# Introduction to Distributed Computing using CORBA

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# Why Do You Go for Distributed Computing ?

- The information itself is inherently distributed due to the physical distributed nature of an organization
- Explicit distribution gives higher reliability, availability, performance etc.

# What is the problem with traditional Single Address Space Computing ?

- Objects have to be in the same address space, and hence an object cannot send a message to an object that is on a different machine.

You need to extend or enrich the traditional model for facilitating distributed computing

# Programming Paradigms Distributed Computing

- Socket based programming
- Typed streams
- Remote Procedure Calls
- Programming Languages: SR, Lynx..
- Distributed Shared Memory
- Distributed Objects

# A Distributed Object Computing Scenario

- *Server objects* and client programs located on different machines
- Client programs send messages to these server objects which are remote
- *Location Transparency*: Clients can send messages to these objects as if they are available locally

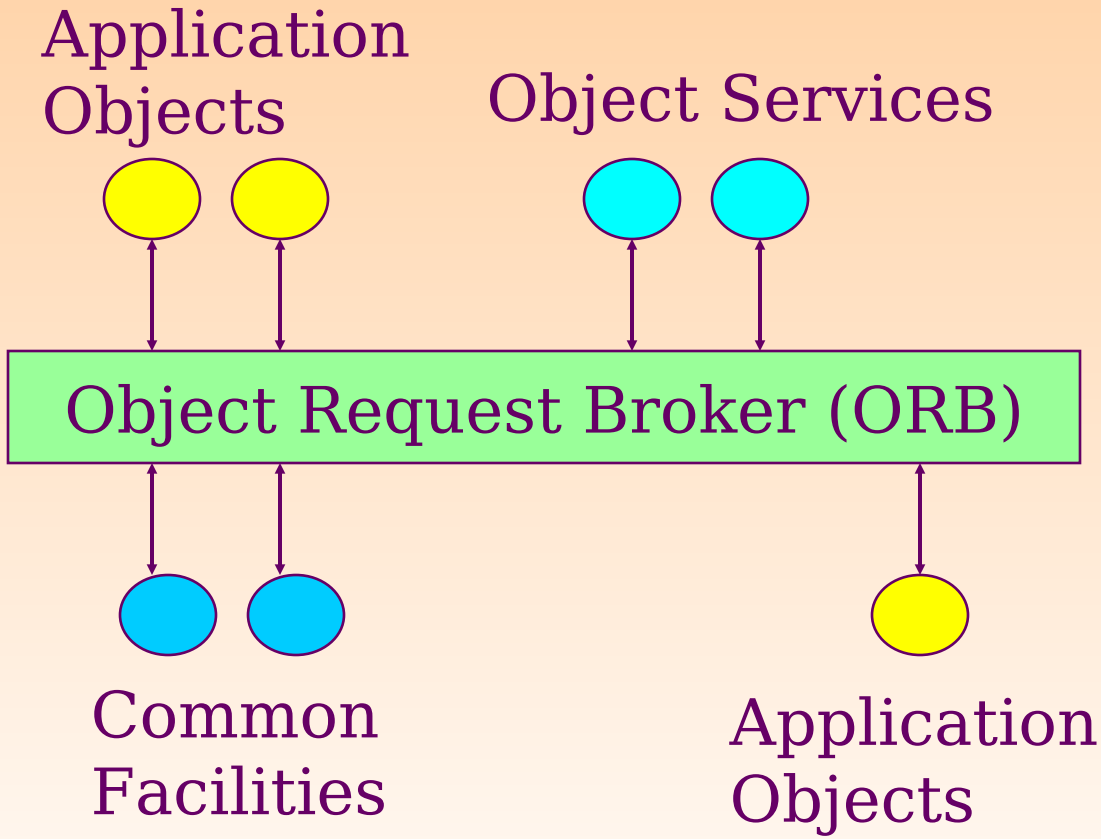
# What is OMG and the CORBA Standard?

- ***OMG*** **: The Object Management Group consisting of over 600 companies evolved the CORBA specs :Since 1989**

- **CORBA is a specification for the distributed object bus architecture defined by OMG**

- **OMG issues specifications, not products**

# Overview of the Object Management Architecture



# The ORB (object request broker)

ORB is the core of the Object Management Architecture

- Through ORB, objects written in different languages on different machines of different architectures running different operating systems can communicate to each other

# Structure of the ORB

ORB is responsible for :

- mechanisms to find implementations for requests
- To  prepare implementations to receive reqs
- To communicate data making up the reqs.
- ORB is not required to be implemented as a single component, but is defined by its interfaces

# Commercial ORBs

There are commercial ORBs available

*Examples:*

- CORBAplus - Expertsoft
- Orbix - IONA
- Visibroker - Visigenic, now with Inprise

# The Language of Application Development

- Client can be developed in one language, say C++
- Server can be developed in another language, say JAVA

# Client

*Observe the Location Transparency*

```
// This is a client
// ...
main ()
{
Library * iitb_lib ;
   //...
   iitb_lib  = Library :: bind (“IITB_LIB”);
   Book b = iitb_lib->list_a_book (“OOP”);
}
```

# Clients

- Have references to objects and invoke operations on them
- Clients know only the logical structure of the server objects (interfaces)
- Have no knowledge of implementations of the objects and object adapters used by these implementations

# How do Clients invoke a Server Interface ?

- May invoke server implementations through the *IDL generated stubs* (proxies)

OR

- May invoke through *the Dynamic Invocation Interface*

# The Interface Definition Language

- A server object declares its interface in the standard **Interface Definition Language** specified by the CORBA specification
- IDL separates the interface from implementation
- These interfaces are also commonly referred to as IDLs.

# The Server

- The server object can register itself with the ORB and declare that it is available for accepting requests
- It can also register its name which the clients use to get a handle for the  server object

# An Example Server

```
//....
Class Library_Skeleton { ....};  // generated for you

Class Library_Impl : public Library_Skeleton {...};
main ( )
{
Library_Impl *lib ;

    lib = new Library_Impl;

    orb->object_is_ready (lib);
    orb->implementation_is_ready (lib);
}
```

# IDL: The Core of CORBA Spec

## The Interface Definition Language

- IDL provides a language/OS independent interfaces to all objects, services and components on the CORBA bus
- The OMG IDL is purely declarative : that means, no implementation details are provided
- It is strongly typed.
- IDL specs can be written and invoked in any language that specifies CORBA bindings (C/C++/COBOL/Smalltalk)

# Server implements an IDL and Client invokes interfaces defined by an IDL

- Implementation is in an implementation language
- Invocations are also in an implementation languages
- IDL to language mapping is necessary
- e.g. mappings for C/C++/COBOL/Smalltalk/Java

# An Example IDL

```
Interface Account {

   void deposit (in float amount);
   void withdraw (in float  amount, out
   float balance);
}
```

# Inheritance

```
Interface Clock {
void  setTime();
void start();
void stop();
};
Interface AlarmClock : Clock {
void setAlarm();
void stopAlarm();
void testAlarm();
};
```

*Multiple inheritance is allowed*

# Inheritance..

- Inheritance of interface
- Components with both types of interfaces may exist
- Does not imply inheritance of implementation. The component implementing the derived may implement both interfaces entirely independently or may reuse an existing component

# OMG IDL Features

- **Modules**
- **interfaces**
- **operations**
- **attributes**
- **inheritance**
- **basic types**
- **Arrays**
- **sequences**
- **struct, enum, union**
- **typedef**
- **consts**
- **exceptions**

# Basic Types for use in IDL

- float
- double
- long
- short
- unsigned long
- unsigned short
- char
- boolean
- octet
- any

# Direction of Parameters

- In object — from client to server
- out — from server to client
- inout — from and to client

# Exceptions

```
Interface Bank {
   exception Reject {
        string reason; // a data member
    };
    exception TooMany {
    }; //  to be returned when capacity exceeded
    Account newAccount (in string name)
                        raises (Reject, TooMany);
};
```

# One-way Operations

```
Interface Account {
oneway void notice (in string notice);
};
```

Oneway operations do not block

They cannot accept out and inout parameters

They cannot have a **raises** clause

# Constructed Types: Structures for use in IDL

```
struct PersonalDetails {
    string Name;
    short age;
};
interface Bank {
    PersonalDetails getPerDet (in string
                                name) ;
};
```

# Constructed Types: Arrays

- They can be multi-dimensional
- They must be of fixed size : known in the idl definition time

```
Account bankAccounts [100];

short matrix [10] [20];  // 2-d array
```

# Constants

```
Interface Bank {
   const long MaxAccounts = 10000 ;
   ...
};
```

constants of types such as long, float, string can be declared

# Typedef Declaration

```
typedef short size;
size i;


typedef Account Accounts [100];
Accounts bankAccounts ;
```

# Modules

```
Module Finance {
   interface Bank { ..... };
   interface Account { ....  };
};
```

*Modules are used to group interfaces into logical units.*

*Use full name of Account and Bank interfaces such as:*

*Finance::Account *a;*

# Preprocessor

- Macro substitution
- conditional compilation
- source IDL file inclusion

such as :

| | | |
|---|---|---|
| #include | #define | #if |
| #ifdef | #defined | ..... |

It is based on the C++ preprocessor

# The IDL to Language Mapping

- Different languages (OO/non-OO) access CORBA objects in different ways
- Mapping covers :
  - Language specific data types
  - Structure of the client stub (only non-OO lang)
  - Dynamic invocation interface
  - Implementation skeleton
  - Object Adapters
  - Direct ORB interface

# Mapping the Identifiers

- *Identifiers are mapped to same names*

e.g. *add_book* in IDL is mapped to --> **add_book**

- *But if they are C++ keywords, an underscore is prefixed*

e.g. *new* is mapped to --> **_new**

# Mapping of Interfaces

- *Interfaces are mapped to classes*

*Interface Account { … }* becomes

**class Account : public virtual CORBA::Object { ..}**

**An IDL mapped C++ class cannot be instanciated**

# Mapping Scoped Names

*Interface Bank {*

*struct Details { ..}*

*…. } is mapped to*

**class Bank {**

**public:**

**struct Details {…}**

**};**

# ...Mapping Scoped Names

*Module M { Interface A {..}*
*Interface B {..} }*

is mapped to

```
namespace M {
  class A {..};
  class B {..};
}
```

**refer to them as ==> M::A or M::B etc.**

# Mapping the standard CORBA module

Is mapped to

**namespace CORBA { ..**

**}**

Use the members as follows :

*CORBA::ORB_init (..);*

# Mapping the Basic Data Types

| **IDL** | **C++** |
| --- | --- |
| short | CORBA::Short |
| long | CORBA::Long |
| unsigned short | CORBA::UShort |
| unsigned long | CORBA::Ulong |
| float | CORBA::Float |
| double | CORBA::Double |

# … Basic Data Types

| **IDL** | **C++** |
| --- | --- |
| char | CORBA::Char |
| boolean | CORBA::Boolean |
| Octet | CORBA::Octet |
| any | CORBA::Any |

# Interface Repository

- Provides storage to store IDL information
- A program may refer to objects whose interface would be known at runtime
- This info may be used by the ORB to perform requests
- IR may be made to store other info about interfaces such as debugging info, browser routines etc

# Implementation Repository

- Contains information that allows ORB to locate and activate the implementation of a required server object

- Also for storing server activation information such as the machine where a server would be started on a client’s request

# Dynamic Invocation Interface

- Rather than calling a specific stub routine for an operation, it is possible to specify an object, operation on it, and parameters to it through a call or sequence of calls

- Client must also supply the types of parameters passed

# Interoperability

- For supporting networks of objects distributed across multiple heterogeneous CORBA-compliant ORBs

--> InterORBability

- *GIOP* : Standard transfer syntax and a set of message formats for communication between ORBs
- *IIOP* : The TCP/IP mapping of GIOP

# CORBA Services: Common Object Service Specification (COSS)

An ORB is just like a telephone exchange that connects objects. Applications require other services defined in terms of IDL

OMG has brought out a COSS that includes services such as naming, events, life cycle, time, transactions, concurrency, persistence, query, security, licensing, relationships, properties, externalization and collection

# Common Facilities

- Newest area of OMG's standardization
- ORB and Object Services are fundamental technologies, and common facilities extend them to application developers
- Horizontal and Vertical facilities
- e.g System management, compound documents, financial services
- May become most important area of OMG standards