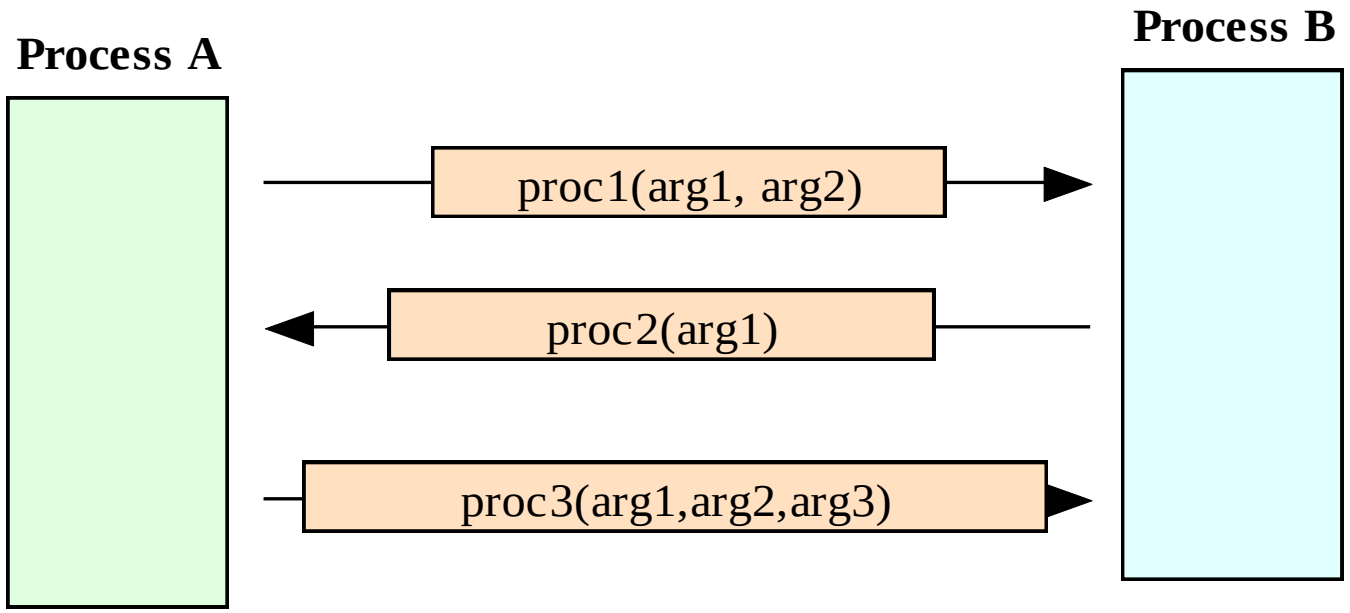
Distributed computing systems

RPC and RMI

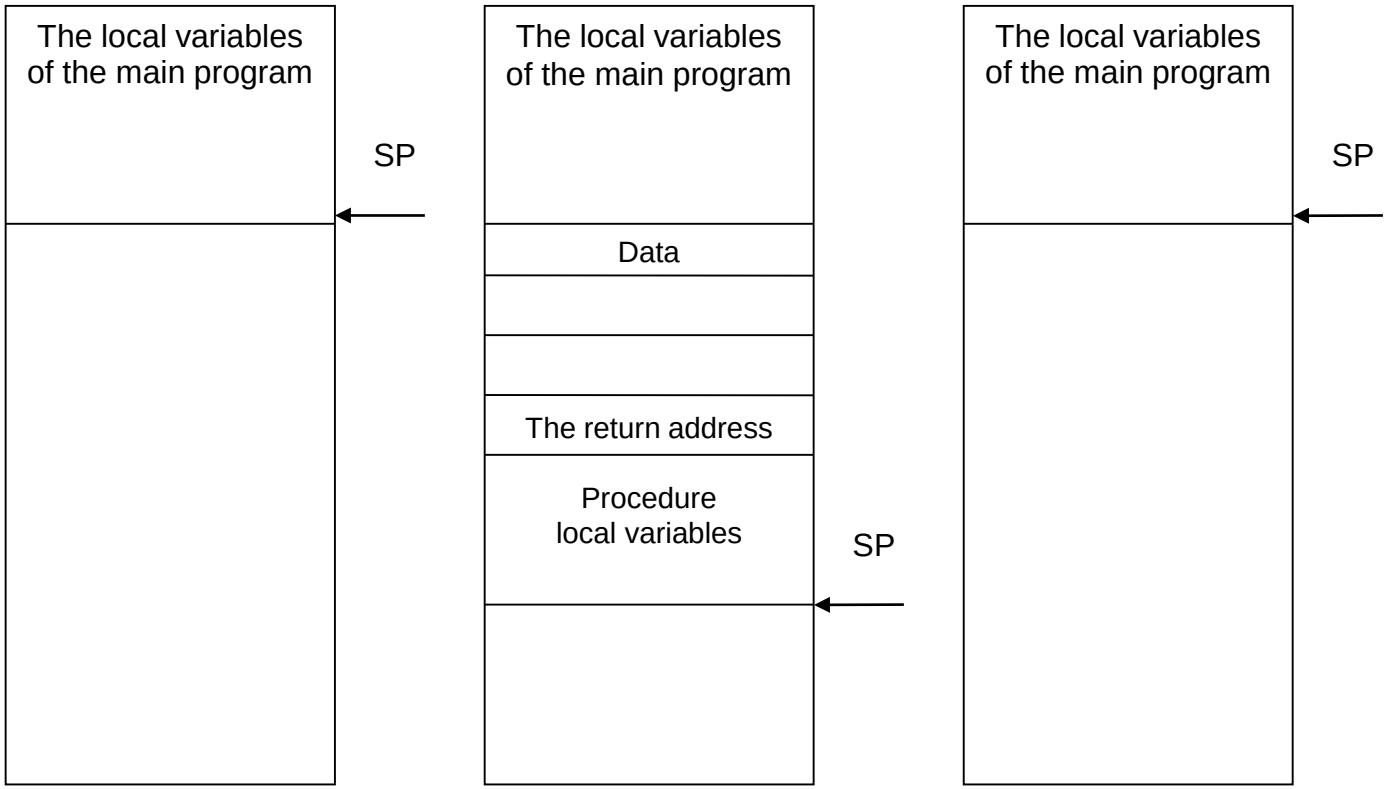
Remote procedure call
RPC-remote procedure call
RMI-remote method invocation

RPC Technology

- **Remote procedure call** is a technology that allows computer programs to call the function or procedure in a different address space.



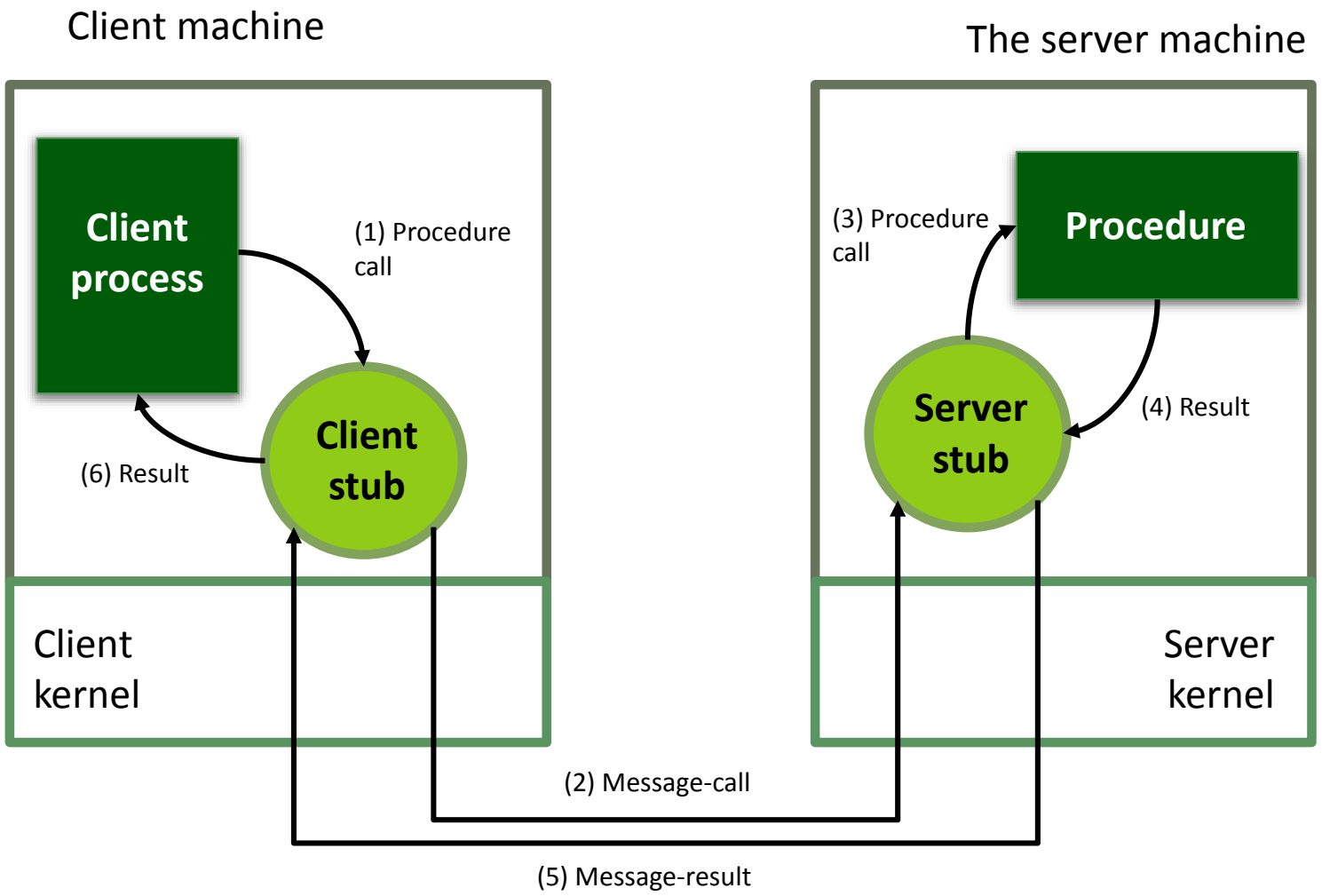
The stack when calling local procedures



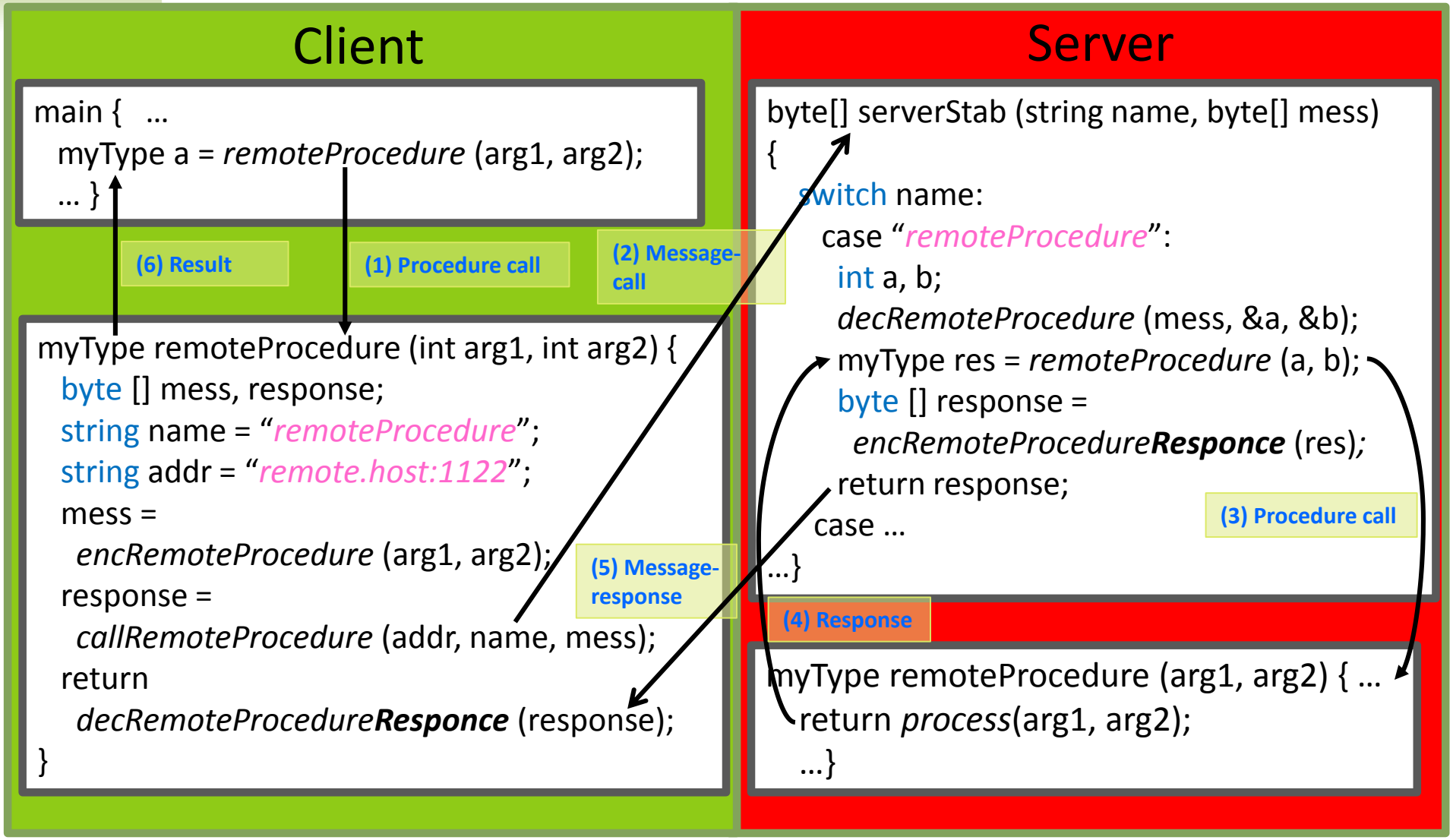
RPC Implementation

- The idea: remote procedure call "transparent" for the local process
- Instead of the local procedure we use the “client stub”.
- It is called as a local procedure, but instead of execution it sends a message the remote machine.

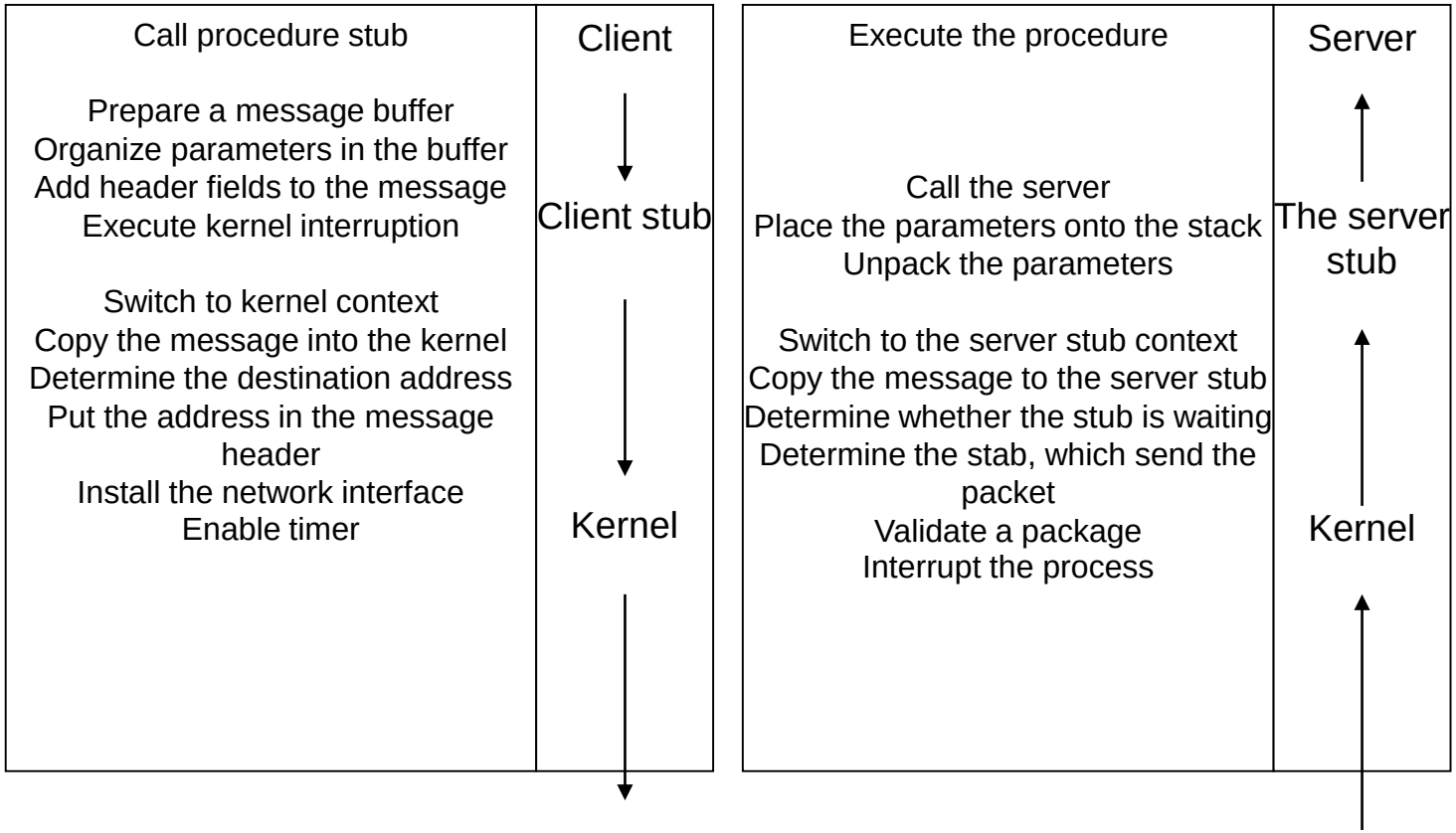
Remote Procedure Call



RPC Pseudo code



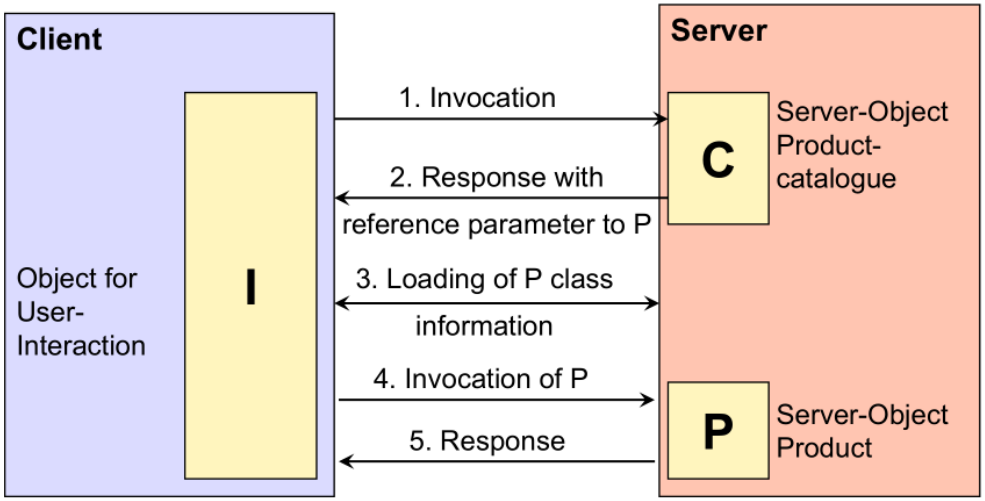
Stages of the RPC



Remote method invocation

In terms of OOP the Remote Method Invocation (RMI) concept was implemented.

- RMI allows to provide transparent access to the methods of remote objects, providing
  - delivery of parameters of the invoked method,
  - message to the remote object to execute the method
  - and the transfer of a return values back to the client

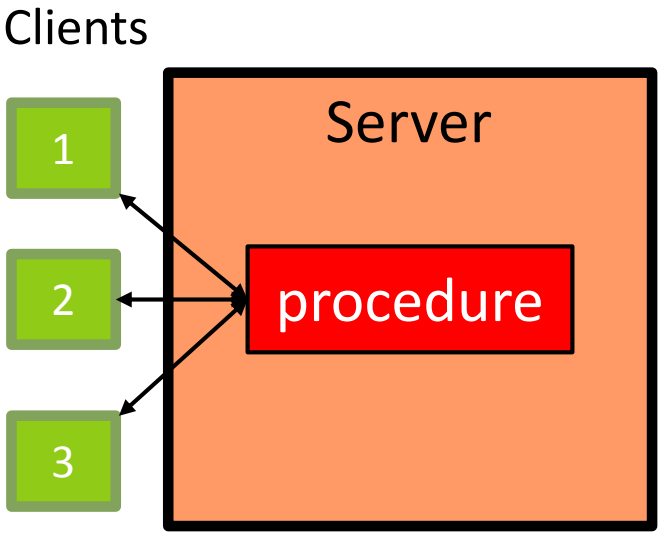


Remote object

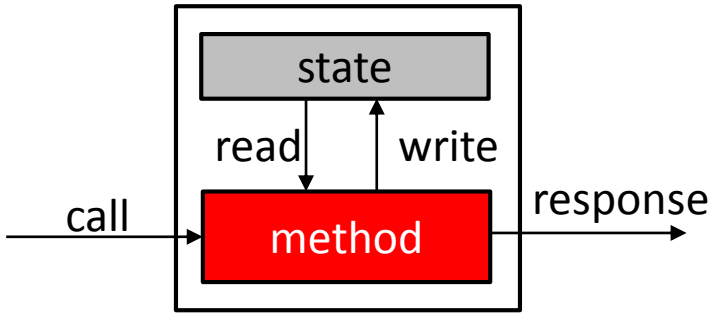
- The remote object is a collection of some data that determine its State. This State can be changed by calling some of his methods.
- Methods and fields of an object that can be used via remote calls, are available through the **external interface** of the objects class.

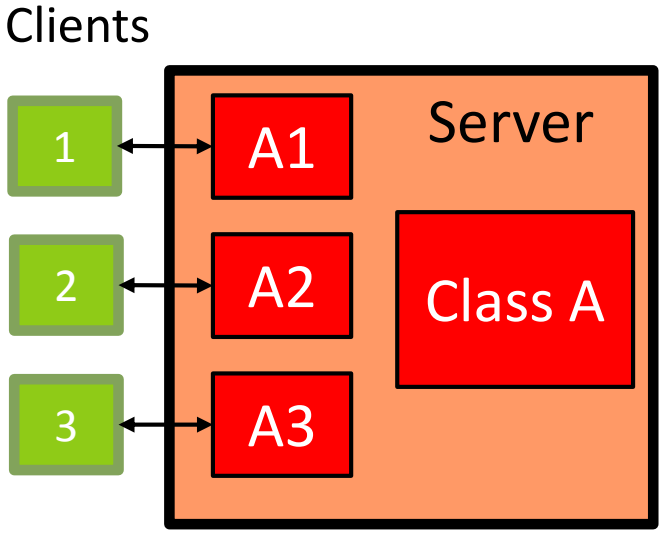
Remote Procedure VS Remote Object

Remote Procedure



Remote Object

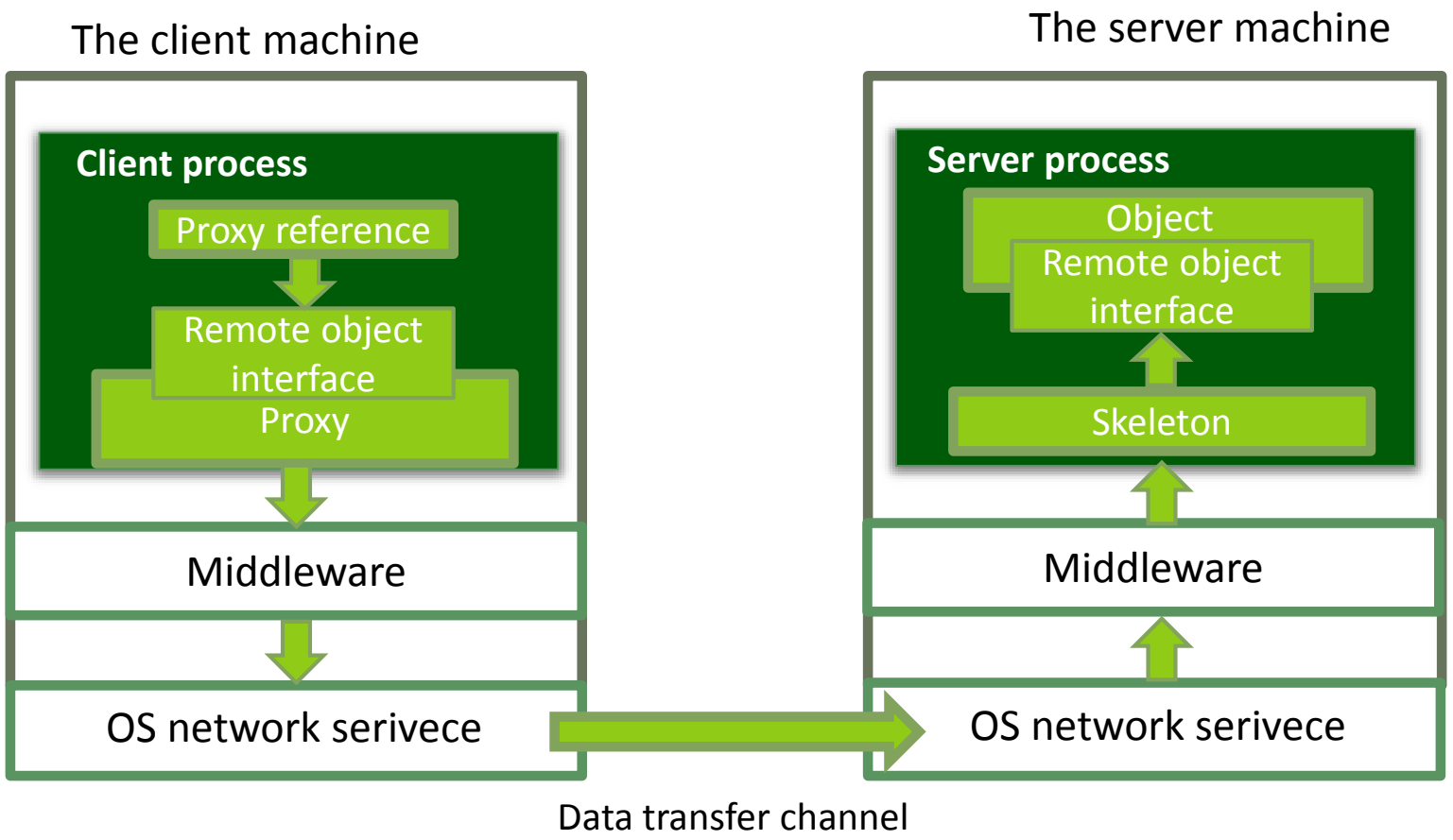




A Proxy and a Sceleton

- A client stub that invokes a remote object is called **the proxy**.
- **Proxy** implements the same interface as the remote object.
- The server-side stub is called **the skeleton** (in Java RMI)
- The skeleton is associated with a specific instance of the remote object and invokes the method with the desired settings

Remote object usage



Remote Method Invocation RMI

Interface:

```
public interface ProductCatalogue extends java.rmi.Remote
{
   ProductDescription[] searchProduct(String productType) throws java.rmi.RemoteException;
   Product provideProduct(ProductDescription d) throws java.rmi.RemoteException;
   int deleteProduct(ProductDescription d) throws java.rmi.RemoteException;
   int updateProduct(Product p) throws java.rmi.RemoteException;
   ...
}
```

Server – interface realization:

```
public class ProductCatalogueImpl extends java.rmi.server.UnicastRemoteObject
implements ProductCatalogue
{
   public ProductCatalogueImpl() throws java.rmi.RemoteException
   {   super();   }

   public ProductDescription[] searchProduct(String productType)
   throws java.rmi.RemoteException
   {
      ProductDescription[] desc = ProductCatalogue.getDescriptionByType(productType);
      return desc;
   }
    ...
}
```

Remote Method Invocation RMI

Server realization:

```
public class ProductCatalogueServer {
   public ProductCatalogueServer() {
      try {
         ProductCatalogue c = new ProductCatalogueImpl();
         Naming.rebind("rmi://localhost:1099/ProductCatalogueService", c);
      }
      catch (Exception e) {…}
   }
   public static void main(String args[]) {
      new ProductCatalogueServer();
   }
}
```

Client Realization:

```
public class ProductCatalogueClient {
   public static void main(String[] args)
   {
      try {
         ProductCatalogue c= (ProductCatalogue)Naming.lookup(
            "rmi://hostname/ProductCatalogueService");
         System.out.println( c.searchProduct("book");
      }
catch (Exception e) {…}
   }
}
```