Java RMI Tutorial

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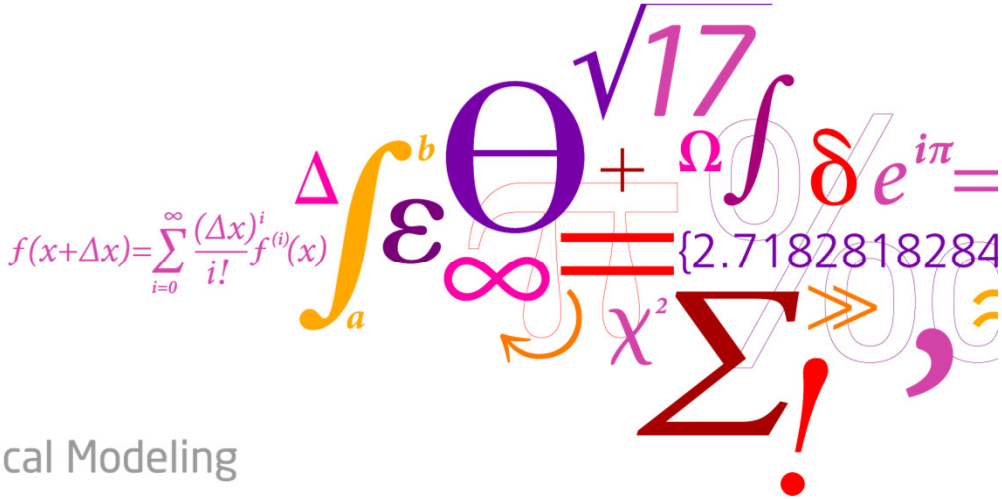

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Java RMI Concept

A way to invoke methods from a different address space, typically remotely but also locally.

Example

Local Machine (client)

```
RemoteObject remoteobject;
int sum;

sum = remoteobject.add(1,2);
```

1, 2

Remote Machine (server)

```
RemoteObject remoteobject;

Public int add(int a, int b){
        return a+b;
        }
```

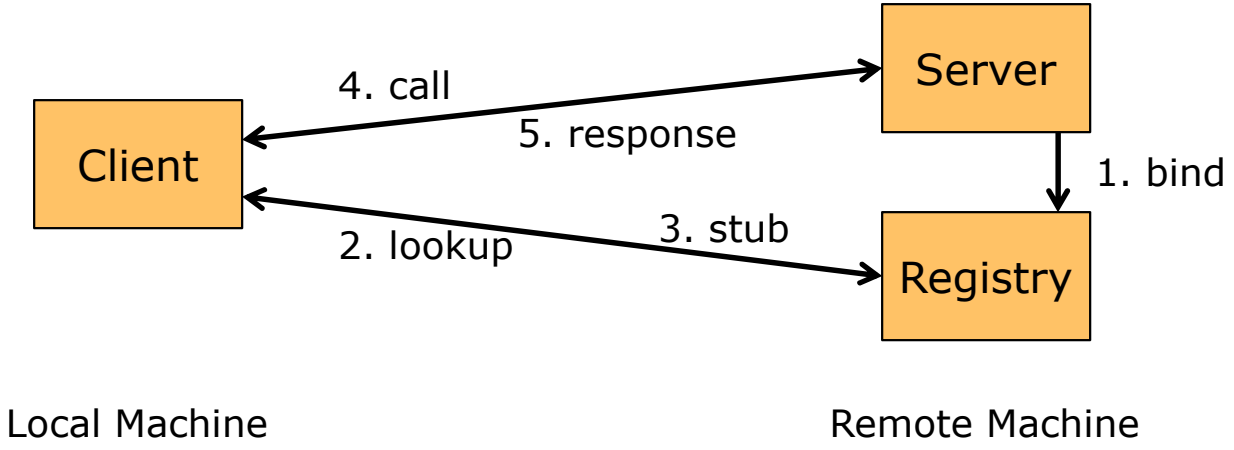
3

```
System.out.println(sum);
```

Java RMI Architecture

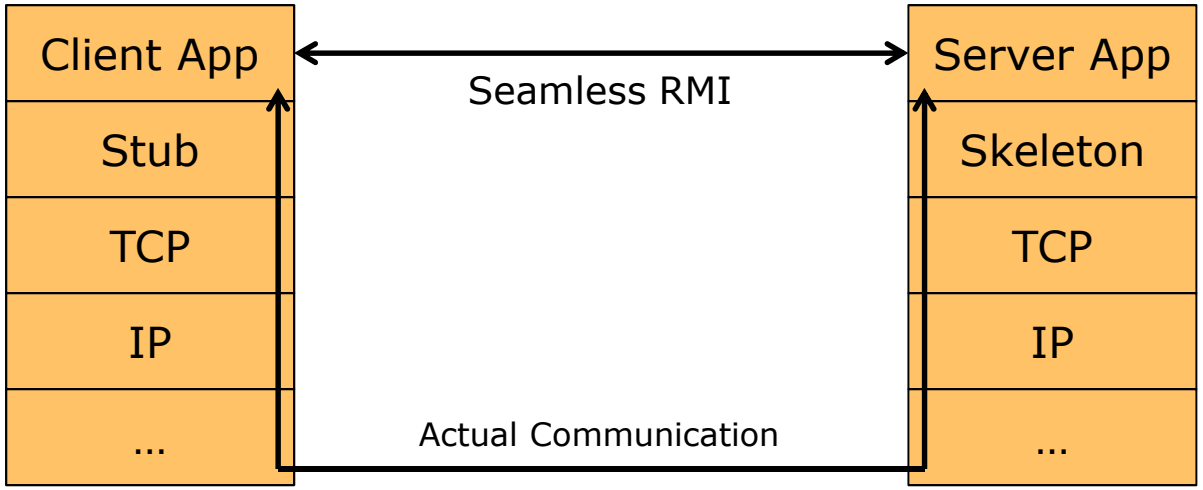
Basic components

- Client
  - Invokes a remote method on a remote object
- Server
  - Owns the remote objects and implements the remote methods
- Registry
  - Relates remote objects with names in plaintext



Java RMI in the TCP/IP Stack

- Middleware between transport and application layer
- Seamless to the programmer (remote object is handled as local object)
- Runs over TCP (reliable communication)



- Stub
  - Pretends to be the remote object
- Skeleton
  - Handles requests from stub / Talks to real remote object

Key Programming Elements

Classes, Interfaces & Methods

- *java.rmi.Remote*
  - Needs to be extended by the classes that contain RMI methods
- *java.rmi.registry.Registry*
  - Associates a name to a remote object
  - Key methods:
    - *bind(string,Remote)*
    - *lookup(string)*
- Static Methods
  - *LocateRegistry.getRegistry([string],[int])*
    - Static method to get the registry
  - *UnicastRemoteObject.exportObject(Remote,[int])*
    - Exports the remote object to JRE to receive remote calls

More in the java docs under the "*java.rmi.**" packages!

Developing an Java RMI System

Implement

- Step 1: Define the interface of the remote object
- Step 2: Implement the server including the remote object
- Step 3: Implement the client

Compile

- Step 4: Compile source files normally

Run

- Step 5: Run *rmiregistry*
- Step 6: Run server
- Step 7: Run client

Step 1: Remote Object Interface

```
import java.rmi.Remote;
import java.rmi.RemoteException;

public interface Hello extends Remote {
        String sayHello() throws RemoteException;
}
```

- It defines the remote object and the input/output of the remote methods
- It needs to extend "java.rmi.Remote" class

Step 2: Implement the Server (pt.1)

```
public class Server implements Hello {

        public Server() {}
        public String sayHello() {
                return "Hello, world!";    }
        public static void main(String args[]) {...        }
}
```

- The Server needs to implement the methods defined in the interface

Step 2: Implement the Server (pt.2)

```
import java.rmi.server.UnicastRemoteObject;
…
public static void main(String args[]) {
        …
        Server obj = new Server();
        Hello stub = (Hello) UnicastRemoteObject.exportObject(obj, 0);
        …
}
```

- The remote object must be *exported* to the Java RMI runtime so that it may receive incoming remote calls
- Method *exportObject* takes care of the Server socket
- Second argument defines the *port* number (optional)
  - *0* for letting the OS choose the port

Step 2: Implement the Server (pt.3)

```
import java.rmi.registry.Registry;
import java.rmi.registry.LocateRegistry;
…
public static void main(String args[]) {
        …
        Registry registry = LocateRegistry.getRegistry();
        registry.bind("Hello", stub);
        …
}
```

- Locate and get the name registry
  - Registry by default operates on port 1099
  - Unless another ip/port is specified in the arguments of *getRegistry*, it looks for the registry on *localhost (127.0.0.1)* in the default port *(1099)*
- Method *bind* registers the remote object (*stub*) with a name in plaintext

Step 3: Implement the Client

```
import java.rmi.registry.Registry;
import java.rmi.registry.LocateRegistry;
…
public static void main(String args[]) {
        …
        Registry registry = LocateRegistry.getRegistry(host);
        Hello stub = (Hello) registry.lookup("Hello");
        String response = stub.sayHello();
        …
}
```

- Locate and get the name registry
- Retrieve the remote object using its plaintext name (method *lookup*)
- Invoke the remote methods

Steps 4-7: Compile and Run

- Compile normally

  > *javac Hello.java Server.java Client.java*

- Run registry

  > *rmiregistry* *[runs on default port 1099]*

  > *rmiregistry 2001* *[runs on chosen port, 2001]*

- Run server

  > *java -Djava.rmi.server.codebase=[url]/ Server*

- Run client

  > *java -Djava.rmi.server.codebase=[url]/ Client*

The *java.rmi.server.codebase* property specifies the location, a codebase **URL**, from which the definitions for classes originating *from* this server can be downloaded.

If the classes are in the local file system use the file URL scheme (e.g. *file:/%CD%/* for Windows*)*.

References

Example is based on “Getting Started Using Java™ RMI” by Oracle

http://docs.oracle.com/javase/6/docs/technotes/guides/rmi/hello/hello-world.html

Bonus slide: Technology Typical Uses

- TCP
  - Used when there is a flow of multiple data packets that need reliability, in order delivery, flow/congestion control
    - Examples: HTTP, FTP, POP3, SMTP, IMAP, SSH
- UDP
  - Used when the application needs low delays but can tolerate some packet loss
    - Example: Streaming audio / video
  - Used when the blocks of transferred data are independent and fit in one packet
    - Example: DNS
- RMI
  - Used when a server needs to provide a remote interface for a local database
  - Used for intensive computational tasks