# Unit 5 :
# RMI

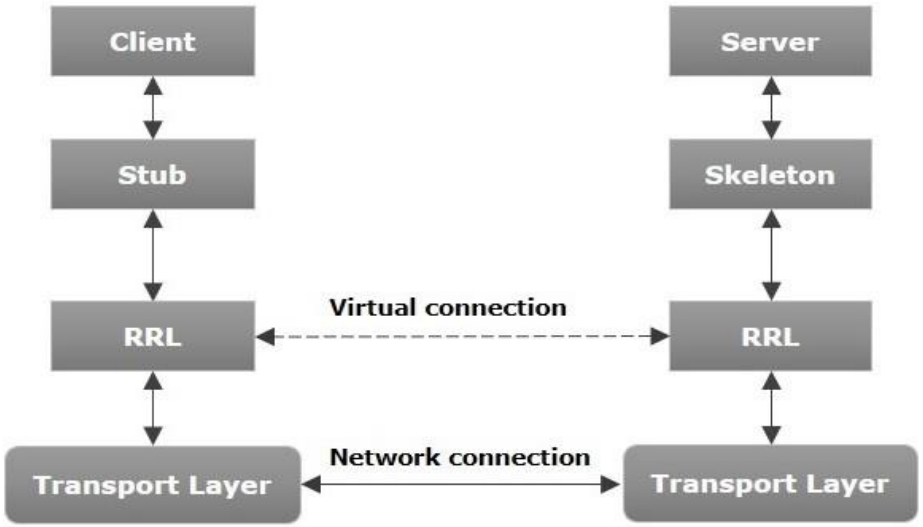
- RMI stands for **Remote Method Invocation**.
- It is a mechanism that allows an object residing in one system (JVM) to access/invoke an object running on another JVM.
- RMI is used to build distributed applications; it provides remote communication between Java programs.
- It is provided in the package **java.rmi**.

## RMI Architecture:

In an RMI application, we write two programs, a **server program** (resides on the server) and a **client program** (resides on the client).

- Inside the server program, a remote object is created, and reference of that object is made available for the client (using the registry).
- The client program requests the remote objects on the server and tries to invoke its methods.





**Transport Layer** :
This layer connects the client and the server. It manages the existing connection and also sets up new connections.

**Stub** :
Stub is a representation (proxy) of the remote object at client. It resides in the client system; it acts as a gateway for the client program.

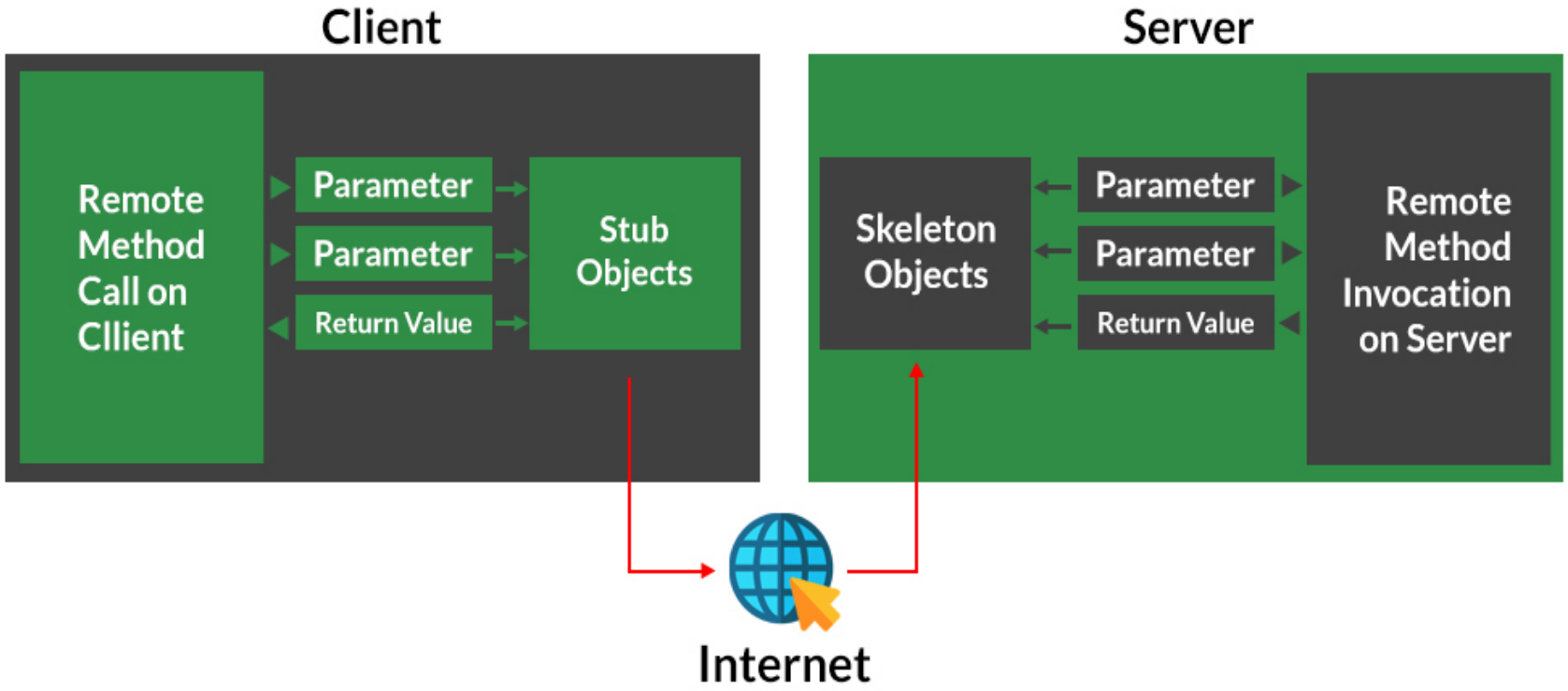
**Skeleton** :
This is the object which resides on the server side. **stub** communicates with this skeleton to pass request to the remote object.



**RRL(Remote Reference Layer)** :
- ❖ It will identify the type of server that is whether it's unicast or multicast.
- ❖ It is the layer which manages the references made by the client to the remote object.

**Working of RMI : (Roles of Client and Server)**

The communication between client and server is handled by using two intermediate objects: Stub object (on client side) and Skeleton object (on server-side) as also can be depicted from below media as follows:






**Server :**

- This is a program that typically creates a remote object to be used for method invocation.
- This object is an ordinary object except that its class implements a Java RMI interface.
- Upon creation, the object is exported and registered with a separate application called object registery.

**Client :**

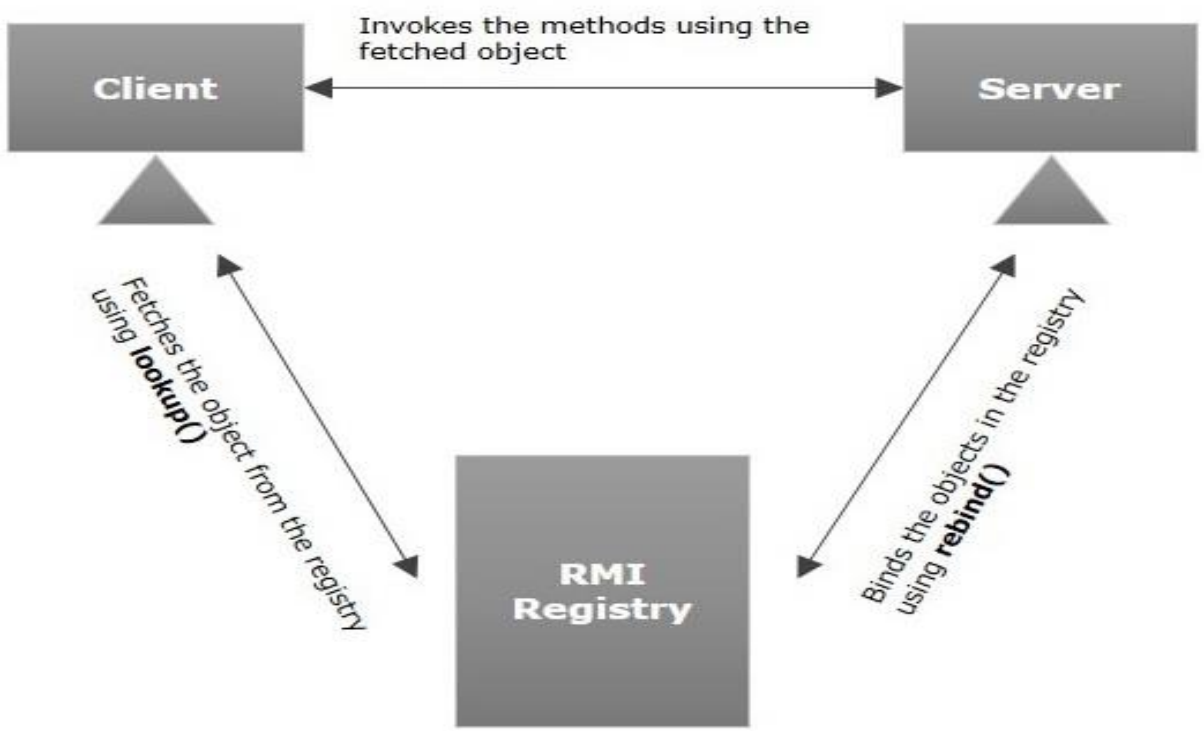
- A client program typically consults the object registery to get a reference (handle) to a remote object with a specific name.

**RMI Registry :**

- RMI registry is a namespace on which all server objects are placed. Each time the server creates an object, it registers this object with the RMIregistry (using **bind()** or **reBind()** methods). These are registered using a unique name known as **bind name**.
- To invoke a remote object, the client needs a reference of that object. At that time, the client fetches the object from the registry using its bind name (using **lookup()** method).



The following illustration explains the entire process:



Developing and running RMI applications involves the following steps: **(RMI Programming Model)**

1. Define the remote interface
2. Implement the remote interface
3. Develop the Server program
4. Develop the Client program
5. Compile the Java source files
6. Execute the application

**1. Define the remote interface :**



- A remote interface provides the description of all the methods of a particular remote object.
- The client communicates with this remote interface.

**To create a remote interface :**

- Create an interface that extends the predefined interface **Remote** which belongs to the package.
- Declare all the business methods that can be invoked by the client in this interface.
- Since there is a chance of network issues during remote calls, an exception named **RemoteException** may occur; throw it.

E.g.

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

public interface CalculatorInterface extends Remote {
public int addition(int num1, int num2) throws RemoteException;
public int multiplictaion(int num1, int num2) throws RemoteException;
public int division(int num1, int num2) throws RemoteException;
public int subtrction(int num1, int num2) throws RemoteException;
}
```

## 2. Implement the remote interface :

The Remote interface, we need to :

- ❖ Either extend the **UnicastRemoteObject** class,
- ❖ or use the exportObject() method of the **UnicastRemoteObject** class

*Note : In case, you extend the **UnicastRemoteObject** class, you must define a constructor that declares RemoteException.*

*E.g.*

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

public class SimpleCalculator extends UnicastRemoteObject implements CalculatorInterface {

 SimpleCalcultor() throws RemoteException {
super();
}
public int addition(int num1, int num2) throws RemoteException {
return num1+num2;
}

public int multiplictaion(int num1, int num2) throws RemoteException {
return num1*num2;
}

public int division(int num1, int num2) throws RemoteException {
return num1/num2;
}

public int subtrction(int num1, int num2) throws RemoteException {
return num1-num2;
}
}
```

**3. Develop the Server Program :**

- Create a remote object by instantiating the implementation class.
- The server program uses createRegistry method of LocateRegistry class to create rmiregistry within the server JVM with the port number passed as an argument.
- The rebind method of Naming class is used to bind the remote object to the new name.

E.g.

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

public class ServerProgram {

public static void main(String[] args) {
try {
SimpleCalculator  calculator = new SimpleCalculator();
LocateRegistry.createRegistry(1900);
Naming.rebind("rmi://localhost:1900/demo", calculator);
System.out.println("Server Started");
} catch (Exception e) {
e.printStackTrace();
}
}
}
```

## 4. Develop the Client Program :

- The lookup method of the Naming class is used to get the reference of the Stub object.
- The lookup method returns an object of type remote and cast it.
- Finally invoke the required method using the obtained remote object.

```
import java.rmi.Naming;
import java.util.Scanner;

public class ClientProgram {

		public static void main(String[] args) {
				try {
				 CalculatorInterface calculatorInterface =	(CalculatorInterface) Naming.lookup("rmi://localhost:1900/demo");
				Scanner scanner = new Scanner(System.in);
				System.out.println("Enter a first number : ");
				int num1 = scanner.nextInt();

				System.out.println("Enter a second number : ");
				int num2 = scanner.nextInt();
				int result1 = calculatorInterface.addition(num1, num2);
				System.out.println("the sum of "+num1+" , "+num2+" = "+result1);

				int result2 = calculatorInterface.multiplictaion(num1, num2);
				System.out.println("the multiplictaion of "+num1+" , "+num2+" = "+result2);

				int result3 = calculatorInterface.division(num1, num2);
				System.out.println("the division of "+num1+" , "+num2+" = "+result3);
				} catch (Exception e) {
						e.printStackTrace();
				}
		}
}
```

**5. Compile Application:**

To compile application :

- ❖ Compile the remote interface.
- ❖ Compile the implementation class.
- ❖ Compile the server program.
- ❖ Compile the client program.

E.g. javac *.java

**6. Execute the application**

**Step-1 :** Start rmi rmiregistry using the following command:
e.g. start rmiregistry

**Step-2** : Run the server class
e.g. java serverclassName

**Step-3** : Run the client class
e.g. java clientClassName

**Stubs and Parameter Marshalling :**

- Client makes procedure call (just like a local procedure call) to the client stub.
- Server is written as a standard procedure.
- Stubs take care of packaging arguments and sending messages.
- Packaging parameters is called **marshalling**

**The stub's job is to:**

- Marshall the parameters passed.
- Create an identifier of the remote object and method to be used.

**CORBA :**

- The Common Object Request Broker Architecture (CORBA) is a standard defined by the Object Management Group (OMG) that enables software components written in multiple computer languages and running on multiple computers to work together.
- CORBA is a standard for distributing objects across networks so that operations on those objects can be called remotely.
- CORBA is not associated with a particular programming language, and any language with a CORBA binding can be used to call and implement CORBA objects. Objects are described in a syntax called Interface Definition Language (IDL).



**CORBA includes four components:**

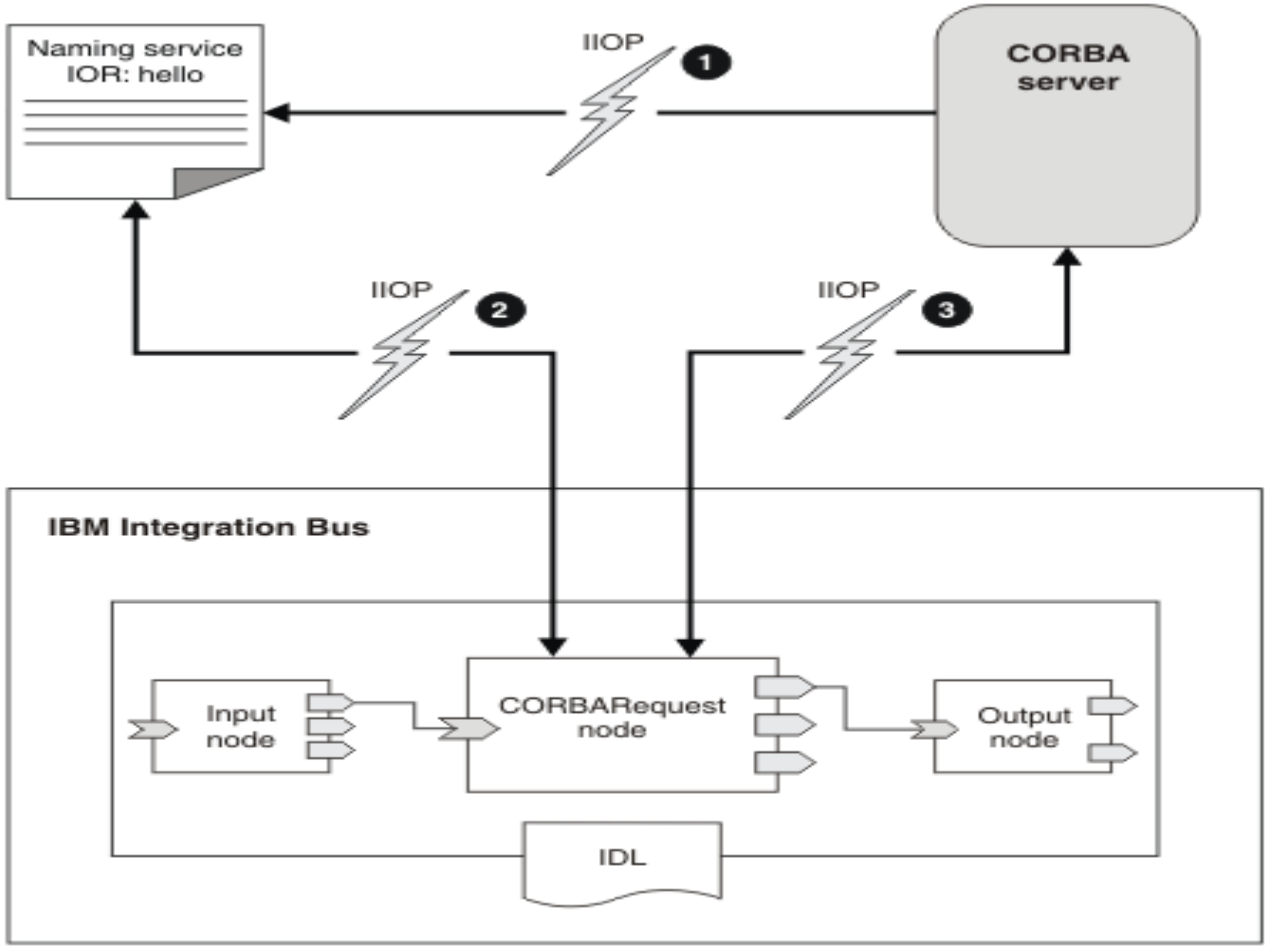
**1. Object Request Broker (ORB) :**
The Object Request Broker (ORB) handles the communication, marshaling, and unmarshaling of parameters so that the parameter handling is transparent for a CORBA server and client applications.

**2. CORBA server:**
The CORBA server creates CORBA objects and initializes them with an ORB. The server places references to the CORBA objects inside a naming service so that clients can access them.

**3. Naming service:**
The naming service holds references to CORBA objects.

**4. CORBARequest node:**
The CORBARequest node acts as a CORBA client.

The following diagram shows the layers of communication between IBM® Integration Bus and CORBA.




- Use CORBA nodes to connect IBM® Integration Bus with CORBA Internet Inter-Orb Protocol (IIOP) applications.
- Interface Definition Language(IDL)



**The diagram illustrates the following steps**.

1. CORBA server applications create CORBA objects and put object references in a naming service so that clients can call them.
2. At deployment time, the node contacts a naming service to get an object reference.
3. When a message arrives, the node uses the object reference to call an operation on an object in the CORBA server.

# Difference between RMI and CORBA :

| RMI | CORBA |
|---|---|
| RMI is a Java-specific technology. | CORBA has implementation for many languages. |
| It uses Java interface for implementation. | It uses Interface Definition Language (IDL) to separate interface from implementation. |
| RMI objects are garbage collected automatically. | CORBA objects are not garbage collected because it is language independent and some languages like C++ does not support garbage collection. |
| RMI programs can download new classes from remote JVM's. | CORBA does not support this code sharing mechanism. |
| RMI passes objects by remote reference or by value. | CORBA passes objects by reference. |
| Java RMI is a server-centric model. | CORBA is a peer-to-peer system. |
| RMI uses the Java Remote Method Protocol as its underlying remoting protocol. | CORBA use Internet Inter- ORB Protocol as its underlying remoting protocol. |
| The responsibility of locating an object implementation falls on JVM. | The responsibility of locating an object implementation falls on Object Adapter either Basic Object Adapter or Portable Object Adapter. |