2. SOA Concepts

Jiří Vokřínek

Agent Technology Center
Department of Cybernetics
Faculty of Electrical Engineering, Czech Technical University in Prague

vokrinek@agents.felk.cvut.cz http://agent.felk.cvut.cz

SOA Technologies

- RPC, CORBA
- HTTP, XML
- UDDI, WSDL
- REST, DCOM
- SOAP
- JAX-RPC, JAX-WS, WCF
- … Web Services

1976

- Apple Computer Company is formed by Steve Jobs and Steve Wozniak
- Peugeot becomes a part of Citroen
- The first 4.6 miles of the Washington Metro subway system opens
- The first laser printer is introduced by IBM
- **Remote Procedure Call** for ARPANET is introduced

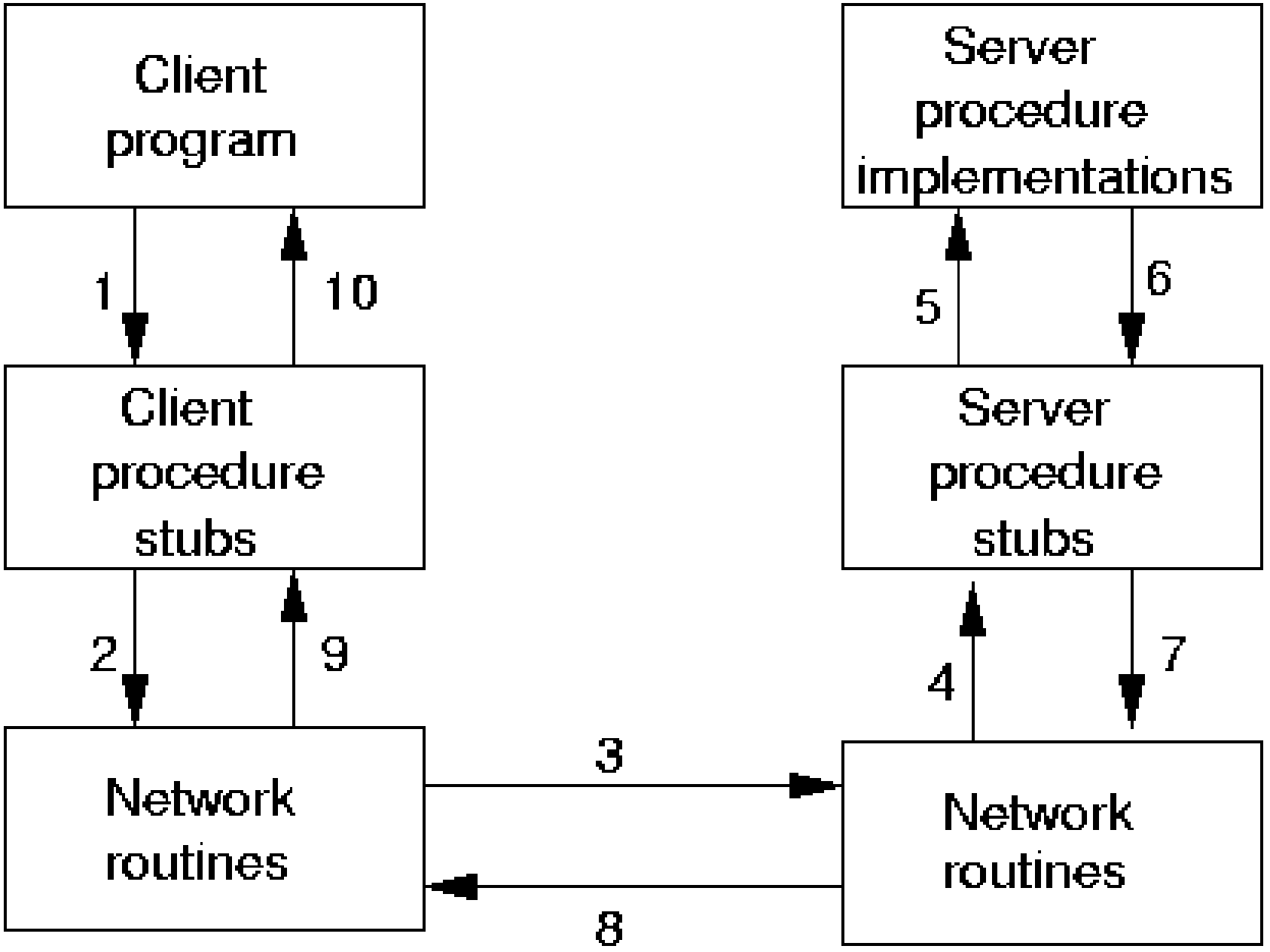
Remote Procedure Call (RPC)

- First business use by XEROX in 1981
- Popular UNIX implementation by Sun
- Base for later DCOM (Microsoft) and CORBA
- Inter-process communication allowing a program to execute subroutine in another address space without the need of explicitly coding this remote interaction
- Programmer writes essentially the same code whether the subroutine is local or remote

Remote Procedure Call (RPC)

- In object-oriented scope, RPC is called remote invocation or remote method invocation
- RPC is initiated by client that is blocked until server responses
- Can fail because of unpredictable network conditions
- Idempotent procedures easily handled

RPC Sequence



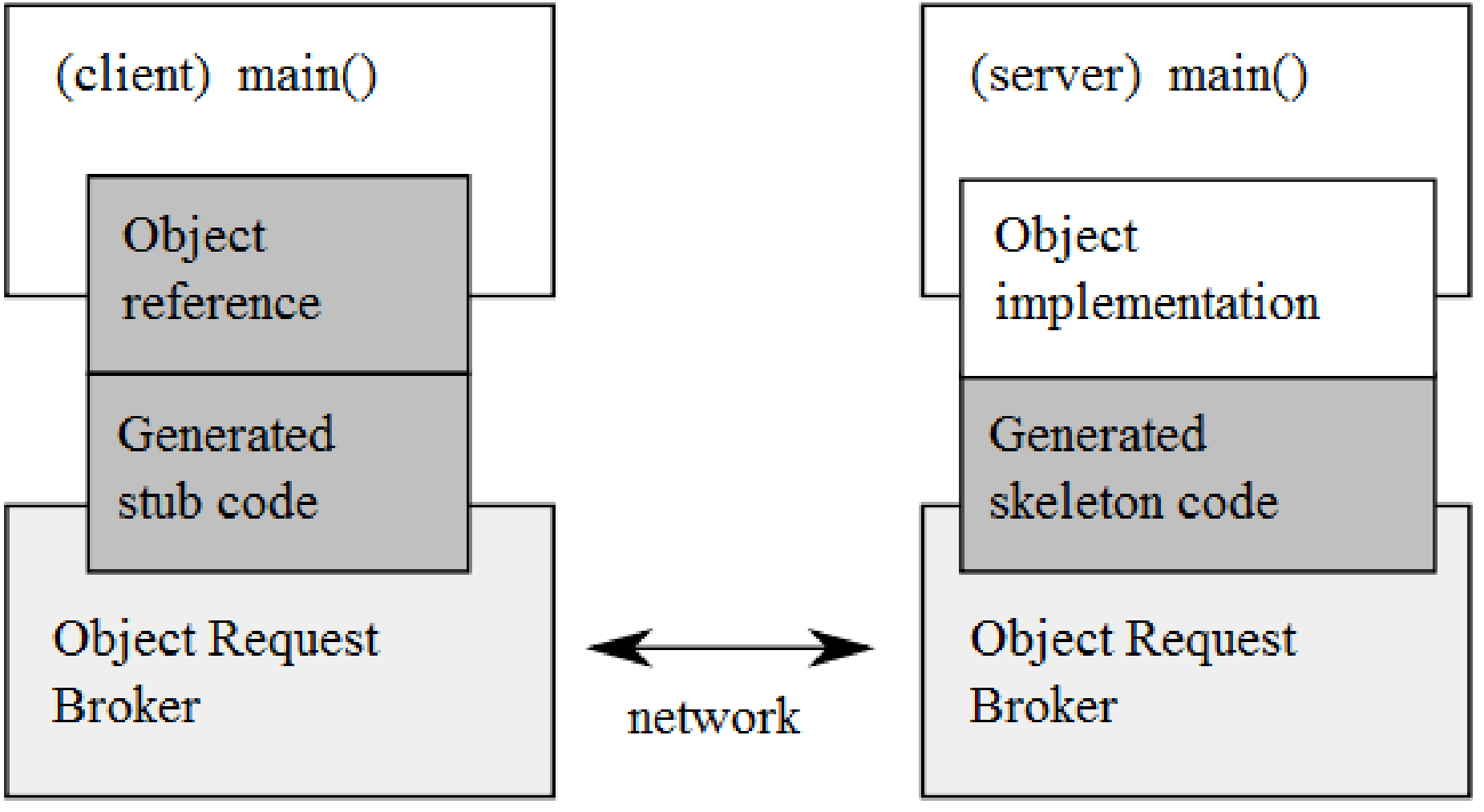
1991

- Soviet Union collapses and is formally dissolved
- Sweden wins the 36th Eurovision Song Contest
- First mobile operator starts (EuroTel)
- AMD starts to compete with Intel by Am386
- Internet connects more than 100 computers
- **Common Object Request Broker Architecture** is introduced

Common Object Request Broker Architecture (CORBA)

- Standard that enables software components written in **multiple computer languages** running on **multiple computers** (i.e. platforms) to work together
- Specification include: data typing, exceptions, network protocol, communication timeouts, etc.
- Does not address: object lifetimes, redundancy, naming/models semantics, memory management, load balancing, etc.

CORBA Call Structure



CORBA Features

- Language independence
- OS independence
- Freedom from technologies
- Strong data typing
- CORBA Interface Definition Language

CORBA Features

- Freedom from data transfer details
- Compression of marshaled binary data
- Transactions and security
- … etc

1996

- NASA launches the Mars Global Surveyor
- AMD's first in-house x86 processor K5
- CESNET is founded
- **HTTP** v1.0 is introduced
- Working Draft of an **XML** specification is published
- **Distributed Component Object Model** introduced in Windows NT

Hypertext Transfer Protocol (HTTP)

- Networking protocol for distributed, collaborative, hypermedia information systems
- Application layer request-response protocol in the client-server computing model
- Foundation of data communication for the World Wide Web

HTTP Request Methods

- HEAD – similar to GET but without response body
- GET – requests a representation of the specified resource
- POST – submits data to be processed to the identified resource
- PUT – uploads a representation of the specified resource
- DELETE – deletes the specified resource

HTTP Request Methods

- TRACE – echoes back the received request, so that a client can see what (if any) changes or additions have been made by intermediate servers
- OPTIONS – returns the HTTP methods that the server supports for specified URL
- CONNECT – converts the request connection to a transparent TCP/IP tunnel
- PATCH – used to apply partial modifications to a resource

Extensible Markup Language (XML)

- Set of rules for encoding documents in machine-readable form
- Design goals emphasize simplicity, generality, and usability over the Internet
- Textual data format with focus on documents
- Widely used for interface data definitions

Extensible Markup Language (XML)

- Uses tags, elements, attributes
- Defined by schemas – Document Type Definition (DTD) or XML Schema Definition (XSD)

```
<?xml version="1.0" encoding="UTF-8" ?>
<painting>
  <img src="madonna.jpg" alt='Foligno Madonna, by Raphael'/>
  <caption>This is Raphael's "Foligno" Madonna, painted in
    <date>1511</date>–<date>1512</date>.
  </caption>
</painting>
```

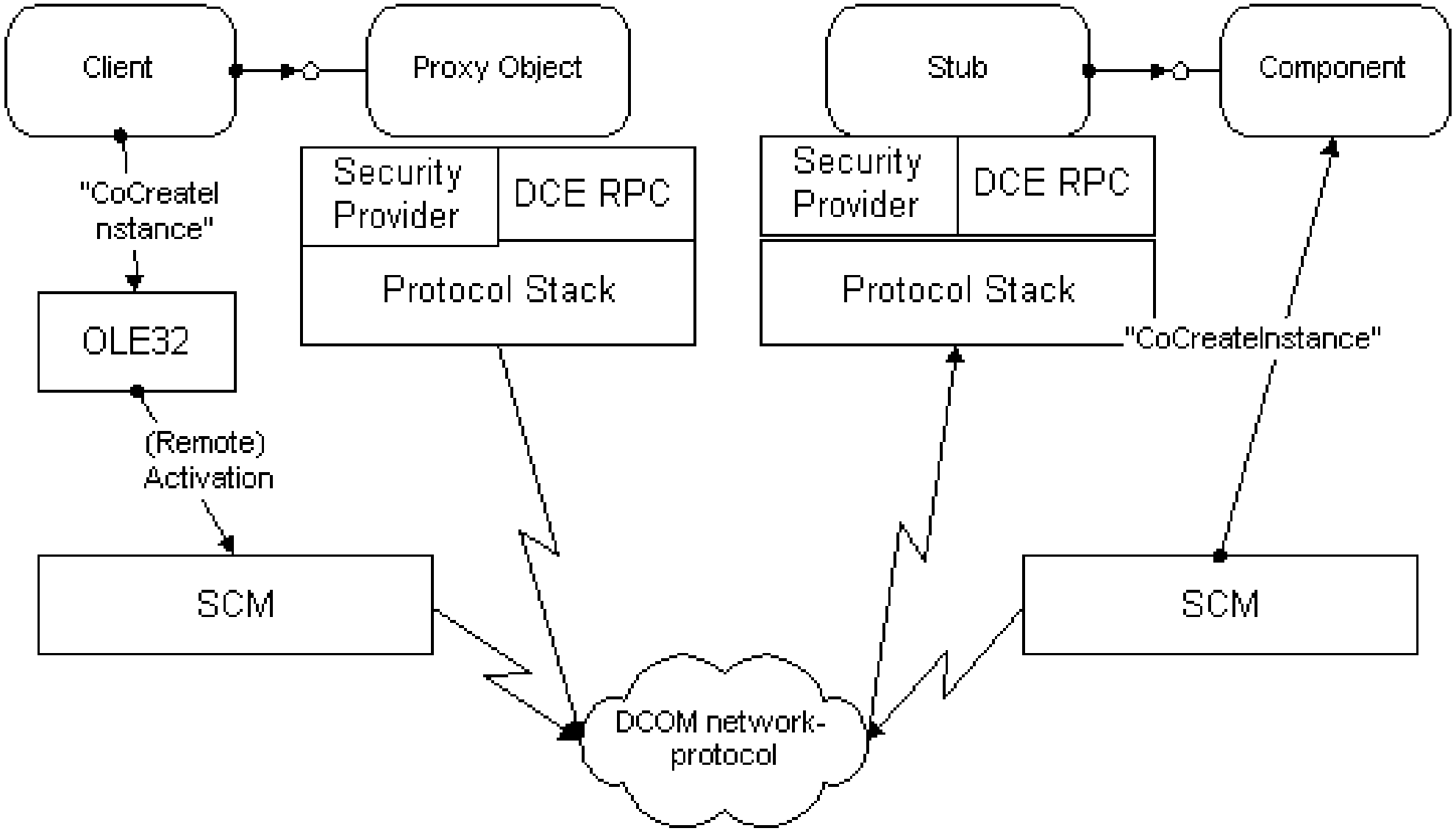
Distributed Component Object Model (DCOM)

- Proprietary Microsoft technology for communication among software components distributed across networked computers
- Has been deprecated in favor of the Microsoft .NET Framework
- COM based implementation of RPC
- Competitor to CORBA

DCOM Added Features

- Marshalling – serializing and deserializing the arguments and return values of method calls
- Distributed garbage collection – ensuring that references held by clients of interfaces are released when, for example, the client process crashed, or the network connection was lost

DCOM Call Structure



2000

- Nuclear power plant Temelin starts operation
- Russian submarine K-141 Kursk sinks in the Barents Sea
- IIHFWC final: Czech Republic beats Slovakia 5:3
- ATI launches Radeon series
- **UDDI** standard is defined
- **WSDL** is introduced
- **REST** is introduced and defined

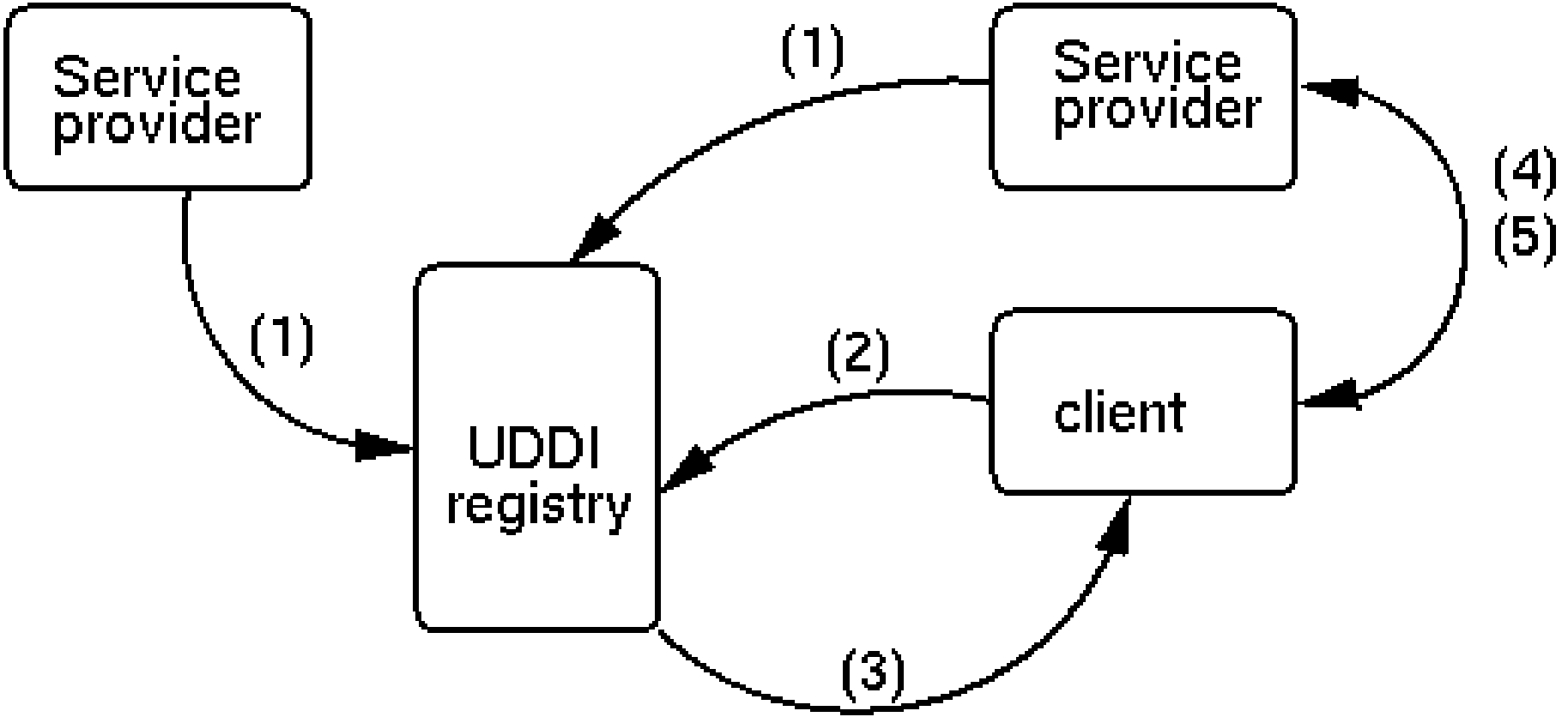
Universal Description, Discovery and Integration (UDDI)

- Platform-independent XML-based registry for businesses worldwide to list themselves on the Internet
- Open industry initiative
- Enables businesses to publish service listings and discover each other and define how the services or software applications interact over the Internet

UDDI Registry

- White Pages — address, contact, and known identifiers
- Yellow Pages — industrial categorizations based on standard taxonomies
- Green Pages — technical information about services exposed by the business

UDDI Search


Service provider
(1)
Service provider
(4)
(5)
(1)
UDDI registry
(2)
client
(3)

Web Services Description Language (WSDL)

- XML-based language that provides a model for describing Web services
- Defines services as collections of network endpoints, or ports associating a network address with a reusable bindings
- Describes the public interface to the web service
- Used in combination with SOAP and XML Schema to provide web services over the Internet

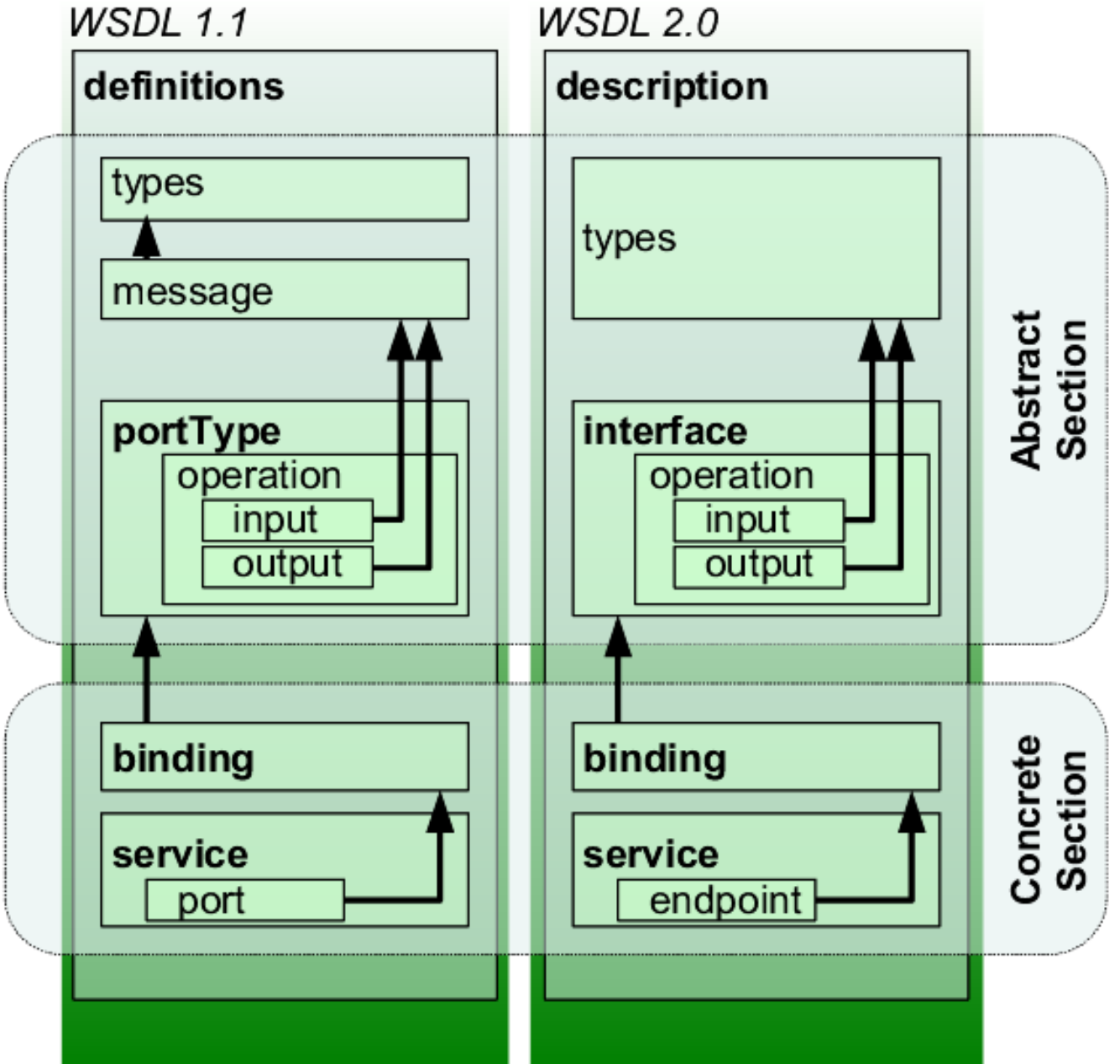
WSDL Versions

- WSDL 1.0 (2000), 1.1 (2001) – developed by IBM, Microsoft, and Ariba
- WSDL 1.2 (2003) – W3C draft; easier and more flexible for developers; attempts to remove non-interoperable features
- WSDL 2.0 (2007) – W3C recommendation

WSDL 2.0 Changes

- Adding further semantics to the description language
- Removal of message constructs
- No support for operator overloading
- PortTypes renamed to interfaces
- Ports renamed to endpoints

WSDL Representation



Representational State Transfer (REST)

- Style of software architecture for distributed hypermedia systems such as the World Wide Web
- REST was by Roy Fielding, principal author of the HTTP 1.0 and 1.1
- Conforming to the REST constraints is referred to as being 'RESTful'

REST Architecture

- Clients and servers
- Clients initiate requests
- Servers process requests and return appropriate responses
- At any particular time, a client can either be in transition between application states or "at rest" (is able to interact with its user, but creates no load and consumes no per-client storage on the set of servers or on the network)

REST Architecture

- Initially described in the context of HTTP, but is not limited to
- RESTful architectures can be based on other Application Layer protocols
- Utilize preexisting defined interface and other built-in capabilities provided by the network protocol (minimize the addition of new application-specific features on top of it)

REST Constraints

- Client–server – uniform interface, separation of concepts
- Stateless – no client context being stored
- Cacheable – clients are able to cache responses
- Layered system – transparent connection
- Code on demand (optional)
- Uniform interface

RESTful web services

- Simple web service implemented using HTTP
- URI for the web service looks like `http://example.com/resources/`
- MIME type of the data supported by the web service (e.g. XML document)
- Operations supported by the web service using HTTP methods (e.g., POST, GET, PUT or DELETE).

2003

- A total solar eclipse is seen over Antarctica
- Space Shuttle Columbia is launched on what turns out to be its last flight
- The Human Genome Project is completed with 99% of the human genome
- Wikipedia is being distributed
- **Simple Object Access Protocol** became a W3C recommendation
- Java **API for XML-based RPC** is standardized

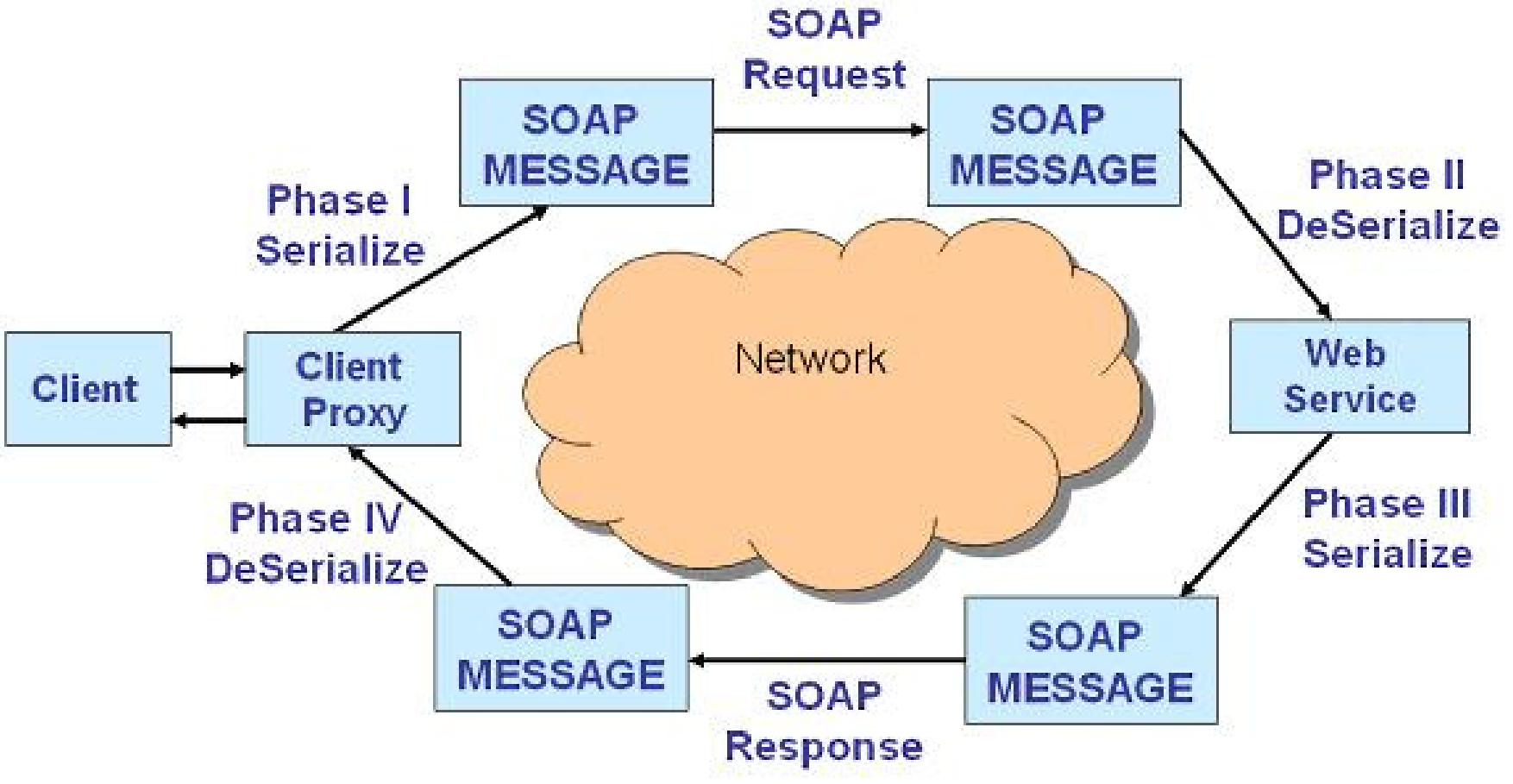
Simple Object Access Protocol (SOAP)

- Protocol specification for exchanging structured information for WS
- Relies on XML for its message format
- Uses other application layer protocols (RPC, HTTP)
- Originally designed as an object-access protocol
- Underlying layer for Web Services, based on WSDL and UDDI

SOAP Specification

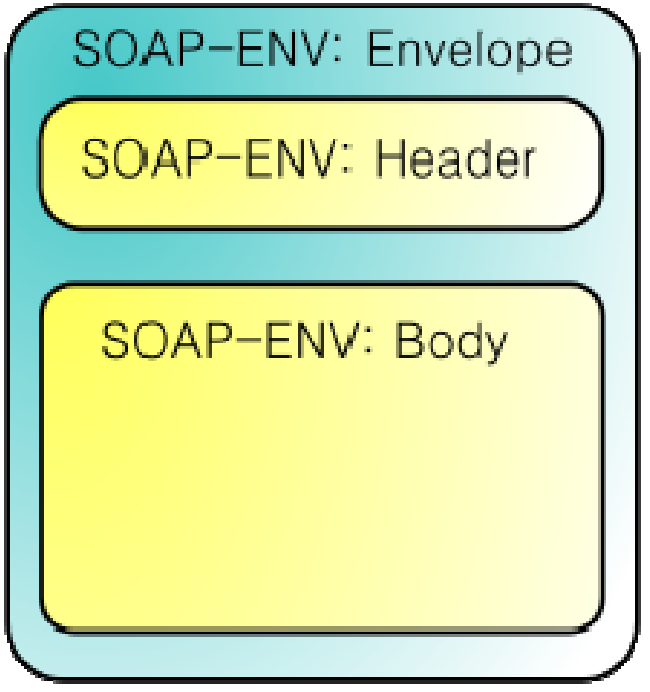
- SOAP processing model – defines the rules for processing a SOAP message
- SOAP extensibility model – defines the concepts of SOAP features and SOAP modules
- SOAP underlying protocol binding – framework describing the rules for defining a binding to a protocol exchanging SOAP messages between nodes
- SOAP message construct – defines the structure of a SOAP message

SOAP Call Structure



SOAP Processing Model

- SOAP sender
- SOAP receiver
- SOAP message path
- Initial SOAP sender (Originator)
- SOAP intermediary
- Ultimate SOAP receiver



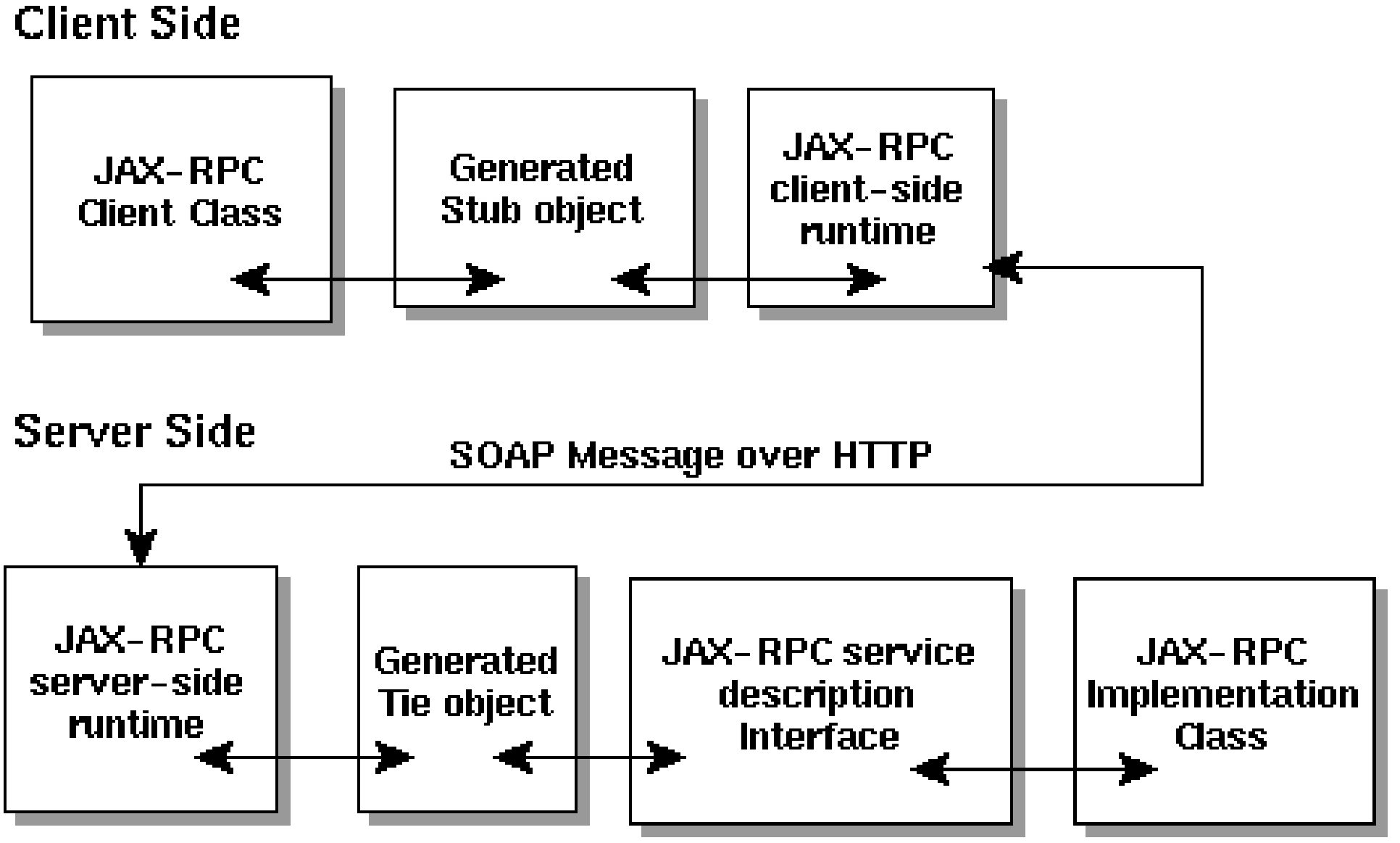
SOAP Message Example

```
POST /InStock HTTP/1.1
Host: www.example.org
Content-Type: application/soap+xml; charset=utf-8
Content-Length: nnn

<?xml version="1.0"?>
<soap:Envelope
xmlns:soap="http://www.w3.org/2001/12/soap-envelope"
soap:encodingStyle="http://www.w3.org/2001/12/soap-encoding">

<soap:Body xmlns:m="http://www.example.org/stock">
  <m:GetStockPrice>
    <m:StockName>IBM</m:StockName>
  </m:GetStockPrice>
</soap:Body>

</soap:Envelope>
```

Java API for XML-based RPC

- JAX-RPC
- Allows Java application to invoke a Java-based Web Service
- Can be seen as Java RMI over Web Service
- Java program invokes methods on stub
- Runtime system converts calls to SOAP and uses HTTP requests

JAX-RPC Call Structure



Java API for XML Web Services

- JAX-WS (2006)
- Java API for creating web services
- Part of the Java EE platform
- Uses annotations to simplify the development and deployment of web service clients and endpoints
- Interface/data mapping model

2007

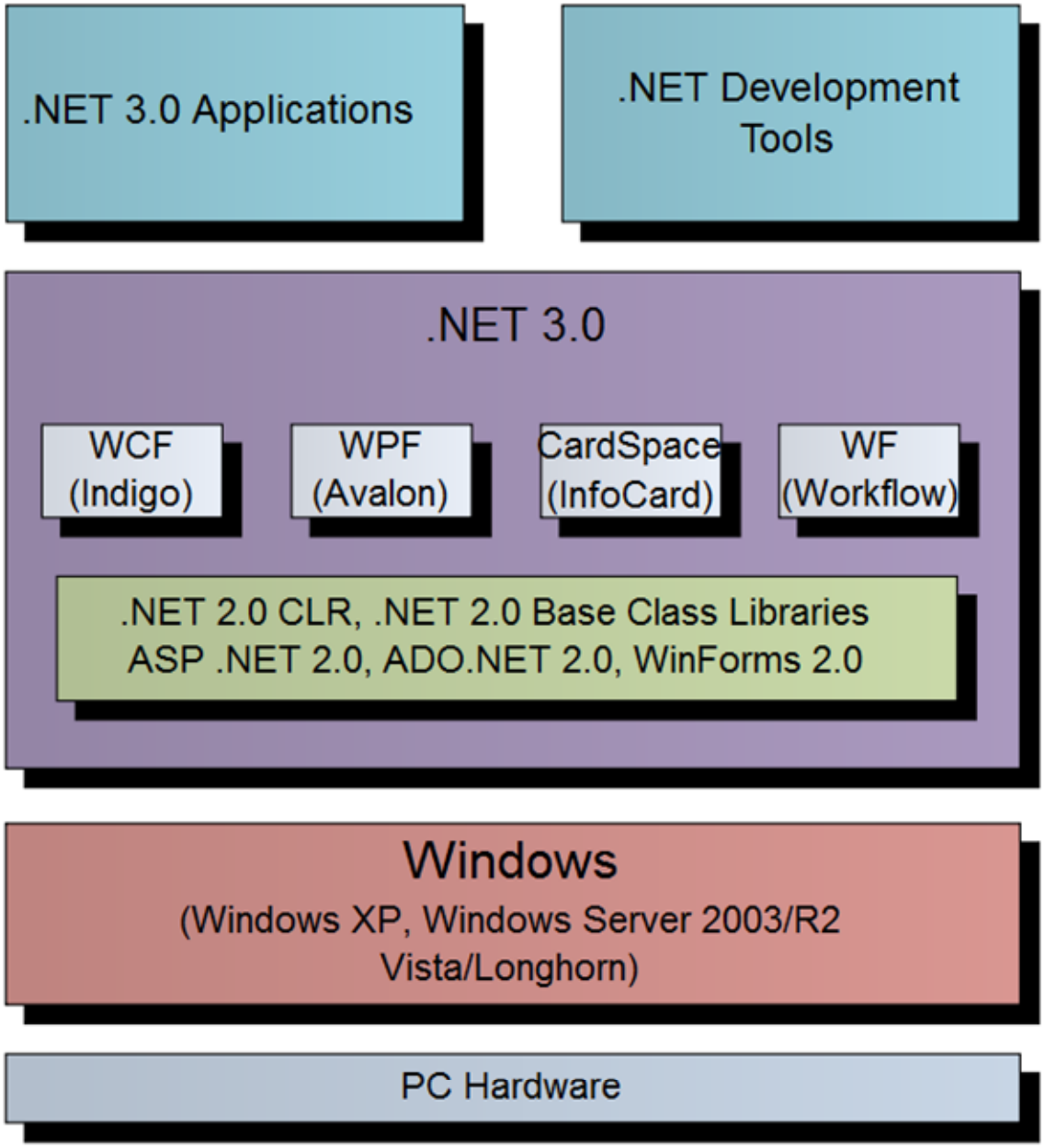
- MESSENGER spacecraft makes its second fly-by of Venus
- Czech Republic joins the Schengen border-free zone
- Windows Vista fails to substitute XP
- Desktop HDD meets 1TB capacity
- **Windows Communication Foundation is released within** .NET Framework 3.5

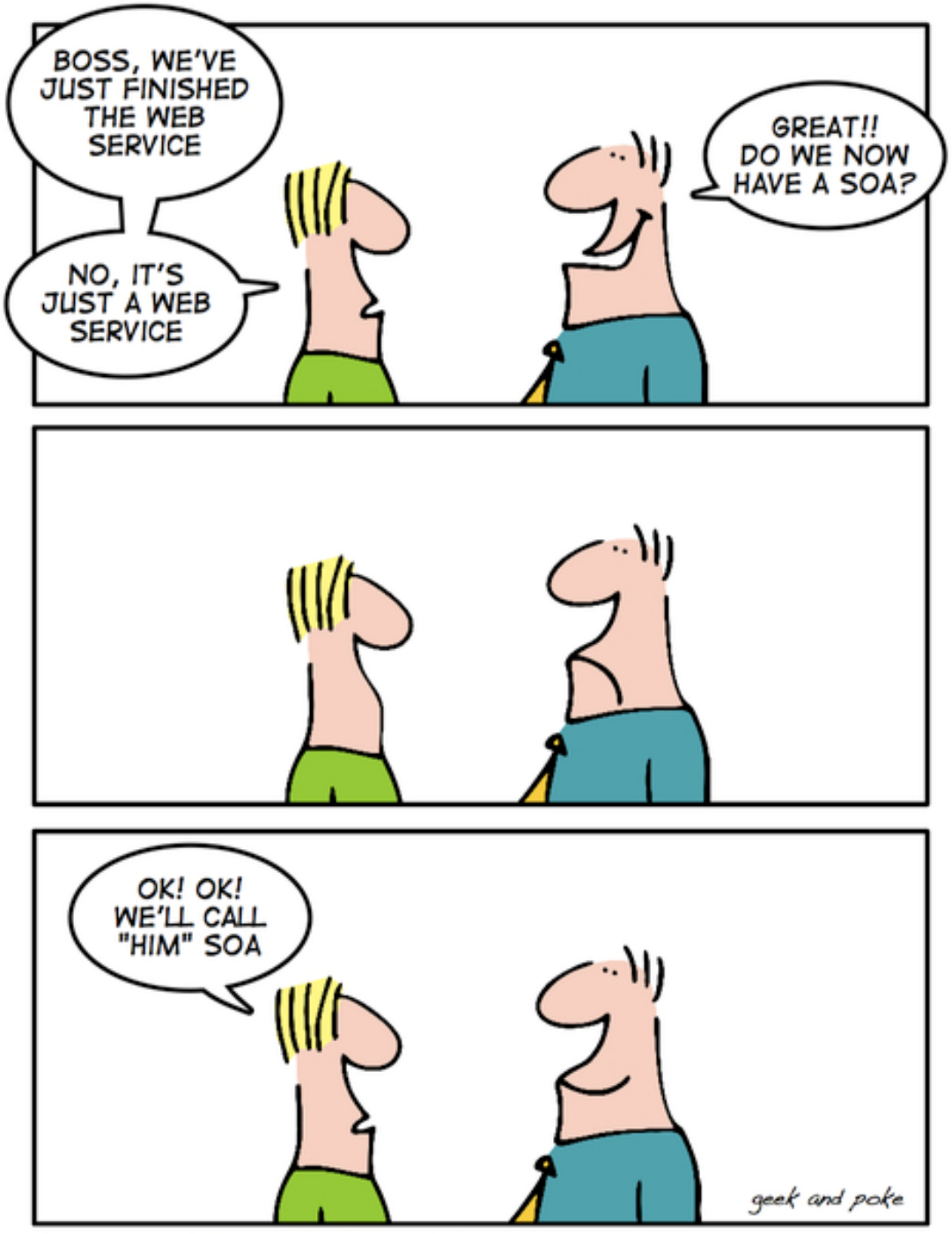
Windows Communication Foundation (WCF)

- API in the .NET Framework for building connected, service-oriented applications
- WS support – WSDL, SOAP, XML based
- Wide support for protocols bindings
- RESTful, Queued Messaging
- … etc.

```
[ServiceContract]
public interface ICalculator
{

    [OperationContract]
    int Add(int Op1, int Op2);
    [OperationContract]
    int Subtract(int Op1, int Op2);
```

WCF Structure





HOW TO GET A SOA