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Contexts and Dependency Injection in Java EE 6

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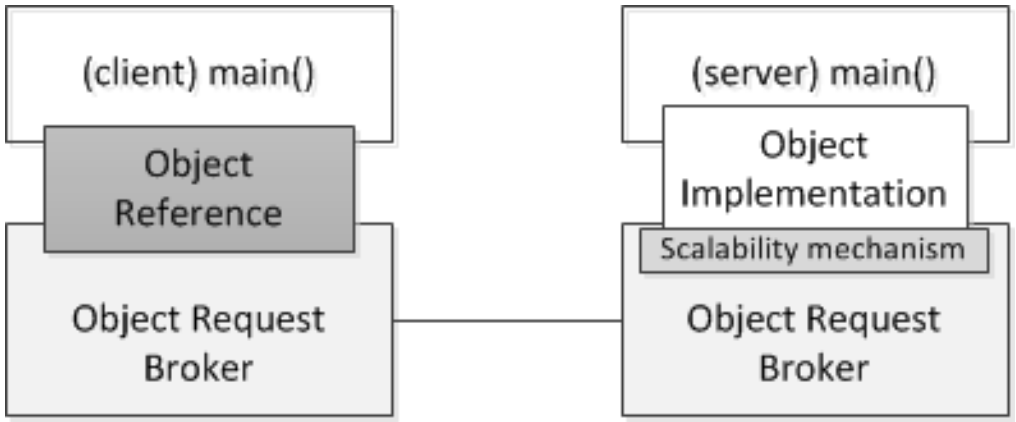
Agenda

- Architecture for distributed systems
  - Server objects
  - Server object containers
  - Services for server objects
- Java EE platform
  - What is missing in Java EE 5
- Inversion of Control (Ioc)
  - What is inverted
  - Sources of IoC
  - Dependency Injection
- Java EE CDI – IoC container
  - Examples
- CDI plus EJB

Server Objects

- Distributed enterprise applications:
  - Client-side architecture is easy
  - all of the mechanisms for scalability reside on the server side
- The most distinguished architecture in recent past is CORBA
  - In CORBA object is an entity with an object reference that provides the operations defined in its interface
  - In CORBA objects' implementations are managed on server, client gets remote reference to these objects



Server Object Lifecycle

- Server Object Lifecycle
  - Container manages server object lifecycle

Java EE server objects

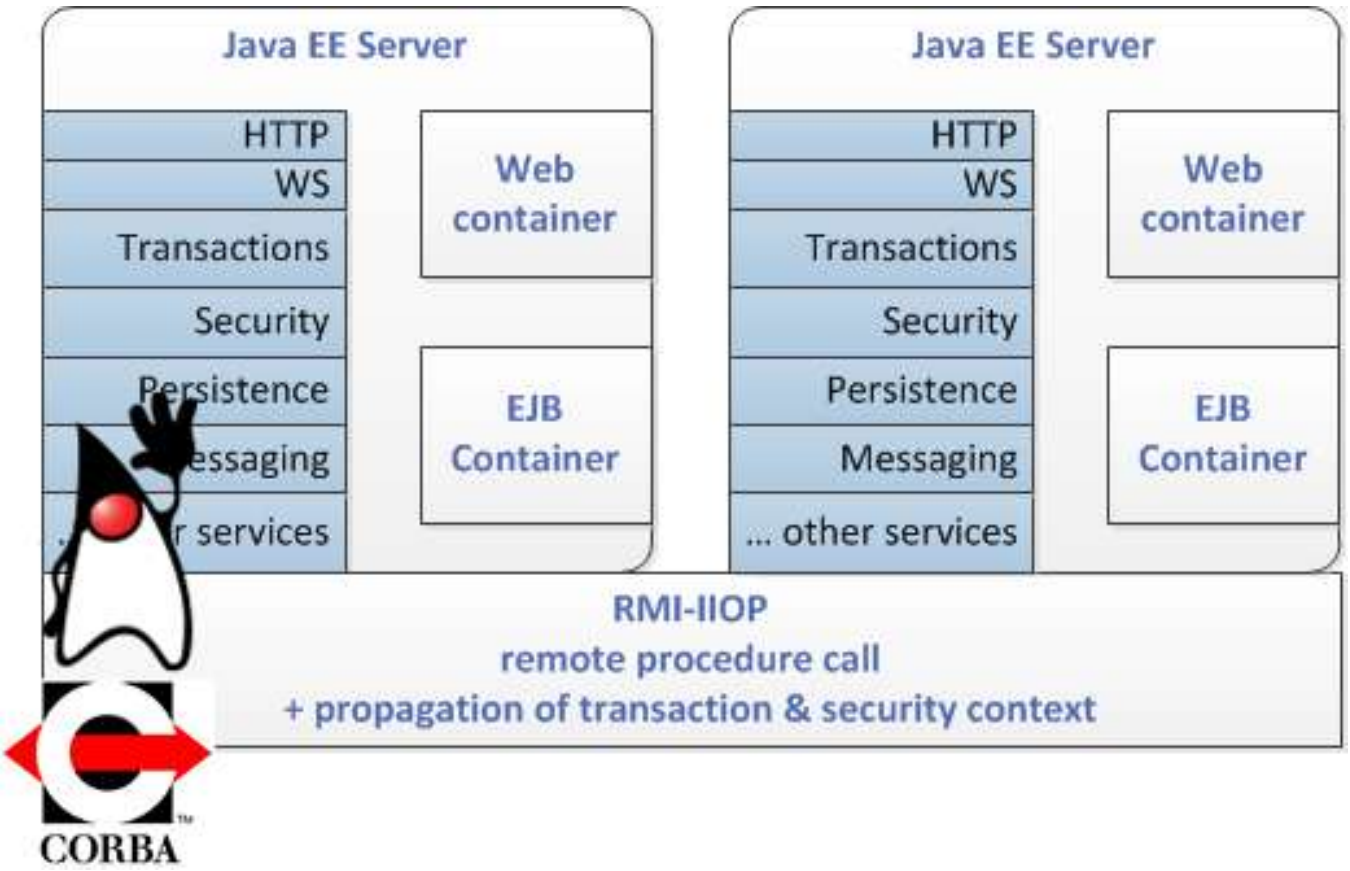
- Java EE Server Objects
  - Servlet, JSF backing bean
  - EJB
- Java EE Containers
  - Web-container (Servlet, JSF backing bean)
  - EJB-container (EJB components)
- How Java EE withstands high load?
  - Servlet
    - Singleton
  - EJB Stateless Session Beans
    - Pooling
  - EJB Stateful Session Beans
    - Passivate, activate

Services for Server Objects

- Important part of the CORBA standard
  - set of distributed services for distributed objects

- Services for distributed objects:
  - naming service
  - lifecycle management
  - security
  - transactions
  - event notification
  - concurrency control
  - …

Java EE 5 Platform



- Containers
- Services
- Communication
  - RMI-IIOP
  - HTTP
  - WS
  - Messaging
- Critical cross-cutting services
  - Distributed transactions
  - Security

Java EE 5 Platform

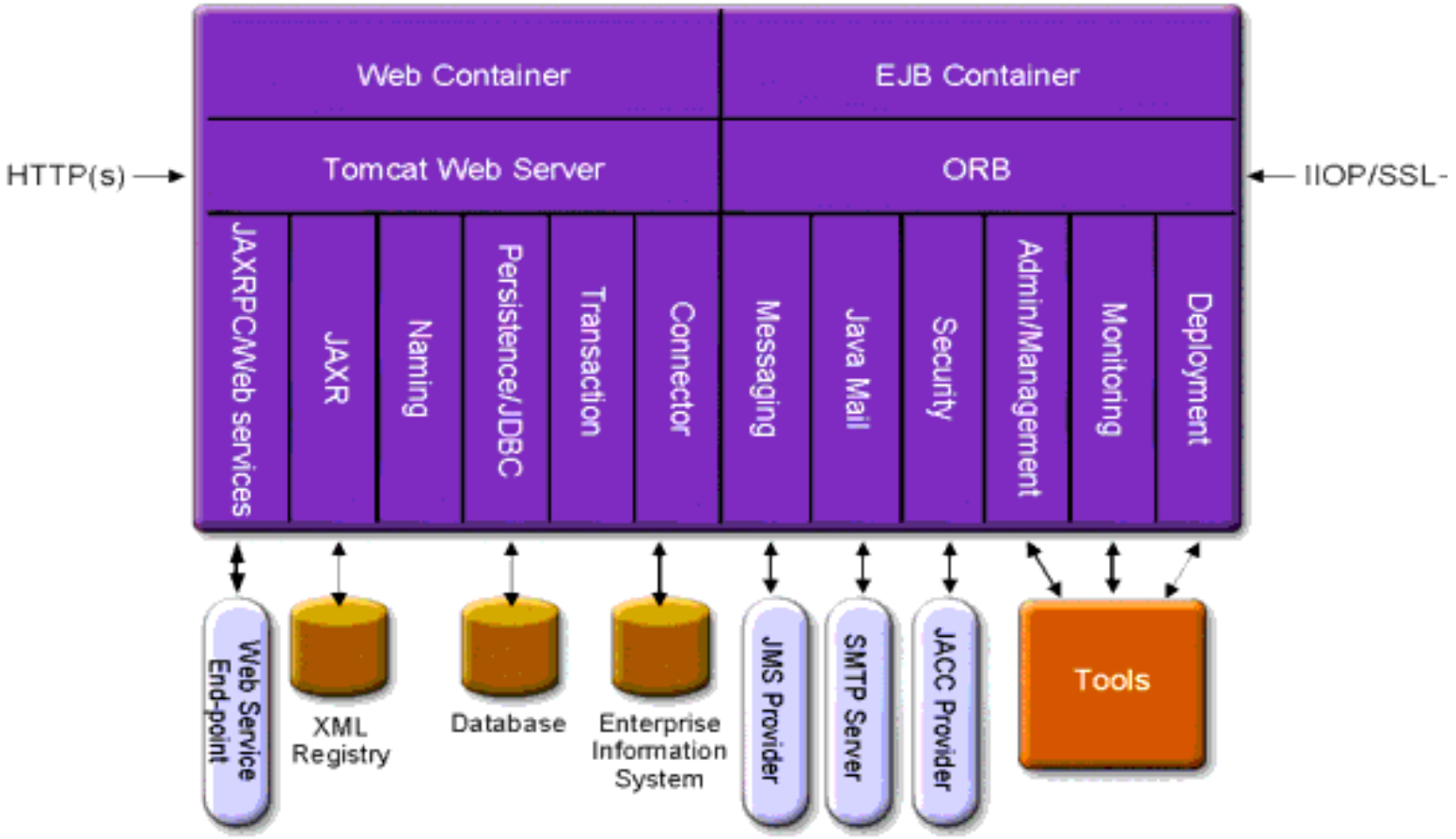
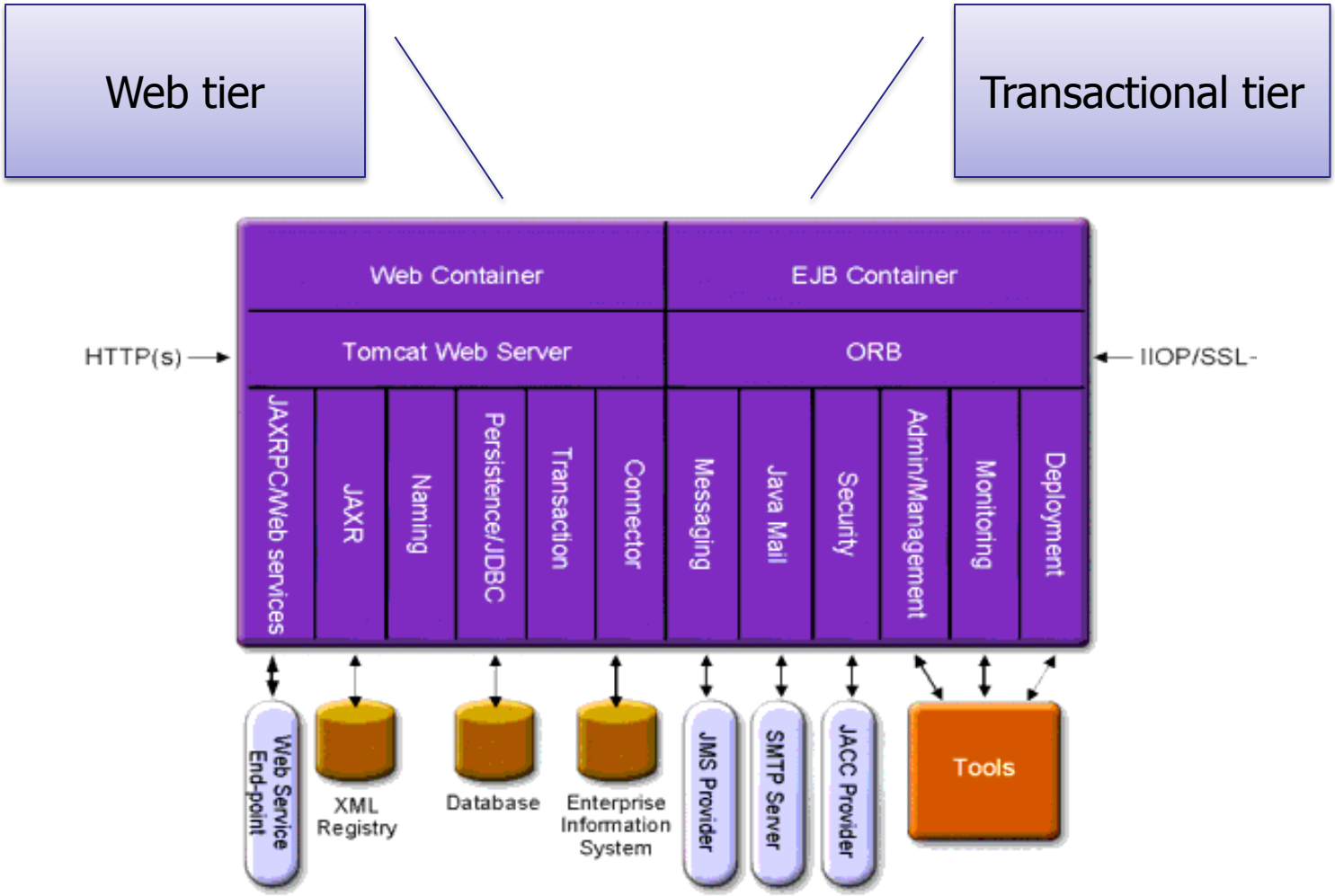


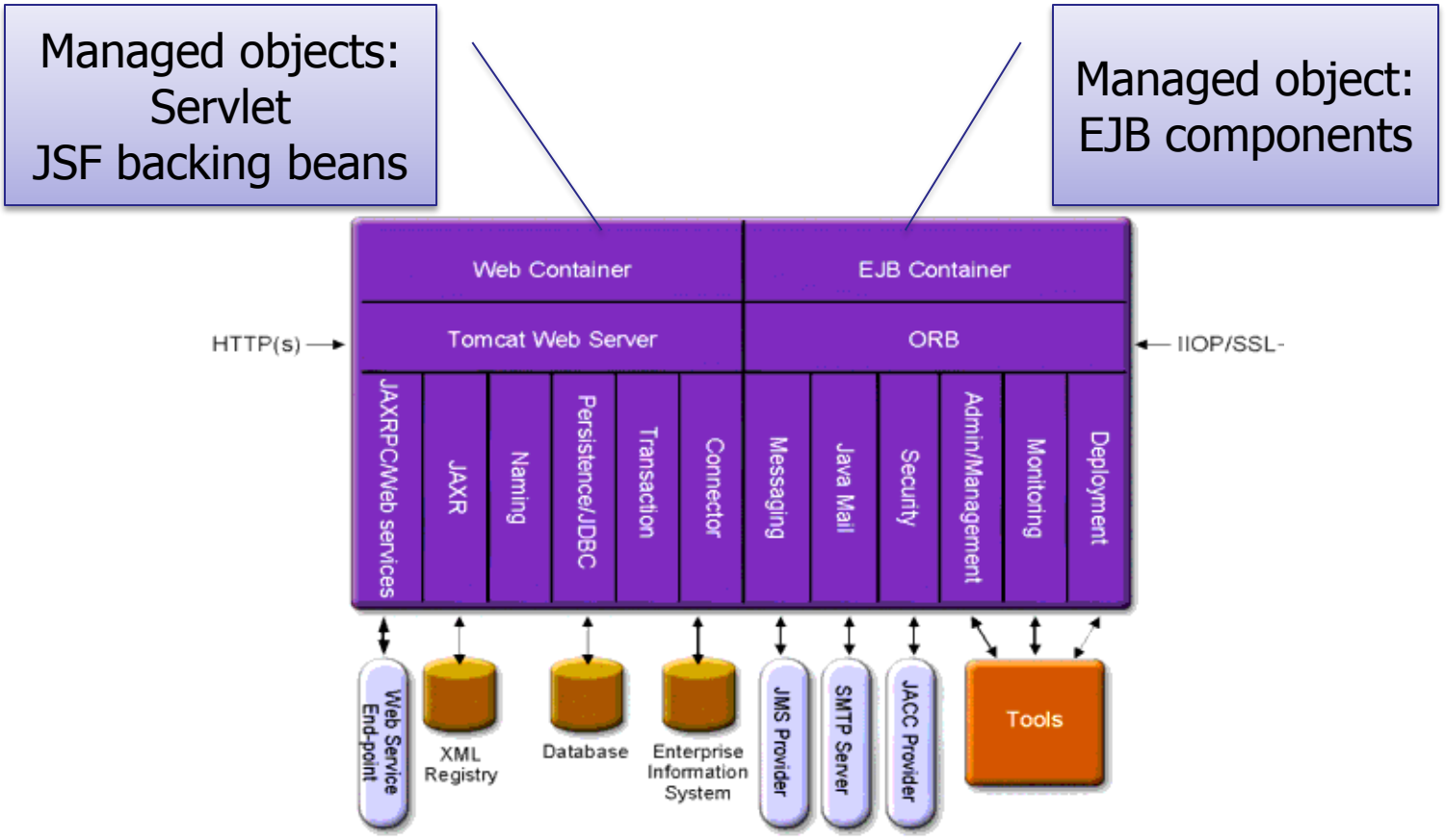
Figure: Sun Java System Application Server 9.1

Java EE tiers



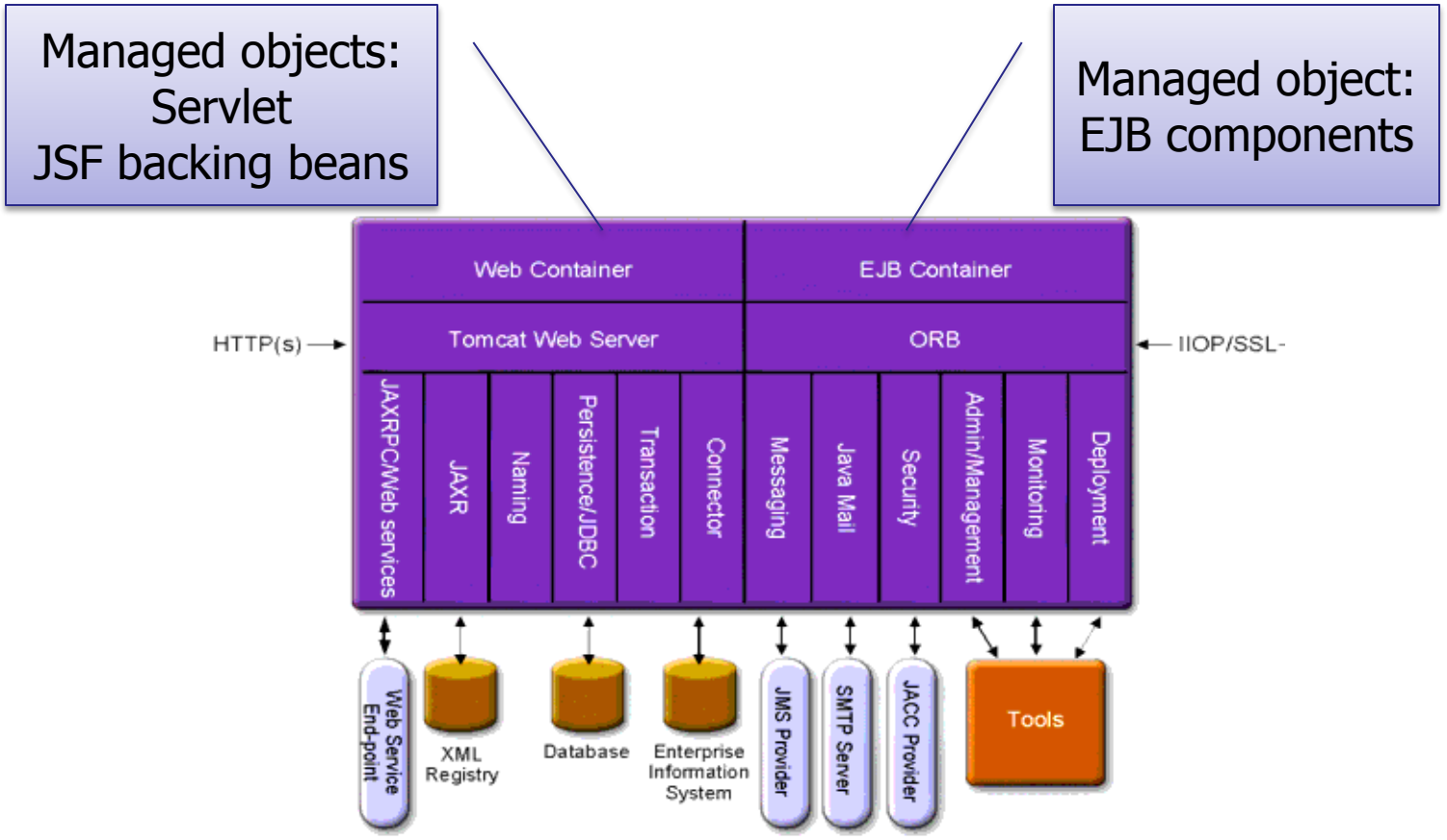
Predefined Set of Server Objects

- Java EE 5: predefined set of server objects managed by containers



Custom Server Object?

- How container can manage custom server object?
  - Custom server object like “command”, “service” etc.



What is missing in Java EE 5?

- Container for custom server objects is needed in Java EE
  - Inversion of Control (IoC) container
- But all advantages of Java EE 5 are still needed

Inversion of control

- Program control flow is inverted because container manages object lifecycle
- Object may be coupled to container:
  - It implements specific interfaces
  - It uses specific container's API to lookup dependent objects
- IoC helps to decouple object from container
  - No specific interfaces that object must implement
  - No calls of specific API to lookup dependent objects. **This is performed using dependency injection**.
- With **dependency injection** there is no explicit request for dependencies. Container wires dependencies.
- Hence **inversion of control**

Sources of “Inversion of control”

- Enterprise application needs enterprise architectures
  - Component architecture for server side logic

Component Architecture

Microsoft Application Architecture Guide v2. p. 24:

- "Components depend upon a mechanism within the platform that provides an environment in which they can execute, often referred to as **component architecture**.
- Examples are the component object model (COM) and the distributed component object model (DCOM) in Windows; and Common Object Request Broker Architecture (CORBA) and Enterprise JavaBeans (EJB) on other platforms.
- Component architectures manage the mechanics of locating components and their interfaces, passing messages or commands between components, and—in some cases—maintaining state."

Invasive component models

- Traditional component based development frameworks:
  - Based on **invasive component models**
  - Have **dependency lookup scenario**.
- **Invasive**
  - Developer should implement framework pre-defined interfaces
- **Dependency lookup scenario**
  - Component performs dependency lookup using framework specific APIs. Lookup in global registry.

- This leads to
  - Non-portable component programming model
  - Non-testable component. Components could only be tested and used within their originally intended frameworks
- Examples: EJB, CCM (CORBA Component Model)

Non-invasive component model

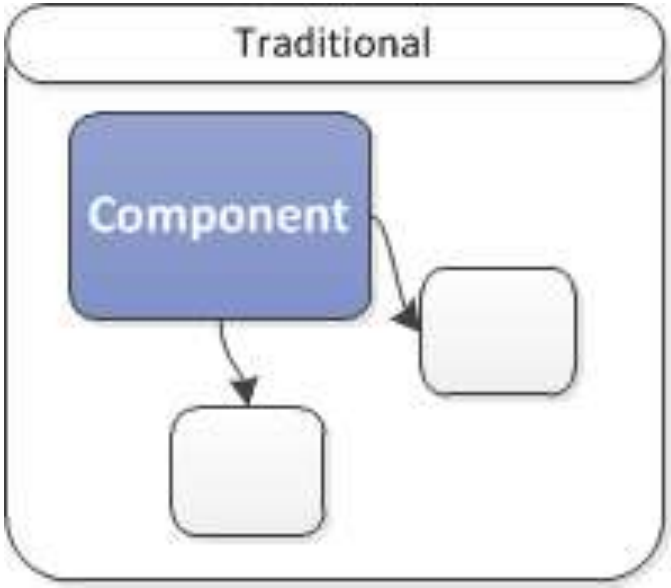
- IoC frameworks are
  - **non-invasive**
  - use the **dependency injection/setting scenario**.
- **Non-invasive**
  - component should not extend any framework specific interfaces
- **dependency injection/setting scenario**
  - This is an inverse version of the traditional *lookup/resolving* scenario

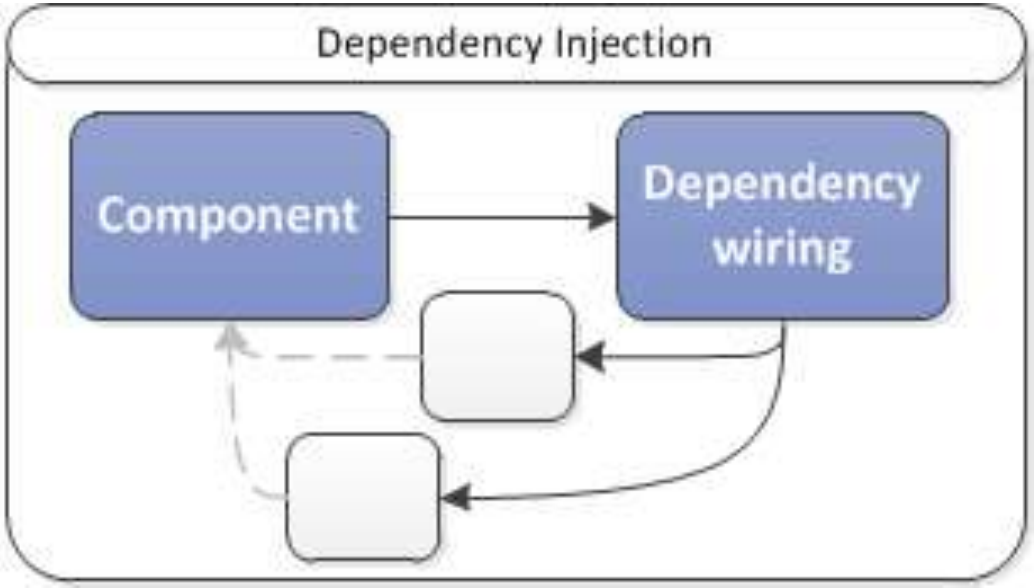
- **This decouples component from container**

- Examples: Spring, PicoContainer, Google Guice, Tapestry IoC, …

Dependency Injection

- When container instantiate component, it assembles all its dependencies
- Dependency injection separates assembling from components





IoC Container Responsibilities

- Component lifecycle management
  - Statefull objects
- Component configuration
- Component dependencies wiring

Dependency Injection in Java EE 5

- Closed set of injectable resources provided by web-container and ejb-container
  - @EJB
  - @PersistenceContext, @PersistenceUnit
  - @Resource (Java EE Resource, e.g. DataSource, JMS destination; UserTransaction)

CDI

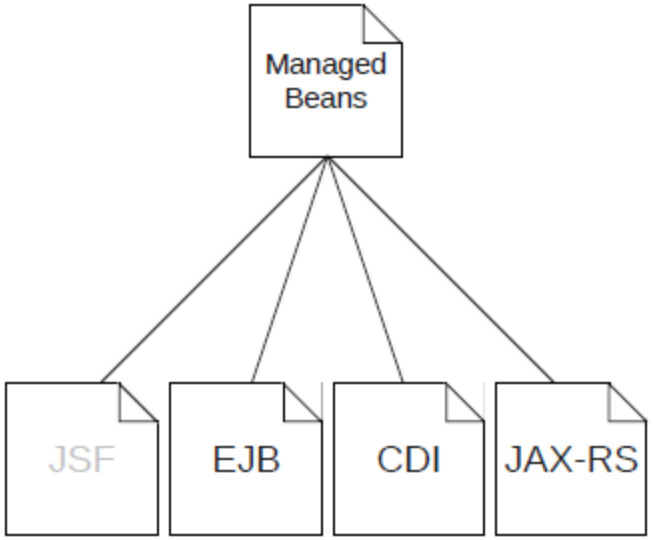
- CDI (Contexts and Dependency Injection) for Java EE Platform, JSR 299
  - IoC Container in Java EE 6
- CDI provides generic services applicable to all managed beans
  - Lifecycle management
  - Dependency injections
  - Event notification
  - Contexts
  - EL integration (bean names)

Goal of CDI

- Simplify the creation of applications that use both web tier and business tier technologies

Managed Beans in Java EE 6

- Java EE 6 platform define “managed bean” as container-managed objects
- Managed beans:
  - EJB session beans
  - annotated with @ManagedBean
  - objects with minimal programming restrictions, aka POJO (Plain Old Java Object). No special declaration/annotation required.



CDI Bean

- CDI bean
  - Objects with minimal programming restrictions, aka POJO (Plain Old Java Object). No special declaration/annotation required.
- Most Java classes can be managed by CDI container

Examples

CDI Bean

```
public class Login implements Serializable {

    private Credentials credentials;

    public boolean login() {
        // login using credentials
        …
    }
}
```

Injection

```
public class Login implements Serializable {

    @Inject
    private Credentials credentials;

    public boolean login() {
        // login using credentials
        …
    }
}
```

- Where @Inject
  - Field, initializer method parameter (e.g. setter)

EL name

```
@Named("login")
public class Login implements Serializable {

    @Inject
    private Credentials credentials;

    public boolean login() {
        // login using credentials
        …
    }
}
```

~~JSF Managed Bean~~ -> CDI

```
@Named(“login”) @SessionScoped
public class Login implements Serializable {

    @Inject
    private Credentials credentials;

    public boolean login() {
        // login using credentials
        …
    }
}
```

JSF

```
<h:form>
    <h:panelGrid columns="2" rendered="#{!login.loggedIn}">
        <h:outputLabel for="usr">Username:</h:outputLabel>
        <h:inputText id="usr" value="#{login.credentials.username}"/>
        <h:outputLabel for="pwd">Password:</h:outputLabel>
        <h:inputText id="pwd" value="#{login.credentials.password}"/>
    </h:panelGrid>
    <h:commandButton value="Login"
                     action="#{login.login}"
                     rendered="#{!login.loggedIn}"/>
    <h:commandButton value="Logout"
                     action="#{login.logout}"
                     rendered="#{login.loggedIn}"/>
</h:form>
```

What can be injected

- What can be injected
  - Beans
  - EJB session bean
  - Resources (Java EE Resources, persistence contexts, persistence units, remote EJBs and web services)

- What else?
  - “Produced” beans

Producer Methods

```
@Named @SessionScoped
public class Login implements Serializable {

    @Inject private Credentials credentials;
    private Client client;

    public void login() { ... }
    public void logout() { ... }

    @Produces @LoggedIn
    public Client getLoggedInClient() {
        return client;
    }
}
```

@LoggedIn – qualifier interface that assign semantic meaning

Client of Producer Method

```
@Named @RequestScoped
public class SomeController {

    @Inject @LoggedIn Client client;
    ...
}
```

Produce Random Numbers Example

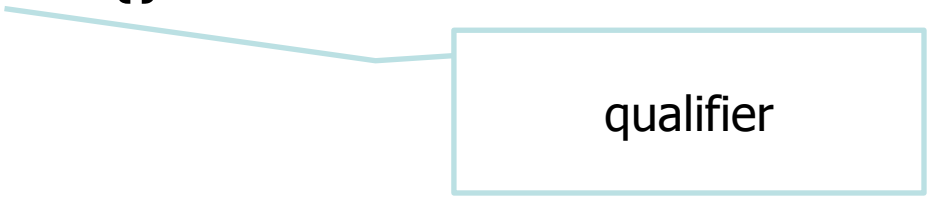
```
@ApplicationScoped
public class RandomNumberGenerator {

 private Random random=new Random(System.currentTimeMillis());

 @Produces @Named @Random
 int getRandomNumber() {
      return random.nextInt(100);
 }
}
```

Event Notification (1/3)

```
@Named @SessionScoped
public class Login implements Serializable {

    private Client client;
    @Inject @LoggedIn private Event<Client> userLoggedInEvent;
    @Inject @LoggedOut private Event<Client> userLoggedOutEvent;

    public void login() {
        client = ...
        if (client!=null)
            userLoggedInEvent.fire(client);
    }

    public void logout() {
        if (client!=null) {
            userLoggedOutEvent.fire(client);
        }
        client = null;
    }
}
```

Event Notification (2/3)

```
@Qualifier
@Retention(RUNTIME)
@Target({METHOD, FIELD, PARAMETER, TYPE})
public @interface LoggedIn {}
```




```
@Qualifier
@Retention(RUNTIME)
@Target({METHOD, FIELD, PARAMETER, TYPE})
public @interface LoggedOut {}
```

Event Notification (3/3)

```
public class DoSomeLogicOnLogin {


    void onLogin(@Observes @LoggedIn Client client) {
        ...
    }

    void onLogout(@Observes @LoggedOut Client client) {
        ...
    }
}
```

Scopes

- Java EE (servlets, EJBs) do not have a well-defined *scope*

Contexts

- CDI defines built-in scopes:
  - @RequestScoped
  - @SessionScoped
  - @ApplicationScoped
  - @ConversationScoped
  - @Dependant

Servlet scopes

JSF scope

Bound to lifecycle
of bean holding reference

- Web + Transactional:
  - EJB Stateful beans can now be bound to context have one of above scope

CDI plus EJB

CDI vs EJB

- EJB provides advanced enterprise services
- CDI provides IoC Container capabilities
  - doesn't provide any transactional, monitoring, or concurrency aspect out of the box
- EJB + CDI = synergy of both technologies

EJB Session Beans

- When should you use a session bean instead of a plain managed bean? Whenever you need:
  - method-level transaction management and security
  - concurrency management
  - instance-level passivation for stateful session beans and instance-pooling for stateless session beans
  - remote or web service invocation
  - timers and asynchronous methods
  - JMX monitoring
- If you do not need these features, use ordinary managed bean

Concurrent access to CDI beans

- @SessionScoped and @ApplicationScoped beans are available for concurrent access
  - For this concurrency management provided by EJB 3.1 is useful
  - Consider session and application scoped beans to be EJBs

Well defined scope for EJBs

- Stateful EJBs now can be bound to well-defined contexts
  - session, request, application, conversation

CDI plus EJB

- **In Java EE 6, the "EJB 3.1 with CDI" combination is the perfect synergy**

Weld - CDI Implementation

- **Weld**
  - GlassFish 3.0
  - Jboss 6.0.0
  - Tomcat 6.0.18 or later
  - Jetty 6.1.x

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