CORBA

Distributed Software Systems

CORBA IDL

- Need to understand IDL-to-Java mapping or IDL-to-C++ mapping
  - usually a chapter in ORB programmer’s manual
  - Chapter 20 of Orfali & Harkey
  - For C++, see Henning & Vinoski
- similar to C++ class declarations
- no code (implementation)
- Java issues – holder classes used for output parameters
- C++ issues - _var classes (smart pointers)

IDL

- Some features
  - oneway operations (must have void return type)
  - interfaces may be derived from other interfaces
    - multiple inheritance allowed
    - no state or code inherited since there is none in IDL
    - derived interfaces cannot redefine attributes or operations (although types, constants, exceptions can be redefined)
  - constructed types
    - struct, enum, union, sequence, array
    - sequences are variable length
    - arrays can be multidimensional

IDL cont’d

- Object references

```
interface account;
interface bank {
  account newAccount(in string name);
  void deleteAccount(in account a);
}
```

newAccount returns a reference to an account object, deleteAccount takes an object reference as a parameter

IDL cont’d

- Attributes
  - default read/write; mapped to two functions
  - readonly attributes mapped to a single function
- Exceptions
  - user defined exceptions can contain any data field desired
  - any number of user exceptions can be listed for an operation
    - all operations, and attributes, can raise **system** exceptions

IDL -- user exceptions

```
Interface bank {
   exception reject {
     string reason;    // programmer chosen fields
};

account newAccount(in string name)
                      raises (reject);
```

Built in IDL types

• Object	root of all IDL interfaces
• NamedValue	a pair (string,value)
• TypeCode	representation of a type
• Principal	caller of an operation

All these are useful in DII/DSI world

Creating multiple copies of objects

- In distributed object systems, objects are always created by the server
  - a server process can be thought of as a “container” for objects
  - must distinguish between *CORBA objects* and other objects
- To create multiple objects (instantiations) of a class, use a *ClassFactory*

Example

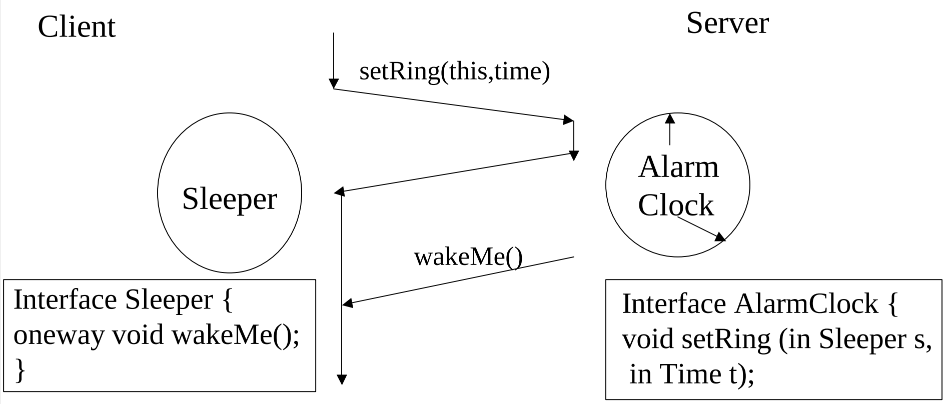
```
module Bank {
  interface Account {
    float balance();
  };
  interface AccountManager {
    Account open(in string name);
  };
};
```

Object stringification

- Can convert object references to strings and vice versa
  - useful for saving object references to a file
  - can be passed between processes
- ORB.object_to_string returns a stringified Internet (or Interoperable) Object Reference (IOR)
- ORB.object_to_string does reverse

Callbacks

- Useful for servers to call objects in clients
  - client object reference does not have to be registered



```
Interface Sleeper {
oneway void wakeMe();
}
```

```
Interface AlarmClock {
void setRing (in Sleeper s,
 in Time t);
```

Approaches for object implementations

- Inheritance: ImplBase approach
  - implementation class that you write extends _<interface_name>ImplBase
  - uses up Java single inheritance
- Delegation: the Tie approach
  - _tie<interface_name> class inherits from ImplBase class ; delegator class that delegates every call to the real implementation class that you write

Delegation based approach

- The implementation class that you write should *implement* the Interface
  - can also *extend* a different class
  - useful for multiple inheritance

Example

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

```
idltojava -ftie  Hello.idl
```

This generates two additional files in a `HelloApp subdirectory:`

`_HelloOperations.java`

The servant class will implement this interface.

`_HelloTie.java`

This class acts as the skeleton, receiving invocations from the ORB and delegating them to the servant that actually does the work.

Example cont’d

```
class HelloBasic {
public String sayHello() {
    return "\nHello world !!\n";
    }
}

class HelloServant extends HelloBasic implements
                    _HelloOperations
{
}
```

Example cont’d

```
public class HelloServer {
 public static void main(String args[])
{
 try{
 // create and initialize the ORB
ORB orb = ORB.init(args, null); //
 create servant and register it with the ORB
HelloServant servant = new HelloServant();
 Hello helloRef = new _HelloTie(servant);
orb.connect(helloRef);
org.omg.CORBA.Object objRef =
              orb.resolve_initial_references("NameService");
NamingContext ncRef = NamingContextHelper.narrow(objRef);
// bind the Object Reference in Naming
NameComponent nc = new NameComponent("Hello", "");
NameComponent path[] = {nc}; ncRef.rebind(path, helloRef);
// wait for invocations from clients
java.lang.Object sync = new java.lang.Object();
synchronized (sync) {
  sync.wait();
   }
 }
 catch (Exception e) {
   System.err.println("ERROR: " + e);
   e.printStackTrace(System.out);
  }
 }
}
```

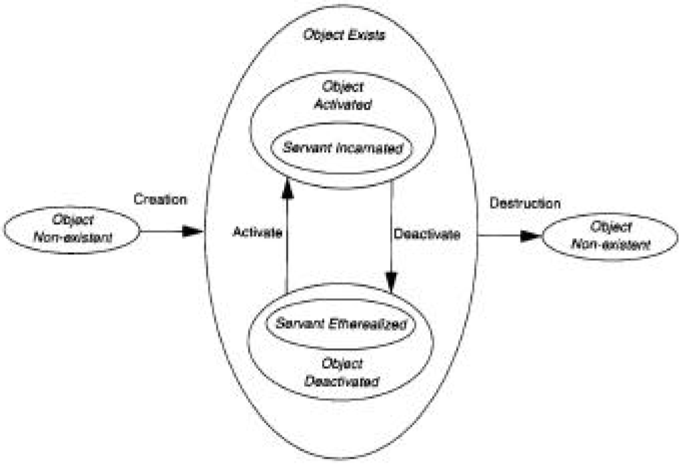
DII/DSI

- Useful for constructing requests (DII) or serving requests (DSI) at run-time
  - no pre-compiled stubs
  - more expensive
  - useful for agents, bridges (inter-operability)
- DII -- query the interface repository for information on operation to be invoked and construct request
- DSI -- servant class inherits from DynamicImplementation class and implements invoke operation that “deconstructs” the request

Portable Object Adaptor (POA)

- “BOA” done right
- deals with activation of objects and servers
- supports both IDL-generated skeletons and DSI

Life-span of a CORBA object



POA concepts

- Objects can be either *transient* or *persistent*
  - persistent objects outlive the processes (servers) they “live in” ; a persistent object spans multiple server lifetimes
  - terminology: *servant* = object implementation
- servant managers
  - An application can register servants directly with the POA OR it can supply servant manager objects to the POA that can create servants to carry out a request
  - you can supply your own or use the default servant manages supplied by the ORB

Servant Managers

- Objects that assist the POA in the management of your server-side objects
- POA invokes operations on servant managers to *create, activate, and deactivate servants*
  - note that there is a *clear distinction* between *creation* and *activation*
  - client only sees an object reference
  - servant managers must be registered with POA

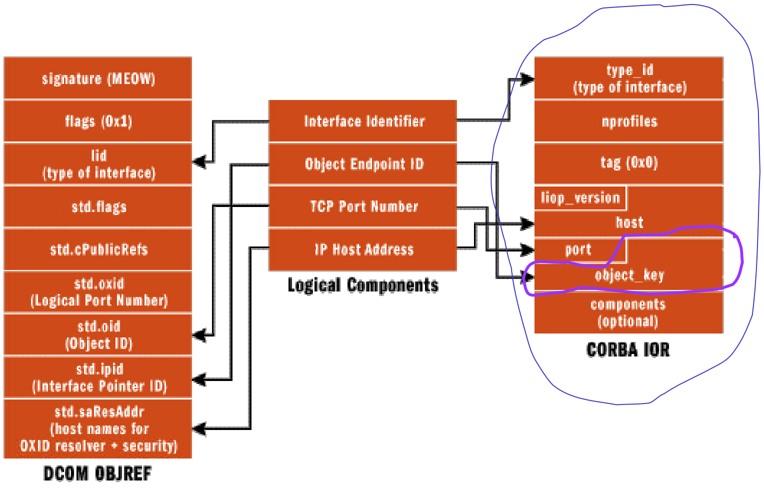
POAs

- A single server can support multiple POAs derived from the root POA (create_POA)
- Each POA can be customized (create_POA_policy)
- Each POA maintains a list of active servant managers
- Each POA also maintains a map of active objects (Object_ID to servant map)

Persistent Objects & References

- CORBA object references are unique
  - encapsulate both the POA and an *Object ID*
  - *Object ID* is a value used by the POA and your implementation to identify a particular object
    - no standard form, can be implementation specific (e.g., key of a DBMS record)
- Implementing persistent objects
  - providing the code for storing and restoring object state
  - maintaining the mapping between object references and object state

Corba IOR



signature (MEOW)

flags (0x1)

Iid
(type of interface)

std.flags

std.cPublicRefs

std.oxid
(Logical Port Number)

std.oid
(Object ID)

std.ipid
(Interface Pointer ID)

std.saResAddr
(host names for
OXID resolver + security)

DCOM OBJREF

Interface Identifier

Object Endpoint ID

TCP Port Number

IP Host Address

Logical Components

type_id
(type of interface)

nprofiles

tag (0x0)

iiop_version

host

port

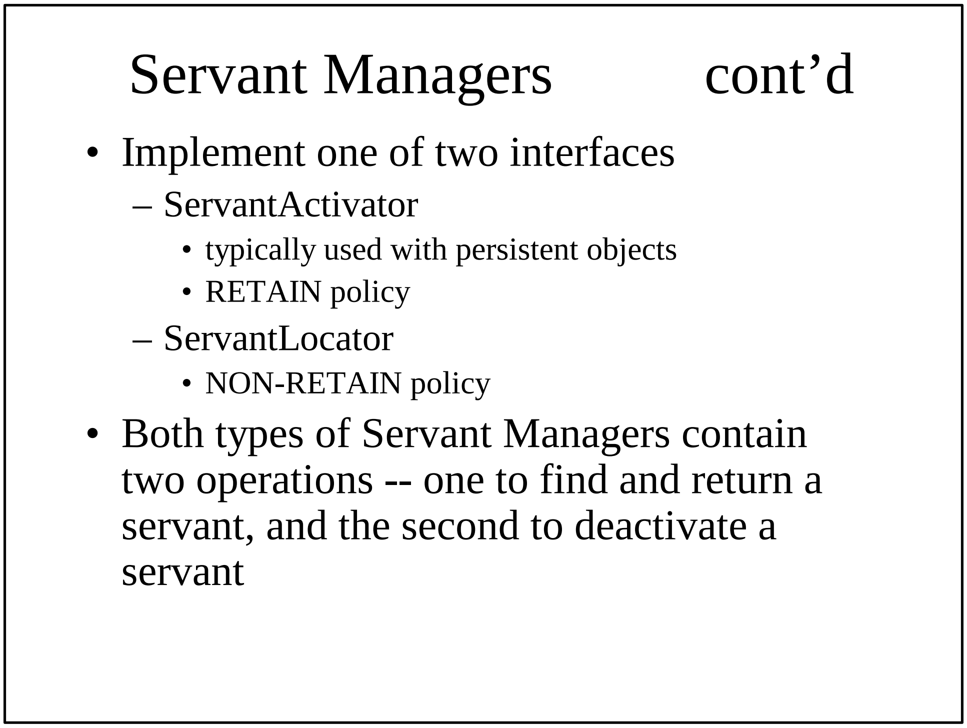
object_key

components
(optional)

CORBA IOR

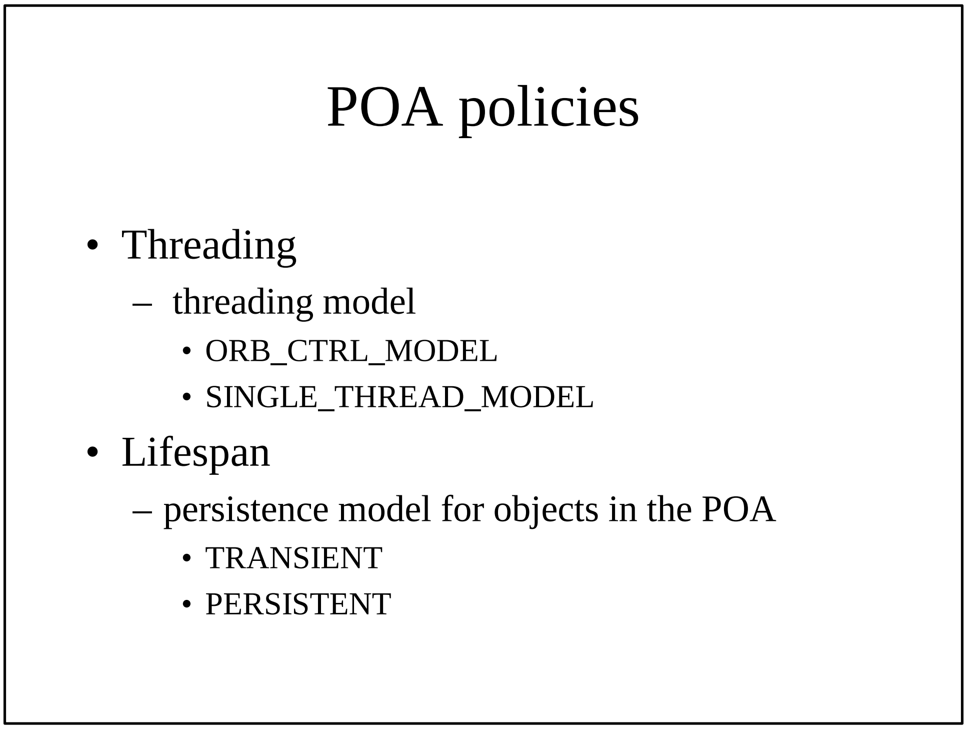
Servant Managers

- Applications that activate all their objects at server start up time do not need servant managers
- Servant managers let POAs activate objects on demand
- Servant Managers are responsible for determining if an object exists, and managing the association between object ids and servants



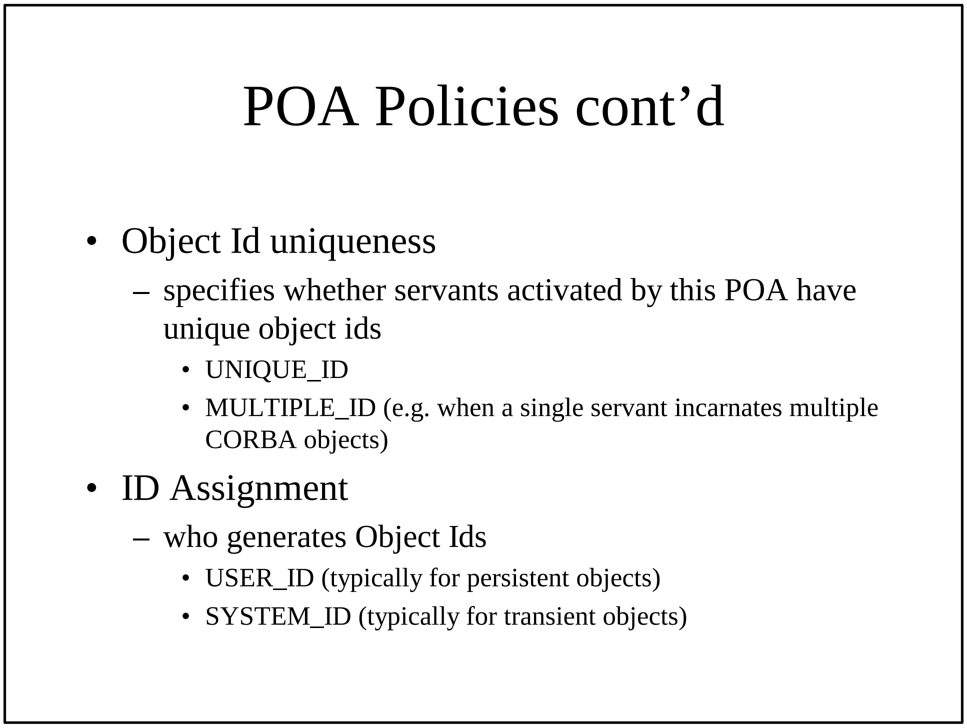
Servant Managers cont’d

- Implement one of two interfaces
  - – ServantActivator
    - typically used with persistent objects
    - RETAIN policy
  - – ServantLocator
    - NON-RETAIN policy
- Both types of Servant Managers contain two operations -- one to find and return a servant, and the second to deactivate a servant



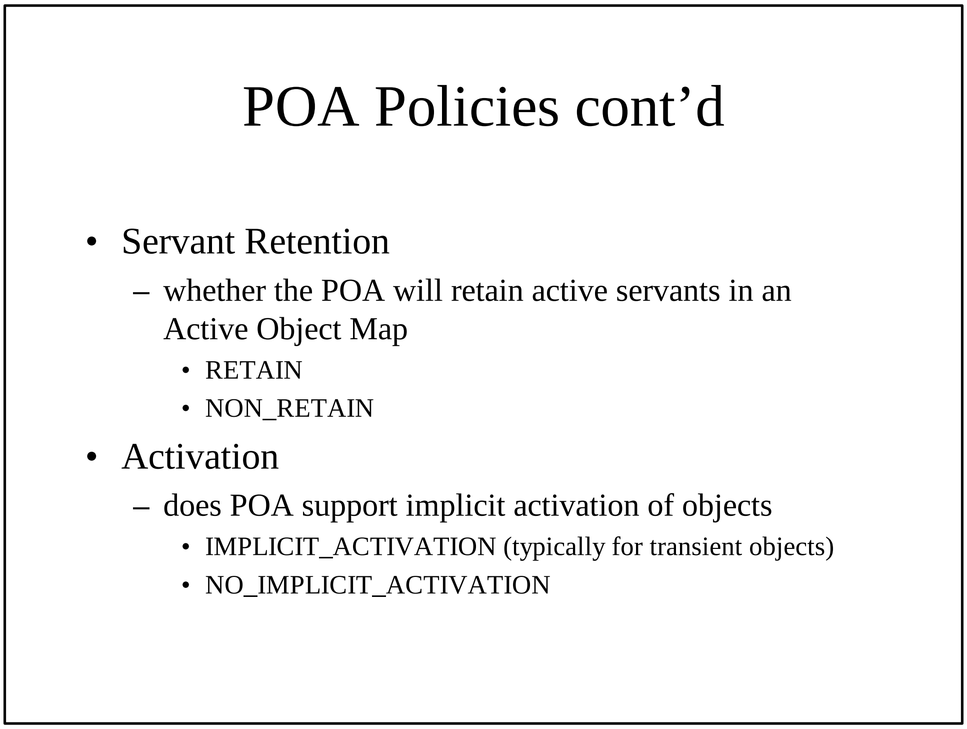
POA policies

- Threading
  - – threading model
    - ORB_CTRL_MODEL
    - SINGLE_THREAD_MODEL
- Lifespan
  - – persistence model for objects in the POA
    - TRANSIENT
    - PERSISTENT



POA Policies cont’d

- Object Id uniqueness
  - specifies whether servants activated by this POA have unique object ids
    - UNIQUE_ID
    - MULTIPLE_ID (e.g. when a single servant incarnates multiple CORBA objects)
- ID Assignment
  - who generates Object Ids
    - USER_ID (typically for persistent objects)
    - SYSTEM_ID (typically for transient objects)



POA Policies cont’d

- Servant Retention
  - whether the POA will retain active servants in an Active Object Map
    - RETAIN
    - NON_RETAIN
- Activation
  - does POA support implicit activation of objects
    - IMPLICIT_ACTIVATION (typically for transient objects)
    - NO_IMPLICIT_ACTIVATION

POA Policies cont’d

- Request Processing
  - – how requests are processed
    - USE_ACTIVE_OBJECT_MAP_ONLY
    - USE_DEFAULT_SERVANT
    - USE_SERVANT_MANAGER

Policy Combinations

- RETAIN & USE_ACTIVE_OBJECT_MAP_ONLY
  - – objects explicitly activated by application on startup
  - – good for servers that manage a finite number of pre-started objects (or well known services)
- RETAIN & USE_SERVANT_MANAGER
  - – ideal for servers that manage a large number of persistent objects
  - – if POA does not find a servant in its active map, it invokes servant managers `incarnate()` method

Policy Combinations

- RETAIN & USE_DEFAULT_SERVANT
  - ideal for servers that support a large number of transient objects
- NON_RETAIN & USE_SERVANT_MANAGER
  - ideal if one servant is invoked per method call
  - POA calls preinvoke on servant manager of type ServantLocator

Object Activation

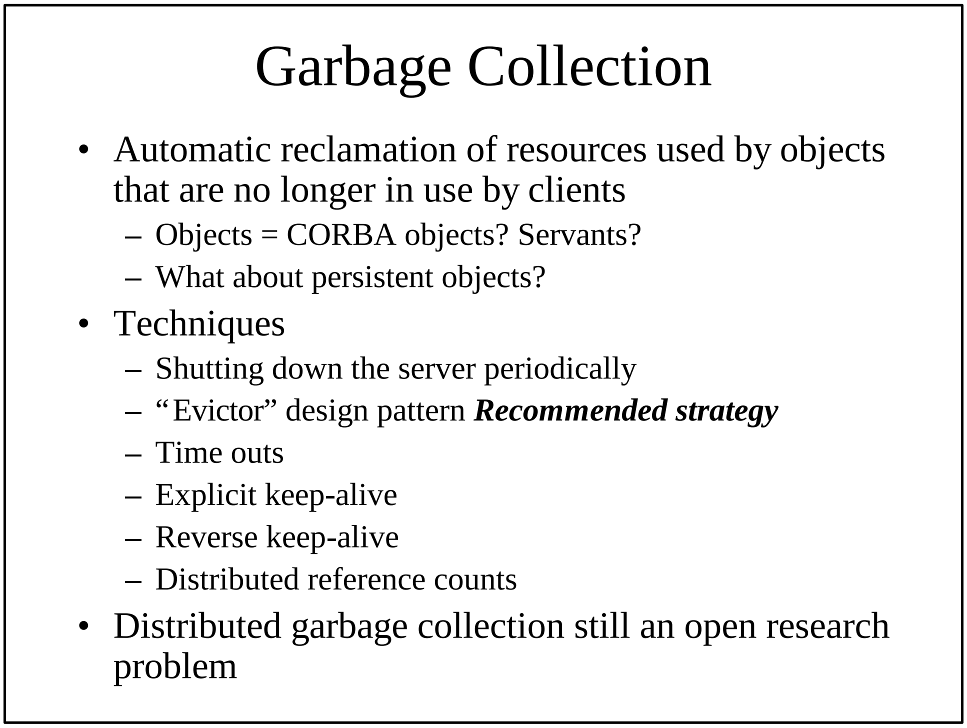
- POA object reference creation and object activation are decoupled
  - create_reference() or create_reference_with_id()
    - only create reference, not an active servant
- Object activation
  - explicitly via activate_object()
  - on-demand using a user-supplied servant manager
  - implicitly using a default servant (if IMPLICIT_ACTIVATION policy in effect)

Finding the Target Object

- ORB requests contain both POA id and Object ID
- server started if not already running
- if POA does not exist, it has to be recreated using an adapter activator
- POA handles request according to Request Processing policy

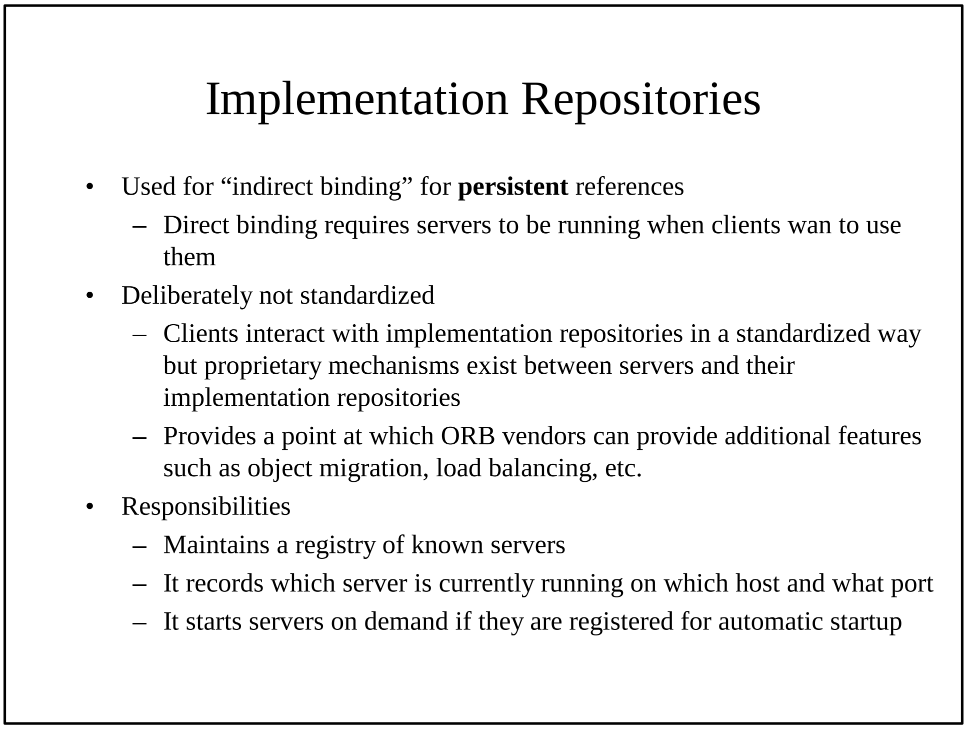
IIOP

- Inter-orb protocol
- IIOP is TCP/IP implementaion of GIOP
- all ORBs have bridges
- IOR: stringified representation of object reference
  - ***it's all you need to invoke a method on a remote object***



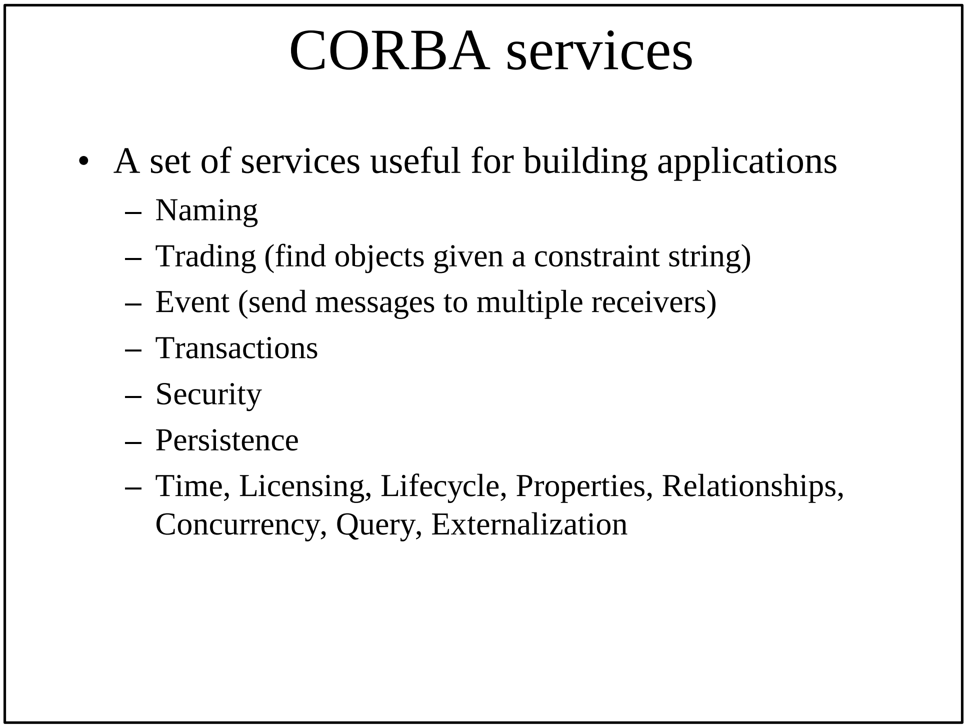
Garbage Collection

- Automatic reclamation of resources used by objects that are no longer in use by clients
  - Objects = CORBA objects? Servants?
  - What about persistent objects?
- Techniques
  - Shutting down the server periodically
  - “Evictor” design pattern ***Recommended strategy***
  - Time outs
  - Explicit keep-alive
  - Reverse keep-alive
  - Distributed reference counts
- Distributed garbage collection still an open research problem



Implementation Repositories

- Used for “indirect binding” for **persistent** references
  - Direct binding requires servers to be running when clients wan to use them
- Deliberately not standardized
  - Clients interact with implementation repositories in a standardized way but proprietary mechanisms exist between servers and their implementation repositories
  - Provides a point at which ORB vendors can provide additional features such as object migration, load balancing, etc.
- Responsibilities
  - Maintains a registry of known servers
  - It records which server is currently running on which host and what port
  - It starts servers on demand if they are registered for automatic startup



CORBA services

- A set of services useful for building applications
  - Naming
  - Trading (find objects given a constraint string)
  - Event (send messages to multiple receivers)
  - Transactions
  - Security
  - Persistence
  - Time, Licensing, Lifecycle, Properties, Relationships, Concurrency, Query, Externalization