Distributed Objects

Request-Response

- A message exchange pattern
  - Knock-Knock Protocol.
  - High-Low Guess (HW #1)
    - HTTP
- Synchronous communication
- Advantage: Simple. Easy to detect problems.
- Disadvantage: Less throughput because client waits

Remote Procedure Call

- Causing a subroutine to execute in another process (maybe on another computer)

- Implemented as a request-response protocol

- To the programmer an RPC looks like a local procedure call.

  - There is some additional overhead

    - Server has to publish the remote object

    - Client has to obtain a reference to the remote object

Java RMI
Remote Method Invocation

- Source: https://docs.oracle.com/javase/tutorial/rmi/

RMI Overview

- Client-server model using distributed objects
- Objects can be in another JVM
    - Why? Share resources. Load balance.
- Any Java object can be passed as a parameter or return type
- Server
    - Creates remote objects
    - Makes references to remote objects available
- Client
    - Gets references to remote objects
    - Calls methods on remote objects

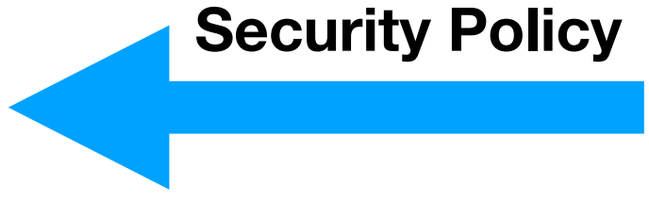
java.rmi.Naming

- Provides methods for getting/setting references to remote objects in a remote object registry
    - A name server for remote Java objects
- Methods
    - void bind(String name, Remote obj)
    - String[] list()
    - Remote lookup(String name)
    - void rebind(String name, Remote obj)
    - void unbind(String name)

RMI Example

Directory Structure

[project home]/
app.policy
build.xml
build/
myrmi/
***.class**
src/
myrmi/
***.java**



Note: the directory structure matches the package naming.

Hello Interface

```
package myrmi;

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

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

Server 1 of 2

```
package myrmi;

import java.rmi.Naming;
import java.rmi.RemoteException;
import java.rmi.server.UnicastRemoteObject;

public class Server extends UnicastRemoteObject implements Hello {

    public Server() throws RemoteException {
    }

    @Override
    public String sayHello(String name) throws RemoteException {
        if (name == null) {
            name = "world";
        }

        return "Hello, " + name;
    }
```

Server 2 of 2

```
public static void main(String[] args) {
    if (System.getSecurityManager() == null) {
        System.setSecurityManager(new SecurityManager());
    }
        try {
            Hello obj = new Server();
            Naming.rebind(“Hello", obj);

            System.out.println("Server ready");
        } catch (Exception re) {
            re.printStackTrace();
        }
    }
}
```

Client

```
package myrmi;

import java.rmi.Naming;

public class Client {
    public static void main(String[] args) {
        // check for 1 command line argument
        String host = args[0];
        if (System.getSecurityManager() == null) {
            System.setSecurityManager(new SecurityManager());
        }

        try {
            String url = "rmi://" + host + "/Hello";
            Hello stub = (Hello)Naming.lookup(url);

            System.out.println("response: " + stub.sayHello(null));
            System.out.println("response: " + stub.sayHello(“UND"));
        } catch (Exception e) {
            e.printStackTrace();
        }
    }
}
```

Match binding name

Security Policy

- The server and client have set a SecurityManager
- Requires a security policy file to grant security permissions
- Type following into app.policy

```
grant codeBase “file:<path to build directory>” {
    permission java.security.AllPermission;
};
```

Compile

$ cd [project home]
$ ant

or

$ java -d build src/myrmi/*.java

Start the RMI Registry

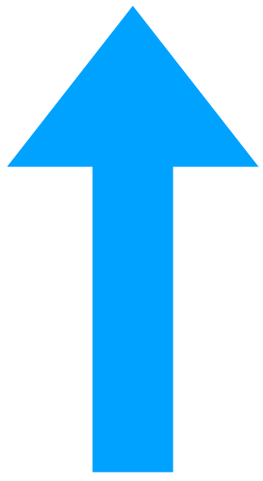
$ cd build

$ rmiregistry

Start the Server

$ cd [project home]

$ java -cp build -Djava.security.policy=app.policy myrmi.Server

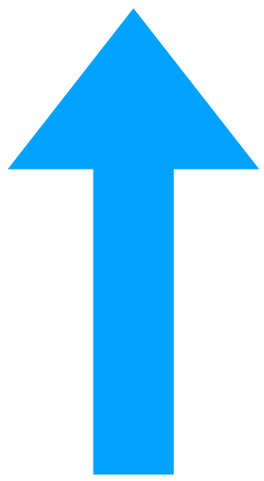


Did you create this file in the project directory?

Start the Client

$ cd [project home]

$ java -cp build -Djava.security.policy=app.policy myrmi.Client localhost



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