Introduction to Java EE

Mobile Web Services

Open Source Frameworks (OSF)
Master of Science in Engineering (MSE)
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The Notion of Systemic Quality

The notion of systemic quality

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- How do we specify the **requirements** of a system?
  - We always build systems to deliver some sort of "**service**" (web, messaging, access control, customer management, etc.).
  - We first have to specify “**what**” the system should do. In other words, we have to specify **functional requirements**.
    - We also have to specify “**how**” the system should behave, i.e. what qualities it should exhibit. These are the **non-functional requirements**.
- Non-functional requirements characterize **systemic qualities, or “-ilities”**:
  - There are lots of different systemic qualities. Depending on the system, some are more important than others.
  - Choices made when defining the system architecture have a large impact on the systemic qualities.
  - Your life as an architect will be to deal with **trade-offs** in addressing conflicting systemic qualities.

Example

System
Vehicle

Functional requirements
Move people around

Non-functional requirements
Performance
Capacity
Reliability
Cost
Aestethics
Ease of use

Different systemic qualities often create **opposing forces**.

Defining the “right” architecture for a system means finding the right **balance** between these forces.

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Some systemic qualities...

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- **Response time**
  - Measures the time required to present a result to the user
  - Important for the end-user
- **Throughput**
  - Measures the number of requests that can be processed in a given time frame
  - Important for the service provier
- **Scalability**
  - Measures how easy/costly it is to adapt the system in order to handle additional load
  - Ideally: linear scalability. "2 x more users => 2 x more servers”
- **Availability**
  - Measures the percentage of time during which the system can be used
  - 99% availability = average unavailability of 3.65 jours per year, i.e 1 hour and 41 minutes per week.

http://en.wikipedia.org/wiki/Ilities

Some systemic qualities...

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- **Reliability**
  - Mesure la capacité du système à "remplir sa fonction" sur une période.
  - Un système peut avoir une fiabilité plus élevée que celle d'un de ces sous-système (notamment grâce à la redondance).
  - Mesure exprimée en "temps moyen entre 2 pannes" (Mean Time Between Failures).
- **Evolutivity**
  - Mesure la facilité avec laquelle le système pourra être adapté pour satisfaire à de nouvelles exigences (fonctionnelles et non-fonctionnelles!).
- **Security**
  - Mesure la capacité du système à empêcher une utilisation abusive.
- **Manageability**
  - Mesure la facilité avec laquelle l'état du système pourra être surveillé, les pannes détectées, des opérations de maintenance réalisées, etc.

http://en.wikipedia.org/wiki/Ilities

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Java Enterprise Edition (Java EE)

What is Java Enterprise Edition?

- It is a development platform: it provides high-level APIs to develop software components.

- It is an execution platform: it provides an environment to deploy and bring these components “to live”.

- It is an entreprise platform: it provides support for distributed transactions, security, integration, etc.

- Separation of concerns: "The developer takes care of the business logic. Java EE takes care of the systemic qualities".

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Java EE and standards

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- Java EE is a specification
  - Defined through the JCP, it is a specification that software editors can decide to implement. Java EE 5 is defined in JSR 244.
- Java EE is an “umbrella” specification
  - Java EE builds upon other specifications (servlets, EJBs, JDBC, etc.) and specifies which specifications (and which versions) need to be implemented by a Java EE certified application server.
  - Java EE also defines a programming model and defines several roles (developer, assembler, deployer, etc.).

Java Community Process

Specification Lead
Bill Shannon Sun Microsystems, Inc.

Expert Group
Barreto, Charlton
Capgemini
Dudney, Bill
Hewlett-Packard
Kohen, Elika S.
Oracle
Pratap, Rama Murthy Amar
Reinshagen, Dirk
Shah, Suneet
Tiwari, Ashish
Umapathy, Sivasundaram

BEA Systems
Chandrasekaran, Muralidharan
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SAP AG
Sun Microsystems, Inc.
Tmax Soft, Inc.

Borland Software Corporation
Crawford, Scott
Genender, Jeff
Ironflare AB
Novell, Inc.
Pramati Technologies
Red Hat Middleware LLC
SeeBeyond Technology Corp.
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Trifork

J2EE or Java EE?

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- Java Enterprise Edition is **not** a recent specification.
- The SDK 1.2 was published in 1999.
- The specification is managed through the JCP since version 1.3
- We used to talk about "Java 2 Enterprise Edition 1.3", or J2EE 1.3
- We then moved from J2EE 1.3 to J2EE 1.4 to... **Java EE 5**
- Today, we should speak of Java EE, but J2EE is still sometimes used...
- Today, most application servers implement Java EE 6
- The early draft 2 for Java EE 7 has been submitted in November 2012; final spec expected for Q2 2013

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Architecture

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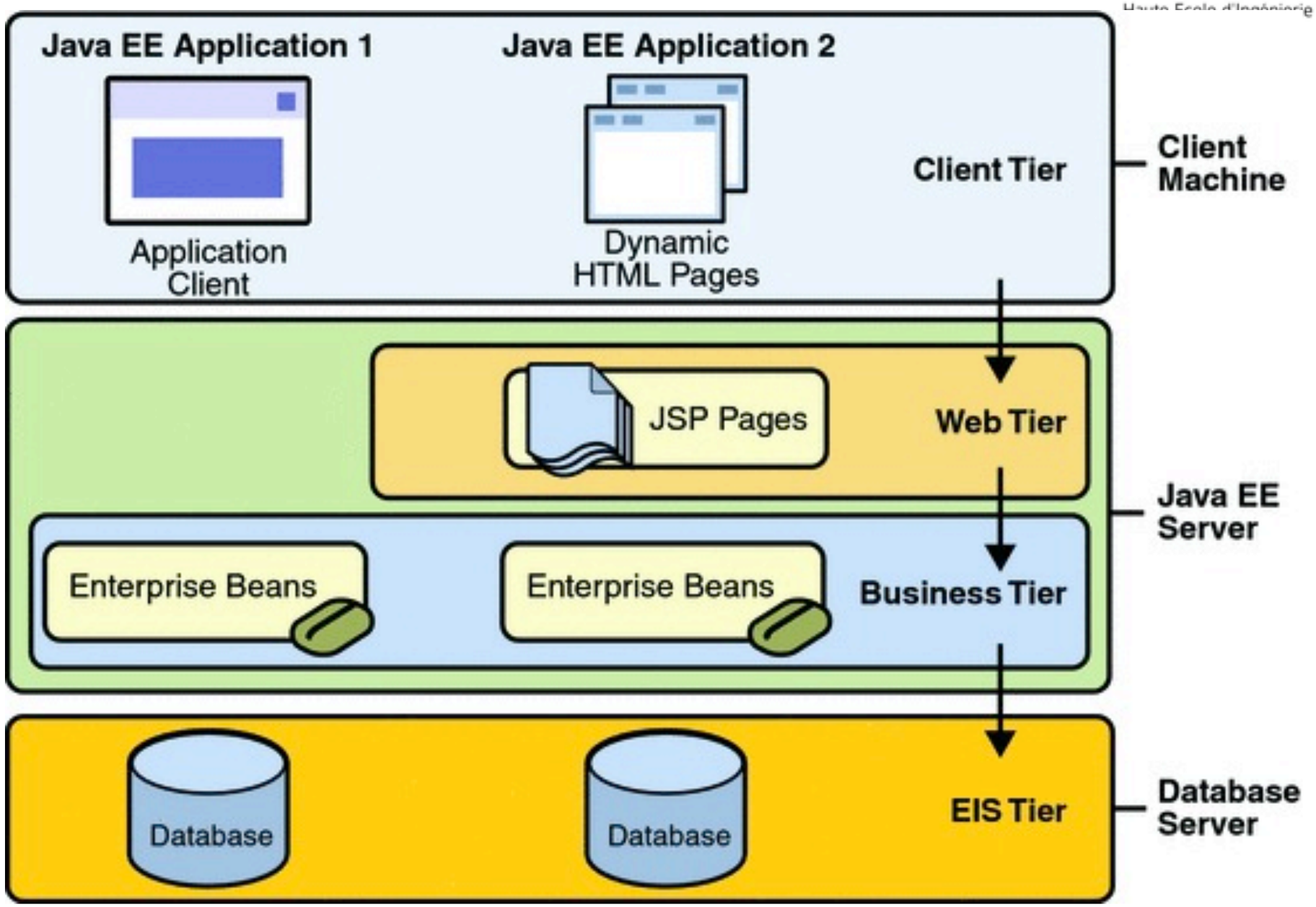
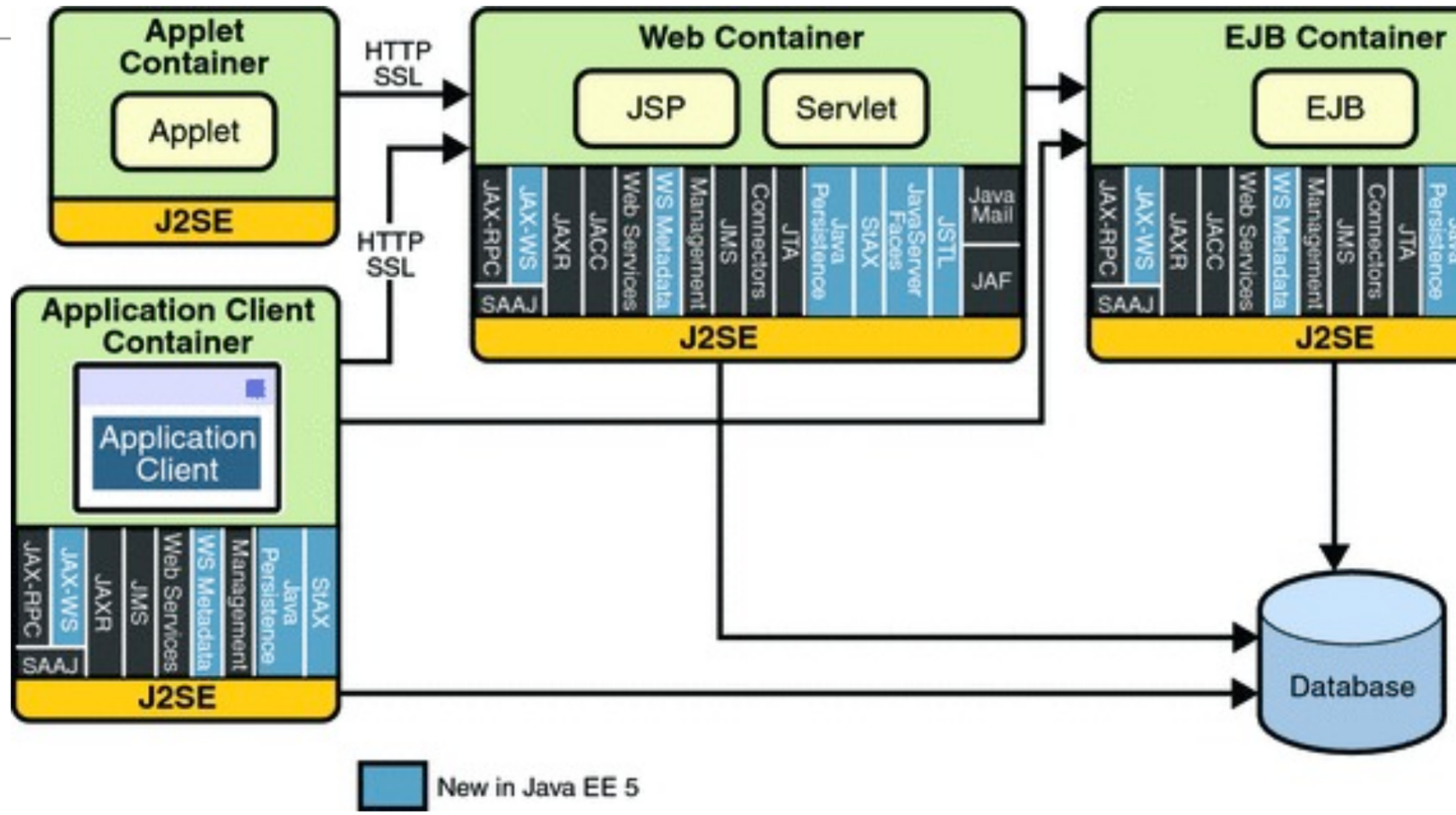
- The software that implements the Java EE specification is called an "**application server**"
  - There are **open source** and **proprietary** application servers.
  - Glassfish, JBoss, WebSphere, BEA WebLogic are examples of application servers.
    - Editors compete on aspects that are not defined the specification (clustering, administration, etc.).
- Key notion in the Java EE architecture: the **containers**
  - a container is an **environment** in which we deploy components;
  - a container **provides services** (transactions, security, etc.) through APIs;
  - there are different containers in Java EE: the "**web**" container, the "**ejb**" container and even a "**client**" container that can be used for rich clients.



http://java.sun.com/javaee/5/docs/tutorial/doc/bnaay.html

Java EE 5 APIs

- Enterprise JavaBeans Technology
- Java Servlet Technology
- JavaServer Pages Technology
- JavaServer Pages Standard Tag Library
- JavaServer Faces
- Java Message Service API
- Java Transaction API
- JavaMail API
- JavaBeans Activation Framework
- Java API for XML Processing
- Java API for XML Web Services (JAX-WS)
- Java Architecture for XML Binding (JAXB)
- SOAP with Attachments API for Java
- Java API for XML Registries
- J2EE Connector Architecture
- Java Database Connectivity API
- Java Persistence API
- Java Naming and Directory Interface
- Java Authentication and Authorization Service
- Simplified Systems Integration



http://java.sun.com/javaee/5/docs/tutorial/doc/bnacj.html

Components, packaging & deployment

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- The first version of J2EE put a lot of emphasis on the separation of roles:
  - **Component developer** builds self-contained, reusable **components** and focuses on business logic (“Here is a customer management brick”, “Here is a pricing brick”).
  - **Application assemblers** create **applications** by gluing together different components (“I connect the customer management and the pricing bricks in order to have an insurance application”).
  - **Deployers** have to take applications and to put them into production. Every application needs resources (DBs, user repositories, etc.). The deployer has to connect the application to the resources (declaratively!!).
- We also want to be able to manage the life-cycle of applications and to have control on the release of new versions. It really helps to create **packages**!

Components, packaging & deployment

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- Different types of components, different types of packages/archives:
  - Java libraries are useful in enterprise applications; we can bundle classes into **traditional .jar files (Java ARchives)** and integrate them in our applications.
  - Some applications do not require all the features provided by the Java EE platform; they are “lightweight” can live entirely in the web container. We package these applications in **.war files (Web ARchives)**.
  - Business services can be packaged and deployed independently from a presentation front-end. We can package **EJBs in .jar files**.
  - Full-blown Java EE applications bundle together web-tier components, service components, libraries. A Java EE application is packaged in a **.ear file (Enterprise ARchive)**. The .ear file contains a .war files and one or more .jar files.

Content of archives

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- In .war, .jar and .ear files, we find:
  - **Compiled classes and libraries**
  - **Resources** (images, property files, configuration files, etc.)
  - **Deployment descriptors**
- Deployment descriptors make it possible to alter the system-level behavior of the application **declaratively**, at deployment time:
  - Change security mappings, change transaction isolation level, change database connection parameters, change URL mappings, etc.
- In J2EE, deployment descriptors were mandatory and quite a pain to write (IDE added support over time, and XDoclet introduced a way to generate them automatically).
- In Java EE, deployment descriptors are still available but are largely replaced by @annotations. In Java EE 5, annotations are generally used for EJBs. The web.xml deployment descriptor is still used.

The Business Tier

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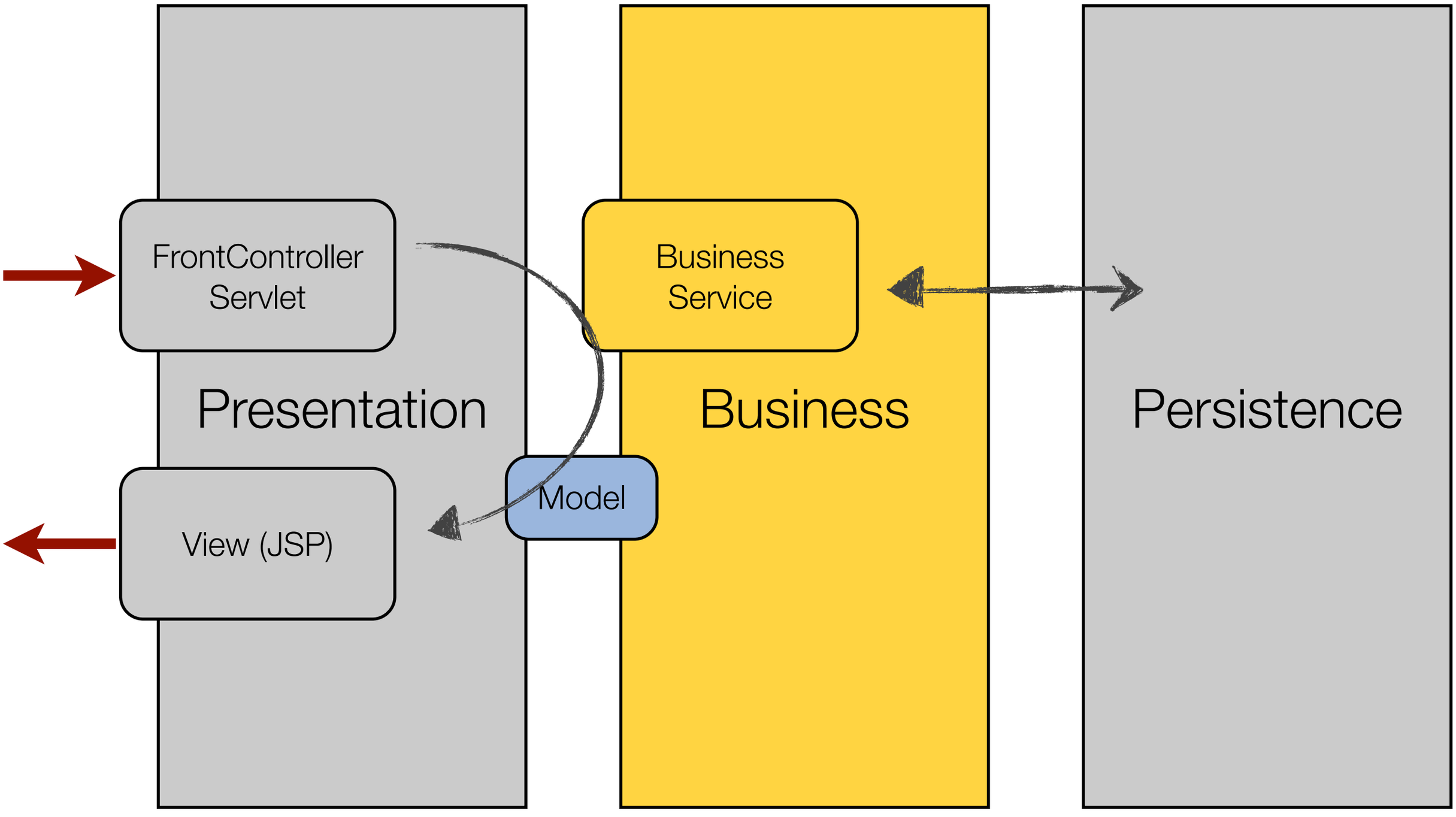

Agenda

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- Containers & components
- Enterprise Java Beans (EJB)
  - Stateless and stateful session beans (SLSB and SFSB)
  - Message-driven beans (MDB / JMS)
- Resource pooling
- Life cycle
- Getting a reference to the service: lookup vs. dependency injection

Containers and components

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- There are **different ways** to design, build and deploy the “business service” components.
- In the **simplest scenario**, think of a plain vanilla web application, where you create a “controllers”, a “services” and a “model” packages. Here, you implement services as POJOs and **do everything yourself**:
  - Instantiation of services, concurrency control, transactions, security, etc.
- When the application/system has some complexity (because of the functionality, because of the volume of transactions, because of the integration, etc.), it becomes interesting to use **“managed” components**.
- The idea is to let “something” in the **infrastructure** manage the life cycle of your service components. That “something” can take different shapes.
- In Java EE, that “something” is the Enterprise Java Bean **container**.

Containers and components

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- The **EJB container** is one sub-system of the Java EE container.
- It provides a **runtime environment** for the business services, implemented as Enterprise Java Beans.
- The **developer** knows that services will be “available” to its components, once they are deployed in the container. He can thus use these services through standard **APIs**.
- The **production manager** configures the EJB container and tunes it in different ways (this is implementation specific).
- With **some application servers**, the EJB container can be **distributed** over several physical nodes (for scalability and availability purposes). This distribution is **transparent to the clients** - they sill only see “one runtime environment”.

From the specs: what are EJBs (v3)

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- "An enterprise bean typically contains **business logic** that operates on the **enterprise's data**.
- An enterprise bean's instances are **managed at runtime by a container**.
- An enterprise bean can be **customized at deployment time** by editing its environment entries.
- Various service information, such as **transaction** and **security** attributes, may be specified **together** with the business logic of the enterprise bean class in the form of **metadata annotations**, or **separately**, in an **XML deployment descriptor**. This service information may be extracted and managed by tools during application assembly and deployment.
- Client **access is mediated by the container** in which the enterprise bean is deployed."

Mediated access

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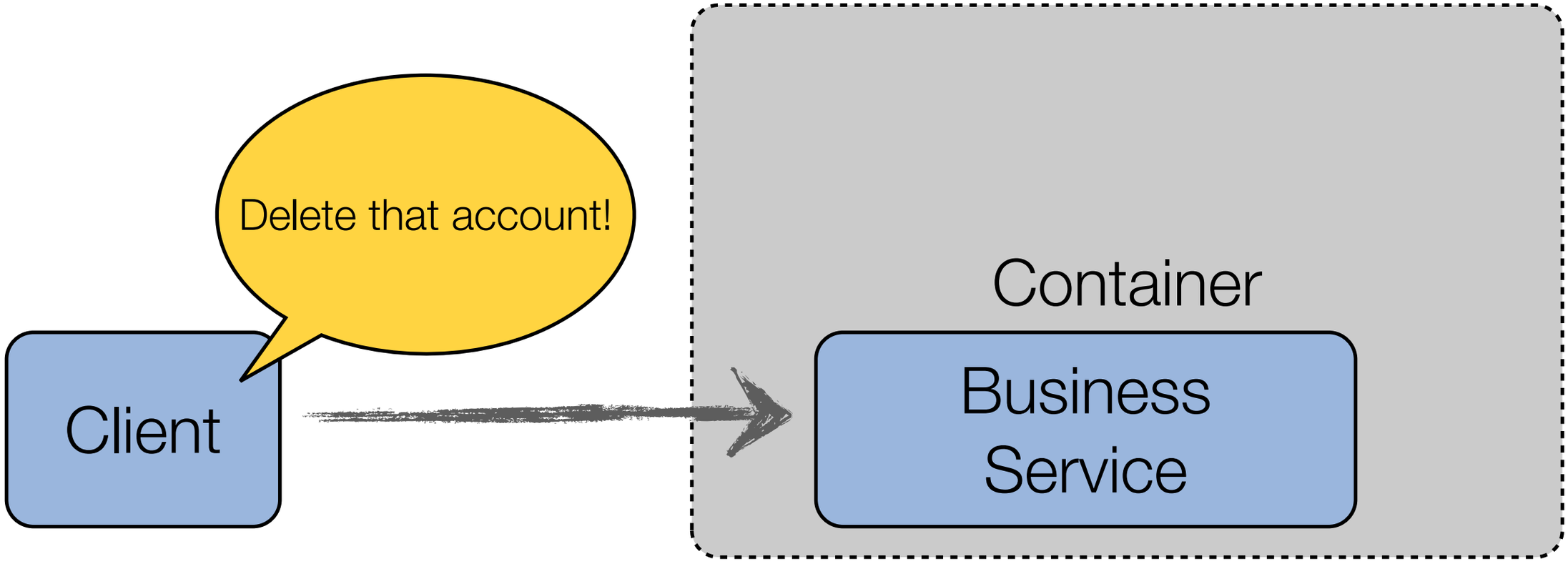


```
deleteAccount();
```

Mediated access

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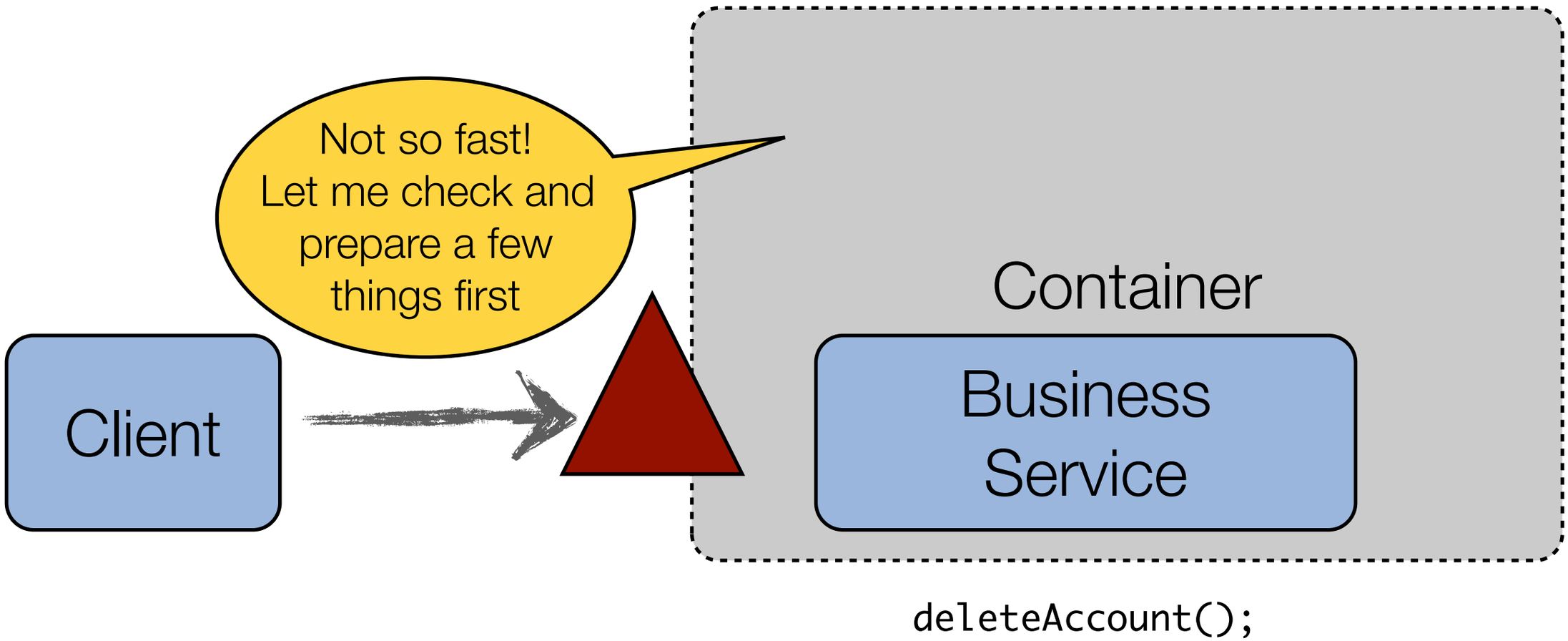


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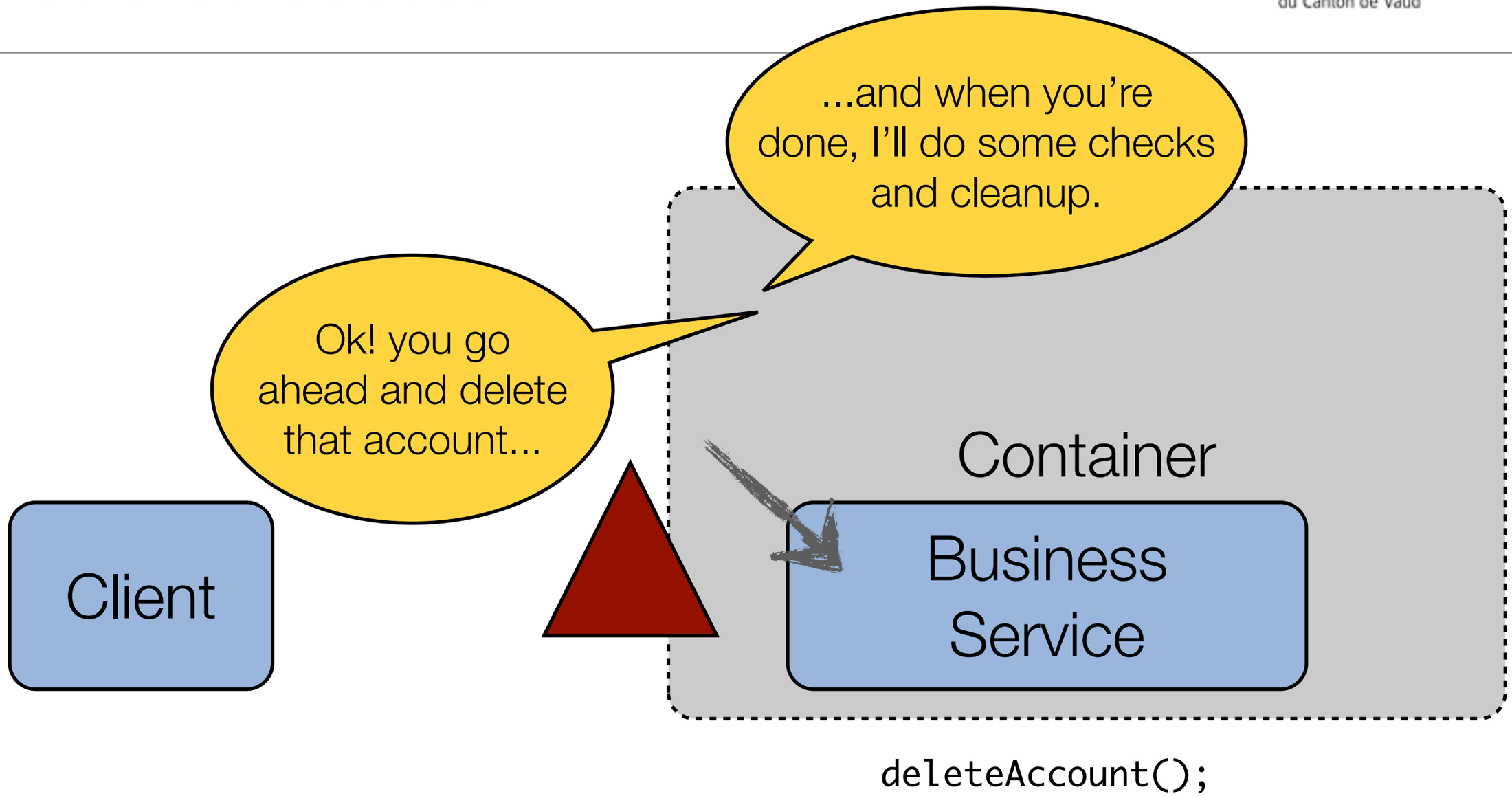


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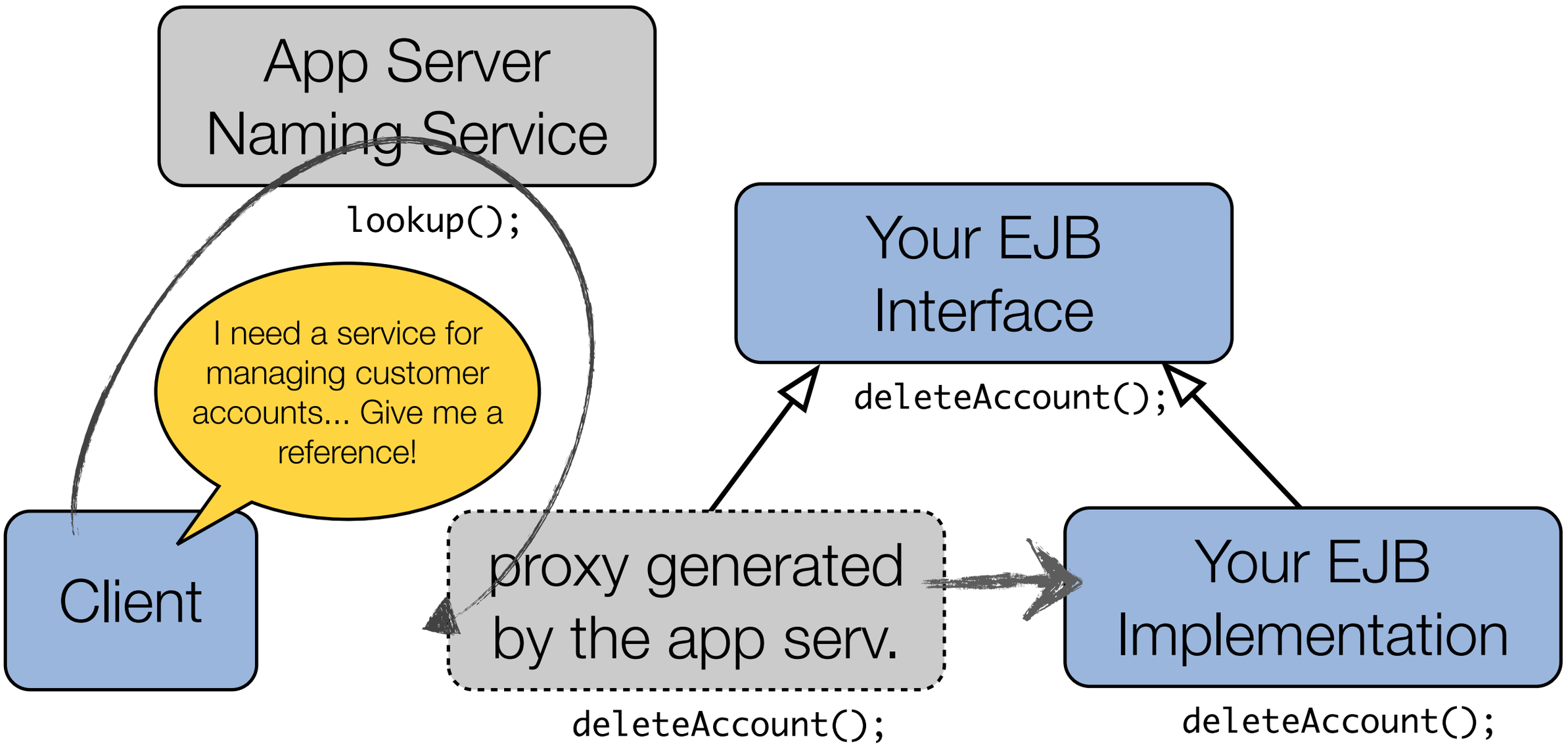

Resource pooling

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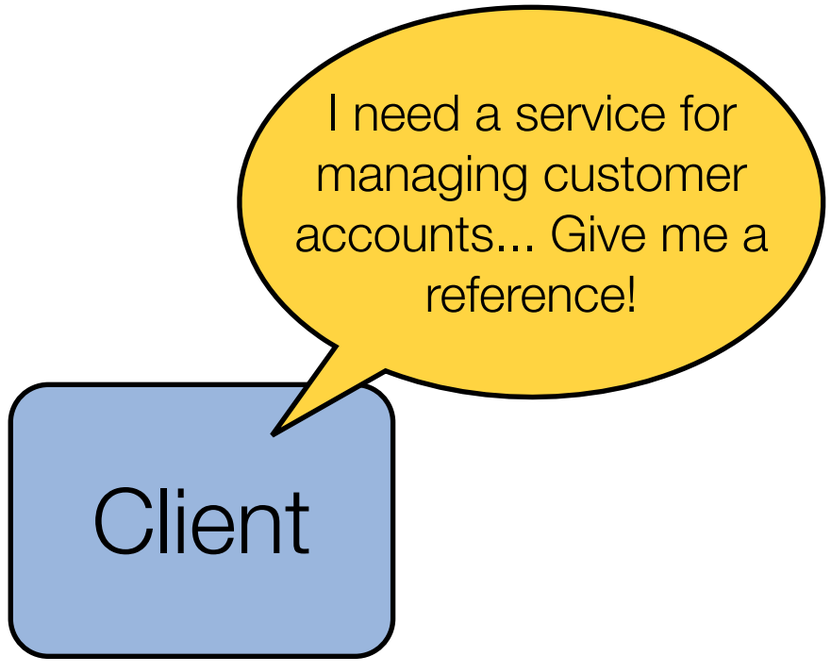
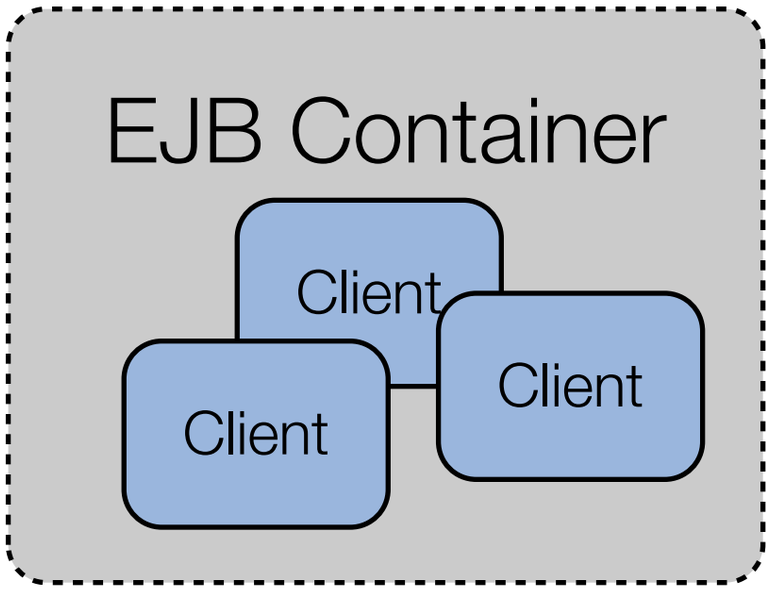
- As a developer, you define a **service interface** and provide an **implementation**.
- **You do not instantiate the service** - the application server takes care of that.
- The container does not instantiate only one instance of a class implementing your interface; **it creates several instances that are placed into a pool**.
- When a client comes along, a **free instance** is picked from the pool and **dedicated** to the client (no concurrency issue).
- In production, you can tune the size of pools (tradeoff between processing **bandwidth** and resource **consumption**).





From the specs: component types

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- “The enterprise bean architecture is flexible enough to implement the following:
  - An object that represents a **stateless service**.
  - An object that represents a stateless service and that implements a **web service endpoint**.
  - An object that represents a stateless service and whose invocation is **asynchronous**, **driven by the arrival of messages**.
  - An object that represents a **conversational session** with a particular client. Such session objects automatically maintain their **conversational state** across multiple client-invoked methods.
  - An entity object that represents a **fine-grained persistent object**.”

From the specs: component types

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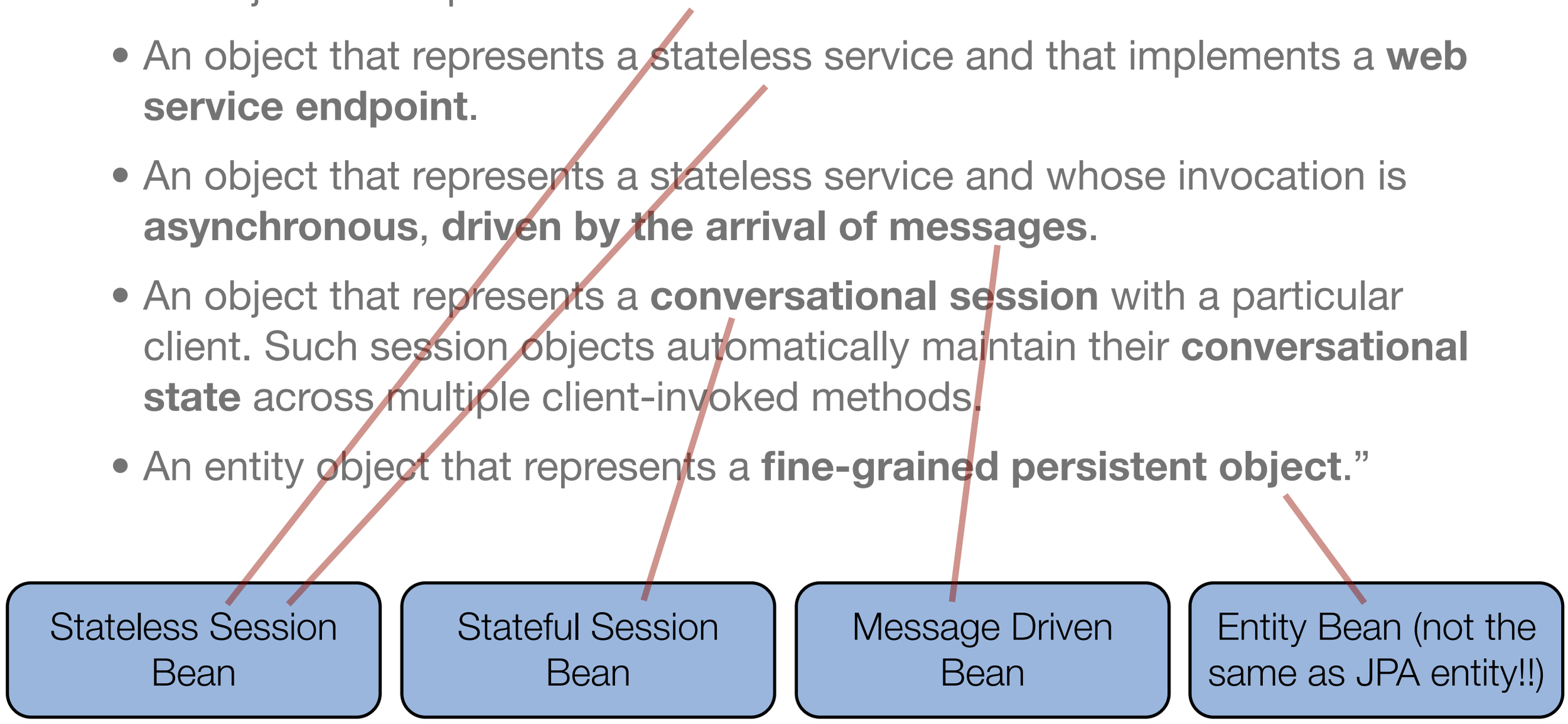

Session Beans (EJB)

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- A session bean may be either:
  - **stateless**—the session bean instances contain no conversational state between methods; **any instance** can be used for any client.
  - **stateful**—the session bean instances contain **conversational state** which must be **retained** across methods and transactions.

- Notes:
  - The term "**stateless**" signifies that an instance has no state **for a specific client**. However, the instance variables of the instance **can** contain the state across client-invoked method calls. Examples of such state include an open database connection and an object reference to an enterprise bean object.
  - The lifetime of stateful session bean is controlled by the client (the client call myStatefulService.remove())

Stateless Session Bean Life Cycle

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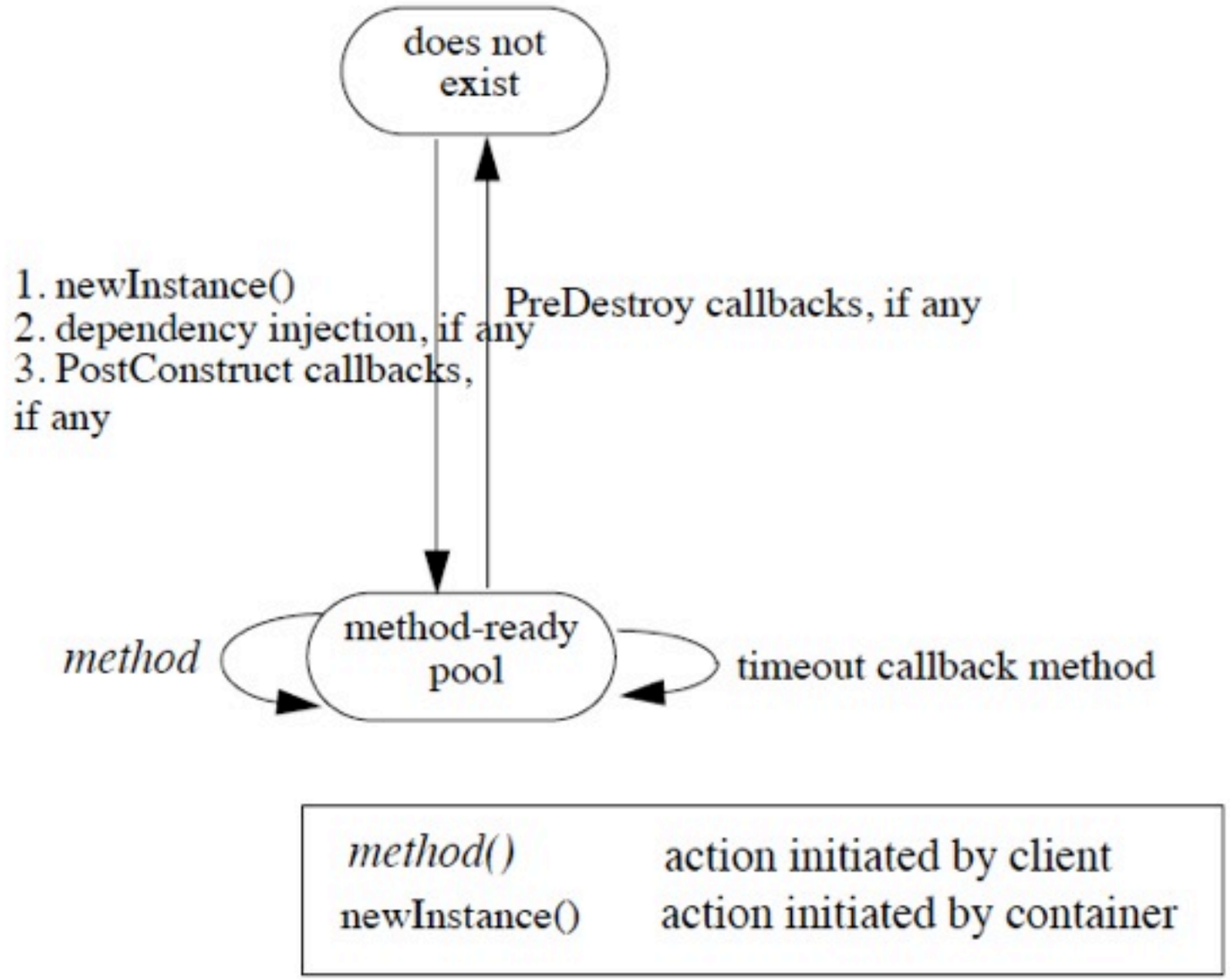
- The container manages the life cycle of the beans.
- The developer may implement callback methods, invoked when the state changes (e.g. for init/ clean-up tasks).
- With EJB3, you can do that with method annotations.
- Remember that you don't know how many instances there are, you don't know which one you're talking to.



Stateful Session Bean Lifecycle

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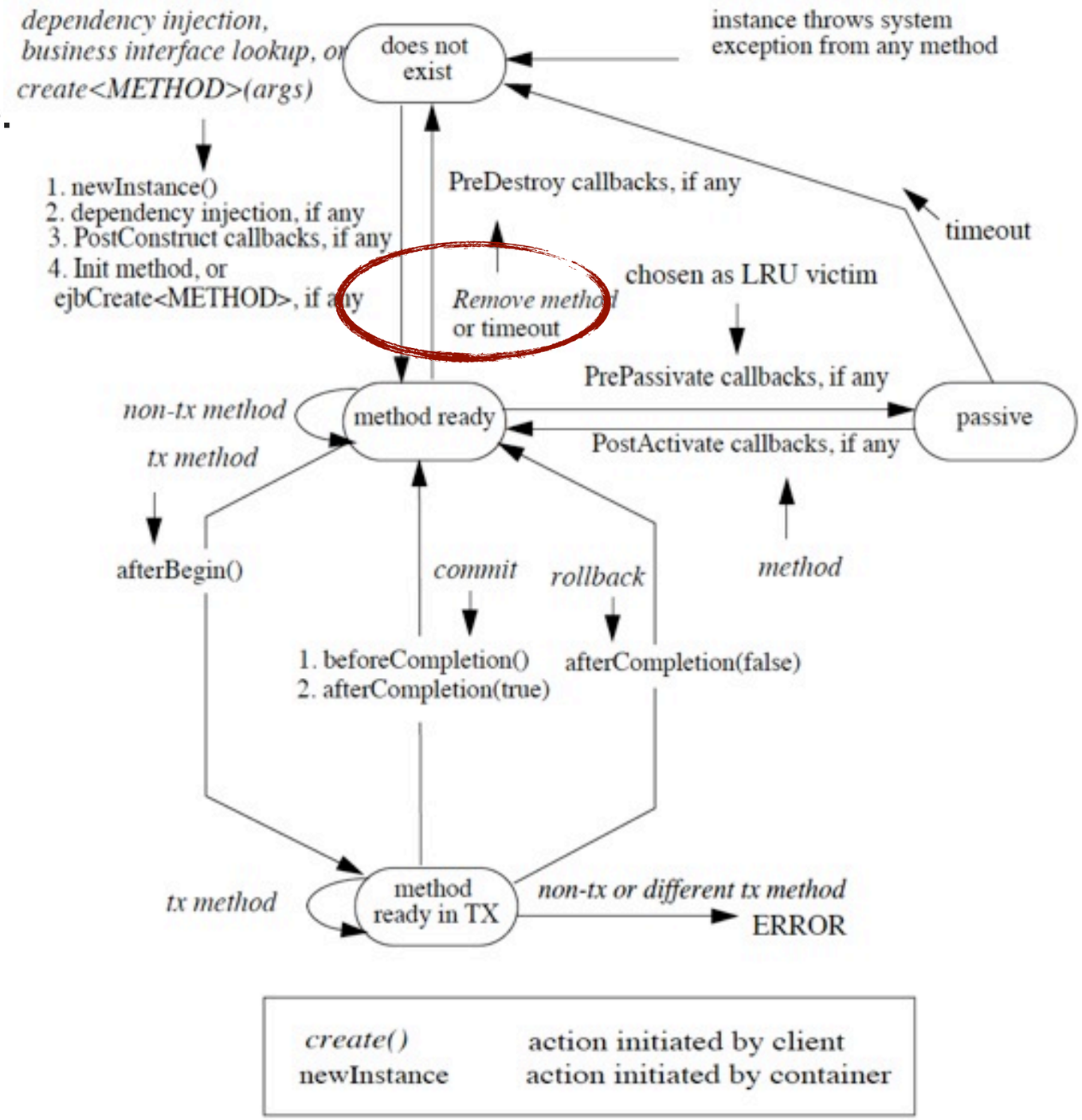
- Things are more complicated here, because we manage client-specific state.
- What happens when we run out of memory? We need to move the state of "some beans" to secondary memory.
- This is called "passivation".
- When a client comes back and wants to invoke a method on a passivated bean, we need to bring it back to life.
- This is called "activation".
- You typically "remove" a bean at the end of the use case (conversation).
- Check out the JBoss Seam Framework for an architecture that makes use of SFSB.



The client view: reaching the service

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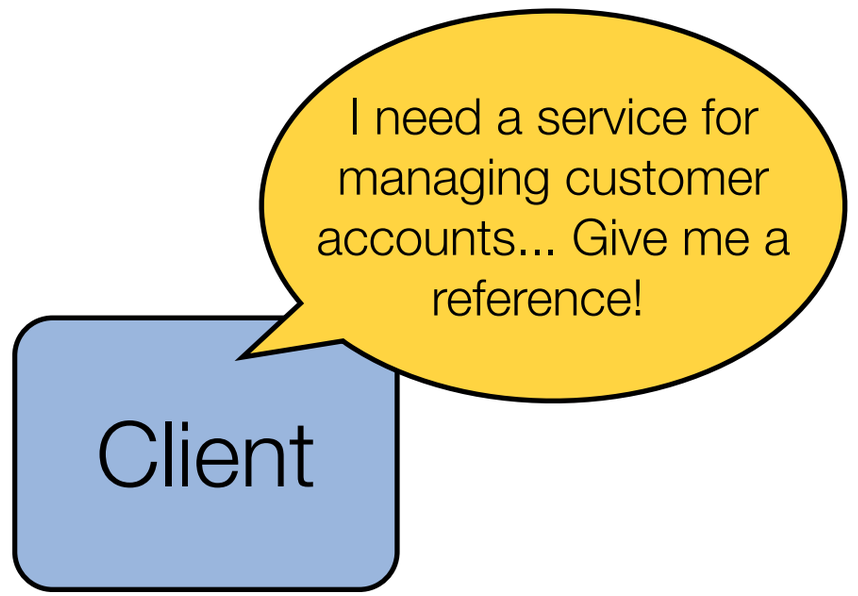
- Before using a service, the client needs to obtain a **reference** to a component that implements th service.
- Two approaches: **lookup** and **dependency injection**
- From the original J2EE model, we can do a lookup - the application server provides a **naming service** through JNDI.
- **Dependency injection** was introduced in the EJB3 / Java EE 5 specification. Here, the app server injects a reference into the client.

```
InitialContext ic = new InitialContext();
CustomerService service = (CustomerService)
ic.lookup("customerService")
```

```
@EJB
CustomerService service
```



Want to try it yourself?

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- To experiment with Java EE, you will need:
  - A **Java EE application server** (e.g. glassfish, jboss, websphere, etc.). This is mandatory.
  - An **IDE** (e.g. Netbeans, eclipse, etc.). This is not strictly mandatory, but it will help you a lot.
    - A **build management system** (e.g. maven, gradle, etc.). This is not strictly mandatory either, but if you are working on a real project, it is not even a question.
    - *The Netbeans Java EE Download bundle gives you a complete and integrated environment.*
- There is a **ton of information** available in books and on-line. A good idea is to start with the official Java EE tutorial:
  - http://docs.oracle.com/javaee/6/tutorial/doc/