CORBA part II

Agenda

- CORBA Object Model
- Interoperability architecture, Language mappings, Portable Interceptors and DGC
- IDL to Java mapping
- Corba Communication Models
- CORBA Services
- CORBA Naming Service
- CORBA Transaction Service
- CORBA Concurrency Service

CORBA Overview
Object Model

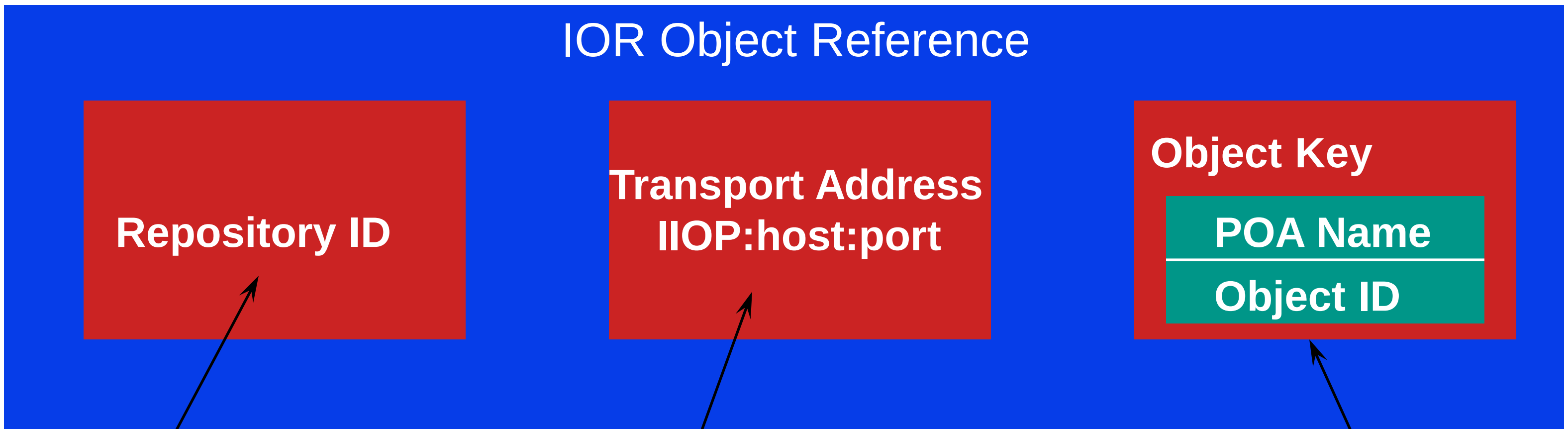
- The OMA Core Object Model defines some fundamental definitions of concepts which are extended, made more specific and concrete by CORBA
- The class concept does not exist in CORBA as non-Object Oriented programming languages can be used as implementation language
- Clients for remote objects are not necessary objects as Client implementation languages also can be non-Object Oriented

CORBA Overview

Object Model - remote object references

- Remote Object References can be in two forms Session form and Interoperable Object Reference (IOR) form
- The session form is a vendor specific format
  - In session form there is no information that is meaningful for the client as the ref is only interpreted at the server side
- The IOR form is intended for interoperability between different ORBs
  - The IOR form can be stringified to enable IORs to be stored, emailed, printed, and retrieved

CORBA Overview
Object Model - remote object references



Identifies Interface Type

Identifies a transport endpoint

Identifies the object within POA

Is in proprietary format for a given ORB

Interoperability is not affected as the server is the only one looking in it

CORBA Overview

Object Model - remote object references

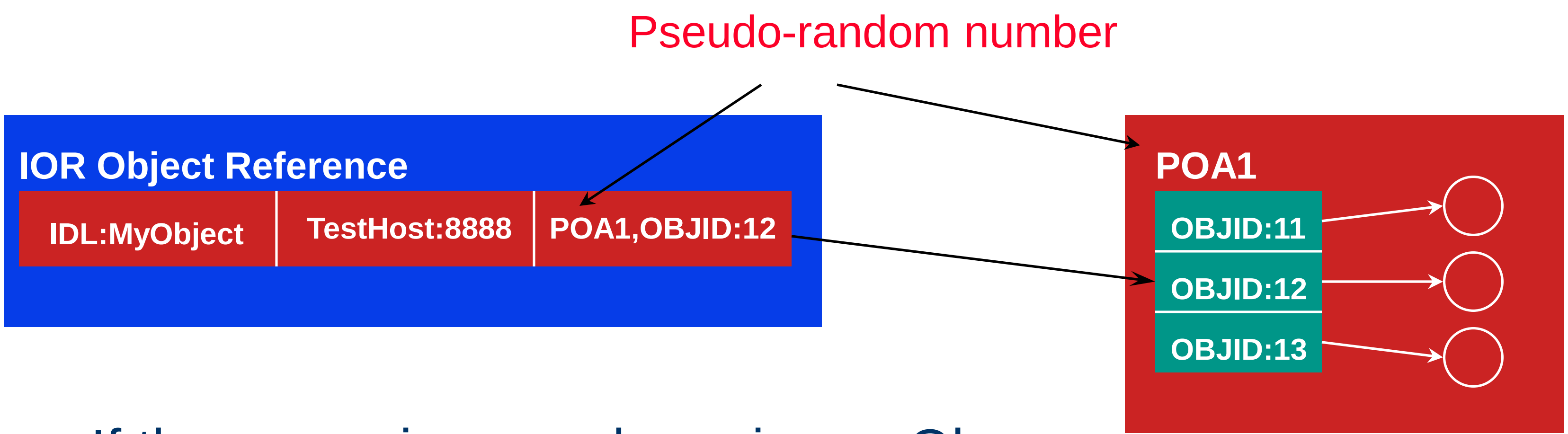
- Object references are opaque - application code isn’t allowed to look inside or make any assumptions about the internals
- Remote Object references have a semantics very similar to class pointers in C++ - they can dangle ie pointing at a non-existing or unreachable object
  - If the server where the remote object lived is shutdown and started again on another host

CORBA Overview
Object Model - remote object references

- CORBA distinguishes between *transient* and *persistent* object references (LifeSpan policy)
- A transient IOR continues to work a long as the corresponding server process where the remote object remains available
  - Once the server process is shutdown the IOR is non-functional forever (even if the server process is started again)
- IOR *Host:port* contains the server process information for the POA

CORBA Overview

Object Model - remote object references



If the server is up and running -> Ok

If the server is down - > OBJECT_NOT_EXIST

If the server is running but not the right adapter ID (check for pseudo-random number) -> OBJECT_NOT_EXIST

If the server is running but not the right ORB (check for vendor specific tag in IOR identifying ORB) ->OBJECT-NOT_EXIST

CORBA Overview

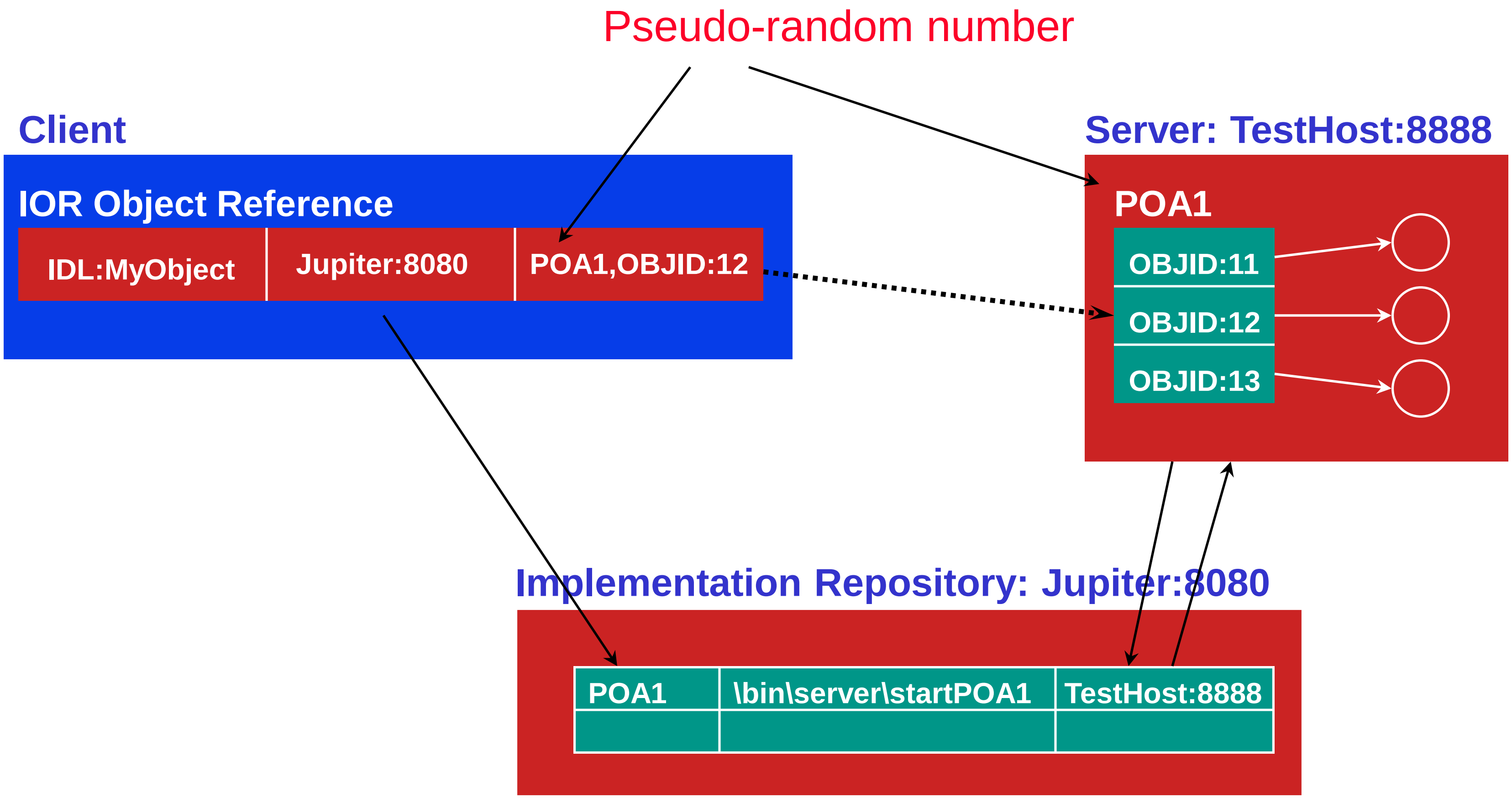
Object Model - remote object references

- A persistent object reference survives shutdown of the server process - it still denotes the same CORBA object
- This works even if the server process is started on another *host:port*
- The persistent object reference has a life cycle independent of the life cycle of the servant
- Many ORBs can transparently start server processes and shut them down again after some idle time in order to save resources

CORBA Overview
Object Model - remote object references

- Persistent object references are implemented by usage of the Implementation Repository
- IOR *Host:port* contains the Implementation Repository server process information
  - More host:port occurences allow for replicated Implementation Services
- Implementation Repository acts as a level of indirection and delivers at runtime the address of the POA server process to the client

CORBA Overview
Object Model - remote object references



CORBA Overview
Object Model - Persistent Reference example

- To make the Hello object references persistent you do the following
  - Create a new Policy
    - the LifeSpanPolicy equals *persistent*
    - the IDAssignmentPolicy equals *user_id*
    - for all others default values are used
  - Create new POA associated with RootManager with Policy ‘the new policy’
  - Create servant and explicit activate servant
  - Example hello_imr

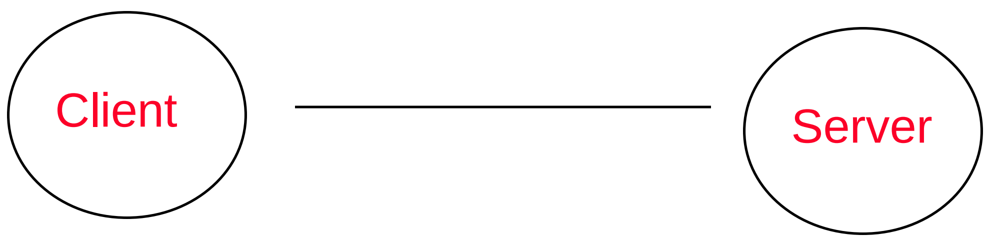
CORBA Overview
Interoperability Architecture

- The Interoperability Architecture for CORBA contain elements like
  - ORB interoperability
  - Inter-ORB bridge support
  - GIOPs and IIOPs
- An ORB is considered being interoperability compliant when supporting
  - GIOP/IIOP
  - IOR

CORBA Overview
Language Mappings

- The following language specific OMG IDL compilers are contained in specifications

Client side	Server side
Phyton	Phyton
ADA	ADA
C++	C++
Java	Java
Smalltalk	Smalltalk
COBOL	COBOL
LISP	LISP
C	C
CORBA Script	CORBA Script

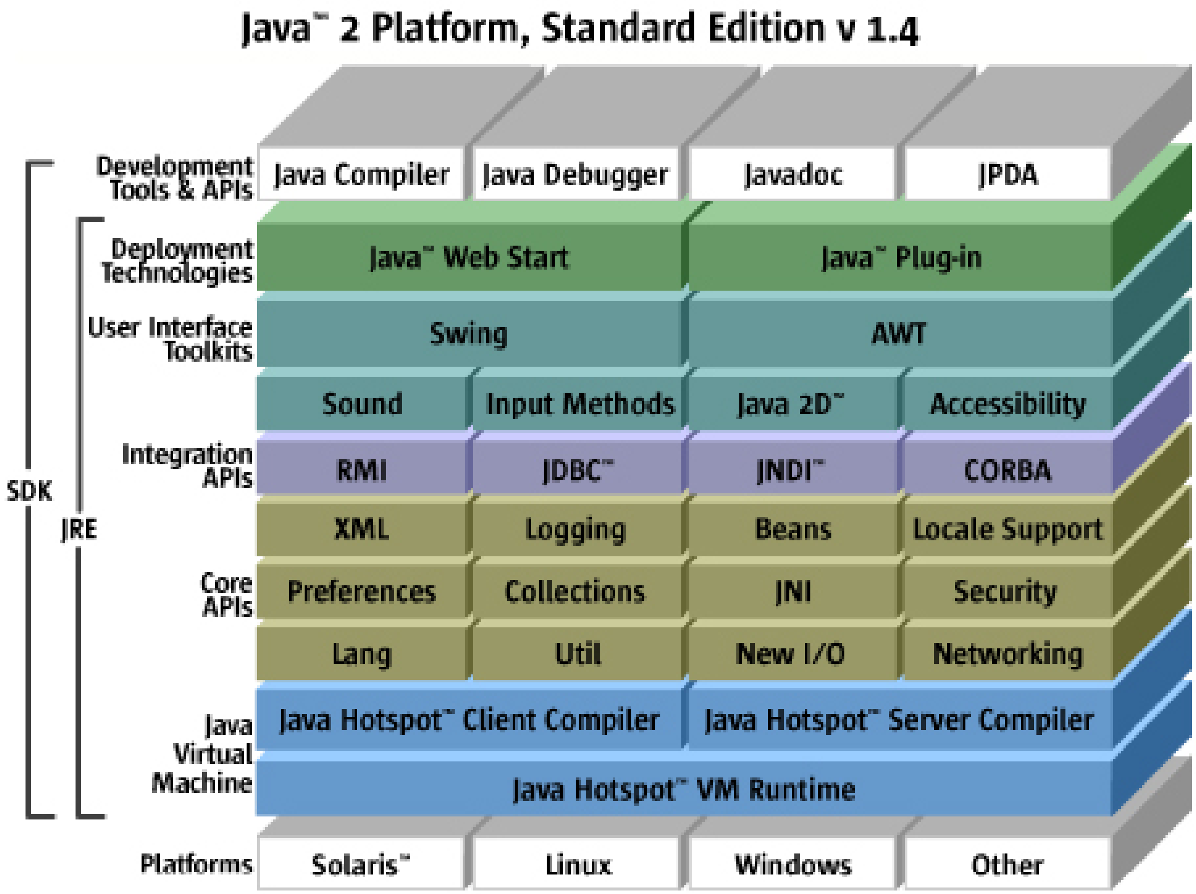


CORBA Overview

Language Mappings - cross language example

- To show CORBA is language independent use the IDL2CPP (idl) compiler on hello.idl to generate a interface and a stub
  - idl --no-skeletons hello.idl
- Make a client.cpp implementation and link it to a client.exe
- Start the Java ORB based hello server and start the C++ ORB based hello client

J2SE 1.4 support for CORBA



J2SE 1.4 support for CORBA

CORBA compliance

- JDK 1.4 contains a Java ORB implementation supporting a part of CORBA specification 2.3.1
  - http://java.sun.com/j2se/1.4/docs/api/org/omg/CORBA/doc-files/compliance.html
- JDK 1.4 contains the following CORBA tools
  - IDL-to-Java compiler (idlj)
  - Implementation Repository (orbd)
  - transient Naming Service (orbd)
  - persistent Naming Service (orbd)
  - servertool (cmd line interface tool)
  - tnamesrv (backward compability)

J2SE 1.4 support for CORBA

CORBA features

- GIOP 1.2 (IIOP)
- POA
- Portable interceptors
  - provides hooks, or interception points, through which ORB services can intercept the normal flow of execution of the ORB
  - three types
    - IORInterceptor
    - ClientRequestInterceptor
    - ServerRequestInterceptor

Common CORBA Services

CCS

CORBA Services

- A set of interface specifications provides fundamental services that application developers may need in order to
  - Find objects
  - Manage objects
  - Coordinate the execution of complex operations
- CORBA Services are the building blocks for other components in the OMA including applications

CORBA Services

- The following services exist:

Naming	Licensing
Notification (event)	Query
Life cycle	Properties
Persistent state	Security
Relationships	Time
Externalization	Collection
Transaction	Trading
Concurrency control	

-Some of the above are simply framework interfaces that will be inherited by the application or other objects (Ex. Life cycle service)
-Others represent low-level components on which higher-level components can be build (Ex. Transaction service)
-Others provide basic services used at all levels of applications (Ex. Naming and Trading service)

CORBA Naming Service

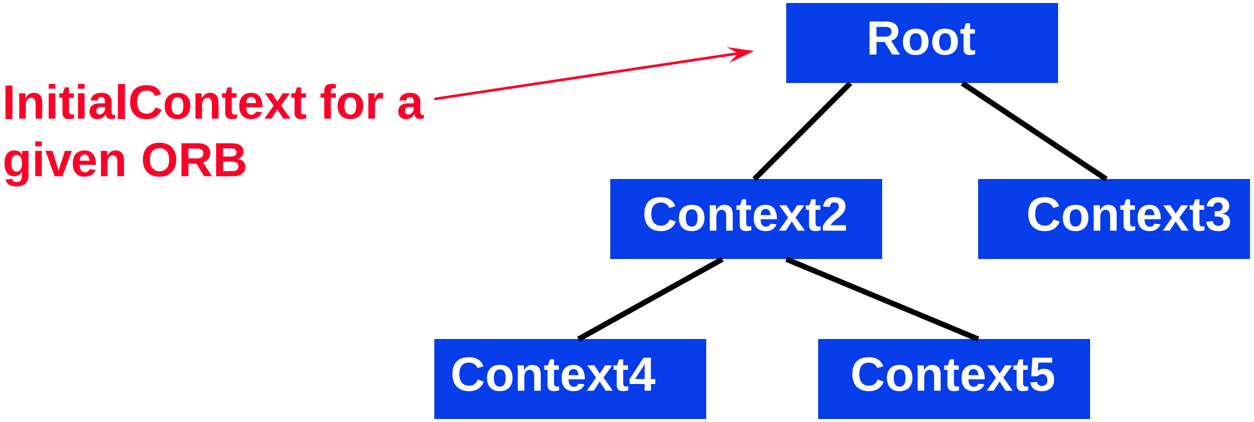
CORBA Naming Service

- Until now we used the file system and object_to_string to communicate the IOR to the client
- Instead we can use a Corba Naming Service to register og obtain remote references to CORBA objects in a more elegant way
- The CORBA Naming service is an example of a concrete Naming Service implementation/standard

CORBA Naming Service

CORBA Naming Service

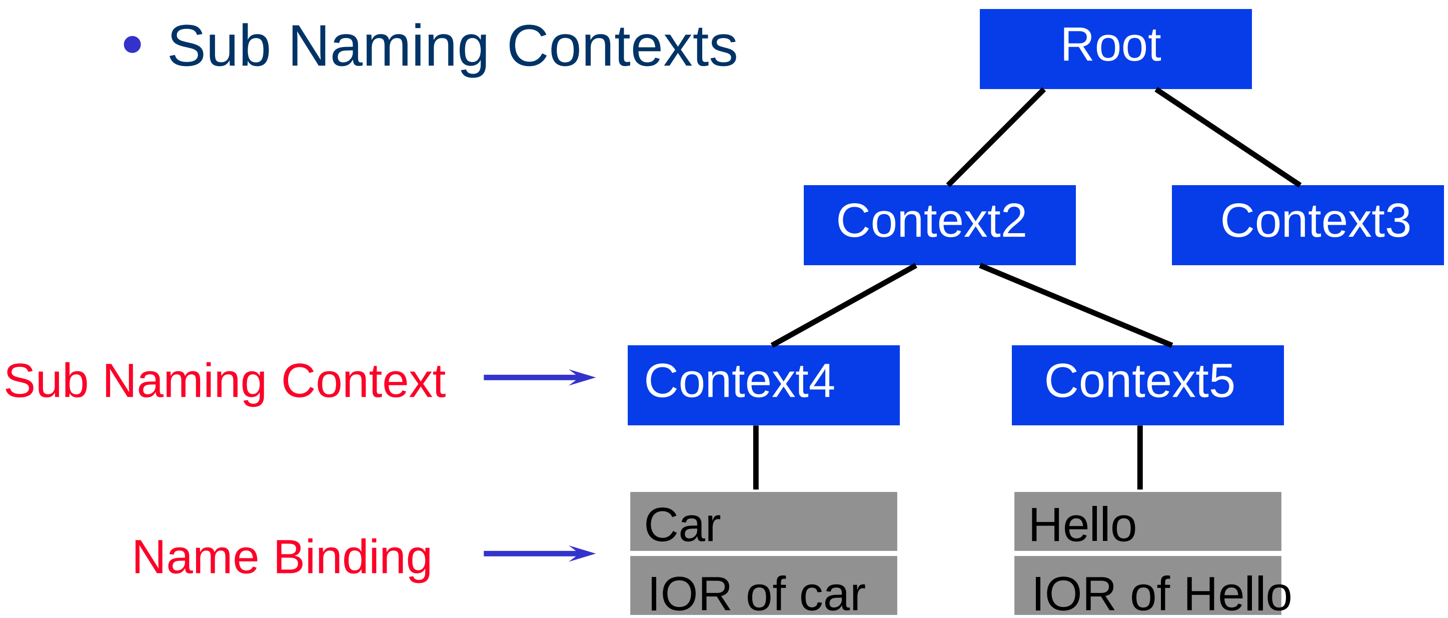
- The CORBA Naming Service is hierarchically structured in Naming Contexts
  - Naming Contexts are similar to directories in file systems



CORBA Naming Service

CORBA Naming Service

- Naming Contexts can contain
  - Name Bindings
  - Sub Naming Contexts



CORBA Naming Service

CORBA Naming Service

- Clients and Servers operates with the CORBA Naming Service in terms of Names
- A Name is a sequence of NameComponents which either can be Naming Contexts or Objects
  - Naming Contexts and Objects are identified through a string

Example: Name for an Account CORBA object

Name= | context2 | context5 | Hello |

IDL Types for Names

```
module CosNaming {
 typedef string Istring;

 struct NameComponent {
   Istring id;
   Istring kind;
 };

 typedef sequence <NameComponent> Name;
 ...
};
```

The IDL Interfaces

- Naming Service is specified by two IDL interfaces:
  - **`NamingContext`** defines operations to bind objects to names and resolve name bindings.
  - **`BindingIterator`** defines operations to iterate over a set of names defined in a naming context.

IDL Interface

```
interface NamingContext {
    void bind(in Name n, in Object obj)
           raises (NotFound, ...);

    Object resolve(in Name n)
        raises (NotFound,CannotProceed,...);

    void unbind (in Name n)
         raises (NotFound, CannotProceed...);

    NamingContext new_context();
    NamingContext bind_new_context(in Name n)
                  raises (NotFound, ...)
    void list(in unsigned long how_many,
              out BindingList bl,
              out BindingIterator bi);
};
```

IDL Interface (cont´d)

```
interface BindingIterator {
  boolean next_one(out Binding b);
  boolean next_n(in unsigned long how_many,
                         out BindingList bl);
  void destroy();
}
```

CORBA Naming Service
CORBA Naming Service

- Name Resolution in CORBA Naming Service happens relative to a *InitialContext*
  - *resolves operation* resolves the first component of the Name,n, to an object reference
  - If there are no remaining Name Components, it returns this object reference to the caller
  - Otherwise it narrows the object reference to a Naming Context and passes the remainder of the Name to the *resolves()* operation
- The above algorithm will probably be optimized concrete implementations

CORBA Naming Service

CORBA Naming Service

- An application uses the Naming service this way:
  - A CORBA Server *bind* IORs to a unique Name in the Naming Server
  - The Client *resolve* to get a particular IOR by supplying a Name to the *resolve* method of a initial Naming Context
    - which you get by ORB.*resolve_inital_references("NameService")*
  - The Client *narrow* the IOR to a given interface type and start using it

CORBA Naming Service

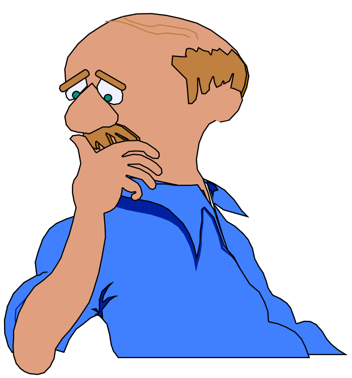
CORBA Naming Service – Interoperable Naming Service

- The Interoperable Naming Service (INS) provides the following features:
  - Capability to resolve using stringified names (e.g., a/b.c/d)
  - URLs for CORBA object references (corbaloc: and corbaname: formats)
    - Corbaloc -> locate CORBA services
    - Corbaname -> stringified resolvement
  - Standard APIs in NamingContextExt for converting between CosNames, URLs, and Strings
  - ORB arguments for bootstrapping (ORBInitRef and ORBDefaultInitRef)

CORBA Naming Service

CORBA Naming Service

So if I have to model a CORBA Order object in a CORBA server - will I then have to register all incarnations of orders in the Naming service?

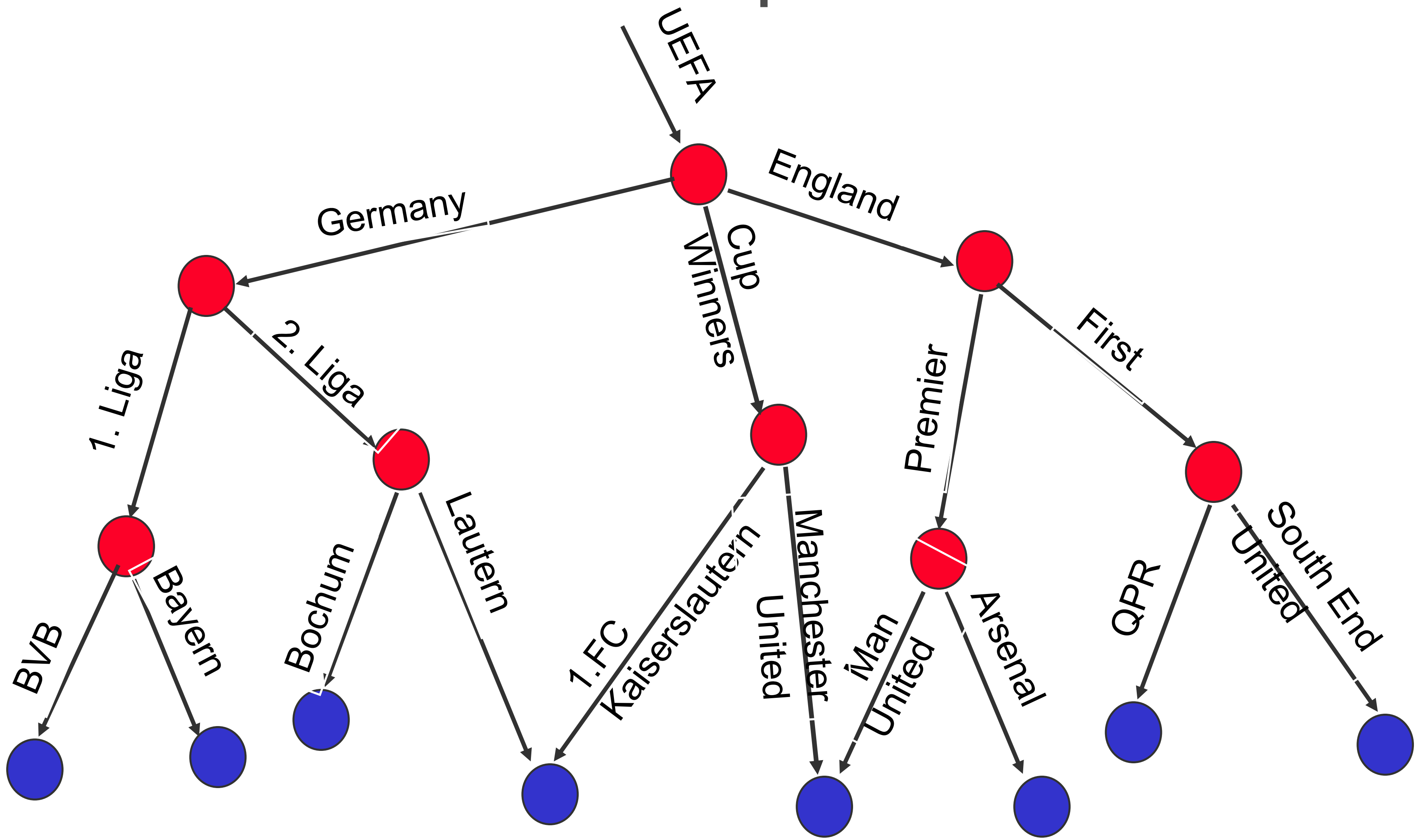


CORBA Naming Service

CORBA Naming Service

- Once again- NO!!!!
- There are more ways of comming around that problem - one common way is to apply the the Factory pattern
  - Delegate object creation to a Factory CORBA object that returns IORs
  - Bind an incarnation of the Factory object in the Naming Service
  - For clients to get IORs to specific Order objects they go through the Factory CORBA object

Naming Contexts Example



C++ Example

```
CORBA::Object *obj;
CosNaming::NamingContext *root;
Soccer::Team *t;
CosNaming::Name* name;
obj=CORBA::BOA.resolve_initial_references
                           ("NameService");
root=CosNaming::NamingContext::_narrow(obj);
name=new CosNaming::Name(4);
name[0].id=CORBA::string_dupl("UEFA");
name[1].id=CORBA::string_dupl("England");
name[2].id=CORBA::string_dupl("Premier");
name[3].id=CORBA::string_dupl("Arsenal");
t=Soccer::Team::_narrow(root->resolve(name));
cout << t->print();
```

Limitations

- Limitation of Naming: Client always has to identify the server by name.
- Inappropriate if client just wants to use a service at a certain quality but does not know from who:
  - Automatic cinema ticketing,
  - Video on demand,
  - Electronic commerce.

OMG/CORBA Trading Service

Trading Characteristics

- Trader operates as broker between client and server.
- Enables client to change perspective from ´who?´ to ´what?´
- Selection between multiple service providers.
- Similar ideas in:
  - yellow pages
  - insurance broker
  - stock brokerage.

Trading Characteristics

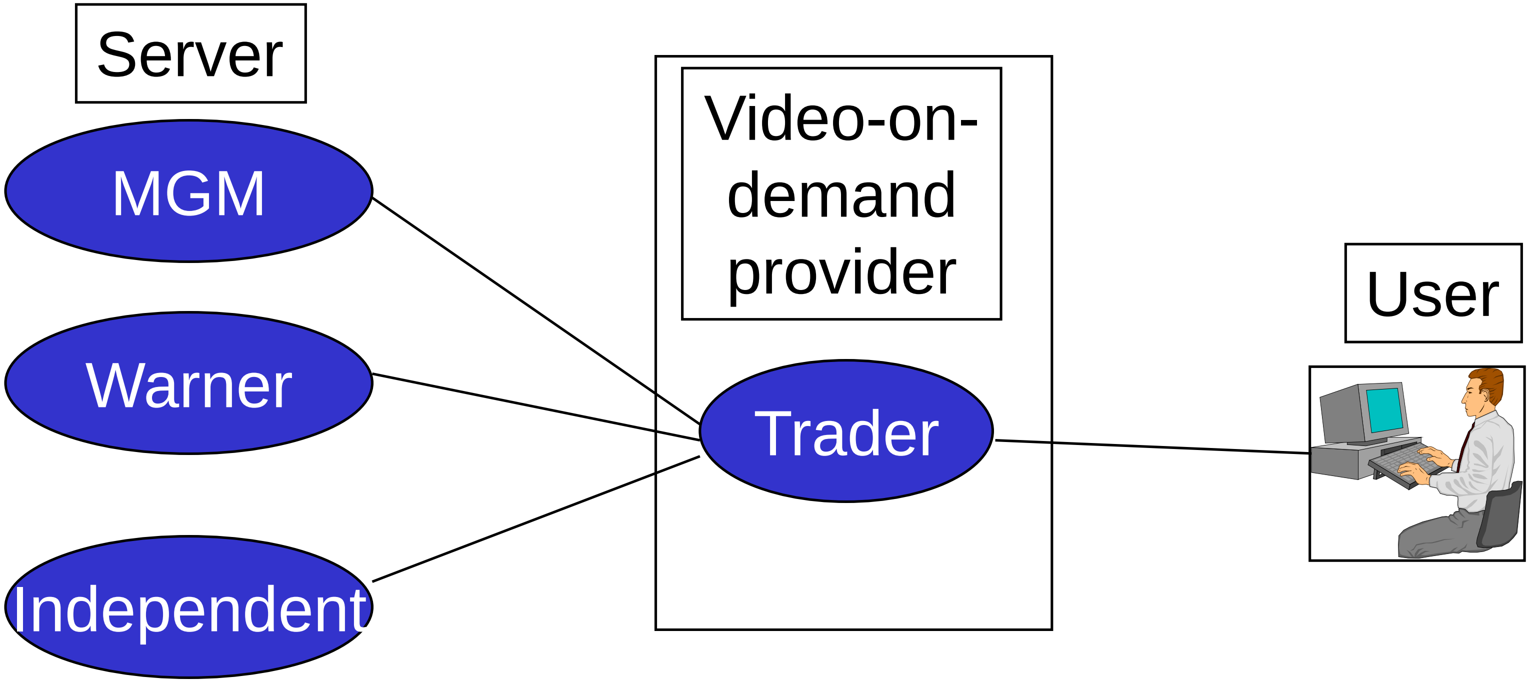
- Common language between client and server:
  - Service types
  - Qualities of service
- Server registers service with trader.
- Server defines assured quality of service:
  - Static QoS definition
  - Dynamic QoS definition.

Trading Characteristics

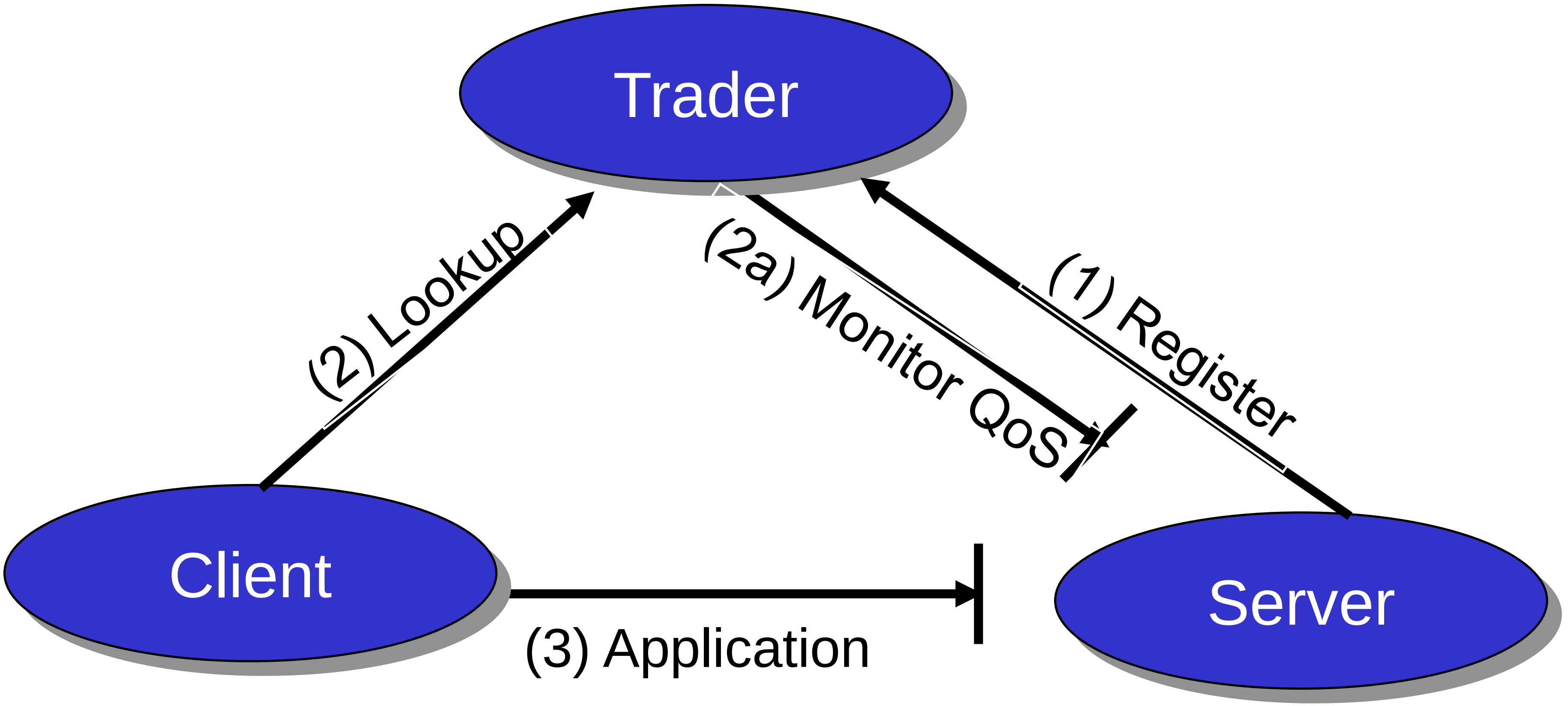
- Clients ask trader for
  - a service of a certain type
  - at a certain level of quality
- Trader supports
  - service matching
  - service shopping

Example

- Distributed system for video-on-demand:



OMG Trading Service



Properties

Specify qualities of service:

```
typedef Istring PropertyName;
typedef sequence<PropertyName> PropertyNameSeq;
typedef any PropertyValue;
struct Property {
  PropertyName name;
  PropertyValue value;
};
typedef sequence<Property> PropertySeq;
enum HowManyProps {none, some, all};
union SpecifiedProps switch (HowManyProps) {
  case some : PropertyNameSeq prop_names;
};
```

Register

Trader interface for servers:

```
interface Register {
  OfferId export(in Object reference,
                 in ServiceTypeName type,
                 in PropertySeq properties)
                 raises(...);
  void withdraw(in OfferId id) raises(...);
  void modify(in OfferId id,
              in PropertyNameSeq del_list,
              in PropertySeq modify_list)
              raises (...);
};
```

Lookup

Trader interface for clients:

```
interface Lookup {
  void query(in ServiceTypeName type,
             in Constraint const,
             in Preference pref,
             in PolicySeq policies,
             in SpecifiedProps desired_props,
             in unsigned long how_many,
             out OfferSeq offers,
             out OfferIterator offer_itr,
             out PolicyNameSeq Limits_applied)
             raises (...);
};
```

Java Naming and Directory Interface JNDI

JNDI

1 What is JNDI?

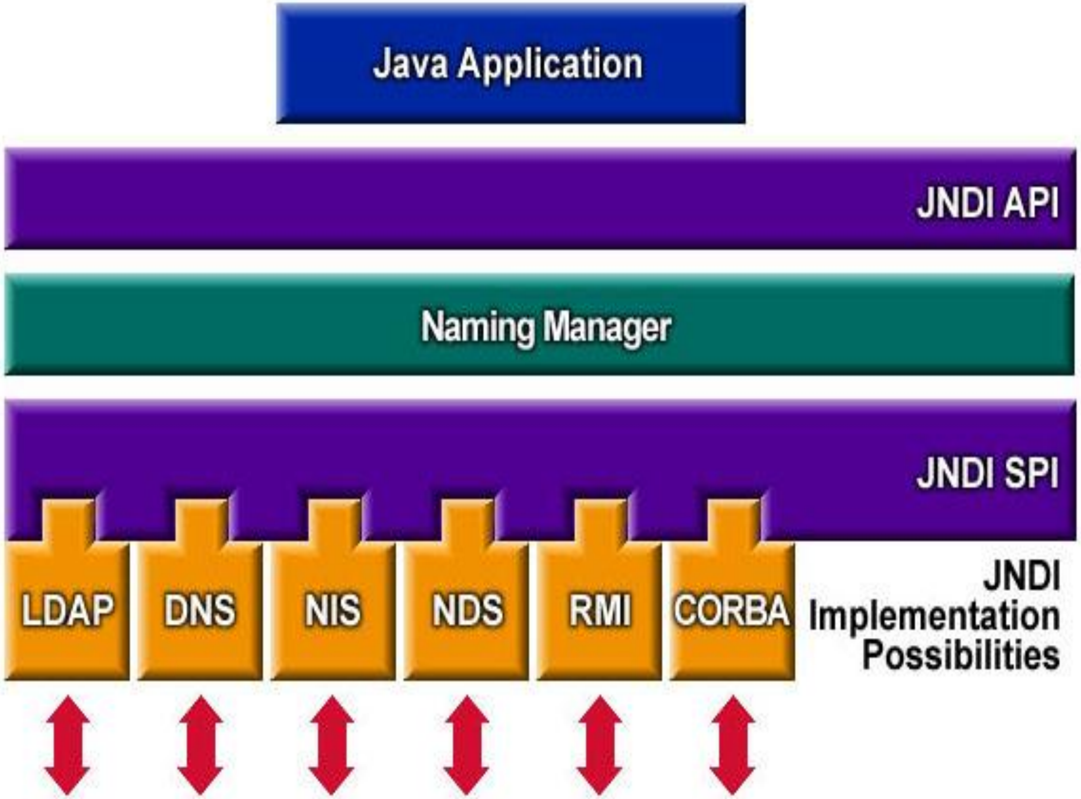
2 Setup

3 Concepts & Classes

What is JNDI?

- Java Naming and Directory Interface API
- Introduced in March, 1997 by Sun Microsystems
- Purpose: to provide a common access to different types of directories

What is JNDI?


Java Application
JNDI API
Naming Manager
JNDI SPI
LDAP
DNS
NIS
NDS
RMI
CORBA
JNDI Implementation Possibilities

JNDI

- The javax.naming packages contains mostly Java interfaces.
- Some vendor implements the interface to provide JNDI support for their service.
- To use the service, you need a JNDI Service Provider that implements the interface
- JDK1.4 comes with RMI, DNS, COS, and LDAP Service providers.
- Sun’s web site has an additional JNDI Service Provider that works with the local file system

JNDI

- A namespace is a logical space in which names can be defined.
- The same names in different namespaces cause no collisions.
- Namespaces can be nested:

    - file system directories are nested

    - the Internet DNS domains and

      sub-domains are nested

Packages

- javax.naming
- javax.naming.directory
- javax.naming.event
- javax.naming.ldap
- javax.naming.spi

Namespaces are represented by the Context Interface

- Different classes implement this interface differently depending on which naming service they are accessing.
- Has methods to

  - bind and unbind objects to names

  - create and delete sub-contexts

  - lookup and list names
- Since a Context is a Java object it can be registered in another Context with its own name.

The Context Interface

- Start from some “root” context.
- Get the “root” from the InitialContext class
- Examples

    LookUp.java

    ListCurrentDirectory.java

Class: Context

- Methods:

```
bind(String name, Object obj);
close();
list(String name);
listBindings(String name);
lookup(String name);                // most commonly used
rebind(String name, Object obj);
rename(String oldName, String newName);
unbind(String name);
```

Class: DirContext

- Extends Context
- methods:

getAttributes(String name);

modifyAttributes(String name, ModificationItem[] mods);

search(String name, Attributes matchAttrs);

Classes: InitialContext & InitialDirContext

- All operations are performed relative to an initial context
- set environment properties
  - Location of server (PROVIDER_URL)
  - How to create a context (INITIAL_CONTEXT_FACTORY)
- instantiation may throw a NamingException

LookUp.java

```
// before running download JNDI provider from Sun
// add .jar files to classpath

import javax.naming.Context;
import javax.naming.InitialContext;
import javax.naming.NamingException;
import java.util.Hashtable;
import java.io.File;
```

```
public class LookUp {

  public static void main(String args[]) throws NamingException {

   try {

     System.out.println("Using a file system (FS) provider");

     // initialize the context with properties for provider
     // and current directory
     Hashtable env = new Hashtable();
     env.put(Context.INITIAL_CONTEXT_FACTORY,
                "com.sun.jndi.fscontext.RefFSContextFactory");
     env.put(Context.PROVIDER_URL,
                "file:D:\\McCarthy\\www\\95-702\\examples\\JNDI");

     Context ctx = new InitialContext(env);

     Object obj = ctx.lookup(args[0]);
```

```
            if(obj instanceof File) {

                  System.out.println("Found a file object");

                  System.out.println(args[0] + " is bound to: " + obj);

                  File f = (File) obj;

                  System.out.println(f + " is " + f.length() + " bytes long");
             }
            // Close the context when we're done
            ctx.close();
           }
           catch(NamingException e) {
                System.out.println("Naming exception caught" + e);
           }
         }
       }
```

```
D:\McCarthy\www\95-702\examples\JNDI>java LookUp LookUp.java
Using a file system (FS) provider
Found a file object
LookUp.java is bound to: D:\McCarthy\www\95-702\examples\JNDI\LookUp.java
D:\McCarthy\www\95-702\examples\JNDI\LookUp.java is 1255 bytes long
```

ListCurrentDirectory.java

```
// Use JNDI to list the contents of the current
// directory

import javax.naming.Context;
import javax.naming.InitialContext;
import javax.naming.NamingException;
import javax.naming.NamingEnumeration;
import javax.naming.NameClassPair;
import java.util.Hashtable;
import java.io.File;
```

```
public class ListCurrentDirectory  {

  public static void main(String args[]) throws NamingException {

   try {

     Hashtable env = new Hashtable();
     env.put(Context.INITIAL_CONTEXT_FACTORY,
                 "com.sun.jndi.fscontext.RefFSContextFactory");
     env.put(Context.PROVIDER_URL,
                  "file:D:\\McCarthy\\www\\95-702\\examples\\JNDI");
```

```
     Context ctx = new InitialContext(env);

     NamingEnumeration list = ctx.list(".");

     while (list.hasMore()) {
         NameClassPair nc = (NameClassPair)list.next();
         System.out.println(nc);
      }
     ctx.close();
    }
    catch(NamingException e) {
        System.out.println("Naming exception caught" + e);
    }
  }
}
```

```
D:\McCarthy\www\95-702\examples\JNDI>java ListCurrentDirectory
ListCurrentDirectory.class: java.io.File
ListCurrentDirectory.java: java.io.File
LookUp.java: java.io.File
SimpleJNDI.java: java.io.File
x: javax.naming.Context
```

```
// Use JNDI to change to a sub directory and list contents

import javax.naming.Context;
import javax.naming.InitialContext;
import javax.naming.NamingException;
import javax.naming.NamingEnumeration;
import javax.naming.NameClassPair;
import java.util.Hashtable;
import java.io.File;

public class ChangeContext  {

  public static void main(String args[]) throws NamingException {

   try {
     Hashtable env = new Hashtable();
     env.put(Context.INITIAL_CONTEXT_FACTORY,
              "com.sun.jndi.fscontext.RefFSContextFactory");
     env.put(Context.PROVIDER_URL,
              "file:D:\\McCarthy\\www\\95-702\\examples\\JNDI");
```

```
        Context ctx = new InitialContext(env);

        // a subdirectory called x contains a file f.txt and a subdirectory t
        Context sub = (Context)ctx.lookup("x");

        NamingEnumeration list = sub.list(".");

        while (list.hasMore()) {
            NameClassPair nc = (NameClassPair)list.next();
            System.out.println(nc);
         }
        ctx.close();
        sub.close();

       }
       catch(NamingException e) {
           System.out.println("Naming exception caught" + e);
       }
     }
   }
```

```
D:\McCarthy\www\95-702\examples\JNDI>java ChangeContext

f.txt: java.io.File
t: javax.naming.Context
```

CORBA Transaction Service
OTS

X/Open Distributed Transaction Processing

CORBA Transaction Service

CORBA Transaction Service

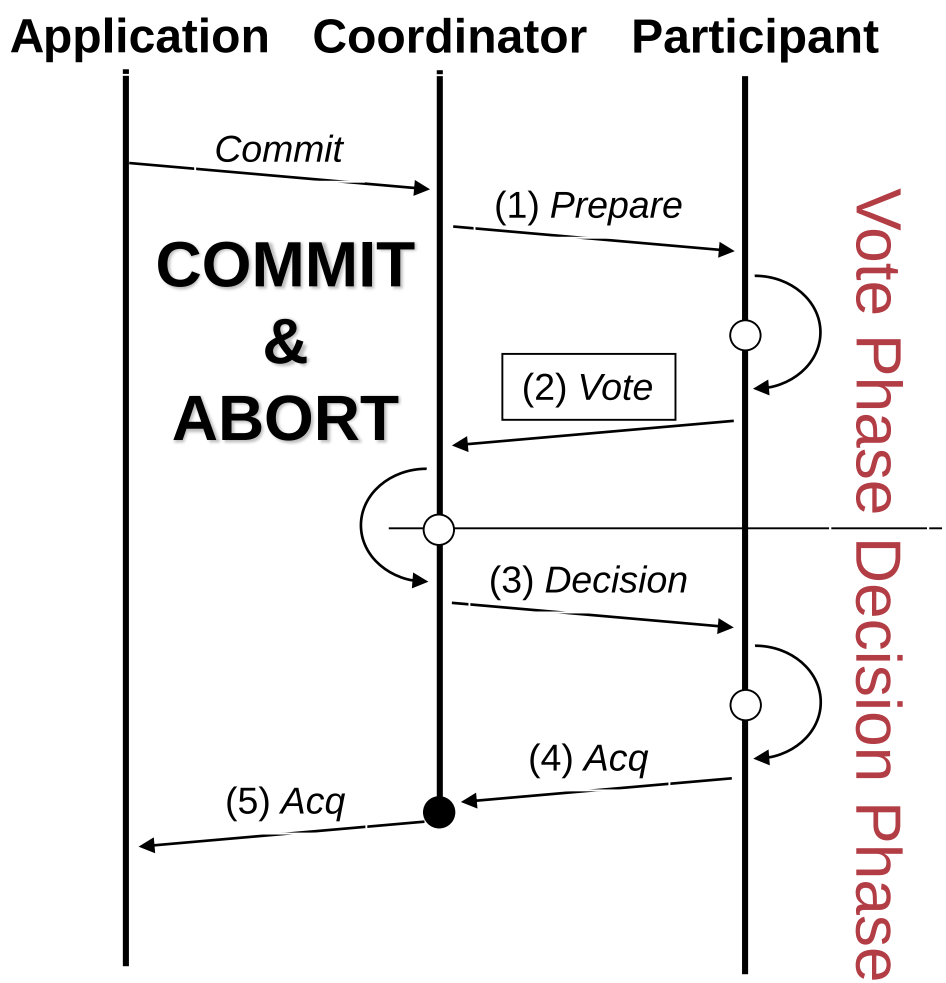
- CORBA Transaction Service (OTS) provides transaction capabilties to CORBA servers
- The Transactions Service defines interfaces and behaviours that allow multiple, distributed objects to cooperate to provide *ACID* transactions
  - Flat transactions
  - Nested transactions
- OTS is very flexible and provide the developers with a variety of programming models
  - OTS can take care of the most of the work managing a transaction
  - OTS also let you be explicit in how the transaction proceed

ACID

- **ATOMICITY:** A transaction should be done or undone completely and unambiguously. In the event of a failure of any operation, effects of all operations that make up the transaction should be undone, and data should be rolled back to its previous state.
- **CONSISTENCY:** A transaction should preserve all the invariant properties (such as integrity constraints) defined on the data. should preserve all the integrity constraints defined on the data.
- **ISOLATION:** Each transaction should appear to execute independently of other transactions that may be executing concurrently in the same environment. The effect of executing a set of transactions serially should be the same as that of running them concurrently.
- **DURABILITY:** The effects of a completed transaction should always be persistent.

2-Phase Commit Protocol Schema

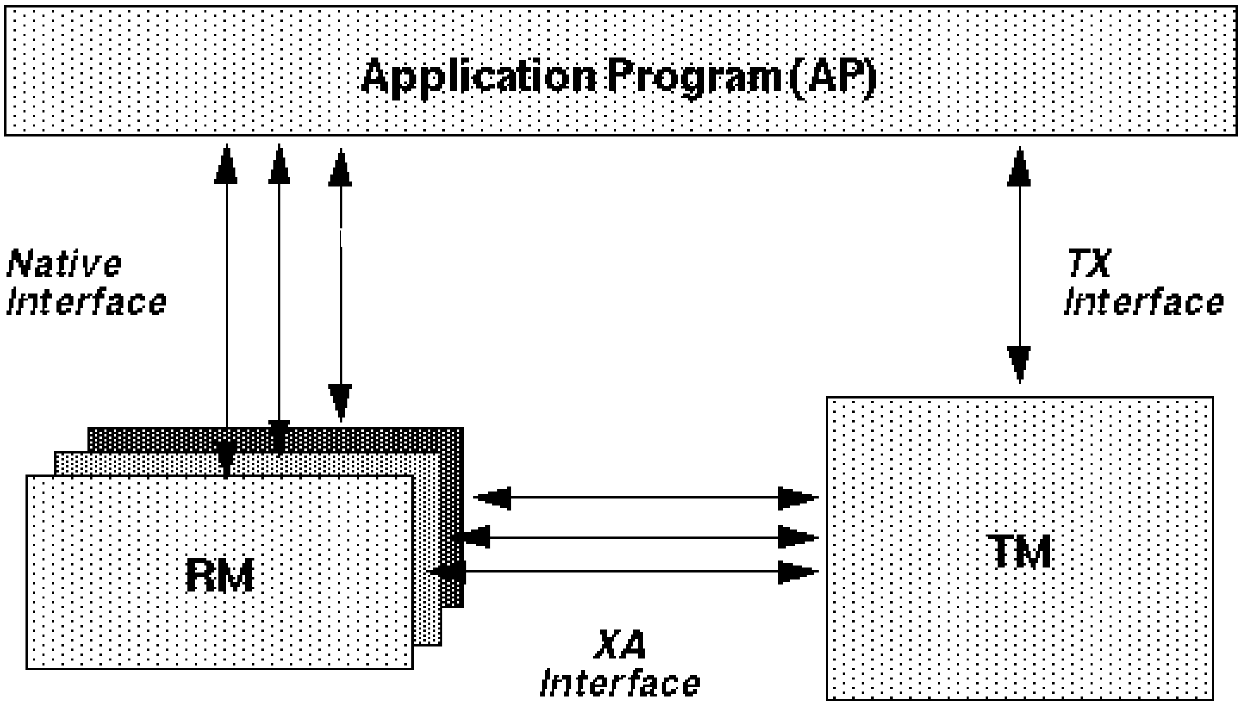
- Process ordered by the application
- **Messages** exchanged between:
  - *1 coordinator*
  - *Several participants*
- **2 Phases**:
  - *Vote phase: decide the issue of the transaction*
  - *Decision phase: apply the issue of the transaction*
- **Logs** at each phase:
  - *Journalize the evolution of the protocol*
  - *Recovery concern*



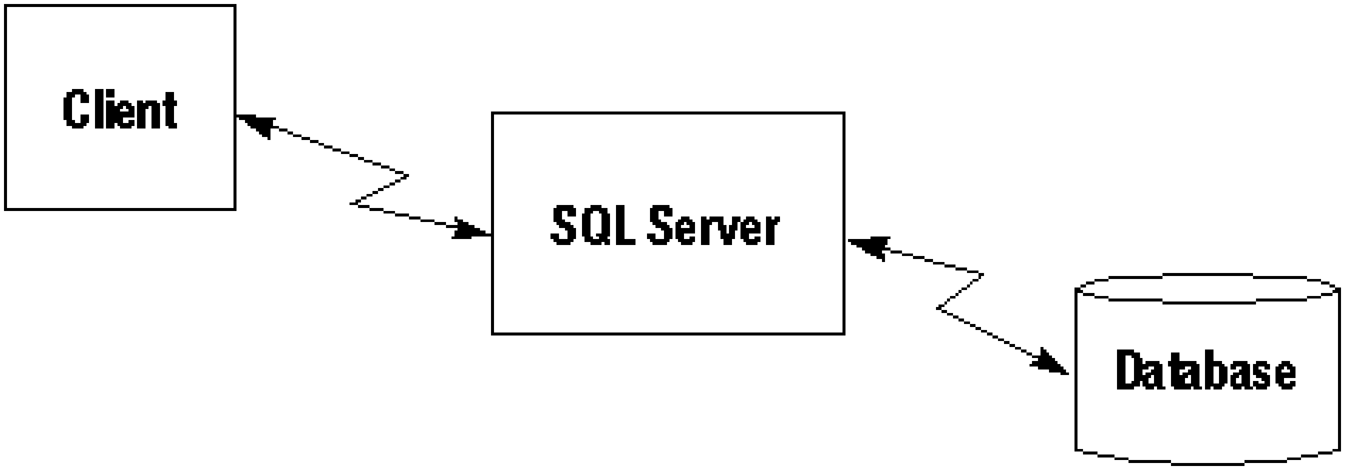
● no force log

○ force log

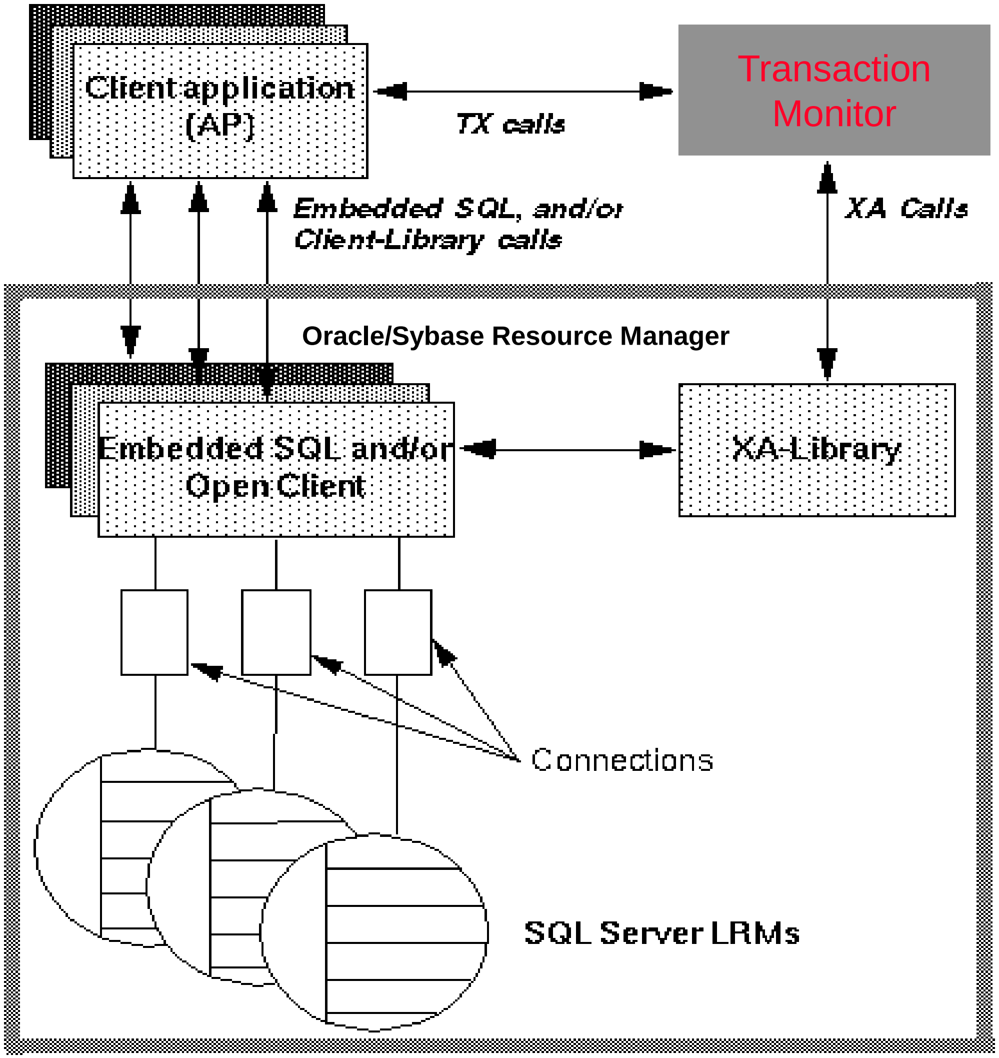
X/Open DTP Model



Transaction Processing Standard Elements



XA DTP Model



Client application (AP)
TX calls
Transaction Monitor
Embedded SQL, and/or Client-Library calls
XA Calls
Oracle/Sybase Resource Manager
Embedded SQL and/or Open Client
XA-Library
Connections
SQL Server LRMs

TX interface Mapping

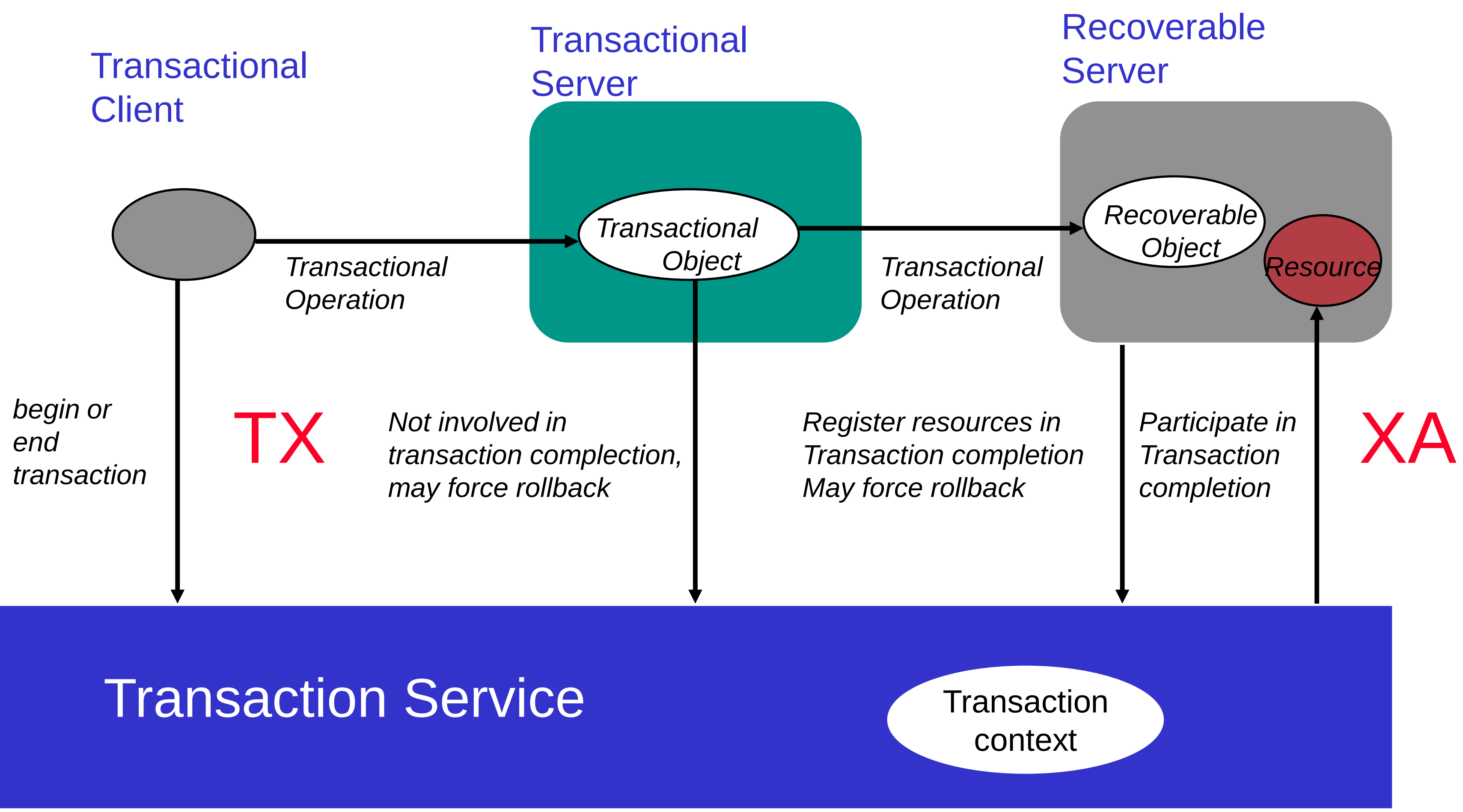
TX interface	*Current* interface
tx_open()	*no equivalent*
tx_close()	*no equivalent*
tx_begin()	Current::begin()
tx_rollback()	Current::rollback() or Current::rollback_only()
tx_commit()	Current::commit()
tx_set_commit_return()	report_heuristics parameter of Current::commit()
tx_set_transaction_control()	*no equivalent* *(chained transactions not supported)*
tx_set_transaction_timeout()	Current::set_timeout()
tx_info() - XID	Coordinator::get_txcontext() Current::get_name()[1]
tx_info() - COMMIT_RETURN	*no equivalent*
tx_info() - TRANSACTION_TIME_OUT	*no equivalent*
tx_info() - TRANSACTION_STATE	Current::get_status()

XA Interface

XA
A `xa_switch_t` object
An opened rmid
`xa_open_entry(char *, int, long)`
`xa_close_entry(char *, int, long)`
`xa_start_entry(XID *, int, long)`
`xa_end_entry(XID *, int, long)`
`xa_rollback_entry(XID *, int, long)`
`xa_prepare(XID *, int, long)`
`xa_commit(XID *, int, long)`
`xa_recover(XID *, long, int, long)`
`xa_forget(XID *, int, long)`
`xa_complete(int *, int *, int, long)`

CORBA Transaction Service

The OTS transaction model



CORBA Transaction Service

The OTS transaction model

- Transactional Client: invokes operations on transactional objects and is usually the originator of a transaction
- Transactional Objects: participate in transactions and contain or reference data affected by the transaction
  - Inherit from the *TransactionalObject* Interface
  - May contain state that is affected by a transaction but is not recoverable
  - May reference some other recoverable object (its state)

CORBA Transaction Service

- Recoverable Objects: is also a transactional object but it directly contains state affected by the transaction
  - Registers an associated *Resource* with the transaction service
  - The Resource stores the persistent state of the recoverable object and participates in the two-phase commit prototcol
- Transactional Servers: contains one or more transactional objects that are affected by the transaction
  - Interacts with resource managers or other transactional servers

CORBA Transaction Service

The OTS transaction model

- Recoverable Servers: contains one or more recoverable objects
  - Has an associated resource that contains persistent data and interacts the protocols of the transaction service
  - The Transaction Service drives the protocol by issuing requests to the resources registered for a transaction
- A client cannot see the difference between a transactional object or a recoverable object – its only concern is that the object is transactional

CORBA Transaction Service

The OTS programming model

- The simple view:
  - The client starts the transaction by contacting the Transaction Service
  - The service creates a transaction context for the new transaction
  - The client then makes a series of requests on transactional or non-transactional objects
  - The client then commits or roll back the changes by instructing the transaction service to commit or rollback
  - The transaction service then coordinate the two-phase commit protocol calling all the registered resources

CORBA Transaction Service
The OTS programming model

- The Transaction Service provides functions for:
  - Control the scope and duration of a transaction
  - Allow multiple objects to be involved in a single atomic transaction
  - Allow objects to associate changes in their internal state with a transaction
  - Coordinate the completion of a transaction using the two-phase commit protocol

CORBA Transaction Service

The OTS programming model

- The client uses the *Current* object to manage transactions (begin, commit, roll back)
- Any participant of the transaction can roll back the transaction – also archieved through the usage of the *Current* object
- If the transactional object is involved in more transactions at a time, it can distinquish between the transactions using a handle to the *Coordinator* (see example coming later)

The OTS programming model - Interfaces

Current

Begin
Commit
Rollback
Rollback_only
Suspend
Resume
Get_status
Get_control
Get_transaction_name

Control

Get_terminator
Get_coordinator

Resource

Prepare
Commit_one_phase
Commit
Rollback
forget

SubtransactionAwareResource

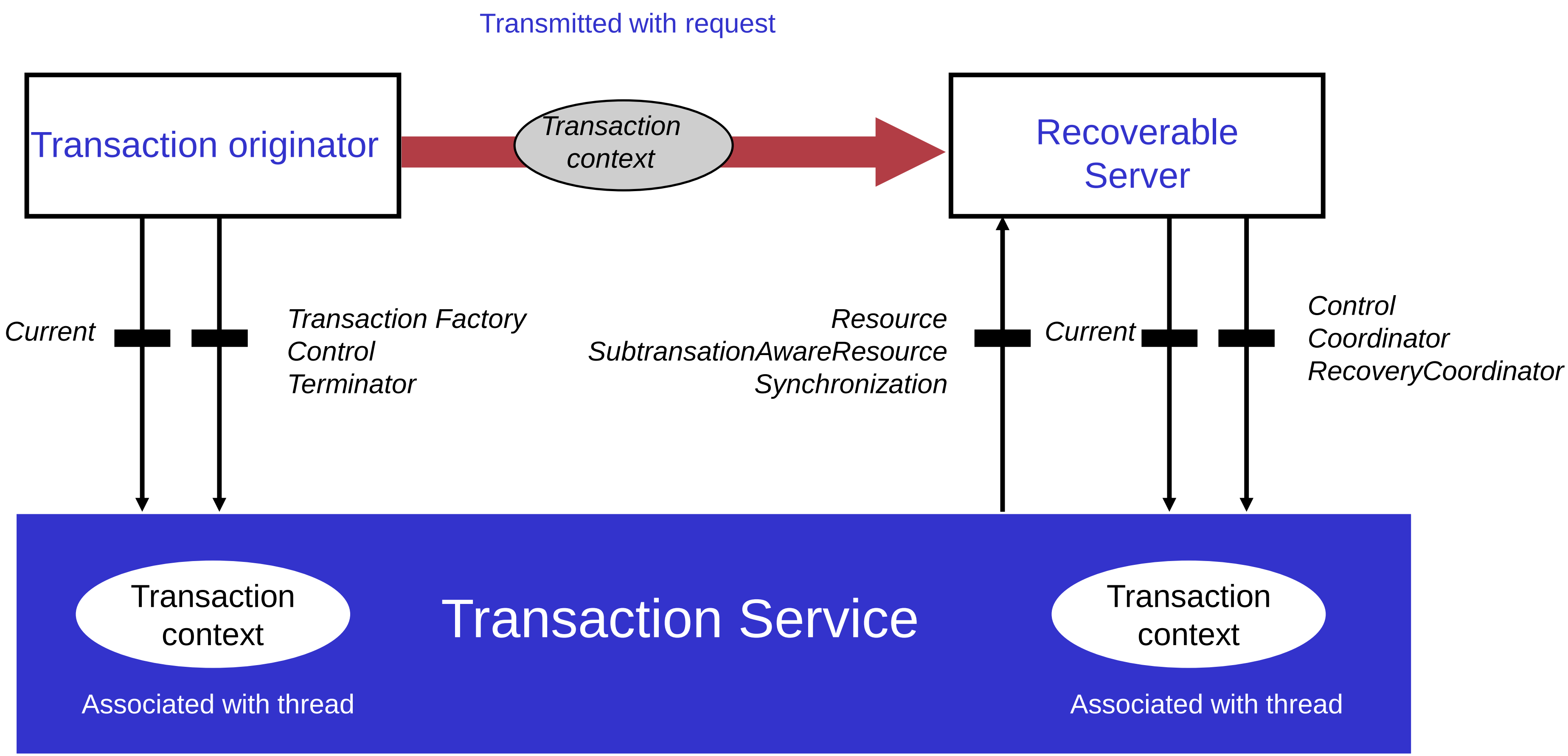
Commit_subtransaction
Rollback_subtransaction

Coordinator

Register_resource
Register_subtranaware
Rollback_only
Get_transaction_name
Create_subtransaction
Get_status
Get_parent_status
Get_top_level_status
Is_same_transaction
Is_related_transaction
Is_ancestor_transaction
Is_decendant_transaction
Is_top_level_transaction
Hash_transaction
Hash_top_level_tran
Get_txcontext

Not all are listed here

The OTS programming model - Interfaces



CORBA Transaction Service

The OTS programming model

- Objects can support two mechanisms to receive information associated with the transaction (transaction context)
  - Implicit propagation: if the object inherits from the *TransactionalObject* interface then a transaction context will be propagated with each method call
  - Explicit propagation: the transaction context is propagated by passing the *Control* object as an explicit parameter to methods being invoked

CORBA Transaction Service

The OTS programming model

- Participants can choose two ways for transaction context management (transaction context creation, initialization and control)
  - Indirect context management: rely on the Transaction Service to perform all context related responsibilities
  - Direct context management: elect to manage the context directly by using the standard OTS interfaces (*Control, TransactionFactory, Terminator*)

Simplyfies code

May be more convenient for explict propagation

CORBA Transaction Service
The OTS programming model

- Example of a transactional server:
  - start Naming Server (startnamingservice)
  - start Transaction Service (Just a POA server) (starttransactionservice)
  - start bank server (startwoserver)
  - start one bank client (startwoclient)
  - show effect of roolback by making a transfer which is not allowed
    - no atomicity

CORBA Transaction Service
The OTS programming model

- When making recoverable resources you have two choices:
  - You can use a database or another form of persistent storage for which there is a resource manager compliant with XA standard or native OTS support
  - You can implement your own recoverable resource
    - Wrapper around some non-XA compliant persistent storage
    - Completely your own code

CORBA Transaction Service

The OTS programming model

- When making recoverable objects, The Transaction Service controls the resource objects
- Each transactional object has to register the resource for a transactional object when the transaction is started
  - More clients concurrently working on the same transactional object are given a copy (the resource object) which is controlled by the Transaction Service
  - Upon commit the transactional object is given the values from the resource object (up to the developer to make this happen)

CORBA Transaction Service

The OTS programming model

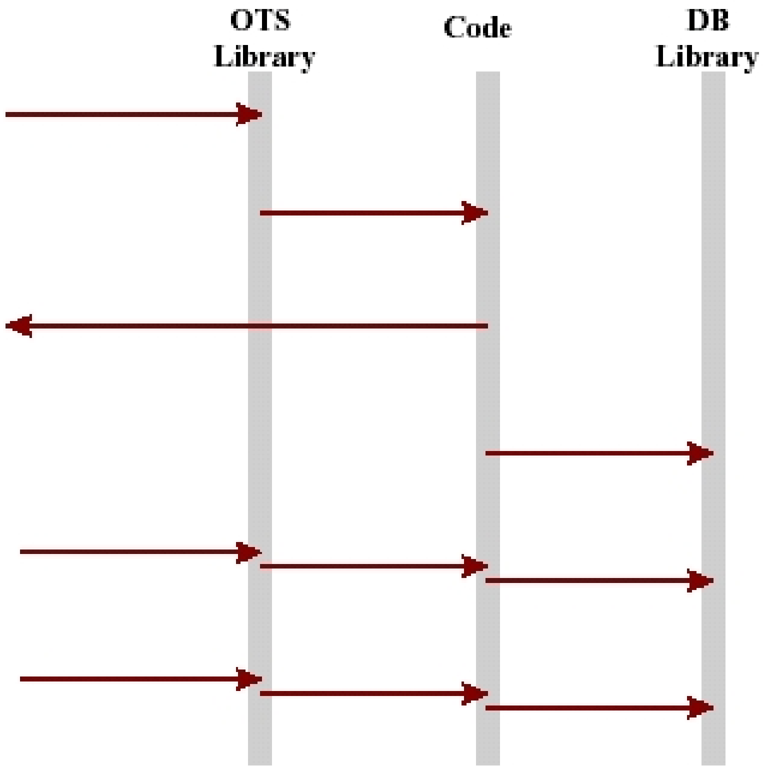
- The resource registration process can either manual or automatic
- In the manual case you use the Coordinator pseudo object implementing the *Coordinator* interface
- Some vendors however cooperate with database vendors to make databases have native support for the *Resource* interface

CORBA Transaction Service

The OTS programming model – Manual resource registration

In the case of explicit transaction Context propagation

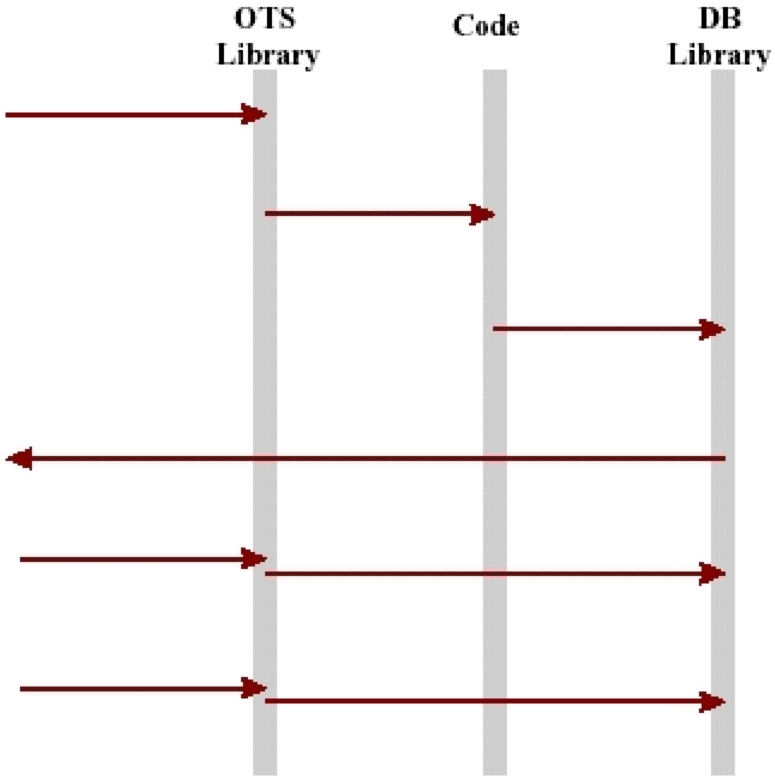
- Invocation Arrives, intercepted by OTS
- Invocation propagated to user code
- Code registers its own resource
- SQL update to database
- Prepare call arrives, code calls DB
- Commit call arrives, code calls DB



CORBA Transaction Service
The OTS programming model – Automatic resource registration

In the case of implicit transaction Context propagation

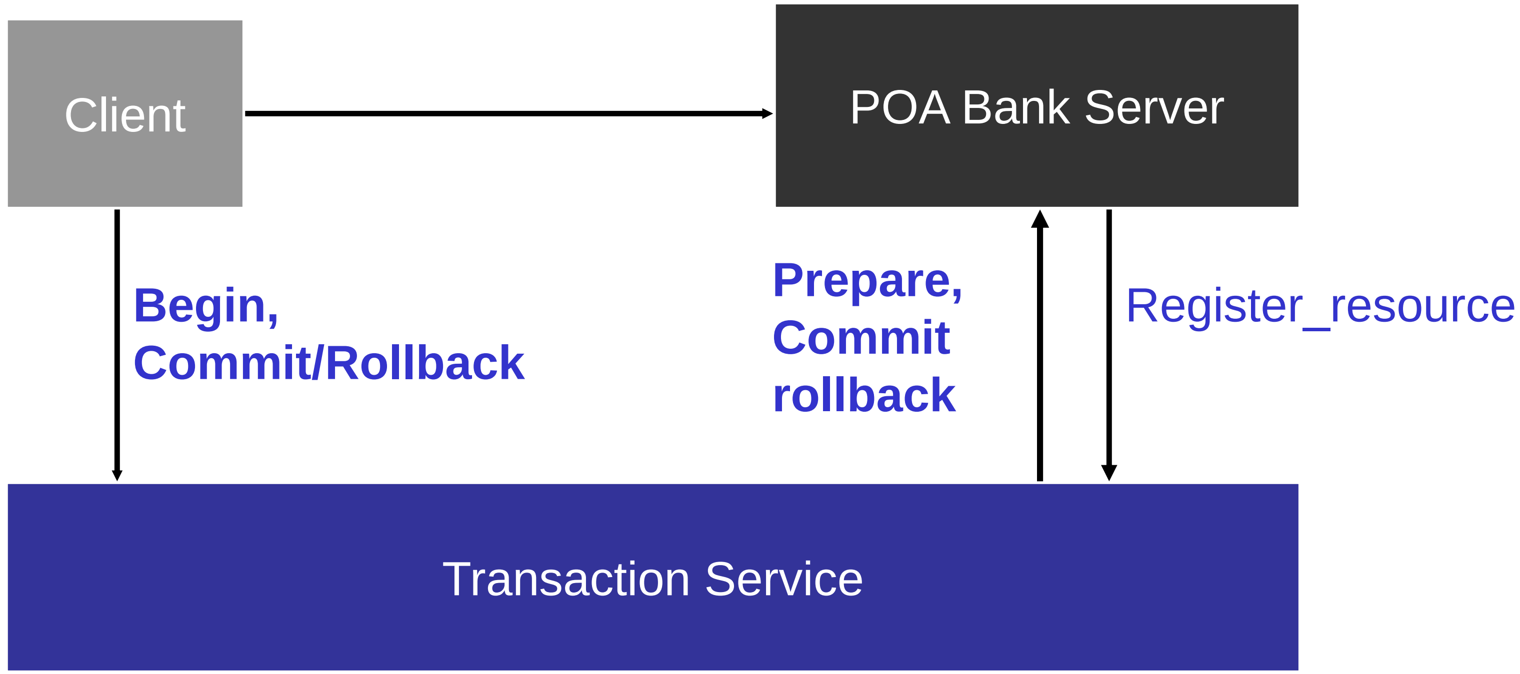
- Invocation Arrives, intercepted by OTS
- Invocation propagated to user code
- SQL update to database
- Database registers its native *Resource*
- Prepare call arrives
- Commit call arrives



The OTS programming model - Example

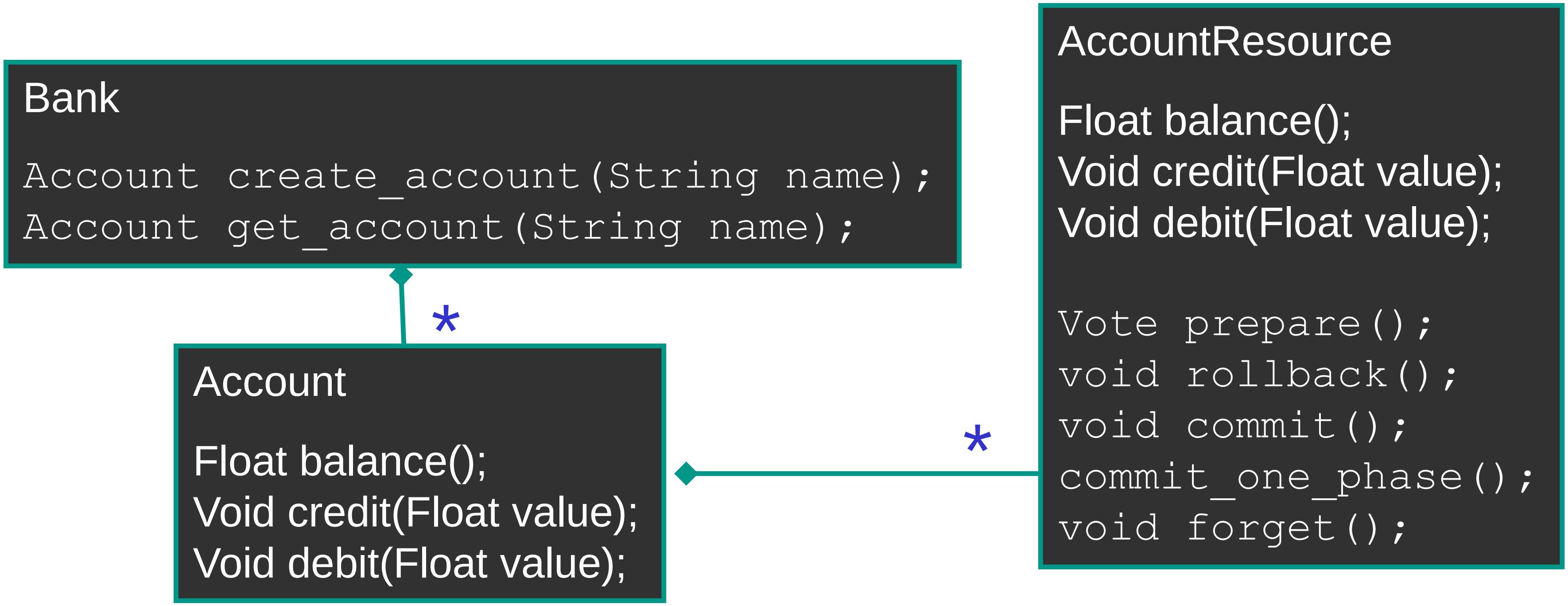
- Example of a (not persistent) recoverable server:
  - start Naming Server (startnamingservice)
  - start Transaction Service (Just a POA server) (starttransactionservice)
  - start new bankserver (startwserver)
  - start one bank client (startwclient)
  - show effect of rollback by making a transfer which is not allowed
    - atomicity achieved
  - Show the effect of a server crash in the middle of a transaction
    - Server is NOT recoverable

The OTS programming model - Example



The OTS programming model - Example

Registered in the Naming Service – factory for accounts



For each Account instance (identified by name) there will be a number of AccountResource instances aggregated (one for each transaction), all which are registered as resources in the Transaction Service server

The OTS programming model - Example

```
public class BankImpl extends BankPOA
{
  private java.util.Hashtable _accounts;
   ...
  public Account create_account( String name ) {
    AccountImpl acc = new AccountImpl( _orb, name );
    _accounts.put( name, acc );
    return acc._this( _orb );
  }

  public Account get_account( String name )
                   throws NotExistingAccount {
    AccountImpl acc = ( AccountImpl ) _accounts.get( name );
    if ( acc == null )
      throw new NotExistingAccount();
    return acc._this( _orb );
  }
}
```

The OTS programming model - Example

```
public class AccountImpl extends AccountPOA {
...
 public float balance() {
  return get_resource().balance();
 }
 public AccountResource get_resource() {
   try {
    Object obj = _orb.resolve_initial_references( "TransactionCurrent" );
    Current current = org.omg.CosTransactions.CurrentHelper.narrow( obj );
    Coordinator coordinator = current.get_control().get_coordinator();
    AccountResourceImpl resource = null;
    for ( int i = 0; i < _resources.size(); i++ ) {
      resource = ( AccountResourceImpl ) _resources.elementAt( i );
      if ( coordinator.is_same_transaction( resource.coordinator() ) )
       return resource._this( _orb );
      }
    resource = new AccountResourceImpl( _poa(), coordinator, this, _name );
    AccountResource res = resource._this( _orb );
    coordinator.register_resource( res );
    _resources.addElement( resource );
   return res;
   } catch (.....)...
```

Clients share the same account instances but requests are routed to an AccountResource which are created for each transaction

The Transaction Service is just a POA server which registers remote callback objects

The OTS programming model - Example

```
public class AccountResourceImpl extends AccountResourcePOA  {
   ...
 private AccountImpl _account;

 public AccountResourceImpl( org.omg.PortableServer.POA poa,
              org.omg.CosTransactions.Coordinator coordinator,
              AccountImpl account, String name ){
  _account = account;
   .....
  }
  .....
 public void credit( float value ) {
    _current_balance += value;
  }

 public void commit() throws org.omg.CosTransactions.NotPrepared,
                     org.omg.CosTransactions.HeuristicRollback,
                     org.omg.CosTransactions.HeuristicMixed,
                     org.omg.CosTransactions.HeuristicHazard {
 _account._balance = _current_balance;
 removeItself();
}
```

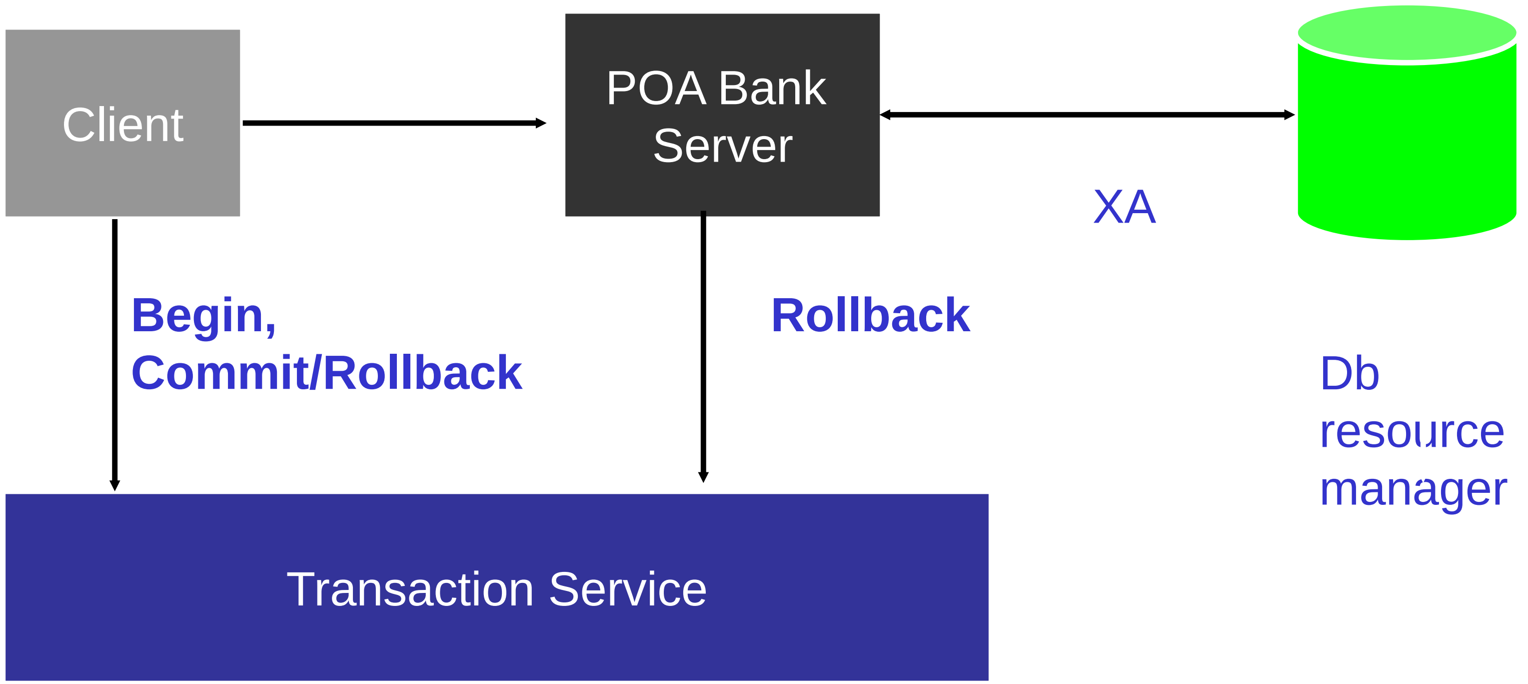
The transactional Object
Can be referenced

By commit the trans-
actional object is up-
dated

The OTS programming model - Example

- Example of using a XA compliant database (Oracle) to make a recoverable object server:
  - start Naming Server (startnamingservice)
  - start Transaction Service (Just a POA server) (starttransactionservice)
  - start new bankserver (startwxaserver)
  - start one bank client (startwxaclient)
  - show effect of rollback by making a transfer which is not allowed
    - atomicity achieved
  - Show the effect of a server crash in the middle of a transaction
    - Server is recoverable

The OTS programming model – Example II



The OTS programming model – Example II

Registered in the Naming Service – factory for accounts

Bank

```
Account create_account(String name);
Account get_account(String name);
```

*

Account

Float balance();
Void credit(Float value);
Void debit(Float value);

1

ResourceConnection

createStatement();
prepareStatement(String);
executeQuery();
....

For each Account instance (identified by name) there will be a database connection aggregated acting as the resource
No resources are registered in the Transaction Service server

The OTS programming model – Example II

```
public class BankImpl extends BankPOA  {
  private java.sql.Connection _db;
  private java.util.Hashtable _accounts;
       ...
  public Account create_account( String name )
                 throws AllreadyExistingAccount {
    connectToDatabase();
    AccountImpl acc = new AccountImpl( _orb, name, _db );
    _accounts.put( name, acc );
    try {
     java.sql.PreparedStatement pstmt =
         _db.prepareStatement("INSERT INTO Accounts VALUES (?,?)");
     pstmt.setString(1,name);
     pstmt.setFloat(2, 0);
     pstmt.executeUpdate();
     pstmt.close();
    }  catch ( ....) {..}
    return acc._this( _orb );
  }
```

Connect to persistent resource

Access Persistent resource

Never do this:
-factor out persistence code
-Call stored procedure instead of insert (or something else)

No commit as the Transaction Service is responsible for this

The OTS programming model – Example II

```
public Account get_account( String name )throws NotExistingAccount {
  AccountImpl acc = ( AccountImpl ) _accounts.get( name );
  if ( acc == null ) {
    connectToDatabase();
      java.sql.ResultSet res = null;
      try {
      PreparedStatement pstmt =
           _db.prepareStatement("SELECT balance from Accounts where name=?");
      pstmt.setString( 1, name );
        res = pstmt.executeQuery();
      if (res.next()) {
       res.getFloat(1);
         acc = new AccountImpl( _orb, name, _db );
         _accounts.put( name, acc );
      }
      pstmt.close();
     } catch ( .. ) {..}
  }
  if ( acc == null ) throw new NotExistingAccount();
  return acc._this( _orb );
}
```

The OTS programming model – Example II

```
  public void connectToDatabase() {
    try {
     Object obj = _orb.resolve_initial_references
                                ("TransactionSessionManager");
     SessionManager session =
           org.openorb.ots.SessionManagerHelper.narrow(obj);
     _db = session.getConnection("test","test","InstantDB");
     _db.setTransactionIsolation(TRANSACTION_READ_COMMITTED);
    }  catch ( ... ) {..}

    if ( !tableExist() )
      createTable();
   }
   ....
}
```

Calls the database through the sessionManager via XA

Oracle JDBC 2.0 driver supports The XA interface

The OTS programming model – Example II

```
public class AccountImpl extends AccountPOA {
  ...
  public float balance()   {
    java.sql.ResultSet res = null;
    java.sql.PreparedStatement pstmt = null;
    try {
     pstmt=_db.prepareStatement("SELECT balance from Accounts where name=?");
     pstmt.setString( 1, _name );
     res = pstmt.executeQuery();
     res.next();
     return res.getFloat( 1 );
    }catch (... ) {}
    finally {... //close pstmt}
    return -1;
  }
  public void credit( float value ) {
     float _balance = balance();
     _balance += value;
     updateBalance( _balance );
  }
```

The OTS programming model – Example II

AcountImpl continued

```
public void debit( float value ){
  float _balance = balance();
  _balance -= value;
  if ( _balance < 0 ) rollbackOnly();
  updateBalance( _balance );
}
public void updateBalance( float _balance ) {
  try {
   PeparedStatement pstmt =
    _db.prepareStatement("UPDATE Accounts
                                     SET balance=? WHERE name=?");
   pstmt.setFloat( 1, _balance );
   pstmt.setString( 2, _name );
   pstmt.executeUpdate();
   pstmt.close();
  } catch ( ... ) {..}
}
```

No commit as the Transaction Service is Responsiblefor this

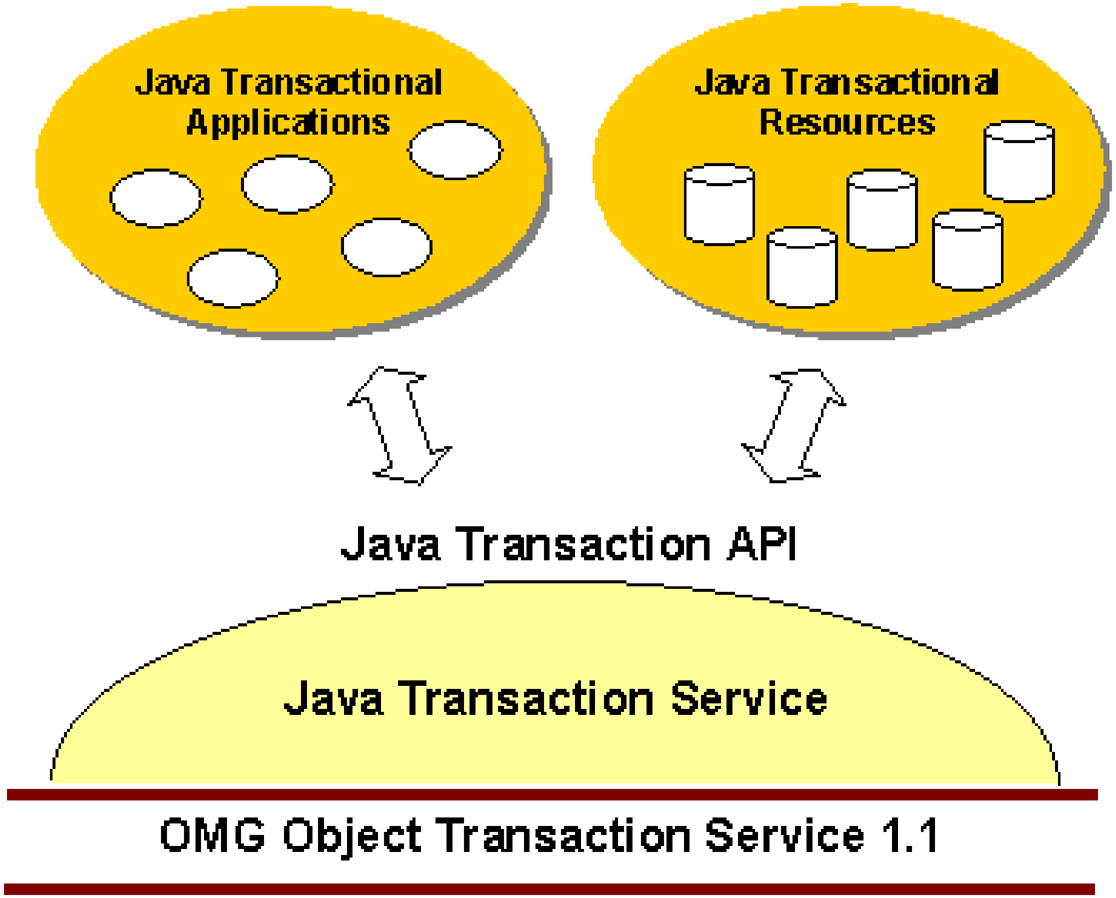
The OTS programming model – Example II

AcountImpl continued

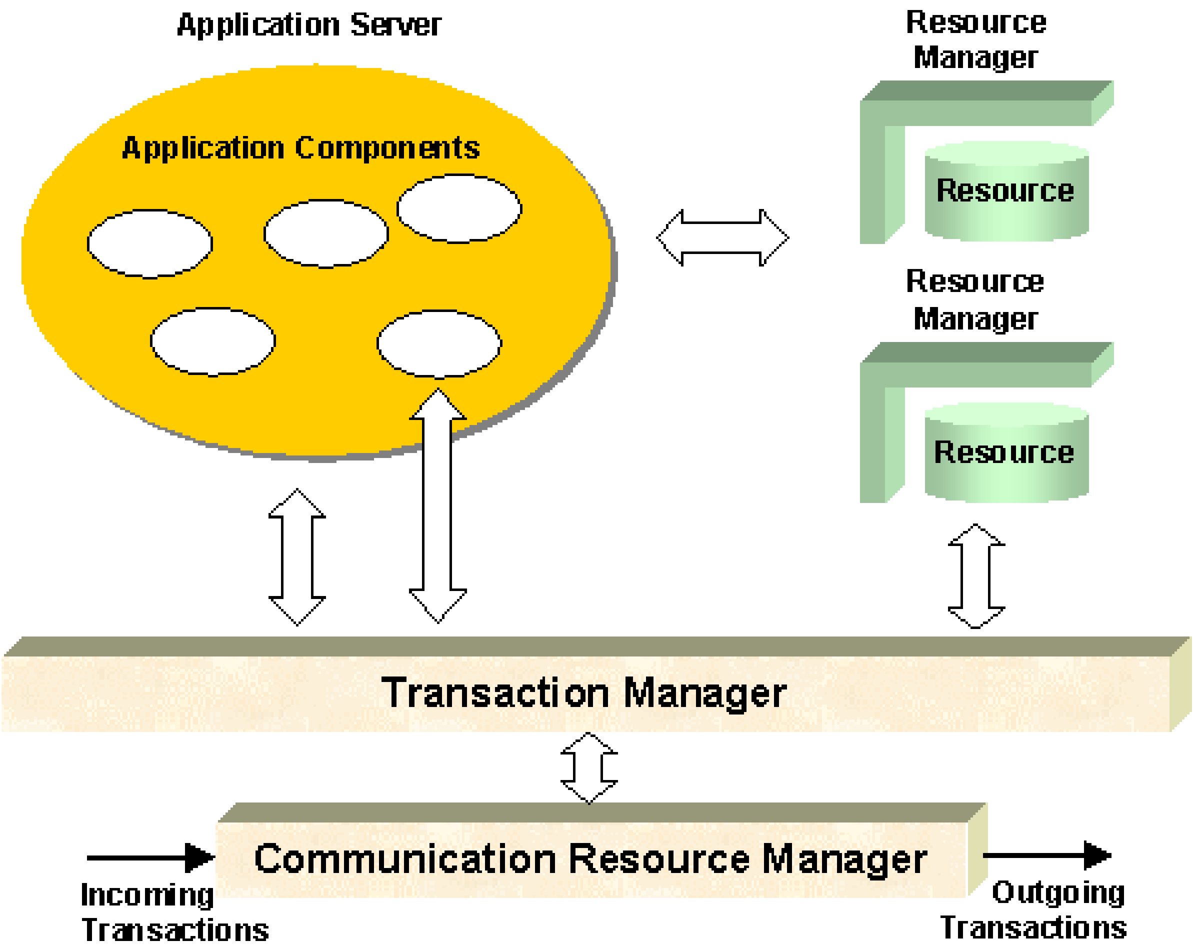
```
 public void rollbackOnly() {
   try {
    Object obj=_orb.resolve_initial_references("TransactionCurrent");
    Current current=org.omg.CosTransactions.CurrentHelper.narrow(obj);
    current.rollback_only();
   }catch (.... ) { .. }
  }
}
```

The method rollback() are in some implementations of Transaction Service only for the transaction originator client therefore rollback_only is used here as it is available to all transaction participants

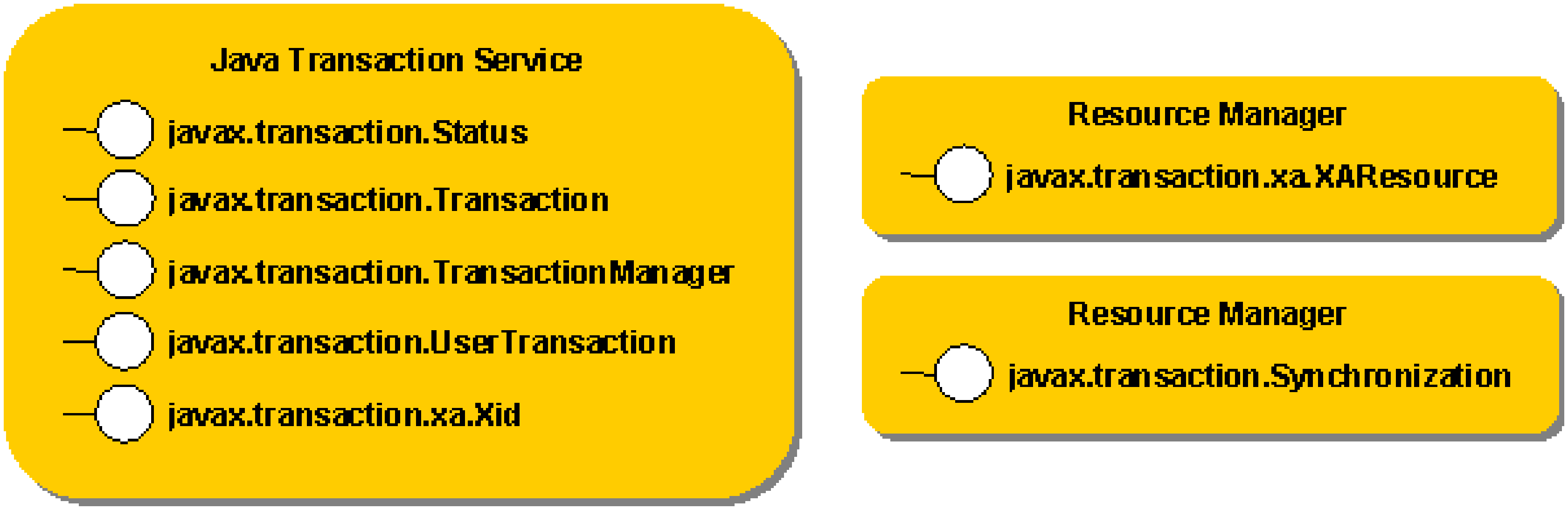
Java Transaction Service
JTS



JTS Architecture



Java Transaction API



OTS vs. JTA

Transaction Service	JTA
Current	`TransactionManager, UserTransaction`
Synchronization	`Synchronization`
Control/Coordinator/Terminator	`Transaction`
Current::begin	`TransactionManager.begin(),` `UserTransaction.begin()`
Current::commit	`TransactionManager.commit(),` `UserTransaction.commit()`

CORBA Transaction Service

Data Isolation

- For pure OTS applications using the *Resource* interface data isolation is best archieved by using the CORBA Concurrency Service

  Later we will see how to use CCS to develop data isolation

- If you are using a database as your recoverable server, the database will/can take care of the data isolation, but you can also combine it with CCS
  - The OTS Transaction Service will act as Transaction manager and coordinate the two-phase commit protocol with the resource manager for the database

CORBA Transaction Service

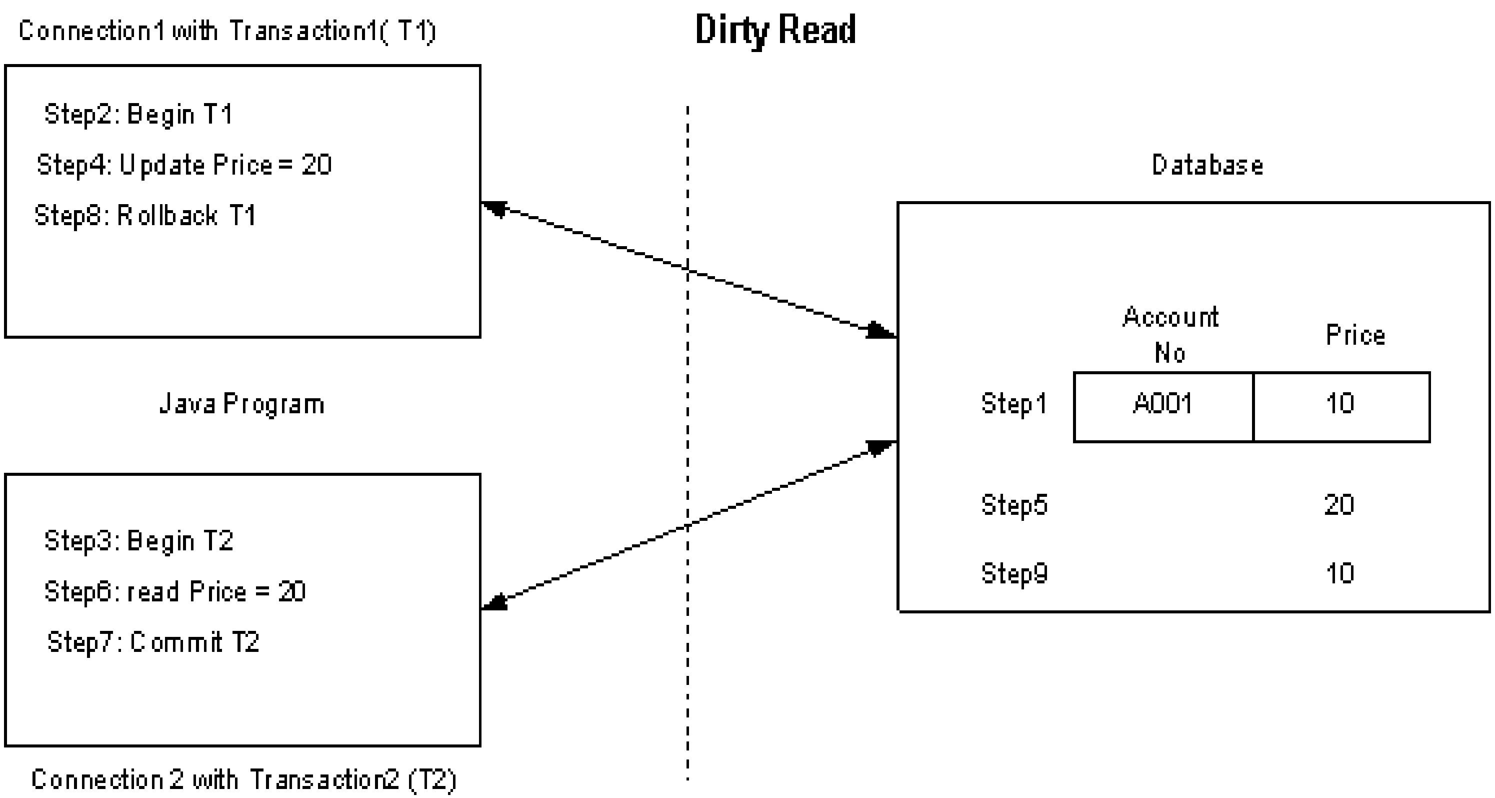
Data Isolation

- Two typical ways of making your XA Recoverable server resistent for concurrent users
  - Adapt an Optimistic locking scheme or
  - Adapt a Pessimistic locking scheme
  - Each client gets its own Account instance and data isolation is delegated to the Database – no sharing of transactional objects
- Or serialize access to Account object with CCS

Isolation Levels

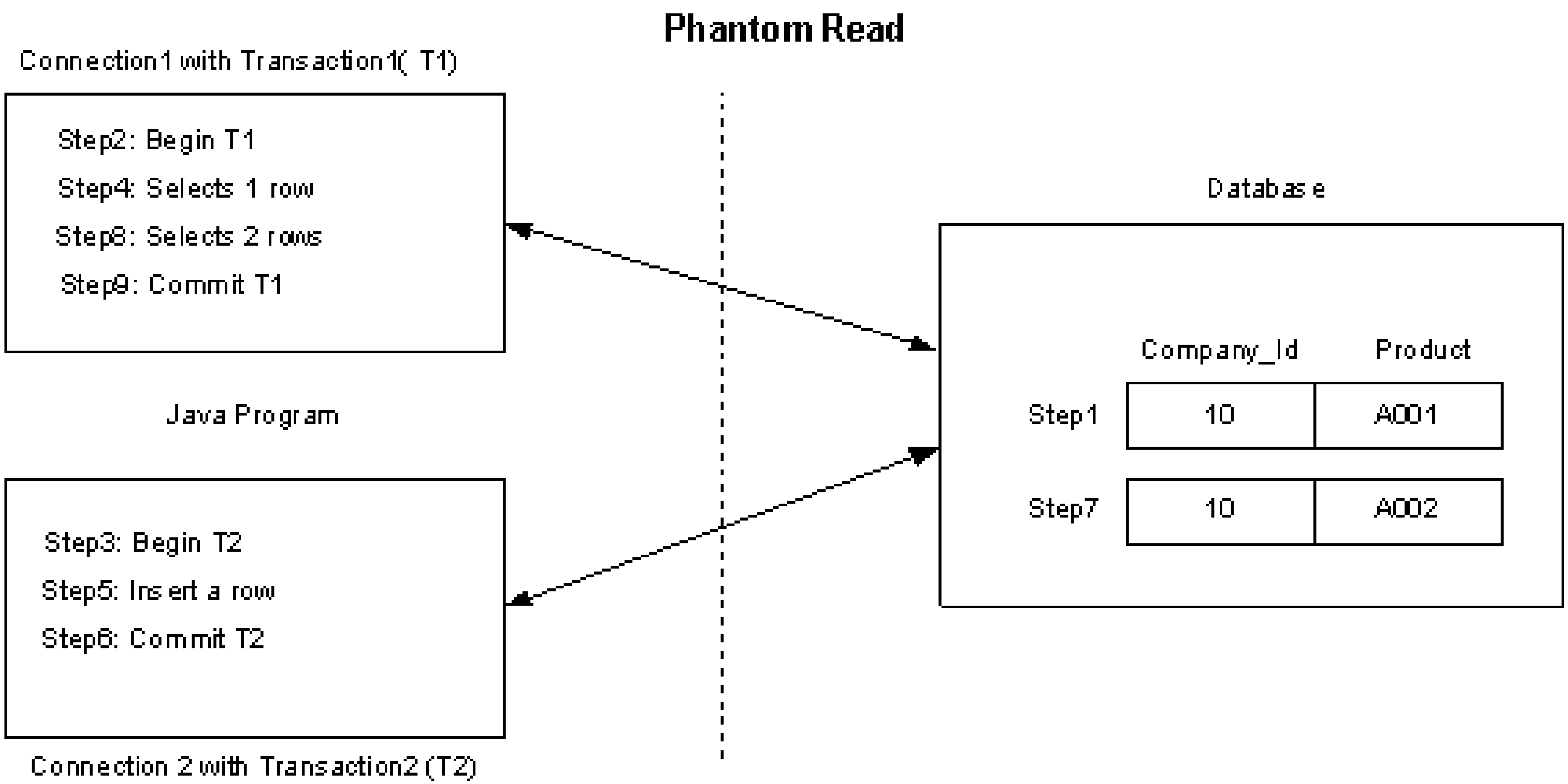
Transaction Level	Permitted Phenomena			Prefromance Impact
	Dirty Reads	Non Repeatable Reads	Phantom Reads	
TRANSACTION_READ_UNCOMMITED	YES	YES	YES	Fastest
TRANSACTION_READ_COMMITED	NO	YES	YES	Fast
TRANSACTION_RPEATABLE_READ	NO	NO	YES	Medium
TRANSACTION_SERIALIZABLE	NO	NO	NO	Slow

Dirty Read

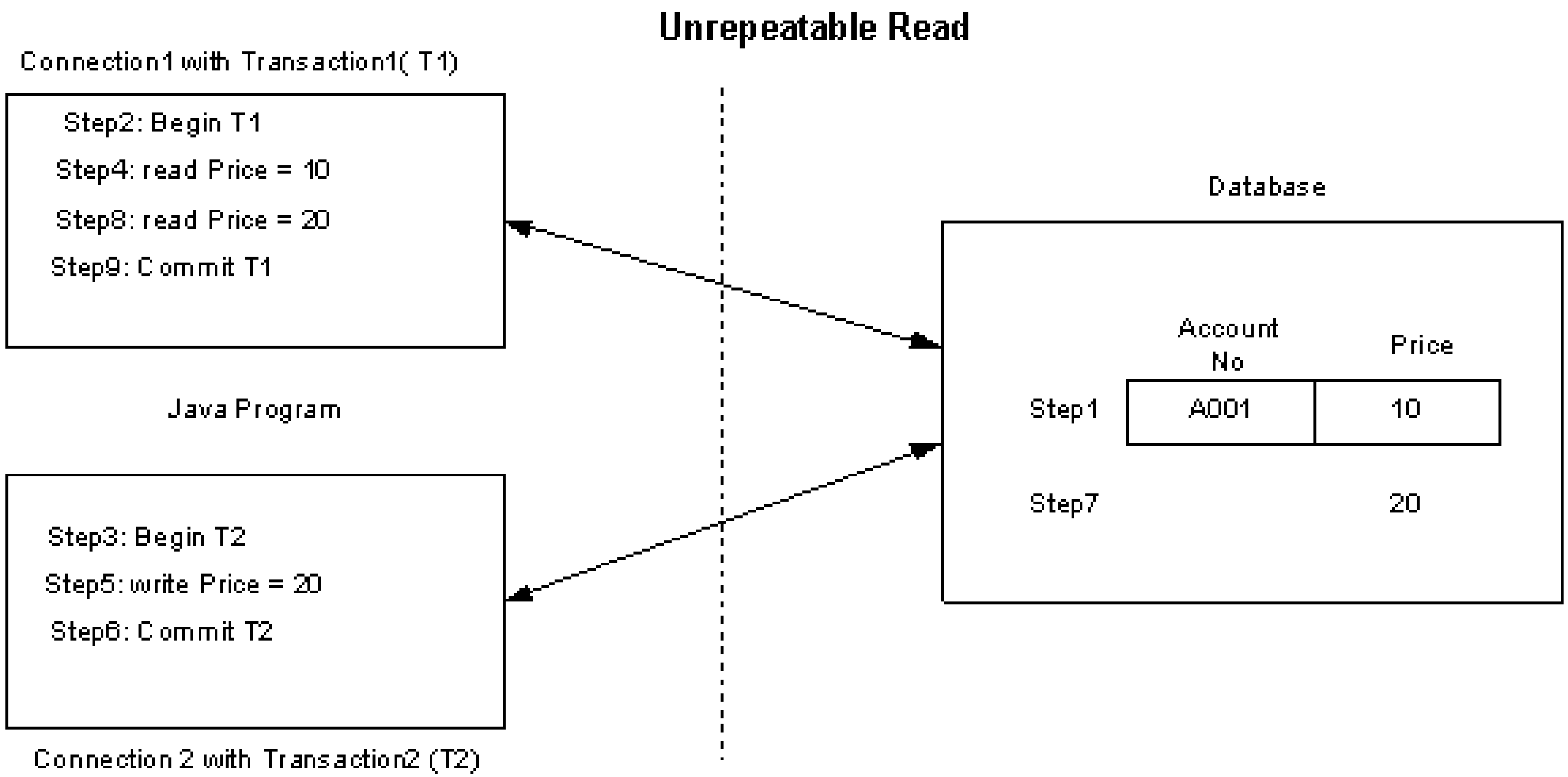


Connection1 with Transaction1(T1)
Dirty Read
Step2: Begin T1
Step4: Update Price = 20
Step8: Rollback T1
Database
Account No
Price
Step1
A001
10
Step5
20
Step9
10
Java Program
Step3: Begin T2
Step6: read Price = 20
Step7: Commit T2
Connection 2 with Transaction2 (T2)

Phantom Read



Unrepeatable Read



CORBA Transaction Service

Data Isolation - Isolation for Oracle Database System

- The Oracle Database provides three isolation levels
  - Read Committed
    - A transaction reads only committed data
    - Each query sees only data that is committed before execution of the query began
  - Serializable
    - A transaction sees only data that was committed before the transaction began plus changes made by the transaction itself
    - Access to data is serialized

CORBA Transaction Service

Data Isolation - Isolation for Oracle Database System

- Read-Only
  - The transaction only sees data as there were when the transaction started
  - Updates not allowed

CORBA Concurrency Service

- ”The pupose of the Concurrency Control Service is to mediate concurrent access to an object such that the consistency of the object is not comprimised when accessed concurrently” (CCS spec)
- Can be used in two ways
  - Transactional: on behalf of an transaction -> transaction service responsible for releasing locks as a part of the transaction completion
  - Non-transactional: outside transactions on behalf of the current thread -> user of CCS is responsible for releasing locks

Lock-based Protocols

- A transaction *must* get a *lock* before operating on the data
- Two types of locks:
  - *Shared* (S) locks (also called *read locks)*
    - Obtained if we want to only read an item
  - *Exclusive* (X) locks (also called *write locks)*
    - Obtained for updating a data item

Lock-based Protocols

- Lock requests are made to the *concurrency control manager*
  - It decides whether to *grant* a lock request
- T1 asks for a lock on data item A, and T2 currently has a lock on it ?
  - Depends

T2 lock type	T1 lock type	Should allow ?
Shared	Shared	YES
Shared	Exclusive	NO
Exclusive	-	NO

- If *compatible,* grant the lock, otherwise T1 waits in a *queue.*

CORBA Concurrency Service

- Lock model of CORBA Concurrency Control Service

*Lock conflict **

Granted Mode	Requested Mode *IR*	R	U	IW	W
Intention Read (IR)					*
Read (R)				*	*
Upgrade (U)			*	*	*
Intention Write (IW)		*	*		*
Write (W)	*	*	*	*	*

You place locks on resources like fx Objects (FIFO)

An Upgrade read lock is to avoid deadlocks

Intention write lock is to do variable Lock granularity in hierachical Relationships – set on ancestor

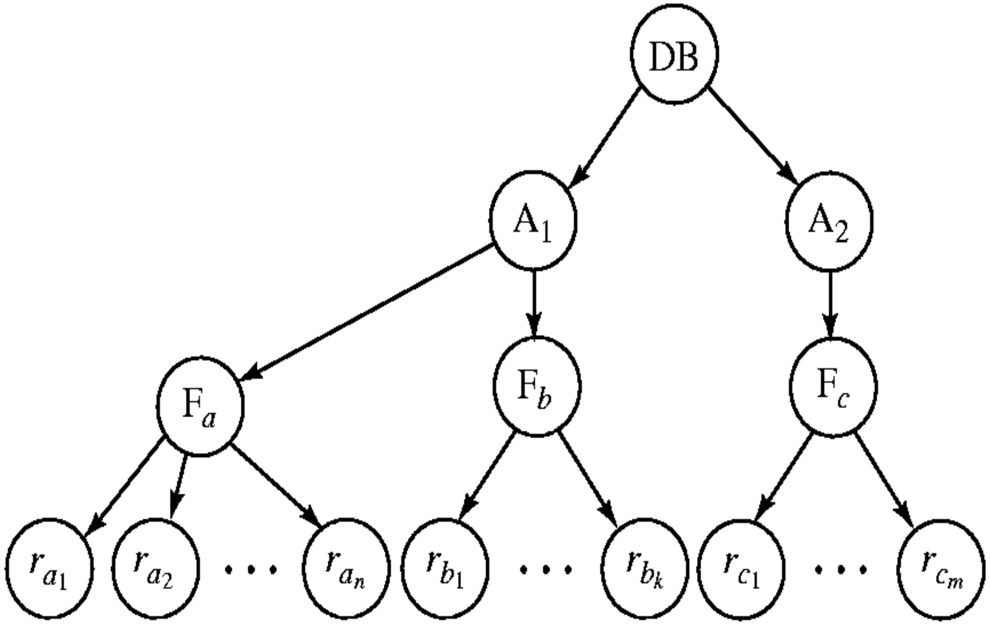
Intention read lock - do.

CORBA Concurrency Service

- The granularity of locks determine the concurrency in the application
  - Coarse-grained locks -> less concurrency and low overhead
  - Fine-grained locks -> more concurrency but high overhead

Database Table Record

Granularity Hierarchy



The highest level in the example hierarchy is the entire database.

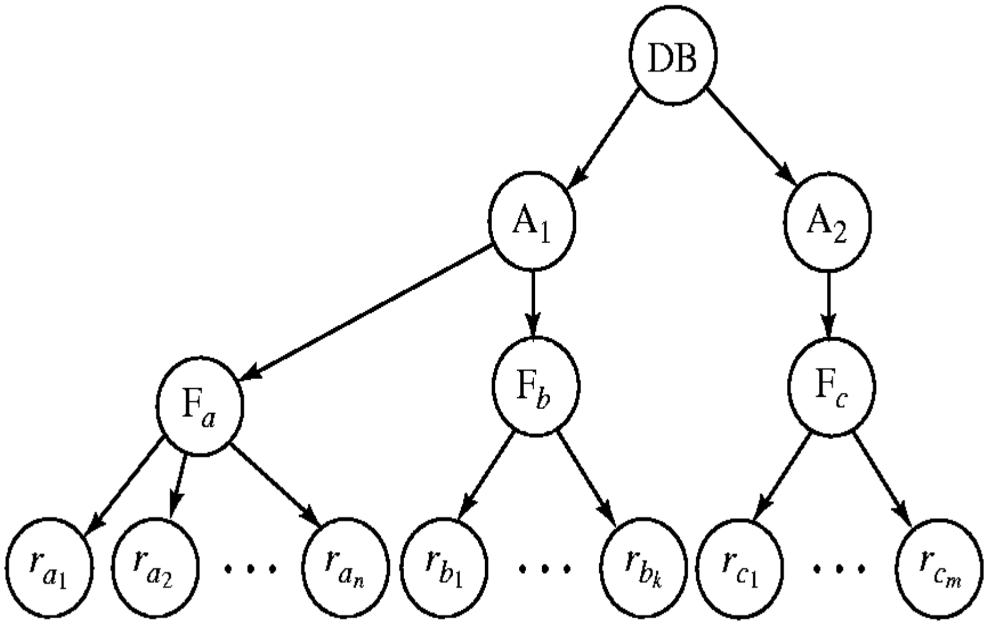
The levels below are of type *area*, *file or relation* and *record* in that order.

Can lock at any level in the hierarchy

Intention Lock

- New lock mode, called *intentional* locks
  - Declare an intention to lock parts of the subtree below a node
  - **IS: *intention shared***
    - The lower levels below may be locked in the shared mode
  - **IX: *intention exclusive***
  - **SIX*: shared and intention-exclusive***
    - The entire subtree is locked in the shared mode, but I might also want to get exclusive locks on the nodes below
- Protocol:
  - If you want to acquire a lock on a data item, all the ancestors must be locked as well, at least in the intentional mode
  - So you always start at the top *root* node

Granularity Hierarchy

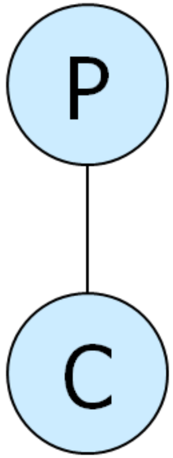


(1) Want to lock *F_a* in shared mode, *DB* and *A1* must be locked in at least IS mode (but IX, SIX, S, X are okay too)

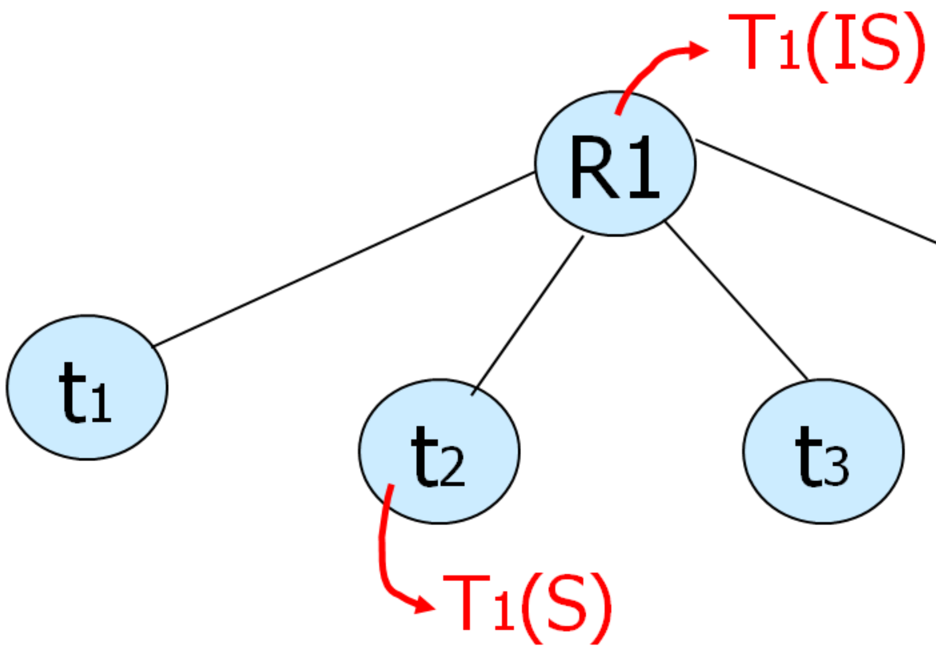
(2) Want to lock *rc1* in exclusive mode, *DB, A2,Fc* must be locked in at least IX mode (SIX, X are okay too)

Granularity Hierarchy

Parent locked in	Child can be locked in
IS	IS, S
IX	IS, S, IX, X, SIX
S	[S, IS] not necessary
SIX	X, IX, [SIX]
X	none

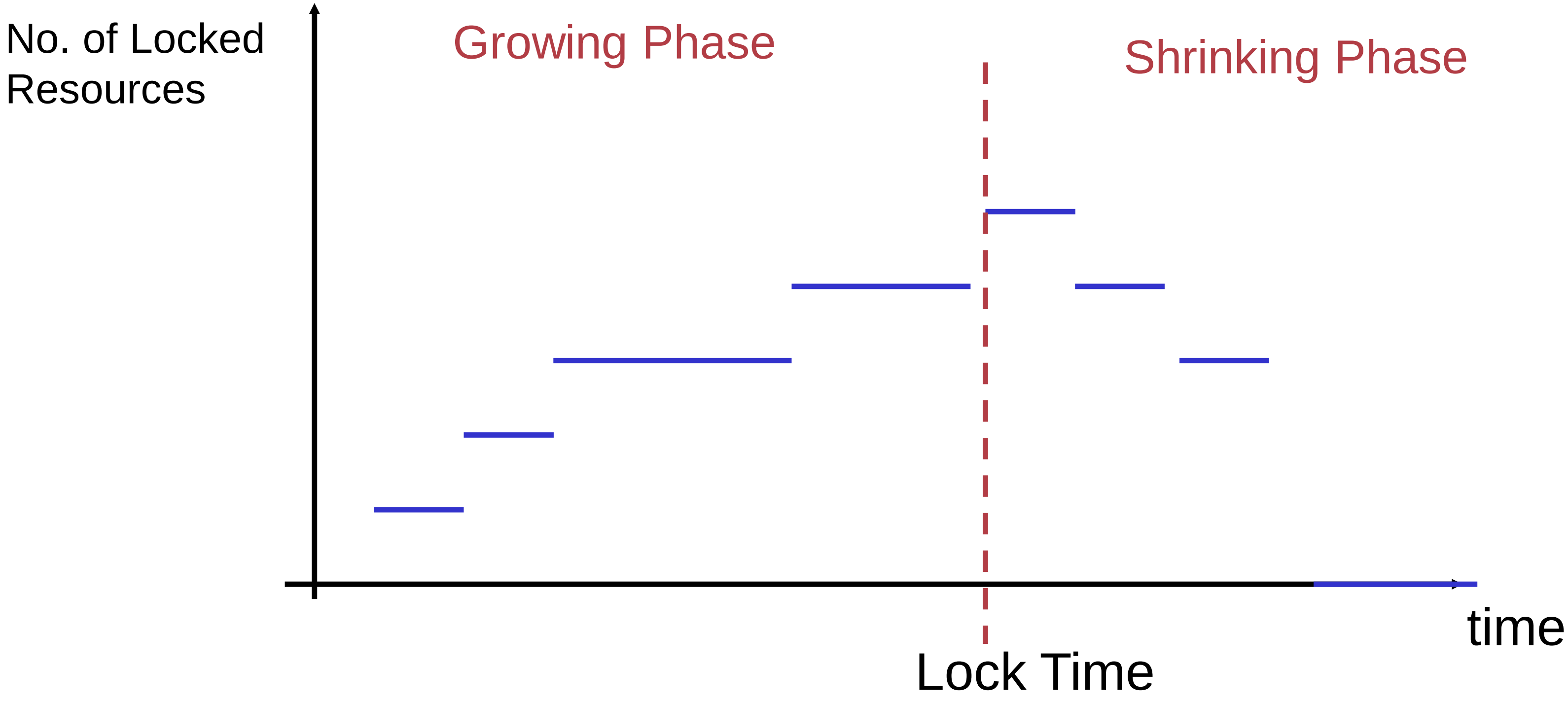


Example



CORBA Concurrency Service

Two Phase Locking Protocol - 2PL



2-Phase Locking Protocol (2PL)

- Phase 1: Growing phase
  - Transaction may obtain locks
  - But may not release them
- Phase 2: Shrinking phase
  - Transaction may only release locks
- Can be shown that this achieves *conflict-serializability*
  - *lock-point*: the time at which a transaction acquired last lock
  - if *lock-point*(T1) < *lock-point*(T2), there can't be an edge from T2 to T1 in the *precedence graph*

T1
lock-X(B) read(B) B ←B-50 write(B) unlock(B) lock-X(A) read(A) A ←A + 50 write(A) unlock(A)

Strict 2PL

- Release *exclusive* locks only at the very end, just before commit or abort
  - Read locks are not important
- Rigorous 2PL: Release both *exclusive and read* locks only at the very end
  - The serializability order === the commit order
  - More intuitive behavior for the users
    - No difference for the system