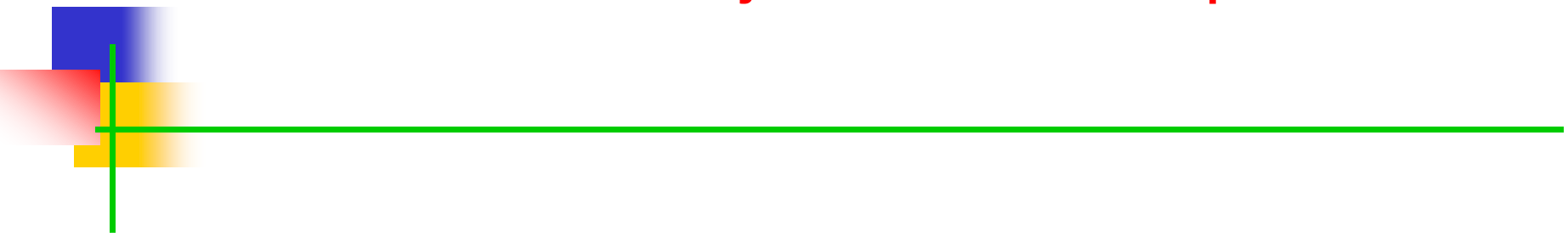
Distributed Objects and Components



Distributed Objects and Components

- Distributed objects and components are two of the most important styles of middleware in use today.
- Distributed object middleware: A range of middleware solutions based on distributed objects include Java RMI and CORBA.
- Java RMI vs. CORBA?

Issues with Object-Oriented Middleware

- Implicit dependencies
  - A distributed object offers a ***contract*** to the outside world in terms of the interface (or interfaces) it offers to the distributed environment.
  - Problem?
  - Requirement: To specify interfaces and dependencies
- Interaction with the middleware
  - Despite the transparency concept, many calls are middleware-related (e.g., calls to the RMI registry)
  - Requirement: To simplify the programming of distributed applications (separation of concerns)

Issues with Object-Oriented Middleware

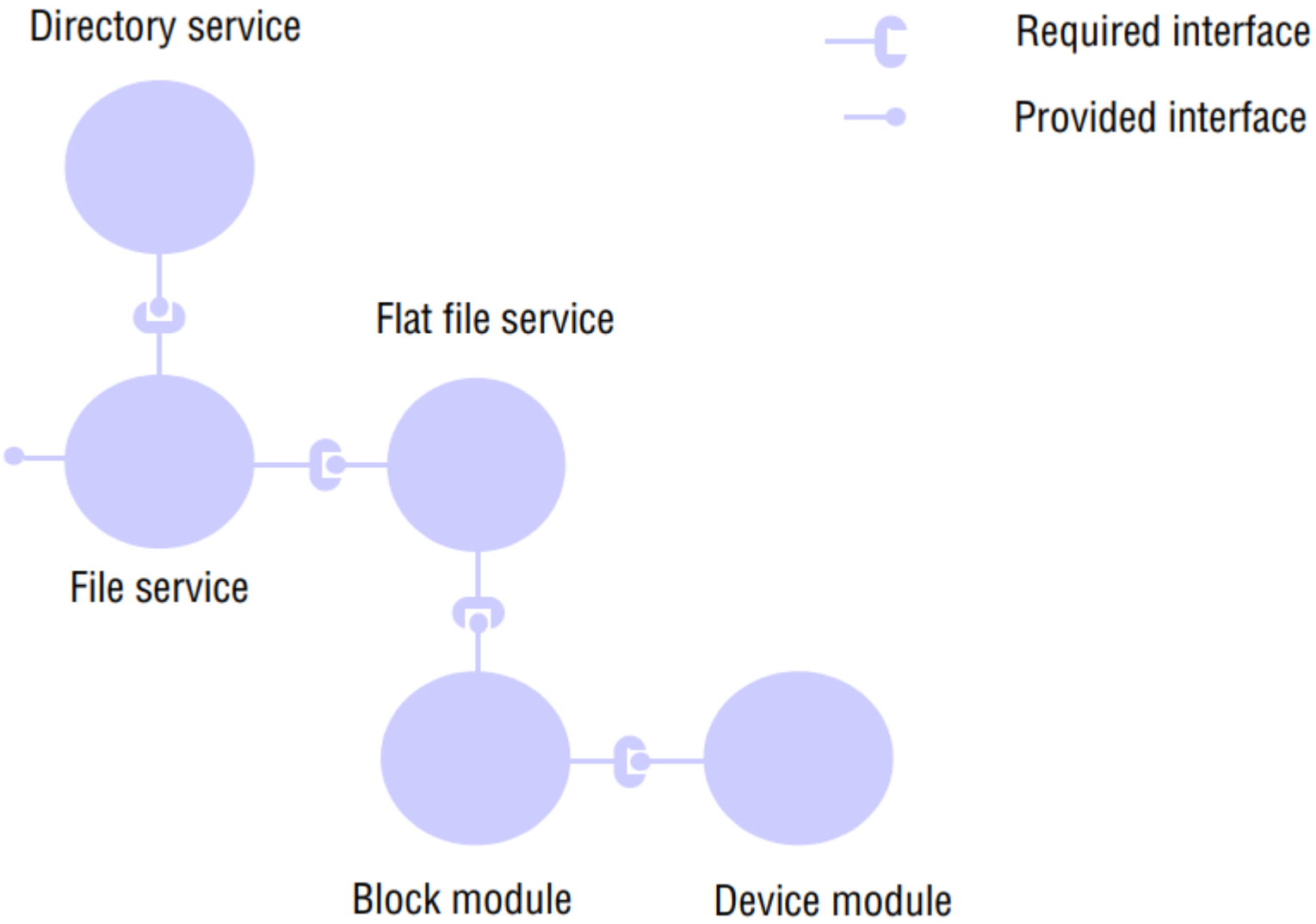
- Lack of separation of distribution concerns:
  - Problem?
  - Requirement: To extend separation of concerns to distributed system's services

- Those requirements have led to the emergence of component-based approaches to distributed systems development alongside the style of middleware referred to as application servers.

Using Components

- Components?
- A component is specified in terms of a **contract**
- Interfaces may be of different styles. In particular, many component-based approaches offer two styles of interface:
  - Interfaces supporting remote method invocation, as in CORBA and Java RMI
  - Interfaces supporting distributed events (as discussed in Chapter 6)

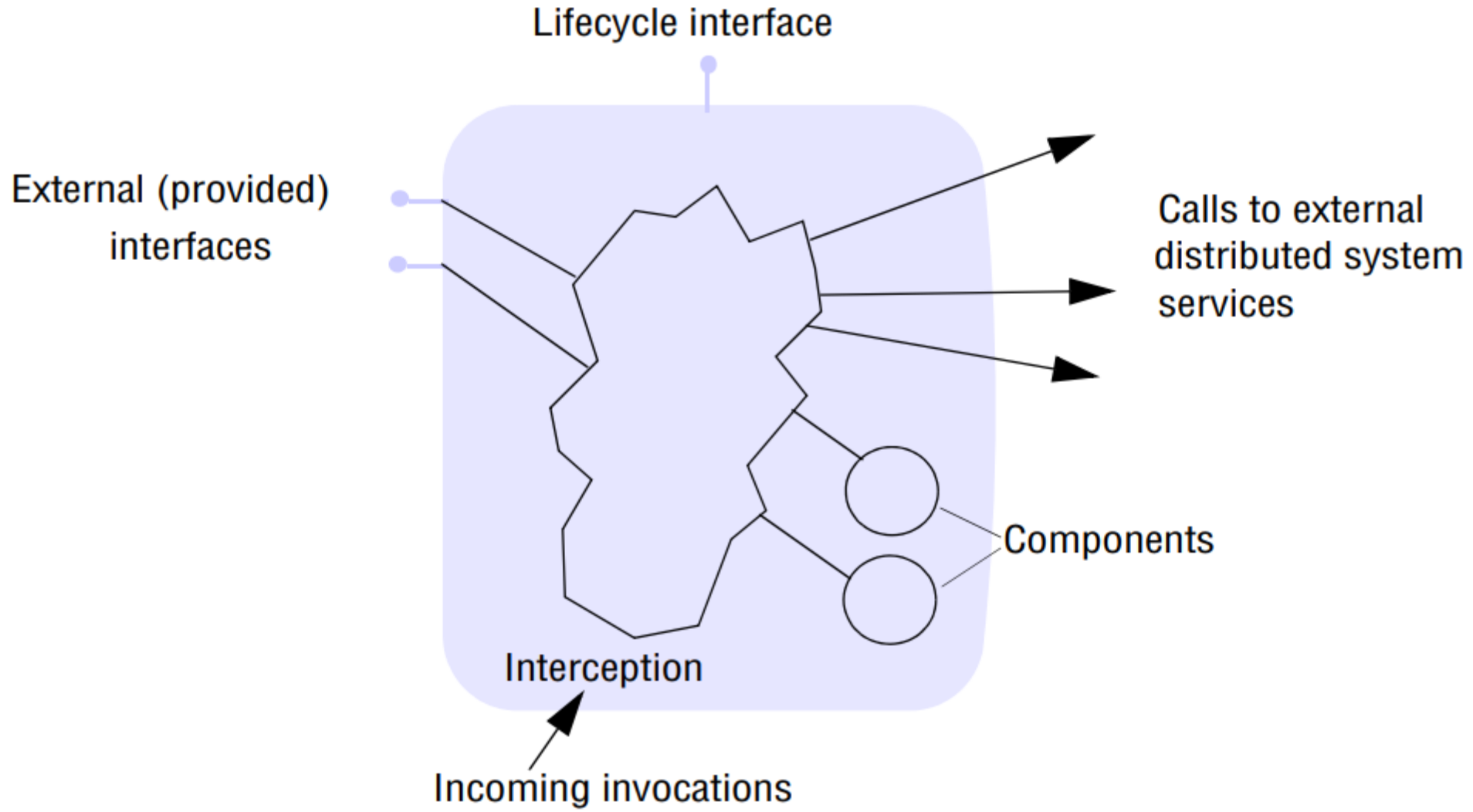
Using Components



Containers

- Containers support a common pattern often encountered in distributed applications, which consists of:
  - a front-end (perhaps web-based) client;
  - a container holding one or more components that implement the application or business logic;
  - system services that manage the associated data in persistent storage

Containers


Lifecycle interface
External (provided) interfaces
Calls to external distributed system services
Components
Interception
Incoming invocations

Application Servers?

Middleware supporting the container pattern and the separation of concerns implied by this pattern is known as an ***application server***

This style of distributed programming is in widespread use in industry today: – range of application servers:

Technology	*Developed by*	*Further details*
WebSphere Application Server	IBM	www.ibm.com
Enterprise JavaBeans	SUN	java.sun.com
Spring Framework	SpringSource (a division of VMware)	www.springsource.org
JBoss	JBoss Community	www.jboss.org
CORBA Component Model	OMG	[Wang *et al.* 2001JOnAS]
JOnAS	OW2 Consortium	jonas.ow2.org
GlassFish	SUN	glassfish.dev.java.net

Case Study: Enterprise Java Beans

- The advantage of application servers is that they provide comprehensive support for one style of distributed programming – the three tier approach.
- Disadvantages:
  - Prescriptive
  - Heavyweight
-

Case Study: Enterprise Java Beans

- Enterprise JavaBeans (EJB) is a specification of a **server-side**, managed component architecture and a major element of the Java Platform
- Enterprise Edition (Java EE), is a set of specifications (including RMI and JMS) for **client-server** programming
- EJB is defined as a *server-side component model* where potentially large numbers of clients interact with a number of services realized through components or configuration of components.

Enterprise Java Beans Architecture

- EJB provides direct support for the three-tier architecture
- Container pattern is used to provide support for key distributed system services (like what? How?)
  - Container-managed
  - Bean-managed
- Candidate applications?

RedHat Material
Chapter 2 – Describing an Application Server

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RedHat Material
Chapter 2 – Describing an Application Server

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JBoss Enterprise Application Platform (EAP)

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JBoss Enterprise Application Platform (EAP)

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JBoss Enterprise Application Platform (EAP)

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Containers

- A container is a logical component within an application server that provides a runtime context for applications deployed on the application server.
- A container acts as an interface between the application components and the low-level infrastructure services provided by the application server
- Containers are responsible for security, transactions, JNDI lookups, and remote connectivity and more.

EJB Component Model

- A *bean* in EJB is a component offering one or more *business interfaces* to potential clients of that component
- Interfaces can be either *remote*, requiring the use of appropriate communication middleware (such as RMI or JMS), or *local*, in which case more direct, and hence efficient, bindings are possible
- EJB supports required interfaces (how?)

EJB Component Model

- Two main styles of beans are supported in the EJB specification
- Session beans: A session bean is a component implementing a particular task within the application logic of a service
  - Stateful
  - Stateless
  - Singleton
- Message-driven beans support indirect communication.

Redhat Content – Chapter 3 Reviewing the Types of EJBs

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Reviewing the Types of EJBs

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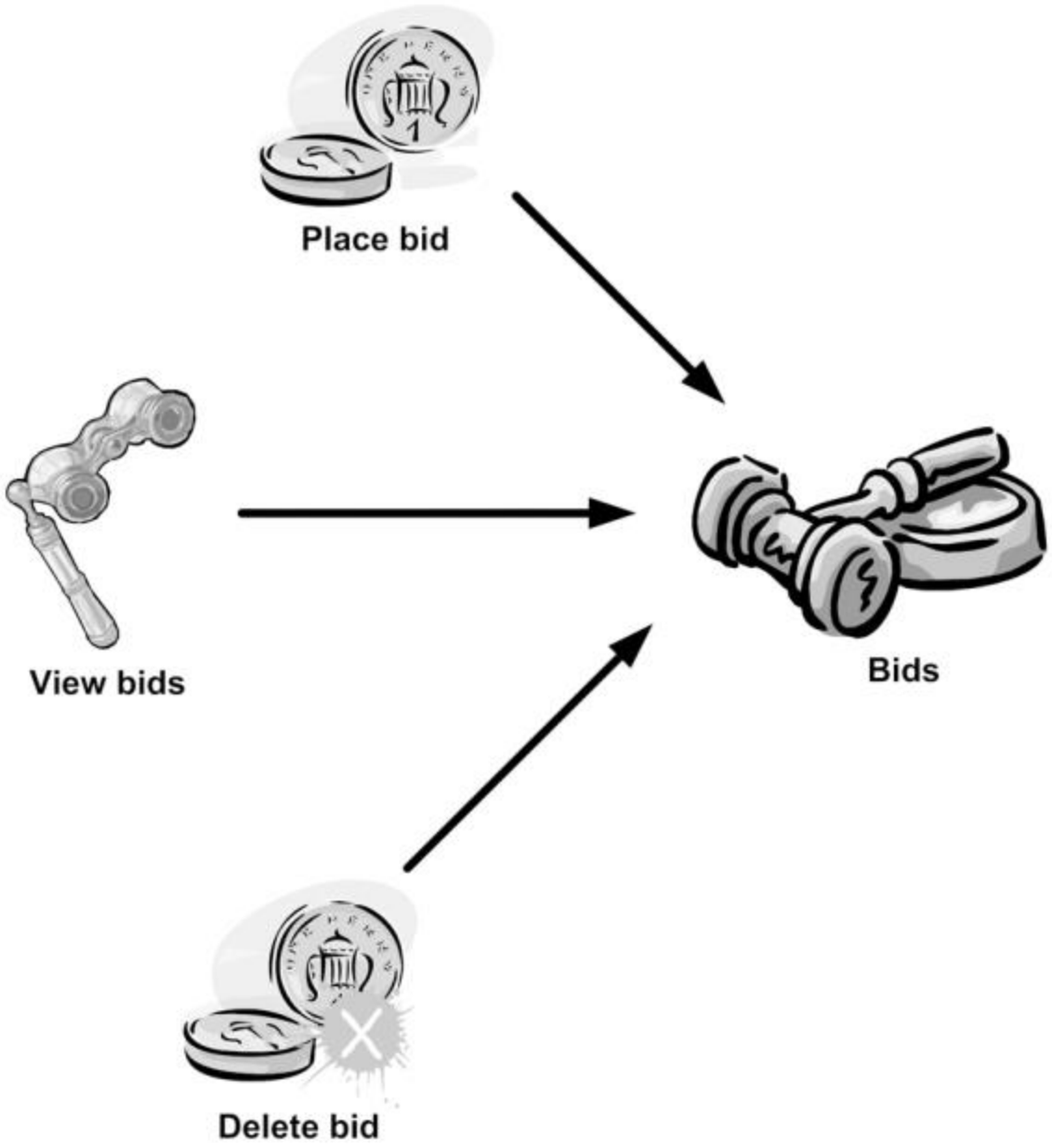
Stateless Session Beans Example



Stateless Session Beans Example

```
@Stateless(name = "BidService")
public class DefaultBidService implements BidService {
  private Connection connection;

  @Resource(name = "jdbc/ActionBazaarDB")
  private DataSource dataSource;

  @PostConstruct
  public void initialize() {
    try {
      connection = dataSource.getConnection();
    } catch (SQLException sqle) {
      sqle.printStackTrace();
    }
  }

  public void addBid(Bid bid) {
    Long bidId = getBidId();
```

1 Marks as a stateless bean

2 Injects data source

3 Receives PostConstruct callback

Stateless Session Beans Example

```
  try {
    Statement statement = connection.createStatement();
    statement.execute("INSERT INTO BIDS "
   + " (BID_ID, BIDDER, ITEM_ID, AMOUNT) VALUES( "
   + bidId
   + ", "
   + bid.getBidder().getUserId()
   + ", "
   + bid.getItem().getItemId()
   + ", "
   + bid.getBidPrice() + ")");
  } catch (Exception sqle) {
 sqle.printStackTrace();
  }
}

private Long getBidId() {
  ...Code for generating a unique key...
}
```

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Reviewing the Types of EJBs

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Reviewing the Types of EJBs

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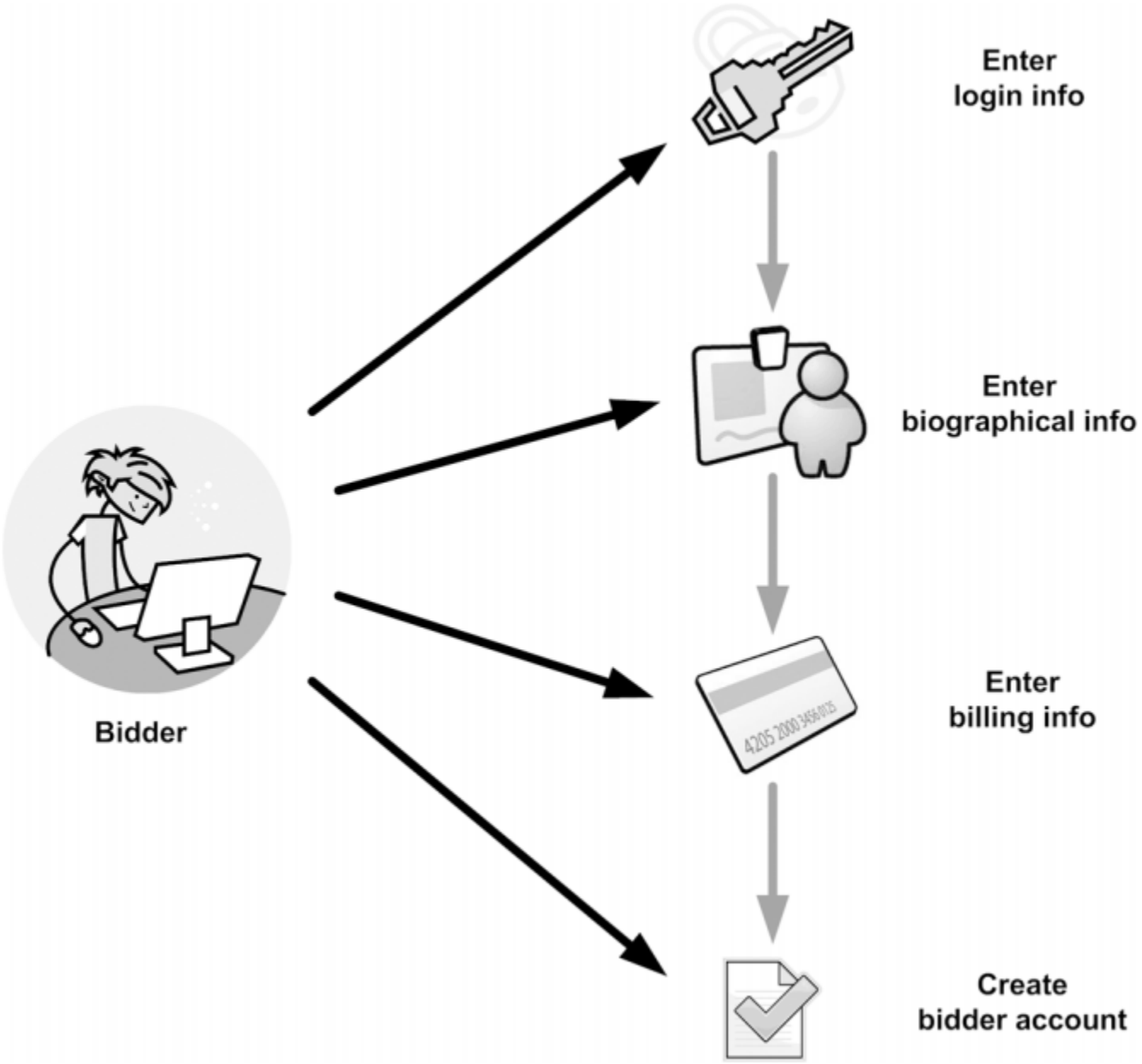
Redhat Content – Chapter 3



Redhat Content – Chapter 3
Reviewing the Types of EJBs

Marks POJO stateful ❶

```
@Stateful(name="BidderAccountCreator")
public class DefaultBidderAccountCreator implements BidderAccountCreator {
  @Resource(name = "jdbc/ActionBazaarDataSource")

  private DataSource dataSource;
  private Connection connection;
  private LoginInfo loginInfo;
  private BiographicalInfo biographicalInfo;
  private BillingInfo billingInfo;

  @PostConstruct
  @PostActivate
  public void openConnection() {
    try {
      connection = dataSource.getConnection();
    } catch (SQLException sqle) {
      sqle.printStackTrace();
}
  }

  public void addLoginInfo(LoginInfo loginInfo) {
    this.loginInfo = loginInfo;
  }
```

❷ Stateful instance variables

❸ Receives PostConstruct callback

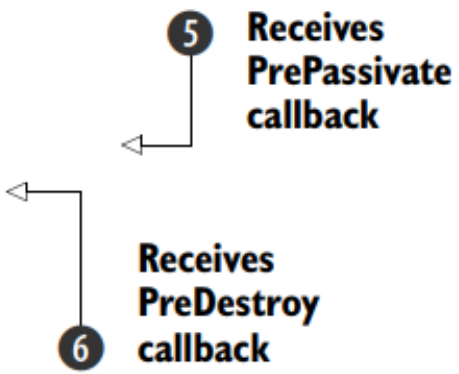
❹ Receives PostActivate callback

```
public void addLoginInfo(LoginInfo loginInfo) {
  this.loginInfo = loginInfo;
}

public void addBiographicalInfo(BiographicalInfo biographicalInfo)
  throws WorkflowOrderViolationException {
  if (loginInfo == null) {
    throw new WorkflowOrderViolationException(
      "Login info must be set before biographical info");
  }
  this.biographicalInfo = biographicalInfo;
}

public void addBillingInfo(BillingInfo billingInfo)
  throws WorkflowOrderViolationException {
  if (biographicalInfo == null) {
    throw new WorkflowOrderViolationException(
      "Biographical info must be set before billing info");
  }
this.billingInfo = billingInfo;
}

@PrePassivate
@PreDestroy
public void cleanup() {
  try {
    connection.close();
    connection = null;
} catch (SQLException sqle) {
  sqle.printStackTrace();
}
```



Redhat Content – Chapter 3 Singleton Session Beans

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When to Use Singleton Session Beans?

- You use singleton beans when you need to have a shared state that's application global
- Example:
- When an application starts up, there could be a need to check the database for consistency or verify that an external system is up and running.
  - Consider an application that is deployed on Glassfish
  - The application needs to connect to some server to function properly
  - Assume that the server is not guaranteed to start before the application
  - How could singleton beans server here?

When to Use Singleton Session Beans?

- Example: Action Bazaar featured deal
  - Each day ActionBazaar Company spotlights a particular item or featured deal.
  - Initially, the featured deal resided in the web tier.
  - However, currently ActionBazaar supports iPhone, Android apps that use a restful web service along with a dedicated mobile website
  - The featured deal logic is now pushed to the business logic tier.
    - Can we use stateful session beans?
    - Can we use stateless session beans?
    - Can we use singleton session beans?

Listing 3.3 Singleton session bean example

```
@Singleton
@Startup
@DependsOn("SystemInitializer")
public class DefaultFeaturedItem implements FfeaturedItem {
  private Connection connection;

  @Resource(name = "jdbc/ActionBazaarDataSource")
  private DataSource dataSource;

  private Item featuredItem;

  @PostConstruct
  public void init() {
    try {
      connection = dataSource.getConnection();
    } catch (SQLException sqle) {
      sqle.printStackTrace();
   }

   loadFeaturedItem();
 }

 @Schedule(dayOfMonth="*",dayOfWeek="*",hour="0",minute="0",second="0")
 private void loadFeaturedItem() {
   featuredItem = ... load item from the database ...
 }

 @Override
 public Item getFeaturedItem() {
   return featuredItem;
 }
}
```

1. Marks POJO as being a singleton session bean
2. Instantiates bean on startup
3. Defines a bean dependency
4. Code to be run immediately after creation
5. Schedules featured item to be reloaded at midnight regularly

Message-Driven Beans

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Message-Driven Beans

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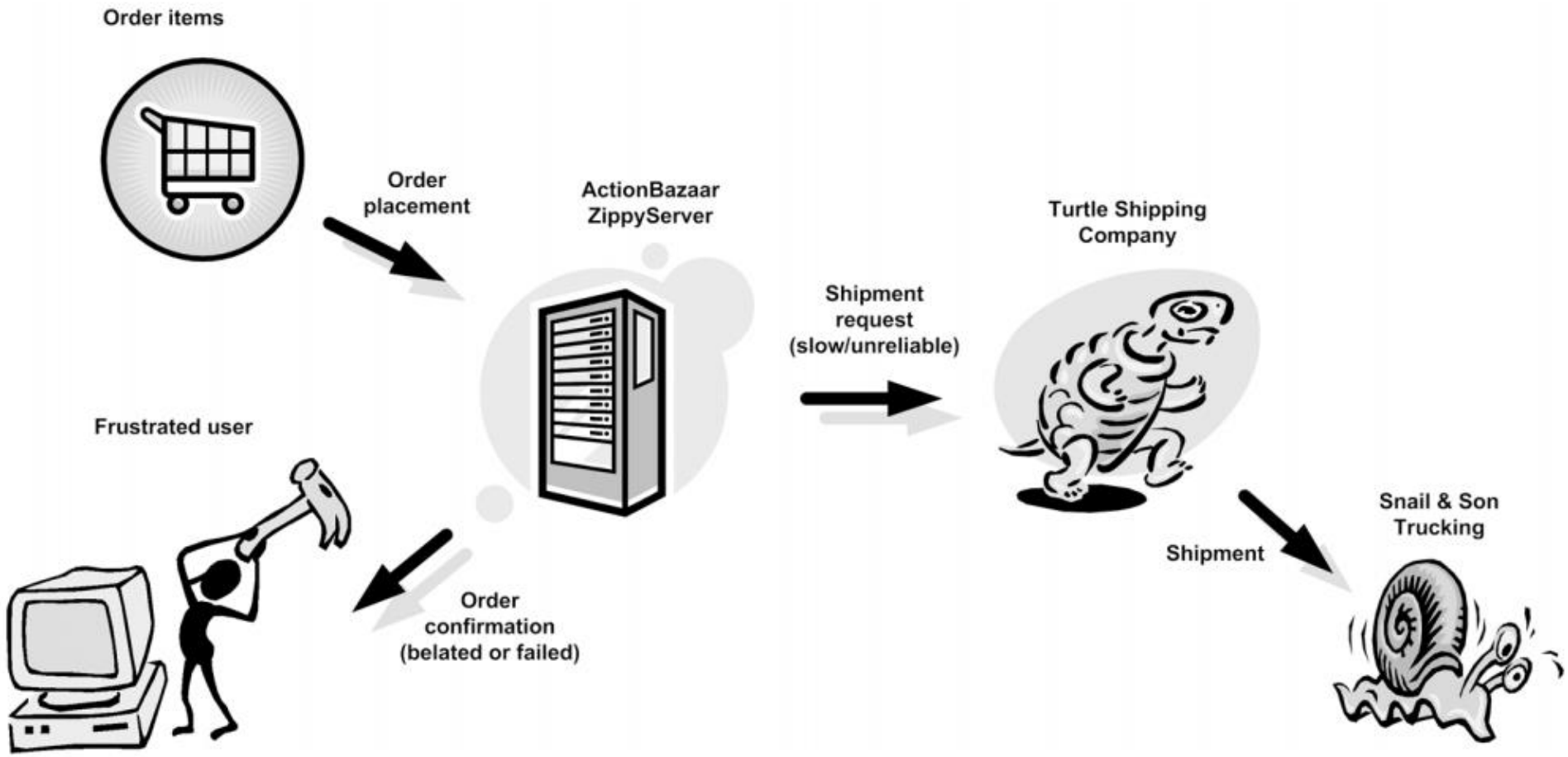
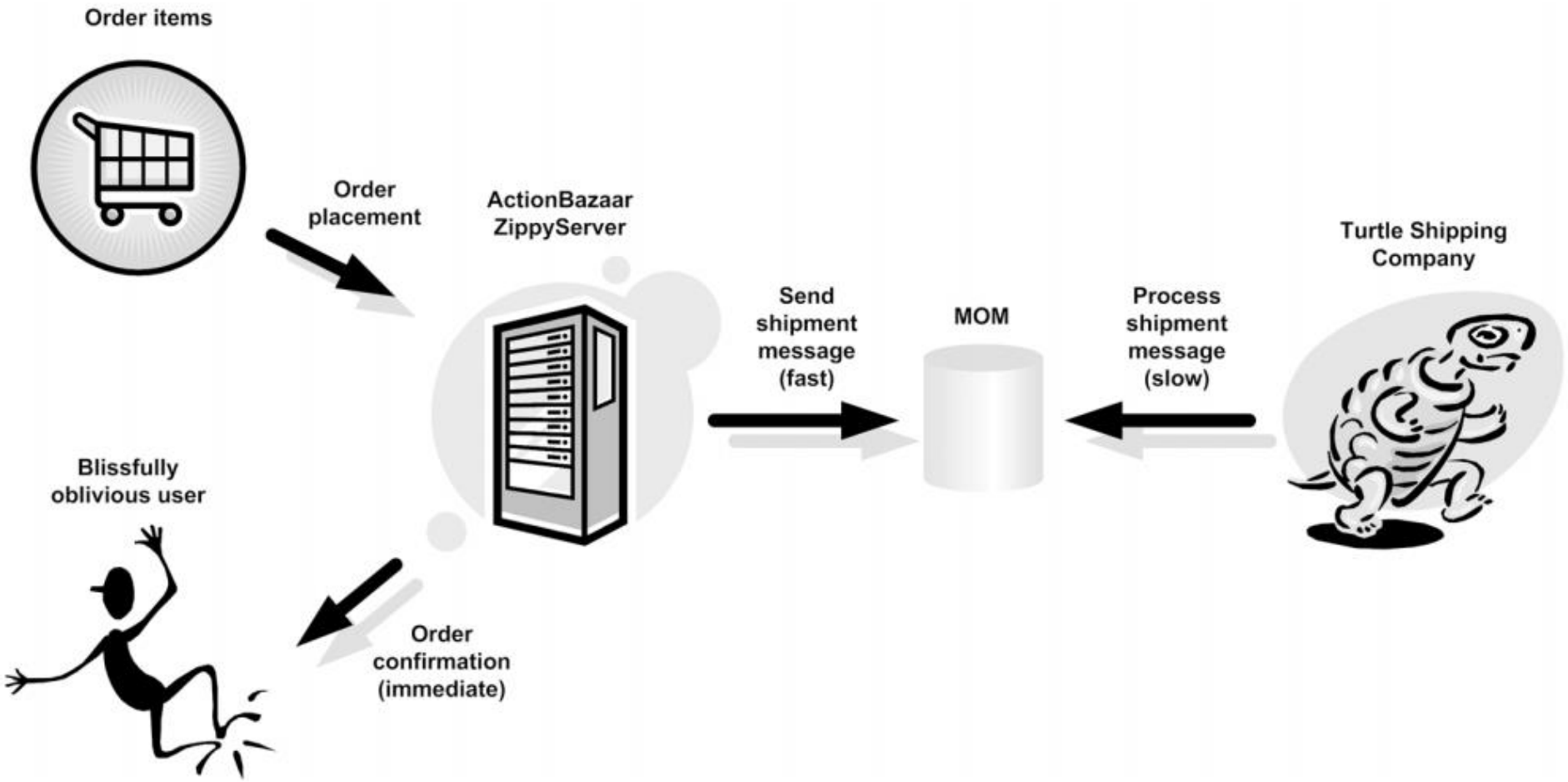
Message-Driven Beans

- ActionBazaar is not a self contained, end-to-end system; its main business is in tracking auctions.
- Other business functions, like accounting and shipping, are handled by dedicated systems provided by specialized vendors.
- For example, ActionBazaar uses Turtle Shipping company to deliver items to winning bidders.
- When a bidder wins an auction, a shipment request is sent to Turtle's system in a synchronous fashion.

Message-Driven Beans



Message-Driven Beans



Describing the Life Cycle of a Stateful EJB

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Describing the Life Cycle of a Stateless EJB

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Describing the Life Cycle of a Singleton EJB

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POJOs and Annotations

- Programming in EJB uses *Enterprise JavaBeanPOJOs* (plain old Java objects) together with Java *Enterprise JavaBean annotations*
- A bean is a plain old Java object: it consists of the application logic written simply in Java with no other code relating to it being a bean.
- Annotations are then used to ensure the correct behaviour in the EJB context.

POJOs and Annotations: Example

Example beans

- *@Stateful public class eShop implements Orders {...}*
- *@Stateless public class CalculatorBean implements Calculator {...}*
- *@MessageDriven public class SharePrice implements MessageListener {...}*

Example interfaces

- *@Remote public interface Orders {...}*
- *@Local public interface Calculator {...}*

Support for Distributed Systems' Features

- Beans are deployed to containers, and the containers provide implicit distributed system management using interception.
- The container provides the necessary policies in areas including transaction management, security, persistence and lifecycle management allowing the bean developer to focus exclusively on the application logic. (Recall Abstraction?)
- Let us see an example

Example: Transactions

- Transactions ensure that all components managed by a single server (or multiple servers in the case of distributed transactions) remain in a consistent state in spite of concurrent access from multiple clients and in the event of server failure.
- Example: In an eShop example, a transaction mechanism will ensure that:
  - two concurrent purchases do not result in a single item being sold twice
  - A server crash does not allow the system to get into an inconsistent state where an item has been paid for but not assigned to the purchaser

Example: Transactions

- The first thing to declare is whether transactions associated with an enterprise bean should be **bean-managed** or **container-managed** using an annotation:
  - *@TransactionManagement (BEAN)*
  - *@TransactionManagement (CONTAINER)*

Example: Transactions

- *@TransactionManagement (BEAN)*

```
@Stateful
@TransactionManagement (BEAN)
public class eShop implements Orders {
        @Resource javax.transaction.UserTransaction ut;

        public void MakeOrder (...) {
                ut.begin ();
                ...
                ut.commit ();
        }
}
```

Example: Transactions

- *@TransactionManagement (Container)*

```
@Stateful public class eShop implements Orders {
        ...
        @TransactionAttribute (REQUIRED)
        public void MakeOrder (...) {
        ...
        }
}
```

Required Readings

- Chapter 8: **Distributed Systems**: **Concepts and Design**, 5th Edition. George **Coulouris**, Cambridge University. Jean Dollimore, Formerly of Queen Mary, University of London.
- Red Hat Application Development 1: Programming in Java EE Edition 2
  - Chapter 3: “Converting a POJO to an EJB” section
  - Chapter 3: “Describing the lifecycle of an EJB” section
  - Chapter 2: “Describing an application server” section

References

- Panda, Debu, Reza Rahman, and Derek Lane. *EJB 3 in Action*. Vol. 15. Manning Publications Company, 2007.
- Chapter 8: **Distributed Systems**: **Concepts and Design**, 5th Edition. George **Coulouris**, Cambridge University. Jean Dollimore, Formerly of Queen Mary, University of London.
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