Web-Based Systems

INF 5040 autumn 2007

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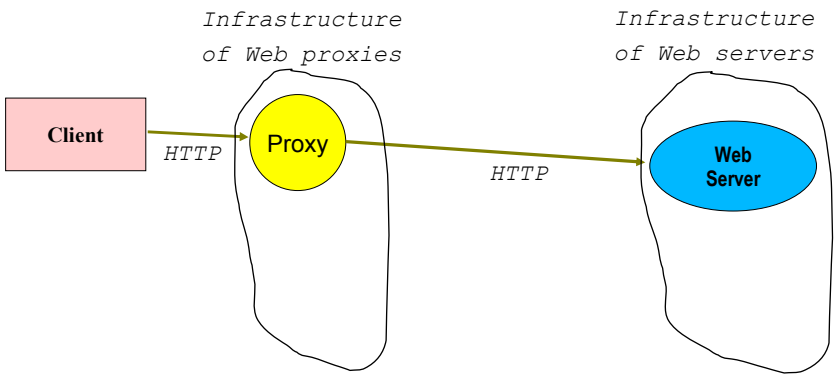
Two main flavors

- Browser-server WWW application
  - Geared towards human interaction
  - Not suitable for automation
    - Automatic restocking from amazon.com
    - Sniping in eBay
- Web services middleware
  - Generic extension of the WWW application
  - Web servers announce and provide services
  - Web server can be a client of another service

Communicating entities



Hypertext Transfer Protocol (HTTP)

- A simple document transfer protocol
  - A client sends a request & waits for a reply
  - GET,PUT,DELETE,HEAD, and POST methods
- Stateless
- Uses TCP as the underlying protocol
- In HTTP 1.0, each request was sent on a separate TCP connection
- HTTP 1.1 introduced persistent connections and pipelining
- A response may redirect the client to another document

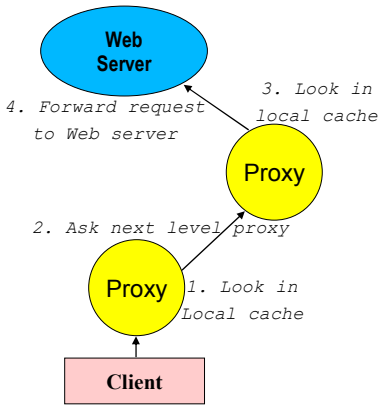
Web proxy functions

- Protocol translation and conversion
  - Not needed for modern browsers/clients
- Filtering requests and responses
- Logging
- Compression
- Caching

Client-side and proxy caches

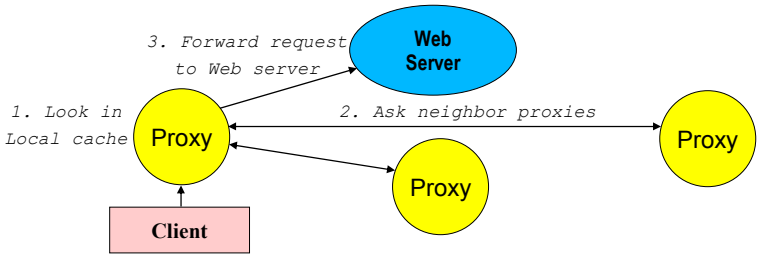
- Cache update protocols
  - Pull with if-modified-since GET HTTP header
  - Lease-based propagation
- Not as effective for dynamic content
- Cache replacement policies
  - LRU is commonly used and it performs well
  - A number of specialised policies, e.g., Greedy-Dual

Hierarchical proxy caching



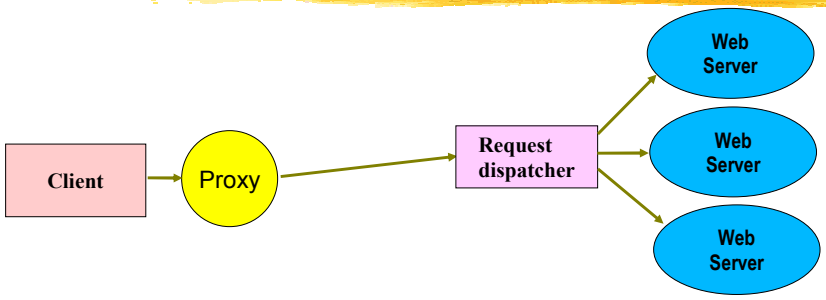
- Commonly deployed throughout the world
- Reduces latency and traffic for popular documents
- Increases latency for other documents
- Higher-level proxies require a lot of storage space

Cooperative proxy caching



- Deployed on a per-organisation basis
- Can be combined with hierarchical caches

Simple server-side backend

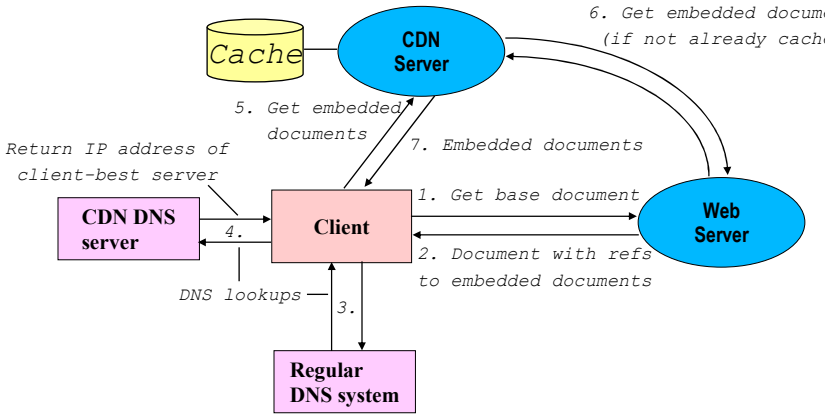


- Several possibilities for request dispatching
  - Round-robin DNS
  - Content-aware dispatcher inspecting HTTP requests
  - TCP-level switch

Content-distribution network (CDN)

- Placement of data/object replicas
  - See the lecture on replication…
  - A number of evaluation metrics
    - Latency (real-time and the number of hops)
    - Bandwidth (available and network usage)
    - Financial
- Consistency enforcement
  - See the lecture on replication…
- Redirection of client requests

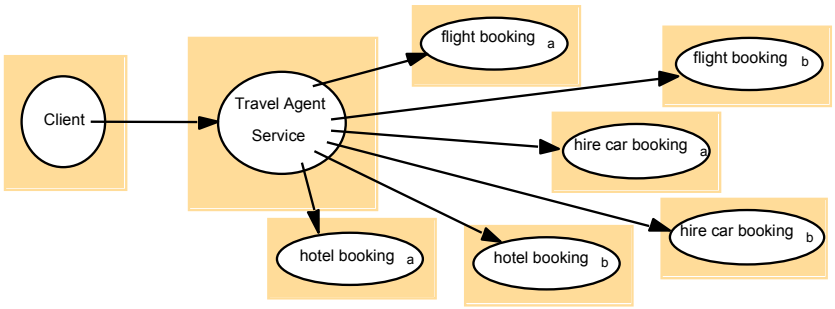
Redirection of client requests in a CDN



Web services

- Allows an application-specific client to communicate with a service over a functionality-specific API
- Allows a client program in an organisation to communicate with a server program in another
- Allows complex applications that integrate services from different other services
- Because the interaction is generic Web-services cannot be directly accessed by browsers

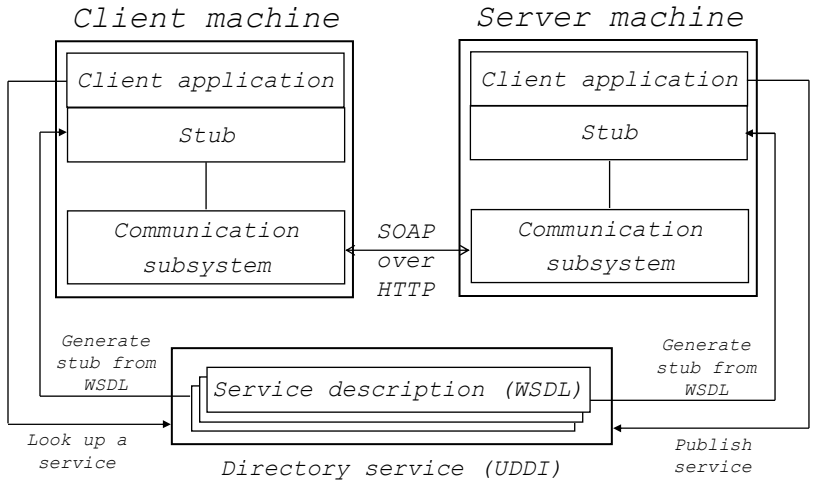
Example from the Coulouris book



Applications of Web Services

- Many well-known web sites offer a Web-services interface to their clients
  - Amazon, Yahoo, Google, eBay…

Architecture of Web Services



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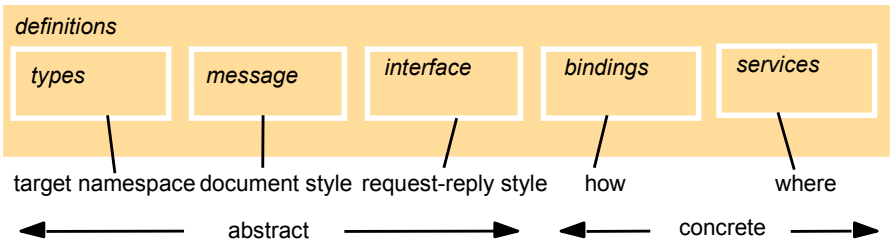
WSDL description

Description of a service



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WSDL

- Types
  - Name and type of exchanged values (similar to declaration of variables)
- Messages (operations)
- Interface
  - Operation parameters
    - In-Out, In-Only, Out-In, Out-only…
- Binding
  - The choice of communication protocol
  - typically SOAP, HTTP, or MIME, but others are also possible (e.g., GIOP in order to communicate with Corba)
- Services
  - Specific endpoint addresses, one for each binding
  - For the SOAP binding, it will be a URI of the service location

URI – Uniform Resource Identifier

- URL is the simplest form of URI
  - Posted via DNS
  - Partly location-dependent (in any case dependent on domain names of the mashine)
- URN (Uniform Resource Names) is another possibility that is location independent
  - But they are also more prone to name clashes
  - Dependent on Directory Service – ”Universal Directory and Discovery Service UDDI”

XML – Extensible Markup Language

- A language for describing message formats
- Defines how the message is parsed
- UNICODE-based
  - Readable by both human and machines
  - Ineffective space-wise
- A language that is suitable to represent a hierarchical data structure in a flat UNICODE-based form

XML definition example

```
<person id="123456789">
        <name>Smith</name>
        <place>London</place>
        <year>1934</year>
        <!-- a comment -->
</person >
```

Namespace in the *Person* structure

```
<person pers:id="123456789"
                xmlns:pers = "http://www.cdk4.net/person">
    <pers:name> Smith </pers:name>
    <pers:place> London </pers:place >
    <pers:year> 1934 </pers:year>
</person>
```


Schema for the Person-structure

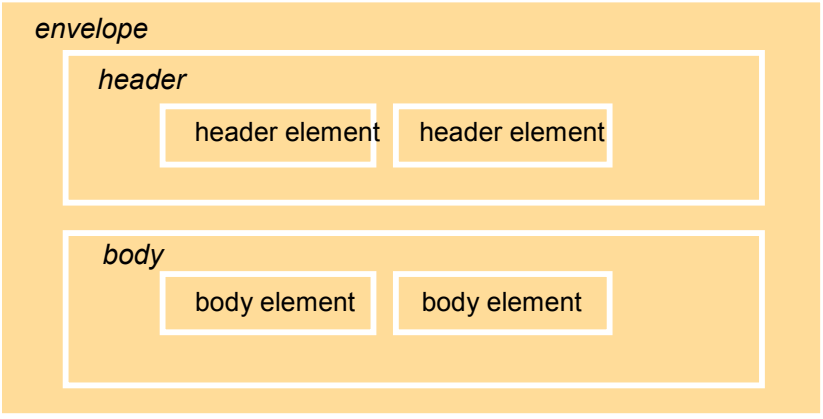
```
<xsd:schema  xmlns:xsd = URL of XML schema definitions  >
   <xsd:element name= "person" type ="personType" />
      <xsd:complexType name="personType">
         <xsd:sequence>
            <xsd:element name = "name"  type="xs:string"/>
            <xsd:element name = "place"  type="xs:string"/>
            <xsd:element name = "year"  type="xs:positiveInteger"/>
         </xsd:sequence>
         <xsd:attribute name= "id"   type = "xs:positiveInteger"/>
      </xsd:complexType>
</xsd:schema>
```

SOAP – Simple Object Access Protocol

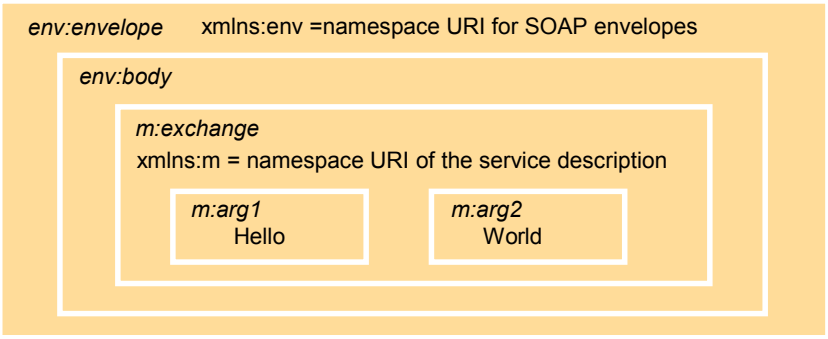
- Defines how XML should be used to represent the content of messages
- Defines how a pair of messages can form a request/reply template
- Rules regarding how message recipient should process contained XML-elements
- How HTTP should be used for exchanging SOAP messages

SOAP Message

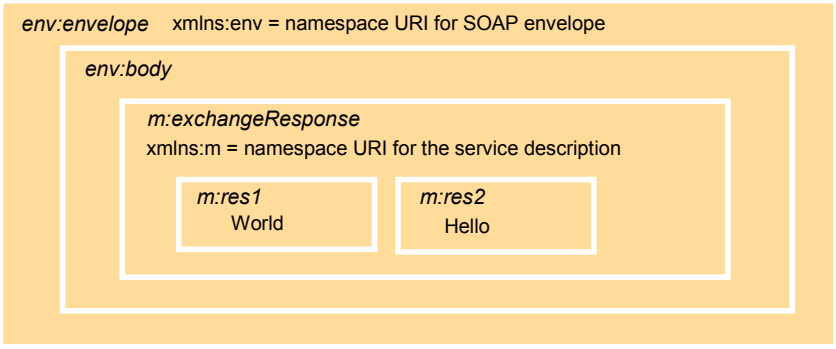
Envelope, Header, and Body



SOAP message without the header



SOAP-response



Example of a SOAP message embedded in HTTP

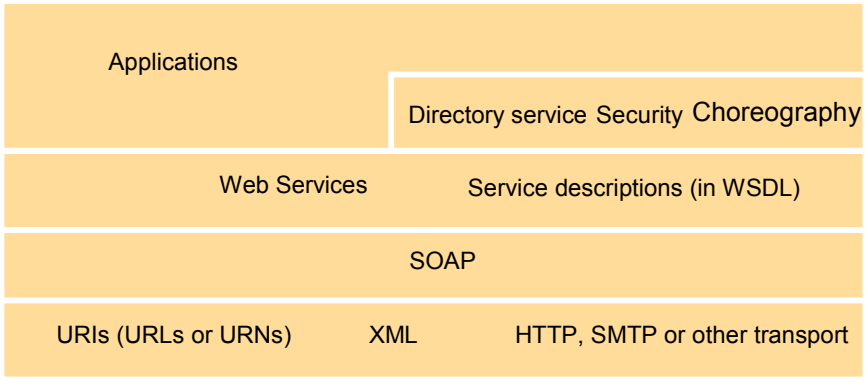
POST /examples/stringer ← endpoint address
Host: www.cdk4.net
Content-Type: application/soap+xml
Action: http://www.cdk4.net/examples/stringer#exchange ← action

HTTP header

<env:envelope xmlns:env= namespace URI for SOAP envelope *>*
<env:header> </env:header>
<env:body> </env:body>
</env:Envelope>

Soap message

Infrastructure and components - summary



Main differences from distributed objects

- Many similarities, but
- Some object concepts do not exist
  - Cannot instantiate and remove objects
  - Garbage collection is irrelevant
  - Using simpler Universal Resource Identifiers instead of Remote Object References
- "Web Services are not Distributed Objects" by Werner Vogels
- "Like it or not, Web Services are Distributed Objects" by Ken Birman

Web services vs CORBA

- The scope of deployment
  - CORBA: inside one organisation or a consortium of mutually known collaborating organisations
  - Web Services: truly global
  - Difference in the naming and references
    - WS discovery is based on DNS that is scalable and global
- Deployment vs communication middleware
  - Corba: both
  - Web services: communication only
- Interoperability

Web services vs CORBA (cont'd)

- Ease of use and the learning curve
  - Web Services
    - Based on HTTP and XML infrastructure that already exists in most operating systems and platforms
    - Messages are human-readable
    - Only additionally requires API for SOAP
  - CORBA: installation/administration + high learning curve
- Efficiency
  - Web Services:
    - Long messages that it takes time to parse
    - Message processing hundreds of times slower compared to CORBA