Lecture 9

S4 - Core Distributed Middleware Programming in JEE

presentation

DAD – Distributed Applications Development

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Agenda for Lecture 7

DAD Section 4 - CORBA Intro, CORBA Architecture & API, g-RPC

CORBA – Common ORB Architecture

CORBA & g-RPC are NOT Required for Exam

1. CORBA Overview

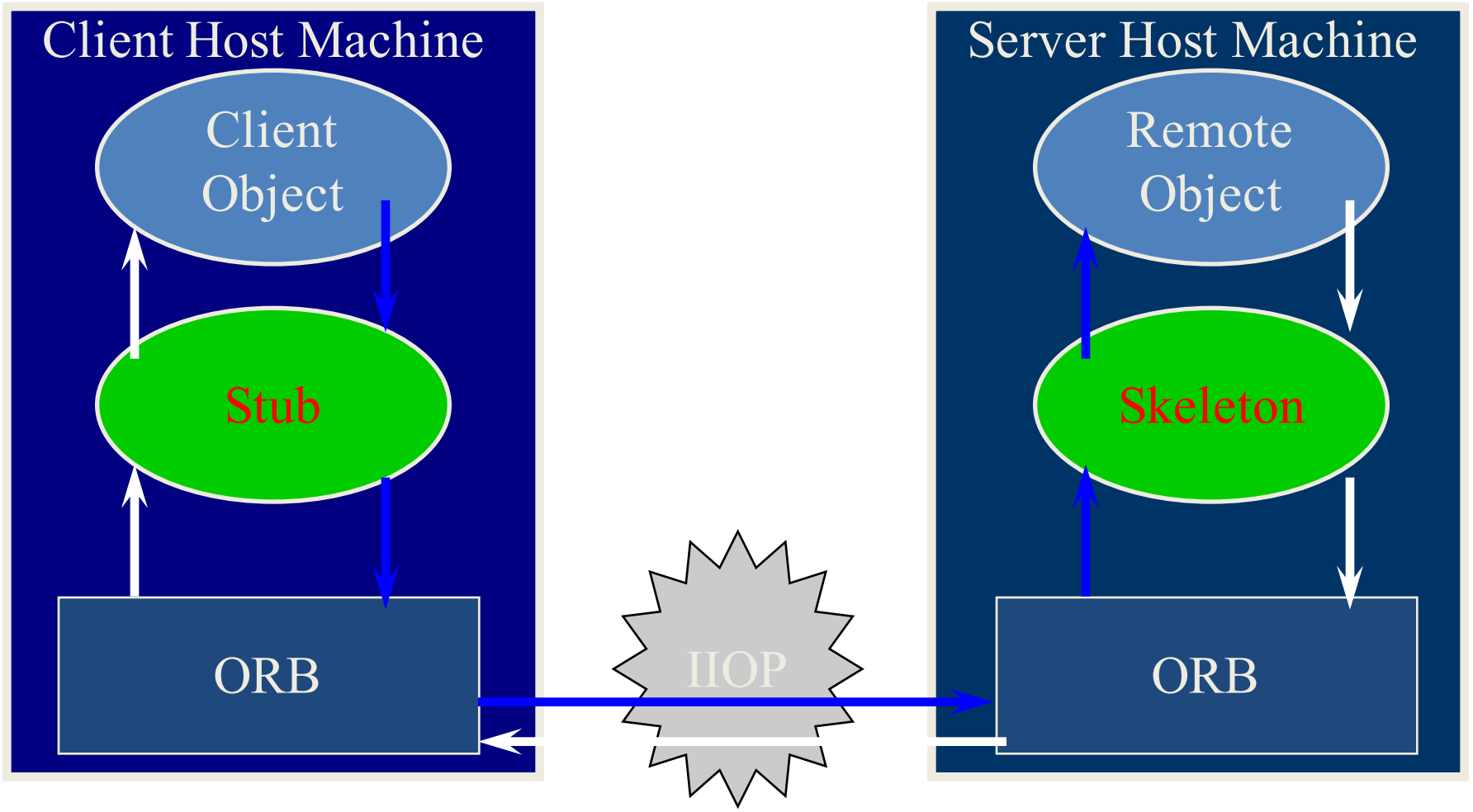
CORBA – Common Object Request Broker Architecture

OMG created CORBA. CORBA loves JAVA.

1. CORBA Basic Architecture
2. CORBA Basic Flow
3. ORB – Object Request Broker
4. GIOP vs. IIOP, IOR
5. IDL is CORBA “language independency”
6. CORBA Services
7. Products – SUN Java IDL

Lecture 7

Part I – CORBA – Basic Architecture

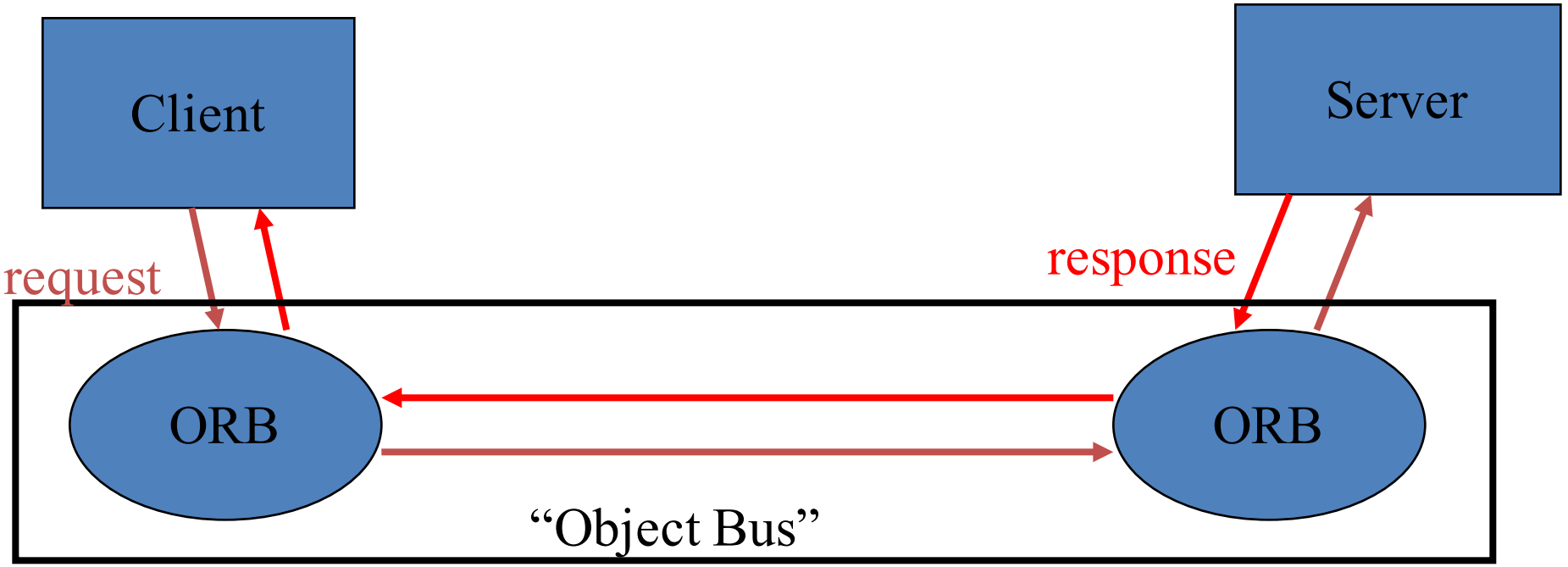


Stubs and Skeletons

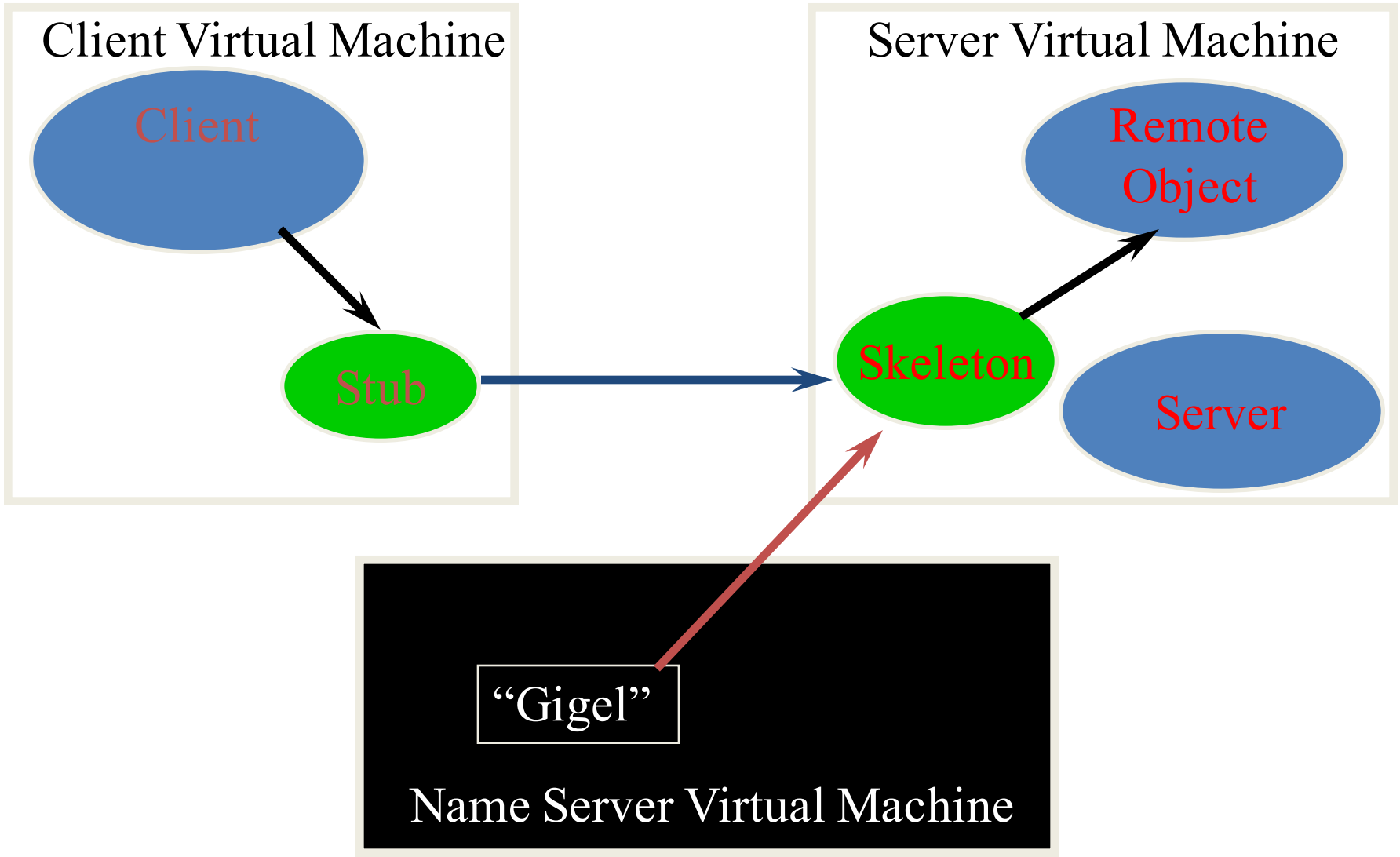
- Stub
  - lives on client
  - pretends to be remote object
- Skeleton
  - lives on server
  - receives requests from stub
  - talks to true remote object
  - delivers response to stub

Similar with RMI 1.1 in concept

Partea I – CORBA – Basic Architecture

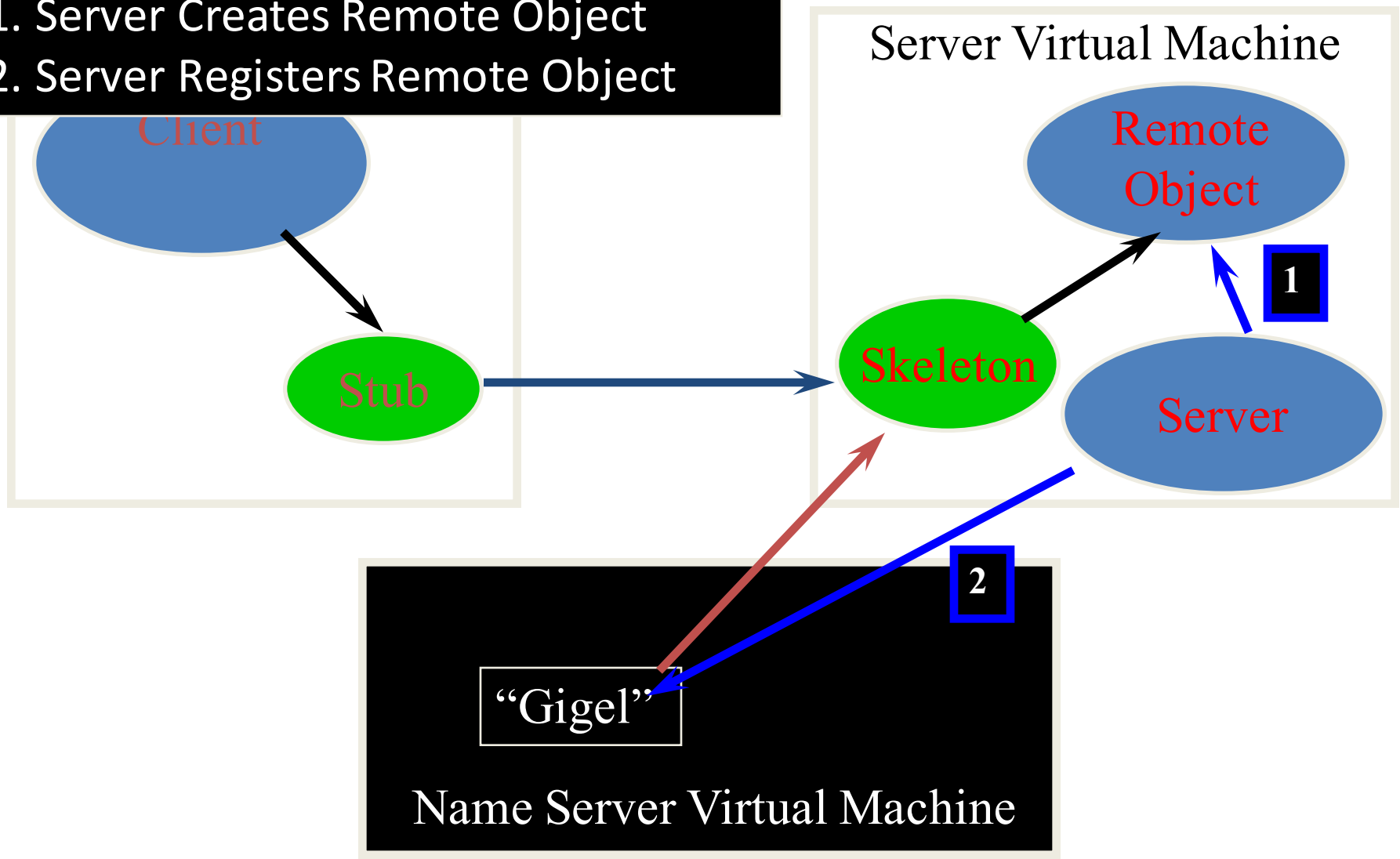


Partea I – CORBA Basic Flow without ORB is like RMI



Partea I – CORBA Basic Flow without ORB is like RMI

1. Server Creates Remote Object
2. Server Registers Remote Object



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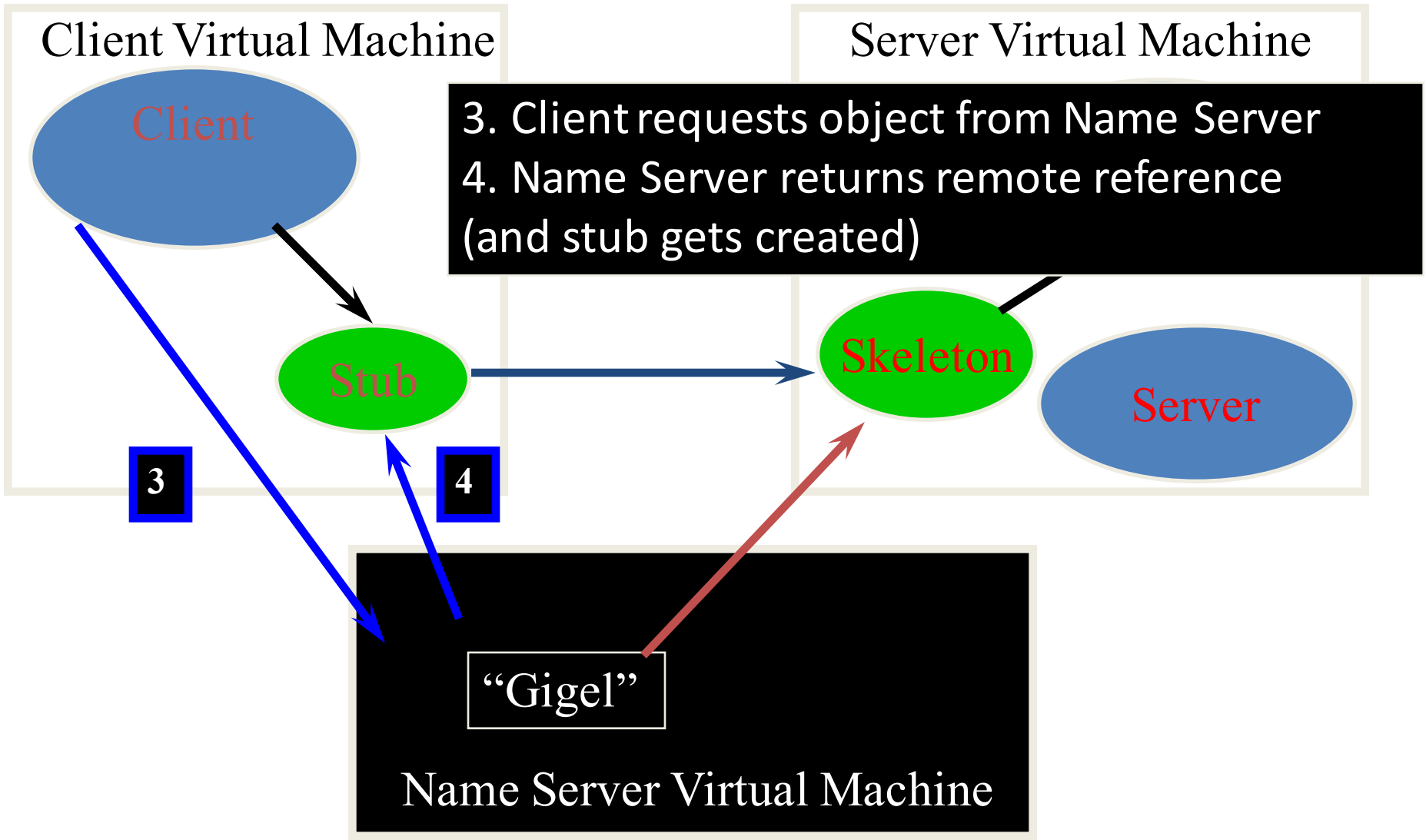
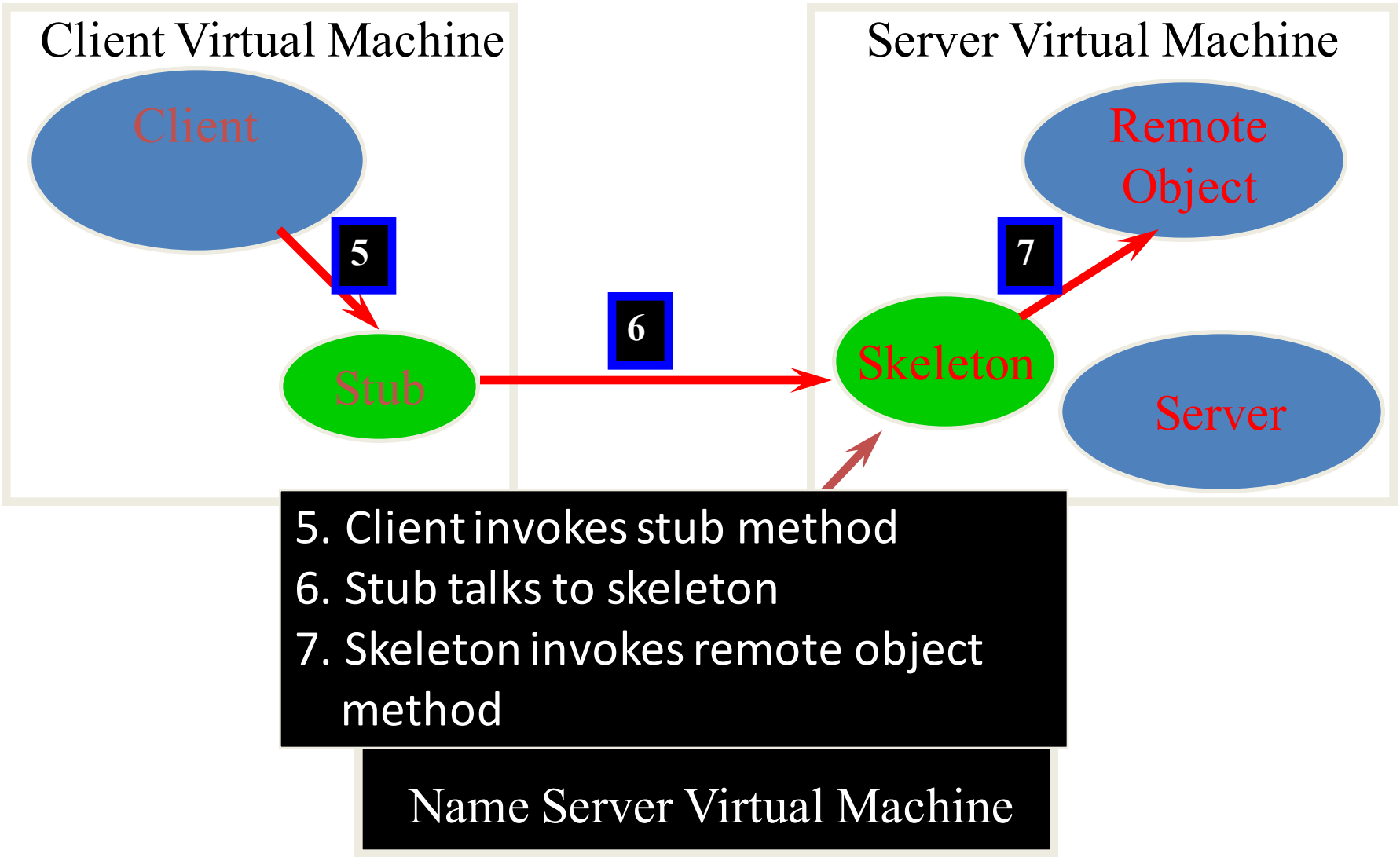


Partea I – CORBA Basic Flow without ORB is like RMI



- OMG does not specify exactly where the ORB is in CORBA.
- Depending on which CORBA implementation (product) is used, the ORB may be:
  - A set of run-time libraries
  - A server machine/process
  - Part of the operating system (Spring)
  - Part of a web browser (Netscape)

Partea I – CORBA – ORB in Practice

FEATURES:

- Object Request Broker - “Object Bus”
- Handles all communication among objects
- Each host (machine) has its own ORB
- ORBs know how to talk to each other
- ORB also provides basic services to client

RESPONSABILITIES:

- Find the object implementation for the request
- Prepare the object implementation to receive the request
- Communicate the data making up the request
- Retrieve results of request

Note:

- There’s an ORB on the server too, and ORB receives request
- *ORB is good if Stub and Skeleton are written in different programming language*

- Method invocations
  - Static and Dynamic
  - Remote objects or CORBA services
- High-level language bindings
  - Use your favorite language; ORB translates
- Self-describing
  - Provides metadata for all objects and services

Partea I – CORBA – ORB Features

- Local or remote
  - Same API wherever target object lives
- Preserves context
  - Distributed security and transactions
- Coexistence with legacy code
  - Just provide a wrapper object

What is an ORB really?

- Not a separate process
- Library code that executes in-process
- Listens to TCP ports for connections
  - One port per local object
- Opens TCP sockets to other objects
  - N ports per remote machine

Partea I – CORBA – GIOP and IIOP

- The OMG agreed protocol for ORB interoperability is called the General Inter-ORB Protocol (GIOP).
- GIOP defines the logical data representation and message formats for communication.
- The OMG defines a realization of GIOP that uses TCP/IP as the transport layer. This specialization is called the Internet Inter-ORB Protocol (IIOP).

Interoperability

Message type	Originator	Description
Request	Client	Contains an invocation request
Reply	Server	Contains the response to an invocation
LocateRequest	Client	Contains a request for the exact location of an object
LocateReply	Server	Contains location information on an object
CancelRequest	Client	Indicates client no longer expects a reply
CloseConnection	Both	Indication that connection will be closed
MessageError	Both	Contains information on an error
Fragment	Both	Part (fragment) of a larger message

Message types in GIOP

- General Inter-ORB Protocol (GIOP) assumes a transport protocol that is reliable, connection oriented and support byte stream notion
- Internet Inter-ORB Protocol (IIOP) is GIOP built on TCP

Partea I – CORBA – GIOP and IIOP

GIOP Messages:

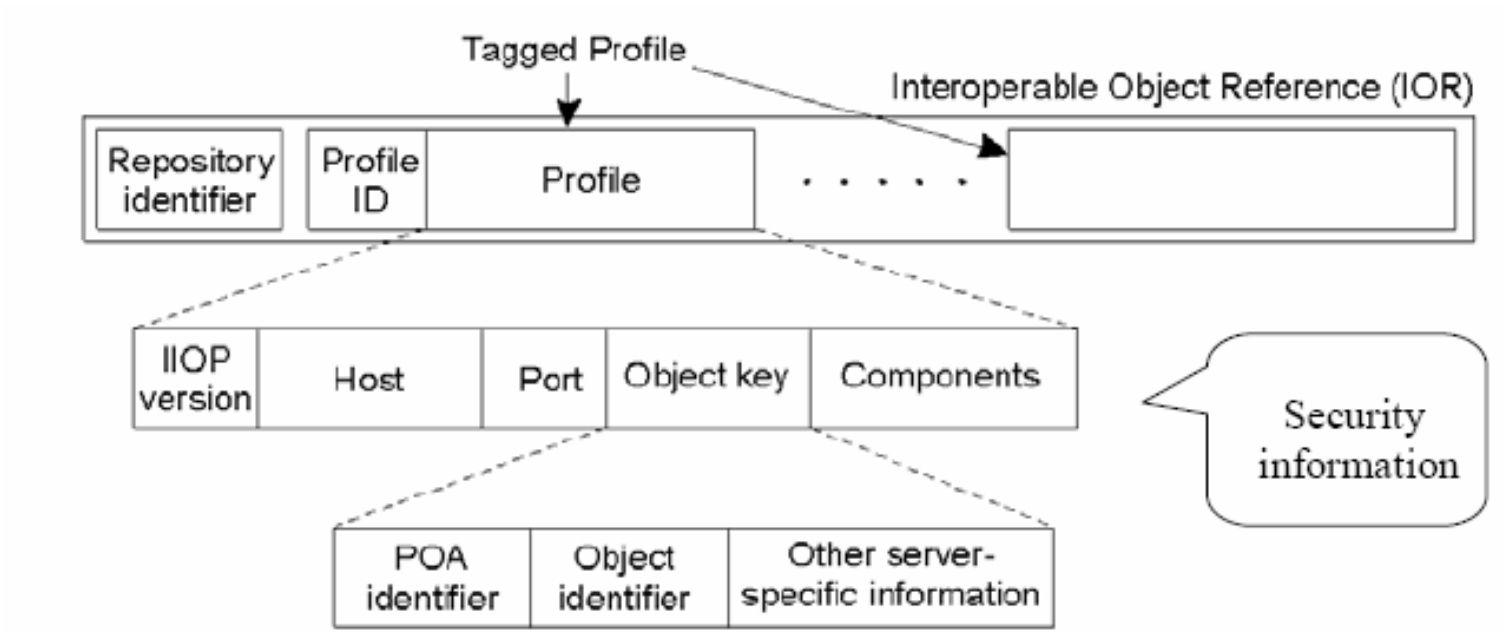
• *Request message* contains a complete marshaled invocation request (object reference, name of the method, input parameters)
– Each request has request ID

• *Reply message* contains a marshaled return values and output parameters
– Reply message has a corresponding request ID of the request message

- An IOR (Interoperable Object Reference) is managed internally by the interoperating ORBs.
- An IOR may include:
  - ORB's internal object reference
  - Internet host address
  - Port number
- It is not necessary for an application programmer to know the structure of an IOR.

Partea I – CORBA – ORB

```
IOR:000000000000001049444c3a466f7274756e653a312e300000
    0000010000000000000005e0001000000000000186d6179666c792
    e73642e6d6f6e6173682e6564752e617500070a000000000036
    3a5c6d6179666c792e73642e6d6f6e6173682e6564752e61753
    a666f7274756e653a466f7274756e65313a3a49523a466f7274
    756e65
```



Pseudo-objects

- The ORB is a pseudo-object
- It works just like a remote object, only it's local

The Basic Object Adapter (BOA)

- Another pseudo-object
- Helps register objects with the ORB
- Functions
  - Maintain Implementation Repository
  - Generate and interpret object references
  - Activate and deactivate implementation objects
  - Invoke methods via skeletons

Why do you need both an ORB and a BOA?

- Allows vendors to optimize or enhance functionality
  - register many objects *en masse*
  - cache object state elsewhere
- E.g. Object database

Using the BOA

- Slightly different procedure for initializing objects
- Hides name service from you
  - Ask the BOA to register the object
  - Ask the Helper object to bind the object
- Once the object is created, interface is identical
  - Just call methods using normal Java syntax

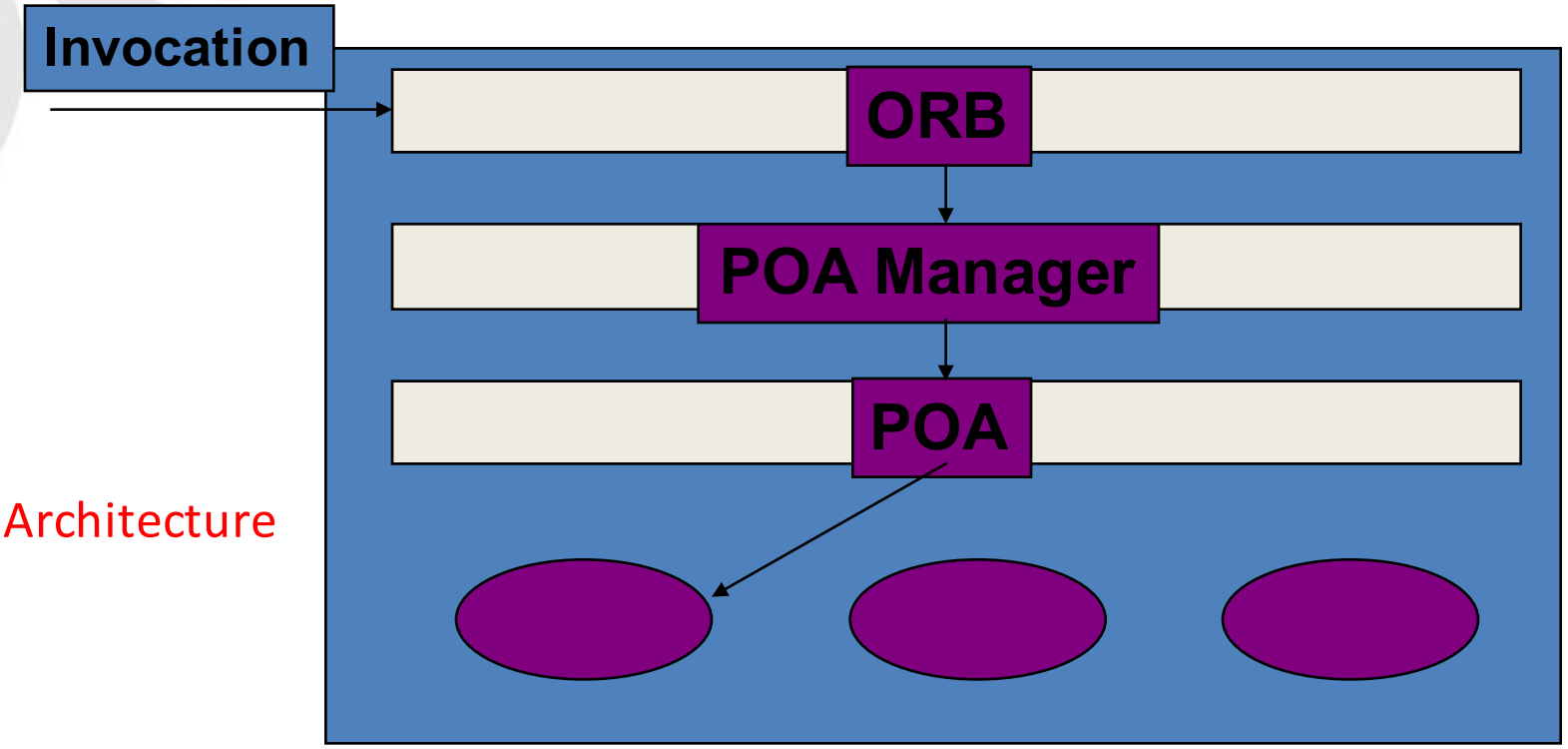
Object Adapters

Portable Object Adapter – POA

The POA:

- Allows the ORB and Objects to communicate
- Provides many services:
  - Dispatches client calls to server objects
  - Handles incoming client calls
  - Handles registration of servers
  - Instantiatiates objects at runtime and creates and manages object references
- *POA is a BOA – Basic Object Adapter*

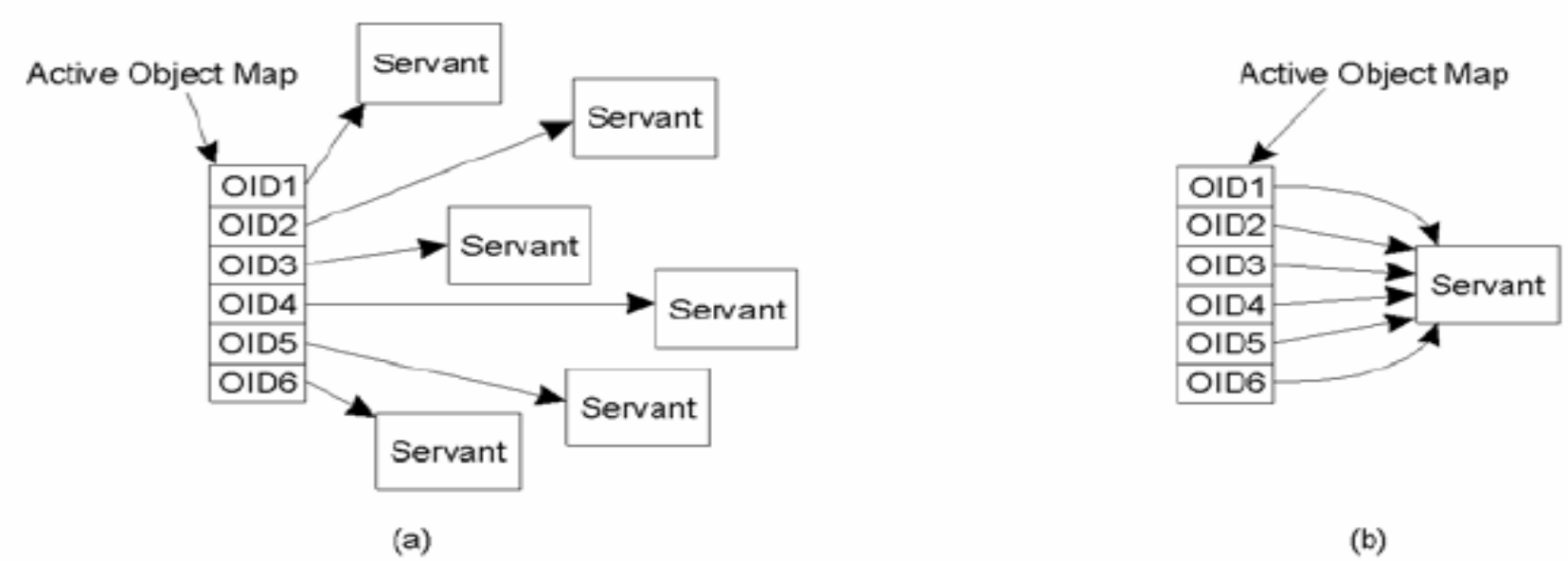
Partea I – CORBA – ORB



POA Architecture

- **A typical example of the relationship between POA and servants**

Different Approaches for POA



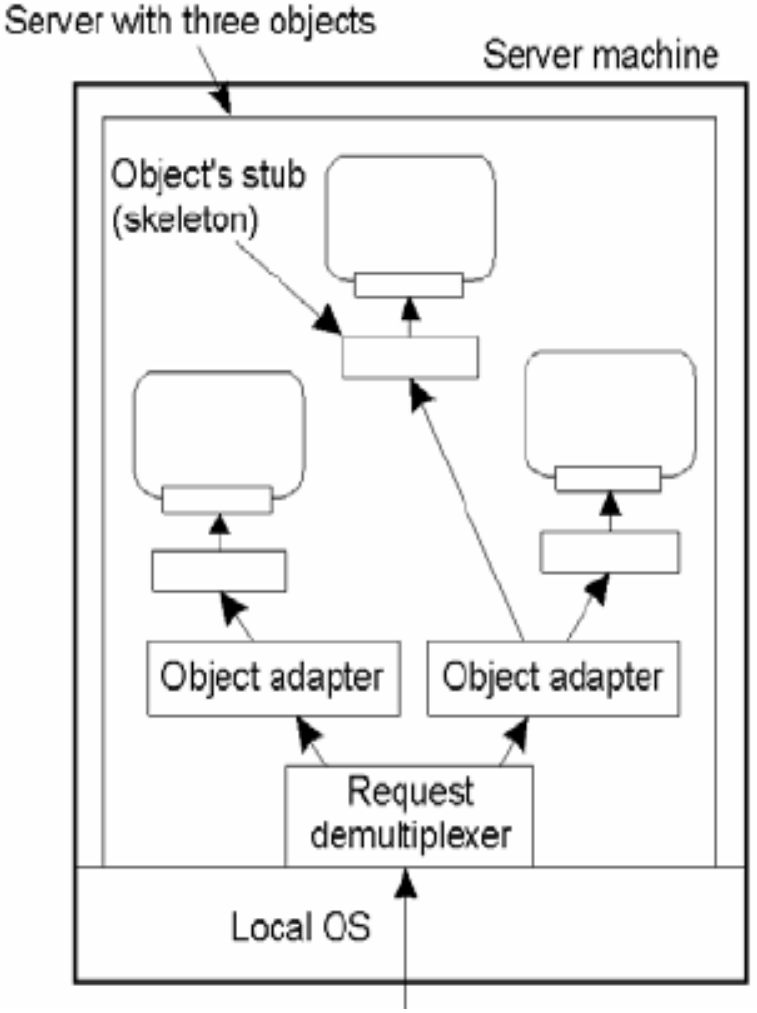
Mapping of CORBA object identifiers to servants of the same class

a) The POA supports multiple servants.

b) The POA supports a single servant.

Object adaptor for implementing a specific activation policy

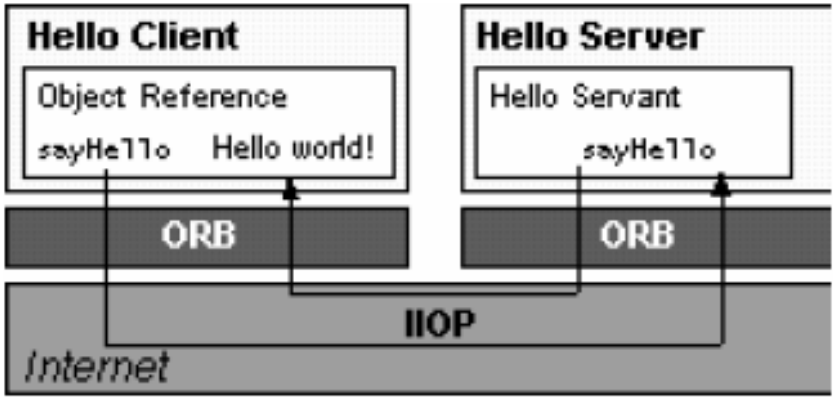
- An object adaptor may be responsible for one or more objects
- Object adaptor is not aware of interfaces implemented on the object it controls
- Object skeleton provides invoke() function for the adaptor to call and pass the message the adaptor receives
- Skeleton does marshall and unmarshall



Partea I – CORBA use IDL for independency

- Interface Definition Language
- Defines protocol to access objects
- Like a contract
- Well-specified
- Language-independent

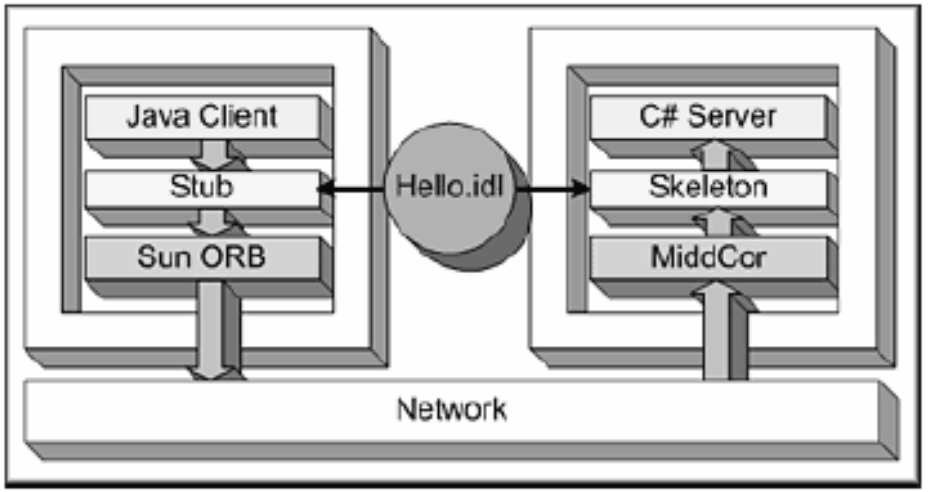
Partea I – CORBA use IDL for independency



From: http://java.sun.com/docs/books/tutorial/idl/hello/index.html

Hello.idl

```
interface Hello {
    string sayHello();
};
```



From: http://www.molecular.com/news/recent_articles/051904_javaworld.aspx

Partea I – CORBA use IDL for independency

```
//IDL Sample:
module Calc {
   interface Adder {
      long add(in long x, in long y);
   }
}
```

- Defines an class called Adder which generates objects with a method called “add”

IDL vs. Java vs. C++ concepts

IDL	Java	C++
module	package	namespace
interface	interface	abstract class
operation	method	member function
attribute	pair of methods	pair of functions

Partea I – CORBA use IDL for independency

IDL Modules

- **Map to Java packages**
- **Unfortunately, it has the root level name of the module**
- **Clutters up your package hierarchy**

IDL Interfaces

- **Map to Java interfaces**

IDL Operations

- **Map to Java methods**

IDL Attributes

- Map to pair of functions – like C# do
- IDL
  - `string name;`
- Java
  - `public void name(String val);`
  - `public String name();`

CORBA Services

- APIs for low-level, common tasks
- Life Cycle Service
  - creating, copying, moving, removing objects
- Naming Service
  - Register objects with a name
  - Look up objects by name

Partea I – CORBA Services

- Concurrency Control Service
  - Obtain and release exclusive locks
- Transaction Service
  - Two-phase commit coordination
  - Supports nested transactions
- Persistence Service
  - Storing objects in a variety of databases
  - RDBMS, OODBMS, file systems
- Security Service
  - Authentication, ACLs, encryption, etc.
- Event Service
  - Uncoupled notifications

Partea I – CORBA Services

- Relationship
- Externalization
- Query
- Licensing
- Properties
- Time
- Trader
- Collection
- … and so on…
- See what means about CORBA will be never being implemented?

Remember!

- CORBA is a standard by OMG, not an implementation.
- There are many implementations in Java and C/C++:
  - SUN JDK – Java 2 ORB
  - VisiBroker for Java or for C++
  - Orbacus
  - Orbix
  - Visigenic(freely available),
- Depending on the particular CORBA implementation, nonstandardized aspects may be different.

Partea I – SUN Java IDL

- Should be named “Java CORBA”
  - More than just IDL
  - Full (?) implementation of CORBA in 100% Java
- SUN Java IDL has 3 Parts – NOW, DEPRECATED:
  - ORB
  - Naming Service – COS – CORBA Object Service: tnameserv.exe (Non-persistent) & orbd.exe (Persistent)
  - idltojava & javatoidl compiler – now: idlj.exe
- Ships starting with JDK 1.2

The Java ORB

- 100% Java
- Generic
- Allows Java IDL applications to run either as stand-alone Java applications, or as applets within Java-enabled browsers
- Uses IIOP

The compiler: Transparent API

- JavaIDL turns IDL into direct method calls
- Easy to program
- Clients have no knowledge of implementation
- Highly portable

The compiler idlj: IDL to Java Mapping

- Defined by OMG and implemented here by SUN
- Translates IDL concepts into Java language constructs
- Everything is accessible by writing normal-looking Java code

The compiler idlj: IDL to Java Type Mapping

IDL Type	Java Type
boolean	boolean
char / wchar	char
octet	byte
short / unsigned short	short
long / unsigned long	int
long long / unsigned long long	long
float	float
double	double
string / wstring	String


The compiler: idlj or idltojava

- Development tool provided by SUN
- Automatically generates Java stubs, skeletons, helpers, holders, ... from IDL
- Generates stubs for specific remote interfaces

Stubs – Client Side

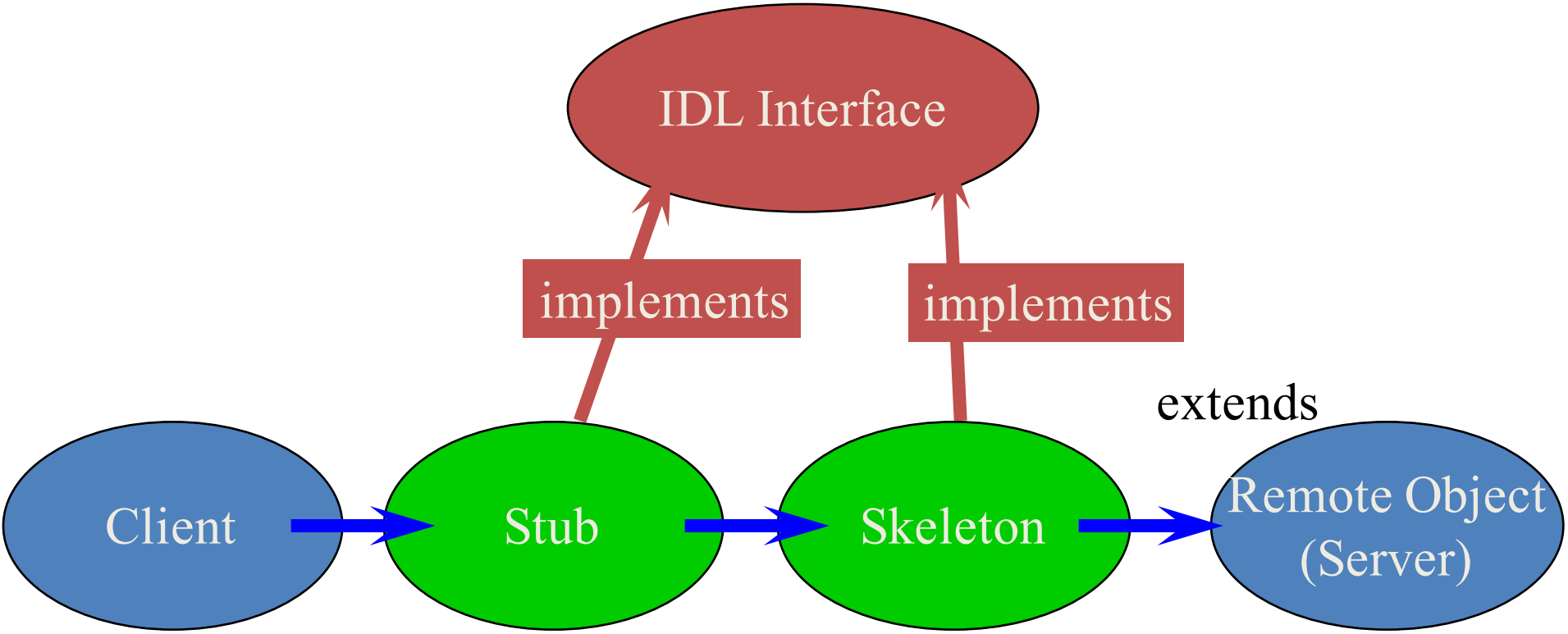
- Java objects call stub methods
- Stubs communicate with CORBA objects
  - and vice versa
- Transparent integration

Skeletons – Server Side

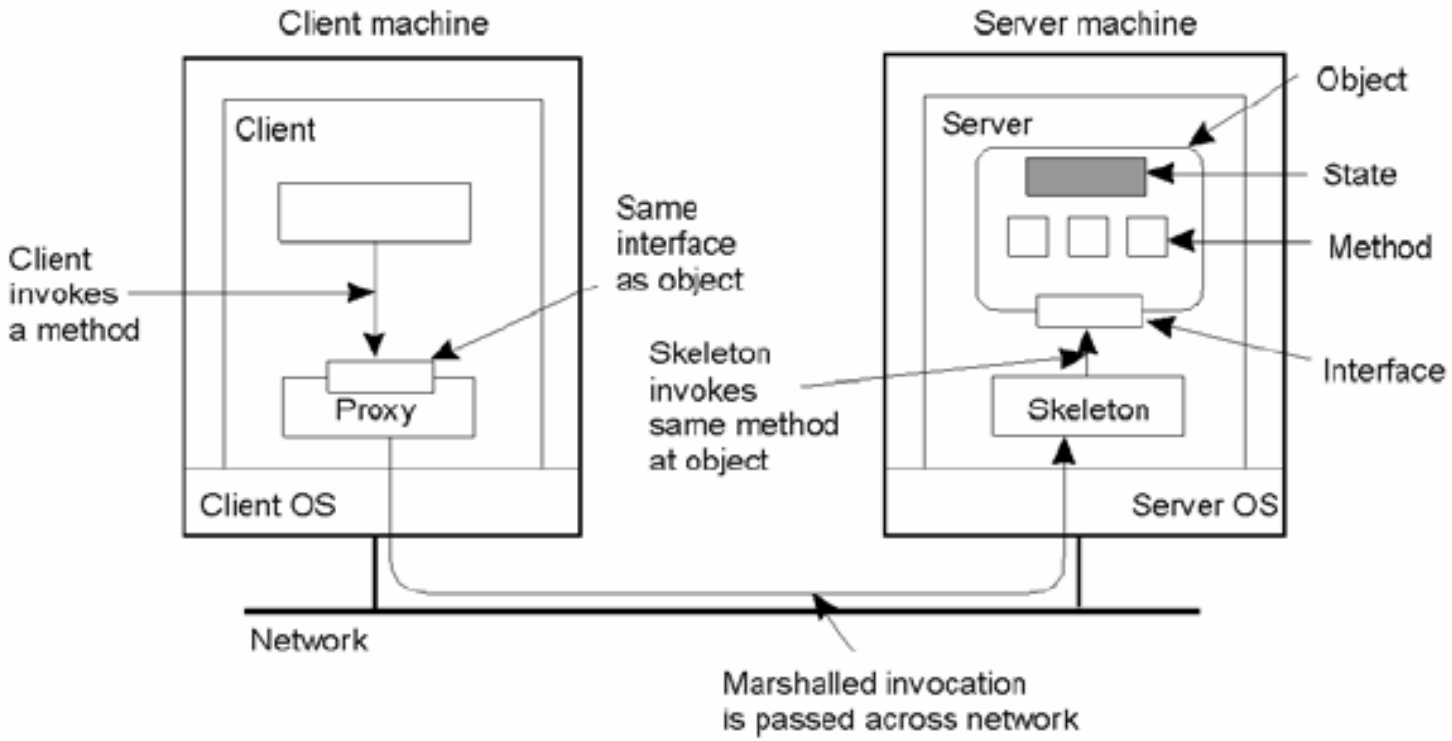
- ORB passes request to skeleton (like a stub)
- Skeleton calls local implementation

CORBA Server & Client

Remote Interfaces and Stubs



Partea I – CORBA vs RPC/RMI

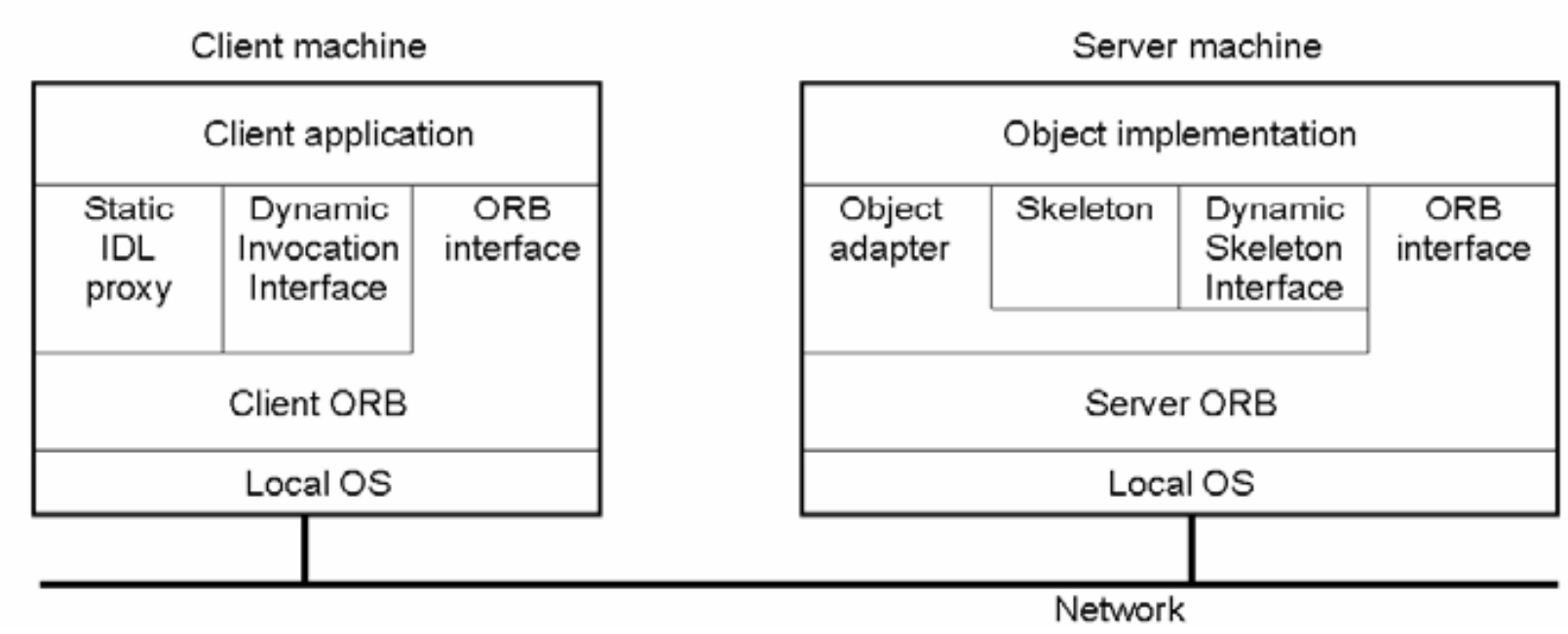


- Proxy is equivalent to client stub in RPC/RMI; it provides the same object interface as the server object
- Proxy marshalls method invocations into messages and unmarshall the reply messages
- Skeleton is like a server stub in RPC/RMI

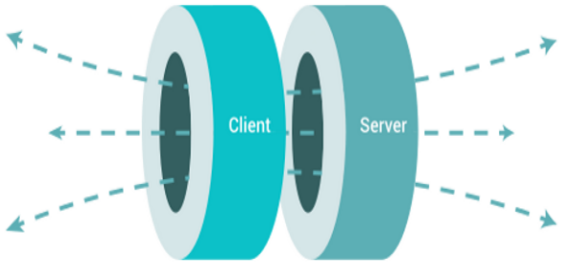
Partea I – CORBA Advanced Architecture

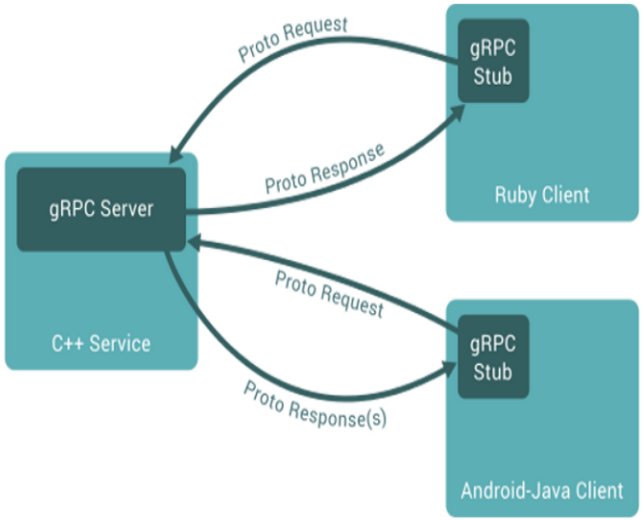
Object Model

- ORB provides few services through ORB interface
- Operations to marshall and unmarshall object references
- Getting object reference to an object implementing a specific CORBA service



Part I – Will be CORBA replaced by gRPC?





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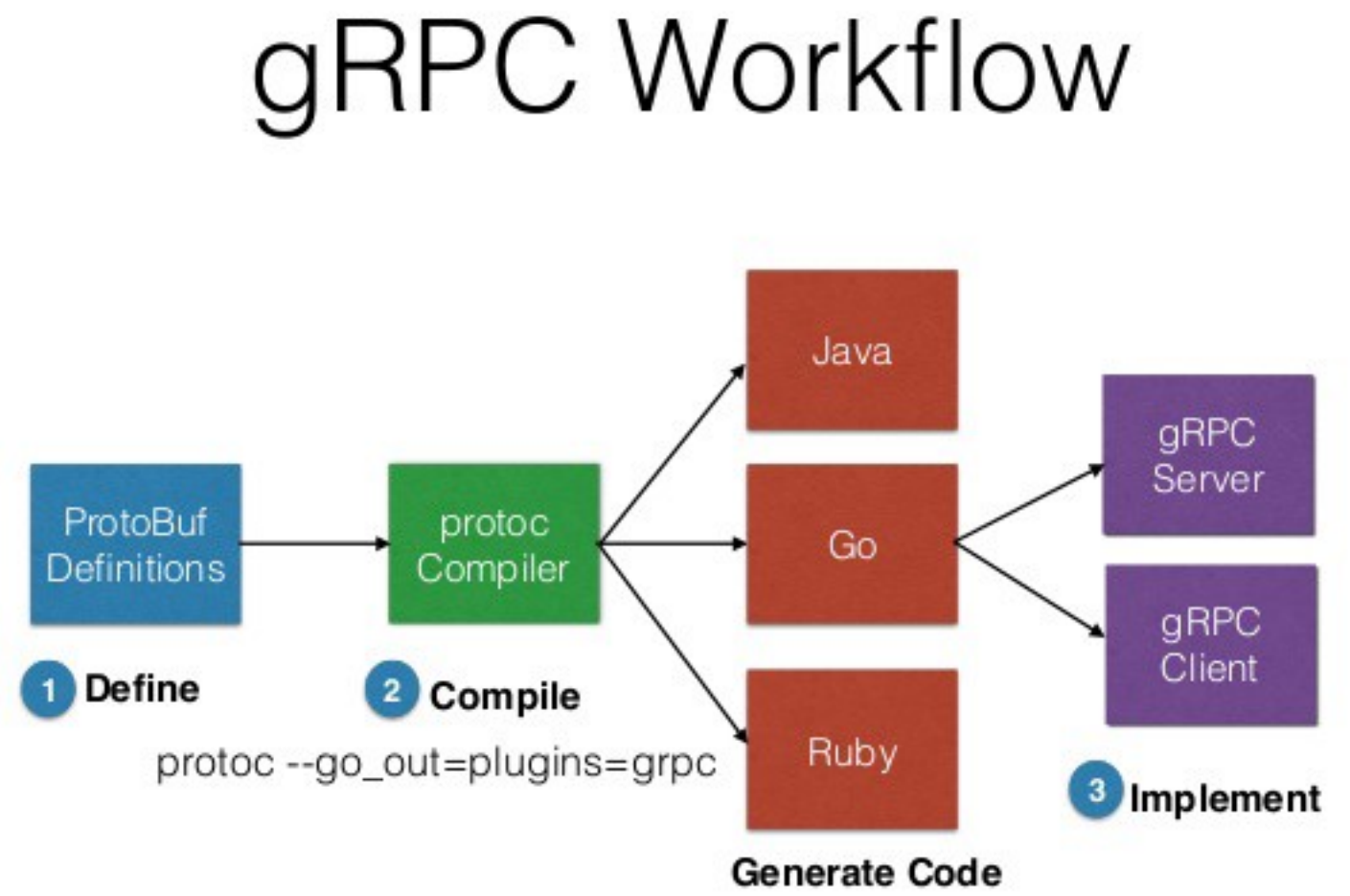

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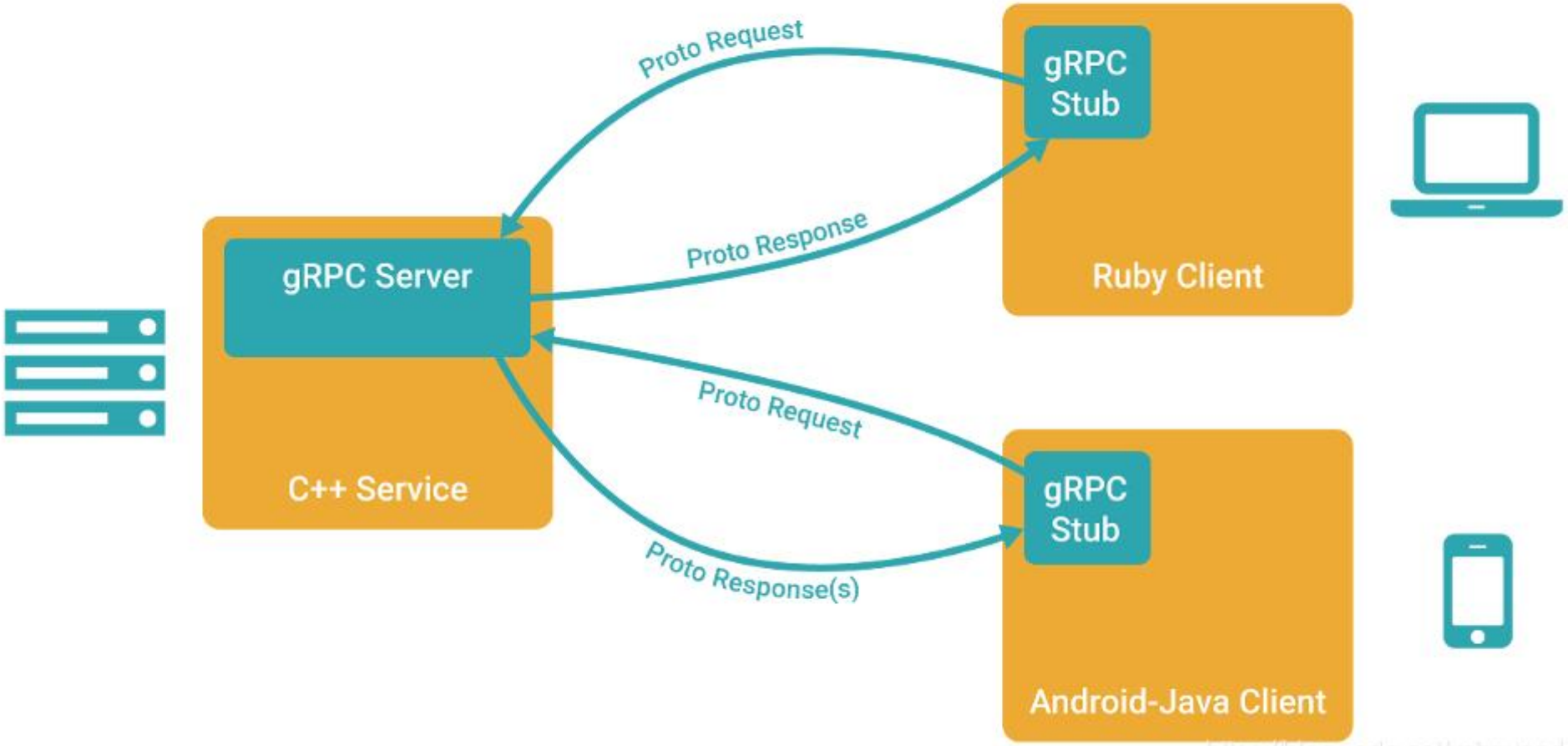
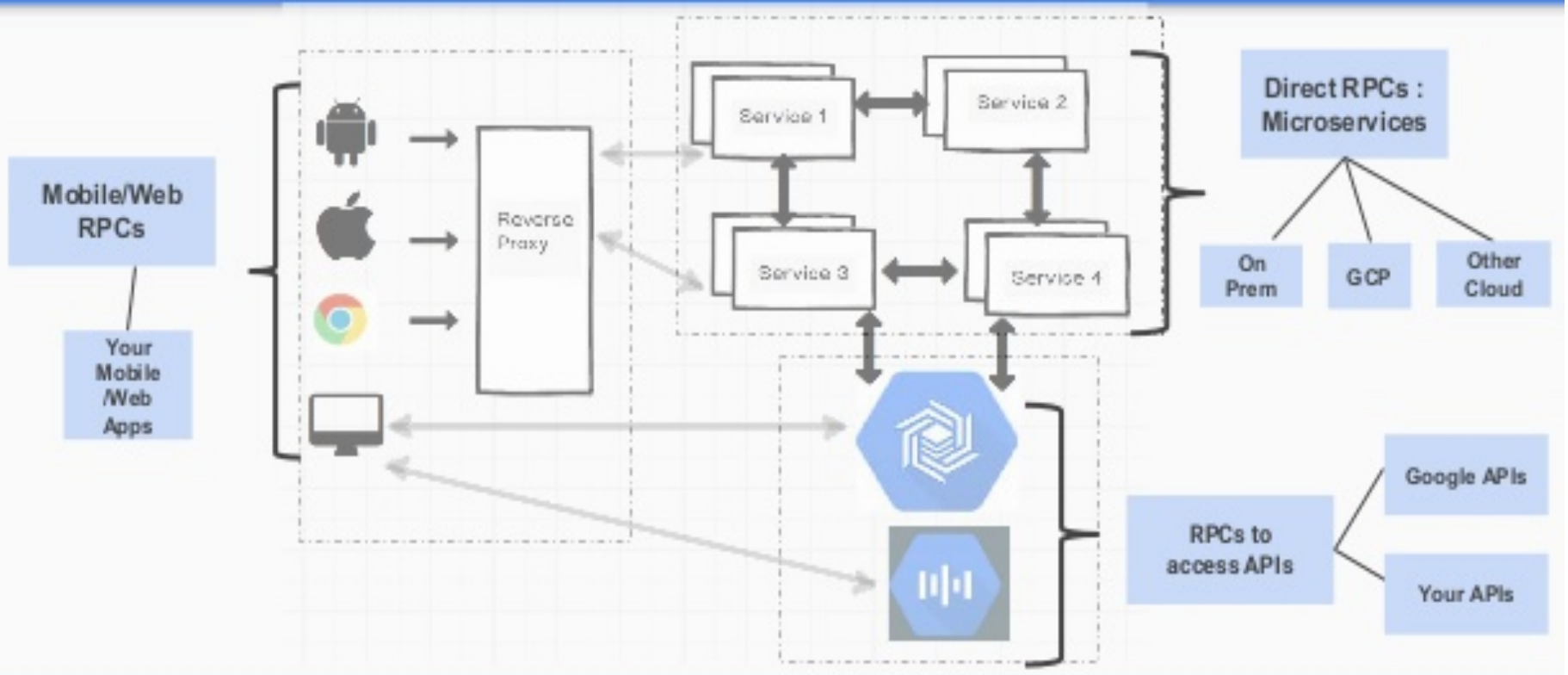


Part I – Will be CORBA replaced by gRPC?

How is gRPC Used?



Section Conclusion

Fact: **DAD core is based on RPC concept**

In few **samples** it is simple to remember: Java RMI Architecture with JRMP protocol analysis in real time plus the core actions for distributed computing and systems:

Picture processing within a RMI Cluster.

DAD Section 4 – Core Middleware Technologies for Distributed Computing / Distributed App Development

Java WS – Web Services

2. Java WS Overview

Java WS – Web Services

1. Web Service Overview
2. XML-RPC
3. Web Service WSDL
4. Web Service SOAP Req & Resp

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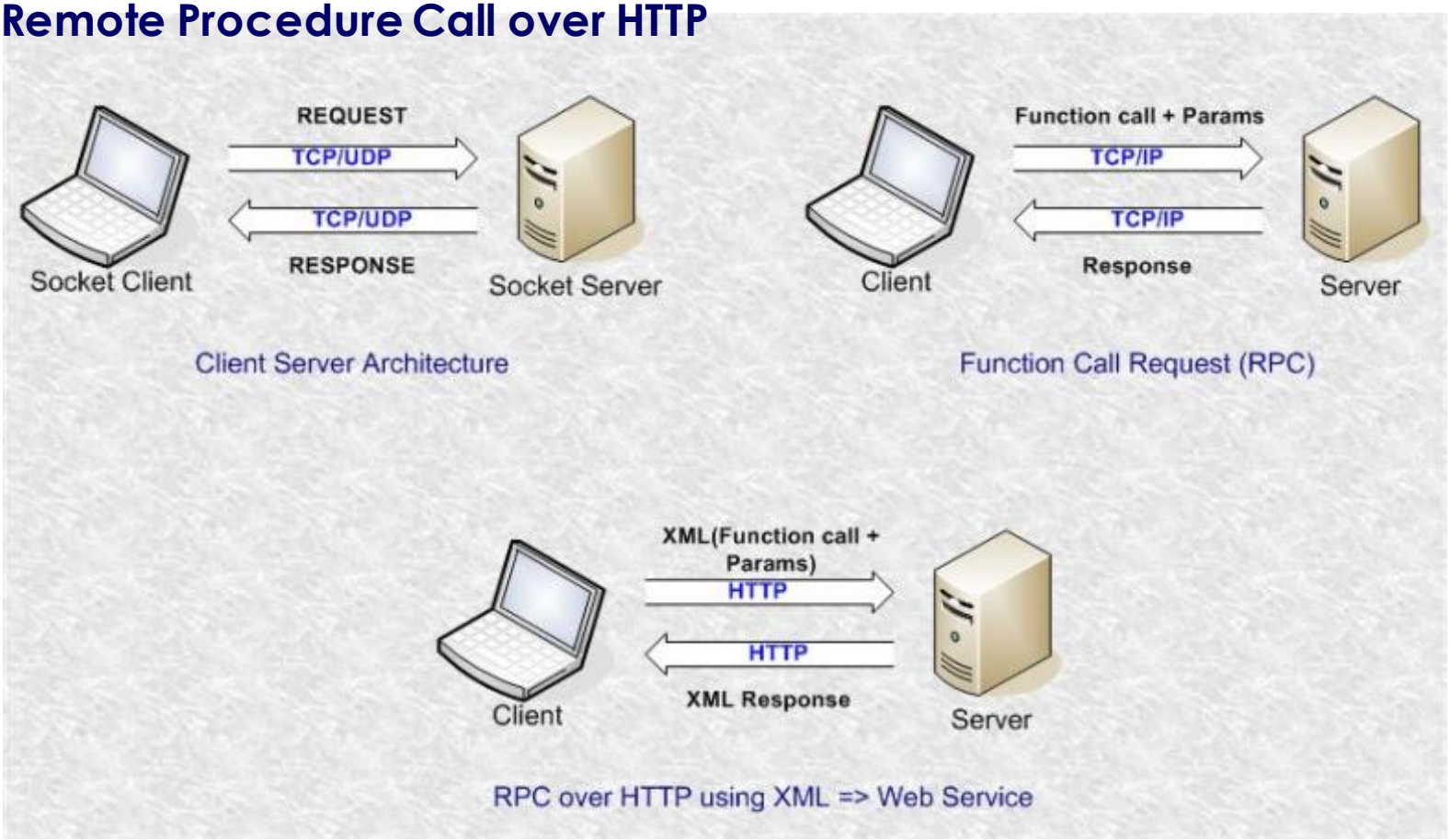
Partea II – Web Services Overview

- **"a software system designed to support interoperable Machine to Machine interaction over a network." (W3C)**
- **Remote Procedure Call over HTTP**



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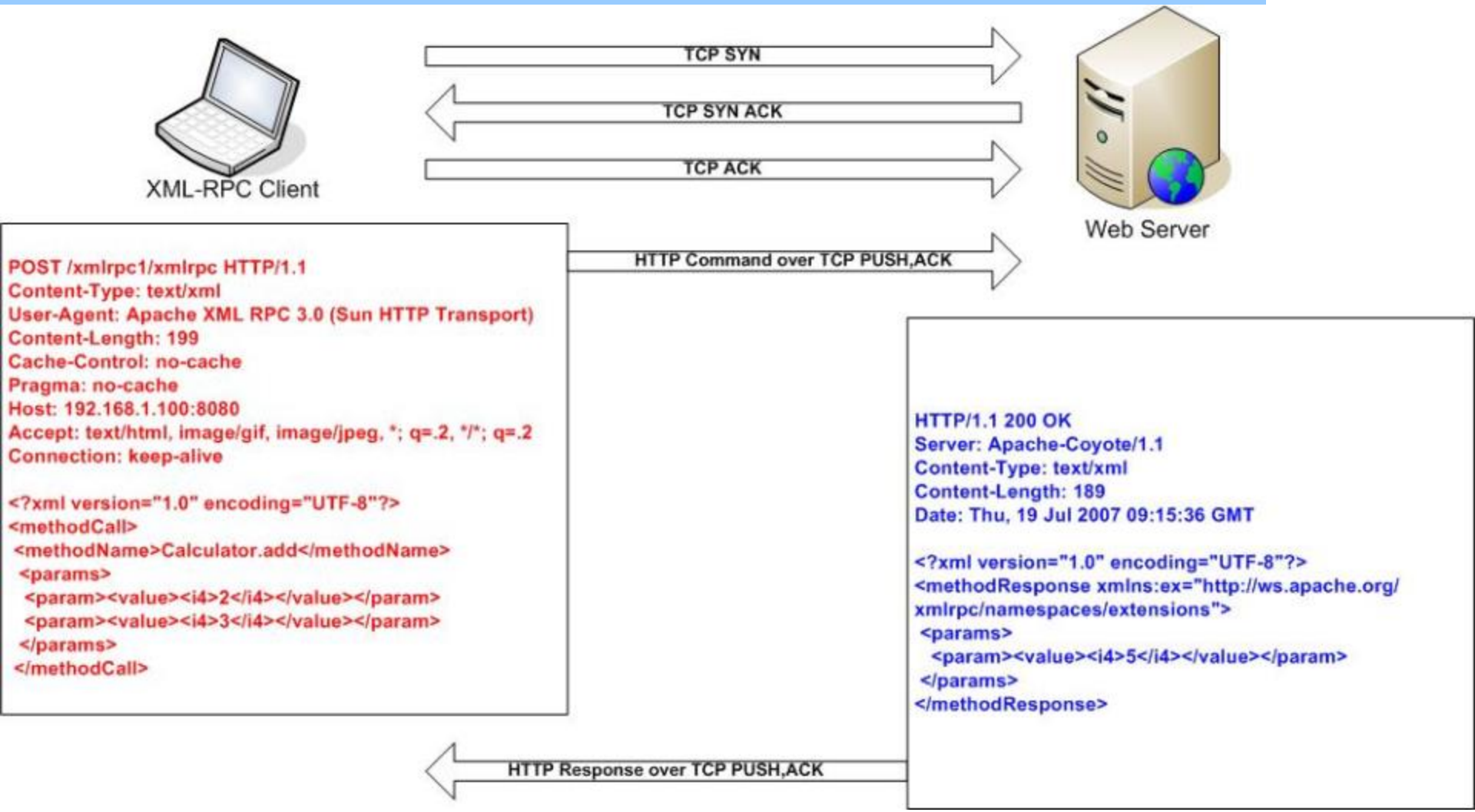
Partea II – Web Services – XML-RPC



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Partea II – Web Services – XML-RPC

- remote procedure calls using HTTP for transport and XML as encoding
- XML-RPC message is an HTTP-POST request
- very simple XML - doesn't use XML namespaces or attributes
- works only with HTTP

```
POST /XMLRPCServer/xmlrpc HTTP/1.1
Content-Type: text/xml
User-Agent: Apache XML RPC 3.0 (Jakarta Commons httpclient Transport)
Host: 192.168.1.103:8080
Content-Length: 199

<?xml version="1.0" encoding="UTF-8"?><methodCall><methodName>Calculator.add</
methodName><params><param><value><i4>2</i4></value></param><param><value><i4>3</i4></
value></param></params></methodCall>HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
X-Powered-By: Servlet 2.4; JBoss-4.2.2.GA (build: SVNTag=JBoss_4_2_2_GA
date=200710221139)/Tomcat-5.5
Content-Type: text/xml
Content-Length: 128
Date: Mon, 21 Jan 2008 21:46:57 GMT

<?xml version="1.0" encoding="UTF-8"?><methodResponse><params><param><value><i4>5</i4></
value></param></params></methodResponse>
```

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Partea II – Web Services – Products & WSDL

Web Services Products:

- **Apache AXIS2 for Java – course**
- **SUN Java-WS – integrated in NetBeans 6.0.1 – seminar**

WSDL Concept:

- **WSDL – Web Service Definition Language**
- **WSDL = XML document that describes a web service**
- **WSDL – Specifies the location of the service and the operations (or methods) it exposes**

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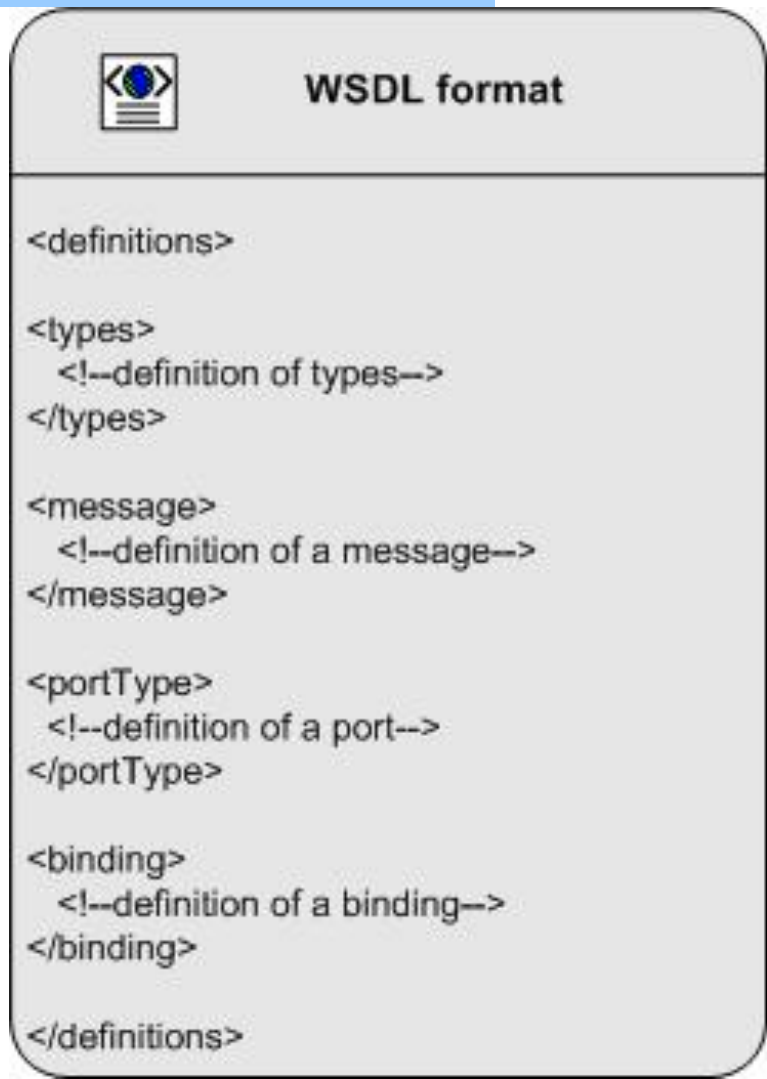
Partea II – Web Services – WSDL

A WSDL describes a web service using the following elements:

- **<binding> contains communication protocols used by the web service**
- **<portType> defines the operations that can be performed by a web service, and the messages that are involved**
- **<message> defines the in/out messages that are used by the operations ⇔ methods**
- **<types> defines data types used by the messages**

A WSDL document can also contain extension elements and a <service> element that makes it possible to group together the definitions of several web services .



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Partea II – Web Services – SOAP

- **SOAP – Simple Object Access Protocol**
- **simple XML based protocol to let applications exchange information over HTTP**
- **defines a format for sending messages**
- **allows you to get around firewalls (firewalls and proxy servers normally block RPC traffic)**
- **platform and language independent**
- **transport Protocols: TCP, HTTP, SMTP, and MQ – Message Queues**

Partea II – Web Services – SOAP

A SOAP message is an ordinary XML containing the following elements:

- **<Envelope> which identifies that the XML document is a SOAP message**
- **<Header> which contains application specific information about the SOAP message (such as authentication, payment, etc) .**
- **<Body> contains the actual SOAP message**
- **<Fault> contains eventual error messages**

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Partea II – Web Services – SOAP with Attachments

- **The SOAP messaging protocol allows you to send MIME attachments via SOAP messages. WSDL provides a description of these attachments.**

- **SOAP with Attachments API for Java (SAAJ) allows you to do XML messaging from the Java platform**

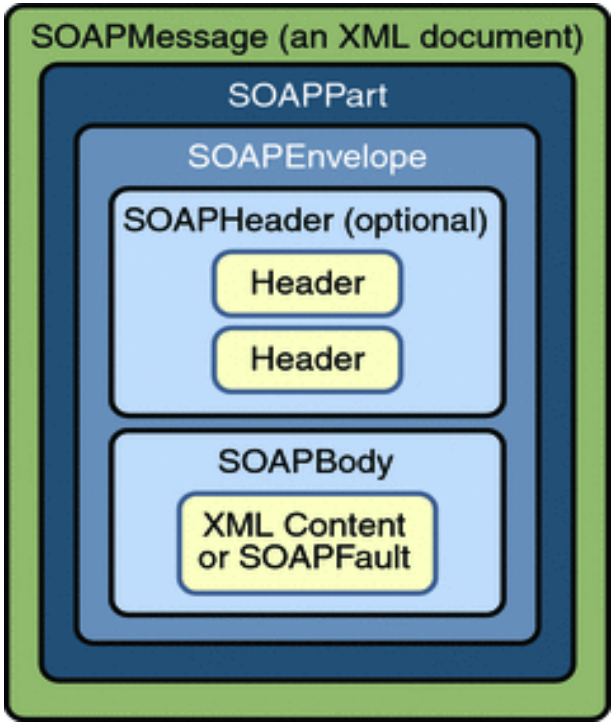
- **The SAAJ API conforms to the Simple Object Access Protocol (SOAP) 1.1 and 1.2 specifications and the SOAP with Attachments specification.**

Partea II – Web Services – SOAP with Attachments

- The SAAJ API provides the SOAPMessage class to represent a SOAP message.

- SAAJ API also provides the SOAPPart class that is the container for the SOAP-specific portion of a SOAPMessage object. All messages are required to have a SOAPPart.

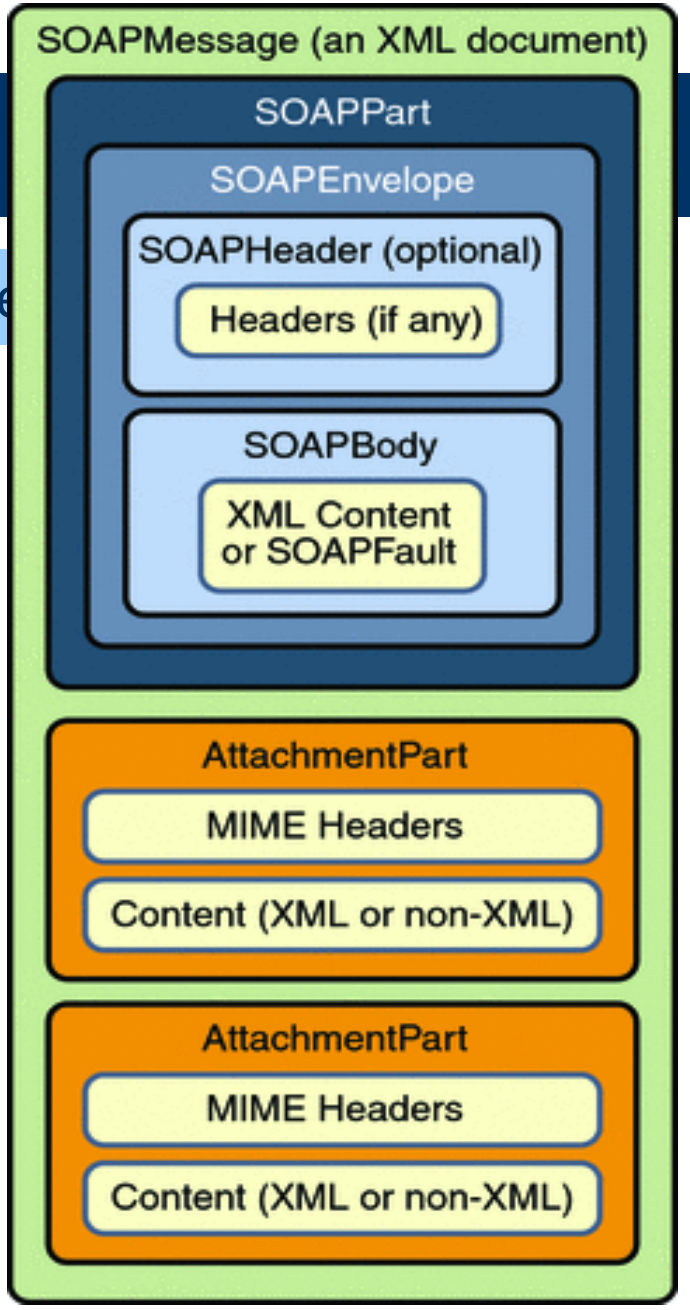
- A SOAPPart object is a MIME part and has the MIME headers Content-Id, Content-Location, and Content-Type



SOAP with no attachments

Partea II – Web Services – SOAP with Attachme

- A SOAP message may include one or more attachment parts in addition to the SOAP part.
- The SAAJ API provides the AttachmentPart class to represent an attachment part of a SOAP message.
- An attachment part can contain any kind of content.

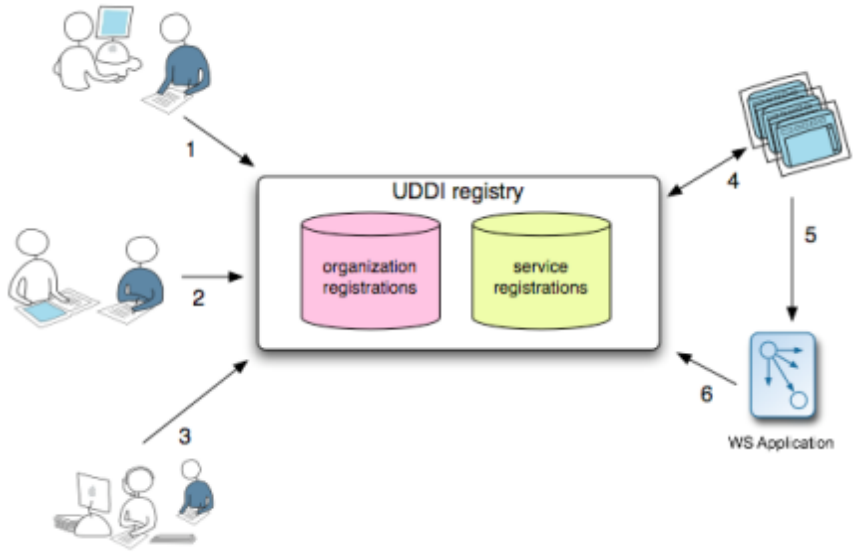


SOAP with two attachments

Curs 9

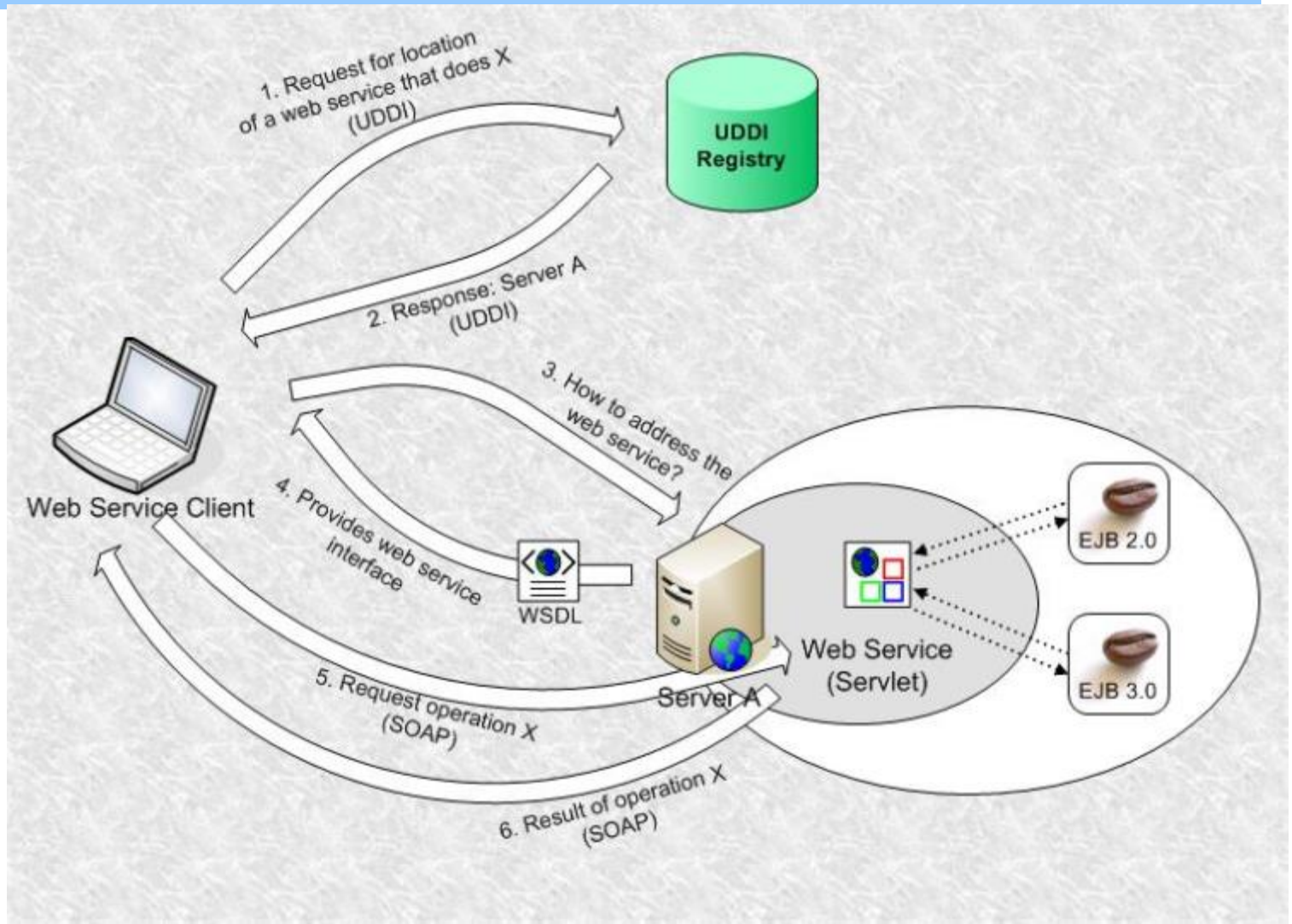
Partea II – Web Services - UDDI

- an XML-based registry for businesses worldwide to list themselves on the Internet.
- used in a similar manner to JNDI – to register and locate web services
- is a directory for storing information about web services
- is a directory of web service interfaces described by WSDL



Curs 9

Partea II – Web Services – A Java Architecture



Section Conclusions

Java WS – Web Services DEMO

REST-ful services and Micro-Services replace the SOA-Web-Services

Will be Internet 3.0 deployed for technologies which provide data & process migration?

Java WS DEMO
for easy sharing

Distributed Application Development

Communicate & Exchange Ideas

Questions & Answers!

But wait…

There's More!

Thanks!

DAD – Distributed Application Development
End of Lecture 9