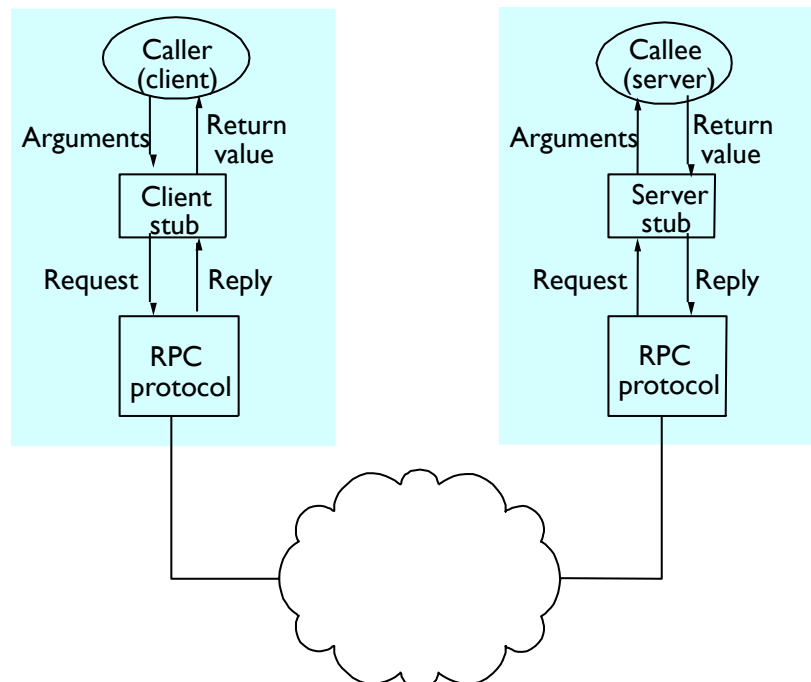


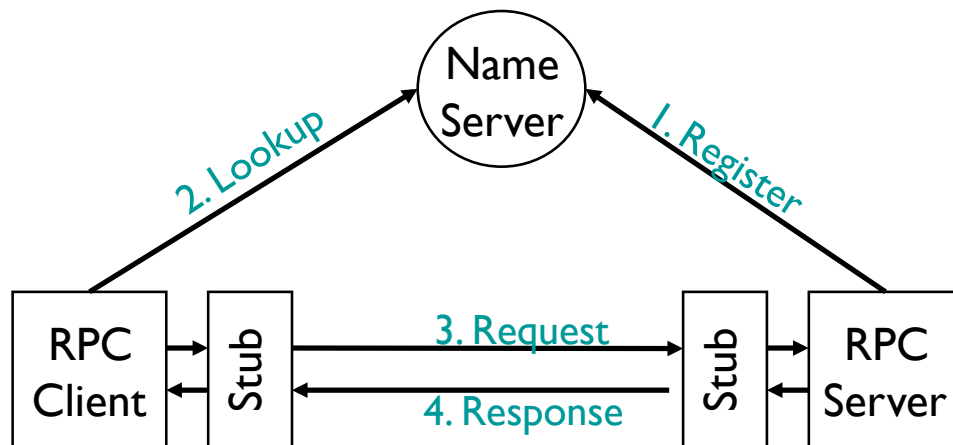
Remote Procedure Calls (RPCs)



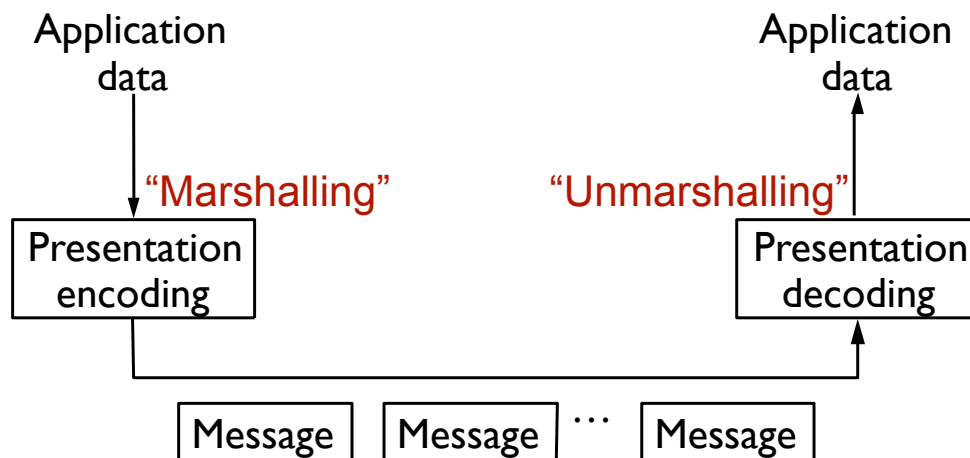
RPC Architecture Overview



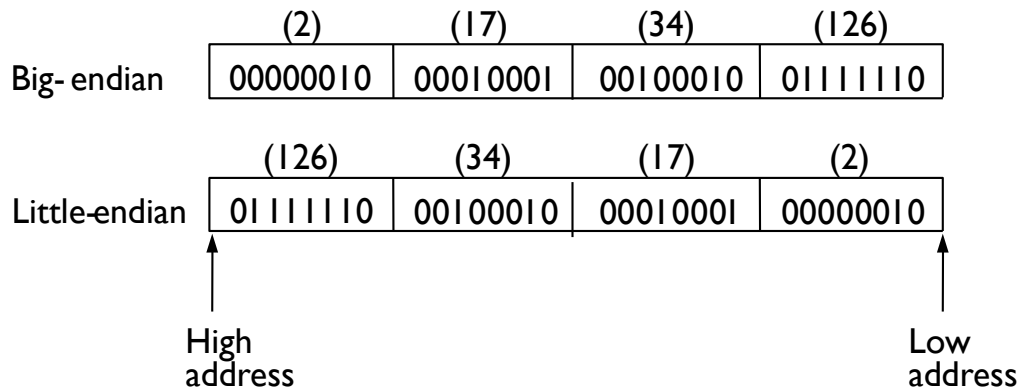
RPC Name Servers



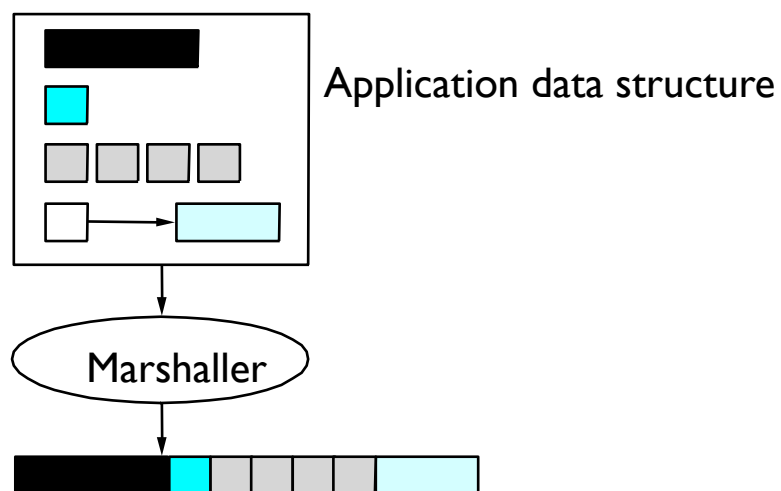
Stub Encoding/Decoding



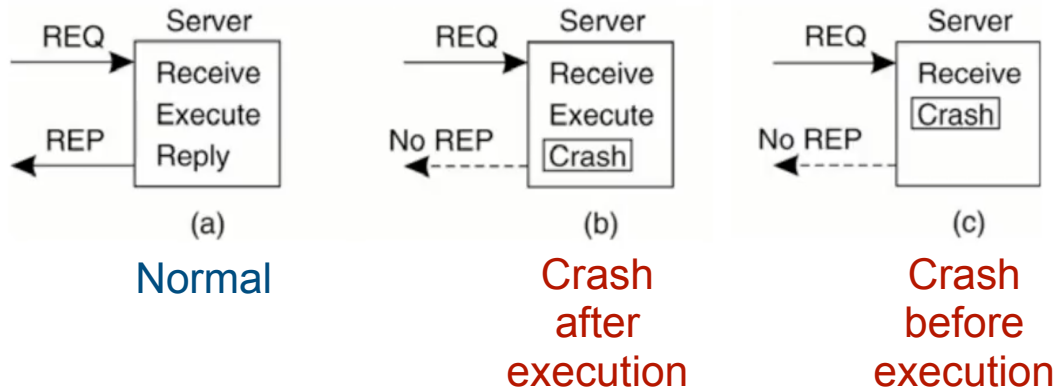
System Encodings



Converting Structures



Failures and RPC Semantics



XML-RPC

```
public Integer[] SumAndDifference(int x, int y) {  
    Integer[] array = new Integer[2];  
    array[0] = new Integer(x+y);  
    array[1] = new Integer(y-x);  
    return array;  
}
```

XML-RPC Request

```
POST /RPC2 HTTP/1.1
Content-Type: text/xml
User-Agent: XML-RPC.NET
Content-Length: 278
Expect: 100-continue
Connection: Keep-Alive
Host: localhost:8080
<?xml version="1.0"?>
<methodCall>
<methodName>SumAndDifference</methodName>
<params>
<param><value><i4>40</i4></value></param>
<param><value><i4>10</i4></value></param>
</params>
</methodCall>
```

XML-RPC Response

```
HTTP/1.1 200 OK
Date: Wed, 5 Mar 2014 21:52:34 GMT
Server: Microsoft-IIS/6.0
Content-Type: text/xml
Content-Length: 467
<?xml version="1.0"?>
<methodResponse>
<params><param>
<value><struct>
<member><name>sum</name><value><i4>50</i4></value></member>
<member><name>diff</name><value><i4>30</i4></value></member>
</struct></value>
</param></params>
</methodResponse>
```

XML-RPC Data Type Examples

```
<array>
  <data>
    <value><i4>12</i4></value>
    <value><string>Egypt</string></value>
    <value><boolean>0</boolean></value>
    <value><i4>-31</i4></value>
  </data>
</array>
```

XML-RPC Server Example (Java)

```
import org.apache.xmlrpc.webserver.WebServer;
import org.apache.xmlrpc.server.XmlRpcServer;
import org.apache.xmlrpc.server.PropertyHandlerMapping;
import org.apache.xmlrpc.XmlRpcException;

public class Server {
    public Integer[] SumAndDifference(int x, int y) {
        Integer[] array = new Integer[2];
        array[0] = new Integer(x+y);
        array[1] = new Integer(y-x);
        return array;
    }
    public static void main (String [] args) {
        try {
            PropertyHandlerMapping phm = new PropertyHandlerMapping();
            XmlRpcServer xmlRpcServer;
            WebServer server = new WebServer(8888);
            xmlRpcServer = server.getXmlRpcServer();
            phm.addHandler("sample", Server.class); // registering with name server
            xmlRpcServer.setHandlerMapping(phm);
            server.start();
        } catch (Exception exception) { System.err.println("Server: " + exception); }
    }
}
```

XML-RPC Client Example (Java)

```
import java.util.*;
import java.net.URL;
import org.apache.xmlrpc.*;
import org.apache.xmlrpc.client.XmlRpcClient;
import org.apache.xmlrpc.client.XmlRpcClientConfigImpl;

public class Client {
    public static void main (String [] args) {
        XmlRpcClientConfigImpl config = new XmlRpcClientConfigImpl();
        XmlRpcClient client=null;
        try {
            config.setServerURL(new URL("http://" + args[0] + ":" + 8888));
            client = new XmlRpcClient();
            client.setConfig(config);
        } catch (Exception e) { System.err.println("Problem! " + e); }

        Vector<Integer> params = new Vector<Integer>();
        params.addElement(new Integer(10));
        params.addElement(new Integer(40));

        try {
            Object[] result = (Object[])client.execute("sample.SumAndDifference", params.toArray());
            int sum = ((Integer) result[0]).intValue();    System.out.println("The sum is: " + sum);
            int diff = ((Integer) result[1]).intValue();    System.out.println("The difference is: " + diff);
        } catch (Exception exception) { System.err.println("Client: " + exception); }
    }
}
```

XML-RPC Client Example (Python)

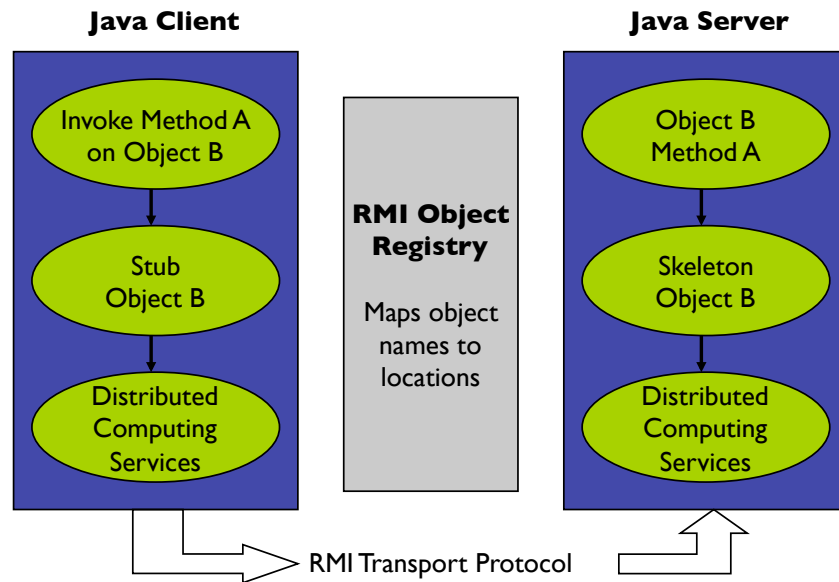
```
import xmlrpc.client

server = xmlrpc.client.Server("http://myserver:8888")

answer = server.sample.SumAndDifference(10, 40)

print("Sum:", answer[0])
print("Difference:", answer[1])
```

Java Remote Method Invocation (RMI)



RMI Example: Interface

```
import java.rmi.Remote;  
import java.rmi.RemoteException;  
  
public interface Hello extends Remote {  
    String sayHello() throws RemoteException;  
}
```

RMI Example: Server

```
import java.rmi.registry.Registry;
import java.rmi.registry.LocateRegistry;
import java.rmi.RemoteException;
import java.rmi.server.UnicastRemoteObject;

public class Server implements Hello {
    public Server() {}
    public String sayHello() { return "Hello, world!"; }
    public static void main(String args[]) {
        try {
            Server obj = new Server();
            Hello stub = (Hello) UnicastRemoteObject.exportObject(obj, 0);
            Registry registry = LocateRegistry.createRegistry(8888);
            registry.bind("Hello", stub);
        } catch (Exception e) { System.err.println("Server exception: " + e.toString()); }
    }
}
```

RMI Example: Client

```
import java.rmi.registry.LocateRegistry;
import java.rmi.registry.Registry;

public class Client {
    private Client() {}
    public static void main(String[] args) {
        String host = (args.length < 1) ? "localhost" : args[0];
        try {
            Registry registry = LocateRegistry.getRegistry(host, 8888);
            Hello stub = (Hello) registry.lookup("Hello");
            String response = stub.sayHello(); // RPC!
            System.out.println("response: " + response);
        } catch (Exception e) { System.err.println("Client exception: " + e.toString()); }
    }
}
```