The Common Object Request Broker Architecture (CORBA)

CORBA

- CORBA is a standard architecture for distributed objects systems
- CORBA is designed to allow distributed objects to interoperate in a heterogenous environment, where objects can be implemented in different programming languages and/or deployed on different platforms

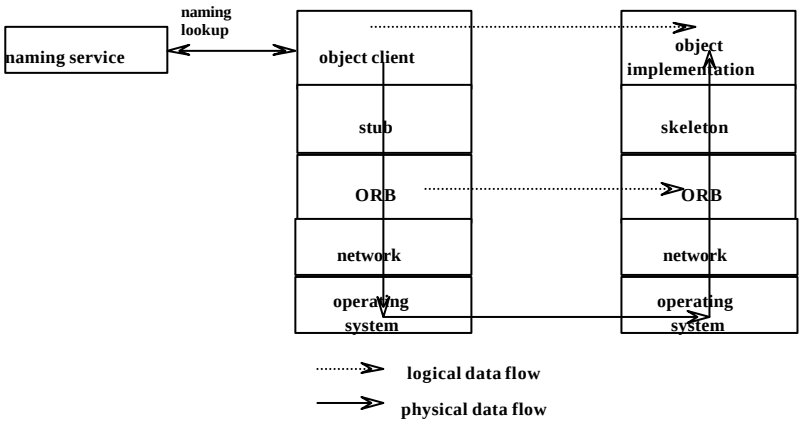
CORBA vs. Java RMI

- RMI is a proprietary facility and supports objects written in the Java programming langugage only
- CORBA is an architecture that was developed by the *Object Management Group* (*OMG*), an industrial consortium

CORBA

- CORBA is a very rich set of protocols
- A distributed object facility which adhere to these protocols is said to be *CORBA-compliant*
- the distributed objects the facility supports can interoperate with objects supported by other CORBA-compliant facilities

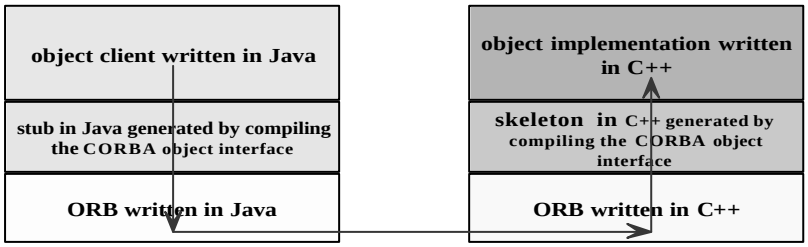
The basic architecture



CORBA object interface

- A distributed object is defined using an interface similar to the remote interface file in Java RMI
- Universal language with a distinct syntax, known as the ***CORBA Interface Definition Language*** (***IDL***)
- For many languages there is a standardized mapping from CORBA IDL

Cross-language CORBA application



Inter-ORB protocols

- To allow ORBs to be interoperable, the OMG specified a protocol known as the ***General Inter-ORB Protocol*** (***GIOP***), a specification which “provides a general framework for protocols to be built on top of specific transport layers”
- ***Inter-ORB Protocol*** (***IIOP***) = GIOP applied to the TCP/IP transport layer

Inter-ORB protocols

The IIOP specification includes the following elements:

- **Transport management requirements**
  - connection and disconnection requirements
  - roles for object client and object server in making and unmaking connections
- **Definition of common data representation**
  - a coding scheme for marshalling and unmarshalling data of each IDL data type
- **Message formats**

Object bus

- An ORB which adheres to the specifications of the IIOP may interoperate with any other IIOP-compliant ORBs over the Internet
- "***Object bus***", where the Internet is seen as a bus that interconnects CORBA objects

CORBA object references

- A CORBA object reference is an abstract entity mapped to a language-specific object reference by an ORB, in a representation chosen by the developer of the ORB
- For interoperability, OMG specifies a protocol for the abstract CORBA object reference object, known as the ***Interoperable Object Reference*** (***IOR***) protocol

Interoperable Object Reference (IOR)

An IOR is a string that contains encoding for the following information:

- The type of the object
- The host where the object can be found
- The port number of the server for that object
- An object key, a string of bytes identifying the object, used by an object server to locate the object

CORBA Naming Service

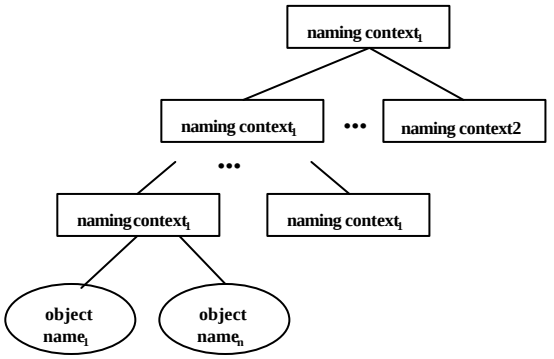
- CORBA specifies a generic directory service. The ***Naming Service*** serves as a directory for CORBA objects
- The Naming Service allows names to be associated with object references

CORBA Naming Service

- To export a distributed object, a CORBA object server contacts a Naming Service to ***bind*** a symbolic name to the object
- The Naming Service maintains a database of names and the objects associated with them.
- The Naming Service *resolves* an object name returning a reference to the object
- The API for the Naming Service is specified in interfaces defined in IDL

CORBA Naming Service

- The CORBA object naming scheme is necessarily complex
- Since the name space is universal, a standard naming hierarchy is defined



CORBA Naming Service

- The full name of an object, including all the associated naming contexts, is known as a *compound name*

```
<naming context > …<naming context><object name>
```

- Naming contexts and name bindings are created using methods provided in the Naming Service interface

Interoperable Naming Service

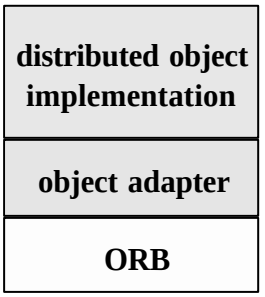
- The ***Interoperable Naming Service*** (***INS***) is a URL-based naming system based on the CORBA Naming Service
- It allows applications to share a common initial naming context and provide a URL to access a CORBA object

CORBA Object Services

CORBA specifies services commonly needed in distributed applications

- Naming Service
- Concurrency Service
- Event Service
- Logging Service
- Scheduling Service
- Security Service
- Trading Service: for locating a service by the type (instead of by name)
- Time Service: a service for time-related events
- Notification Service
- Object Transaction Service

Object Adapters



Object Adapter

- An object adapter assists an ORB in delivering a client request to an object implementation
- When an ORB receives a client's request, it locates the object adapter associated with the object and forwards the request to the adapter
- The adapter interacts with the object implementation's skeleton, which performs data marshalling and invokes the appropriate method in the object

The **Portable Object Adapter**

- There are different types of CORBA object adapters.
- The ***Portable Object Adapter***, or ***POA***, is a particular type of object adapter that is defined by the CORBA specification
- An object adapter that is a POA allows an object implementation to function with different ORBs

The Java IDL

Java IDL – Java's CORBA facility

- IDL is part of the Java 2 Platform
- The Java IDL facility includes a CORBA Object Request Broker (ORB), an IDL-to-Java compiler, and a subset of CORBA standard services
- Java also provides a number of CORBA-compliant facilities, including ***RMI over IIOP***, which allows a CORBA application to be written using the RMI syntax and semantics

Key Java IDL packages

- org.omg.CORBA – contains interfaces and classes providing the mapping of the OMG CORBA APIs to the Java programming language
- org.omg.CosNaming - contains interfaces and classes providing the naming service for Java IDL

Java IDL tools

Java IDL provides a set of tools needed for developing a CORBA application:

- idlj - the IDL-to-Java compiler
- orbd - a server process which provides Naming Service and other services
- servertool – provides a command-line interface for application programmers to register/unregister an object, and startup/shutdown a server

The CORBA interface

```
module HelloApp
{    interface Hello
     {    string sayHello();
          oneway void shutdown();
     };
};
```

Compiling the IDL file

- The IDL is compiled as follows:

```
idlj -fall Hello.idl
```

- The ***-fall*** command option is necessary for the compiler to generate all the files needed
- If the compilation is successful, the following files can be found in a `Hello`App subdirectory:

```
HelloOperations.java    Hello.java
HelloHelper.java        HelloHolder.java
_HelloStub.java         HelloPOA.java
```

HelloOperations.java

- The file HelloOperations.java is the ***Java* operations *interface***
- It is a Java interface file that is equivalent to the CORBA IDL interface file (***Hello.idl***)
- You should look at this file to make sure that the method signatures correspond to what you expect

Hello.java

- **The signature interface file combines the characteristics of the Java *operations* interface (*HelloOperations.java*) with the characteristics of the CORBA classes that it extends (*org.omg.CORBA.Object*, *org.omg.CORBA.portable.IDLEntity*)**

HelloHelper.java

- The Java class **`HelloHelper`** provides auxiliary functionality needed to support a CORBA object in the context of the Java language
- In particular, a method, ***`narrow`***, allows a CORBA object reference to be cast to its corresponding type in Java, so that a CORBA object may be operated on using syntax for Java object

_HelloStub.java

- The Java class ***_HelloStub*** is the stub file, which interfaces with the client object
- It extends **`org.omg.CORBA.portable.ObjectImpl`** and implements the ***Hello.java*** interface

HelloPOA.java, the server skeleton

- The Java class ***HelloImplPOA*** is the skeleton combined with the portable object adapter

Server-side classes

- On the server side, two classes need to be provided
  - The servant, ***HelloImpl***, is the implementation of the ***Hello*** IDL interface
  - The object server, ***HelloServer***

The servant

```
import org.omg.CosNaming.*;
import org.omg.CORBA.ORB;

class HelloImpl extends HelloPOA
{ private ORB orb;

  public void setORB(ORB _orb)
  {   orb = _orb; }

  public String sayHello()
  {   return "Hello world !! "; }

  public void shutdown()
  {   orb.shutdown(false); }
}
```

The server /1

```
import org.omg.CosNaming.*;
import org.omg.CORBA.ORB;
import org.omg.PortableServer.*;

public class HelloServer
{ public static void main(String args[])
  {   try
      {     ORB orb = ORB.init(args, null);
            POA rootpoa = (POA)orb.resolve_initial_
                  references("RootPOA");
            rootpoa.the_POAManager().activate();
            HelloImpl helloImpl = new HelloImpl();
            helloImpl.setORB(orb);
            org.omg.CORBA.Object ref = rootpoa.servant_
                  to_reference(helloImpl);
            Hello href = HelloHelper.narrow(ref);
            […]
```

The server /2

```
   org.omg.CORBA.Object objRef =
       orb.resolve_initial_references("NameService");
   NamingContextExt ncRef =
       NamingContextExtHelper.narrow(objRef);
   String name = "Hello";
   NameComponent path[] = ncRef.to_name( name );
   ncRef.rebind(path, href);
   System.out.println("HelloServer ready
       and waiting ...");
   orb.run();
   }
   catch(Exception e)
   {   System.out.println(e);
   }
 } // main
 } // class
```

The object client /1

- The client code is responsible for:
  - creating and initializing the ORB
  - looking up the object using the Interoperable Naming Service
  - invoking the narrow method of the ***Helper*** object to cast the object reference to a reference to a ***Hello*** object implementation
  - invoking remote methods using the reference
- The object's ***sayHello*** method is invoked to receive a string, and the object's shutdown method is invoked to deactivate the service

The object client /2

```
import org.omg.CosNaming.*;
import org.omg.CORBA.ORB;

public class HelloClient
{ static Hello helloImpl;
  public static void main(String args[])
  {   try
      {     ORB orb = ORB.init(args, null);
            org.omg.CORBA.Object objRef =
            orb.resolve_initial_references(
                  "NameService");
            NamingContextExt ncRef =
                  NamingContextExtHelper.narrow(
                  objRef);
            helloImpl = HelloHelper.narrow(
                  ncRef.resolve_str("Hello"));
            […]
```

The object client /3

```
            System.out.println(
                  helloImpl.sayHello());
            helloImpl.shutdown();
      }
      catch(Exception e)
      {     System.out.println(e);
      }
  }
}
```

Starting the Java ORB on the server

The Java ORB daemon ***orbd*** includes a Naming Service

```
orbd -ORBInitialPort 1050
   -ORBInitialHost servermachinename
```

Running the application

- On the server

```
java HelloServer
      –ORBInitialHost nameserverhost
      -ORBInitialPort 1050
```

- On the client

```
java HelloClient
      -ORBInitialHost nameserverhost
      -ORBInitialPort 1050
```

- N.B.: *nameserverhost* is the host on which the IDL name server is running