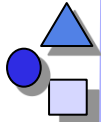


# 12) Enterprise Java Beans

Prof. Dr. Uwe Aßmann  
Technische Universität Dresden  
Institut für Software- und  
Multimediatechnik  
<http://st.inf.tu-dresden.de>  
11-0.1, May 19, 2010

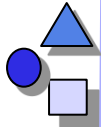
1. Basics
2. Different Kinds of Beans
3. EJB in 2.0
4. EJB in 3.0
5. Evaluation





## *Obligatory Reading*

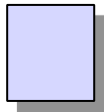
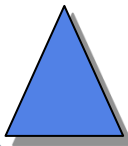
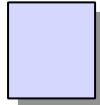
- ▶ Sun's enterprise bean tutorial  
<http://java.sun.com/javaee/reference/tutorials/index.jsp>
- ▶ Szyperski, Chap 14
- ▶ <http://xdoclet.sourceforge.net>
- ▶ EJB 3.0 Features  
[http://java.sun.com/developer/technicalArticles/J2EE/intro\\_ee5/](http://java.sun.com/developer/technicalArticles/J2EE/intro_ee5/)

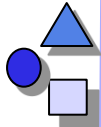


# Literature

- ▶ JBoss EJB 3.0 Documentation  
<http://docs.jboss.org/ejb3/app-server/>
- ▶ <http://developers.sun.com/docs/web/swdp/r1/tutorial/doc/toc.html>
- ▶ [http://java.sun.com/developer/technicalArticles/Interviews/community/bien\\_qa.html](http://java.sun.com/developer/technicalArticles/Interviews/community/bien_qa.html)
- ▶ The Java EE 5 Tutorial. For Sun Java System Application Server 9.1. Sun Microsystems, Sept. 2007.  
<http://java.sun.com/javaee/5/docs/tutorial/doc/JavaEETutorial.pdf>
- ▶ Ed Roman: Mastering EJB. Wiley & Sons.  
<http://www.theserverside.com/books/wiley/masteringEJB/index.jsp>
- ▶ B. Tate, M. Clark, B. Lee, P. Linskey: Bitter EJB. Manning Publications Co.

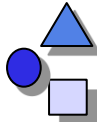
# 12.1 Basics





# Basics of Enterprise Java Beans (EJB)

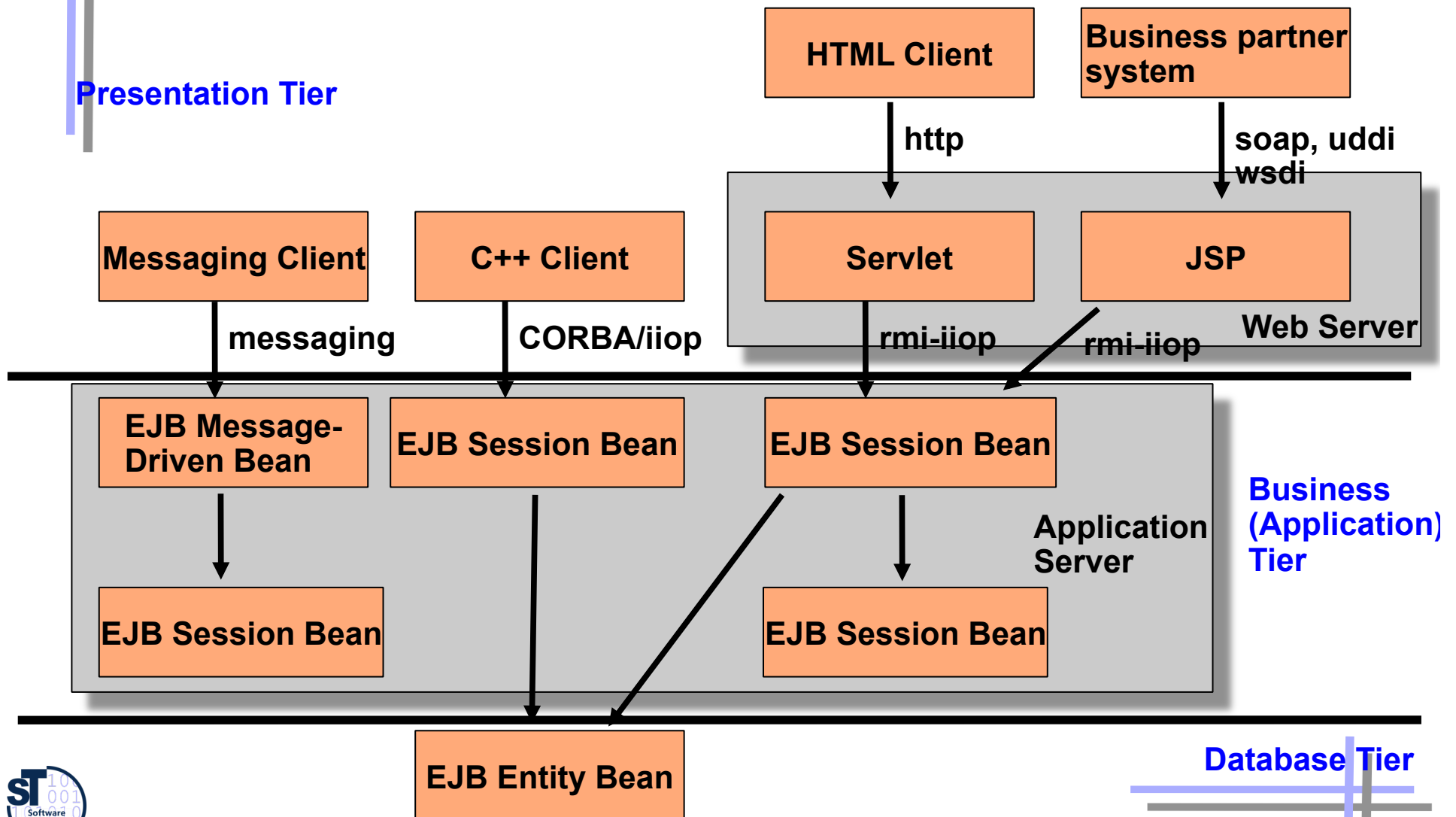
- ▶ Developed by SUN, now Oracle
  - Server-side component architecture for building distributed OO business applications in Java
  - Separation of business logic and lower-level concerns (e.g., networking, transactions, persistence, ...) into *implicit middleware*
- ▶ EJB 1.0 1998, EJB 2.0 2001, current version is 3.0
- ▶ EJB integrates several principles:
  - Adapters (Interceptor)
  - Container as application server for transparency of transaction and persistency
  - A simple XML-based composition language

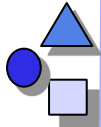


# Ingredients of EJB

- ▶ Component Model
  - Static components contain classes
  - Dynamic components contain objects
  - **Session Beans:** for business logic and application algorithms
  - **Message-Driven Beans:** Same function as session beans
    - Called by sending messages instead of calling methods
    - Have a message queue, react to an asynchronous message connector
  - **Entity Beans:** for business objects (data)
    - Persistent object that caches database information (an account, an employee, an order, etc)
  - Component factory (Home bean)
  - Customization possible by deployment descriptors
- ▶ Composition Technique
  - Adaptation/Glue:
    - Transparent distribution (Almost, see local/remote interfaces)
    - Transparent network protocols
    - Transparent transaction and persistency
  - No connectors

# Interactions in an EJB Component System (Where are the Beans?)



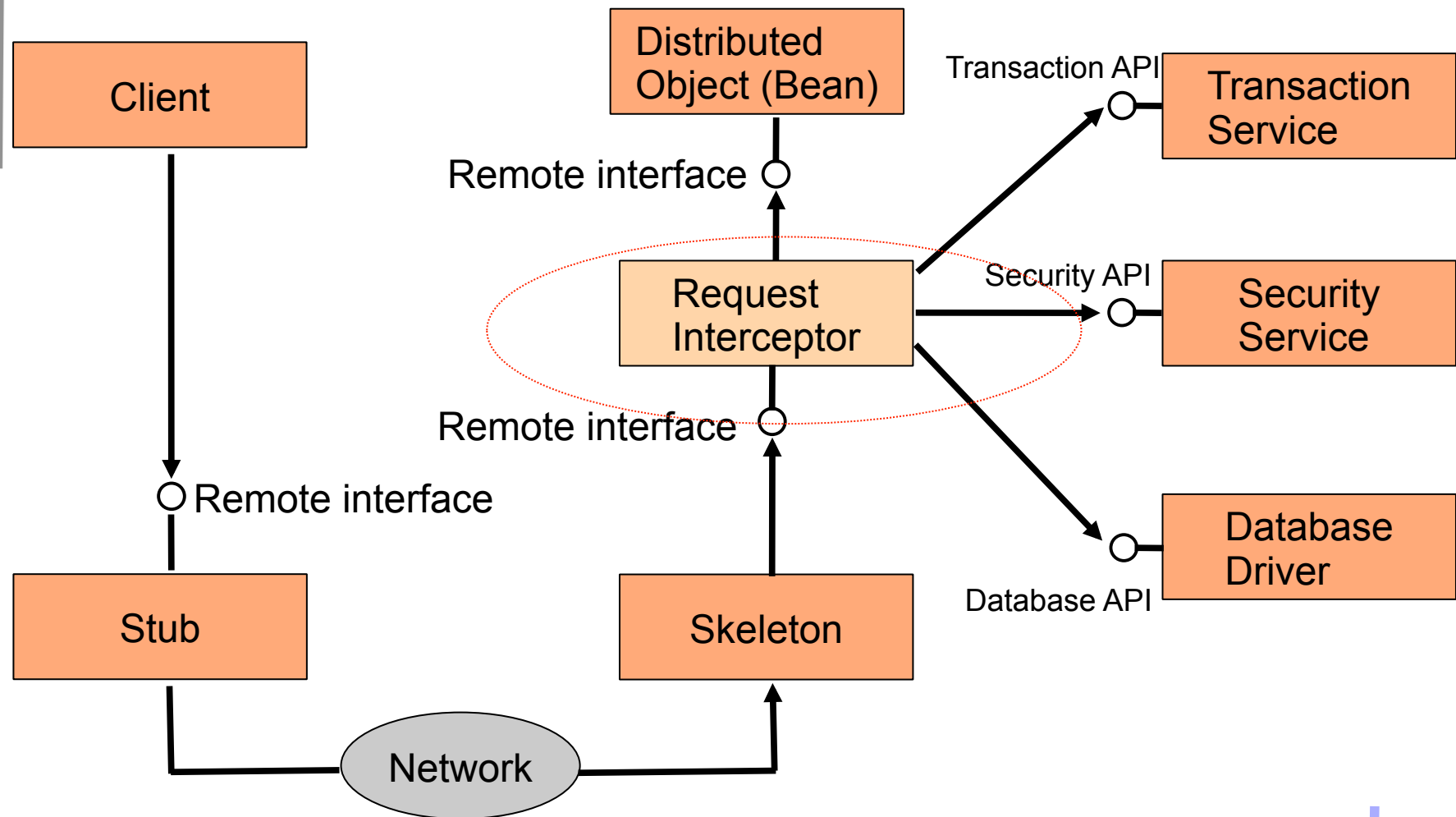


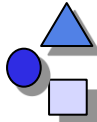
# The Container/Application Server

- ▶ Container (application server)
  - The container is a wrapper (Decorator, Interceptor) of the bean
    - In a container, some business logic may run on the server, hiding the direct data access
    - The container manages the beans
    - Factory: create; Repository: find, remove
  - The container provides middleware services the beans can use (*implicit middleware*)
    - Write *only* business logic
    - Declare the middleware services that you need (transactions, persistence, security, resource management, ...etc)
    - The middleware services are provided automatically
    - In explicit middleware (see CORBA), middleware services have to be addressed by the programmer
- ▶ Some common application servers
  - JBoss – free software [www.jboss.org](http://www.jboss.org), Apache Geronimo
  - BEA's WebLogic, IBM's WebSphere, Oracle's Oracle 11g



# Implicit Middleware by Interceptors (Decorators)

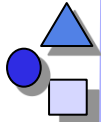




# ***The Parts of an EJB***

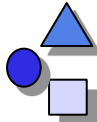
## ***- The Enterprise Bean Class***

- ▶ The implementation of the bean looks different depending on which kind of bean
- ▶ Session beans
  - Business-process-related logic
  - e.g., compute prices, transfer money between accounts
- ▶ Entity beans
  - Data-related logic
  - e.g., change name of a customer, withdraw money from an account
- ▶ Message-driven beans
  - Message-oriented logic
  - e.g., receive a message and call a session bean



## *Parts - Overview*

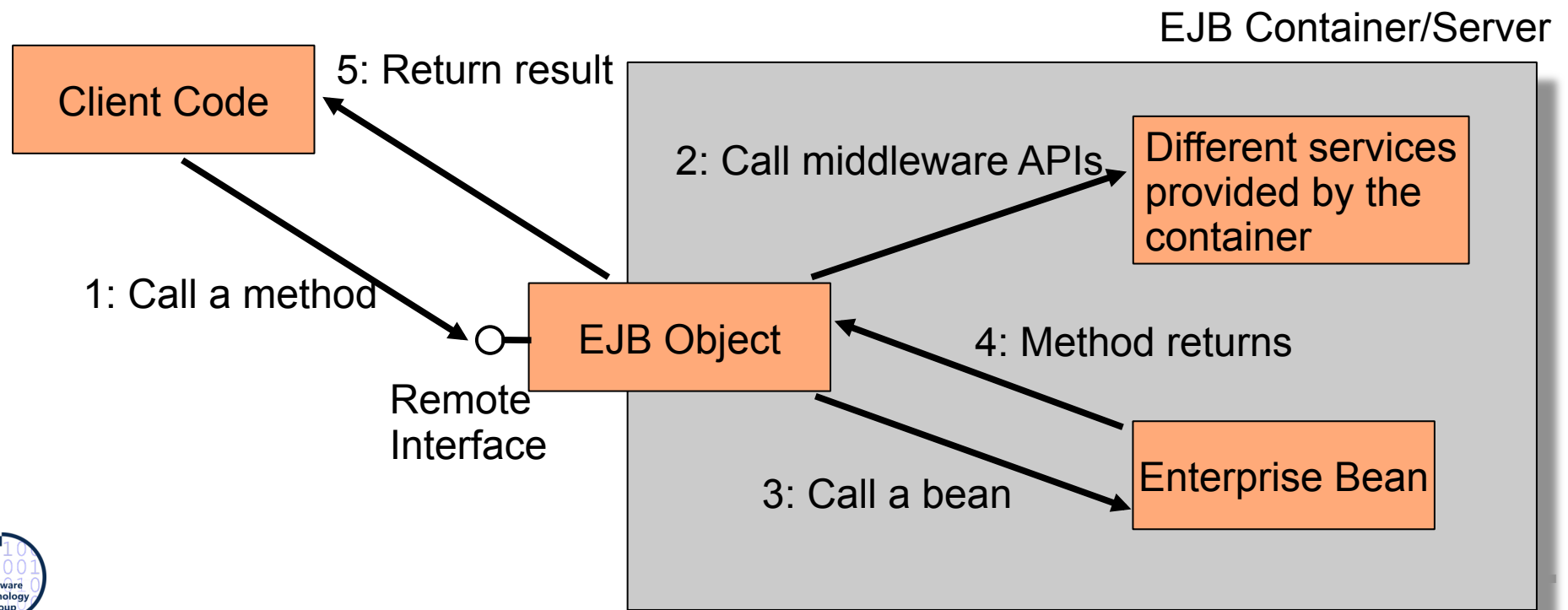
- ▶ Bean class
- ▶ Home – a factory
- ▶ Local interface [3.0: annotation]
- ▶ Remote interface [3.0: annotation]
- ▶ Deployment descriptor

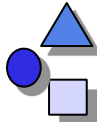


# The Parts of an EJB

## - The EJB Object

- ▶ The enterprise bean is not called directly
  - Instead an EJB object is generated by the container (facade object, proxy)
  - The EJB object filters the input and intercepts calls and delegates them to the bean
  - The EJB object is responsible for providing middleware services



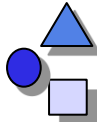


# The Parts of an EJB

## - The Remote Object Interface

- ▶ The interface to the bean that the client sees
  - Must contain all methods the bean should expose
- ▶ As the EJB object lies between the client and the bean, it has to implement this interface
  - Must extend `javax.ejb.EJBObject`

```
public interface Bank extends javax.ejb.EJBObject {  
  
    public Account getAccount(String name)  
        throws java.rmi.RemoteException;  
  
    public void openAccount(String name)  
        throws java.rmi.RemoteException;  
  
}
```



# The Parts of an EJB

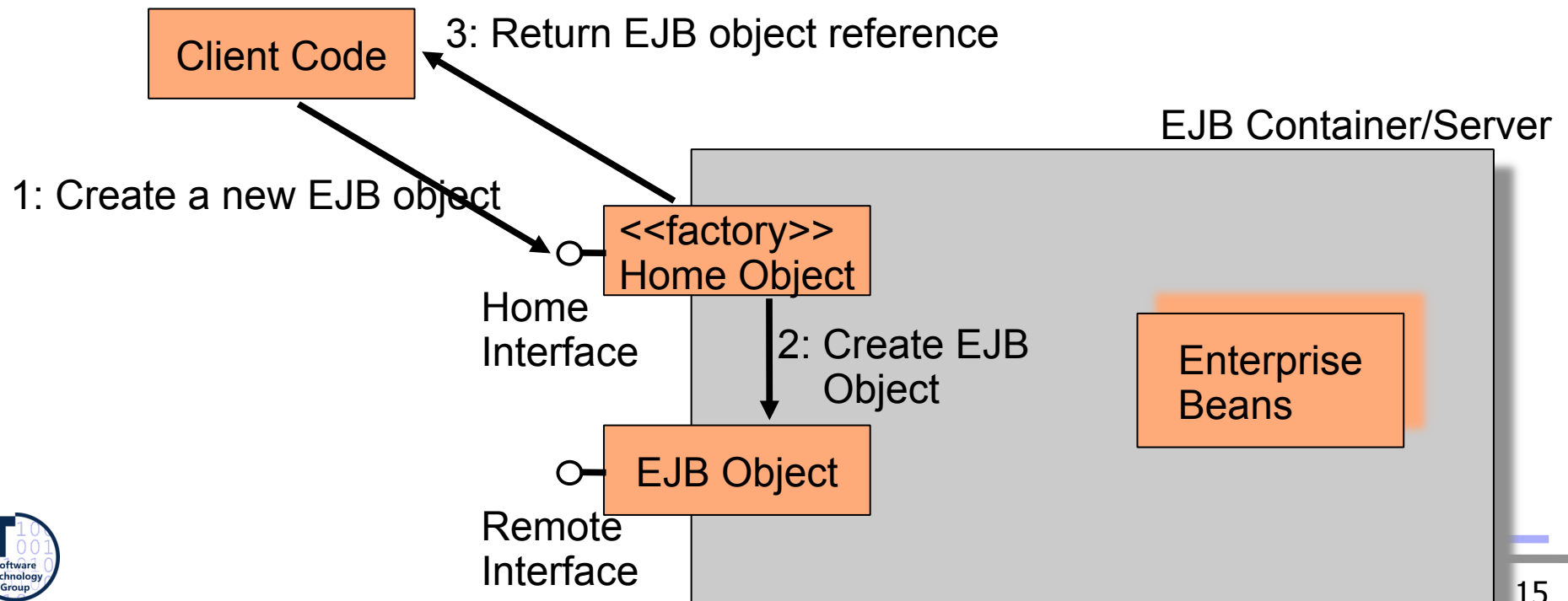
## - The Home Object

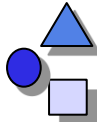
- ▶ How does the client get hold of an EJB object?
  - The EJB object can exist on a different machine
  - EJB promotes location transparency, so the client shouldn't have to care where the EJB object is located
- ▶ An EJB object *factory* and *repository* is needed: The home object
  - Create EJB objects
  - Find existing EJB objects
  - Remove EJB objects

# The Parts of an EJB

## - The Home Object and Interfaces

- ▶ The home object needs a *home interface* (factory)
  - Defines methods for creating, finding and removing EJB objects
- ▶ The communication uses Java RMI over IIOP
  - If an argument is serializable, it is sent as pass-by-value
  - RMI can also simulate pass-by-reference
  - A serialized stub for the remote object is sent instead





# The Parts of an EJB

## - Local Interfaces

- ▶ Optionally, you can provide local interfaces
  - local interface corresponding to remote interface
  - local home interface corresponding to home interface
- ▶ When beans are located locally it is possible to use local calls

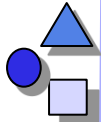
### Remote:

- ▶ Client calls a local stub
- ▶ Marshalling
- ▶ Stub calls skeleton over a network connection
- ▶ Unmarshalling
- ▶ EJB object is called, performs middleware services
- ▶ Bean is called
- ▶ Repeat to return result

### Local:

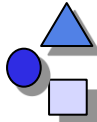
- ▶ Client calls a local object
- ▶ Local object performs middleware services
- ▶ Bean is called
- ▶ Control is returned to the client





## ***Drawbacks of Using Local Interfaces***

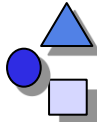
- ▶ They only work when calling beans in the same process
  - Code for local interfaces differs from code for remote interfaces
  - To switch between local and remote calls it is necessary to change the code
  - Location transparency is not preserved
- ▶ The marshalling of parameters is by reference
  - This is different from remote calls which are by value
  - There is a definite speed gain...
  - ...but it can be error-prone because the semantics are different from remote calls
- ▶ Horrible: this should be encapsulated in a connector!



# *The Parts of an EJB*

## *- The Deployment Descriptor*

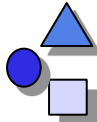
- ▶ An XML file in which the middleware service requirements are declared (There is a DD-DTD)
  - Bean management and lifecycle requirements
  - Transaction, persistence, and security requirements
- ▶ Composition of beans (references to other beans)
  - Names: Name, class, home interface name, remote-interface name, class of the primary key
  - States: type (session, entity, message), state, transaction state, persistency management - how?
- ▶ The application assembler may allocate or modify additional different information
  - Name, environments values, description forms
  - Binding of open references to other EJB
  - Transaction attributes



## Example of a Deployment Descriptor

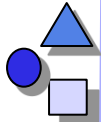
```
<!DOCTYPE ejb-jar PUBLIC "-//Sun Microsystems, Inc.//DTD Enterprise  
JavaBeans 2.0//EN" "http://java.sun.com/dtd/ejb-jar_2_0.dtd">
```

```
<ejb-jar>  
  <enterprise-beans>  
    <session>  
      <ejb-name>Bank</ejb-name>  
      <home>com.somedomain.BankHome</home>  
      <remote>com.somedomain.Bank</remote>  
      <local-home>com.somedomain.BankLocalHome</local-home>  
      <local>com.somedomain.BankLocal</local>  
      <ejb-class>com.somedomain.BankBean</ejb-class>  
      <session-type>Stateless</session-type>  
      <transaction-type>Container</transaction-type>  
    </session>  
  </enterprise-beans>  
</ejb-jar>
```



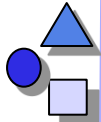
## *The Parts of an EJB (2.0)* *- Putting It All Together*

- ▶ Finally all the above mentioned files are put into an EJB-jar file
  - bean class
  - home (and local home) interface
  - remote (and local) interface
  - deployment descriptor, i.e., the composition specification
  - (possibly vendor-specific files)



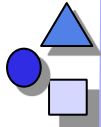
## Deployment of an EJB

- ▶ The *deployment* of a bean is a new step in component systems we have not yet seen
- ▶ The application server is notified of the new bean by
  - using a command-line tool,
  - dropping the EJB in a specific directory,
  - or in some other way
- ▶ The EJB-jar file is verified by the container
- ▶ The container generates an EJB object and home object
- ▶ The container generates any necessary RMI-IIOP stubs and skeletons



## Roles in the EJB Software Process

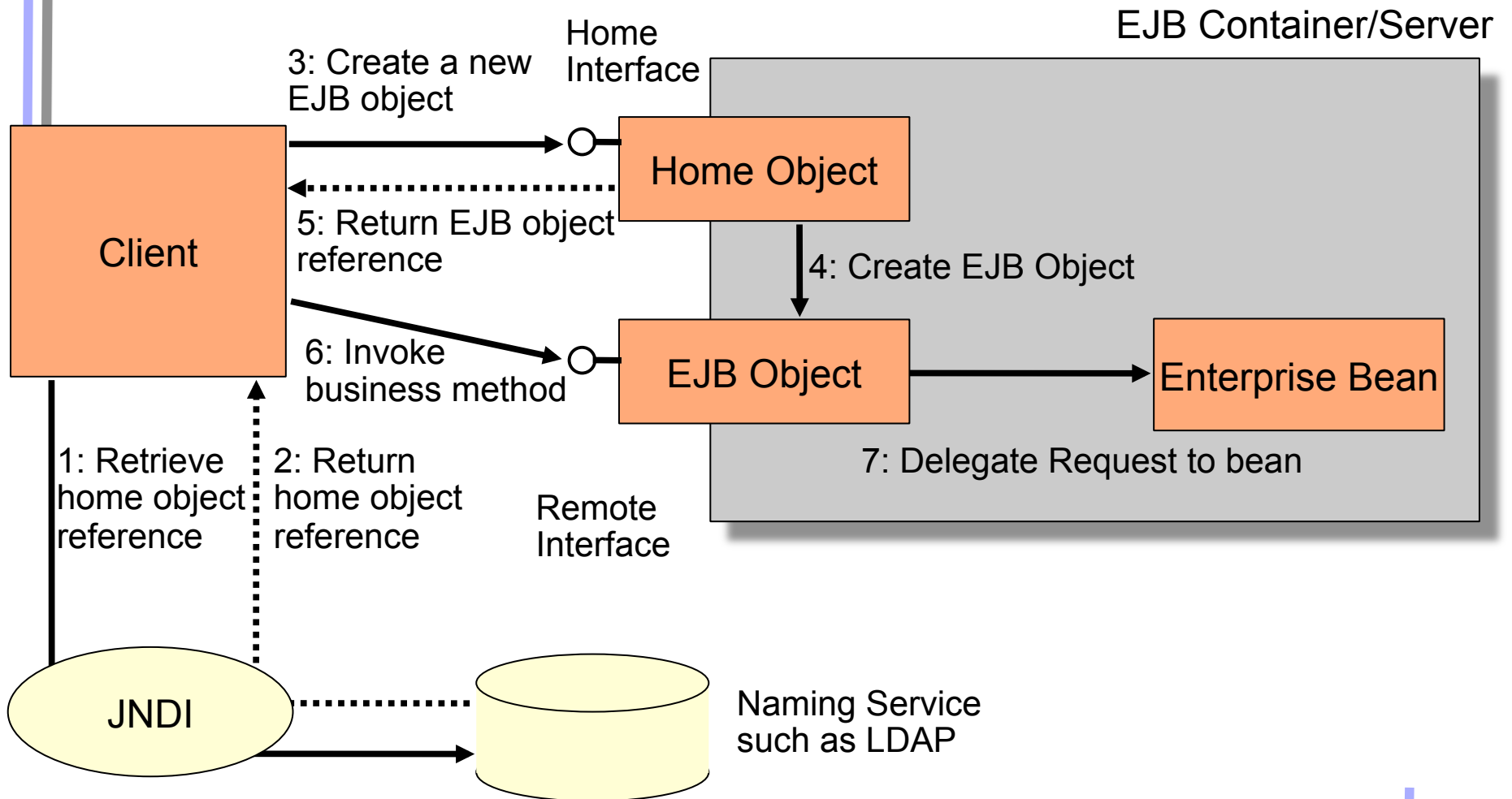
- ▶ *Bean provider* (bean producer) is an application expert
  - Builds a EJB-jar with application specific methods, deployment-descriptor, remote, home interface
- ▶ *Application assembler* composes EJB to larger EJB, i.e., applications units.
  - She extends the deployment-descriptors
- ▶ *Employer* (deployer) puts the EJB into a environment, consisting of a EJB Server and Container (Adapter).
  - Is the EJB connected to a EJB-Container, it is configured and usable
- ▶ *Server-provider* is a specialist in transaction management and distributed systems.
  - Provides basic functionality for distribution
- ▶ *Container-provider* (container provider) delivers the container tools for configuration and for run time inspection of EJB
  - The Container manages persistency of Entity Beans, generation of communication code (glue code) to underlying data bases



## *How to Find a Home Object*

- ▶ To achieve location transparency the machine address of the home object should not be hard-coded
- ▶ Instead the Java Naming and Directory Interface (JNDI) is used to lookup home objects
  - JNDI is a standard interface for locating resources, similar to the Corba name service
  - Only the address to the JNDI server is needed
  - JNDI provides a mapping between the name of a resource and its physical location

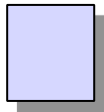
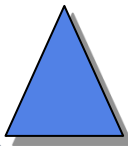
# The Entire Process

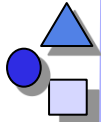




## *12.2 A Closer Look at the Different Kinds of Enterprise JavaBeans*

(only 2.0)



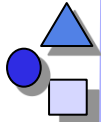


# Session Beans Overview

- ▶ Reusable components that contain logic for business processes
  - The lifetime of a session bean is roughly equivalent to the lifetime of the client code calling it
  - A session bean is nonpersistent
- ▶ Two kinds of session beans
  - Stateful
  - Stateless

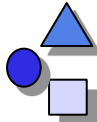
java.ejb.SessionBean

- **setSessionContext(SessionContext context)**  
The bean can query the SessionContext for information concerning the container
- **ejbCreate()**  
Used to perform initialization when the bean is created
- **ejbPassivate()**  
Used by stateful session beans, explained later
- **ejbActivate()**  
Used by stateful session beans, explained later
- **ejbRemove()**  
Used to release any resources the bean has been holding before it is removed



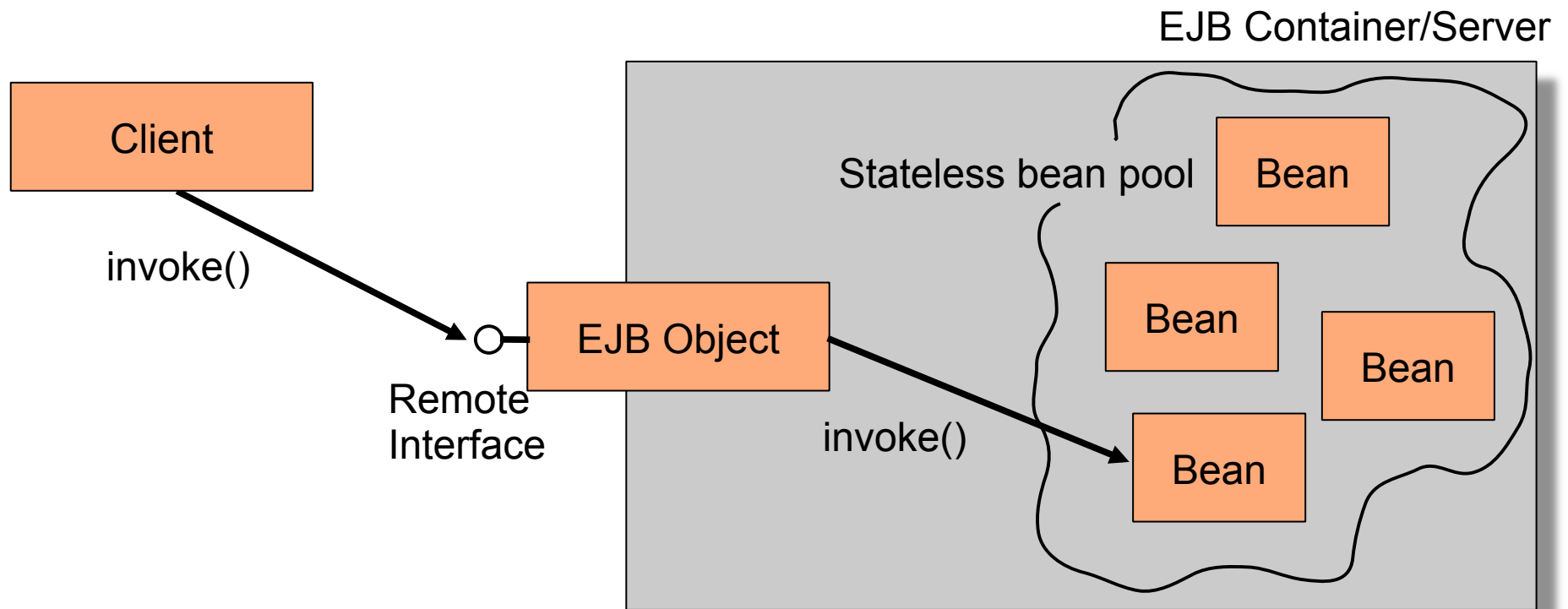
# Stateless Session Beans

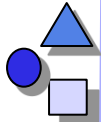
- ▶ Handle single request conversations
  - Conversations that span a single method call
  - Does not hold a conversational state
- ▶ The bean may be destroyed by the container after a call or it has to be cleared of old information
- ▶ Examples of stateless session beans
  - A user verification service
  - An encoding engine
  - Any service that given some input always produces the same result



# Pooling Stateless Session Beans

- ▶ Stateless session beans can easily be pooled (reused) to allow better scaling
  - They contain no state



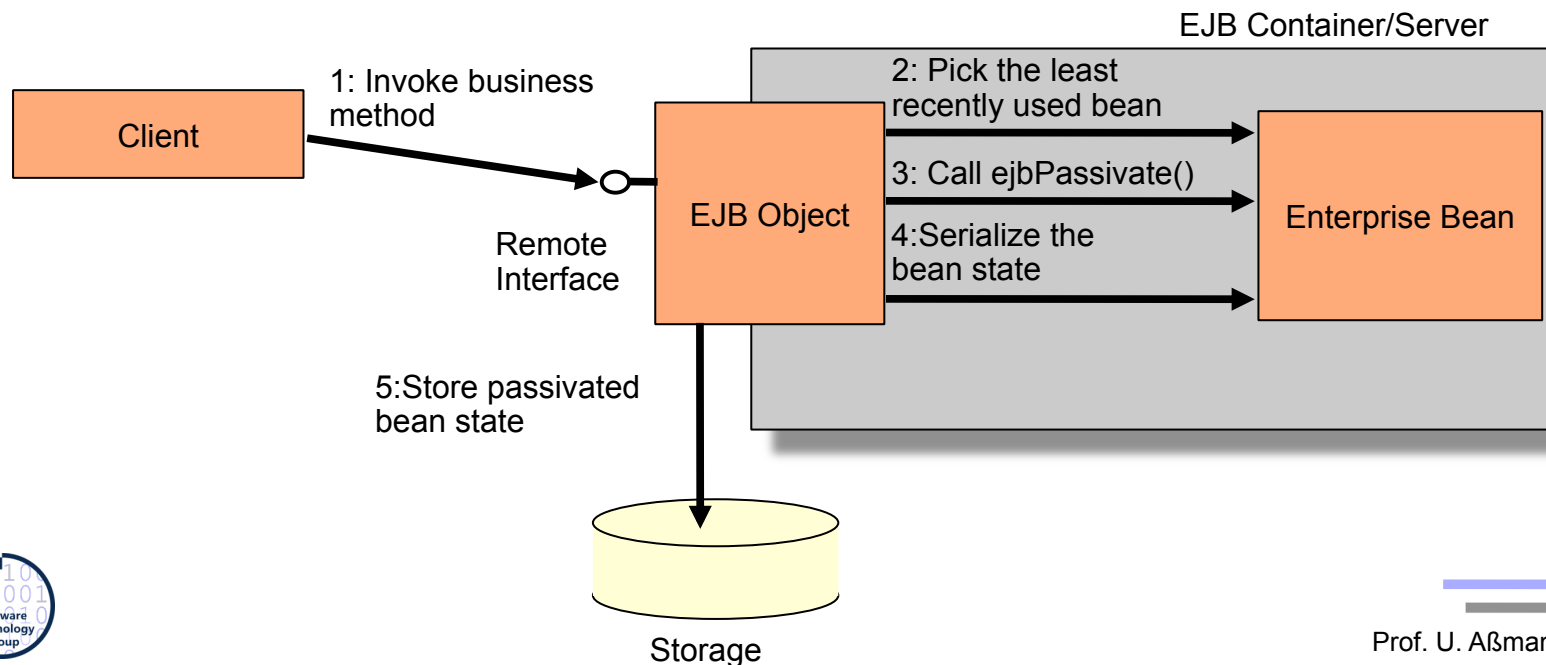


# Stateful Session Beans

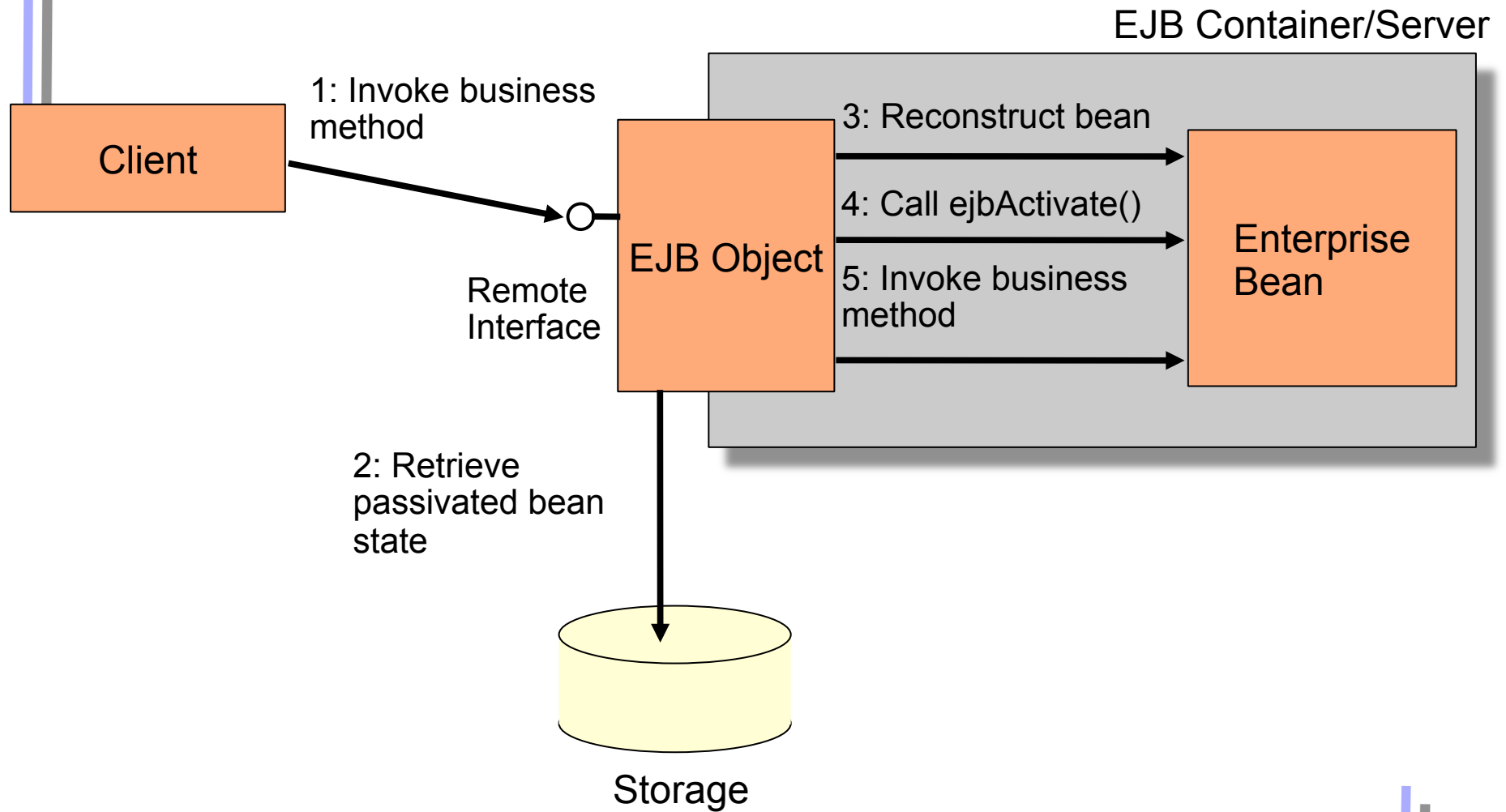
- ▶ Handles drawn-out conversations
  - E-commerce web store with a shopping cart
  - Online bank
  - Tax declaration
- ▶ Thus it has to retain its state between invocations

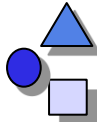
# Pooling Stateful Session Beans

- ▶ Pooling becomes more complicated
  - Beans must be swapped from physical memory to disk
- ▶ A stateful session bean has to implement:
  - `ejbPassivate()`: Called to let the bean release any resources it holds before it gets swapped out
  - `ejbActivate()`: Called right after the bean has been swapped in to let it acquire the resources it needs

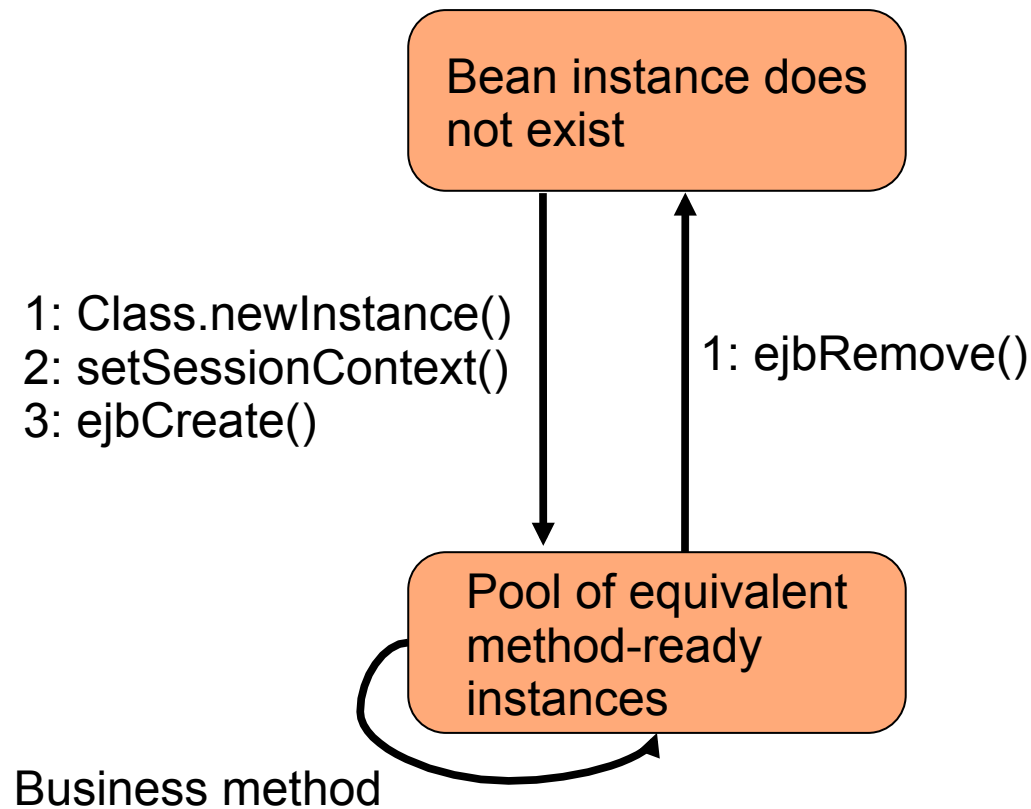


# Activation of a Stateful Session Bean

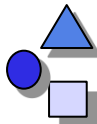




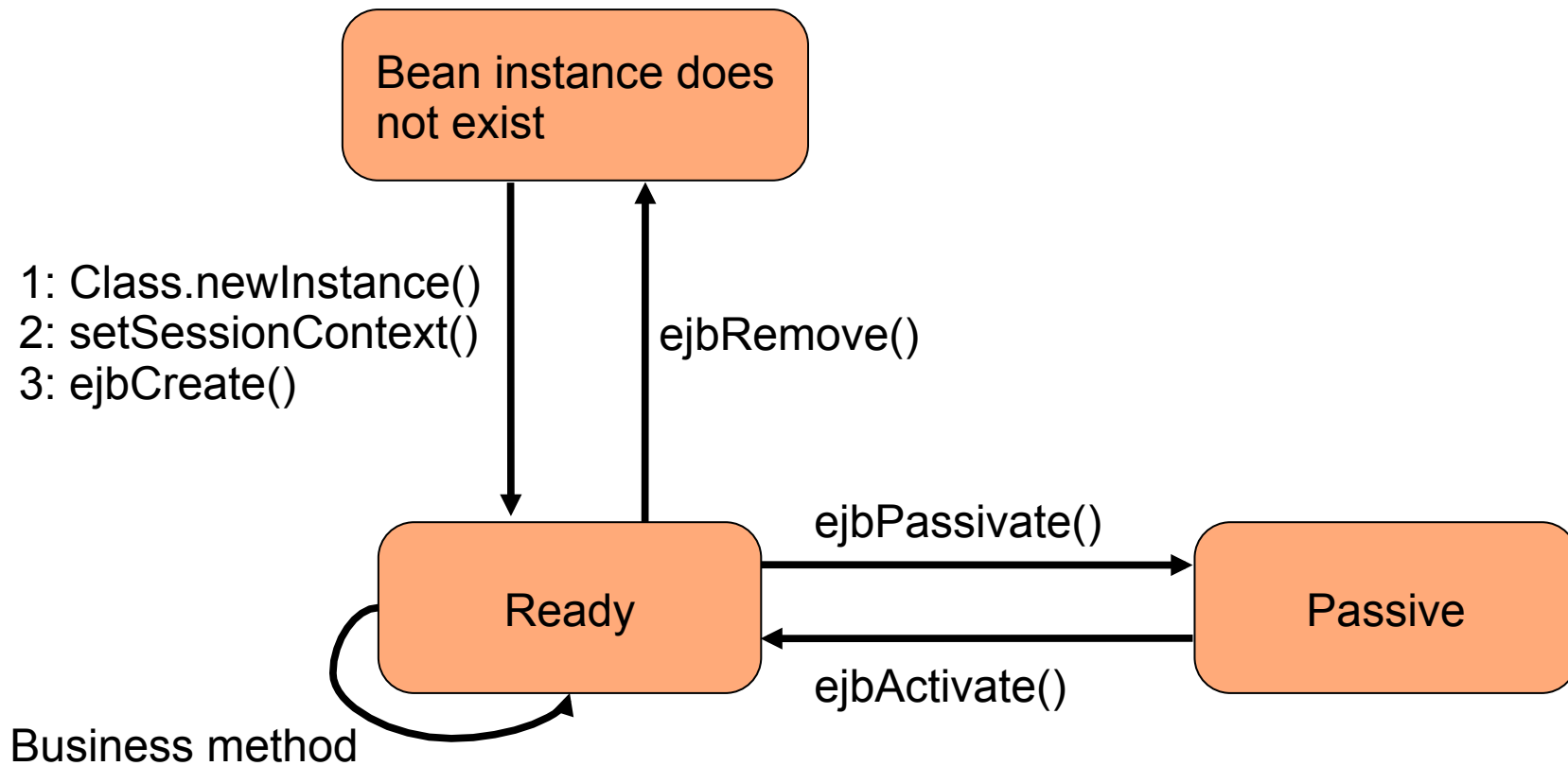
# Life Cycle of a Stateless Session Bean

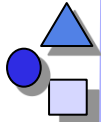






# Life Cycle of a Stateful Session Bean

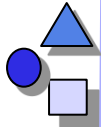




# Message-Driven Beans

## ▶ Why?

- Performance
  - Asynchronous process means that clients don't have to wait for the bean to finish
- Reliability
  - With RMI-IIOP the server has to be up when the client is calling it.
  - With a message-oriented middleware (MOM) that supports guaranteed delivery, the message is delivered when the server gets back online
- Support for multiple senders and receivers
  - RMI-IIOP is limited to one client talking to one server

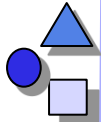


## ***Characteristics of Message-Driven Beans***

- ▶ MDBs don't have a home, local home, remote or local interface
- ▶ MDBs have a single, weakly typed business method
  - onMessage() is used to process messages
  - MDBs don't have any return values
  - However, it is possible to send a response to the client
  - MDBs cannot send exceptions back to clients
- ▶ MDBs are stateless
- ▶ MDBs can be durable or nondurable subscribers
  - durable means that the subscriber receives all messages, even if it is inactive

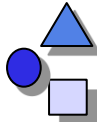
## 12.3 Entity Beans in 2.0





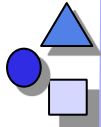
# Entity Beans Overview

- ▶ Entity beans are persistent objects that can be stored in permanent storage
  - Live on the entity or database layer of the 3-tier architecture
  - The entity bean data is the physical set of data stored in the database
- ▶ An entity bean consists of the same files as a session bean
  - remote/local interface
  - home/local home interface
  - the enterprise bean class
  - the deployment descriptor
- ▶ Two kinds of entity beans
  - *Bean-managed persistent or container-managed persistent*



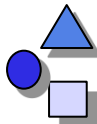
## *Features of Entity Beans*

- ▶ Entity bean instances are a view into a database
  - The bean and the data in the database are conceptually the same
  - Entity beans survive failures: persistent
- ▶ Several entity bean instances may represent the same underlying data
  - An entity bean has a primary key to uniquely identify the database data
  - Entity bean instances can be pooled
    - must implement `ejbActivate()` and `ejbPassivate()`
- ▶ Entity beans are found with special finder methods

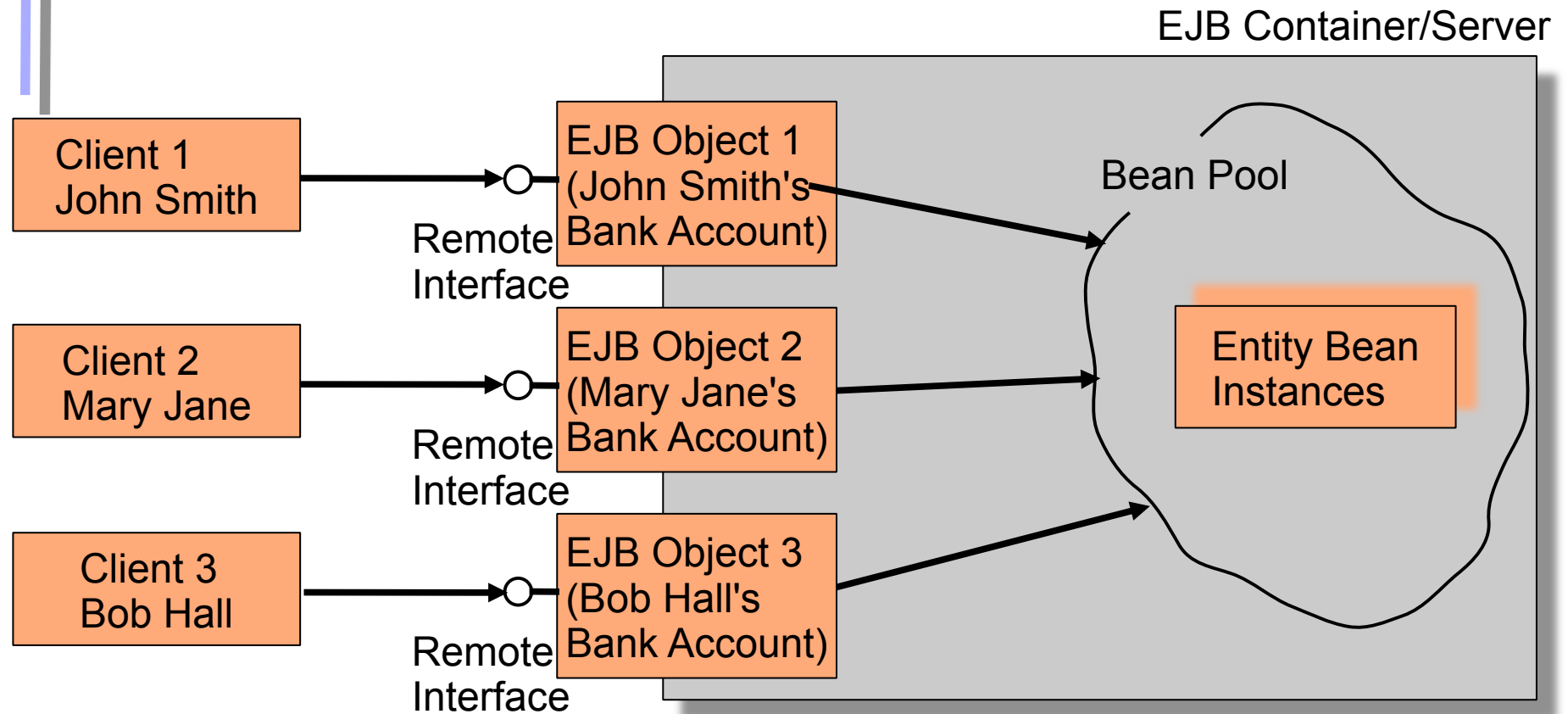


# How is Persistence Achieved?

- ▶ **Serialization**
  - Very expensive to query objects stored using serialization
  - consider getting all accounts with a specific amount of money
- ▶ **Object-relational mapping (relational databases)**
  - Map the object to a relational database when it is stored
  - Allows advanced queries and visualization
  - The mapping is either hand-coded or achieved by finished products
- ▶ **Object databases**
  - Persistent store that holds entire objects, no mapping step
  - Queries possible by using an object query language (OQL)
  - Supports relationships between objects
  - Predictable scalability and performance
  - Strong integrity and security
  - Object databases haven't taken off so Object-relational mappings are normally used

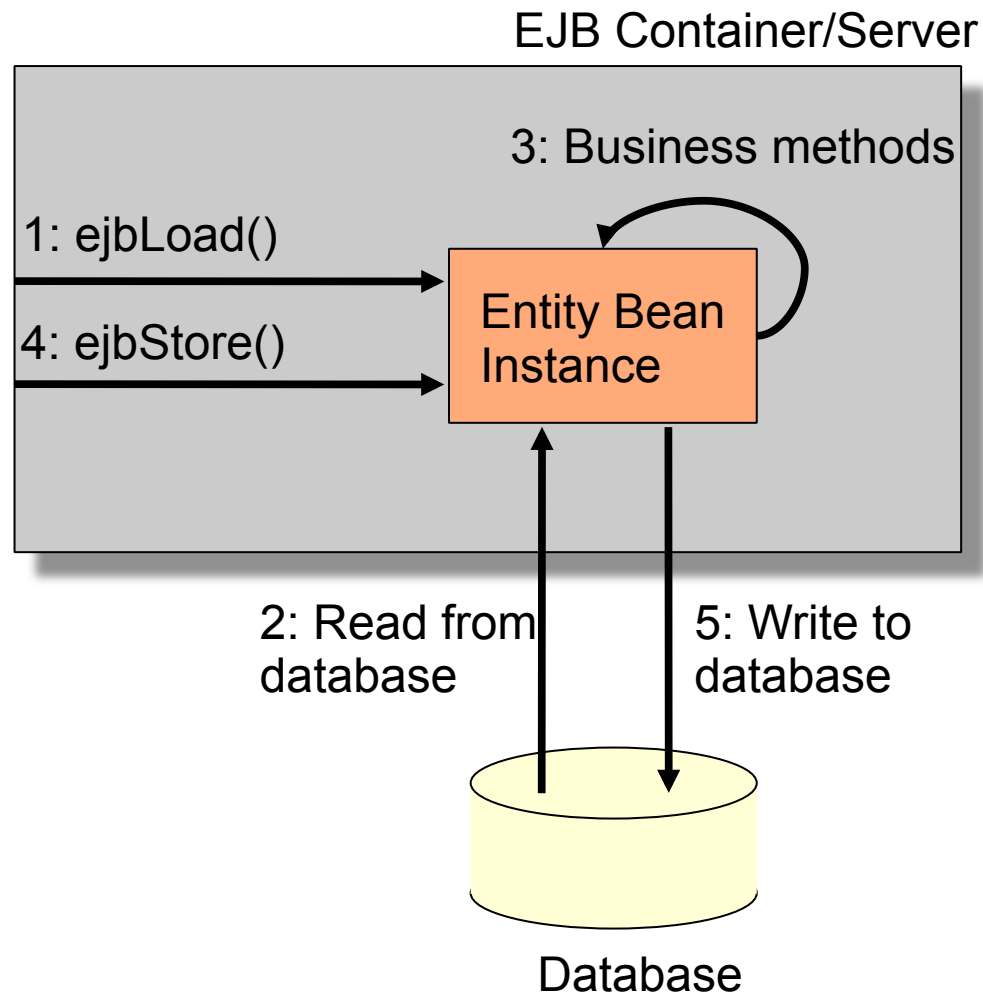


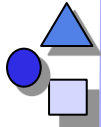
# Pooling Entity Beans





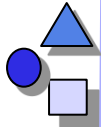
# Loading and Storing an Entity Bean





# Bean-Managed Persistent Entity Beans (BMP Beans)

- ▶ The developer is required to provide the implementation to map the instances to and from storage
  - Java Database Connectivity (JDBC)
- ▶ BMP beans have to implement `javax.ejb.EntityBean`:
  - `setEntityContext(javax.ejb.EntityContext)`
    - The context can be queried of information regarding the container
  - `unsetEntityContext()`
  - `ejbRemove()`
    - Removes the data from the persistent storage
  - `ejbActivate()`
    - Lets the bean allocate resources after being swapped in
  - `ejbPassivate()`
    - Called before the bean is swapped out so it can release resources
  - `ejbLoad()`
    - Loads database data into the bean
  - `ejbStore()`
    - Stores the data in the bean to the database



# Bean-Managed Persistent Entity Beans

- ▶ BMP beans also have to other kinds of methods relating to storage
  - `ejbCreate()`
    - Used to create new entries in the database (optional)
  - Finder methods
    - `ejbFindXXX()`
    - Must have at least one: `ejbFindByPrimaryKey()`
    - Normally contains database queries
      - e.g., `SELECT id FROM accounts WHERE balance > 3000`
  - `ejbHomeXXX()` methods
    - Performs simple services over a set of beans
- ▶ A BMP entity bean consists of
  - Bean-managed state fields, persistable fields that are loaded from the database
  - Business logic methods: Performs services for clients
  - EJB-required methods: Required methods that the container calls to manage the bean



# Example - Bean-Managed State Fields

## ▶ AccountBean.java

```
import java.sql.*;
import javax.naming.*;
import javax.ejb.*;
import java.util.*;

public class AccountBean implements EntityBean {
    protected EntityContext context;

    // Bean-managed state fields
    private String accountID;
    private String ownerName;
    private double balance;

    public AccountBean() { }

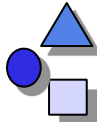
    ...cont...
```

```
...cont...
public void deposit(double amount) {
    balance += amount;
}

public void withdraw(double amount) {
    if (amount < balance) {
        balance -= amount;
    }
}

public void getBalance() {
    return balance;
}

...cont...
```

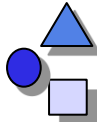


# Example

## - Business Logic Methods

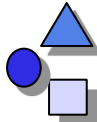
```
...cont...
public void ejbHomeGetTotalBankValue() {
    PreparedStatement pStatement = null;
    Connection connection = null;
    try {
        connection = getConnection();
        pStatement = connection.prepareStatement(
            "select sum(balance) as total from accounts");
        ResultSet rs = pStatement.executeQuery();
        if (rs.next()) { return rs.getDouble("total"); }
    } catch (Exception e) { ... }
    finally {
        try { if (pStatement != null) pStatement.close(); }
        catch (Exception e) { ... }
        try { if (connection != null) connection.close(); }
        catch (Exception e) { ... }
    }
}
```

...cont...



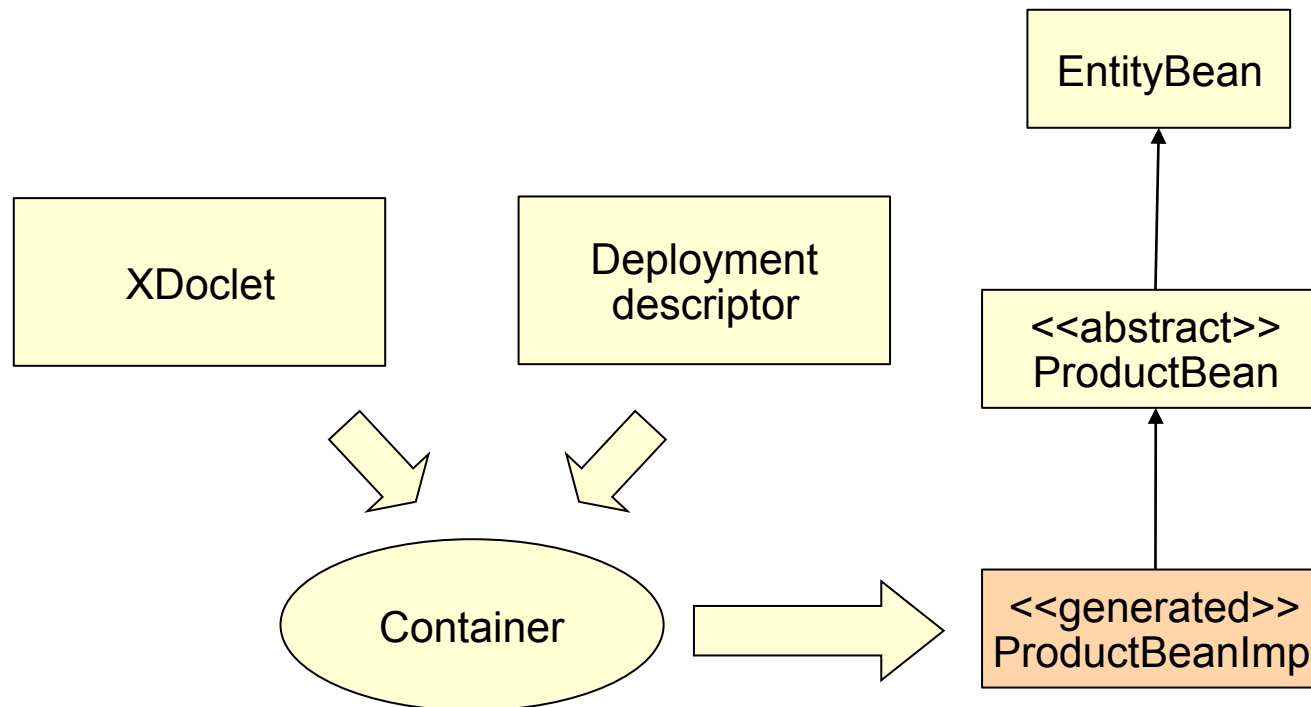
## Example - Required Methods

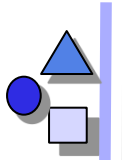
```
...cont...
public void ejbRemove {
    PreparedStatement pStatement = null;
    Connection connection = null;
    AccountPK pk = (AccountPK) context.getPrimaryKey();
    String id = pk.accountID;
    try {
        connection = getConnection();
        pStatement = connection.prepareStatement(
            "delete from accounts where id = ?1");
        pStatement.setString(1, id);
        pStatement.executeQuery();
    } catch (Exception e) { ... }
    finally {
        try { if (pStatement != null) pStatement.close(); }
        catch (Exception e) { ... }
        try { if (connection != null) connection.close(); }
        catch (Exception e) { ... }
    }
}
...
...cont...
```



# Container-Managed Persistence in 2.0

- ▶ TemplateMethod design pattern with generated hook class implementation

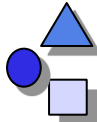




# Container-Managed Persistent Entity Beans (CMB)

- ▶ The container performs the storage operations
  - This gives a clean separation between the entity bean and its persistent representation
  - The container generates the persistence logic
- ▶ The CMP entity bean is always abstract
  - The container generates a concrete subclass
- ▶ The CMP entity beans have no declared fields
  - Also the get/set method implementations are generated by the container from the deployment descriptor
- ▶ CMP beans get an abstract persistence schema
  - An abstract persistence schema is declared in the deployment descriptor so the container will know what to generate
- ▶ There is a query language, EJB Query Language (EJB-QL. Example
  - `SELECT OBJECT(a) FROM Account AS a WHERE a.balance > ?1`



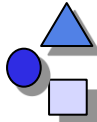


# Example: TemplateMethod Pattern

```
import javax.ejb.*;
public abstract class ProductBean implements EntityBean {
    protected EntityContext context;
    public abstract String getName();
    public abstract void setName(String name);
    public abstract String getDescription();
    public abstract void setDescription(String description);
    public abstract double getBasePrice();
    public abstract void setBasePrice(double price);
    public abstract String getProductID();
    public abstract void setProductID(String productID);

    public void ejbActivate() { }
    public void ejbRemove() { }
    public void ejbPassivate() { }
    public void ejbLoad() { }
    public void ejbStore() { }
    public void setEntityContext(EntityContext ctx) { context = ctx; }
    public void unsetEntityContext() { context = null; }
    public void ejbPostCreate(String productID, String name,
        String description, double basePrice) { }
    public String ejbCreate(String productID, String name,
        String description, double basePrice) {
        setProductID(productID);      setName(name);
        setDescription(description);  setBasePrice(basePrice);
        return productID;
    }
}
```

Hook methods



## ***CMP Entity Beans – Deployment Descriptor***

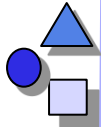
- ▶ You have to declare how the container should generate methods and fields

...declarations of interfaces, etc ....

```
<cmp-field>
  <field-name>productID</field-name>
</cmp-field>
<cmp-field>
  <field-name>name</field-name>
</cmp-field>
<cmp-field>
  <field-name>description</field-name>
</cmp-field>
<cmp-field>
  <field-name>basePrice</field-name>
</cmp-field>
```

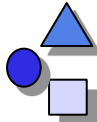
.. queries ...

```
<query>
  <query-method>
    <method-name>findByName</method-name>
    <method-params>
      <method-param>java.lang.String</method-param>
    </method-params>
  </query-method>
  <ejb-ql>
    <![CDATA(SELECT OBJECT(a) FROM ProductBean AS a WHERE name=?1)]>
  </ejb-ql>
</query>
```



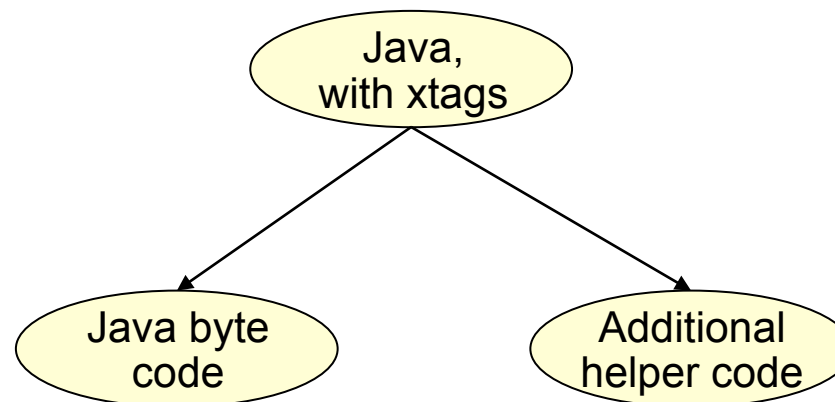
## *EJB and Others*

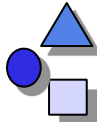
- ▶ Interceptors and Decorators
  - The Interceptor of a bean is like a decorator
  - It can be overwritten and extended from outside the EJB
  - User can write filters for EJB
  - JBoss uses this for aspect-oriented EJB (see later)
- ▶ EJB was formed after Microsoft's MTS (now COM+)
  - COM+ is in .NET
  - Models are somewhat similar
- ▶ Corba Component Model (CCM) is also similar



# XDoclets

- ▶ An XDoclet is a plugin into the XDoclet framework
- ▶ The XDoclet framework is a doclet, i.e., a Javadoc extension
- ▶ XDoclets define new tags (xtags), used for metadata
  - Tags can have attribute lists
  - `/* @ejb.bean type = "CMP" name="client" view-type="local" */`
- ▶ Tags steer code generation
  - XDoclet compiler reads the Java source files, evaluates commented tags and generates additional code





## Use of XDoclets

- ▶ Generation of
  - Deployment descriptors
  - Default interfaces
  - Implementation stubs
- ▶ Example [from XDoclet documentation]

```
/** Account
    @see Customer
    @ejb.bean name="bank/Account" type="CMP"
             jndi-name="ejb/bank/Account"
             primkey-field="id"
    @ejb.finder signature="java.util.collection findAll()"
             unchecked="true"
    @ejb.transaction type="required"
    @ejb.interface remote-class="test.interfaces.Account"
    @version 1.5
*/
```

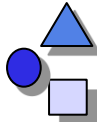


- ▶ XDoclet is used now for many Java metadata-based applications
  - Hibernate (persistence)
  - Component markup
- ▶ Integration with ANT, the Java make tool
  - Definition of ANT tasks possible that collaborate with XDoclet

## 12.4. EJB 3.0

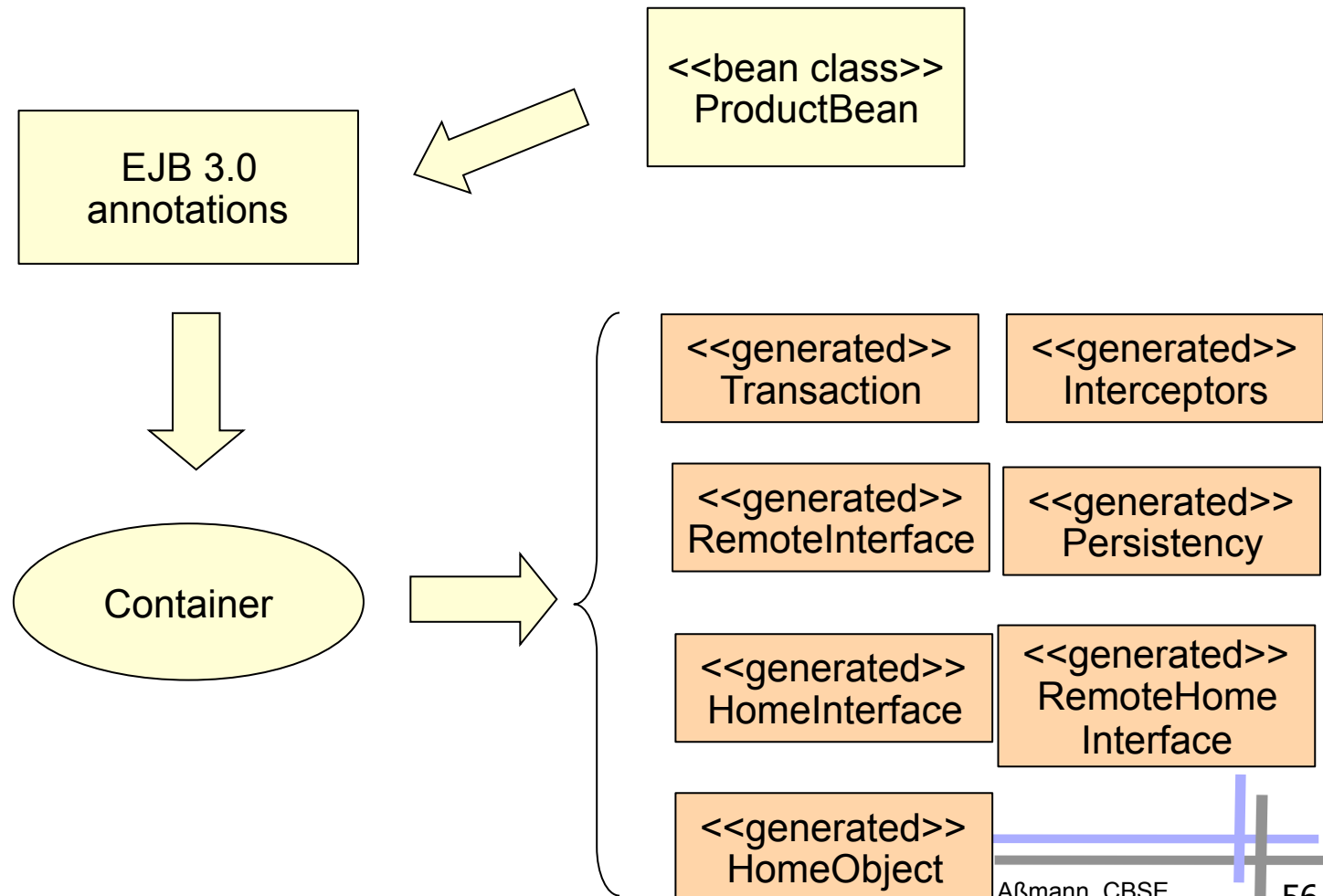
heavily uses metadata markup to generate all dependent interfaces and code



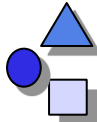


# EJB 3.0

- ▶ Only the bean class is specified
  - Rest of the classes is generated from metadata annotations







## Marking in EJB 3.0 – Annotation Types

- ▶ Bean class annotations refer to classes and create interfaces with adapters:

```
@Entity
```

```
public class AccountBean implements Account {  
    public void deposit (double money) {...}  
}
```

```
@Stateless
```

```
@Stateful
```

```
@MessageDriven
```

```
@Local
```

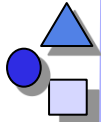
```
@Remote
```

```
@RemoteHome
```

```
@LocalHome
```



From [EJB 3.0 Features]



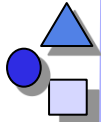
# Method Callback Annotations

- ▶ The default methods can be adorned with user-written *filters* (*before*, *after*, and *around advices*)

```
@PrePassivate
void signalPassivation() {
    System.out.println("passivating bean now...");
}
```

```
@PreDestroy           [from EJB 3.0 Features]
@PrePersist
@PostPersist           /* Callback method defined inside a Listener class*/
@PreActivate
@PostActivate
@PrePassivate
@PostPassivate
@CallbackListener

public class AccountListener{
    @PostPersist
    insertAccountDetails(AccountDetails accountDetails){}
}
```



# Custom Interceptors

```
[from EJB 3.0 Features]
// Provides profiling logic in a business method (with interceptors)
/* The interceptor class */
public class ProfilingInterceptor {
    @AroundInvoke // indicates that this is the interceptor method
    public Object profile(InvocationContext invocation) throws Exception {
        long start = System.currentTimeMillis();
        try {
            return invocation.proceed(); // this statement would call the withdraw method
        } finally {
            long time = start - System.currentTimeMillis();
            Method method = invocation.getMethod();
            System.out.println(method.toString() + "took" + time + " (ms)");
        }
    }
}
/* The bean class */
@Stateless
public class BankAccountBean implements BankAccount {
    @PersistenceContext EntityManager entityManager;
    @Interceptors(ProfilingInterceptor.class)
    public void withdraw(int acct, double amount) { ... }
    public void deposit(int acct, double amount) { ... }
}
```



# Transaction Control with Attributes

- ▶ Classes and methods may receive transaction attributes
  - **Required:** bean joins the client's transaction
  - **RequiresNew:** bean starts new transaction
  - **NotSupported:** interrupt transaction, execute without it
  - **Supported:** bean joins the client's transaction, otherwise executes without transaction
  - **Mandatory:** bean joins the client's transaction, otherwise signals error

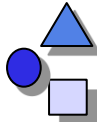
[The Java 2 EE tutorial]

```
@TransactionAttribute(NOT_SUPPORTED)
@Stateful
public class TransactionBean implements Transaction {
    ...
    @TransactionAttribute(REQUIRES_NEW)
    public void firstMethod() {...}
    @TransactionAttribute(REQUIRED)
    public void secondMethod() {...}
    public void thirdMethod() {...}
    public void fourthMethod() {...}
}
```

## 12.5 Evaluation of EJB

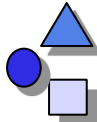
as composition system





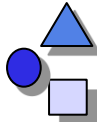
# Component Model

- ▶ Mechanisms for secrets and transparency: very good
  - Interface and implementation repository
  - Location, transaction, persistence transparency
  - Life-time of service hidden, states hidden
  - Communication protocol can be replaced (RMI-IIOP, CORBA-IIOP)
- ▶ (Limited) local parameterization by deployment descriptors
  - The services to use are specified
  - The storage mechanisms for CMP entity beans can be modified
- ▶ Deployment of EJB supported
  - Code generation of stubs
- ▶ Standardization: Good
  - Technical vs. application specific vs. business components
- ▶ EJB 2.0 is quite heavy; 3.0 is slimmer
  - Not a universal technique for everything
  - The goal is to make enterprise systems easier to implement and maintain



# Composition Technique

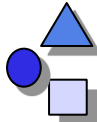
- ▶ Mechanisms for connection
  - Mechanisms for locating
    - JNDI
  - Mechanisms for adaptation
    - RMI – stubs, skeletons
  - Mechanisms for glueing
    - Container producing glue code
- ▶ Mechanisms for aspect separation
  - Middleware services declared in the deployment descriptor
- ▶ Mechanisms for Meta-modeling
  - with Java reflection and metadata annotations
- ▶ Scalability
  - Pooling ensures scaling



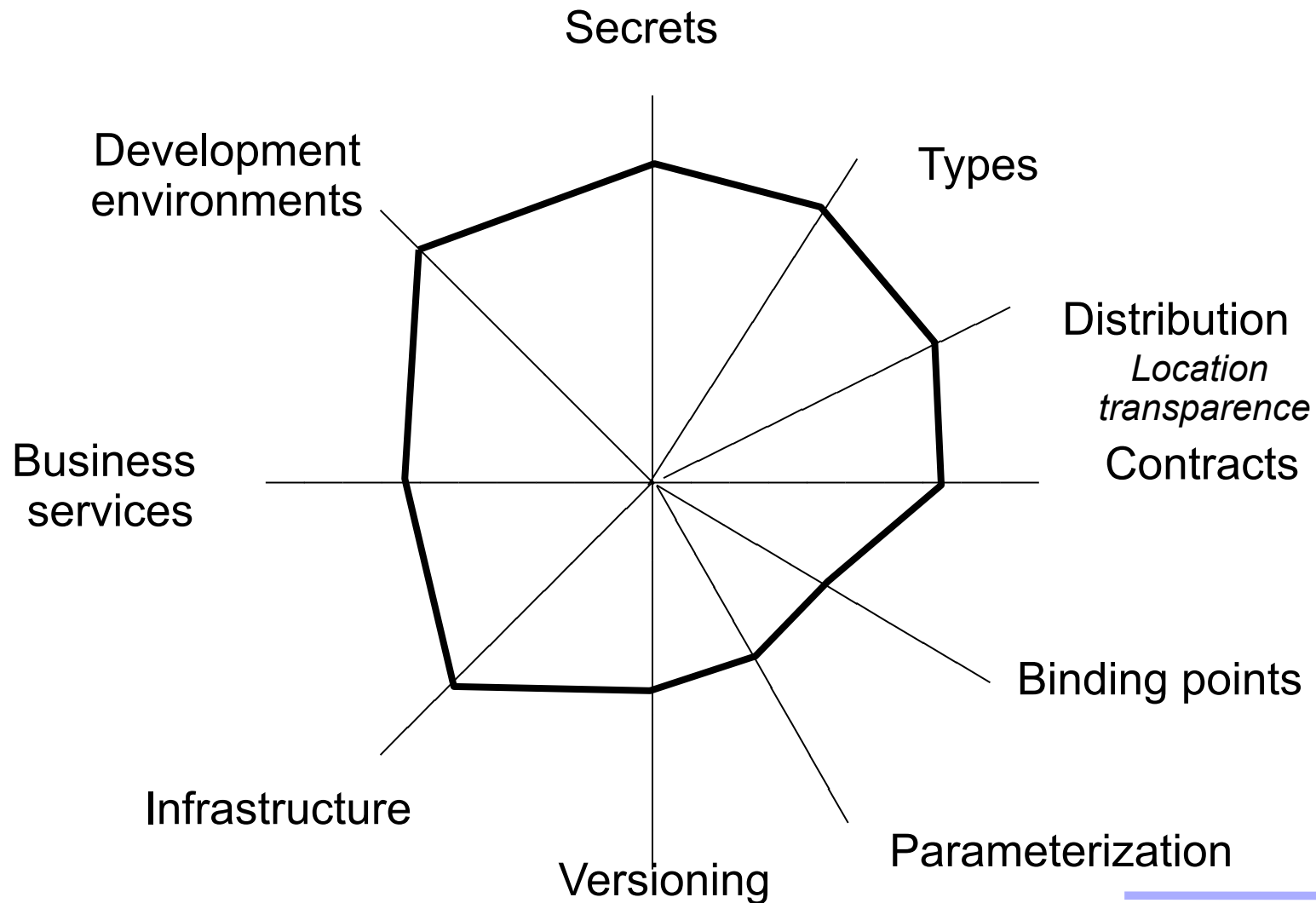
# Composition Language

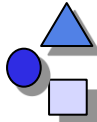
- ▶ The deployment descriptor language is a simple composition language
- ▶ Limited:
  - Glue code is provided by the container
  - Services can be added/removed/modified by changing the deployment descriptor
  - CMP entity beans can be customized by changing the deployment descriptor



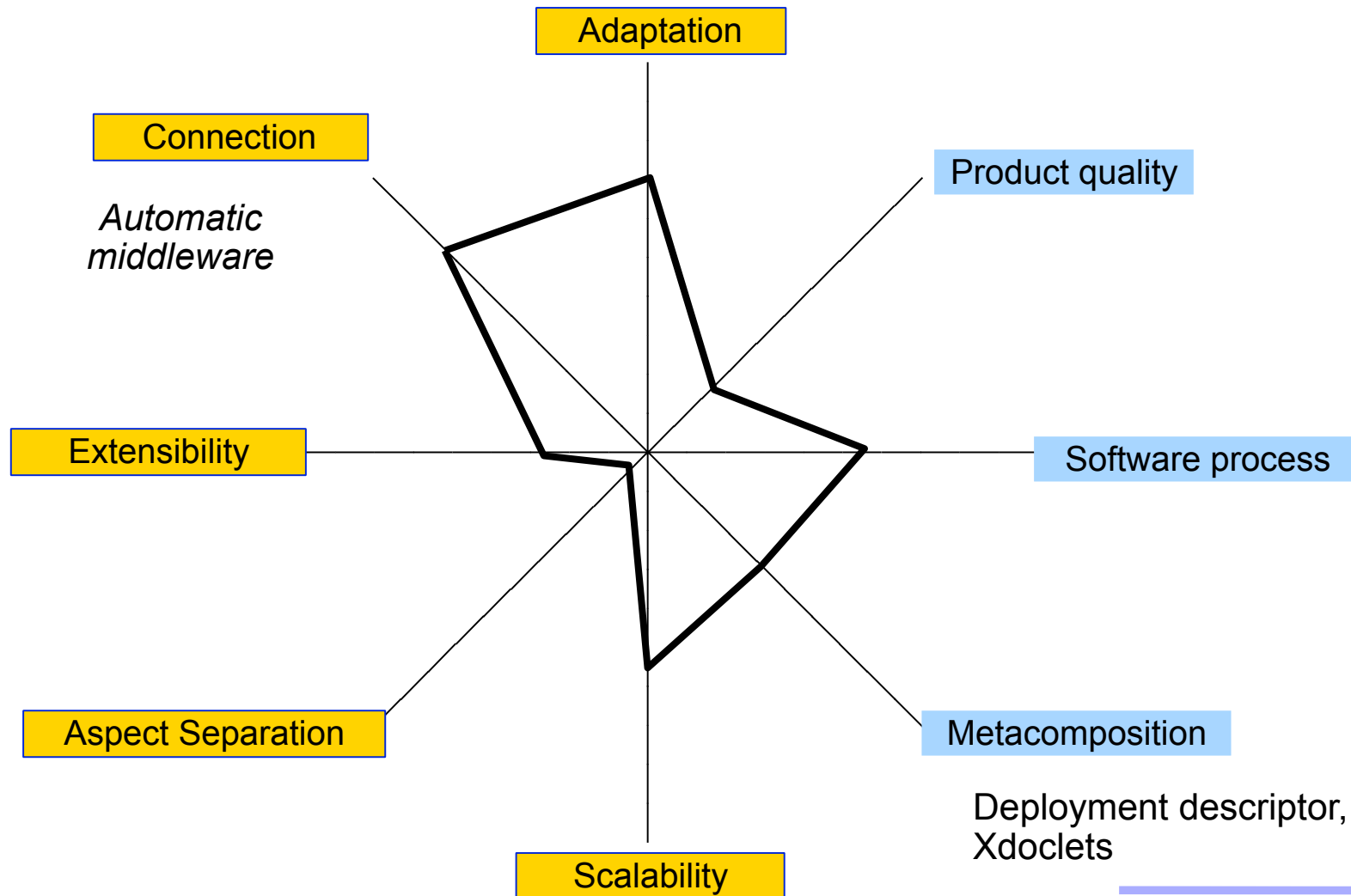


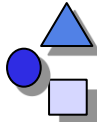
# EJB - Component Model



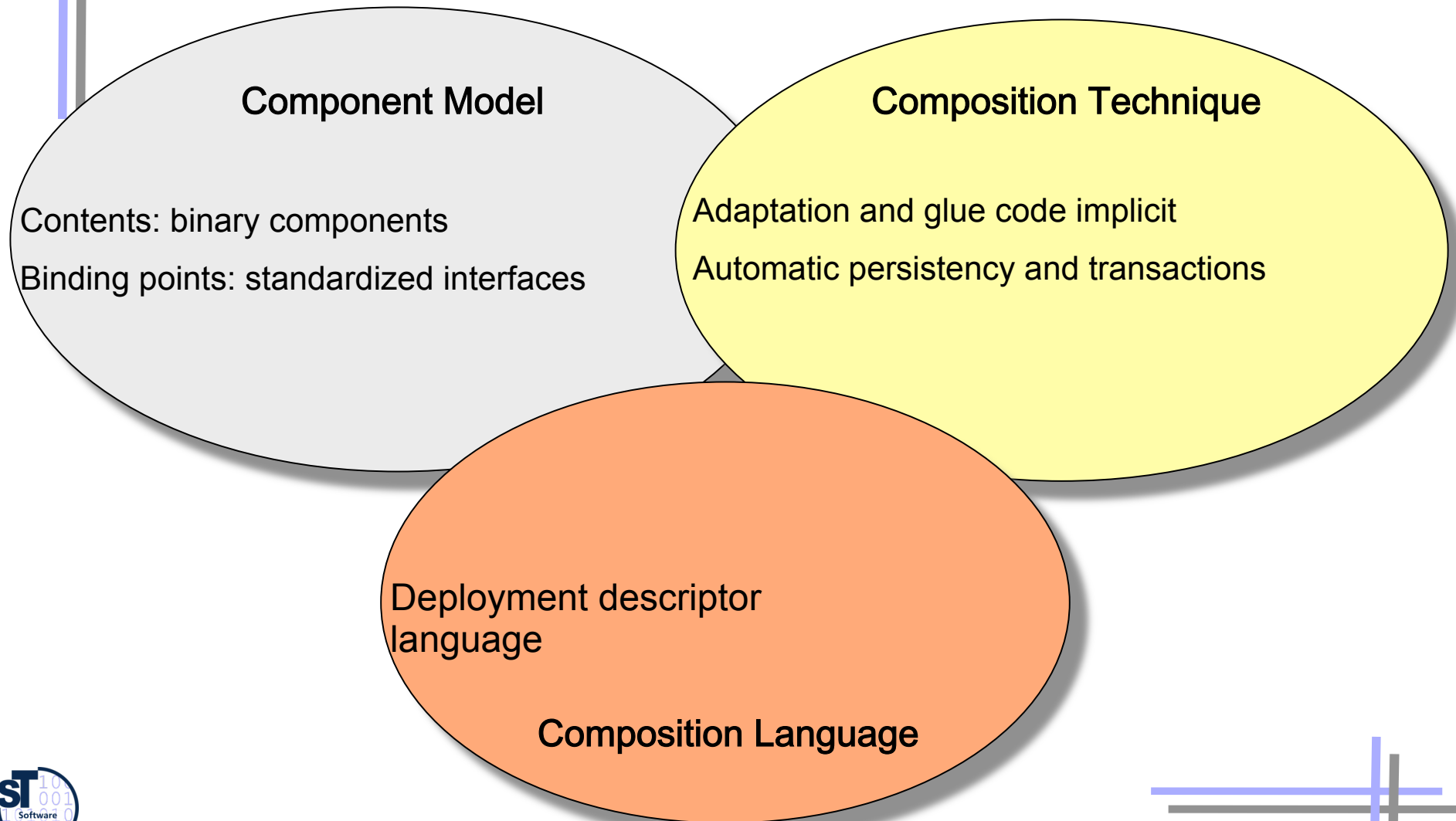


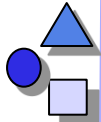
# EJB – Composition Technique and Language





# *EJB as Composition Systems*





## *What Have We Learned*

- ▶ EJB is big, not for everything
  - Allows the developer to focus on business logic
  - Provides very useful services, like transparency, persistence, security, networking independence, etc
  - Can interoperate with CORBA
- ▶ It is a well-defined standard by SUN
- ▶ It works in symbiosis with several other APIs
  - JNDI, RMI, JDBC, JMS, etc



*The End*