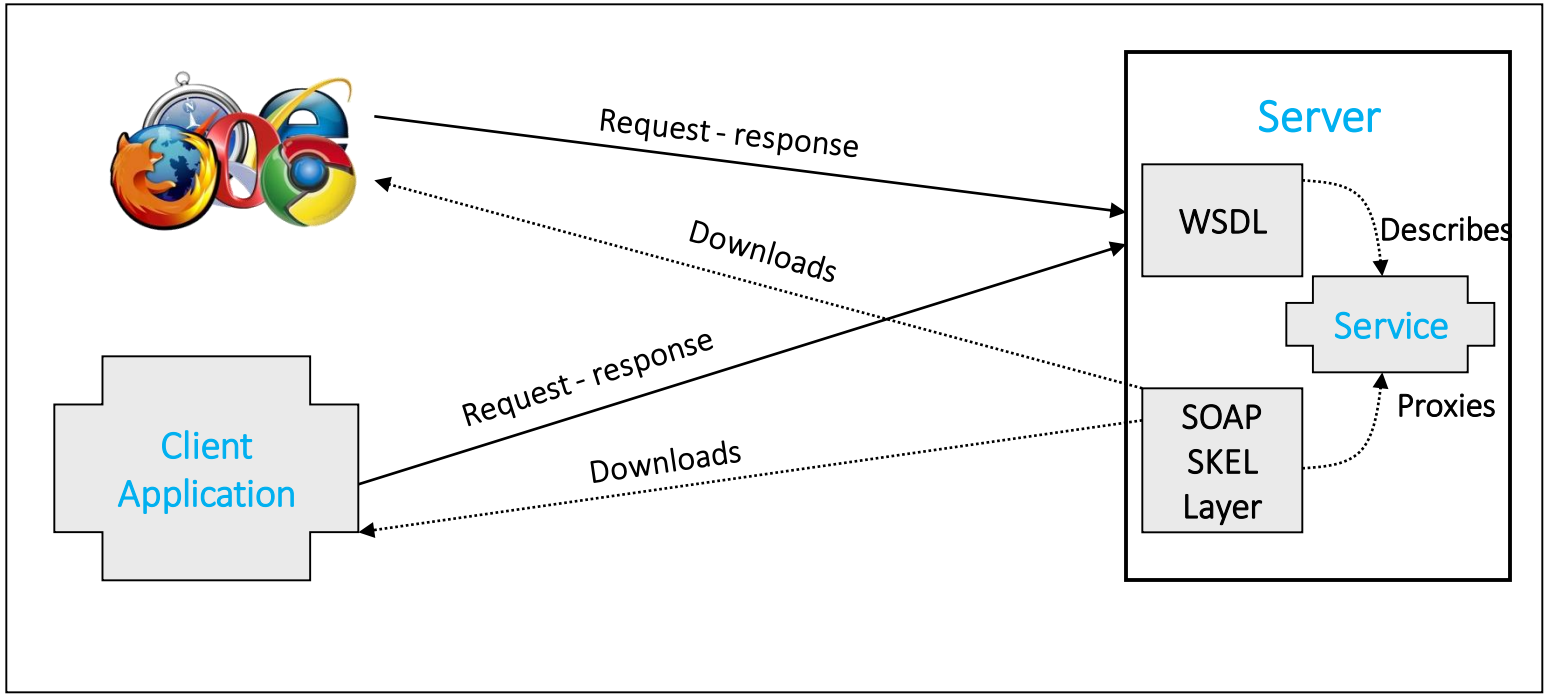
XML based RPC



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REST based Web Services

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- Big data – the challenge
  - Parallel computing
  - NoSQL DBs
  - Saving bandwidth & faster response
- Introduction to REST
- HTTP for RPC
- JAX-RS - RESTful
  - Creating a Java service
  - Publishing & testing
  - Using Jersey client API for generating clients
  - Tokens & session management
  - WADL
  - JEE support

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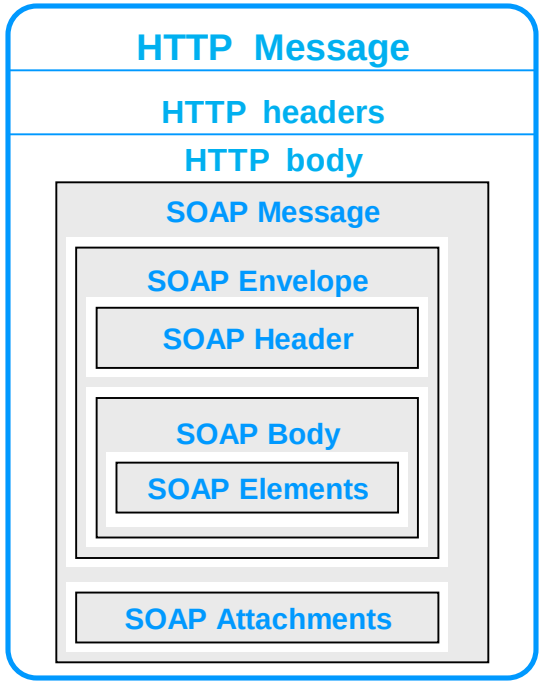
Big data – the challenge

- From single & concurrent to parallel & cloud computing
- Using NoSQL DB in addition to the classic relational DB
- Saving bandwidth & performance
  - XML is a very inefficient protocol uses tags to wrap data
  - XML forces the use of parsers
  - SOAP is an additional protocol on top of HTTP



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Introduction to REST

- REST – REpresentational State Transfer
  - is an HTTP ‘enrichment’ that provides advanced RPC
    - passing data in any format including XML, JSON and binary data
- REST can be counted as part of HTTP unlike SOAP which is a separate protocol

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HTTP for RPC

- Client may use the following HTTP features in order to invoke a service:
  - URI – path can determine the endpoint class and even method
  - ACCEPT header – used by the client to specify response MIME type
    - service methods may result in different MIME types
    - client call can be delegated to method that produces the MIME type it expects
  - METHOD – GET, POST, DELETE, PUT, HEAD
    - each method can be mapped to several HTTP-methods
    - client call is delegated to the method matches client HTTP request method

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HTTP for RPC

Suggested way to implement business according to HTTP method

HTTP Method	Single element	Collection
GET	Fetch an element from a collection	Fetch the whole collection
PUT	Replace or create new element in a collection	Override one collection with a new one
POST	Assign a value to an object	Add new value to a collection
DELETE	Delete a specific element from a collection	Delete the entire collection

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Building and publishing RESTful module

Service example:

```
package  hello.in.different.formats;
@Path("/hello")
public class Hello {

    @GET
    @Produces(MediaType.TEXT_PLAIN)
    public String sayTextHello() { return "Hello JAX-RS !"; }

   @GET
   @Produces(MediaType.TEXT_XML)
   public String sayXMLHello() {
        return "<?xml version=\"1.0\"?>" + "<hello> Hello JAX-RS" + "</hello>"; }

  @GET
  @Produces(MediaType.TEXT_HTML)
  public String sayHtmlHello() {
       return "<html> " + "<title>" + "Hello JAX-RS" + "</title>" +
       "<body><h1>" + "Hello JAX-RS " + "</body></h1>" + "</html> "; }
}
```

This format can be shown in browsers

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Building and publishing RESTful module:

Services invoked via Http requests

*http://ip:port/**root-context**/**rest**/hello*

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