EJB and JavaServer Faces

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EJB (Enterprise Java Beans)

Contents

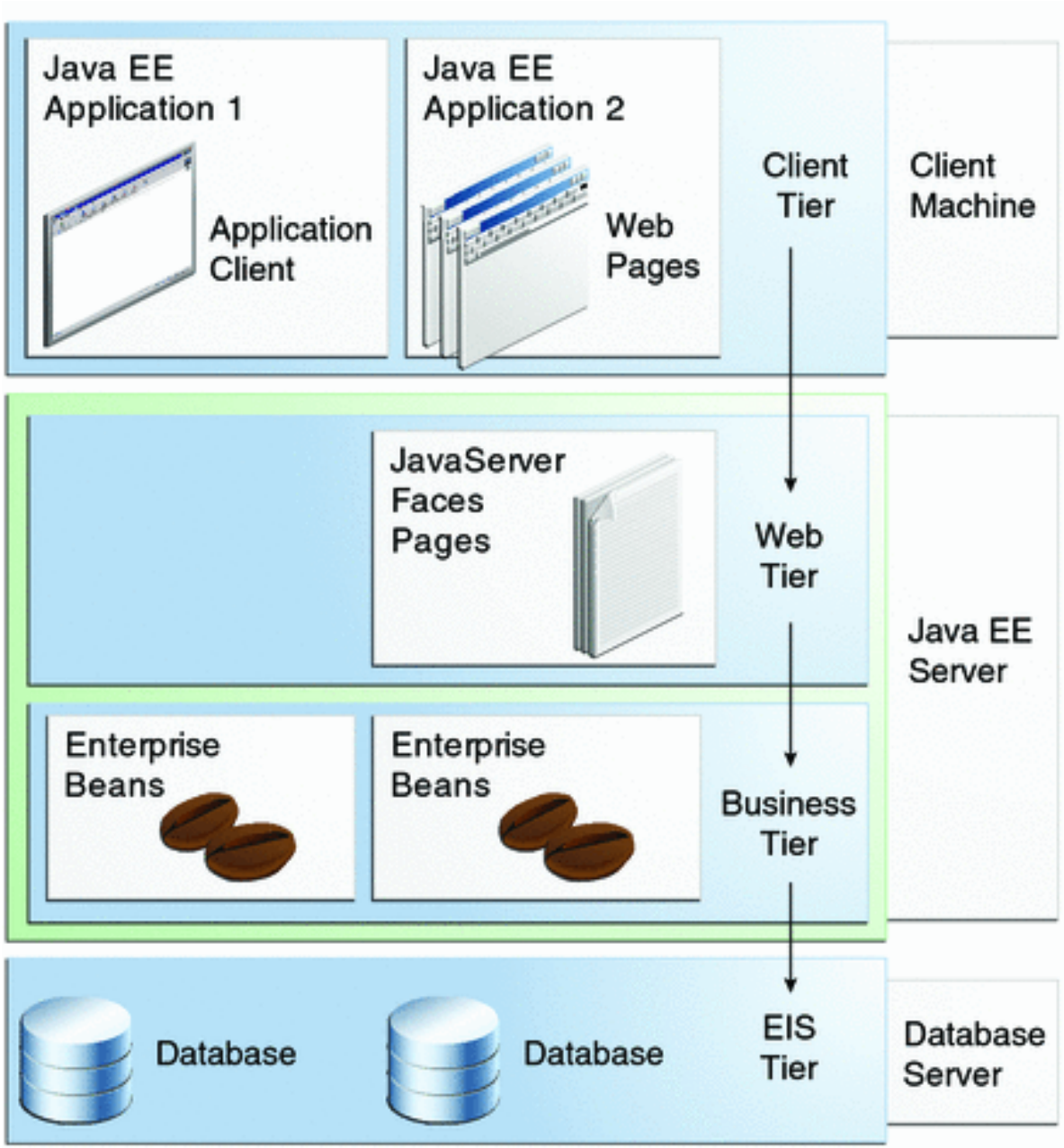
- Enterprise JavaBeans (EJB)
  - Enterprise bean is a server-side component that encapsulates the business logic of an application.
  - EJB execute within an EJB container, which is running in the EJB server.

- EJB server is a part of an application server that hosts EJB containers
  - can be also standalone (Apache TomEE)
- EJBs do not interact directly with the EJB server.
- GlassFish (Oracle), WebSphere (IBM), WebLogic (Oracle), WildFly (Red Hat), WebObjects (Apple), ...
- EJB specification outlines eight services that must be provided by an EJB server:
  - Naming
  - Transaction
  - Security
  - Persistence
  - Concurrency
  - Life cycle
  - Messaging
  - Timer

EJB Container

- EJB Container is a runtime environment for EJB component beans.
- Containers are transparent to the client.
  - There is no client API to manipulate the container.
- Container provides EJB instance life cycle management and EJB instance identification.
- Container manages the connections to the enterprise information systems (EISs).
- Container provides services, such as transaction management, concurrency control, pooling (cache with beans) and security authorization.

Multitiered Java EE Applications



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

Enterprise Java Bean types

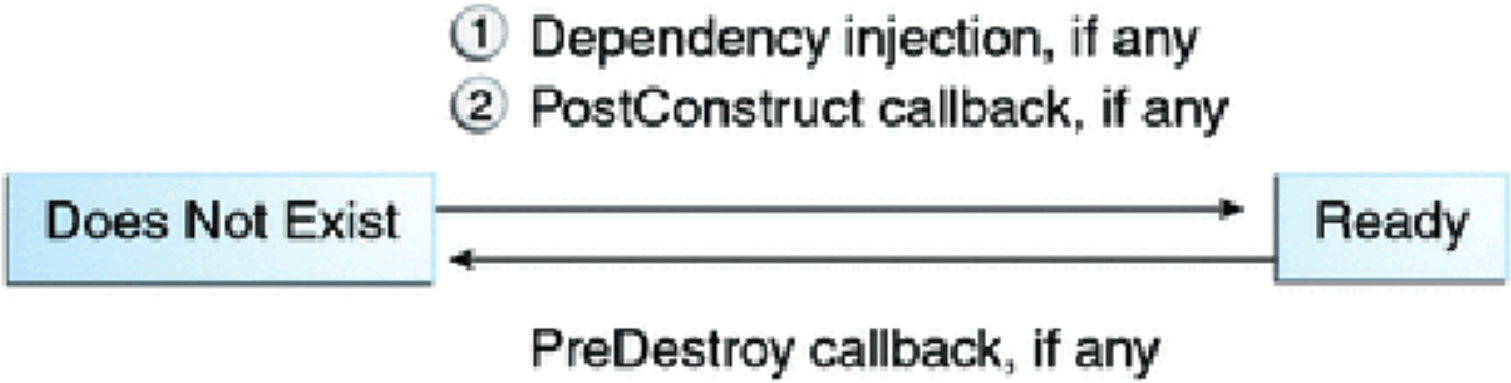
- Session Beans
  - models task or workflow
  - Façade for Entity beans
    - structural design pattern – simplified interface to a larger set of interfaces.
  - maintains conversational state with clients (one bean per client)
- Message Driven Beans
  - asynchronous communication with MOM (Message Oriented Middleware) – distributed over heterogeneous platforms
  - allows non-Java EE resources to access Session and Entity Beans via JCA (Java EE Connector Architecture – connects AS with EIS) Resource adapters
  - uses JMS
- (Entity Beans 2.1) JPA 2.0 in Java EE 6
  - implicitly persistent
  - transparent persistence with transaction support
  - typically stored in a relational database (Object/Relational Mapping)

Example guestbook-jee6 (Entity)

- `@Stateless` annotation
- State only for the duration of a client invocation of a single method.
- Pool of stateless beans is managed by the container.
- Any available stateless session bean may handle the client request.
- Lifecycle event callbacks supported for stateless session beans (optional)
  - `@PostConstruct` – occurs before the first business method invocation on the bean.
  - `@PreDestroy` – occurs at the time the bean instance is destroyed.

```
@Stateless
public class FooBean {
  @PostConstruct
  private void init() {...}

  @Remove
  public void remove() {}  // removed from container
}
```



Example StatelessBean

Stateful Session Beans

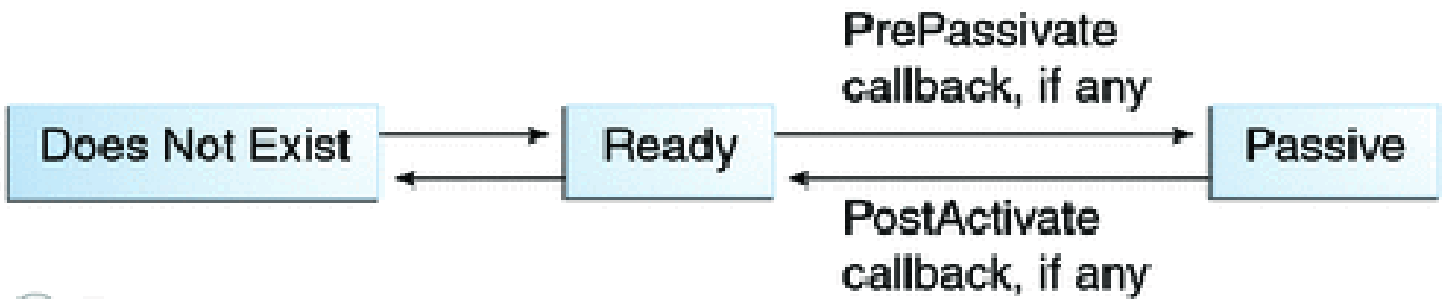
- Instance variables unique to the client/session.
- State is retained for the duration of the client/bean session.
- Client initiate creation and destruction (or timeout).
- Stateful Session Beans can not be pooled.
- Stateful Session Beans can be passivated.
- Supports following callbacks for the lifecycle events:
  - `@PostConstruct` – same as stateless bean, once for each session.
  - `@Init` – designates the initialization method of a bean.
  - `@PreDestroy` – same as stateless, once for each session.
  - `@PrePassivate` – container invokes this method right before it passivates a stateful session bean (clean up held resources, such as database connections or any resources that cannot be transparently passivated using object serialization).
  - `@PostActivate` – container invokes this method right after it reactivates the bean.
  - `@Remove` – called by container before it ends the life of the stateful session bean. Than invokes the bean's `PreDestroy` method, if any.
  - `@AroundInvoke` – interceptor method that interposes on business methods (one per class).

Stateful Session Beans

```
@Stateful
public class FooBean {
  @PostConstruct
  private void init() {...}

  @Remove
  public void remove() {}
}
```

1. Create
2. Dependency injection, if any
3. PostConstruct callback, if any
4. Init method, or ejbCreate<METHOD>, if any



1. Remove
2. PreDestroy callback, if any

Example StatefullBean

Singleton Session Beans

- Singleton Session Bean is a POJOs marked with `@Singleton` annotation,
- has only a single instance per JVM,
- supports data sharing and concurrent access,
- allows to set order of initialization (`@DependsOn`),
- initialization can be eager (`@Startup`).

```
@Startup
@Singleton(name = "PrimaryBean")
@DependsOn("SecondaryBean")
public class PrimaryBean {...}

@Startup
@Singleton(name = "SecondaryBean")
public class SecondaryBean {...}
```

- Business interfaces
  - visible to the client
  - implemented inside the bean

Local and Remote Interface

- Local Interface (`@Local`)
  - invoking EJBs within the same JVM,
  - faster, but not so flexible, scalable and adaptable,
  - no network traffic,
  - parameters passed by reference.
- Remote Interface (`@Remote`)
  - invoking EJBs across JVMs,
  - anywhere on the network,
  - parameters passed by value (serialization/de-serialization).

```
@Stateless
public class CalculatorBean
  implements CalculatorRemote, CalculatorLocal {
    public int add(int x, int y) {
        return x + y;
    }
    public int subtract(int x, int y) {
        return x - y;
    }
}
public interface Calculator {
    int add(int x, int y);
    int subtract(int x, int y);
}

@Remote
public interface CalculatorRemote extends Calculator {}
@Local
public interface CalculatorLocal extends Calculator {}
```

No-interface view

- New in EJB 3.1
- EJB may not have business interface.
- Session Beans are simple POJO.
- Automatically exposes public methods.

```
@Stateless
public class FooBean {
    public void foo() {...}
}
```

- It is not necessary to use `@local` or `@remote` (selected automatically).

- `@MessageDriven` annotation
- invoked asynchronously by messages from standard Session Beans,
- cannot be invoked with local or remote interfaces (from clients),
- stateless, transaction aware,
- JMS (Java Messaging Service) used as a transport layer,
- implements method `onMessage(...)`.
- Two types of messaging:
  - point-to-point (queues)
  - pub-sub (topics)

Example MessageDrivenBean (JDK 1.8)

Types of EJB

- Session Beans
  - Stateless
  - Statefull
  - Singleton
- Message Driven Beans
- Entity Beans

Accessing Session Beans

- Clients never use "`new`" operator on managed beans.
- Session Beans are accessed using DI or JNDI.
- Dependency Injection
  - only from clients in an Java EE environment
    - other EJB, other managed beans, servlet, ...
  - during deployment of the bean to the container
  - `@EJB Foo fooBean;`
- JNDI
  - programming interface to the directory services to locate any object in a network
  - even from non-EE clients
  - access remote business interface

```
Context ctx = new InitialContext();
FooRemote example = (FooRemote)
    ctx.lookup("java:global/myApp/FooRemote");
```

Dependency Injection Example

```
public class Main {
    @EJB
    private static BookEJBRemote bookEJB;
    public static void main(String[] args) {
        // Creates an instance of Book
        Book book = new Book();
        book.setTitle("The Hitchhiker's Guide to the Galaxy");
        book.setPrice(12.5F);
        book.setDescription("Science fiction by Douglas Adams.");
        book.setIsbn("1-84023-742-2");
        book.setNbOfPage(354);
        book.setIllustrations(false);
        book = bookEJB.createBook(book); // business layer request
        book.setTitle("H2G2");
        book = bookEJB.updateBook(book); // business layer request
        List<Book> books = bookEJB.findBooks(); // business layer
                                                // request
        System.out.println("List of books in DB:");
        for (Book b : books) {
            System.out.println(b);
        }
        bookEJB.deleteBook(book); // business layer request
    }
}
```

JNDI names

- `java:global[/<app-name>]/<module-name>/<bean-name>[!<fully-qualified-interface-name>]`
- `java:app/<module-name>/<bean-name>[!<fully-qualified-interface-name>]`
- `java:module/<bean-name>[!<fully-qualified-interface-name>]`
- Examples:
  - `java:global/fooEar/fooweb/FooBean`
  - `java:global/fooEar/fooweb/FooBean!com.acme.Foo`
  - `java:app/fooweb/FooBean`
  - `java:app/fooweb/FooBean!com.acme.Foo`
  - `java:module/FooBean`
  - `java:module/FooBean!com.acme.Foo`

Calendar-based Timer Service

- Annotation `@Schedule` with attributes:
  - `year, month, dayOfMonth, dayOfWeek`
  - `hour, minute, second`
  - `timezone`

```
@Singleton
public class ServiceBean {
  @Schedule(dayOfWeek = "Sun", hour =  "2", minute =  "30")
  public void cleanDatabase() {...}
}
```

- Calls are synchronous by default.
- Methods can be invoked also asynchronously.
- Return value is a `Future<V>` object of the `java.util.concurrent`

```
@Stateless
public class MathSessionBean {
    @Asynchronous
    public Future<Integer> compute(Integer x, Integer y) {
        Integer z = ...
        return new AsyncResult(z);
    }
}

Future<Integer> r = mathBean.compute(20, 11);
while (!r.isDone()) { ... }
Integer i = r.get();
```

- **Container-managed (default)**
  - Container maintains persistence transparently using JDBC calls.

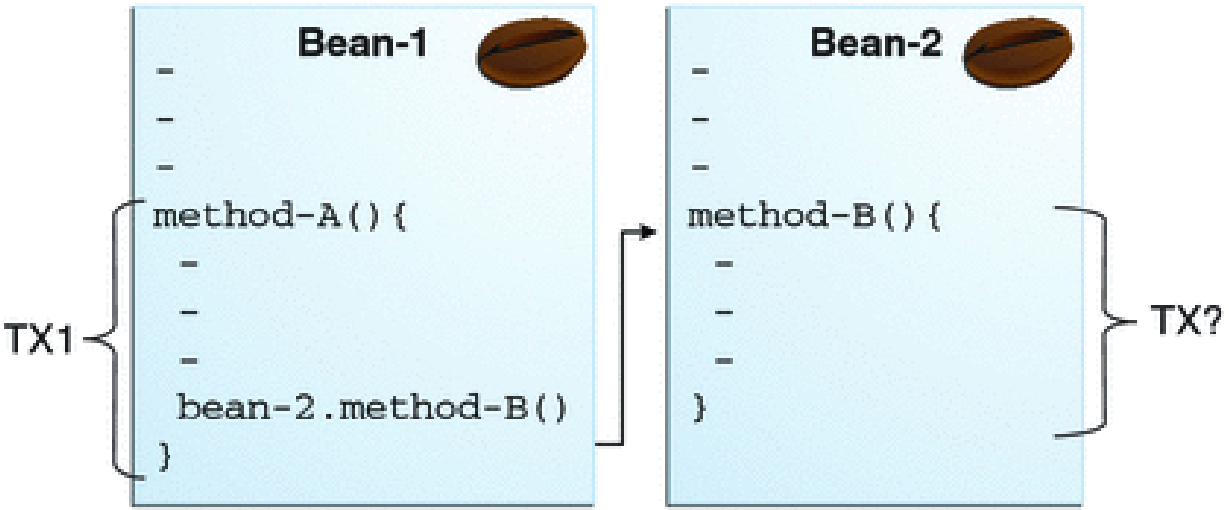
```
@TransactionAttribute(
  TransactionAttributeType.REQUIRED)
  public void foo() {...}
```

    - `REQUIRED` – if the transaction is running, it will be used, else it will be created.
    - `REQUIRES_NEW` – new transaction required.
    - `MANDATORY` – transaction must be already running.
    - `NOT_SUPPORTED` – out of transaction.
    - `SUPPORTS` – can be inserted into transaction, but will not be created.
    - `NEVER` – can not be inserted into transaction.
  - Rollback
    - Exception is thrown.
    - Transaction is marked for rollback and can never commit.

```
@Resource SessionContext scx;
...
scx.setRollbackOnly();
```

    - Test if the transaction has been marked for rollback only: `getRollbackOnly()`

- **Bean-managed**
  - Programmer provides persistence logic.
  - Used to connect to non-JDBC data sources like LDAP, mainframe, etc.



- Bean-managed

```
@TransactionManagement(TransactionManagementType.BEAN)
class MyBean { ...

    @Resource
    UserTransaction userTransaction;

    ...
    userTransaction.begin();
    ...
    ...
    userTransaction.commit();
    userTransaction.rollback();
    ...
}
```

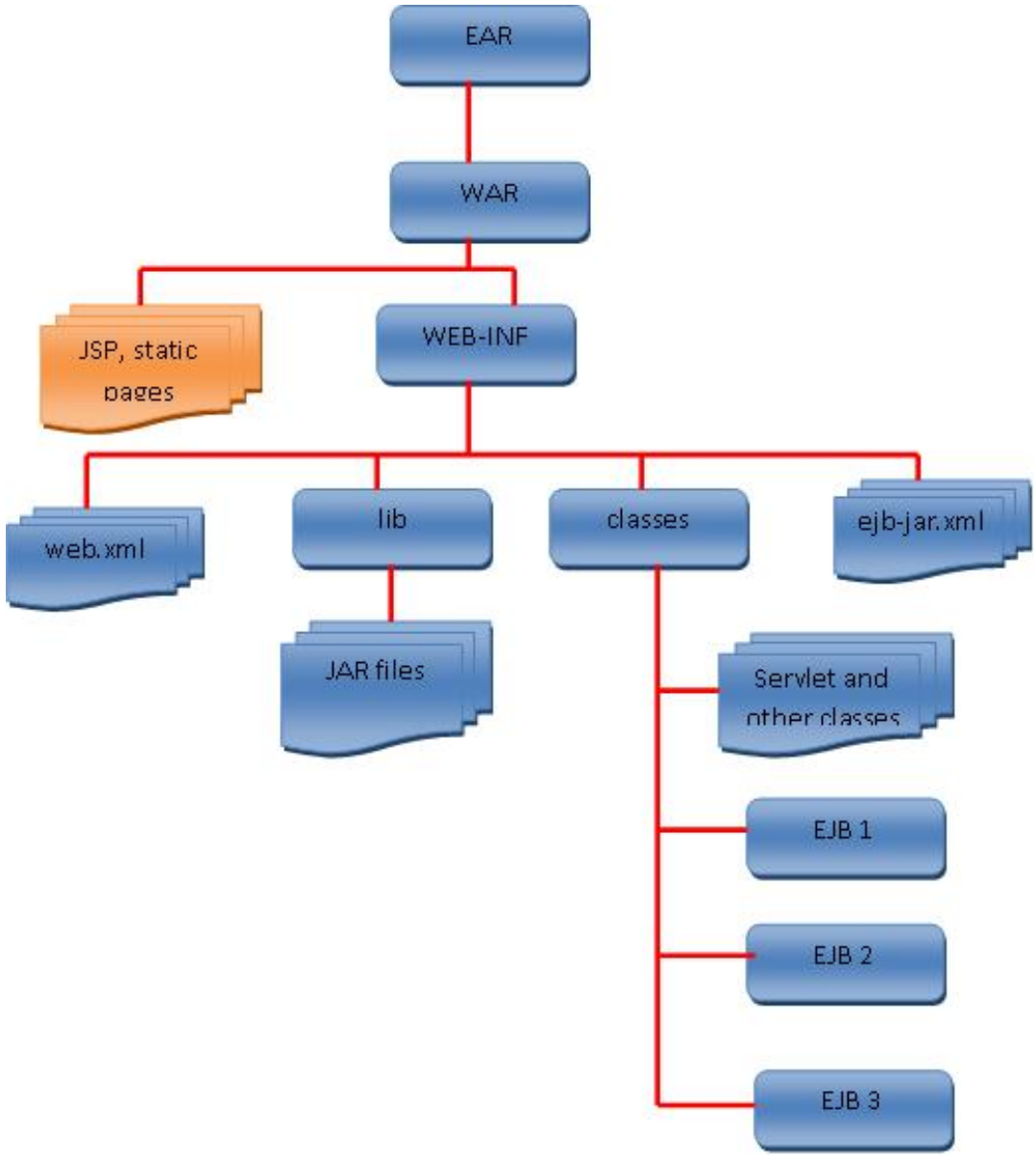
- EJB Lite is a subset of the full EJB.
- EJB Lite can be a part of .war file.
- A Java EE Web Profile certified container has to support the EJB Lite.
- A subset of EJB Full
  - no Message Driven Beans
  - no remote interfaces
  - no EJB timers and scheduling
  - no asynchronous invocation
  - no web services

- Client and EJB runs on the same JVM.
- Better support for testing.
- Batch processing.
- Usage of EJB programming model in desktop applications.

```
@Test
public void hello() throws Exception {
    EJBContainer ec = EJBContainer.createEJBContainer();
    Context c = ec.getContext();
    HelloSessionBean hello = (HelloSessionBean)
       c.lookup( "java:global/classes/HelloSessionBean" );
    String s = hello.sayHello( "Eva" );
    assertEquals( "Hello, Eva", s );
}
```

Contents of EJB

- Enterprise bean class
- Business interfaces
- Other classes
- Deployment descriptor (optional)



- Deployment Descriptors are included in the JARs, along with component-related resources.
- Deployment Descriptors are XML documents that describe configuration and other deployment settings.
- The statements in the deployment descriptor are declarative instructions to the Java EE container (transactional settings, ...).
- The deployment descriptor for an EJB component must be named `ejb-jar.xml`, and it resides in the META-INF directory inside the EJB JAR files.
- It is also possible to configure it using annotations.

References

- JSR-299 (CDI)

  `http://docs.jboss.org/weld/reference/latest/en-US/html/`
- Java EE 6 Tutorial

  `https://docs.oracle.com/javaee/6/tutorial/doc/`
- Jakarta EE Tutorial
  - `https://eclipse-ee4j.github.io/jakartaee-tutorial/`
- Oracle® Containers for J2EE Enterprise JavaBeans Developer's Guide

  `https://docs.oracle.com/cd/E16439_01/doc.1013/e13981/toc.htm`
- Programming WebLogic Enterprise JavaBeans

  `https://docs.oracle.com/cd/E13222_01/wls/docs81/ejb/session.html`
- Simplify enterprise Java development with EJB 3.0, Part 1

  `https://www.javaworld.com/article/2072037/java-web-development-simplify-enterprise-java-development-with-ejb-3-0-part-1.html`

- Distributed Multitiered Applications – Tiers
  - `https://docs.oracle.com/javaee/6/tutorial/doc/bnaay.html`
- The Open Tutorials - Java EE

  `http://theopentutorials.com/content/tutorials/java-ee/`
- Stateful session beans (EJB 3)

  `http://vkpedia.com/sandbox/files/EJB%203%20in%20Action.pdf`
- Others
  - `https://access.redhat.com/solutions/158153`

JavaServer Faces

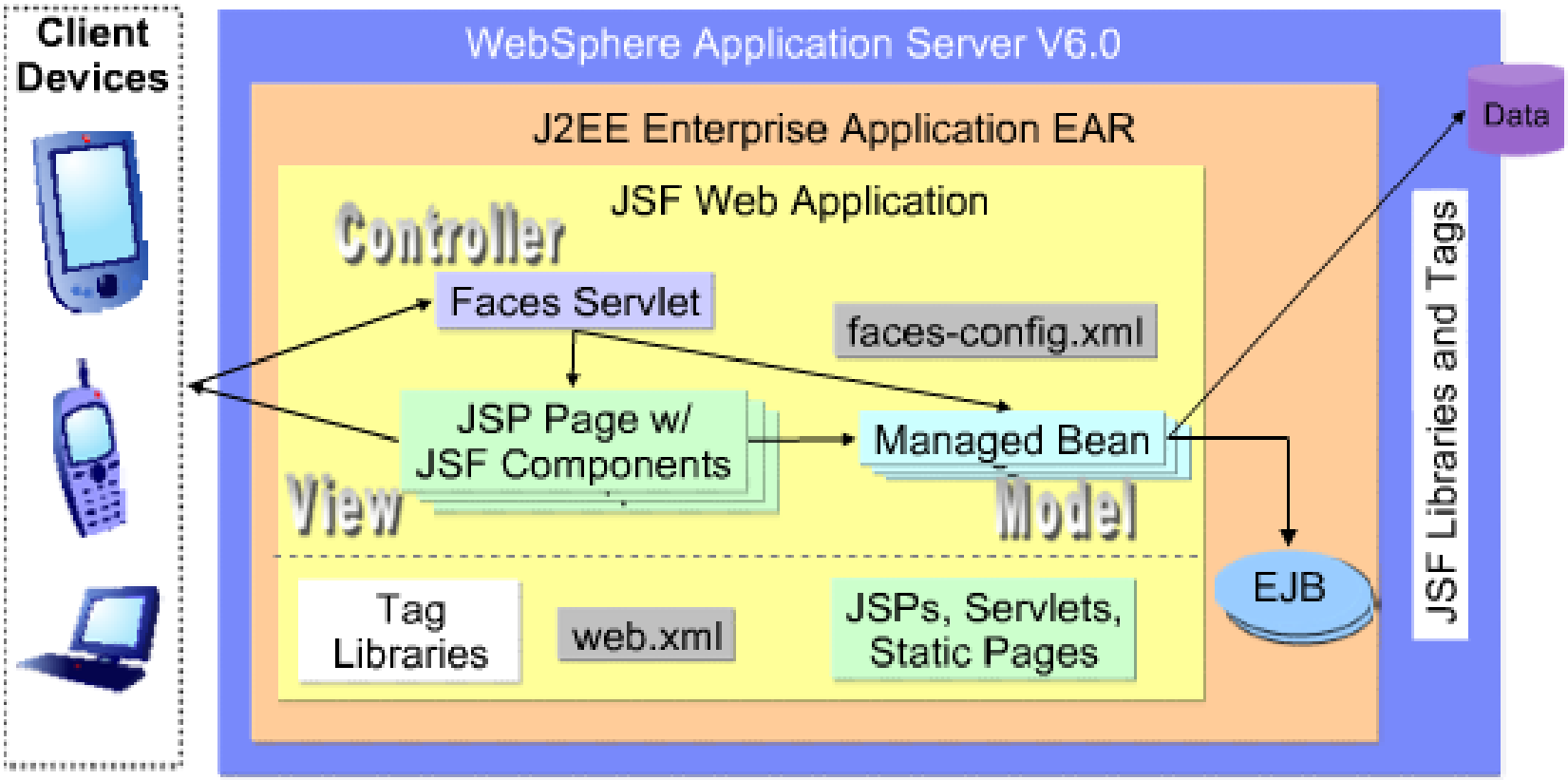
Contents

- JavaServer Faces (JSF)
  - application framework for creating Web-based user interfaces
  - component-based
  - provides standard set of components
  - transparently saves and restores component state
  - event handling, server side validation, data conversion
  - framework for implementing custom components
  - based on Model-View-Controller (MVC)
  - running in the standard web container (e.g. Tomcat or Jetty)

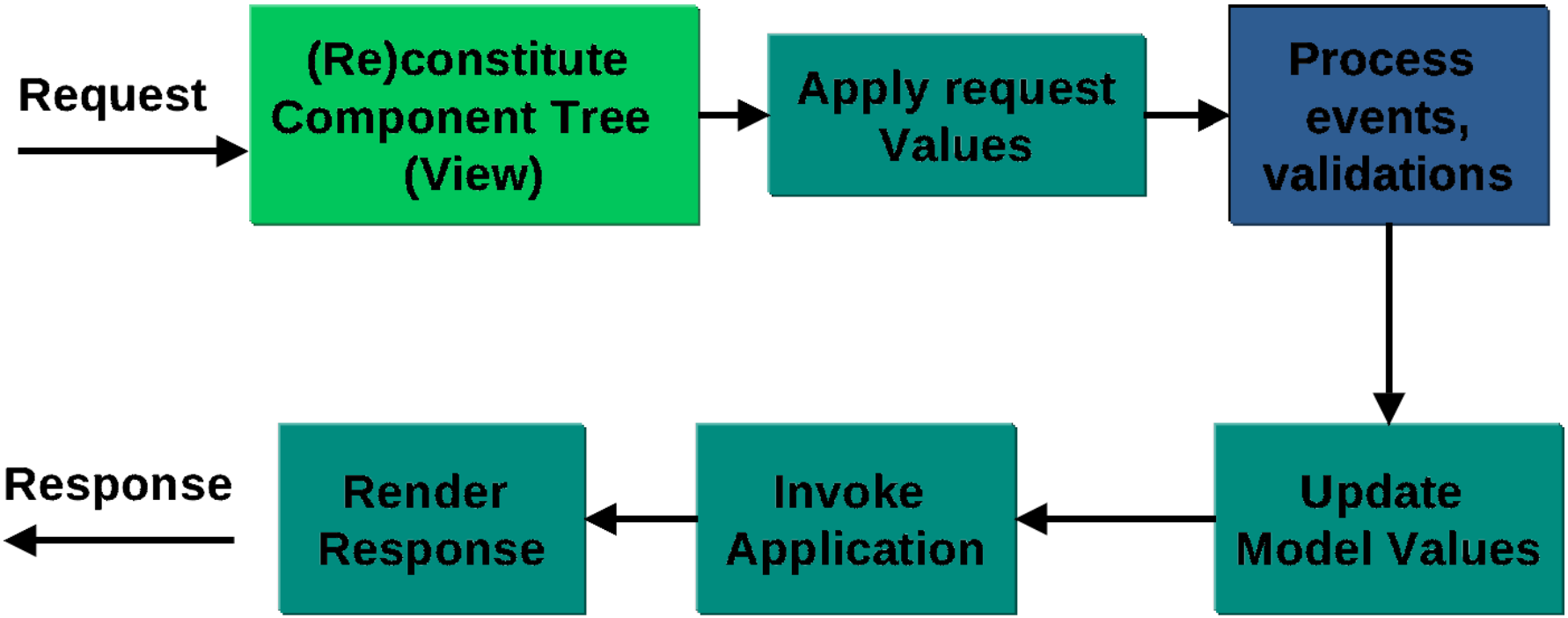
JSF application

- JSF tags in a Java Server Pages (JSP) files (`.jsp`) or in facelets (`.xhtml`)
  - defines the layout of JSF components
- Backing beans (`.java`)
  - JavaBeans components, defines properties and functions for UI components on a page
- Configuration resource files (`web.xml`, `faces-config.xml`)
  - navigation, configuration of backing beans, custom components, deployment descriptor
- Custom objects (`.java`)
  - Custom UI components, validators, converters, listeners
- Custom tag library definition (`.xml`)

JSF runtime: The big picture



- JSF manages components' state



- ID of the view is extracted from the request (name of the page).
- Component tree for the current view is created.
- Two possibilities
  - initial request
    - build a view of the page (ui components), event handlers, validators, . . .
  - postback
    - form was sent
    - restore view from state information (server or client)

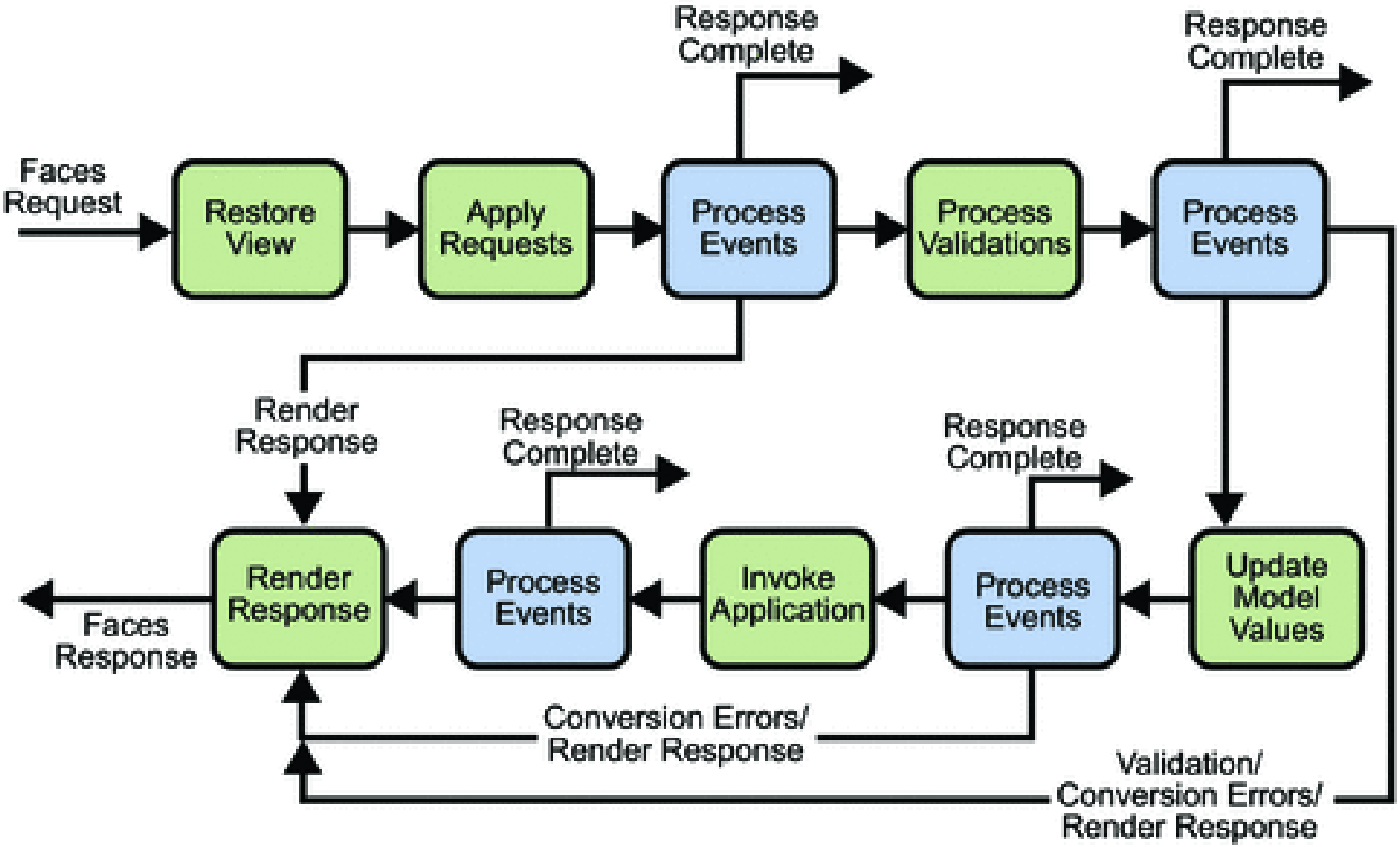
- Every component retrieves current state.
- Calls the decode method on component renderer
  - set component values, queue events, messages
  - values from request (headers, cookies, form data)
- If any decode methods / event listeners called `renderResponse` on the current `FacesContext` instance, the JSF moves to the render response phase.
- Values are converted from strings and set into instances of UI component classes.

- Queued events processed after Apply Request Phase.
- Processes all validators registered on the components in the tree
  - validators may `setValid(false)`
  - error message added to `FacesContext`
  - if any validation error, skip to Render Response phase
  - otherwise, continue to the Update Model Values Phase.
- If the local value is invalid, the JSF adds an error message to the `FacesContext` instance, and the life cycle advances to the Render Response phase and display the same page again with the error message.
  - `FacesContext` contains objects on the page.

- Updates values of the model (properties of the managed beans).
- Conversion errors may happen.
- If any `updateModels` methods or any listeners called `renderResponse` on the current `FacesContext` instance, the JSF moves to the Render Response phase.

- Handles any application-level events, such as submitting of a form or linking to another page.
- Application may define a next view
  - action event (form submission).
  - default `ActionListener` handles the "action" result and passes to `NavigationHandler`.
  - Value of `action` in `UICommand` is compared with the rules in the `faces-config.xml`.

- JSP or facelet container will render the page
  - JSF tag handlers will setup rendering of the components.
  - User can see the result.
- After the content of the view is rendered, the response state is saved so that subsequent requests can access it and it is available to the restore view phase.
  - Tags `<message/>` and `<messages/>` (for errors, etc.)


Response Complete
Response Complete
Faces Request
Restore View
Apply Requests
Process Events
Process Validations
Process Events
Render Response
Response Complete
Response Complete
Render Response
Process Events
Invoke Application
Process Events
Update Model Values
Faces Response
Conversion Errors/ Render Response
Validation/ Conversion Errors/ Render Response

JSF UI Components

- basic building blocks of a JSF application
- can represent simple to complex user interface components ranging from a button or input field to a complete page
- can be associated to Model data objects through Value Binding
  - usage of EL (`${...}` and `#{...}`)
- UI Components use helper objects: validators, converters, listeners/events

User Interface Component Classes

- JSF components have two parts
  - Component (Java Class)
  - Renderer (JQuery)
- Displaying of component
  - Direct implementation (component encodes/decodes itself)
  - Delegated implementation (encoding/decoding delegated to Renderer – used for extensions)
- `UIComponent`
  - form a tree, instance of `UIViewRoot` class is the root
  - hold state (interface `StateHolder`), registers listeners, ...
- UI Component classes
  - `UIViewRoot, UIForm`
  - `UIOutput, UIInput`
  - `UICommand`
  - `UISelectMany, UISelectOne, UISelectItem`
  - `UIData, UIColumn`
  - `UIPanel`

Example JSFTutorial

Component rendering

- Renderer
  - JSF tree to HTML (XUL, SVG, . . .)
- Renderkit
  - set of renderers with same output format
  - multiple renderers for one component
    - `UICommand` – `commandLink`, `commandButton`
    - `UISelectOne` – `selectOneListbox`, `selectOneMenu`, `selectOneRadio`
  - defined in tag library
- Component tags
  - `outputText`, `inputText`, `inputTextarea`, `inputHidden`, `inputSecret`, ...
- Component tag attributes
  - `id`: unique id of the component
  - `immediate`: events, validation, conversion should happen in the "apply request phase" – use this attribute to skip validation in case of Cancel button is clicked.
  - `rendered`: do not render if set to false
  - `value`: binds the value to some backing bean property
  - `binding`: binds the instance to some backing bean property (whole component!)
  - `style`
  - `styleClass`

Creating pages

- JSP pages with JSF tag library
- View is a tree of JSF components
- Editable components inside a “form” component

```
<%@ taglib uri="http://xmlns.jcp.org/jsf/html" prefix="h" %>
<%@ taglib uri="http://xmlns.jcp.org/jsf/core" prefix="f" %>
<f:view>
  <h:form id="signinForm">
    <h:inputText id="name" value="#SigninBean.name" required="true"/>
    <h:commandButton id="submit" action="#SigninBean.signin"
                     value="Submit" />
  </h:form>
</f:view>
```

- Usually one managed bean per page.
- Backing beans defines properties and methods associated with UI components.
- Component value to bean property binding defined in JSF page using Unified Expression Language (EL)

```
class SigninBean {
    private String name;
    public String getName() { return name; }
    public void setName(String name) { this.name = name; }
    public String signin() {
        ...
        if (ok) { return "success"; } else { return null; }
    }
}
```

- JSF Managed Beans works as Model for UI component,
- can be acessed from JSF page,
- contains getters, setters (like backing bean),
  - Backing bean contains all the HTML form values, managed not.
- registered through annotations
  - `@ManagedBean(name="helloWorld", eager=true)`
    - `eager=true` – created before requested, otherwise lazy
- Scopes

  `@RequestScoped, @NoneScoped, @ViewScoped, @SessionScoped, @ApplicationScoped, @CustomScoped`
  - `@NoneScoped` created on every single EL expression referencing the bean.
- `@ManagedProperty` annotation
  - Bean can be injected to another managed bean.

- From JSF 2.2 it is highly recommended to use CDI (Contexts and Dependency Injection).
- `@ManagedBean` is deprecated
  - `@Named` (`jakarta.inject.Named`) can be used instead
  - `eager = true` needs extension `https://www.javacodegeeks.com/2013/02/jsf-eager-cdi-beans.html`
- `javax.faces.bean.SessionScoped` is deprecated
  - `jakarta.enterprise.context.SessionScoped` can be used instead
  - similar for other scopes (e. g. `jakarta.enterprise.context.ApplicationScoped`)

Page navigation

- Page navigation is defined in `faces-config.xml` file
- can be defined in managed beans
- implicit navigation
- set of navigation rules
  - `from-view-id` (optional)
  - `navigation-case`
    - `from-outcome` – outcome as defined in JSF page or as returned by action method

```
<h:commandButton action="success" value="Submit" />
<h:commandButton action="#{SigninBean.signin}"
                 value="Submit" />
```

    - It is also possible to return page name directly, but it is not recommended.
    - Use `<redirect/>` to switch view and redirect (change URL) instead of forward (internal forwarding – same URL).

```
<navigation-rule>
   <from-view-id>/index.jsp</from-view-id>
   <navigation-case>
       <from-outcome>success</from-outcome>
       <to-view-id>/home.jsp</to-view-id>
   </navigation-case>
</navigation-rule>
```

Example JSFPageNavigation

Conversion

- Value of a component can be bound (not same as binding) to a backing bean property.
- Conversion to some types is automatic
  - e.g. `UISelectBoolean` to `boolean` or `java.lang.Boolean`
- Converter Classes
  - `BigDecimalConverter, IntegerConverter, DoubleConverter, ...`
  - `<h:inputText value="#{bean.foo}" converter="jakarta.faces.convert.IntegerConverter" />`
- `DateTimeConverter`

```
<h:outputText value="#{bean.someDate}">
    <f:convertDateTime style="full" />
</h:outputText>
```

  - style full, short, medium, long
  - pattern „MM dd yyyy“
- Can be created also for custom objects.

- Custom converters
  - interface `Converter`

    ```
    Object getAsObject(FacesContext, UIComponent, String)
    String getAsString(FacesContext, UIComponent, Object)
    ```

  - `f:converter`
    - registered converter

      ```
      <h:inputText>
          <f:converter converterId="MyConverter" />
      </h:inputText>
      ```

    - binding attribute
  - Converter registration in faces config

    ```
    <converter>
        <converter-for-class>com.example.MyClass
        </converter-for-class>
        <converter-class>com.example.MyConverter
        </converter-class>
    </converter>
    ```

- Validates components data, produces an error message.
- Standard validators
  - `validateDoubleRange, validateLength, validateLongRange`
  - ```
    <h:inputSecret id="password">
        <f:validateLength minimum="8"/>
    </h:inputSecret>
    <h:message for="password"/>
    ```
- Custom validation
  - `<h:inputText validator="#{bean.validateFoo}"/>`
  - ```
    public void validateFoo(FacesContext context,UIComponent
     toValidate, Object value) {
        ...
        ((UIInput)toValidate).setValid(false);
    }
    ```
  - or implement a `Validator` interface (method `validate()` throws `ValidatorException`) and register a validator in faces-config ...
    - `<f:validator validatorId="MyValidator"/>`

Event and Listener

- Action events
  - clicking on buttons or links
  - ```
    <h:commandLink action="something">
      <f:actionListener binding="fooBean.bar"/>
    </h:actionLink>
    ```
    - `public void bar(ActionEvent event);`
  - `<f:setPropertyActionListener target="#{user.username}" value="some"/>`
    - sets target property of backing bean (e.g. on click)
- Value change event
  - user changes the value of a `UIInput` component
  - `f:valueChangeListener` tag
    - `type` – name of the class that implements `ValueChangeListener` interface
    - `binding` – EL expression which evaluates to bean instance of class implementing `ValueChangeListener`
- Data model event (interface `DataModelListener`)
  - new row of a `UIData` is selected

Examples JSFActionListener, JSFActionListenerCDI and JSFEventListeners
    ```

Using UIData

- `h:dataTable`
  - `value` - EL expression which evaluates to:
    - list/array of beans, `jakarta.faces.model.DataModel`, `java.sql.ResultSet`, `javax.sql.RowSet`,...
  - `var` – name of the variable which iterates through the `DataModel`
  - `first, rows, ...`

```
<h:dataTable var="i" value="#{DataTableBean.items}">
  <h:column>
    <f:facet name="header"><h:outputText value="key"/></f:facet>
      <h:commandLink action="details" value="#{i.key}">
        <f:setPropertyActionListener
          target="#{ItemDetailBean.item}"
          value="#{i}"/>
      </h:commandLink>
  </h:column>
  <h:column>
    <f:facet name="header">
      <h:outputText value="value"/>
    </f:facet>
    <h:outputText value="#{i.value}"/>
  </h:column>
</h:dataTable>
```

Custom components

- `UIComponent`
  - subclass `UIComponentBase`
  - behavioral interfaces `StateHolder, ValueHolder, NamingContainer, EditableValueHolder, ActionSource`
  - component family
- Renderer
  - `encodeBegin` (before descendants)
  - `encodeEnd` (after descendants)
  - `decode` (state from request)
- Tag
  - abstract class `UIComponentELTag` (values from EL API)
  - `UIComponentBodyELTag` (processing of tag body)
  - `getComponentType, getRendererType`
  - sets the component properties based on attributes

Example JSFCustomComponent

- Using AJAX technique, JavaScript code exchanges data with server and updates parts of web page without reloading of the whole page (partial rendering).
- JSF Tag

```
<f:ajax execute="input-component-name"
        render="output-component-name" />
```

- Tag attributes
  - `disabled`
  - `event` (what events invokes AJAX – `blur, keypress, click, ...`)
  - `execute` (processed components – `@all`)
  - `immediate` (`True` – action attribute evaluated in apply request values / `False` – action attribute evaluated in invoke application phase)
  - `listener` – what should be called during AJAX request (on the server)
  - `oneerror` – name of JavaScript function, when error in AJAX occurs
  - `onevent` – JavaScript callback to handle UI event
  - `render` – what should be rendered

Example JSFAjax

- Apache MyFaces
  - Implementation of JSF with additional components
  - UI-Component Sets
    - Trinidad
    - Tobago
- ICEFaces (ICEsoft Technologies) and RichFaces (Red Hat)
  - AJAX components without writing JavaScript code
  - skinable
  - Menus, Trees, Calendar, File Upload, Drag and Drop, Google Maps, ...
  - Rich text editor
    - TinyMCE in RichFaces
    - CKEditor in ICEFaces
- PrimeFaces (PrimeTek Informatics)
- Others

Conclusion

- JavaServer Faces is a standard EE component based framework.
- JSF by default uses JSP for rendering, provides basic HTML-based components (facelets are replacing JSPs).
- Managed beans as backing beans for pages defines properties and methods.
- View state is stored between requests.
- Rich frameworks on top of JSF.

References

- JSF
  - http://www.tutorialspoint.com/jsf/
- API
  - http://docs.oracle.com/javaee/6/api/
  - https://jakarta.ee/specifications/platform/10/apidocs/
  - https://eclipse-ee4j.github.io/jakartaee-tutorial/
- Others
  - https://www.mkyong.com/jsf2/jsf-page-forward-vs-page-redirect/
  - https://jakarta.ee/xml/ns/jakartaee/#10

Appendix – parameter encoding

- GlassFish AS have deployment descriptor `glassfish-web.xml` (see documentation)
- For correct reading of the form values with diacritic, it is necessary to set:

```
<parameter-encoding default-charset="UTF-8"/>
```

Thank you for your attention!