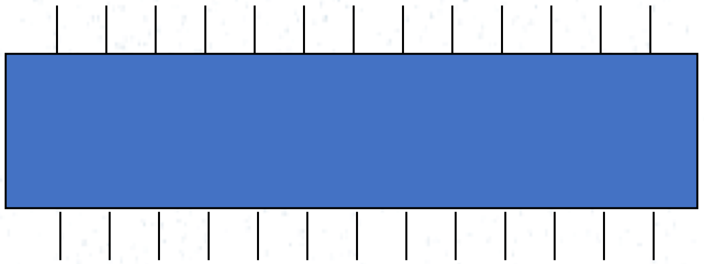
Lecture 6 - Distributed Component frameworks

What is a component?

- Very intuitive, but often vaguely defined
- A semiconductor chip is a component

pins ara called as interfaces . they are connect with outsiders



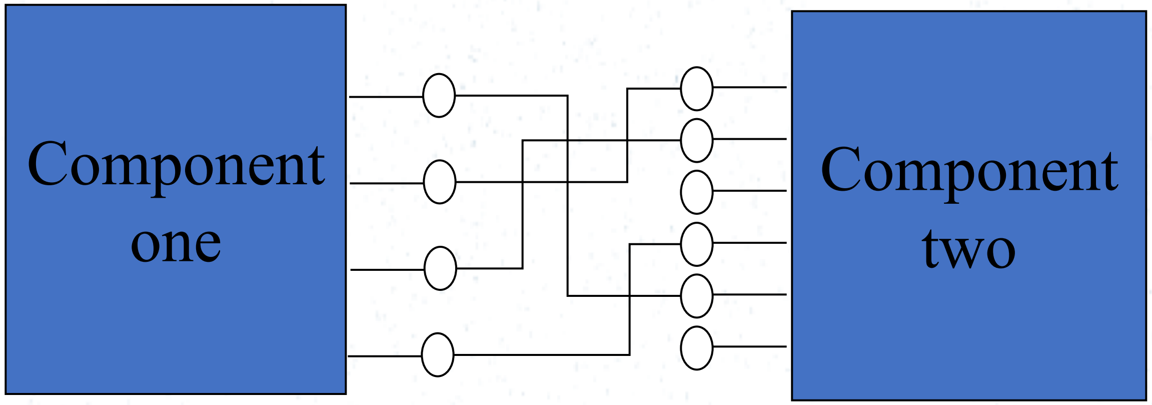
The chip vendor publishes manuals that tell developers the functionality of each pin

A0-A16	I/O	Address bus
D0-D8	I/O	Data bus
ACK	O	Acknowledge: Accepted when low

Building complex systems

- Hardware system integrators connect pins of chips together according to their functions to build complex electronic devices such as computers.

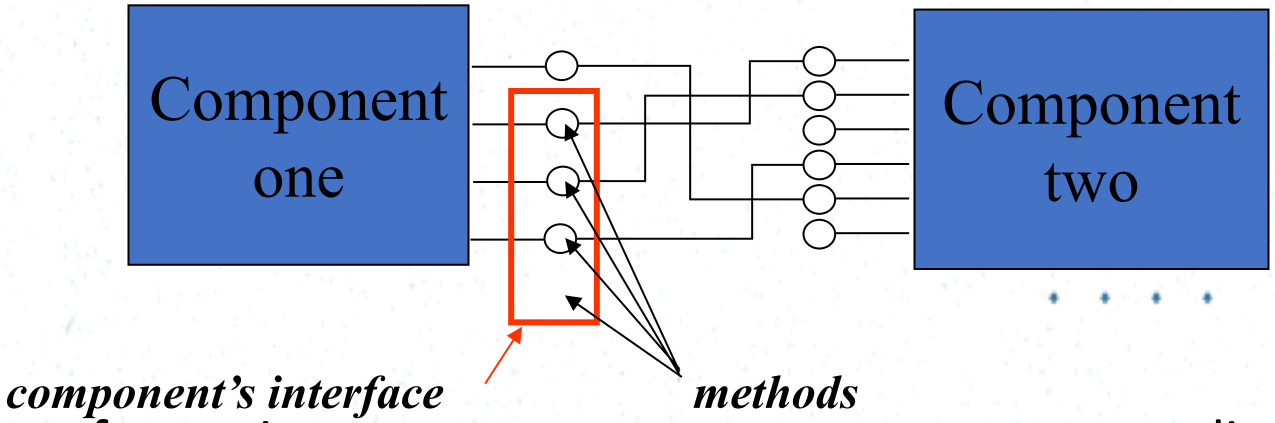
group similar functionalities together hight cohesion
separate dissimilar coupling,independ component



- Pins functionality defines behavior of the chip.
- Pins functionality is standardized to match functionality of the board (and take advantage of common services).

Software components

- The software component model takes a very similar approach:
  - the “pins” of software components are called interfaces
  - an interface is a set of methods that the component implements

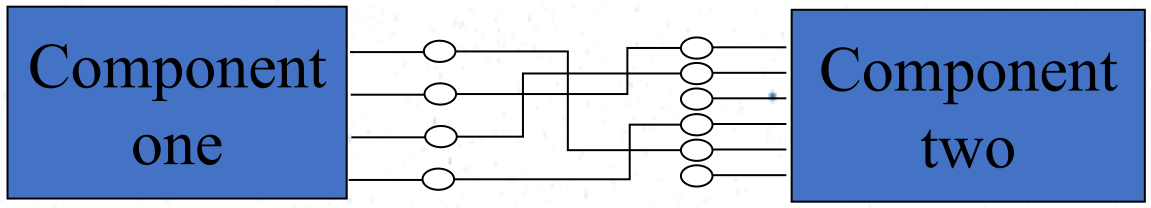


  - software integrators connects components according to the descriptions of the methods within the interface.

Software components (2)

- Component technology is still young, and there isn't even agreement on the definition of its most important element - the component.
- ***"a component is a software module that publishes or registers its interfaces"***, a definition by P. Harmon, Component Development Strategy newsletter (1998).
- Note: a component does not have to be an object!
  An object can be implemented in any language as long as all the methods of its interface are implemented.
- Objects – Design level
- Components – Architectural level

Component wiring



- The traditional programming model is caller-driven (application calls methods of a component's interface, information is pulled from the callee as needed). Component never calls back.
- In the component programming model, connecting components may call each other (connection-oriented programming).
- The components can interacts with each other through event notification (a component pushes information to another component as some event arises). This enables wiring components at runtime.

Pragmatic definition

- Software Components:
  - predictable behavior: implement a *common* interface
  - embedded in a framework that provides common services (events, persistence, security, transactions,…)
  - developer implements only business logic

Distributed Component Models

- Hide implementation details
- Bring power of a container
- Focus on business logic
- Enable development of third-party interoperable components

inside the main container we can have sub containers. and all the business logic resides in the container and they can be reuse

Examples of component frameworks

- CORBA (Component Object Request Broker Architecture)
- Java/Java EE - EJB (Enterprise Java Beans)
- Spring Framework
- Microsoft/.NET – DCOM, WCF Services

CORBA

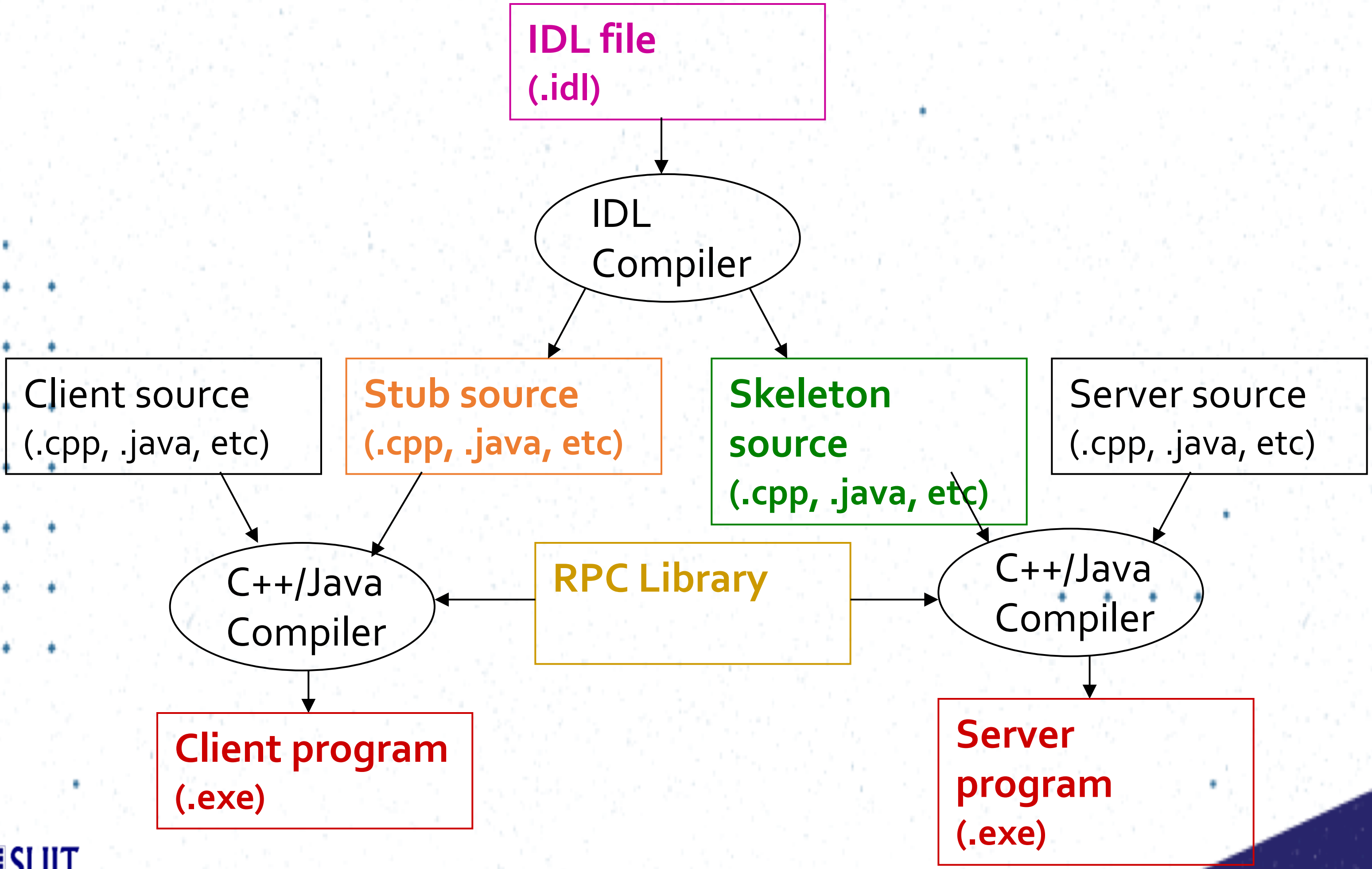
- **CORBA** is the acronym for **C**ommon **O**bject **R**equest **B**roker **A**rchitecture
- CORBA grew out of academic efforts to build a distributed computing framework around RPC
  - Dubbed 'middleware' since it aims to transparently connect systems running on different platforms
- CORBA specification administered by the Object Management Group (OMG)
  - Now up to CORBA 3

wire the differenent diff lanaguage component using ORB. and this built for c++ and java interconnection

- Implementations of the CORBA spec are referred to as Object Request Brokers (ORBs)
  - An ORB is built for a particular language (e.g. C++, Java)

CORBA Code Generation

IDL use common language format to understand for the client and server. not java neither c++



IDL file (.idl)
IDL Compiler
Client source (.cpp, .java, etc)
Stub source (.cpp, .java, etc)
Skeleton source (.cpp, .java, etc)
Server source (.cpp, .java, etc)
C++/Java Compiler
RPC Library
C++/Java Compiler
Client program (.exe)
Server program (.exe)

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CORBA and O-O

- Object-orientation gave the opportunity to hide the internal details of RPC such as marshaling
  - Interfaces are implemented as C++/Java/etc objects that inherit from an IDL-generated C++/Java/etc class
    - Uses polymorphism to direct incoming call to your object
- An object that implements an interface is roughly equivalent to the concept of a component
    - CORBA never really mentioned ‘component’ until the CORBA Component Model (CCM) that added things like support for authentication, persistence and transactions

CORBA Interoperability

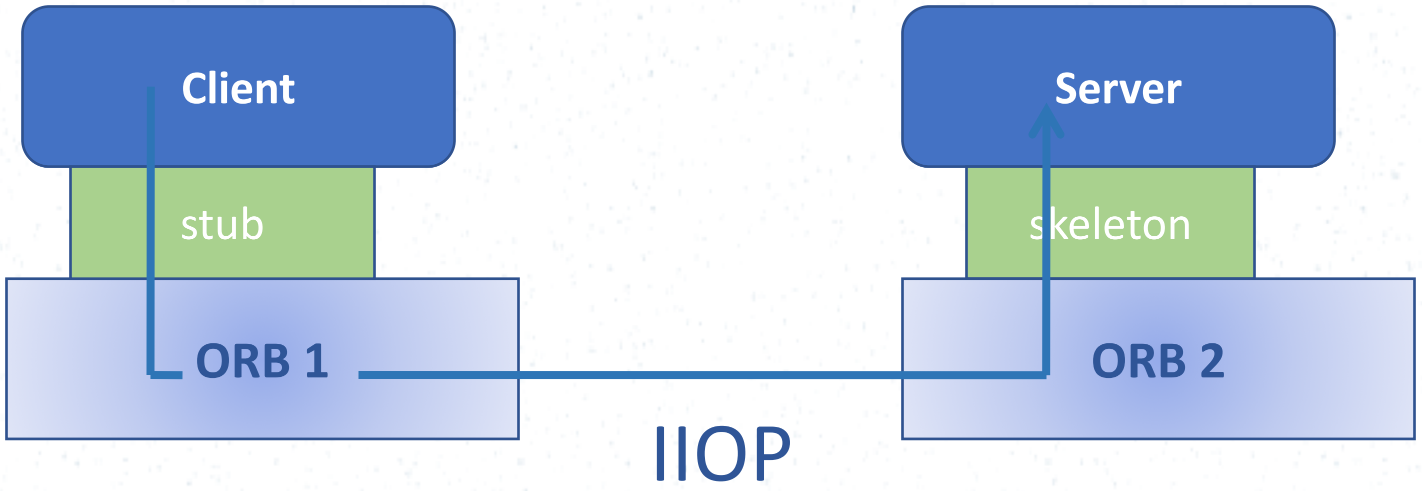
- ORB's use IIOP to communicate with each other.
- Using the standard protocol IIOP, a CORBA-based program from any vendor, on almost any computer, operating system, programming language, and network, can interoperate with a CORBA-based program from the same or another vendor, on almost any other computer, operating system, programming language, and network.
  - IIOP (Internet Inter-ORB Operability Protocol); Defines:
    - Message types and binary message format
    - Data format - Binary format for data types (e.g. int, double, string)
    - Object reference format - identifies the object and its host server

CORBA Interoperability

send data to server through network. the difference it both sideshas orb. these use to understand the request if it is in different language.

if the client send request using c++ server must understand it. so as the response. if respons send using java client must understand likewise

this is the initial step of interoperabilty



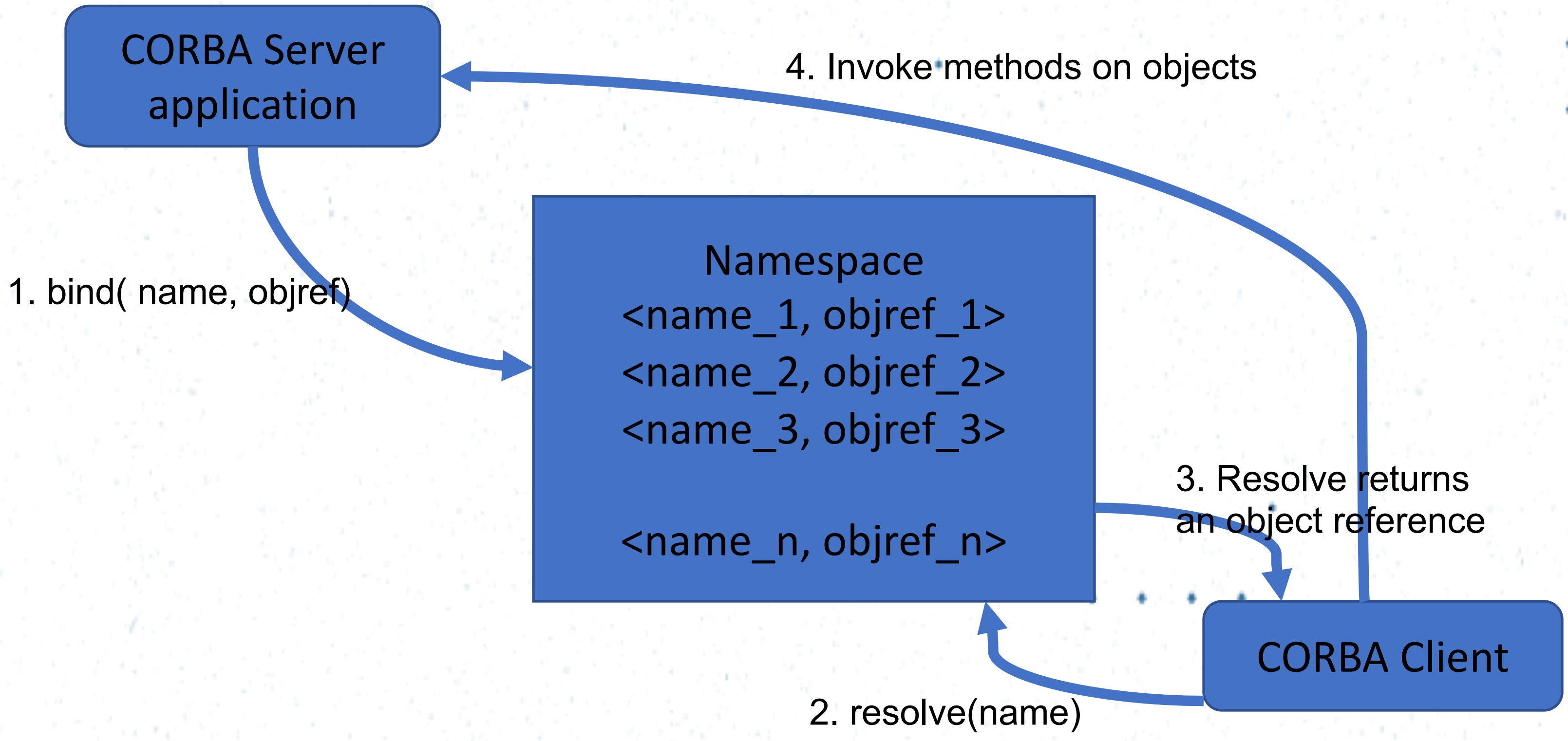
CORBA Naming Service

this is like RMI registry

- CORBA Naming Service allows you to associate abstract names with CORBA objects and allows clients to find those objects by looking up the corresponding name.
- A naming service is a central server that knows where other servers can be found, like an index
  - Allows locating an object based on a user-friendly name, avoiding the need to hard-code object-server allocations
  - Means that the server machine, an object is hosted on, can be changed without breaking the distributed application

CORBA Naming Service

same archi as rmi but this is with component service



IDL Example: CORBA IDL

```
module Utilities
{
    // Basic example interface
    interface Calculator
    {
        int Add(in int operand1, in int operand2);
        double Add(in double operand1, in double operand2);
    }

    // Interface inheritance
    interface ScientificCalculator : Calculator
    {
        // Returning values by the parameter list
        void SolveQuadratic(in float a, in float b, in float c, out float
  x1,
                                                                out float x2);

        // Example with a string
        double EvaluateExpression(in string expr);
    }
}
```

CORBA Example (Java) - Server

```
public class CalculatorImpl
             extends CalculatorImplBase          ← xyzImplBase is generated by IDL compiler
{
   public CalculatorImpl() {
      super();                         ← Let xyzImplBase do important initialisation work
   }
   public int Add(int operand1, int operand2) {        ← Actual interface function
      return operand1 + operand2;
   }
}
-----------------------------------------------------------------------------------------
import org.omg.*;

public class CalcServer {
   public static void main(String[] args) {
      CORBA.ORB orb = CORBA.ORB.init(args, null);      ← Initialise Java's ORB
      CalculatorImpl calc;
      calc = new CalculatorImpl();
      orb.connect(calc);                               ← Tell ORB about Calculator object
      sObjRef = orb.object_to_string(calc);
      System.out.println("Object ref: " + sObjRef);    ← Print stringified obj ref for use by clients
      System.out.println("Press Enter to exit");            (using a name server is better, but more complex)
      System.in.readln();                              ← Wait for client requests
   }
}
```

CORBA Example (Java) - Client

```
import org.omg.*;

public class CalcClient
{
    public static void Main(String[] args) {
        CORBA.ORB orb = CORBA.ORB.init(args, null);    ← Initialise Java's ORB

        String sServerRef = args[0];          ← Assume user has reference for server
                                        (better to use name server, but more complex)

        CORBA.Object temp = orb.string_to_object(sServerRef);        ← Create Calculator
                                                  on  remote server, return ref

        Calculator calc = CalculatorHelper.narrow(temp);      ← Narrow (downcast)
                                                   Object to Calculator

        System.out.println("1 + 2 = " + calc.Add(1, 2));
    }
}
```

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CORBA Notes

- Each vendor will have slightly different ways of declaring and creating CORBA objects
  - The basic organisation of the code will be similar, just the specifics of ORB initialisation and where to get classes
- Note that a CORBA server object is *first* created by the server host process, *then* registered with the ORB
  - Means that the server object is always running awaiting new incoming client connections
  - Registration (via orb.connect) must only happen once for each object

CORBA Today

- Although conceptually quite elegant, CORBA never really caught on, for a couple of reasons:
  - The CORBA spec is huge, making it complex to use
  - Competing frameworks were developed around the same time that had better backing and/or a broader coder base

Although CORBA was not widely adopted, some concepts that
it focused on such as interoperability and common standards were relevant for Web Services as well.

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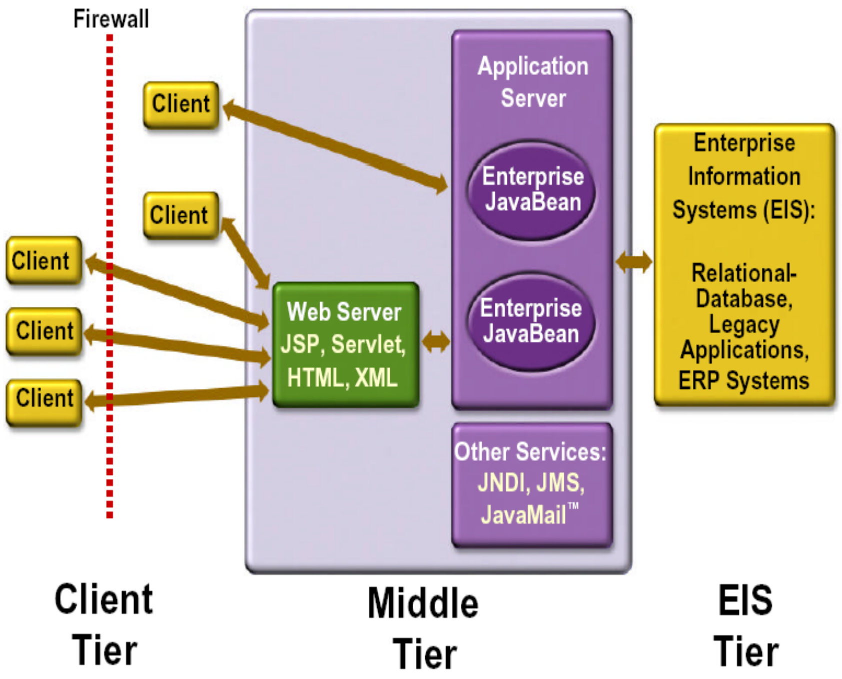
JEE/Enterprise Java Beans

Java EE Architecture

- Three/Four tiered applications that run in this way extend the standard two-tiered client and server model by placing a multithreaded application server between the client application and back-end storage


Firewall
Client
Client
Client
Client
Client
Web Server JSP, Servlet, HTML, XML
Application Server
Enterprise JavaBean
Enterprise JavaBean
Other Services: JNDI, JMS, JavaMail™
Enterprise Information Systems (EIS): Relational-Database, Legacy Applications, ERP Systems
Client Tier
Middle Tier
EIS Tier

Java EE Containers

Text

- The application server maintains control and provides services through an interface or framework known as a *container*
- Server-side containers:
  - The server itself, which provides the Java EE runtime environment and the other two containers
  - An **EJB container** to manage EJB components
  - A **Web container** to manage servlets and JSP pages

Java EE Components

- As said earlier, Java EE applications are made up of components
- A *Java EE component* is a self-contained functional software unit that is assembled into a Java EE application with its related classes and files and that communicates with other components
- Client components run on the client machine, which correlate to the client containers
- Web components -servlets and JSP pages
- EJB Components

both these are in server side

Packaging Applications and Components

- Under Java EE, applications and components reside in Java Archive (JAR) files
- These JARs are named with different extensions to denote their purpose, and the terminology is important

Various File types

- Enterprise Archive (EAR) files represent the application, and contain all other server-side component archives that comprise the application
- Web components reside in Web Archive (WAR) files
- Client interface files and EJB components reside in JAR files

EJB Components

- EJB components are server-side, modular, and reusable, comprising specific units of functionality
- They are similar to the Java classes we create every day, but are subject to special restrictions and must provide specific interfaces for container and client use and access
- We should consider using EJB components for applications that require scalability, transactional processing, or availability to multiple client types

EJB Components- Major Types

- **Session beans (verbs of a system)**
  - These may be either *stateful* or *stateless* and are primarily used to encapsulate business logic, carry out tasks on behalf of a client, and act as controllers or managers for other beans
- **Entity beans (nouns of a system)**
  - Entity beans represent persistent objects or business concepts that exist beyond a specific application's lifetime; they are typically stored in a relational database
- **Message Driven Beans:**
  - Asynchronous communication with MOM
  - Conduit for non-Java EE resources to access Session and Entity Beans via JCA Resource adapters

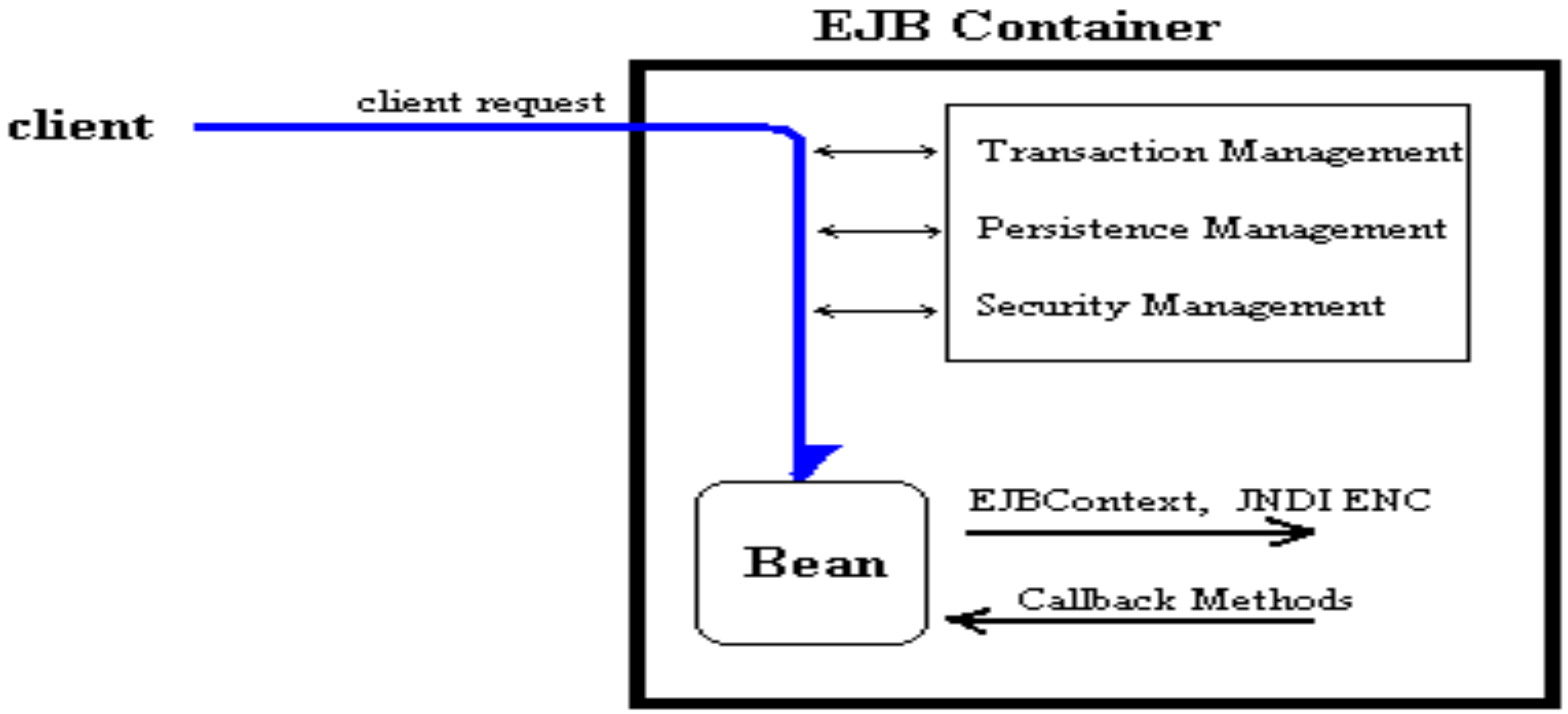
Enterprise Java Server (EJS) / Application Server

- Part of an application server that hosts EJB containers
- EJBs do not interact directly with the EJB server
- EJB specification outlines eight services that must be provided by an EJB server:
  - Naming
  - Transaction
  - Security
  - Persistence
  - Concurrency
  - Life cycle
  - Messaging
  - Timer

EJB Container

- Functions as a runtime environment for EJB components beans
- Containers are transparent to the client in that there is no client API to manipulate the container
- Container provides EJB instance life cycle management and EJB instance identification.
- Manages the connections to the enterprise information systems (EISs)

EJB Container(cont'd)

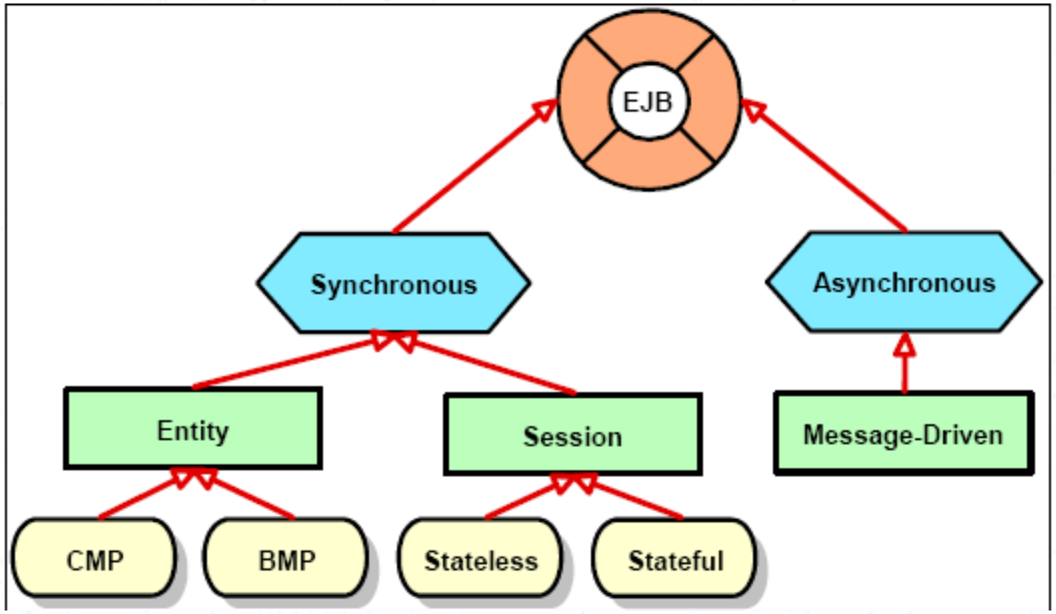


EJB Containers manage enterprise beans at runtime

EJB Client

- Finds EJBs via JNDI.
- Invokes methods on EJBs.

EJB components



EJB Interfaces - Local and Remote

- Local Interface
  - Used for invoking EJBs within the same JVM (process)
  - `@Local` annotation marks an interface local
  - Parameters passed by reference
- Remote Interface
  - Used for invoking EJBs across JVMs (processes)
  - `@Remote` annotation marks an interface remote
  - Parameters passed by value (serialization/de- serialization)

Note: An EJB can implement both interfaces if needed.

Business Interface

- Defines business methods
- Session beans and message-driven beans require a business interface, optional for entity beans.
- Business interface do not extend local or remote component interface (unlike EJB2.x)
- Business Interfaces are POJIs (Plain Old Java Interfaces)

Business Interface - examples

- Shopping cart that maintains state

```
public interface ShoppingStatefulCart {
   void startShopping(String customerId);
   void addProduct(String productId);
   float getTotal();
}
```

- Shopping cart that does not maintain state

```
public interface ShoppingStatelessCart {
   String startShopping(String customerId); //
 return cartId
   void addProduct(String cartId, String productId);
   float getTotal(String cartId);
}
```

Stateless Session EJB (SLSB)

- Does not maintain any conversational state with client
- Instances are pooled to service multiple clients
- `@Stateless` annotation marks a been stateless.
- Lifecycle event callbacks supported for stateless session beans (optional)
  - `@PostConstruct` occurs before the first business method invocation on the bean
  - `@PreDestroy` occurs at the time the bean instance is destroyed

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Stateless Session EJB example (1/2)

- The business interface:

```
public interface HelloSessionEJB3Interface{
    public String sayHello();
}
```

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Stateless Session EJB example (2/2)

- The stateless bean with local interface:

```
import javax.ejb.*;
import javax.annotation.*;
@Local({HelloSessionEJB3Interface.class})
@Stateless public class HelloSessionEJB3 implements

    HelloSessionEJB3Interface{
 public String sayHello(){
      return "Hello from Stateless bean“;
   }
 @PreDestroy void restInPeace() {
     System.out.println(“I am about to die now“);
 }
}
```

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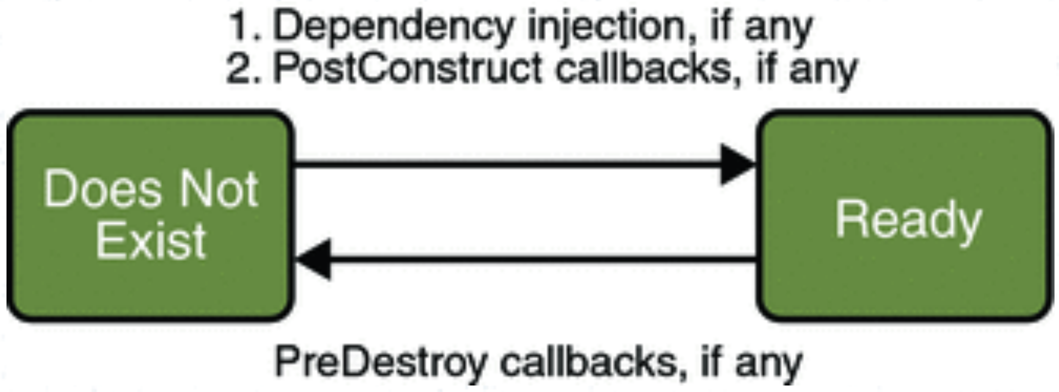
Lifecycle of a Stateless Session Bean

- A client initiates the life cycle by obtaining a reference
- The container invokes the `@PostConstruct` method, if any
- The bean is now ready to have its business methods invoked by clients


1. Dependency injection, if any
2. PostConstruct callbacks, if any
Does Not Exist
Ready
PreDestroy callbacks, if any

Stateful Session EJB (SFSB)

- Maintains conversational state with client
- Each instance is bound to specific client session
- Support callbacks for the lifecycle events listed on the next slide

Stateful Session EJB – example (1/2)

- Define remote business interface (remote can be marked in bean class also) :

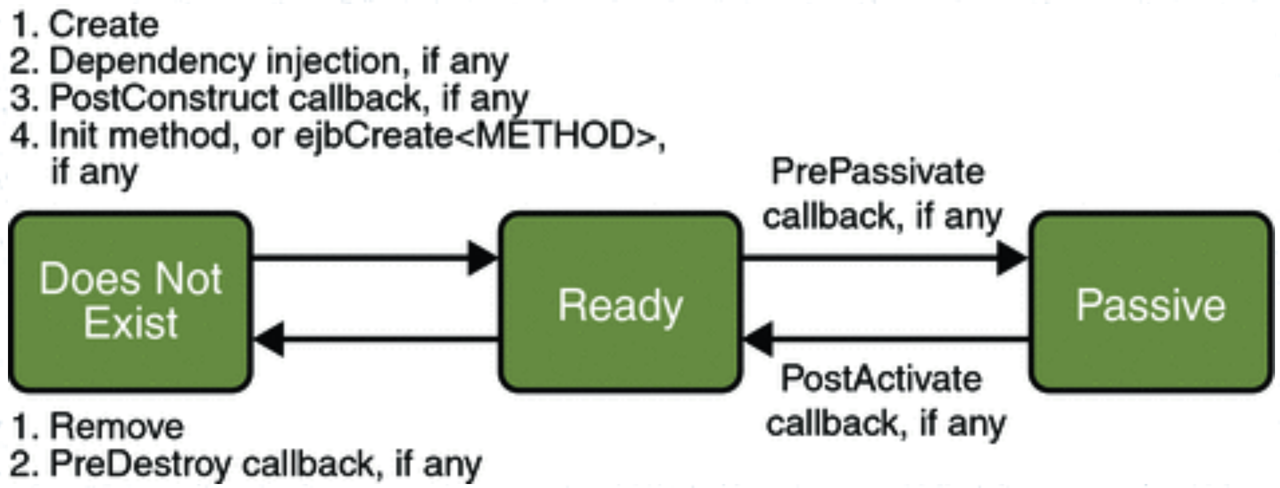
```
@Remote public interface ShoppingCart {
    public void addItem(String item);
    public void addItem(String item);
    public Collection getItems();
}
```

Stateful Session EJB – example (2/2)

```
@Stateful public class CartBean implements
 ShoppingCart {
     private ArrayList items;
     @PostConstruct public void initArray() {
         items = new ArrayList();
     }
   public void addItem(String item) {
         items.add(item);
     }
     public void removeItem(String item) {
         items.remove(item);
     }
     public Collection getItems() {
         return items;
     }
   @Remove void logoff() {items=null;}
}
```

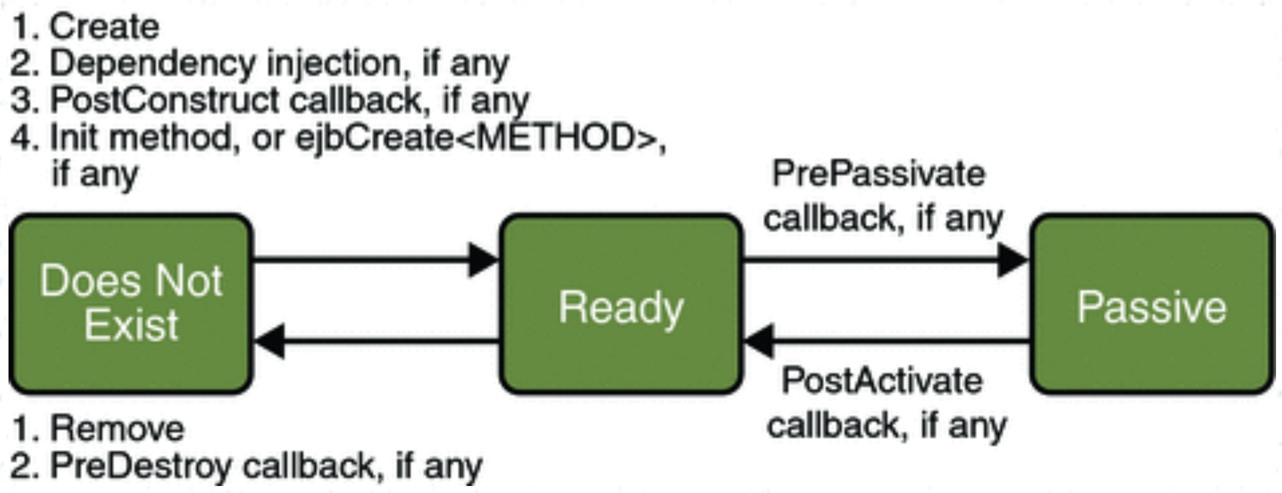
Lifecycle of a Stateful Session Bean

- Client initiates the lifecycle by obtaining a reference
- Container invokes the `@PostConstruct` and `@Init` methods, if any
- Now bean ready for client to invoke business methods


1. Create
2. Dependency injection, if any
3. PostConstruct callback, if any
4. Init method, or ejbCreate<METHOD>, if any
PrePassivate callback, if any
Does Not Exist
Ready
Passive
PostActivate callback, if any
1. Remove
2. PreDestroy callback, if any

Lifecycle of a Stateful Session Bean

- While in ready state, container may passivate and invoke the `@PrePassivate` method, if any
- If a client then invokes a business method, the container invokes the `@PostActivate` method, if any, and it returns to ready stage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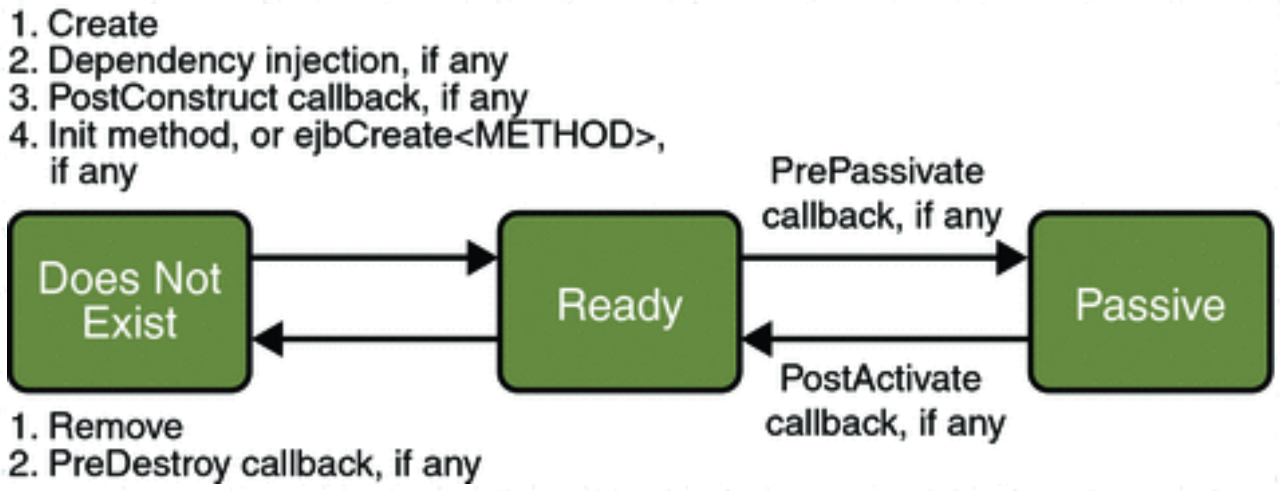
Ready
Passive
PostActivate callback, if any
1. Remove
2. PreDestroy callback, if any

Lifecycle of a Stateful Session Bean

- At the end of the life cycle, the client invokes a method annotated `@Remove`
- The container calls the `@PreDestroy` method, if any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4. Init method, or ejbCreate<METHOD>, if any
Does Not Exist
Ready
Passive
PrePassivate callback, if any
PostActivate callback, if any
1. Remove
2. PreDestroy callback, if any

Entity EJB (1)

- **It is permanent.** Standard Java objects come into existence when they are created in a program. When the program terminates, the object is lost. But an entity bean stays around until it is deleted. In practice, entity beans need to be backed up by some kind of permanent storage, typically a database.

- **It is identified by a primary key.** Entity Beans must have a primary key. The primary key is unique -- each entity bean is uniquely identified by its primary key. For example, an "employee" entity bean may have Social Security numbers as primary keys.

- Note: Session beans do not have a primary key.

Entity Bean Class

- `@Entity` annotation marks a class as Enity EJB
- Persistent state of an entity bean is represented by non-public instance variables
- For single-valued persistent properties, these method signatures are:

```
<Type> getProperty()
void setProperty(<Type> t)
```

- Must be a non-final concrete class
- Must have public or protected no-argument constructor
- No methods of the entity bean class may be final
- If entity bean must be passed by value (through a remote interface) it must implement `Serializable` interfa

Entity EJB

- CMP (Container Managed Persistence)
  - Container maintains persistence transparently using JDBC calls
- BMP (Bean Managed Persistence)
  - Programmer provides persistence logic
  - Used to connect to non-JDBC data sources like LDAP, mainframe etc.
  - Useful for executing stored procedures that return result sets

Entity EJB – example (1)

```
@Entity // mark as Entity Bean
public class Customer implements Serializable {
  private Long id;
  private String name;
  private Collection<Order> orders = new
   HashSet();
  @Id(generate=SEQUENCE) // primary key
  public Long getId() {
  return id;
  }
  public void setId(Long id) {
  this.id = id;
  }
```

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Entity EJB – example (2)

```
   @OneToMany // relationship between
    Customer and Orders
   public Collection<Order> getOrders() {
   return orders;
   }
   public void setOrders(Collection<Order>
    orders) {
   this.orders = orders;
   }
}
```

EntityManager

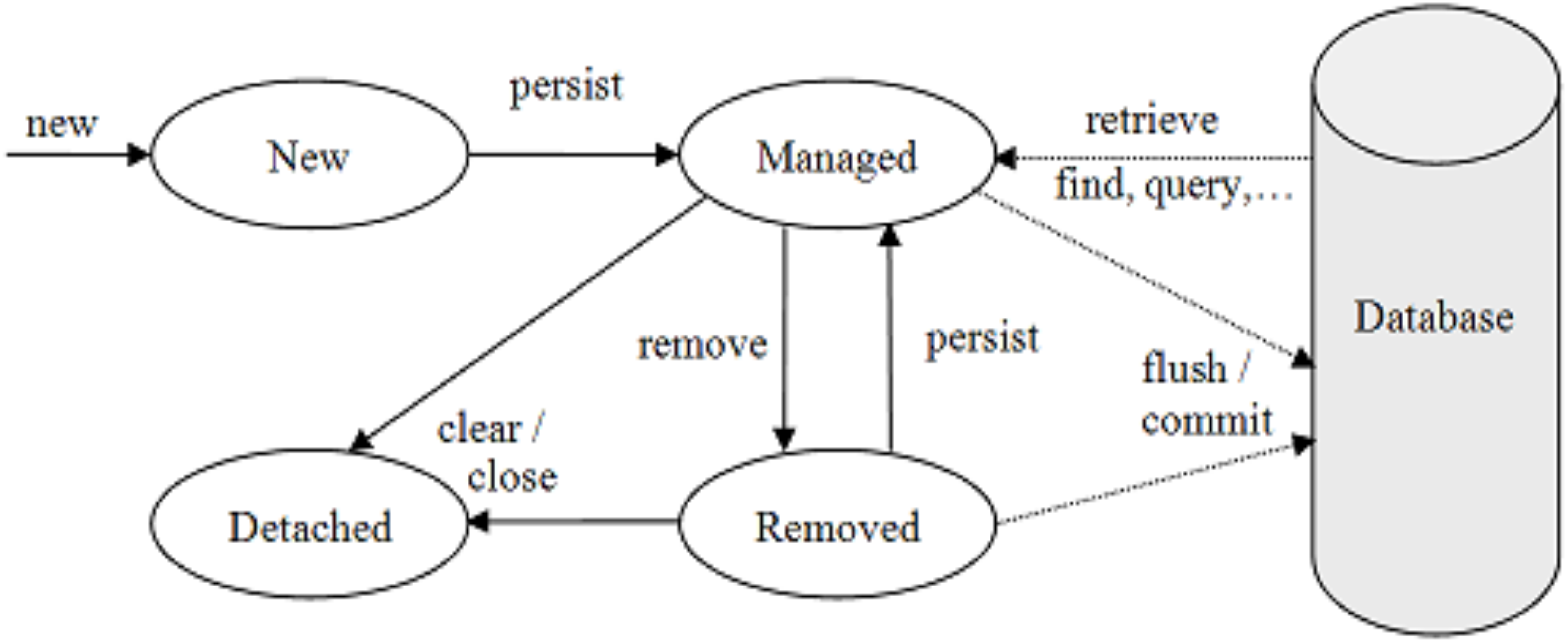
- EntityManager API is used to:
  - create and remove persistent entity instances
  - to find entities by their primary key identity, and to query over entities
- EntityManager supports EJBQL and (non-portable) native SQL

Entity Bean Lifecycle

Entity bean instance has four possible states:

- **New** entity bean instance has no persistent identity, and is not yet associated with a persistence context.
- **Managed** entity bean instance is an instance with a persistent identity that is currently associated with a persistence context.
- **Detached** entity bean instance is an instance with a persistent identity that is not (or no longer) associated with a persistence context.
- **Removed** entity bean instance is an instance with a persistent identity, associated with a persistence context, scheduled for removal from the database.

Entity Bean Lifecyle



Example of Use of EntityManager API

```
@Stateless public class OrderEntry {
@Inject EntityManager em;
 public void enterOrder(int custID, Order
 newOrder) {
     Customer cust = (Customer)em.find("Customer",
                            custID);
     cust.getOrders().add(newOrder);
     newOrder.setCustomer(cust);
  }
}
```

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Message Driven EJB

- Invoked by asynchronously by messages
- Cannot be invoked with local or remote interfaces
- `@MessageDriven` annotation with in class marks the Bean message driven
- Stateless
- Transaction aware

Message Driven EJB example

```
import javax.jms.Message;
import javax.jms.MessageListener;
import javax.ejb.MessageDriven;
@MessageDriven
public class MessageDrivenEJBBean implements
 MessageListener {

    public void onMessage(Message message) {
     if(message instanceof MyMessageType1)
         doSomething(); // business method 1
     if(message instanceof MyMessageType2)
         doSomethingElse(); // business method 2

    }
}
```

EJB Query Language (EJBQL)

- EJBQL : RDBMS vendor independent query syntax
- Query API supports both static queries (i.e., named queries) and dynamic queries.
- Since EJB3.0, supports HAVING, GROUP BY, LEFT/RIGHT JOIN etc.

EJBQL - examples

- Define named query:

```
@NamedQuery(
  name="findAllCustomersWithName",
  queryString="SELECT c FROM Customer c WHERE c.name
  LIKE :custName"
)
```

- Use named query:

```
@Inject public EntityManager em;
//..
List customers =
  em.createNamedQuery("findAllCustomersWithName")
      .setParameter("custName", "Smith")
      .getResultList();
```

Deploying EJBs

- EJB 3.0 annotations replace EJB 2.0 deployment descriptors in almost all cases
- Values can be specified using annotations in the bean class itself
- Deployment descriptor *may be used* to override the values from annotations

Some EJB Servers (Application Servers)

Company	Product
IBM	WebSphere
BEA Systems	BEA WebLogic
Sun Microsystems	Sun Application Server
Oracle	Oracle Application Server
JBoss	JBoss

Advantages of EJB

- Simplifies the development of middleware components that are secure, transactional, scalable & portable.
- Simplifies the process to focus mainly on business logic rather than application development.
- Overall increase in developer productivity
- Reduces the time to market for mission critical applications

Summary

- Component based development focuses in grouping cohesive functions into reusable units called components
- Components interact with other components and clients through interfaces
- Distributed computing makes extensive use of component based development as it allows the different functionalities to be distributed over different systems.
- Different component development technologies are there by different vendors (Java EE, Spring Framework.NET WCF services, etc.)