Designing, setting up and accessing Web Services

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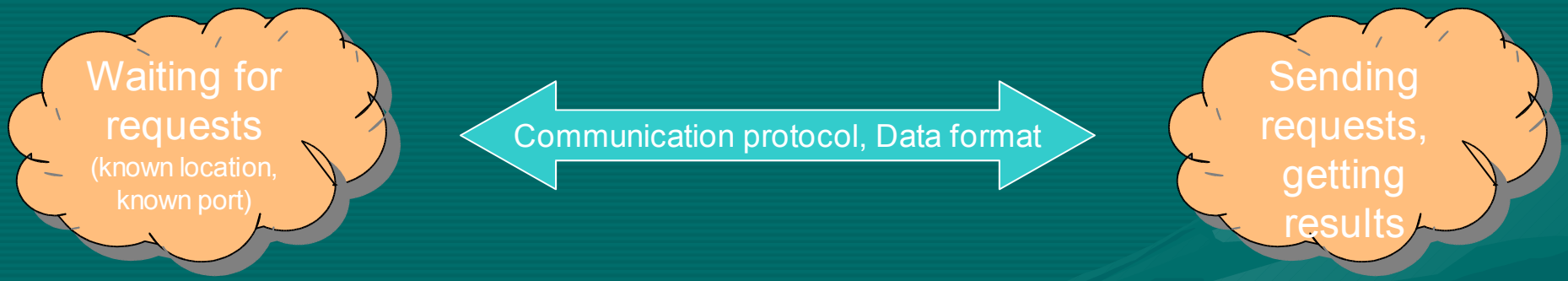
A starting point…

- Google is full of Web Services; perhaps too full…
- An "official site" is perhaps:
  - http://www.w3.org/2002/ws/
- The best starting point is a question:
  - "Do I need it?" "How Web Services can solve my problem?"
  - Which leads us to the distributed architecture…

Distributed architecture

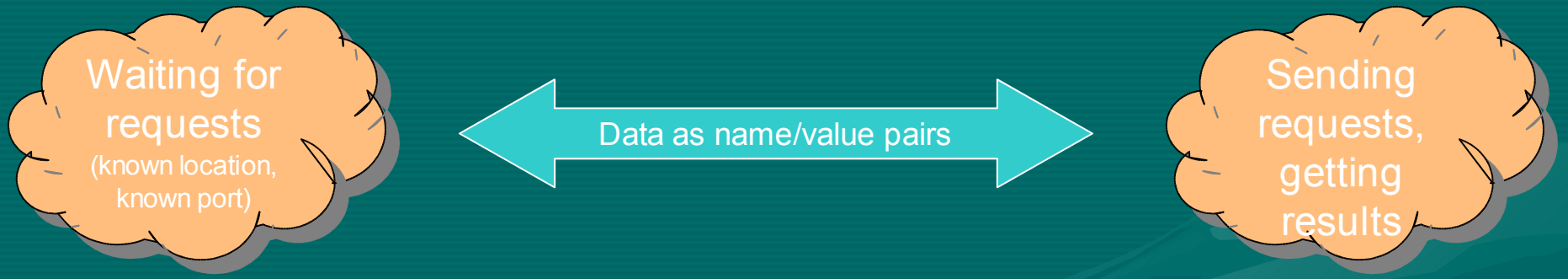
- *gives*
  - access to distributed resources
  - development encapsulation
    - maintainability, re-usability, legacy-awareness
  - implementation independence
- *requires*
  - adding a communication layer between parts
  - synchronization of efforts
    - including such nasty things as distributed garbage collection

Distributed architecture



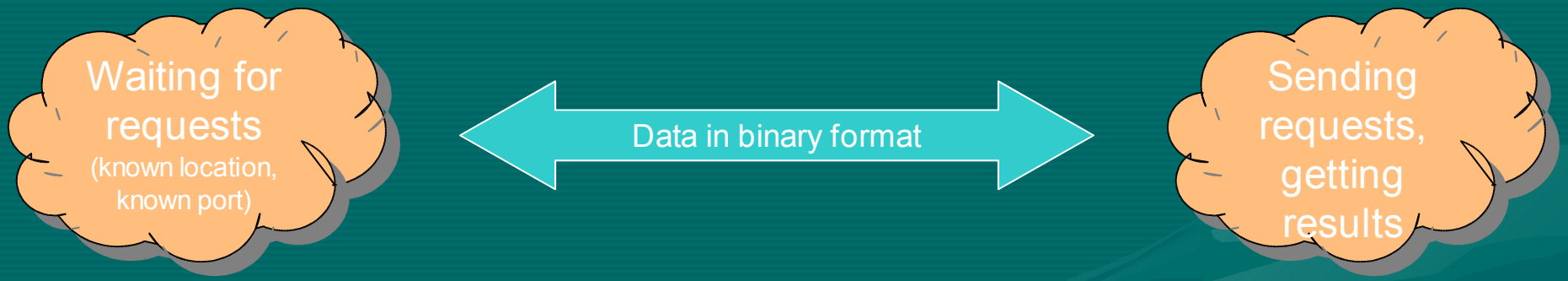
- Basic questions are:
  - What kind of protocol to use, and what data to transmit
  - What to do with requests on the server side

Traditional CGI-based approach



- cgi-bin scripts:
  - Data transmitted as name-value pairs (HTML forms)
  - Transport over (state-less) HTTP protocol
  - no standards for keeping user sessions (state-fullness)
  - server side: a script is called

CORBA-based approach

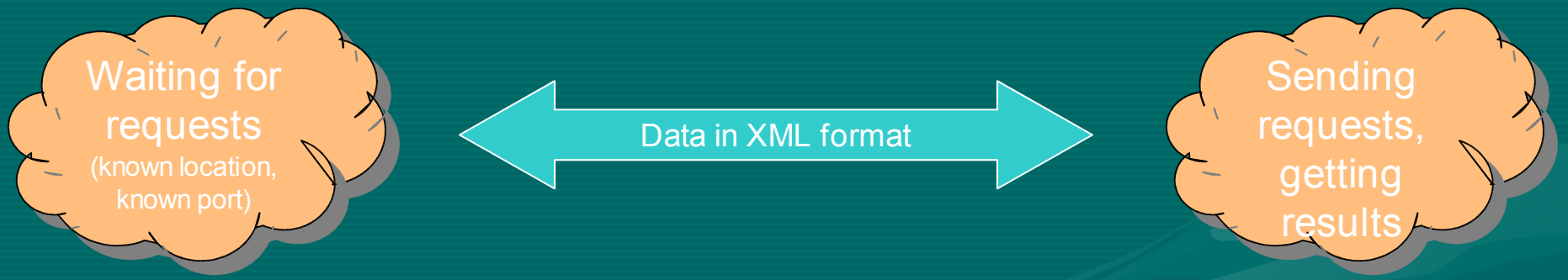


- CORBA:
  - Data transmitted as objects (at least it looks like that)
  - Transport (usually) over well standardised IIOP protocol
  - user sessions (state-fullness) very inter-operable
  - server side: an RPC call is made

Many more approaches…

- Direct access to data sources (JDBC, DBI,…)
- VPN (Virtual Private Network)
- Various shell programs
- p2p networks (Jaxta,…)
- And perhaps some more…
  - ….but let's jump to the one we are interested the most at the moment:

SOAP-based communication

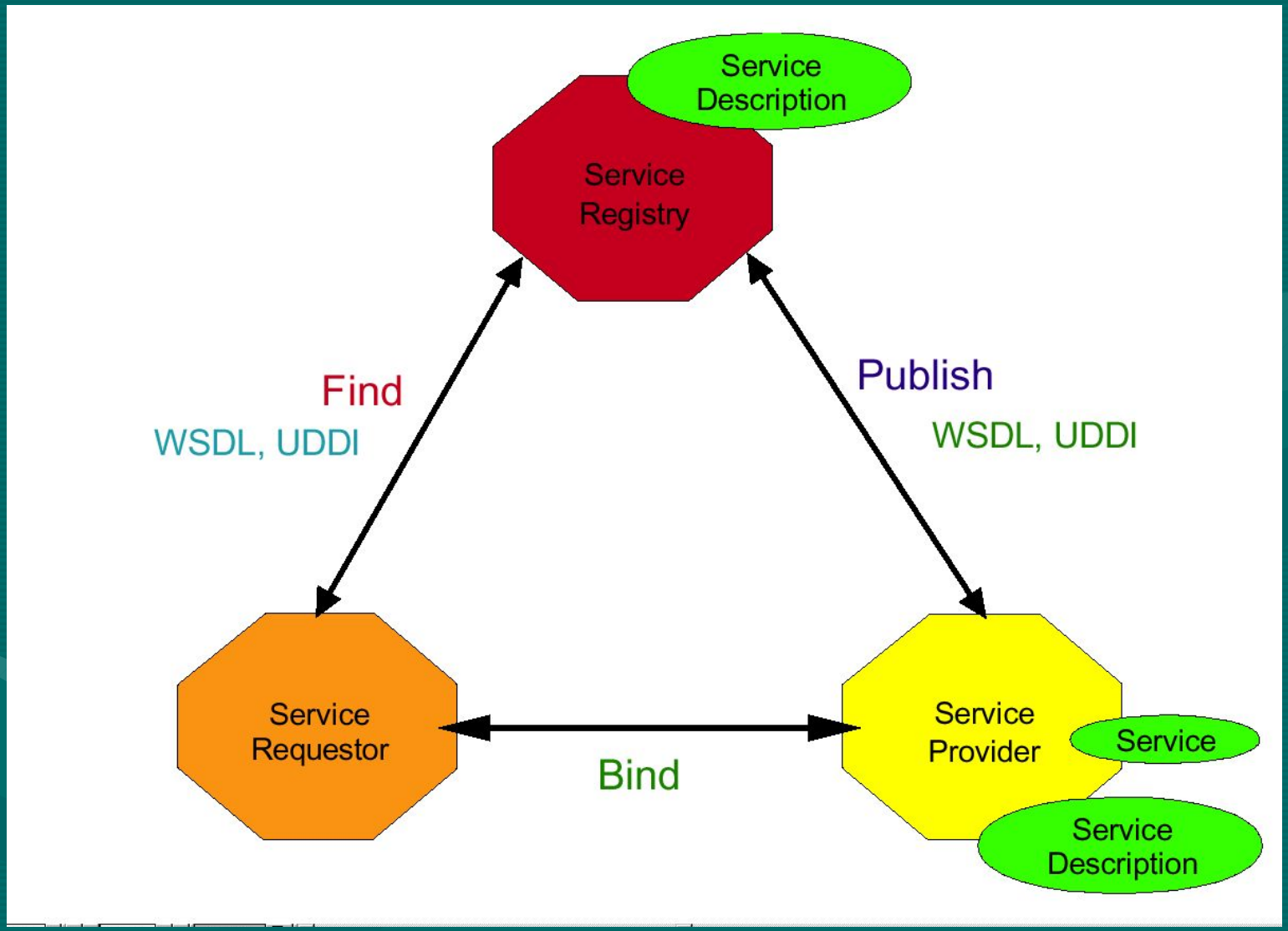


- SOAP:
  - Data in a well-defined XML format
  - Transport over various protocols
    - HTTP, SMTP are the most used, perhaps because they are firewall-friendly
  - server side: either an RPC call or a message delivered

W3C (working group) definition

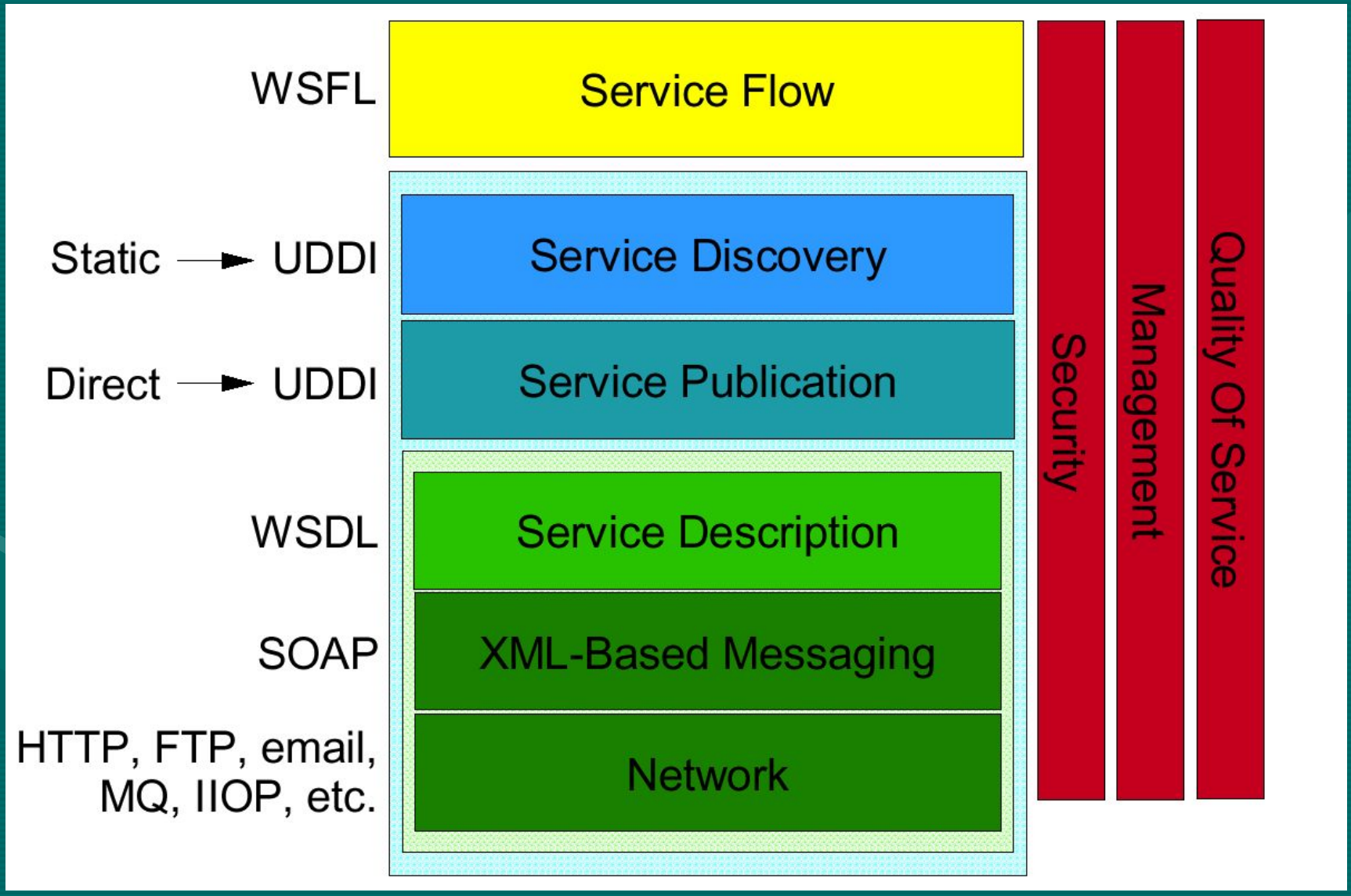
- *"A Web service is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format (specifically WSDL). Other systems interact with the Web service in a manner prescribed by its description using SOAP-messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web-related standards. "*
- http://www.w3.org/TR/2004/NOTE-ws-gloss-20040211/

Web Services Architecture



Let a program "click on a web page"

Web Services Stack

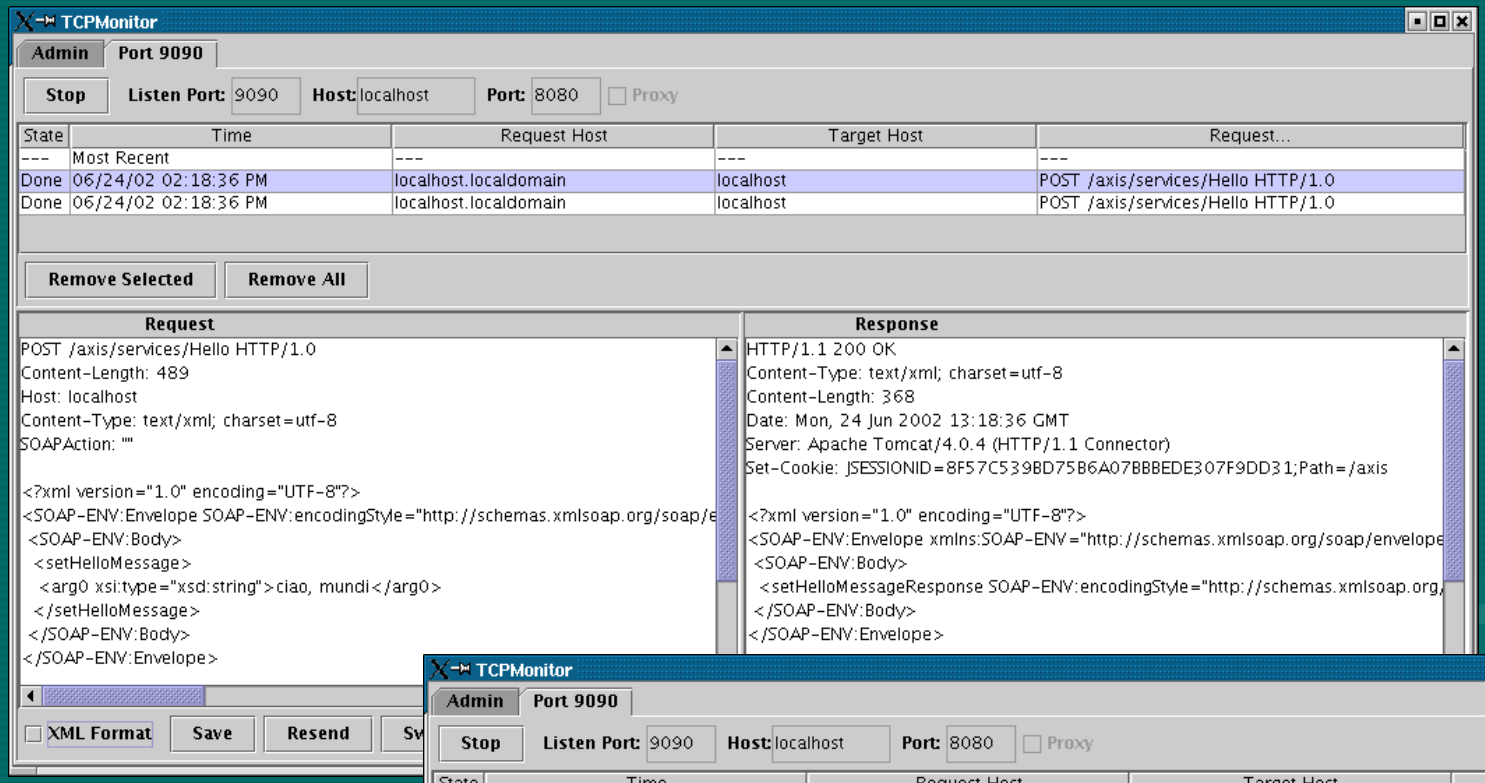


SOAP

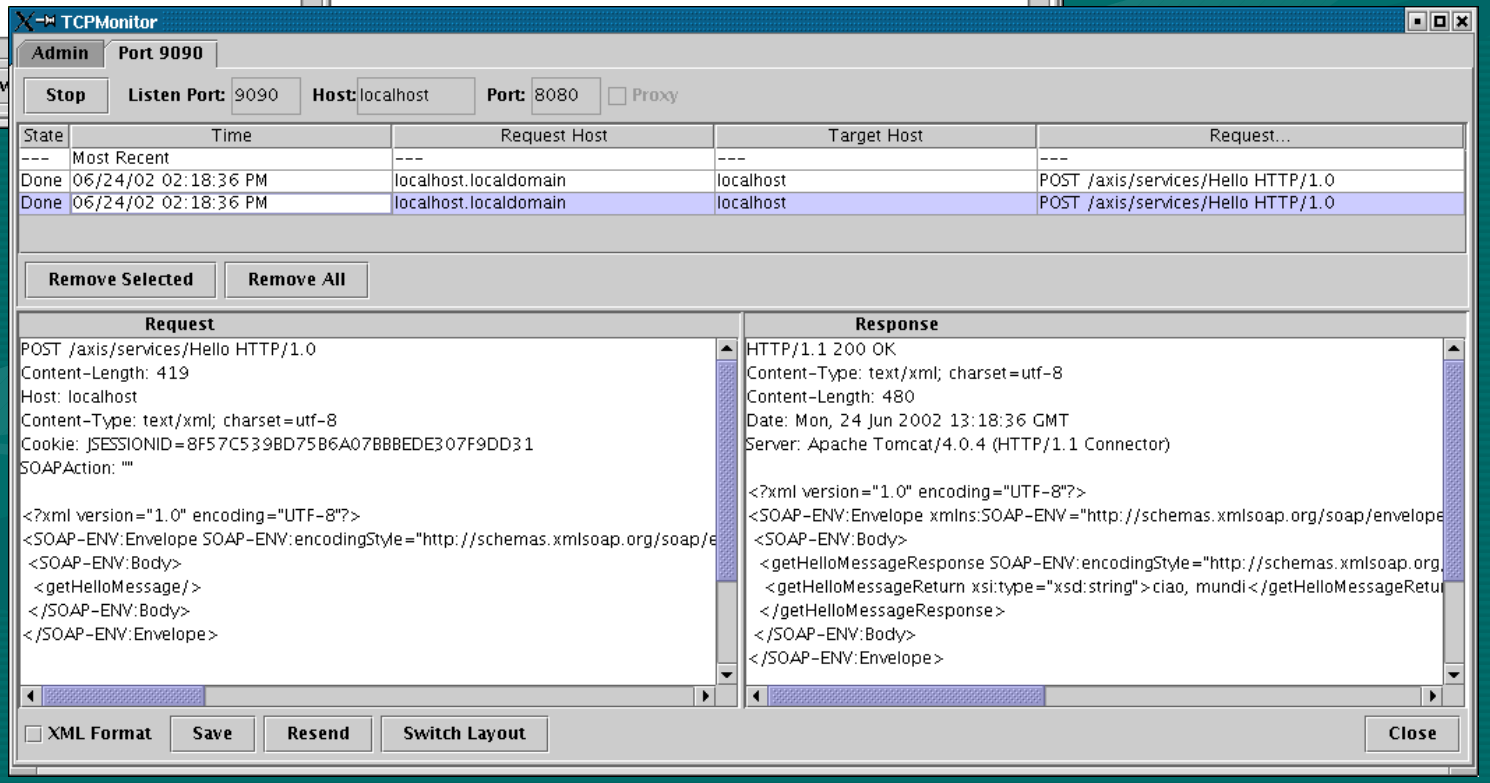
- **S**imple **O**bject **A**ccess **P**rotocol
  - http://www.w3c.org/TR/SOAP/
- A lightweight protocol for exchange of information in a decentralised, distributed environment
- Two different styles to use:
  - to encapsulate RPC calls using the extensibility and flexibility of XML
  - …or to deliver a whole document without any method calls encapsulated

What is inside SOAP

- SOAP is an XML based protocol that consists of three parts
  - an envelope that defines a framework for describing what is in a message and how to process it
  - a set of encoding rules for expressing instances of application-defined datatypes
  - a convention for representing remote procedure calls and responses

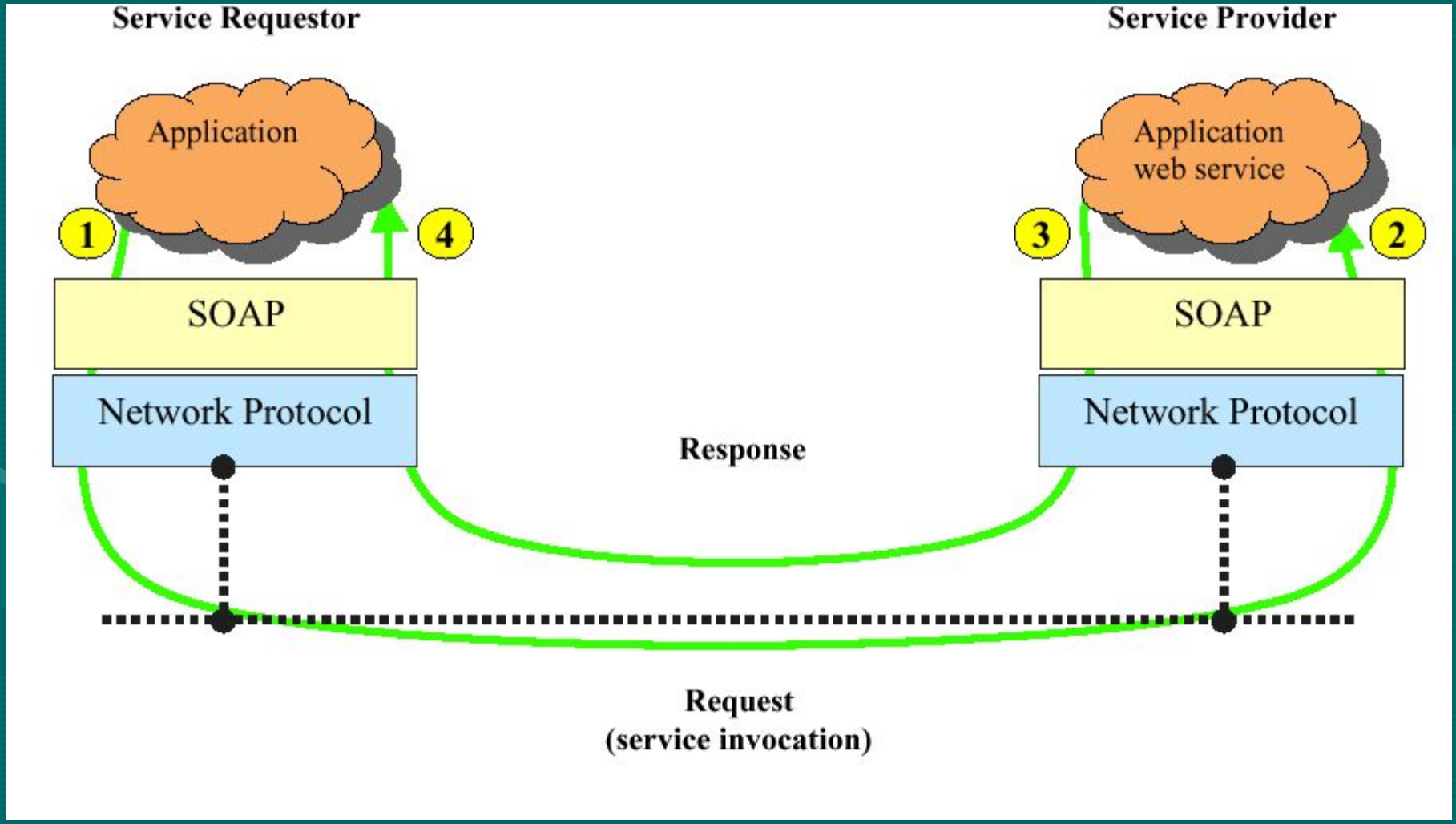


Request: setHelloMessage



Request: getHelloMessage

XML Messaging Using SOAP



WSDL

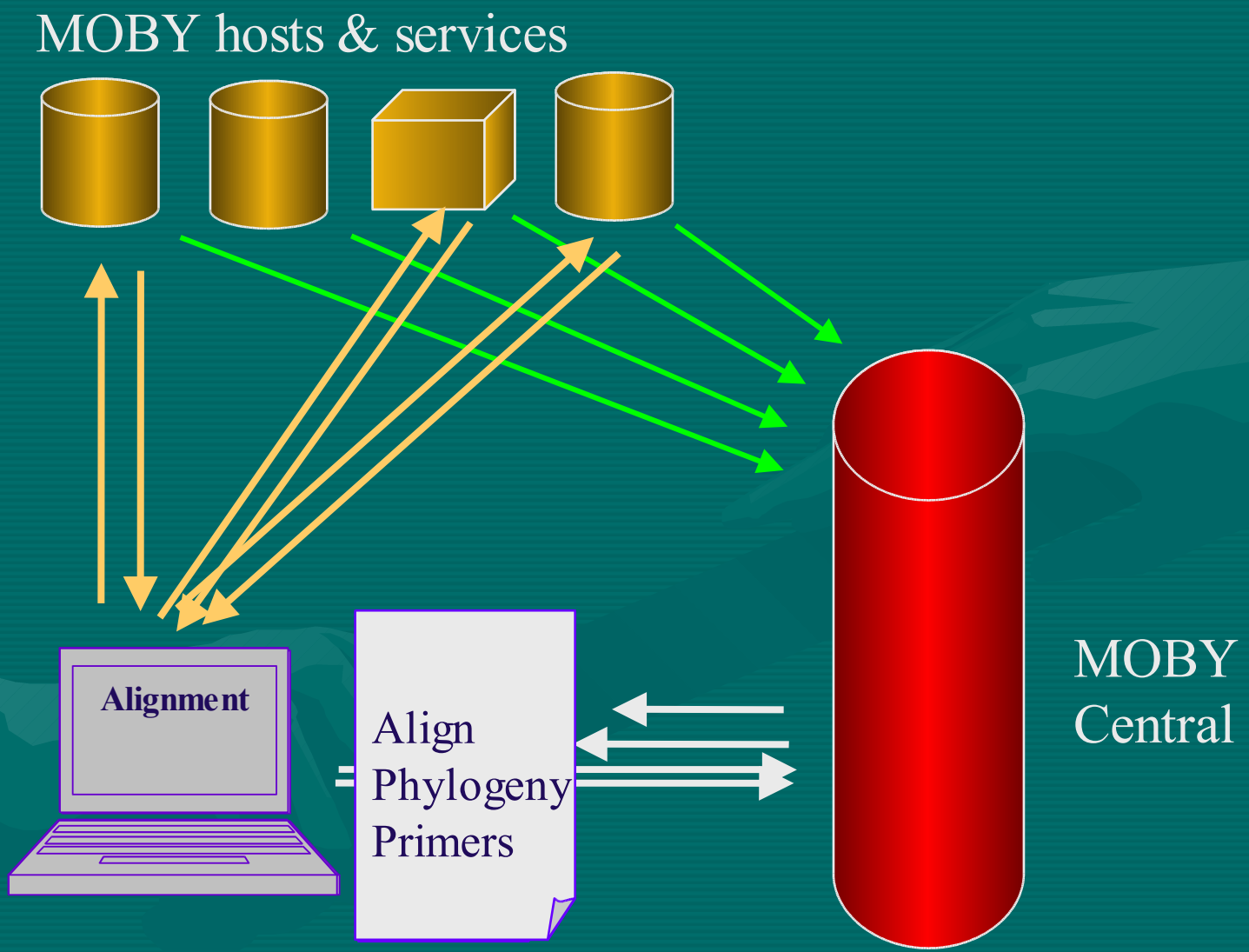
- **W**eb **S**ervices **D**efinition **L**anguage
  - http://www.w3.org/TR/wsdl/
- An XML-based language for describing Web Services
  - what the service does (description)
  - how to use it (method signatures)
  - where to find the service
- It *does not* depend on the underlying protocol
- But: It is not much human-readable

Hello.wsdl

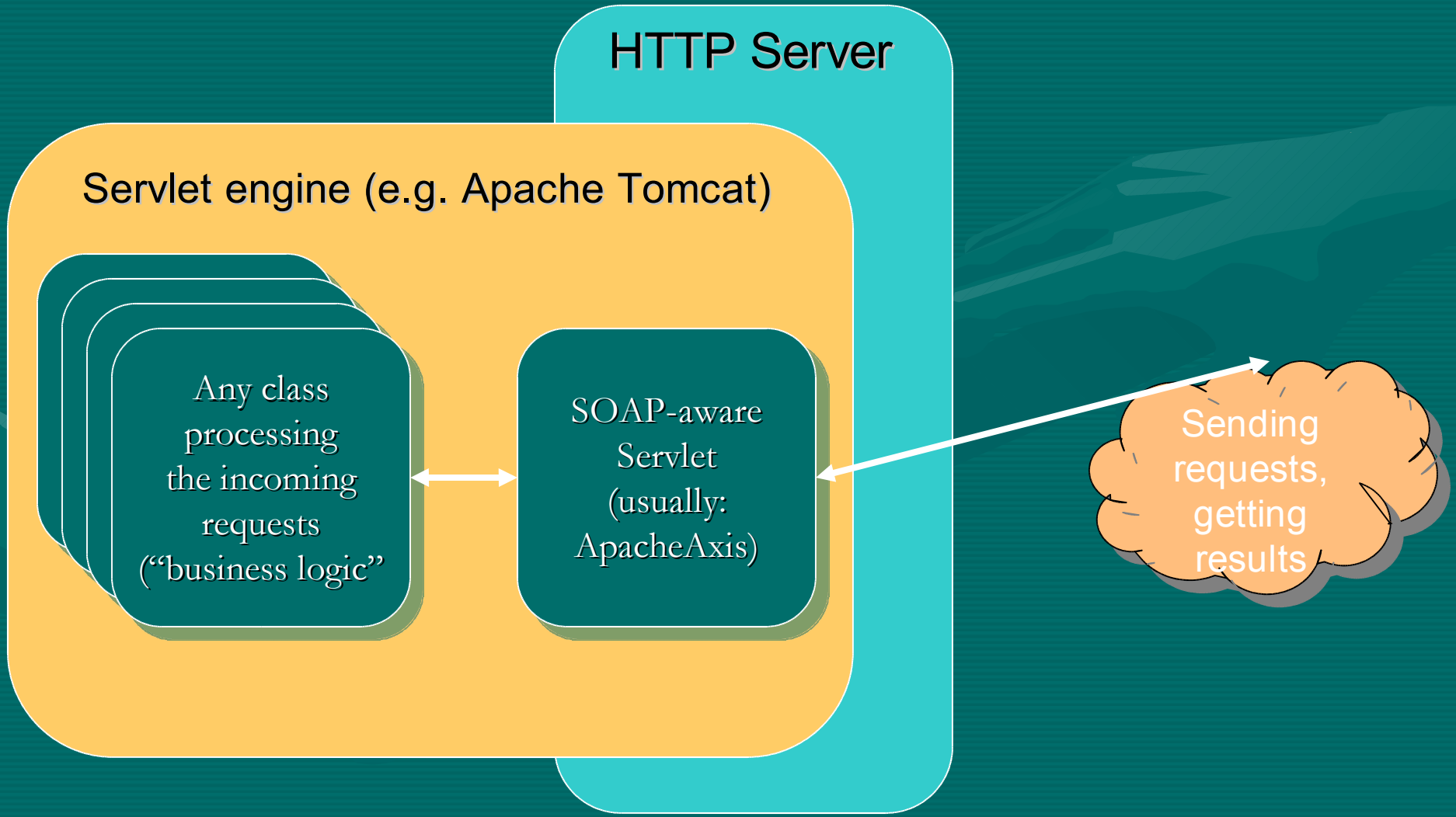
```
<?xml version="1.0" encoding="UTF-8"?>
<wsdl:definitions targetNamespace="http://localhost:8080/axis/services/Hello"
    xmlns="http://schemas.xmlsoap.org/wsdl/" xmlns:SOAP-
    ENC="http://schemas.xmlsoap.org/soap/encoding/"
    xmlns:impl="http://localhost:8080/axis/services/Hello-impl"
    xmlns:intf="http://localhost:8080/axis/services/Hello"
    xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
    xmlns:wsdlsoap="http://schemas.xmlsoap.org/wsdl/soap/"
    xmlns:xsd="http://www.w3.org/2001/XMLSchema">  <wsdl:message
    name="setHelloMessageRequest">    <wsdl:part name="in0" type="xsd:string"/>
    </wsdl:message>  <wsdl:message name="getHelloMessageResponse">    <wsdl:part
    name="return" type="xsd:string"/>  </wsdl:message>  <wsdl:message
    name="setHelloMessageResponse">  </wsdl:message>  <wsdl:message
    name="getHelloMessageRequest">  </wsdl:message>  <wsdl:portType
    name="HelloWorldService">    <wsdl:operation name="getHelloMessage">
    <wsdl:input message="intf:getHelloMessageRequest"/>     <wsdl:output
    message="intf:getHelloMessageResponse"/>    </wsdl:operation>    <wsdl:operation
    name="setHelloMessage" parameterOrder="in0">      <wsdl:input
    message="intf:setHelloMessageRequest"/>     <wsdl:output
    message="intf:setHelloMessageResponse"/>    </wsdl:operation>  </wsdl:portType>
    <wsdl:binding name="HelloSoapBinding" type="intf:HelloWorldService">
    <wsdlsoap:binding style="rpc" transport="http://schemas.xmlsoap.org/soap/http"/>
       <wsdl:operation name="getHelloMessage">      <wsdlsoap:operation
    soapAction=""/>      <wsdl:input>        <wsdlsoap:body
    encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
    namespace="getHelloMessage" use="encoded"/>      </wsdl:input>
    <wsdl:output>        <wsdlsoap:body
    encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
    namespace="http://localhost:8080/axis/services/Hello" use="encoded"/>
    </wsdl:output>    </wsdl:operation>    <wsdl:operation name="setHelloMessage">
       <wsdlsoap:operation soapAction=""/>      <wsdl:input>        <wsdlsoap:body
    encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
    namespace="setHelloMessage" use="encoded"/>      </wsdl:input>
    <wsdl:output>        <wsdlsoap:body
    encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
    namespace="http://localhost:8080/axis/services/Hello" use="encoded"/>
    </wsdl:output>    </wsdl:operation>  </wsdl:binding>  <wsdl:service
    name="HelloWorldServiceService">    <wsdl:port binding="intf:HelloSoapBinding"
```

UDDI (and alternatives)

- **U**niversal **D**escription, **D**iscovery and **I**ntegration
  - http://www.uddi.org
- UDDI creates a platform-independent, open framework & registry for:
  - Describing services
  - Discovering businesses
  - Integrating business services
- The UDDI may be less used than predicted, especially on the Internet level
- BioMoby - an alternative for Life Sciences domain?


MOBY hosts & services
Alignment
Align
Phylogeny
Primers
MOBY
Central

A Web Service example in Java



Steps to develop a WS in Java

1. Write your service implementation
2. Make all your classes available to the toolkit
3. Deploy your service *(usually done just once)*
4. Restart the whole servlet engine
5. Test it with a client request

Java Web Services Toolkit

- More of them, but The One is:
  - Apache Axis: http://ws.apache.org/axis/
- Principles:
  - Writing server is easier than writing clients (but only regarding the toolkit, not the business logic)
  - Servers may be written independently on the used toolkit
  - Always test interoperability with a non-Java client (because of data serialization and de-serialization)

hello/HelloWorld.java

```
package hello;
public interface HelloWorld {
        String getHelloMessage();
        void setHelloMessage (String newHello);
}
```

hello/HelloWorldService.java

```
package hello;
public class HelloWorldService
        implements HelloWorld {
        String message = "Hello, world!";
        public String getHelloMessage() {
                return message;
        }
        public void setHelloMessage (String newMessage) {
                message = newMessage;
        }
}
```

HelloWorldClient.java

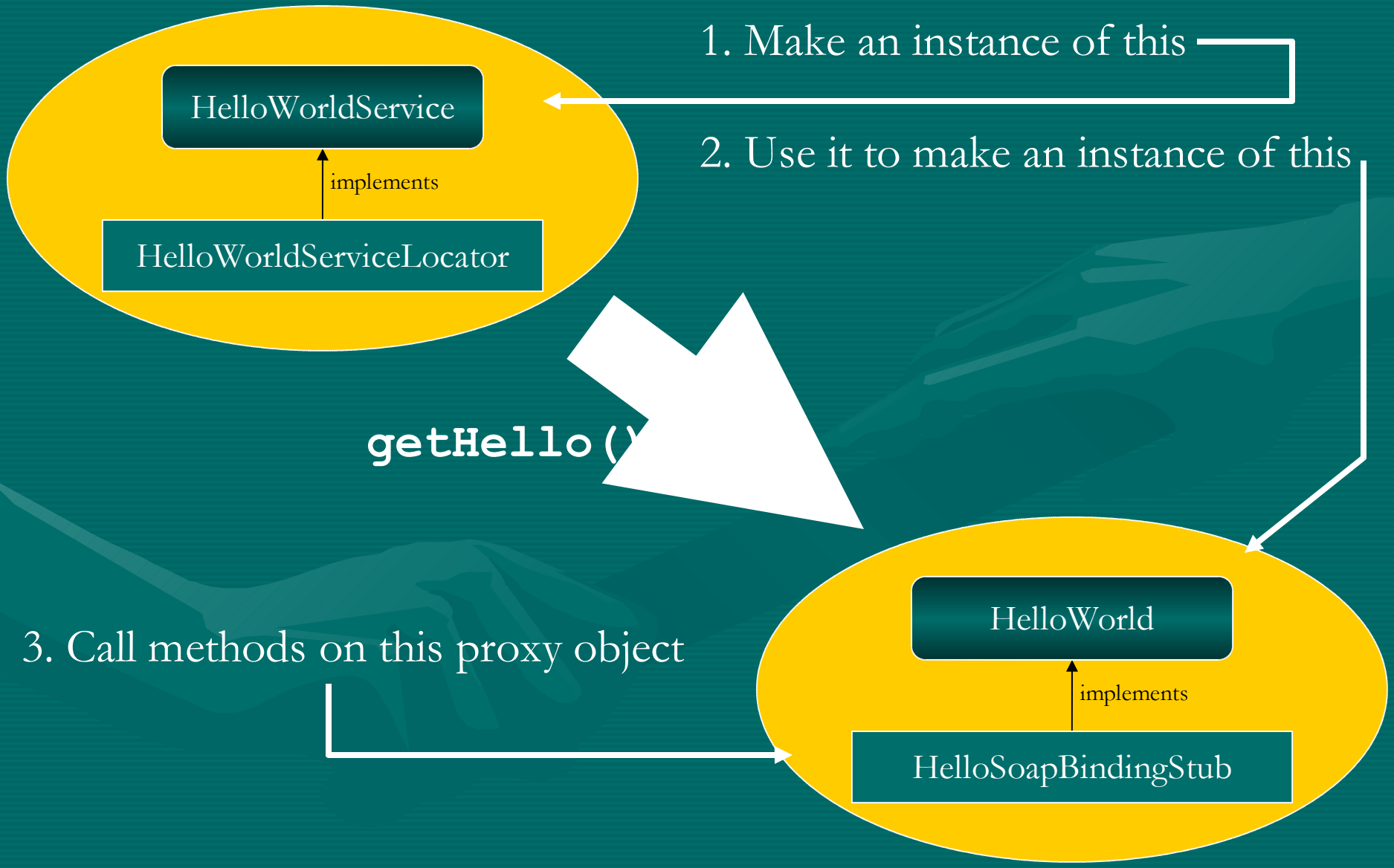
```
import org.apache.axis.client.*;
public class HelloWorldClient {
  public static void main (String [] args) {
    try {
      // prepare the call (the same for all called methods)
      Call call = (Call) new Service().createCall();
      call.setTargetEndpointAddress
        (new java.net.URL("http://localhost:8080/axis/services/Hello"));

      // call "get message"
      if (args.length == 0) {
        call.setOperationName ("getHelloMessage");
        String result = (String) call.invoke ( new Object [] {} );
        System.out.println (result);
        System.exit (0);
      }

      // call "set message" and afterwards "get message"
      call.setMaintainSession (true);   // TRY also without this line...
      call.setOperationName ("setHelloMessage");
      call.invoke ( new Object [] { args[0] } );
      call.setOperationName ("getHelloMessage");
      System.out.println (call.invoke ( new Object [] {} ));

    } catch (Exception e) {
      System.err.println ("ERROR:\n" + e.toString());
    }
  }
```

Generated for HelloWorld



HelloWorldClientFromStubs.java

```
public class HelloWorldClientFromStubs {
  public static void main (String [] args) {
    try {
      // prepare the calls (the same for all called methods)
      hello.generated.HelloWorldService service =
        new hello.generated.HelloWorldServiceLocator();
      hello.generated.HelloWorld myHelloProxy = service.getHello();

      // call "get message"
      if (args.length == 0) {
        String result = myHelloProxy.getHelloMessage()
        System.out.println (result);
        System.exit (0);
      }

      // call "set message" and afterwards "get message"
      myHelloProxy.setHelloMessage (args[0]);
      System.out.println (myHelloProxy.getHelloMessage());

    } catch (Exception e) {
      System.err.println ("ERROR:\n" + e.toString());
    }
  }
}
```

Java <=> XML Data Mapping

- How Java objects are converted to/from XML data (in order to be able to be put into SOAP messages)
- Important especially for the non-basic data types
- It's easier if your non-basic data types are Java Beans (having `set`/`get` methods for members)

A Web Service example in Perl

```
#!/usr/bin/perl -w    -- Perl -
use SOAP::Transport::HTTP;
SOAP::Transport::HTTP::CGI
  -> dispatch_to('HelloPerl')
  -> handle;
```

This is a cgi-bin script

```
package HelloPerl;
use strict;
use vars qw( $Message );
$Message = 'Hello, here is Perl.';
sub getHelloMessage { $Message; }
sub setHelloMessage { $Message = shift; }
1;
```

This is a module implementing the "business logic"

```
#!/usr/bin/perl -w
use SOAP::Lite
    on_fault => sub {…};
print SOAP::Lite
    -> uri ('HelloPerl')
    -> proxy ('http://localhost/cgi-bin/helloserver.cgi')
    -> getHelloMessage
    -> result;
```

This is a client

SOAP::Lite

- a collection of (many) modules
  - but they are loaded automatically when needed
- supports SOAP 1.1 specification
- all methods can be used for both setting and retrieving values:
  - if you provide no parameters, you will get current value, and if parameters are provided, a new value will be assigned to the object
  - and the method in question will return the current object (if not stated otherwise) which is is suitable for stacking these calls like:

```
$lite = SOAP::Lite
      -> uri('openBQS')
      -> proxy('http://industry.ebi.ac.uk/soap/openBQS')
      ;
```

Using “wsdl” - directly

- getting “.wsdl” file by using its URL
- then, you do not need to worry about autotyping

```
#!/usr/bin/perl -w

use SOAP::Lite on_fault => sub {…};
print SOAP::Lite
    -> service ('file:/home/senger/ws-ws/perl/Hello.wsdl')
    -> setHelloMessage (123);
```

```
#!/usr/bin/perl -w

use SOAP::Lite on_fault => sub {…};
my $service = SOAP::Lite -> service ('file:./Hello.wsdl');
$service->setHelloMessage ($ARGV[0] or "Hello!!!");
print $service->getHelloMessage, "\n";
```

Why to use Web Services…

- WS are easier to deploy because of their firewall-friendliness
- WS are quite well marketed (both from IT companies and Open Source projects)
- It well integrates into workflows (hence this tutorial at NETTAB!)
- The programming effort and maintainability is similar to other distributed technologies

But be aware that…

- Client is different from server; both have different resources and restrictions
  - notification by "server-push" is harder to achieve
- User sessions are less standardised; there is no real standard:
  - HTTP level (cookies)
  - SOAP headers
  - Within your implementation code
  - but: Web Services Resource Framework (WSRF) and Web Services Notifications (WSN) is perhaps an incoming standards for state-full web services

Designing principles

- Make it simple
  - use data structures that are understood by many languages/toolkits
  - avoid (if possible) the need for specialized [de]serializers
- Follow standards
  - allow to use WSDL (if possible)
  - try to localize dependency on a used toolkit/servlet engine
- Test the interoperability
  - between languages
  - think about different encodings