

Seam - Contextual Components

A Framework for Java EE 5

Version: 1.0.CR3

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Introduction to JBoss Seam

Seam is an application framework for Java EE 5. It is inspired by the following principles:

Integrate JSF with EJB 3.0

JSF and EJB 3.0 are two of the best new features of Java EE 5. EJB3 is a brand new component model for server side business and persistence logic. Meanwhile, JSF is a great component model for the presentation tier. Unfortunately, neither component model is able to solve all problems in computing by itself. Indeed, JSF and EJB3 work best used together. But the Java EE 5 specification provides no standard way to integrate the two component models. Fortunately, the creators of both models foresaw this situation and provided standard extension points to allow extension and integration of other solutions.

Seam unifies the component models of JSF and EJB3, eliminating glue code, and letting the developer think about the business problem.

One Kind of "Stuff"

Seam provides a uniform component model. A Seam component may be stateful, with the state associated to any one of a number of contexts, ranging from the long-running business process to a single web request.

There is no distinction between presentation tier components and business logic components in Seam. It is possible to write Seam applications where "everything" is an EJB. This may come as a surprise if you are used to thinking of EJBs as coarse-grained, heavyweight objects that are a pain in the backside to create! However, EJB 3.0 completely changes the nature of EJB from the point of view of the developer. An EJB is a fine-grained object - nothing more complex than an annotated JavaBean. Seam even encourages you to use session beans as JSF action listeners!

Unlike plain Java EE or J2EE components, Seam components may *simultaneously* access state associated with the web request and state held in transactional resources (without the need to propagate web request state manually via method parameters). You might object that the application layering imposed upon you by the old J2EE platform was a Good Thing. Well, nothing stops you creating an equivalent layered architecture using Seam - the difference is that *you* get to architect your own application and decide what the layers are and how they work together.

Declarative State Management

We are all used to the concept of declarative transaction management and J2EE declarative security from EJB 2.x. EJB 3.0 even introduces declarative persistence context management. These are three examples of a broader problem of managing state that is associated with a particular *context*, while ensuring that all needed cleanup occurs when the context ends. Seam takes the concept of declarative state management much further and applies it to *application state*. Traditionally, J2EE applications almost always implement state management manually, by getting and setting servlet session and request attributes. This approach to state management is the source of many bugs and memory leaks when applications fail to clean up session attributes, or when session data associated with different workflows collides in a multi-window application. Seam has the potential to almost entirely eliminate this class of bugs.

Declarative application state management is made possible by the richness of the *context model* defined by Seam. Seam extends the context model defined by the servlet spec—request, session, application—with two new contexts—conversation and business process—that are more meaningful from the point of view of the business logic.

Bijection

The notion of *Inversion of Control* or *dependency injection* exists in both JSF and EJB3, as well as in numerous so-called "lighweight containers". Most of these containers emphasize injection of components that

implement *stateless services*. Even when injection of stateful components is supported (such as in JSF), it is virtually useless for handling application state because the scope of the stateful component cannot be defined with sufficient flexibility.

Bijection differs from IoC in that it is *dynamic*, *contextual*, and *bidirectional*. You can think of it as a mechanism for aliasing contextual variables (names in the various contexts bound to the current thread) to attributes of the component. Bijection allows auto-assembly of stateful components by the container. It even allows a component to safely and easily manipulate the value of a context variable, just by assigning to an attribute of the component.

Workspace Management

Optionally, Seam applications may take advantage of *workspace management*, allowing users to freely switch between different conversations (workspaces) in a single browser window. Seam provides not only correct multi-window operation, but also multi-window-like operation in a single window!

Integrate Business Process as a First Class Construct

Optionally, Seam integrates transparent business process management via jBPM. You won't believe how easy it is to implement complex workflows using jBPM and Seam.

Seam even allows definition of presentation tier conversation flow by the same means.

JSF provides an incredibly rich event model for the presentation tier. Seam enhances this model by exposing jBPM's business process related events via exactly the same event handling mechanism, providing a uniform event model for Seam's uniform component model.

Annotated POJOs Everywhere

EJB 3.0 embraces annotations and "configuration by exception" as the easiest way to provide information to the container in a declarative form. Unfortunately, JSF is still heavily dependent on verbose XML configuration files. Seam extends the annotations provided by EJB 3.0 with a set of annotations for declarative state management and declarative context demarcation. This lets you eliminate the noisy JSF managed bean declarations and reduce the required XML to just that information which truly belongs in XML (the JSF navigation rules).

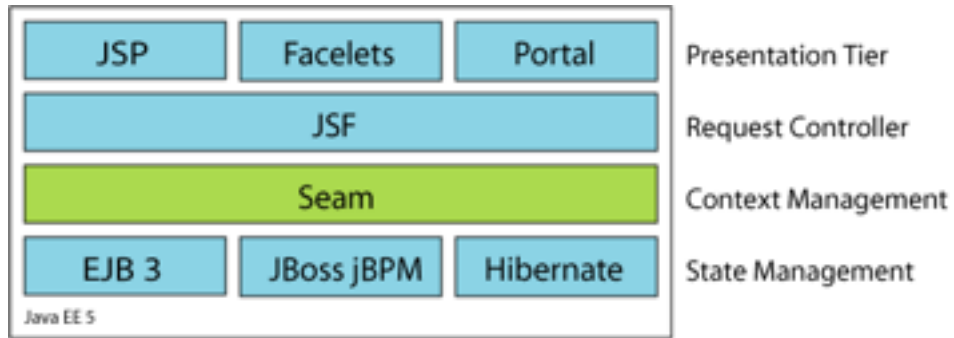
Testability as a Core Feature

Seam components, being POJOs, are by nature unit testable. But for complex applications, unit testing alone is insufficient. Integration testing has traditionally been a messy and difficult task for Java web applications. Therefore, Seam provides for testability of Seam applications as a core feature of the framework. You can easily write JUnit or TestNG tests that reproduce a whole interaction with a user, exercising all components of the system apart from the view (the JSP or Facelets page). You can run these tests directly inside your IDE, where Seam will automatically deploy EJB components into the JBoss Embeddable EJB3 container.

Get started now!

Seam works in any application server that supports EJB 3.0. You can even use Seam in a servlet container like Tomcat, or in any J2EE application server, by leveraging the new JBoss Embeddable EJB3 container.

However, we realize that not everyone is ready to make the switch to EJB 3.0. (After all, the Java EE 5 spec is not even final yet!) So, in the interim, you can use Seam as a framework for applications that use JSF for presentation, Hibernate (or plain JDBC) for persistence and JavaBeans for application logic. Then, when you're ready to make the switch to EJB 3.0, migration will be straightforward.



It turns out that the combination of Seam, JSF and EJB3 is *the* simplest way to write a complex web application in Java. You won't believe how little code is required!

Chapter 1. Seam Tutorial

1.1. Try the examples

In this tutorial, we'll assume that you have downloaded JBoss AS 4.0.4 and installed the EJB 3.0 profile (using the JBoss AS installer). You should also have a copy of Seam downloaded and extracted to a work directory.

The directory structure of each example in Seam follows this pattern:

- Web pages, images and stylesheets may be found in `examples/registration/view`
- Resources such as deployment descriptors and data import scripts may be found in `examples/registration/resources`
- Java source code may be found in `examples/registration/src`
- The Ant build script is `examples/registration/build.xml`

1.1.1. Running the examples on JBoss AS

First, make sure you have Ant correctly installed, with `$ANT_HOME` and `$JAVA_HOME` set correctly. Next, make sure you set the location of your JBoss AS 4.0.4 installation in the `build.properties` file in the root folder of your Seam installation. If you haven't already done so, start JBoss AS now by typing `bin/run.sh` or `bin/run.bat` in the root directory of your JBoss installation.

Now, build and deploy the example by typing `ant deploy` in the `examples/registration` directory.

Try it out by accessing `http://localhost:8080/seam-registration/` with your web browser.

1.1.2. Running the examples on Tomcat

First, make sure you have Ant correctly installed, with `$ANT_HOME` and `$JAVA_HOME` set correctly. Next, make sure you set the location of your Tomcat 5.5 installation in the `build.properties` file in the root folder of your Seam installation.

Now, build and deploy the example by typing `ant deploy.tomcat` in the `examples/registration` directory.

Finally, start Tomcat.

Try it out by accessing `http://localhost:8080/jboss-seam-registration/` with your web browser.

When you deploy the example to Tomcat, any EJB3 components will run inside the JBoss Embeddable EJB3 container, a complete standalone EJB3 container environment.

1.1.3. Running the example tests

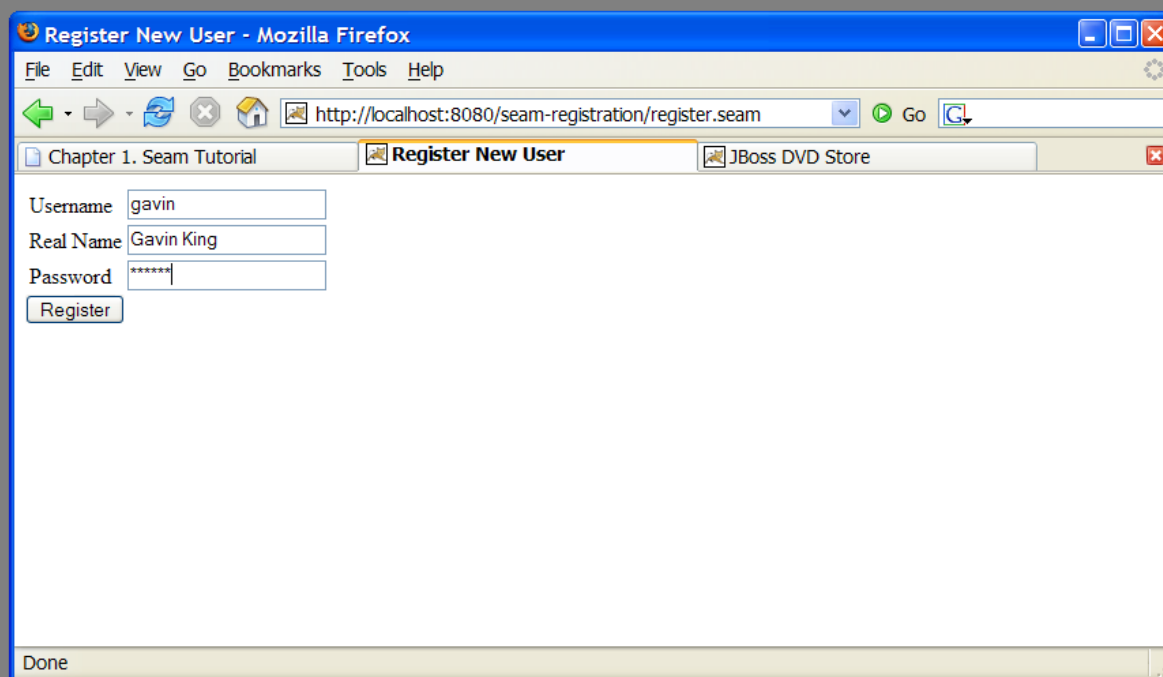
Most of the examples come with a suite of TestNG integration tests. The easiest way to run the tests is to run `ant testexample` inside the `examples/registration` directory. It is also possible to run the tests inside your IDE using the TestNG plugin.

1.2. Your first Seam application: the registration example

The registration example is a fairly trivial application that lets a new user store his username, real name and password in the database. The example isn't intended to show off all of the cool functionality of Seam. However, it demonstrates the use of an EJB3 session bean as a JSF action listener, and basic configuration of Seam.

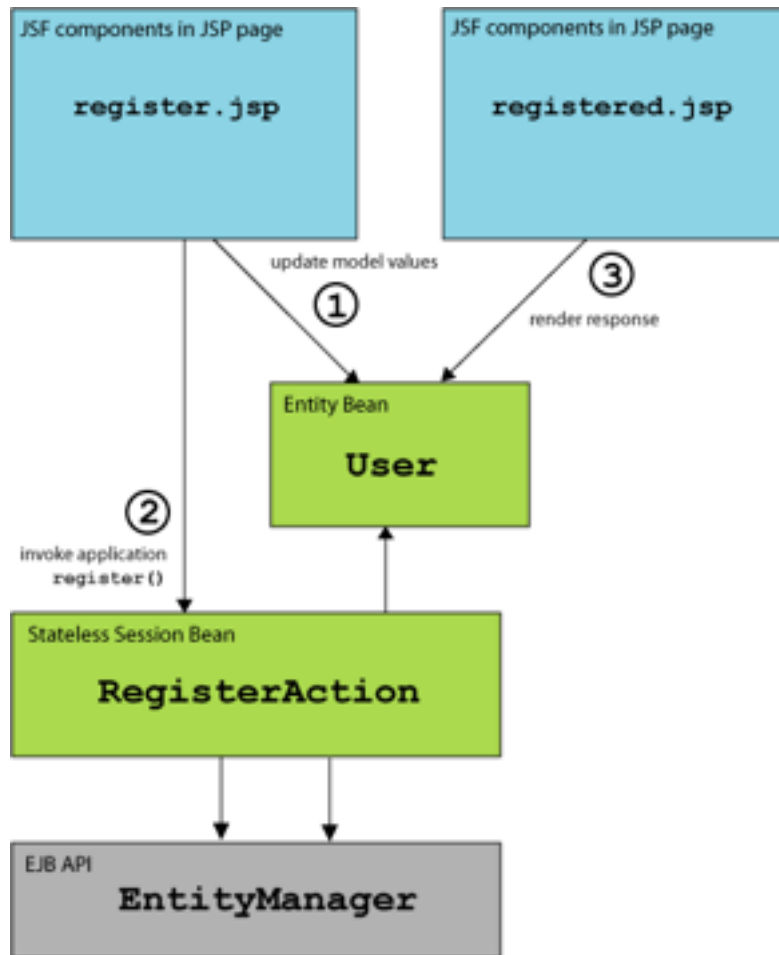
We'll go slowly, since we realize you might not yet be familiar with EJB 3.0.

The start page displays a very basic form with three input fields. Try filling them in and then submitting the form. This will save a user object in the database.

A screenshot of a Mozilla Firefox browser window titled "Register New User - Mozilla Firefox". The address bar shows the URL "http://localhost:8080/seam-registration/register.seam". The browser has three tabs: "Chapter 1. Seam Tutorial", "Register New User" (which is the active tab), and "JBoss DVD Store". The "Register New User" page contains a registration form with three input fields: "Username" with the value "gavin", "Real Name" with the value "Gavin King", and "Password" with the value "*****". Below the password field is a "Register" button. The browser's status bar at the bottom shows "Done".

1.2.1. Understanding the code

The example is implemented with two JSP pages, one entity bean and one stateless session bean.



Let's take a look at the code, starting from the "bottom".

1.2.1.1. The entity bean: User.java

We need an EJB entity bean for user data. This class defines *persistence* and *validation* declaratively, via annotations. It also needs some extra annotations that define the class as a Seam component.

Example 1.1.

```

@Entity (1)
@Name("user") (2)
@Scope(SESSION) (3)
@Table(name="users") (4)
public class User implements Serializable
{
    private static final long serialVersionUID = 1881413500711441951L;

    private String username; (5)
    private String password;
    private String name;

    public User(String name, String password, String username)
    {
        this.name = name;
        this.password = password;
        this.username = username;
    }

    public User() {} (6)

    @NotNull @Length(min=5, max=15) (7)
    public String getPassword()

```

```

    {
        return password;
    }

    public void setPassword(String password)
    {
        this.password = password;
    }

    @NotNull
    public String getName()
    {
        return name;
    }

    public void setName(String name)
    {
        this.name = name;
    }

    @Id @NotNull @Length(min=5, max=15)
    public String getUsername()
    {
        return username;
    }

    public void setUsername(String username)
    {
        this.username = username;
    }
}

```

- (1) The EJB3 standard `@Entity` annotation indicates that the `User` class is an entity bean.
- (2) A Seam component needs a *component name* specified by the `@Name` annotation. This name must be unique within the Seam application. When JSF asks Seam to resolve a context variable with a name that is the same as a Seam component name, and the context variable is currently undefined (null), Seam will instantiate that component, and bind the new instance to the context variable. In this case, Seam will instantiate a `User` the first time JSF encounters a variable named `user`.
- (3) Whenever Seam instantiates a component, it binds the new instance to a context variable in the component's *default context*. The default context is specified using the `@Scope` annotation. The `User` bean is a session scoped component.
- (4) The EJB standard `@Table` annotation indicates that the `User` class is mapped to the `users` table.
- (5) `name`, `password` and `username` are the persistent attributes of the entity bean. All of our persistent attributes define accessor methods. These are needed when this component is used by JSF in the render response and update model values phases.
- (6) An empty constructor is both required by both the EJB specification and by Seam.
- (7) The `@NotNull` and `@Length` annotations are part of the Hibernate Validator framework. Seam integrates Hibernate Validator and lets you use it for data validation (even if you are not using Hibernate for persistence).
- (8) The EJB standard `@Id` annotation indicates the primary key attribute of the entity bean.

The most important things to notice in this example are the `@Name` and `@Scope` annotations. These annotations establish that this class is a Seam component.

We'll see below that the properties of our `User` class are bound to directly to JSF components and are populated by JSF during the update model values phase. We don't need any tedious glue code to copy data back and forth between the JSP pages and the entity bean domain model.

However, entity beans shouldn't do transaction management or database access. So we can't use this component as a JSF action listener. For that we need a session bean.

1.2.1.2. The stateless session bean class: RegisterAction.java

Most Seam application use session beans as JSF action listeners (you can use JavaBeans instead if you like).

We have exactly one JSF action in our application, and one session bean method attached to it. In this case, we'll use a stateless session bean, since all the state associated with our action is held by the `User` bean.

This is the only really interesting code in the example!

Example 1.2.

```

@Stateless (1)
@Name("register")
public class RegisterAction implements Register
{
    @In @Valid (2)(3)
    private User user;

    @PersistenceContext (4)
    private EntityManager em;

    @IfInvalid(outcome=Outcome.REDISPLAY) (5)
    public String register() (6)
    {
        List existing = em.createQuery("select username from User where username=:username")
            .setParameter("username", user.getUsername())
            .getResultList();

        if (existing.size()==0)
        {
            em.persist(user);
            return "/registered.jsp"; (7)
        }
        else
        {
            FacesMessages.instance().add("User #{user.username} already exists"); (8)
            return null;
        }
    }
}

```

- (1) The EJB standard `@Stateless` annotation marks this class as stateless session bean.
- (2) The `@In` annotation marks an attribute of the bean as injected by Seam. In this case, the attribute is injected from a context variable named `user` (the instance variable name).
- (3) The `@Valid` annotation is provided by Hibernate Validator to specify that recursive validation of related objects should occur.
- (4) The EJB standard `@PersistenceContext` annotation is used to inject the EJB3 entity manager.
- (5) The `@IfInvalid` annotation tells Seam to validate the component state using Hibernate Validator before invoking the action listener method, and return a different JSF outcome if the state is invalid. In this example, the `user` is validated when the `register()` method is invoked, and the form is redisplayed with messages if a validation failure occurs.
- (6) The action listener method uses the standard EJB3 `EntityManager` API to interact with the database, and returns the JSF outcome. Note that, since this is a session bean, a transaction is automatically begun when the `register()` method is called, and committed when it completes.
- (7) JSF action listener methods return a string-valued outcome that determines what page will be displayed next. A null outcome (or a void action listener method) redisplayes the previous page. In plain JSF, it is normal to always use a JSF *navigation rule* to determine the JSF view id from the outcome. For complex

application this indirection is useful and a good practice. However, for very simple examples like this one, Seam lets you use the JSF view id as the outcome, eliminating the requirement for a navigation rule. *Note that when you use a view id as an outcome, Seam always performs a browser redirect.*

- (8) Seam provides a number of *built-in components* to help solve common problems. The `FacesMessages` component makes it easy to display templated error or success messages. Built-in Seam components may be obtained by injection, or by calling an `instance()` method.

Note that we did not explicitly specify a `@Scope` this time. Each Seam component type has a default scope if not explicitly specified. For stateless session beans, the default scope is the stateless context. Actually, *all* stateless session beans belong in the stateless context.

Our session bean action listener performs the business and persistence logic for our mini-application. In more complex applications, we might need to layer the code and refactor persistence logic into a dedicated data access component. That's perfectly trivial to do. But notice that Seam does not force you into any particular strategy for application layering.

Furthermore, notice that our session bean has simultaneous access to context associated with the web request (the form values in the `User` object, for example), and state held in transactional resources (the `EntityManager` object). This is a break from traditional J2EE architectures. Again, if you are more comfortable with the traditional J2EE layering, you can certainly implement that in a Seam application. But for many applications, it's simply not very useful.

1.2.1.3. The session bean local interface: `Register.java`

Naturally, our session bean needs a local interface.

Example 1.3.

```
@Local
public interface Register
{
    public String register();
}
```

That's the end of the Java code. Now onto the deployment descriptors.

1.2.1.4. The web deployment description: `web.xml`

The presentation layer for our mini-application will be deployed in a WAR. So we'll need a web deployment descriptor.

Example 1.4.

```
<?xml version="1.0" encoding="UTF-8"?>
<web-app version="2.4"
    xmlns="http://java.sun.com/xml/ns/j2ee"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://java.sun.com/xml/ns/j2ee
        http://java.sun.com/xml/ns/j2ee/web-app_2_4.xsd">

    <!-- Seam -->

    <listener>
```

```

    <listener-class>org.jboss.seam.servlet.SeamListener</listener-class>
</listener>

<!-- Global JNDI name pattern for JBoss EJB3 (change for other servers) -->
<context-param>
    <param-name>org.jboss.seam.core.init.jndiPattern</param-name>
    <param-value>jboss-seam-registration/#{ejbName}/local</param-value>
</context-param>

<!-- MyFaces -->

<listener>
    <listener-class>
        org.apache.myfaces.webapp.StartupServletContextListener
    </listener-class>
</listener>

<context-param>
    <param-name>javax.faces.STATE_SAVING_METHOD</param-name>
    <param-value>client</param-value>
</context-param>

<servlet>
    <servlet-name>Faces Servlet</servlet-name>
    <servlet-class>javax.faces.webapp.FacesServlet</servlet-class>
    <load-on-startup>1</load-on-startup>
</servlet>

<!-- Faces Servlet Mapping -->
<servlet-mapping>
    <servlet-name>Faces Servlet</servlet-name>
    <url-pattern>*.seam</url-pattern>
</servlet-mapping>

</web-app>

```

This `web.xml` file configures Seam and MyFaces. The configuration you see here is pretty much identical in all Seam applications.

1.2.1.5. The JSF configuration: `faces-config.xml`

All Seam applications use JSF views as the presentation layer. So we'll need `faces-config.xml`.

Example 1.5.

```

<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE faces-config
PUBLIC "-//Sun Microsystems, Inc.//DTD JavaServer Faces Config 1.0//EN"
    "http://java.sun.com/dtd/web-facesconfig_1_0.dtd">
<faces-config>

    <!-- A phase listener is needed by all Seam applications -->

    <lifecycle>
        <phase-listener>org.jboss.seam.jsf.SeamPhaseListener</phase-listener>
    </lifecycle>

</faces-config>

```

The `faces-config.xml` file integrates Seam into JSF. Note that we don't need any JSF managed bean declarations! The managed beans are the Seam components. In Seam applications, the `faces-config.xml` is used much less often than in plain JSF.

In fact, once you have all the basic descriptors set up, the *only* XML you need to write as you add new functionality to a Seam application is the navigation rules, and possibly jBPM process definitions. Seam takes the view that *process flow* and *configuration data* are the only things that truly belong in XML.

In this simple example, we don't even need a navigation rule, since we decided to embed the view id in our action code.

1.2.1.6. The EJB deployment descriptor: `ejb-jar.xml`

The `ejb-jar.xml` file integrates Seam with EJB3, by attaching the `SeamInterceptor` to all session beans in the archive.

```
<ejb-jar>
  <assembly-descriptor>
    <interceptor-binding>
      <ejb-name>*</ejb-name>
      <interceptor-class>org.jboss.seam.ejb.SeamInterceptor</interceptor-class>
    </interceptor-binding>
  </assembly-descriptor>
</ejb-jar>
```

1.2.1.7. The EJB persistence deployment descriptor: `persistence.xml`

The `persistence.xml` file tells the EJB persistence provider where to find the datasource, and contains some vendor-specific settings. In this case, enables automatic schema export at startup time.

```
<persistence>
  <persistence-unit name="userDatabase">
    <provider>org.hibernate.ejb.HibernatePersistence</provider>
    <jta-data-source>java:/DefaultDS</jta-data-source>
    <properties>
      <property name="hibernate.hbm2ddl.auto" value="create-drop"/>
    </properties>
  </persistence-unit>
</persistence>
```

1.2.1.8. The view: `register.jsp` and `registered.jsp`

The view pages for a Seam application could be implemented using any technology that supports JSF. In this example we use JSP, since it is familiar to most developers and since we have minimal requirements here anyway. (But if you take our advice, you'll use Facelets for your own applications.)

Example 1.6.

```
<%@ taglib uri="http://java.sun.com/jsf/html" prefix="h" %>
<%@ taglib uri="http://java.sun.com/jsf/core" prefix="f" %>
<html>
  <head>
    <title>Register New User</title>
  </head>
  <body>
    <f:view>
      <h:form>
        <table border="0">
          <tr>
            <td>Username</td>
            <td><h:inputText value="#{user.username}"/></td>
          </tr>
          <tr>
            <td>Real Name</td>
```



```

        <td><h:inputText value="#{user.name}"/></td>
    </tr>
    <tr>
        <td>Password</td>
        <td><h:inputSecret value="#{user.password}"/></td>
    </tr>
</table>
<h:messages/>
<h:commandButton type="submit" value="Register" action="#{register.register}"/>
</h:form>
</f:view>
</body>
</html>

```

Example 1.7.

```

<%@ taglib uri="http://java.sun.com/jsf/html" prefix="h" %>
<%@ taglib uri="http://java.sun.com/jsf/core" prefix="f" %>
<html>
<head>
    <title>Successfully Registered New User</title>
</head>
<body>
    <f:view>
        Welcome, <h:outputText value="#{user.name}"/>,
        you are successfully registered as <h:outputText value="#{user.username}"/>.
    </f:view>
</body>
</html>

```

These are boring old JSP pages using standard JSF components. There is nothing specific to Seam here.

1.2.1.9. The EAR deployment descriptor: application.xml

Finally, since our application is deployed as an EAR, we need a deployment descriptor there, too.

Example 1.8.

```

<application>
    <display-name>Seam</display-name>

    <module>
        <web>
            <web-uri>jboss-seam-registration.war</web-uri>
            <context-root>/seam-registration</context-root>
        </web>
    </module>
    <module>
        <ejb>jboss-seam-registration.jar</ejb>
    </module>
    <module>
        <java>jboss-seam.jar</java>
    </module>
</application>

```

This deployment descriptor links modules in the enterprise archive and binds the web application to the context root /seam-registration.

We've now seen *all* the files in the entire application!

1.2.2. How it works

When the form is submitted, JSF asks Seam to resolve the variable named `user`. Since there is no value already bound to that name (in any Seam context), Seam instantiates the `user` component, and returns the resulting `User` entity bean instance to JSF after storing it in the Seam session context. JSF binds the form input values to properties of the `User` entity bean.

Next, JSF asks Seam to resolve the variable named `register`. Seam finds the `RegisterAction` stateless session bean in the stateless context and returns it. JSF invokes the `register()` action listener method.

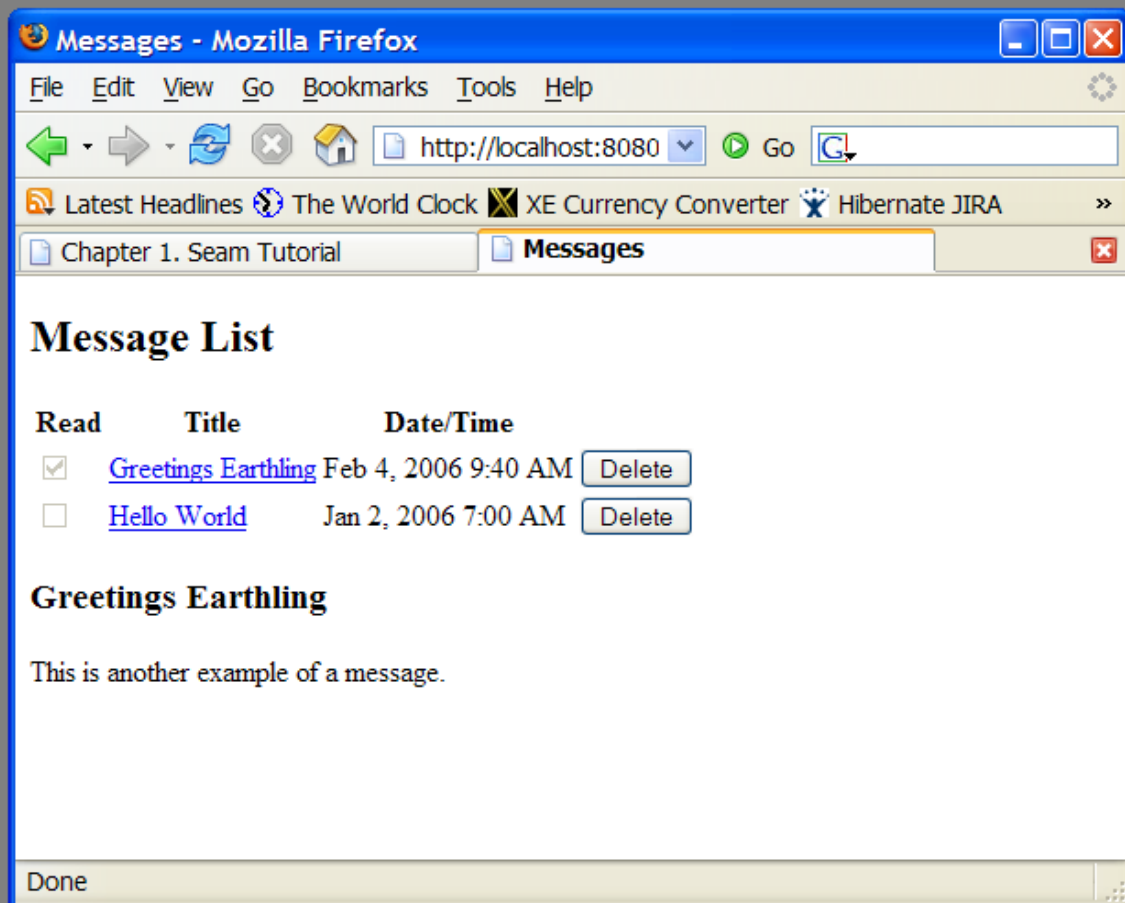
Seam intercepts the method call, injects the `User` entity from the session context, before asking Hibernate Validator to validate the session bean instance (and, recursively, the `User` entity bean instance). If the state is valid, the invocation proceeds and the `register()` method is called. If not, Seam returns a `null` outcome and JSF re-displays the page.

The `register()` method checks if a user with the entered username already exists. If so, an error message is queued with the `FacesMessages` component, and a `null` outcome is returned, causing a page redisplay. The `FacesMessages` component interpolates the JSF expression embedded in the message string and adds a JSF `FacesMessage` to the view.

If no user with that username exists, the `"/registered.jsp"` outcome triggers a browser redirect to the `registered.jsp` page. When JSF comes to render the page, it asks Seam to resolve the variable named `user` and uses property values of the returned `User` entity from Seam's session scope.

1.3. Clickable lists in Seam: the messages example

Clickable lists of database search results are such an important part of any online application that Seam provides special functionality on top of JSF to make it easier to query data using EJB-QL or HQL and display it as a clickable list using a JSF `<h:dataTable>`. The messages example demonstrates this functionality.



1.3.1. Understanding the code

The message list example has one entity bean, `Message`, one session bean, `MessageListBean` and one JSP.

1.3.1.1. The entity bean: `Message.java`

The `Message` entity defines the title, text, date and time of a message, and a flag indicating whether the message has been read:

Example 1.9.

```
@Entity
@Name("message")
@Scope(EVENT)
public class Message implements Serializable
{
    private Long id;
    private String title;
    private String text;
    private boolean read;
    private Date datetime;

    @Id @GeneratedValue
    public Long getId() {
        return id;
    }
}
```

```

    }
    public void setId(Long id) {
        this.id = id;
    }

    @NotNull @Length(max=100)
    public String getTitle() {
        return title;
    }
    public void setTitle(String title) {
        this.title = title;
    }

    @NotNull @Lob
    public String getText() {
        return text;
    }
    public void setText(String text) {
        this.text = text;
    }

    @NotNull
    public boolean isRead() {
        return read;
    }
    public void setRead(boolean read) {
        this.read = read;
    }

    @NotNull
    @Basic @Temporal(TemporalType.TIMESTAMP)
    public Date getDatetime() {
        return datetime;
    }
    public void setDatetime(Date datetime) {
        this.datetime = datetime;
    }
}

```

1.3.1.2. The stateful session bean: `MessageManagerBean.java`

Just like in the previous example, we have a session bean, `MessageManagerBean`, which defines the action listener methods for the two buttons on our form. One of the buttons selects a message from the list, and displays that message. The other button deletes a message. So far, this is not so different to the previous example.

But `MessageManagerBean` is also responsible for fetching the list of messages the first time we navigate to the message list page. There are various ways the user could navigate to the page, and not all of them are preceded by a JSF action—the user might have bookmarked the page, for example. So the job of fetching the message list takes place in a Seam *factory method*, instead of in an action listener method.

We want to cache the list of messages in memory between server requests, so we will make this a stateful session bean.

Example 1.10.

```

@Stateful
@Scope(SESSION)
@Name("messageManager")
public class MessageManagerBean implements Serializable, MessageManager
{

    @DataModel

```

(1)

```

private List<Message> messageList;

@DataModelSelection (2)
@Out(required=false) (3)
private Message message;

@PersistenceContext(type=EXTENDED) (4)
private EntityManager em;

@Factory("messageList") (5)
public void findMessages()
{
    messageList = em.createQuery("from Message msg order by msg.datetime desc").getResultList();
}

public void select() (6)
{
    message.setRead(true);
}

public void delete() (7)
{
    messageList.remove(message);
    em.remove(message);
    message=null;
}

@Remove @Destroy (8)
public void destroy() {}
}

```

- (1) The `@DataModel` annotation exposes an attribute of type `java.util.List` to the JSF page as an instance of `javax.faces.model.DataModel`. This allows us to use the list in a JSF `<h:dataTable>` with clickable links for each row. In this case, the `DataModel` is made available in a session context variable named `messageList`.
- (2) The `@DataModelSelection` annotation tells Seam to inject the `List` element that corresponded to the clicked link.
- (3) The `@Out` annotation then exposes the selected value directly to the page. So ever time a row of the clickable list is selected, the `Message` is injected to the attribute of the stateful bean, and the subsequently *outjected* to the event context variable named `message`.
- (4) This stateful bean has an EJB3 *extended persistence context*. The messages retrieved in the query remain in the managed state as long as the bean exists, so any subsequent method calls to the stateful bean can update them without needing to make any explicit call to the `EntityManager`.
- (5) The first time we navigate to the JSP page, there will be no value in the `messageList` context variable. The `@Factory` annotation tells Seam to create an instance of `MessageManagerBean` and invoke the `findMessages()` method to initialize the value. We call `findMessages()` a *factory method* for messages.
- (6) The `select()` action listener method marks the selected `Message` as read, and updates it in the database.
- (7) The `delete()` action listener method removes the selected `Message` from the database.
- (8) All stateful session bean Seam components *must* have a method marked `@Remove @Destroy` to ensure that Seam will remove the stateful bean when the Seam context ends, and clean up any server-side state.

Note that this is a session-scoped Seam component. It is associated with the user login session, and all requests from a login session share the same instance of the component. (In Seam applications, we usually use session-scoped components sparingly.)

1.3.1.3. The session bean local interface: `MessageManager.java`

All session beans have a business interface, of course.

```
@Local
public interface MessageManager
{
    public void findMessages();
    public void select();
    public void delete();
    public void destroy();
}
```

From now on, we won't show local interfaces in our code examples.

Let's skip over `persistence.xml`, `web.xml`, `ejb-jar.xml`, `faces-config.xml` and `application.xml` since they are much the same as the previous example, and go straight to the JSP.

1.3.1.4. The view: `messages.jsp`

The JSP page is a straightforward use of the JSF `<h:dataTable>` component. Again, nothing specific to Seam.

Example 1.11.

```
<%@ taglib uri="http://java.sun.com/jsf/html" prefix="h" %>
<%@ taglib uri="http://java.sun.com/jsf/core" prefix="f" %>
<html>
  <head>
    <title>Messages</title>
  </head>
  <body>
    <f:view>
      <h:form>
        <h2>Message List</h2>
        <h:outputText value="No messages to display" rendered="#{messageList.rowCount==0}" />
        <h:dataTable var="msg" value="#{messageList}" rendered="#{messageList.rowCount>0}">
          <h:column>
            <f:facet name="header">
              <h:outputText value="Read" />
            </f:facet>
            <h:selectBooleanCheckbox value="#{msg.read}" disabled="true" />
          </h:column>
          <h:column>
            <f:facet name="header">
              <h:outputText value="Title" />
            </f:facet>
            <h:commandLink value="#{msg.title}" action="#{messageManager.select}" />
          </h:column>
          <h:column>
            <f:facet name="header">
              <h:outputText value="Date/Time" />
            </f:facet>
            <h:outputText value="#{msg.datetetime}">
              <f:convertDateTime type="both" dateStyle="medium" timeStyle="short" />
            </h:outputText>
          </h:column>
          <h:column>
            <h:commandButton value="Delete" action="#{messageManager.delete}" />
          </h:column>
        </h:dataTable>
        <h3><h:outputText value="#{message.title}" /></h3>
        <div><h:outputText value="#{message.text}" /></div>
      </h:form>
    </f:view>
  </body>
</html>
```

1.3.2. How it works

The first time we navigate to the `messages.jsp` page, whether by a JSF postback (faces request) or a direct browser GET request (non-faces request), the page will try to resolve the `messageList` context variable. Since this context variable is not initialized, Seam will call the factory method `findMessages()`, which performs a query against the database and results in a `DataModel` being outjected. This `DataModel` provides the row data needed for rendering the `<h:dataTable>`.

When the user clicks the `<h:commandLink>`, JSF calls the `select()` action listener. Seam intercepts this call and injects the selected row data into the `message` attribute of the `messageManager` component. The action listener fires, marking the selected `Message` as read. At the end of the call, Seam outjects the selected `Message` to the context variable named `message`. Next, the EJB container commits the transaction, and the change to the `Message` is flushed to the database. Finally, the page is re-rendered, redisplaying the message list, and displaying the selected message below it.

If the user clicks the `<h:commandButton>`, JSF calls the `delete()` action listener. Seam intercepts this call and injects the selected row data into the `message` attribute of the `messageList` component. The action listener fires, removing the selected `Message` from the list, and also calling `remove()` on the `EntityManager`. At the end of the call, Seam refreshes the `messages` context variable and clears the context variable named `message`. The EJB container commits the transaction, and deletes the `Message` from the database. Finally, the page is re-rendered, redisplaying the message list.

1.4. Seam and jBPM: the todo list example

jBPM provides sophisticated functionality for workflow and task management. To get a small taste of how jBPM integrates with Seam, we'll show you a simple "todo list" application. Since managing lists of tasks is such core functionality for jBPM, there is hardly any Java code at all in this example.

Description	Created	Priority	Due Date	
Book flight to Isreal	Jan 13, 2006	4		Done
Get the stupid Seam release finished!	Jan 13, 2006	5	1/17/06	Done
Haircut	Jan 13, 2006	3		Done
Review Hibernate in Action second edition	Jan 13, 2006	2		Done
Kick Roy out of my office	Jan 13, 2006	5		Done
Blog about workspace management	Jan 13, 2006	3		Done

Update Items

Create New Item

1.4.1. Understanding the code

The center of this example is the jBPM process definition. There are also two JSPs and two trivial JavaBeans (There was no reason to use session beans, since they do not access the database, or have any other transactional behavior). Let's start with the process definition:

Example 1.12.

```
<process-definition name="todo">

  <start-state name="start">                                (1)
    <transition to="todo"/>
  </start-state>

  <task-node name="todo">                                   (2)
    <task name="todo" description="#{todoList.description}"> (3)
      <assignment actor-id="#{actor.id}" />                 (4)
    </task>
    <transition to="done"/>
  </task-node>

  <end-state name="done" />                                (5)

</process-definition>
```

- (1) The `<start-state>` node represents the logical start of the process. When the process starts, it immediately transitions to the `todo` node.
- (2) The `<task-node>` node represents a *wait state*, where business process execution pauses, waiting for one or more tasks to be performed.
- (3) The `<task>` element defines a task to be performed by a user. Since there is only one task defined on this node, when it is complete, execution resumes, and we transition to the end state. The task gets its description from a Seam component named `todoList` (one of the JavaBeans).
- (4) Tasks need to be assigned to a user or group of users when they are created. In this case, the task is assigned to the current user, which we get from a built-in Seam component named `actor`. Any Seam component may be used to perform task assignment.
- (5) The `<end-state>` node defines the logical end of the business process. When execution reaches this node, the process instance is destroyed.

If we view this process definition using the process definition editor provided by JBossIDE, this is what it looks like:



This document defines our *business process* as a graph of nodes. This is the most trivial possible business process: there is one *task* to be performed, and when that task is complete, the business process ends.

The first JavaBean handles the login screen `login.jsp`. Its job is just to initialize the jBPM actor id using the `actor` component. (In a real application, it would also need to authenticate the user.)

Example 1.13.

```
@Name("login")
public class Login {

    @In(create=true)
    private Actor actor;

    private String user;

    public String getUser() {
        return user;
    }

    public void setUser(String user) {
        this.user = user;
    }

    public String login()
    {
        actor.setId(user);
        return "/todo.jsp";
    }
}
```

Here we see the use of `@In(create=true)`, which tells Seam to create an instance of a component, in this case the component named `actor`, if none currently exists in the context.

The JSP itself is trivial:

Example 1.14.

```
<%@ taglib uri="http://java.sun.com/jsf/html" prefix="h"%>
<%@ taglib uri="http://java.sun.com/jsf/core" prefix="f"%>
<html>
<head>
<title>Login</title>
</head>
<body>
<h1>Login</h1>
<f:view>
  <h:form>
    <div>
      <h:inputText value="#{login.user}" />
      <h:commandButton value="Login" action="#{login.login}" />
    </div>
  </h:form>
</f:view>
</body>
</html>
```

The second JavaBean is responsible for starting business process instances, and ending tasks.

Example 1.15.

```
@Name("todoList")
public class TodoList {

    private String description;

    public String getDescription() (1)
    {
        return description;
    }

    public void setDescription(String description) {
        this.description = description;
    }

    @CreateProcess(definition="todo") (2)
    public void createTodo() {}

    @StartTask @EndTask (3)
    public void done() {}

}
```

- (1) The description property accepts user input from the JSP page, and exposes it to the process definition, allowing the task description to be set.
- (2) The Seam `@CreateProcess` annotation creates a new jBPM process instance for the named process definition.
- (3) The Seam `@StartTask` annotation starts work on a task. The `@EndTask` ends the task, and allows the business process execution to resume.

In a more realistic example, `@StartTask` and `@EndTask` would not appear on the same method, because there is usually work to be done using the application in order to complete the task.

Finally, the meat of the application is in `todo.jsp`:

Example 1.16.

```
<%@ taglib uri="http://java.sun.com/jsf/html" prefix="h"%>
<%@ taglib uri="http://java.sun.com/jsf/core" prefix="f"%>
<html>
<head>
<title>Todo List</title>
</head>
<body>
<h1>Todo List</h1>
<f:view>
  <h:form id="list">
    <div>
      <h:outputText value="There are no todo items." rendered="#{empty taskInstanceList}"/>
      <h:dataTable value="#{taskInstanceList}" var="task" rendered="#{not empty taskInstanceList}">
        <h:column>
          <f:facet name="header">
            <h:outputText value="Description"/>
          </f:facet>
          <h:inputText value="#{task.description}"/>
        </h:column>
        <h:column>
          <f:facet name="header">
            <h:outputText value="Created"/>
          </f:facet>
          <h:outputText value="#{task.taskMgmtInstance.processInstance.start}">
            <f:convertDateTime type="date"/>
          </h:outputText>
        </h:column>
        <h:column>
          <f:facet name="header">
            <h:outputText value="Priority"/>
          </f:facet>
          <h:inputText value="#{task.priority}" style="width: 30"/>
        </h:column>
        <h:column>
          <f:facet name="header">
            <h:outputText value="Due Date"/>
          </f:facet>
          <h:inputText value="#{task.dueDate}" style="width: 100">
            <f:convertDateTime type="date" dateStyle="short"/>
          </h:inputText>
        </h:column>
        <h:column>
          <h:commandLink action="#{todoList.done}">
            <h:commandButton value="Done"/>
            <f:param name="taskId" value="#{task.id}"/>
          </h:commandLink>
        </h:column>
      </h:dataTable>
    </div>
    <div>
      <h:messages/>
    </div>
    <div>
      <h:commandButton value="Update Items" action="update"/>
    </div>
  </h:form>
  <h:form id="new">
    <div>
      <h:inputText value="#{todoList.description}"/>
      <h:commandButton value="Create New Item" action="#{todoList.createTodo}"/>
    </div>
  </h:form>
</f:view>
</body>
```

```
</html>
```

Let's take this one piece at a time.

The page renders a list of tasks, which it gets from a built-in Seam component named `taskInstanceList`. The list is defined inside a JSF form.

```
<h:form id="list">
  <div>
    <h:outputText value="There are no todo items." rendered="#{empty taskInstanceList}"/>
    <h:dataTable value="#{taskInstanceList}" var="task" rendered="#{not empty taskInstanceList}">
      ...
    </h:dataTable>
  </div>
</h:form>
```

Each element of the list is an instance of the jBPM class `TaskInstance`. The following code simply displays the interesting properties of each task in the list. For the description, priority and due date, we use input controls, to allow the user to update these values.

```
<h:column>
  <f:facet name="header">
    <h:outputText value="Description"/>
  </f:facet>
  <h:inputText value="#{task.description}"/>
</h:column>
<h:column>
  <f:facet name="header">
    <h:outputText value="Created"/>
  </f:facet>
  <h:outputText value="#{task.taskMgmtInstance.processInstance.start}">
    <f:convertDateTime type="date"/>
  </h:outputText>
</h:column>
<h:column>
  <f:facet name="header">
    <h:outputText value="Priority"/>
  </f:facet>
  <h:inputText value="#{task.priority}" style="width: 30"/>
</h:column>
<h:column>
  <f:facet name="header">
    <h:outputText value="Due Date"/>
  </f:facet>
  <h:inputText value="#{task.dueDate}" style="width: 100">
    <f:convertDateTime type="date" dateStyle="short"/>
  </h:inputText>
</h:column>
```

This button ends the task by calling the action method annotated `@StartTask @EndTask`. It passes the task id to Seam as a request parameter.

```
<h:column>
  <h:commandLink action="#{todoList.done}">
    <h:commandButton value="Done"/>
    <f:param name="taskId" value="#{task.id}"/>
  </h:commandLink>
</h:column>
```

This button is used to update the properties of the tasks. When the form is submitted, Seam and jBPM will make any changes to the tasks persistent. There is no need for any action listener method.

```
<h:commandButton value="Update Items" action="update"/>
```

A second form on the page is used to create new items, by calling the action method annotated `@CreateProcess`.

```
<h:form id="new">
  <div>
    <h:inputText value="#{todoList.description}"/>
    <h:commandButton value="Create New Item" action="#{todoList.createTodo}"/>
  </div>
</h:form>
```

There are several other files needed for the example, but they are just standard jBPM and Seam configuration and not very interesting.

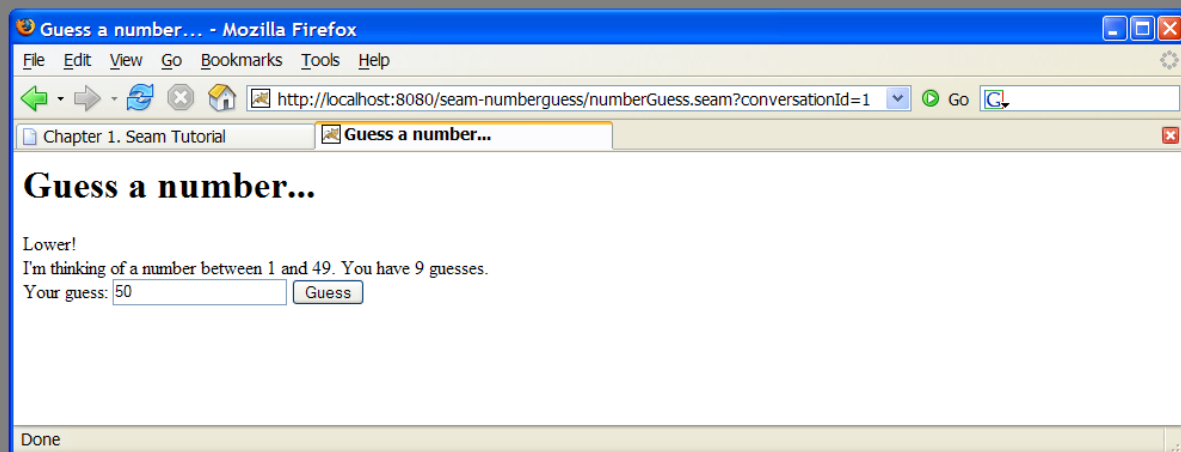
1.4.2. How it works

TODO

1.5. Seam pageflow: the numberguess example

For Seam applications with relatively freeform (ad hoc) navigation, JSF navigation rules are a perfectly good way to define the page flow. For applications with a more constrained style of navigation, especially for user interfaces which are more stateful, navigation rules make it difficult to really understand the flow of the system. To understand the flow, you need to piece it together from the view pages, the actions and the navigation rules.

Seam allows you to use a jPDL process definition to define pageflow. The simple number guessing example shows how this is done.



1.5.1. Understanding the code

The example is implemented using one JavaBean, three JSP pages and a jPDL pageflow definition. Let's begin with the pageflow:

Example 1.17.

```
<pageflow-definition name="numberGuess">
```

```
<start-page name="displayGuess" view-id="/numberGuess.jsp">
  <redirect/>
  <transition name="guess" to="evaluateGuess">
    <action expression="#{numberGuess.guess}" />
  </transition>
</start-page>

<decision name="evaluateGuess" expression="#{numberGuess.correctGuess}">
  <transition name="true" to="win"/>
  <transition name="false" to="evaluateRemainingGuesses"/>
</decision>

<decision name="evaluateRemainingGuesses" expression="#{numberGuess.lastGuess}">
  <transition name="true" to="lose"/>
  <transition name="false" to="displayGuess"/>
</decision>

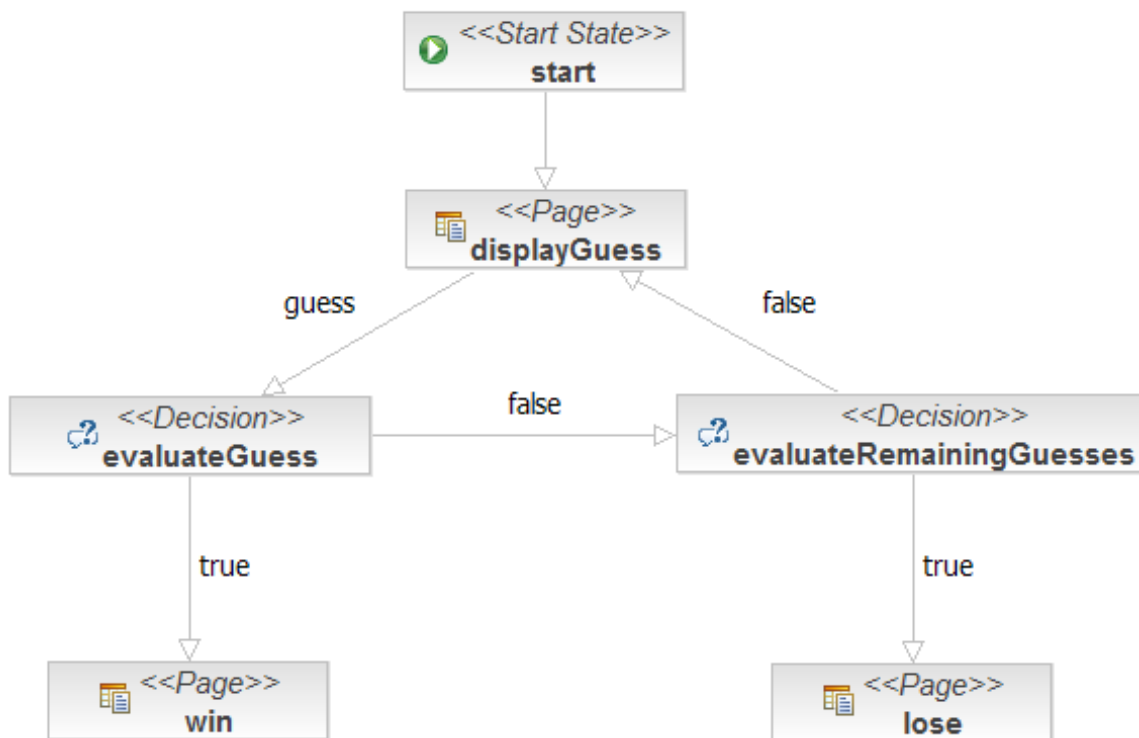
<page name="win" view-id="/win.jsp">
  <redirect/>
  <end-conversation />
</page>

<page name="lose" view-id="/lose.jsp">
  <redirect/>
  <end-conversation />
</page>

</pageflow-definition>
```

- (1) The `<page>` element defines a wait state where the system displays a particular JSF view and waits for user input. The `view-id` is the same JSF view id used in plain JSF navigation rules. The `redirect` attribute tells Seam to use post-then-redirect when navigating to the page. (This results in friendly browser URLs.)
- (2) The `<transition>` element names a JSF outcome. The transition is triggered when a JSF action results in that outcome. Execution will then proceed to the next node of the pageflow graph, after invocation of any jBPM transition actions.
- (3) A transition `<action>` is just like a JSF action, except that it occurs when a jBPM transition occurs. The transition action can invoke any Seam component.
- (4) A `<decision>` node branches the pageflow, and determines the next node to execute by evaluating a JSF EL expression.

Here is what the pageflow looks like in the JBossIDE pageflow editor:



Now that we have seen the pageflow, it is very, very easy to understand the rest of the application!

Here is the main page of the application, `numberGuess.jsp`:

Example 1.18.

```

<%@ taglib uri="http://java.sun.com/jsf/html" prefix="h"%>
<%@ taglib uri="http://java.sun.com/jsf/core" prefix="f"%>
<html>
<head>
<title>Guess a number...</title>
</head>
<body>
<h1>Guess a number...</h1>
<f:view>
  <h:form>
    <h:outputText value="Higher!" rendered="#{numberGuess.randomNumber>numberGuess.currentGuess}" />
    <h:outputText value="Lower!" rendered="#{numberGuess.randomNumber<numberGuess.currentGuess}" />
    <br />
    I'm thinking of a number between <h:outputText value="#{numberGuess.smallest}" /> and
    <h:outputText value="#{numberGuess.biggest}" />. You have
    <h:outputText value="#{numberGuess.remainingGuesses}" /> guesses.
    <br />
    Your guess:
    <h:inputText value="#{numberGuess.currentGuess}" id="guess" required="true">
      <f:validateLongRange
        maximum="#{numberGuess.biggest}"
        minimum="#{numberGuess.smallest}" />
    </h:inputText>
    <h:commandButton type="submit" value="Guess" action="guess" />
    <br />
    <h:message for="guess" style="color: red"/>
  </h:form>
</f:view>
</body>
</html>

```

Notice how the command button names the `guess` transition instead of calling an action directly.

The `win.jsp` page is predictable:

Example 1.19.

```
<%@ taglib uri="http://java.sun.com/jsf/html" prefix="h"%>
<%@ taglib uri="http://java.sun.com/jsf/core" prefix="f"%>
<html>
<head>
<title>You won!</title>
</head>
<body>
<h1>You won!</h1>
<f:view>
    Yes, the answer was <h:outputText value="#{numberGuess.currentGuess}" />.
    It took you <h:outputText value="#{numberGuess.guessCount}" /> guesses.
    Would you like to <a href="numberGuess.seam">play again</a>?
</f:view>
</body>
</html>
```

As is `lose.jsp` (which I can't be bothered copy/pasting). Finally, the JavaBean Seam component:

Example 1.20.

```
@Name("numberGuess")
@Scope(ScopeType.CONVERSATION)
public class NumberGuess {

    private int randomNumber;
    private Integer currentGuess;
    private int biggest;
    private int smallest;
    private int guessCount;
    private int maxGuesses;

    @Create (1)
    @Begin(pageflow="numberGuess") (2)
    public void begin()
    {
        randomNumber = new Random().nextInt(100);
        guessCount = 0;
        biggest = 100;
        smallest = 1;
    }

    public void setCurrentGuess(Integer guess)
    {
        this.currentGuess = guess;
    }

    public Integer getCurrentGuess()
    {
        return currentGuess;
    }

    public void guess()
    {
        if (currentGuess > randomNumber)
        {
            biggest = currentGuess - 1;
        }
        if (currentGuess < randomNumber)
```



```

        {
            smallest = currentGuess + 1;
        }
        guessCount++;
    }

    public boolean isCorrectGuess()
    {
        return currentGuess==randomNumber;
    }

    public int getBiggest()
    {
        return biggest;
    }

    public int getSmallest()
    {
        return smallest;
    }

    public int getGuessCount()
    {
        return guessCount;
    }

    public boolean isLastGuess()
    {
        return guessCount==maxGuesses;
    }

    public int getRemainingGuesses() {
        return maxGuesses-guessCount;
    }

    public void setMaxGuesses(int maxGuesses) {
        this.maxGuesses = maxGuesses;
    }

    public int getMaxGuesses() {
        return maxGuesses;
    }

    public int getRandomNumber() {
        return randomNumber;
    }
}

```

- (1) The first time a JSP page asks for a `numberGuess` component, Seam will create a new one for it, and the `@Create` method will be invoked, allowing the component to initialize itself.
- (2) The `@Begin` annotation starts a Seam *conversation* (much more about that later), and specifies the page-flow definition to use for the conversation's page flow.

As you can see, this Seam component is pure business logic! It doesn't need to know anything at all about the user interaction flow. This makes the component potentially more reusable.

1.5.2. How it works

TODO

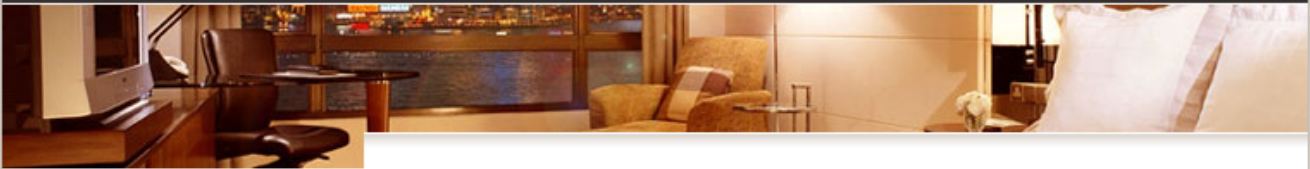
1.6. A complete Seam application: the Hotel Booking example

1.6.1. Introduction

The booking application is a complete hotel room reservation system incorporating the following features:

- User registration
- Login
- Logout
- Set password
- Hotel search
- Hotel selection
- Room reservation
- Reservation confirmation
- Existing reservation list

jboss suites
seam framework demo
Welcome Gavin King | Search | Settings | Logout



State management in Seam

State in Seam is *contextual*. When you click "Find Hotels", the application retrieves a list of hotels from the database and caches it in the session context. When you navigate to one of the hotel records by clicking the "View Hotel" link, a *conversation* begins. The conversation is attached to a particular tab, in a particular browser window. You can navigate to multiple hotels using "open in new tab" or "open in new window" in your web browser. Each window will execute in the context of a different conversation. The application keeps state associated with your hotel booking in the conversation context, which ensures that the concurrent conversations do not interfere with each other.

[How does the search page work?](#)

Thank you, Gavin King, your confirmation number for Doubletree is 1

Search Hotels

Maximum results:

Name	Address	City, State	Zip	Action
Marriott Courtyard	Tower Place, Buckhead	Atlanta, GA, USA	30305	View Hotel
Doubletree	Tower Place, Buckhead	Atlanta, GA, USA	30305	View Hotel
Ritz Carlton	Peachtree Rd, Buckhead	Atlanta, GA, USA	30326	View Hotel

Current Hotel Bookings

Name	Address	City, State	Check in date	Check out date	Confirmation number	Action
Doubletree	Tower Place, Buckhead	Atlanta, GA	Apr 16, 2006	Apr 17, 2006	1	Cancel

Created with JBoss EJB 3.0, Seam, MyFaces, and Facelets

The booking application uses JSF, EJB 3.0 and Seam, together with Facelets for the view. There is also a port of this application to JSF, Facelets, Seam, JavaBeans and Hibernate3.

One of the things you'll notice if you play with this application for long enough is that it is extremely *robust*. You can play with back buttons and browser refresh and opening multiple windows and entering nonsensical data as much as you like and you will find it very difficult to make the application crash. You might think that we spent weeks testing and fixing bugs to achieve this. Actually, this is not the case. Seam was designed to make it very straightforward to build robust web applications and a lot of robustness that you are probably used to having to code yourself comes naturally and automatically with Seam.

As you browse the sourcecode of the example application, and learn how the application works, observe how the declarative state management and integrated validation has been used to achieve this robustness.

1.6.2. Overview of the booking example

The project structure is identical to the previous one, to install and deploy this application, please refer to Section 1.1, “Try the examples”. Once you've successfully started the application, you can access it by pointing your browser to `http://localhost:8080/seam-booking/`

Just ten classes (plus six session beans local interfaces and 1 annotation interface) were used to implement this application. Six session bean action listeners contain all the business logic for the listed features.

- `BookingListAction` retrieves existing bookings for the currently logged in user.
- `ChangePasswordAction` updates the password of the currently logged in user.
- `HotelBookingAction` implements the core functionality of the application: hotel room searching, selection, booking and booking confirmation. This functionality is implemented as a *conversation*, so this is the most interesting class in the application.
- `LoginAction` validates the login details and retrieves the logged in user.
- `LogoutAction` ends the login session.
- `RegisterAction` registers a new system user.

Three entity beans implement the application's persistent domain model.

- `Hotel` is an entity bean that represent a hotel
- `Booking` is an entity bean that represents an existing booking
- `User` is an entity bean to represents a user who can make hotel bookings

Finally, the `LoggedIn` annotation and the `LoggedInInterceptor` are used to protect actions that require a logged in user.

1.6.3. Understanding Seam conversations

We encourage you browse the sourcecode at your pleasure. In this tutorial we'll concentrate upon one particular piece of functionality: hotel search, selection, booking and confirmation. From the point of view of the user, everything from selecting a hotel to confirming a booking is one continuous unit of work, a *conversation*. Searching, however, is *not* part of the conversation. The user can select multiple hotels from the same search results page, in different browser tabs.

Most web application architectures have no first class construct to represent a conversation. This causes enormous problems managing state associated with the conversation. Usually, Java web applications use a combination of two techniques: first, some state is thrown into the `HttpSession`; second, persistable state is flushed to the database after every request, and reconstructed from the database at the beginning of each new request.

Since the database is the least scalable tier, this often results in an utterly unacceptable lack of scalability. Added latency is also a problem, due to the extra traffic to and from the database on every request. To reduce this redundant traffic, Java applications often introduce a data (second-level) cache that keeps commonly accessed data between requests. This cache is necessarily inefficient, because invalidation is based upon an LRU policy instead of being based upon when the user has finished working with the data. Furthermore, because the cache is shared between many concurrent transactions, we've introduced a whole raft of problem's associated with

keeping the cached state consistent with the database.

Now consider the state held in the `HttpSession`. By very careful programming, we might be able to control the size of the session data. This is a lot more difficult than it sounds, since web browsers permit ad hoc non-linear navigation. But suppose we suddenly discover a system requirement that says that a user is allowed to have *multiple concurrent conversations*, halfway through the development of the system (this has happened to me). Developing mechanisms to isolate session state associated with different concurrent conversations, and incorporating failsafes to ensure that conversation state is destroyed when the user aborts one of the conversations by closing a browser window or tab is not for the faint hearted (I've implemented this stuff twice so far, once for a client application, once for Seam, but I'm famously psychotic).

Now there is a better way.

Seam introduces the *conversation context* as a first class construct. You can safely keep conversational state in this context, and be assured that it will have a well-defined lifecycle. Even better, you won't need to be continually pushing data back and forth between the application server and the database, since the conversation context is a natural cache of data that the user is currently working with.

Usually, the components we keep in the conversation context are stateful session beans. (We can also keep entity beans and JavaBeans in the conversation context.) There is an ancient canard in the Java community that stateful session beans are a scalability killer. This may have been true in 1998 when WebFoobar 1.0 was released. It is no longer true today. Application servers like JBoss 4.0 have extremely sophisticated mechanisms for stateful session bean state replication. (For example, the JBoss EJB3 container performs fine-grained replication, replicating only those bean attribute values which actually changed.) Note that all the traditional technical arguments for why stateful beans are inefficient apply equally to the `HttpSession`, so the practice of shifting state from business tier stateful session bean components to the web session to try and improve performance is unbelievably misguided. It is certainly possible to write unscalable applications using stateful session beans, by using stateful beans incorrectly, or by using them for the wrong thing. But that doesn't mean you should *never* use them. Anyway, Seam guides you toward a safe usage model. Welcome to 2005.

OK, I'll stop ranting now, and get back to the tutorial.

The booking example application shows how stateful components with different scopes can collaborate together to achieve complex behaviors. The main page of the booking application allows the user to search for hotels. The search results are kept in the Seam session scope. When the user navigates to one of these hotels, a conversation begins, and a conversation scoped component calls back to the session scoped component to retrieve the selected hotel.

The search functionality is implemented using a session-scope stateful session bean, similar to the one we saw in the message list example above.

Example 1.21.

```
@Stateful                                                    (1)
@Name("hotelSearch")
@Scope(ScopeType.SESSION)
@LoggedIn                                                    (2)
public class HotelSearchingAction implements HotelSearching
{
    @PersistenceContext
    private EntityManager em;

    private String searchString;
    private int pageSize = 10;
```

```

@DataModel (3)
private List<Hotel> hotels;
@DataModelSelection (4)
private Hotel selectedHotel;

public String find()
{
    String searchPattern = searchString==null ? "%" : '%' + searchString.toLowerCase().replace('*',
    hotels = em.createQuery("from Hotel where lower(name) like :search or lower(city) like :search
        .setParameter("search", searchPattern)
        .setMaxResults(pageSize)
        .getResultList();

    return "main";
}

public Hotel getSelectedHotel()
{
    return selectedHotel;
}

public int getPageSize() {
    return pageSize;
}

public void setPageSize(int pageSize) {
    this.pageSize = pageSize;
}

public String getSearchString()
{
    return searchString;
}

public void setSearchString(String searchString)
{
    this.searchString = searchString;
}

@Destroy @Remove (5)
public void destroy() {}
}

```

- (1) The EJB standard `@Stateful` annotation identifies this class as a stateful session bean. Stateful session beans are scoped to the conversation context by default.
- (2) The `@LoggedIn` annotation applies a custom Seam interceptor to the component. This works because `@LoggedIn` is marked with an `@Interceptor` meta-annotation.
- (3) The `@DataModel` annotation exposes a `List` as a JSF `ListDataModel`. This makes it easy to implement clickable lists for search screens. In this case, the list of hotels is exposed to the page as a `ListDataModel` in the conversation variable named `hotels`.
- (4) The `@DataModelSelection` annotation defines a field or setter as holding the selected row for the corresponding `@DataModel` property.
- (5) The EJB standard `@Remove` annotation specifies that a stateful session bean should be removed and its state destroyed after invocation of the annotated method. In Seam, all stateful session beans should define a method marked `@Destroy @Remove`. This is the EJB remove method that will be called when Seam destroys the session context. Actually, the `@Destroy` annotation is of more general usefulness, since it can be used for any kind of cleanup that should happen when any Seam context ends. If you don't have an `@Destroy @Remove` method, state will leak and you will suffer performance problems.

Now let's see how the booking example application uses a conversation-scoped stateful session bean to achieve a natural cache of persistent data related to the conversation. The following code example is pretty long. But if

you think of it as a list of scripted actions that implement the various steps of the conversation, it's understandable. Read the class from top to bottom, as if it were a story.

Example 1.22.

```

@Stateful
@Name("hotelBooking")
@Conversational(ifNotBegunOutcome="main") (1)
@LoggedIn
public class HotelBookingAction implements HotelBooking
{

    @PersistenceContext(type=EXTENDED) (2)
    private EntityManager em;

    @In(required=false) @Out (3)
    private Hotel hotel;

    @In(required=false)
    @Out(required=false)
    @Valid
    private Booking booking;

    @In
    private User user;

    @In(create=true)
    private transient FacesMessages facesMessages;

    @In(required=false)
    private BookingList bookingList;

    @In
    private HotelSearching hotelSearch;

    @Begin (4)
    public String selectHotel()
    {
        hotel = em.merge( hotelSearch.getSelectedHotel() );
        //hotel = em.find(Hotel.class, hotelId);
        return "hotel";
    }

    public String bookHotel()
    {
        booking = new Booking(hotel, user);
        Calendar calendar = Calendar.getInstance();
        booking.setCheckinDate( calendar.getTime() );
        calendar.add(Calendar.DAY_OF_MONTH, 1);
        booking.setCheckoutDate( calendar.getTime() );

        return "book";
    }

    @IfInvalid(outcome=REDISPLAY)
    public String setBookingDetails()
    {
        if (booking==null || hotel==null) return "main";
        if ( !booking.getCheckinDate().before( booking.getCheckoutDate() ) )
        {
            facesMessages.add("Check out date must be later than check in date");
            return null;
        }
        else
        {
            return "confirm";
        }
    }
}

```

```

@End
public String confirm()
{
    if (booking==null || hotel==null) return "main";
    em.persist(booking);
    if (bookingList!=null) bookingList.refresh();
    facesMessages.add("Thank you, #{user.name}, your confirmation number for #{hotel.name} is #{book:
    return "confirmed";
}

@End
public String cancel()
{
    return "main";
}

@Destroy @Remove
public void destroy() {}
}

```

- (1) The Seam `@Conversational` annotation declares this as a *conversational* component that cannot be invoked outside of a long-running conversation that was started by a call to its `@Begin` method. If such an invocation does occur, Seam returns the `ifNotBegunOutcome` to JSF.
- (2) This bean uses an EJB3 *extended persistence context*, so that any entity instances remain managed for the whole lifecycle of the stateful session bean.
- (3) The `@Out` annotation declares that an attribute value is *outjected* to a context variable after method invocations. In this case, the context variable named `hotel` will be set to the value of the `hotel` instance variable after every action listener invocation completes.
- (4) The `@Begin` annotation specifies that the annotated method begins a *long-running conversation*, so the current conversation context will not be destroyed at the end of the request. Instead, it will be reassociated with every request from the current window, and destroyed either by timeout due to conversation inactivity or invocation of a matching `@End` method.
- (5) The `@End` annotation specifies that the annotated method ends the current long-running conversation, so the current conversation context will be destroyed at the end of the request.
- (6) This EJB remove method will be called when Seam destroys the conversation context. Don't ever forget to define this method!

`HotelBookingAction` contains all the action listener methods that implement selection, booking and booking confirmation, and holds state related to this work in its instance variables. We think you'll agree that this code is much cleaner and simpler than getting and setting `HttpSession` attributes.

Even better, a user can have multiple isolated conversations per login session. Try it! Log in, run a search, and navigate to different hotel pages in multiple browser tabs. You'll be able to work on creating two different hotel reservations at the same time. If you leave any one conversation inactive for long enough, Seam will eventually time out that conversation and destroy its state. If, after ending a conversation, you backbutton to a page of that conversation and try to perform an action, Seam will detect that the conversation was already ended, and redirect you to the search page.

1.6.4. The Seam UI control library

If you check inside the WAR file for the booking application, you'll find `seam-ui.jar` in the `WEB-INF/lib` directory. This package contains a number of JSF custom controls that integrate with Seam. The booking application uses the `<s:link>` control for navigation from the search screen to the hotel page:

```
<s:link value="View Hotel" action="#{hotelBooking.selectHotel}"/>
```


The use of `<s:link>` here allows us to attach an action listener to a HTML link without breaking the browser's "open in new window" feature. The standard JSF `<h:commandLink>` does not work with "open in new window".

1.6.5. The Seam Debug Page

The WAR also includes `seam-debug.jar`. If this jar is deployed in `WEB-INF/lib`, along with the Facelets, and if you set the following Seam property in `web.xml` or `seam.properties`:

```
<context-param>
  <param-name>org.jboss.seam.core.init.debug</param-name>
  <param-value>true</param-value>
</context-param>
```

Then the Seam debug page will be available. This page lets you browse and inspect the Seam components in any of the Seam contexts associated with your current login session. Just point your browser at `http://localhost:8080/seam-booking/debug.seam`.

JBoss Seam Debug Page

This page allows you to view and inspect any component in any Seam context associated with the current session.

Conversations

conversation id	activity	description	view id	
4	1:51:34 AM - 1:51:34 AM	Search hotels: M	/main.xhtml	Select conversation context
6	1:51:40 AM - 1:52:23 AM	Book hotel: Marriott Courtyard	/book.xhtml	Select conversation context

- Component (booking)

checkinDate	Fri Jan 20 20:52:20 EST 2006
checkoutDate	Sat Jan 21 20:52:20 EST 2006
class	class org.jboss.seam.example.booking.Booking
creditCard	
description	Marriott Courtyard, Jan 20, 2006 to Jan 21, 2006
hotel	Hotel(Tower Place, Buckhead,Atlanta,30305)
id	
user	User(gavin)

- Conversation Context (6)

booking
conversation
hotel
hotelBooking
hotels

- Business Process Context

Empty business process context

+ Session Context

+ Application Context

1.7. A complete application featuring Seam and jBPM: the DVD

Store example

The DVD Store demo application shows the practical usage of jBPM for both task management and pageflow.

The user screens take advantage of a jPDL pageflow to implement searching and shopping cart functionality.

JBoss Seam DVD Store Demo

Search for Movies

My Orders

Search Results

Add to cart	Title	Actor	Price
<input type="checkbox"/>	Life is Beautiful	Roberto Benini	\$12.00
<input type="checkbox"/>	Finding Nemo	Albert Brooks	\$22.49
<input type="checkbox"/>	March of the Penguins	Morgan Freeman	\$16.98
<input type="checkbox"/>	Indiana Jones and the Temple of Doom	Harrison Ford	\$19.99
<input type="checkbox"/>	Clear and Present Danger	Harrison Ford	\$19.99
<input type="checkbox"/>	Roman Holiday	Audrey Hepburn	\$12.99
<input type="checkbox"/>	Breakfast at Tiffany's	Audrey Hepburn	\$12.99
<input type="checkbox"/>	Sabrina	Audrey Hepburn	\$12.99
<input type="checkbox"/>	Sabrina	Harrison Ford	\$19.99
<input type="checkbox"/>	Kill Bill Vol. 1	Uma Thurman	\$19.99
<input type="checkbox"/>	Kill Bill Vol. 2	Uma Thurman	\$19.99
<input type="checkbox"/>	Lost in Translation	Bill Murray	\$19.99
<input type="checkbox"/>	Broken Flowers	Bill Murray	\$19.99
<input type="checkbox"/>	Better Off Dead	John Cusak	\$8.99
<input type="checkbox"/>	Grosse Pointe Blank	John Cusak	\$11.99
<input type="checkbox"/>	High Fidelity	John Cusak	\$14.99
<input type="checkbox"/>	Somewhere in Time	Christopher Reeve	\$11.24
<input type="checkbox"/>	Superman - The Movie	Christopher Reeve	\$14.99
<input type="checkbox"/>	Superman II	Christopher Reeve	\$14.99
<input type="checkbox"/>	Superman III	Christopher Reeve	\$14.99

Update Shopping Cart

Welcome, Harry

Thank you for choosing the DVD Store

Logout

Search for DVDs:

Title:

Actor:

Category:

Any

Results Per Page:

20

Search

Shopping Cart

1 Napoleon Dynamite

Total: \$14.06

Checkout

Done

The administration screens take use jBPM to manage the approval and shipping cycle for orders. The business process may even be changed dynamically, by selecting a different process definition!

JBoss Seam DVD Store Demo

Manage Orders

Order Management

Pending orders are shown here on the order management screen for the store manager to process. Rather than being data-driven, order management is process-driven. A JBoss jBPM process assigns fulfillment tasks to the manager based on the version of the process loaded. The manager can change the version of the process at any time using the admin options box to the right.

- Order process 1 sends orders immediately to shipping, where the manager should ship the order and record the tracking number for the user to see.
- Order process 2 adds an approval step where the manager is first given the chance to approve the order before sending it to shipping. In each case, the status of the order is shown in the customer's order list.
- Order process 3 introduces a decision node. Only orders over \$100.00 need to be accepted. Smaller orders are automatically approved for shipping.

Task Assignment

Order Id	Order Amount	Customer	Task	
5	\$12.99	user1	ship	Assign
7	\$77.70	user2	ship	Assign

Order Acceptance

There are no orders to be accepted.

Shipping

Order Id	Order Amount	Customer	
6	\$94.95	user1	Ship

Welcome, Albus

Thank you for choosing the DVD Store

Logout

Statistics

Inventory

28 sold, 2473 in stock

Sales

\$437.63 from 7 orders

Admin Options

Process Management

ordermanagement3

Switch Order Process

Done

TODO

Look in the `dvdstore` directory.

1.8. A complete application featuring Seam workspace management: the Issue Tracker example

The Issue Tracker demo shows off Seam's workspace management functionality: the conversation switcher, conversation list and breadcrumbs.

Update/Delete Issue

[Home](#) | [Find Issues](#) | [Create Issue](#) | [Logout](#) | [Project \[HHH\]](#) | [Issue \[1\] for Project \[HHH\]](#)
Issue [1] for Project [HHH] [Switch](#)

Issue Attributes

Id
1

Status
OPEN

Short description
My laptop does not Hibernate

Version
3.1

Long description

Created
1/14/06 6:47:00 PM

[Update](#)
[Delete](#)
[Done](#)
[Resolve Issue](#)

Reporter

Username	Name
gavin	Gavin King

Project

Name	Description
HHH	Hibernate 3 Core

[Select Project](#)

Assigned developer

No Assigned developer

[Assign](#)
[Unassign](#)

Comments

Comment text	Created	Action
Go to the user forum!	Jan 14, 2006	View Comment

[Create Comment](#)

TODO

Look in the `issues` directory.

1.9. An example of Seam with Hibernate: the Hibernate Booking example

The Hibernate Booking demo is a straight port of the Booking demo to an alternative architecture that uses Hibernate for persistence and JavaBeans instead of session beans.

TODO

Look in the `hibernate` directory.

1.10. A RESTful Seam application: the Blog example

Seam makes it very easy to implement applications which keep state on the server-side. However, server-side state is not always appropriate, especially in for functionality that serves up *content*. For this kind of problem we often need to let the user bookmark pages and have a relatively stateless server, so that any page can be accessed at any time, via the bookmark. The Blog example shows how to a implement RESTful application using Seam. Every page of the application can be bookmarked, including the search results page.



The Blog example demonstrates the use of "pull"-style MVC, where instead of using action listener methods to retrieve data and prepare the data for the view, the view pulls data from components as it is being rendered.

1.10.1. Using "pull"-style MVC

This snippet from the `index.xhtml` facelets page displays a list of recent blog entries:

Example 1.23.

```
<h:dataTable value="#{blog.recentBlogEntries}" var="blogEntry" rows="3">
  <h:column>
    <div class="blogEntry">
      <h3>#{blogEntry.title}</h3>
      <div>
        <h:outputText escape="false"
          value="#{blogEntry.excerpt==null ? blogEntry.body : blogEntry.excerpt}"/>
      </div>
      <p>
        <h:outputLink value="entry.seam" rendered="#{blogEntry.excerpt!=null}">
          <f:param name="blogEntryId" value="#{blogEntry.id}"/>
          Read more...
        </h:outputLink>
      </p>
      <p>
        [Posted on
        <h:outputText value="#{blogEntry.date}">
          <f:convertDateTime timeZone="#{blog.timeZone}" locale="#{blog.locale}" type="both"/>

```

```

        </h:outputText>]
        &#160;
        <h:outputLink value="entry.seam">[Link]
            <f:param name="blogEntryId" value="#{blogEntry.id}" />
        </h:outputLink>
    </p>
</div>
</h:column>
</h:dataTable>

```

If we navigate to this page from a bookmark, how does the data used by the `<h:dataTable>` actually get initialized? Well, what happens is that the `Blog` is retrieved lazily—"pulled"—when needed, by a Seam component named `blog`. This is the opposite flow of control that is usual in traditional web action-based frameworks like Struts.

Example 1.24.

```

@Name("blog")
@Scope(ScopeType.STATELESS)
public class BlogService
{
    @In(create=true)                                     (1)
    private EntityManager entityManager;

    @Unwrap                                              (2)
    public Blog getBlog()
    {
        return (Blog) entityManager.createQuery("from Blog b left join fetch b.blogEntries")
            .setHint("org.hibernate.cacheable", true)
            .getSingleResult();
    }
}

```

- (1) This component uses a *seam-managed persistence context*. Unlike the other examples we've seen, this persistence context is managed by Seam, instead of by the EJB3 container. The persistence context spans the entire web request, allowing us to avoid any exceptions that occur when accessing unfetched associations in the view.
- (2) The `@Unwrap` annotation tells Seam to provide the return value of the method—the `Blog`—instead of the actual `BlogService` component to clients. This is the *Seam manager component pattern*.

This is good so far, but what about bookmarking the result of form submissions, such as a search results page?

1.10.2. Bookmarkable search results page

The blog example has a tiny form in the top right of each page that allows the user to search for blog entries. This is defined in the facelets template, `template.xhtml`:

Example 1.25.

```

<div id="search">
    <h:form>
        <h:inputText value="#{searchAction.searchPattern}" />
        <h:commandButton value="Search" action="#{searchAction.search}" />
    </h:form>

```

```
</div>
```

To implement a bookmarkable search results page, we need to perform a browser redirect after processing the search form submission. Seam provides a built-in component named `redirect` that makes it very easy to perform redirects with request parameters.

You can either use a templated outcome, with JSF EL expressions as the request parameter values:

Example 1.26.

```
@Name("searchAction")
public class SearchAction
{
    private String searchPattern;

    public String getSearchPattern()
    {
        return searchPattern;
    }

    public void setSearchPattern(String searchPattern)
    {
        this.searchPattern = searchPattern;
    }

    public String search()
    {
        return "/search.xhtml?searchPattern=#{searchAction.searchPattern}";
    }
}
```

Or, if that feels too magical, you can inject and call the `redirect` component directly:

Example 1.27.

```
@Name("searchAction")
public class SearchAction
{
    @In(create=true)
    private Redirect redirect;

    private String searchPattern;

    public String getSearchPattern()
    {
        return searchPattern;
    }

    public void setSearchPattern(String searchPattern)
    {
        this.searchPattern = searchPattern;
    }

    public void search()
    {
        redirect.setViewId("/search.xhtml");
        redirect.setParameter("searchPattern", searchPattern);
        redirect.execute();
    }
}
```

```
}  
  
}
```

The redirect takes us to the `search.xhtml` page:

Example 1.28.

```
<h:dataTable value="#{searchResults}" var="blogEntry">  
  <h:column>  
    <div>  
      <h:outputLink value="entry.seam">  
        <f:param name="blogEntryId" value="#{blogEntry.id}"/>  
        #{blogEntry.title}  
      </h:outputLink>  
      posted on  
      <h:outputText value="#{blogEntry.date}">  
        <f:convertDateTime timeZone="#{blog.timeZone}" locale="#{blog.locale}" type="both"/>  
      </h:outputText>  
    </div>  
  </h:column>  
</h:dataTable>
```

Which again uses "pull"-style MVC to retrieve the actual search results:

Example 1.29.

```
@Name("searchResults")  
public class SearchService  
{  
  
    @In(create=true)  
    private EntityManager entityManager;  
  
    @RequestParameter  
    private String searchPattern;  
  
    private List<BlogEntry> searchResults;  
  
    @Create  
    public void initSearchResults()  
    {  
        searchResults = entityManager.createQuery("from BlogEntry be where lower(be.title) like :searchPattern")  
            .setParameter("searchPattern", getSqlSearchPattern())  
            .setMaxResults(100)  
            .getResultList();  
    }  
  
    private String getSqlSearchPattern()  
    {  
        return searchPattern==null ? "" : '%' + searchPattern.toLowerCase().replace('*', '%').replace(' ', '%') + '%';  
    }  
  
    @Unwrap  
    public List<BlogEntry> getSearchResults()  
    {  
        return searchResults;  
    }  
}
```


1.10.3. Using "push"-style MVC in a RESTful application

Very occasionally, it makes more sense to use push-style MVC for processing RESTful pages, and so Seam provides the notion of a *page action*. The Blog example uses a page action for the blog entry page, `entry.xhtml`. Note that this is a little bit contrived, it would have been easier to use pull-style MVC here as well.

The `entryAction` component works much like an action class in a traditional push-MVC action-oriented framework like Struts:

Example 1.30.

```
@Name("entryAction")
@Scope(ScopeType.STATELESS)
public class EntryAction
{
    @In(create=true)
    private Blog blog;

    @RequestParameter
    private String blogEntryId;

    @Out(scope=ScopeType.EVENT, required=false)
    private BlogEntry blogEntry;

    public void getBlogEntry()
    {
        blogEntry = blog.getBlogEntry(blogEntryId);
        if (blogEntry==null)
        {
            HttpError.instance().send(HttpServletResponse.SC_NOT_FOUND);
        }
    }
}
```

The page action must be declared a file called `pages.xml`:

Example 1.31.

```
<pages>
  <page view-id="/entry.xhtml" action="#{entryAction.getBlogEntry}"/>
  <page view-id="/post.xhtml" action="#{loginAction.challenge}"/>
  <page view-id="*" action="#{blog.hitCount.hit}"/>
</pages>
```

(Notice that the example is using page actions for some other functionality—the login challenge, and the page counter.)

When the `entry.xhtml` page is requested, Seam first runs the page action, which retrieves the needed data—the `blogEntry`—and places it in the Seam event context. Next, the following is rendered:

Example 1.32.

```
<div class="blogEntry">
```

```
<h3>#{blogEntry.title}</h3>
<div>
  <h:outputText escape="false" value="#{blogEntry.body}" />
</div>
<p>
  [Posted on
  <h:outputText value="#{blogEntry.date}">
    <f:convertDateTime timezone="#{blog.timeZone}" locale="#{blog.locale}" type="both"/>
  </h:outputText>]
</p>
</div>
```

Chapter 2. The contextual component model

The two core concepts in Seam are the notion of a *context* and the notion of a *component*. Components are stateful objects, usually EJBs, and an instance of a component is associated with a context, and given a name in that context. *Bijection* provides a mechanism for aliasing internal component names (instance variables) to contextual names, allowing component trees to be dynamically assembled, and reassembled by Seam.

Let's start by describing the contexts built in to Seam.

2.1. Seam contexts

Seam contexts are created and destroyed by the framework. The application does not control context demarcation via explicit Java API calls. Context are usually implicit. In some cases, however, contexts are demarcated via annotations.

The basic Seam contexts are:

- Stateless context
- Event (or request) context
- Page context
- Conversation context
- Session context
- Business process context
- Application context

You will recognize some of these contexts from servlet and related specifications. However, two of them might be new to you: *conversation context*, and *business process context*. One reason state management in web applications is so fragile and error-prone is that the three built-in contexts (request, session and application) are not especially meaningful from the point of view of the business logic. A user login session, for example, is a fairly arbitrary construct in terms of the actual application work flow. Therefore, most Seam components are scoped to the conversation or business process contexts, since they are the contexts which are most meaningful in terms of the application.

Let's look at each context in turn.

2.1.1. Stateless context

Components which are truly stateless (stateless session beans, primarily) always live in the stateless context (this is really a non-context). Stateless components are not very interesting, and are arguably not very object-oriented. Nevertheless, they are important and often useful.

2.1.2. Event context

The event context is the "narrowest" stateful context, and is a generalization of the notion of the web request context to cover other kinds of events. Nevertheless, the event context associated with the lifecycle of a JSF re-

quest is the most important example of an event context, and the one you will work with most often. Components associated with the event context are destroyed at the end of the request, but their state is available and well-defined for at least the lifecycle of the request.

When you invoke a Seam component via RMI, or Seam Remoting, the event context is created and destroyed just for the invocation.

2.1.3. Page context

The page context allows you to associate state with a particular instance of a rendered page. You can initialize state in your event listener, or while actually rendering the page, and then have access to it from any event that originates from that page. This is especially useful for functionality like clickable lists, where the list is backed by changing data on the server side. The state is actually serialized to the client, so this construct is extremely robust with respect to multi-window operation and the back button.

2.1.4. Conversation context

The conversation context is a truly central concept in Seam. A *conversation* is a unit of work from the point of view of the user. It might span several interactions with the user, several requests, and several database transactions. But to the user, a conversation solves a single problem. For example, "book hotel", "approve contract", "create order" are all conversations. You might like to think of a conversation implementing a single "use case", but the relationship is not necessarily quite exact.

A conversation holds state associated with "what the user is doing now, in this window". A single user may have multiple conversations in progress at any point in time, usually in multiple windows. The conversation context allows us to ensure that state from the different conversations does not collide and cause bugs.

It might take you some time to get used to thinking of applications in terms of conversations. But once you get used to it, we think you'll love the notion, and never be able to not think in terms of conversations again!

Some conversations last for just a single request. Conversations that span multiple requests must be demarcated using annotations provided by Seam.

Some conversations are also *tasks*. A task is a conversation that is significant in terms of a long-running business process, and has the potential to trigger a business process state transition when it is successfully completed. Seam provides a special set of annotations for task demarcation.

Conversations may be *nested*, with one conversation taking place "inside" a wider conversation. This is an advanced feature.

Usually, conversation state is actually held by Seam in the servlet session between requests. Seam implements configurable *conversation timeout*, automatically destroying inactive conversations, and thus ensuring that the state held by a single user login session does not grow without bound if the user abandons conversations.

Alternatively, Seam may be configured to keep conversational state in the client browser.

2.1.5. Session context

A session context holds state associated with the user login session. While there are some cases where it is useful to share state between several conversations, we generally frown on the use of session context for holding components other than global information about the logged in user.

In a JSR-168 portal environment, the session context represents the portlet session.

2.1.6. Business process context

The business process context holds state associated with the long running business process. This state is managed and made persistent by the BPM engine (JBoss jBPM). The business process spans multiple interactions with multiple users, so this state is shared between multiple users, but in a well-defined manner. The current task determines the current business process instance, and the lifecycle of the business process is defined externally using a *process definition language*, so there are no special annotations for business process demarcation.

2.1.7. Application context

The application context is the familiar servlet context from the servlet spec. Application context is mainly useful for holding static information such as configuration data, reference data or metamodels. For example, Seam stores its own configuration and metamodel in the application context.

2.1.8. Context variables

A context defines a namespace, a set of *context variables*. These work much the same as session or request attributes in the servlet spec. You may bind any value you like to a context variable, but usually we bind Seam component instances to context variables.

So, within a context, a component instance is identified by the context variable name (this is usually, but not always, the same as the component name). You may programatically access a named component instance in a particular scope via the `Contexts` class, which provides access to several thread-bound instances of the `Context` interface:

```
User user = (User) Contexts.getSessionContext().get("user");
```

You may also set or change the value associated with a name:

```
Contexts.getSessionContext().set("user", user);
```

Usually, however, we obtain components from a context via injection, and put component instances into a context via outjection.

2.1.9. Context search priority

Sometimes, as above, component instances are obtained from a particular known scope. Other times, all stateful scopes are searched, in *priority order*. The order is as follows:

- Event context
- Page context
- Conversation context
- Session context
- Business process context

- Application context

You can perform a priority search by calling `Contexts.lookupInStatefulContexts()`. Whenever you access a component by name from a JSF page, a priority search occurs.

2.2. Seam components

Seam components are POJOs (Plain Old Java Objects). In particular, they are JavaBeans or EJB 3.0 enterprise beans. While Seam does not require that components be EJBs and can even be used without an EJB 3.0 compliant container, Seam was designed with EJB 3.0 in mind and includes deep integration with EJB 3.0. Seam supports the following *component types*.

- EJB 3.0 stateless session beans
- EJB 3.0 stateful session beans
- EJB 3.0 entity beans
- JavaBeans

2.2.1. Stateless session beans

Stateless session bean components are not able to hold state across multiple invocations. Therefore, they usually work by operating upon the state of other components in the various Seam contexts. They may be used as JSF action listeners, but cannot provide properties to JSF components for display.

Stateless session beans always live in the stateless context.

Stateless session beans are the least interesting kind of Seam component.

2.2.2. Stateful session beans

Stateful session bean components are able to hold state not only across multiple invocations of the bean, but also across multiple requests. Application state that does not belong in the database should usually be held by stateful session beans. This is a major difference between Seam and many other web application frameworks. Instead of sticking information about the current conversation directly in the `HttpSession`, you should keep it in instance variables of a stateful session bean that is bound to the conversation context. This allows Seam to manage the lifecycle of this state for you, and ensure that there are no collisions between state relating to different concurrent conversations.

Stateful session beans are often used as JSF action listener, and as backing beans that provide properties to JSF components for display or form submission.

By default, stateful session beans are bound to the conversation context. They may never be bound to the page or stateless contexts.

2.2.3. Entity beans

Entity beans may be bound to a context variable and function as a seam component. Because entities have a persistent identity in addition to their contextual identity, entity instances are usually bound explicitly in Java

code, rather than being instantiated implicitly by Seam.

Entity bean components do not support bijection or context demarcation. Nor does invocation of an entity bean trigger validation.

Entity beans are not usually used as JSF action listeners, but do often function as backing beans that provide properties to JSF components for display or form submission. In particular, it is common to use an entity as a backing bean, together with a stateless session bean action listener to implement create/update/delete type functionality.

By default, entity beans are bound to the conversation context. They may never be bound to the stateless context.

2.2.4. JavaBeans

JavaBeans may be used just like a stateless or stateful session bean. However, they do not provide the functionality of a session bean (declarative transaction demarcation, declarative security, automatic clustered state replication, EJB 3.0 persistence, timeout methods, etc).

In a later chapter, we show you how to use Seam and Hibernate without an EJB container. In this use case, components are JavaBeans instead of session beans.

By default, JavaBeans are bound to the conversation context.

2.2.5. Interception

In order to perform its magic (bijection, context demarcation, validation, etc), Seam must intercept component invocations. For JavaBeans, Seam is in full control of instantiation of the component, and no special configuration is needed. For entity beans, interception is not required since bijection and context demarcation are not defined. For session beans, we must register an EJB interceptor for the session bean component. We could use an annotation, as follows:

```
@Stateless
@Interceptors(SeamInterceptor.class)
public class LoginAction implements Login {
    ...
}
```

But a much better way is to define the interceptor in `ejb-jar.xml`.

2.2.6. Component names

Almost all seam components need a name. We assign a name to a component using the `@Name` annotation:

```
@Name("loginAction")
@Stateless
public class LoginAction implements Login {
    ...
}
```

This name is the *seam component name* and is not related to any other name defined by the EJB specification. However, seam component names work just like JSF managed bean names and you can think of the two concepts as identical.

Just like in JSF, a seam component instance is usually bound to a context variable with the same name as the component name. So, for example, we would access the `LoginAction` using `Contexts.getStatelessContext().get("loginAction")`. In particular, whenever Seam itself instantiates a component, it binds the new instance to a variable with the component name. However, again like JSF, it is possible for the application to bind a component to some other context variable by programmatic API call. This is only useful if a particular component serves more than one role in the system. For example, the currently logged in `User` might be bound to the `currentUser` session context variable, while a `User` that is the subject of some administration functionality might be bound to the `user` conversation context variable.

For very large applications, and for built-in seam components, qualified names are often used.

```
@Name("com.jboss.myapp.loginAction")
@Stateless
@Interceptors(SeamInterceptor.class)
public class LoginAction implements Login {
    ...
}
```

Unfortunately, JSF's expression language interprets a period as a property dereference. So, inside a JSF expression, we use `$` to indicate a qualified component name:

```
<h:commandButton type="submit" value="Login"
    action="#{com$jbos$myapp$loginAction.login}"/>
```

2.2.7. Defining the component scope

We can override the default scope (context) of a component using the `@Scope` annotation. This lets us define what context a component instance is bound to, when it is instantiated by Seam.

```
@Name("user")
@Entity
@Scope(SESSION)
public class User {
    ...
}
```

`org.jboss.seam.ScopeType` defines an enumeration of possible scopes.

2.2.8. Components with multiple roles

Some Seam component classes can fulfill more than one role in the system. For example, we often have a `User` class which is usually used as a session-scoped component representing the current user but is used in user administration screens as a conversation-scoped component. The `@Role` annotation lets us define an additional named role for a component, with a different scope—it lets us bind the same component class to different context variables. (Any Seam component *instance* may be bound to multiple context variables, but this lets us do it at the class level, and take advantage of auto-instantiation.)

```
@Name("user")
@Entity
@Scope(CONVERSATION)
@Role(name="currentUser", scope=SESSION)
public class User {
    ...
}
```

The `@Roles` annotation lets us specify as many additional roles as we like.


```

@Name("user")
@Entity
@Scope(CONVERSATION)
@Roles({@Role(name="currentUser", scope=SESSION)
        @Role(name="tempUser", scope=EVENT)})
public class User {
    ...
}

```

2.2.9. Built-in components

Like many good frameworks, Seam eats its own dogfood and is implemented mostly as a set of built-in Seam interceptors (see later) and Seam components. This makes it easy for applications to interact with built-in components at runtime or even customize the basic functionality of Seam by replacing the built-in components with custom implementations. The built-in components are defined in the Seam namespace `org.jboss.seam.core` and the Java package of the same name.

The built-in components may be injected, just like any Seam components, but they also provide convenient static `instance()` methods:

```

FacesMessages.instance().add("Welcome back, #{user.name}!");

```

Seam was designed to integrate tightly in a Java EE 5 environment. However, we understand that there are many projects which are not running in a full EE environment, and at the time of writing, Java EE 5 is not yet final. We also realize the critical importance of easy unit and integration testing using frameworks such as TestNG and JUnit. So, we've made it easy to run Seam in Java SE environments by allowing you to bootstrap certain critical infrastructure normally only found in EE environments by installing built-in Seam components.

For example, you can run your EJB3 components in Tomcat or an integration test suite just by installing the built-in component `org.jboss.seam.core.ejb`, which automatically bootstraps the JBoss Embeddable EJB3 container and deploys your EJB components.

Or, if you're not quite ready for the Brave New World of EJB 3.0, you can write a Seam application that uses only JavaBean components, together with Hibernate3 for persistence, by installing the built-in component `org.jboss.seam.core.hibernate`. When using Hibernate outside of a J2EE environment, you will also probably need a JTA transaction manager and JNDI server, which are available via the built-in component `org.jboss.seam.core.microcontainer`. This lets you use the bulletproof JTA/JCA pooling datasource from JBoss application server in an SE environment like Tomcat!

2.2.10. Configuring components

Seam components may be provided with configuration data either via servlet context parameters, or via a properties file named `seam.properties` in the root of the classpath.

The configurable Seam component must expose a JavaBeans-style property setter methods for the configurable attributes. If a seam component named `com.jboss.myapp.settings` has a setter method named `setLocale()`, we can provide a property named `com.jboss.myapp.settings.locale` in the `seam.properties` file or as a servlet context parameter, and Seam will set the value of the `locale` attribute whenever it instantiates the component.

Note that it is not possible to configure stateless session beans or entity beans.

The same mechanism is used to configure Seam itself. For example, to set the conversation timeout, we provide a value for `org.jboss.seam.core.manager.conversationTimeout` in `web.xml` or `seam.properties`. (There is

a built-in Seam component named `org.jboss.seam.core.manager` with a setter method named `setConversationTimeout()`.

2.3. Bijection

Dependency injection or *inversion of control* is by now a familiar concept to most Java developers. Dependency injection allows a component to obtain a reference to another component by having the container "inject" the other component to a setter method or instance variable. In all dependency injection implementations that we have seen, injection occurs when the component is constructed, and the reference does not subsequently change for the lifetime of the component instance. For stateless components, this is reasonable. From the point of view of a client, all instances of a particular stateless component are interchangeable. On the other hand, Seam emphasizes the use of stateful components. So traditional dependency injection is no longer a very useful construct. Seam introduces the notion of *bijection* as a generalization of injection. In contrast to injection, bijection is:

- *contextual* - bijection is used to assemble stateful components from various different contexts (a component from a "wider" context may even have a reference to a component from a "narrower" context)
- *bidirectional* - values are injected from context variables into attributes of the component being invoked, and also *outjected* from the component attributes back out to the context, allowing the component being invoked to manipulate the values of contextual variables simply by setting its own instance variables
- *dynamic* - since the value of contextual variables changes over time, and since Seam components are stateful, bijection takes place every time a component is invoked

In essence, bijection lets you alias a context variable to a component instance variable, by specifying that the value of the instance variable is injected, outjected, or both. Of course, we use annotations to enable bijection.

The `@In` annotation specifies that a value should be injected, either into an instance variable:

```
@Name("loginAction")
@Stateless
@Interceptors(SeamInterceptor.class)
public class LoginAction implements Login {
    @In User user;
    ...
}
```

or into a setter method:

```
@Name("loginAction")
@Stateless
@Interceptors(SeamInterceptor.class)
public class LoginAction implements Login {
    User user;

    @In
    public void setUser(User user) {
        this.user=user;
    }

    ...
}
```

By default, Seam will do a priority search of all contexts, using the name of the property or instance variable that is being injected. You may wish to specify the context variable name explicitly, using, for example, `@In("currentUser")`.

If you want Seam to create an instance of the component when there is no existing component instance bound to the named context variable, you should specify `@In(create=true)`. If the value is optional (it can be null), specify `@In(required=false)`.

You can even inject the value of an expression:

```
@Name("loginAction")
@Stateless
@Interceptors(SeamInterceptor.class)
public class LoginAction implements Login {
    @In("#{user.username}") String username;
    ...
}
```

(There is much more information about component lifecycle and injection in the next chapter.)

The `@Out` annotation specifies that an attribute should be outjected, either from an instance variable:

```
@Name("loginAction")
@Stateless
@Interceptors(SeamInterceptor.class)
public class LoginAction implements Login {
    @Out User user;
    ...
}
```

or from a getter method:

```
@Name("loginAction")
@Stateless
@Interceptors(SeamInterceptor.class)
public class LoginAction implements Login {
    User user;

    @Out
    public User getUser() {
        return user;
    }

    ...
}
```

An attribute may be both injected and outjected:

```
@Name("loginAction")
@Stateless
@Interceptors(SeamInterceptor.class)
public class LoginAction implements Login {
    @In @Out User user;
    ...
}
```

or:

```
@Name("loginAction")
@Stateless
@Interceptors(SeamInterceptor.class)
public class LoginAction implements Login {
    User user;

    @In
    public void setUser(User user) {
        this.user=user;
    }
}
```

```

@Out
public User getUser() {
    return user;
}

...
}

```

2.4. Seam interceptors

EJB 3.0 introduced a standard interceptor model for session bean components. To add an interceptor to a bean, you need to write a class with a method annotated `@AroundInvoke` and annotate the bean with an `@Interceptors` annotation that specifies the name of the interceptor class. For example, the following interceptor checks that the user is logged in before allowing invoking an action listener method:

```

public class LoggedInInterceptor {

    @AroundInvoke
    public Object checkLoggedIn(InvocationContext invocation) throws Exception {

        boolean isLoggedIn = Contexts.getSessionContext().get("loggedIn")!=null;
        if (isLoggedIn) {
            //the user is already logged in
            return invocation.proceed();
        }
        else {
            //the user is not logged in, fwd to login page
            return "login";
        }
    }
}

```

To apply this interceptor to a session bean which acts as an action listener, we must annotate the session bean `@Interceptors(LoggedInInterceptor.class)`. This is a somewhat ugly annotation. Seam builds upon the interceptor framework in EJB3 by allowing you to use `@Interceptors` as a meta-annotation. In our example, we would create an `@LoggedIn` annotation, as follows:

```

@Target(TYPE)
@Retention(RUNTIME)
@Interceptors(LoggedInInterceptor.class)
public @interface LoggedIn {}

```

We can now simply annotate our action listener bean with `@LoggedIn` to apply the interceptor.

```

@Stateless
@Name("changePasswordAction")
@LoggedIn
@Interceptors(SeamInterceptor.class)
public class ChangePasswordAction implements ChangePassword {

    ...

    public String changePassword() { ... }
}

```

If interceptor ordering is important (it usually is), you can add `@Within` and `@Around` annotations to your interceptor classes to specify a partial order of interceptors.

```
@Around({BiJECTIONInterceptor.class,
        ValidationInterceptor.class,
        ConversationInterceptor.class})
@Within(RemoveInterceptor.class)
public class LoggedInInterceptor
{
    ...
}
```

Much of the functionality of Seam is implemented as a set of built-in Seam interceptors, including the interceptors named in the previous example. You don't have to explicitly specify these interceptors by annotating your components; they exist for all interceptable Seam components.

You can even use Seam interceptors with JavaBean components, not just EJB3 beans!

2.5. Seam events

The Seam component model was developed for use with *event-driven applications*, specifically to enable the development of fine-grained, loosely-coupled components in a fine-grained eventing model. Events in Seam come in several types, most of which we have already seen:

- JSF events
- jBPM transition events
- Seam page actions
- Seam component-driven events

All of these various kinds of events are mapped to Seam components via JSF EL method binding expressions. For a JSF event, this is defined in the JSF template:

```
<h:commandButton value="Click me!" action="#{helloWorld.sayHello}"/>
```

For a jBPM transition event, it is specified in the jBPM process definition or pageflow definition:

```
<start-page name="hello" view-id="/hello.jsp">
    <transition to="hello">
        <action expression="#{helloWorld.sayHello}"/>
    </transition>
</start-page>
```

You can find out more information about JSF events and jBPM events elsewhere. Lets concentrate for now upon the two additional kinds of events defined by Seam.

2.5.1. Page actions

A Seam page action is an event that occurs just before we render a page. We declare page actions in `WEB-INF/pages.xml`. We can define a page action for either a particular JSF view id:

```
<pages>
    <page view-id="/hello.jsp" action="#{helloWorld.sayHello}"/>
</pages>
```

Or we can use a wildcard to specify an action that applies to all view ids that match the pattern:

```
<pages>
  <page view-id="/hello/*" action="#{helloWorld.sayHello}" />
</pages>
```

If multiple wildcarded page actions match the current view-id, Seam will call all the actions, in order of least-specific to most-specific.

The page action method can return a JSF outcome. If the outcome is non-null, Seam will delegate to the defined JSF navigation rules and a different view may end up being rendered.

Furthermore, the view id mentioned in the `<page>` element need not correspond to a real JSP or Facelets page! So, we can reproduce the functionality of a traditional action-oriented framework like Struts or WebWork using page actions. For example:

```
TODO: translate struts action into page action
```

This is quite useful if you want to do complex things in response to non-faces requests (for example, HTTP GET requests).

2.5.2. Component-driven events

Seam components can interact by simply calling each others methods. Stateful components may even implement the observer/observable pattern. But to enable components to interact in a more loosely-coupled fashion than is possible when the components call each others methods directly, Seam provides *component-driven events*.

We specify event listeners (observers) in `WEB-INF/events.xml`.

```
<events>
  <event type="hello">
    <action expression="#{helloListener.sayHelloBack}" />
    <action expression="#{logger.logHello}" />
  </event>
</events>
```

Where the *event type* is just an arbitrary string.

When an event occurs, the actions registered for that event will be called in the order they appear in `events.xml`. How does a component raise an event? Seam provides a built-in component for this.

```
@Name("helloWorld")
public class HelloWorld {
  public void sayHello() {
    FacesMessages.instance().add("Hello World!");
    Events.instance().raiseEvent("hello");
  }
}
```

Notice that this event producer has no dependency upon event consumers. The event listener may now be implemented with absolutely no dependency upon the producer:

```
@Name("helloListener")
public class HelloListener {
  public void sayHelloBack() {
    FacesMessages.instance().add("Hello to you too!");
  }
}
```

If you don't like the `events.xml` file, we can use an annotation instead:

```
@Name("helloListener")
public class HelloListener {
    @Observer("hello")
    public void sayHelloBack() {
        FacesMessages.instance().add("Hello to you too!");
    }
}
```

You might wonder why I've not mentioned anything about event objects in this discussion. In Seam, there is no need for an event object to propagate state between event producer and listener. All state is held in the Seam contexts, and is shared between components.

Chapter 3. Conversations and workspace management

It's time to understand Seam's conversation model in more detail.

Historically, the notion of a Seam "conversation" came about as a merger of three different ideas:

- The idea of a *workspace*, which I encountered in a project for the Victorian government in 2002. In this project I was forced to implement workspace management on top of Struts, an experience I pray never to repeat.
- The idea of an *application transaction* with optimistic semantics, and the realization that existing frameworks based around a stateless architecture could not provide effective management of extended persistence contexts. (The Hibernate team is truly fed up with copping the blame for `LazyInitializationExceptions`, which are not really Hibernate's fault, but rather the fault of the extremely limiting persistence context model supported by stateless architectures such as the Spring framework or the traditional *stateless session facade* (anti)pattern in J2EE.)
- The idea of a workflow *task*.

By unifying these ideas and providing deep support in the framework, we have a powerful construct that lets us build richer and more efficient applications with less code than before.

3.1. Seam's conversation model

The examples we have seen so far make use of a very simple conversation model that follows these rules:

- There is always a conversation context active during the apply request values, process validations, update model values, invoke application and render response phases of the JSF request lifecycle.
- At the end of the restore view phase of the JSF request lifecycle, Seam attempts to restore any previous long-running conversation context. If none exists, Seam creates a new temporary conversation context.
- When an `@Begin` method is encountered, the temporary conversation context is promoted to a long running conversation.
- When an `@End` method is encountered, any long-running conversation context is demoted to a temporary conversation.
- At the end of the render response phase of the JSF request lifecycle, Seam stores the contents of a long running conversation context or destroys the contents of a temporary conversation context.
- Any faces request (a JSF postback) will propagate the conversation context. By default, non-faces requests (GET requests, for example) do not propagate the conversation context, but see below for more information on this.
- If the JSF request lifecycle is foreshortened by a redirect, Seam transparently stores and restores the current conversation context.

Seam transparently propagates the conversation context across JSF postbacks and redirects. If you don't do anything special, a *non-faces request* (a GET request for example) will not propagate the conversation context and

will be processed in a new temporary conversation. This is usually - but not always - the desired behavior.

If you want to propagate a Seam conversation across a non-faces request, you need to explicitly code the Seam *conversation id* as a request parameter:

```
<a href="main.jsf?conversationId=#{conversation.id}">Continue</a>
```

Or, the more JSF-ish:

```
<h:outputLink value="main.jsf">
  <f:param name="conversationId" value="#{conversation.id}" />
  <h:outputText value="Continue" />
</h:outputLink>
```

If you use the Seam tag library, this is equivalent:

```
<h:outputLink value="main.jsf">
  <s:conversationId />
  <h:outputText value="Continue" />
</h:outputLink>
```

If you wish to disable propagation of the conversation context for a postback, a similar trick is used:

```
<h:commandLink action="main" value="Exit">
  <f:param name="conversationPropagation" value="none" />
</h:commandLink>
```

If you use the Seam tag library, this is equivalent:

```
<h:commandLink action="main" value="Exit">
  <s:conversationPropagation type="none" />
</h:commandLink>
```

Note that disabling conversation context propagation is absolutely not the same thing as ending the conversation.

The `conversationPropagation` request parameter, or the `<s:conversationPropagation>` tag may even be used to begin and end conversation, or begin a nested conversation.

```
<h:commandLink action="main" value="Exit">
  <s:conversationPropagation type="end" />
</h:commandLink>
```

```
<h:commandLink action="main" value="Select Child">
  <s:conversationPropagation type="nested" />
</h:commandLink>
```

```
<h:commandLink action="main" value="Select Hotel">
  <s:conversationPropagation type="begin" />
</h:commandLink>
```

```
<h:commandLink action="main" value="Select Hotel">
  <s:conversationPropagation type="join" />
</h:commandLink>
```

This conversation model makes it easy to build applications which behave correctly with respect to multi-window operation. For many applications, this is all that is needed. Some complex applications have either or both of the following additional requirements:

- A conversation spans many smaller units of user interaction, which execute serially or even concurrently. The smaller *nested conversations* have their own isolated set of conversation state, and also have access to the state of the outer conversation.
- The user is able to switch between many conversations within the same browser window. This feature is called *workspace management*.

3.2. Nested conversations

A nested conversation is created by invoking a method marked `@Begin(nested=true)` inside the scope of an existing conversation. A nested conversation has its own conversation context, and also has read-only access to the context of the outer conversation. (It can read the outer conversation's context variables, but not write to them.) When an `@End` is subsequently encountered, the nested conversation will be destroyed, and the outer conversation will resume, by "popping" the conversation stack. Conversations may be nested to any arbitrary depth.

Certain user activity (workspace management, or the back button) can cause the outer conversation to be resumed before the inner conversation is ended. In this case it is possible to have multiple concurrent nested conversations belonging to the same outer conversation. If the outer conversation ends before a nested conversation ends, Seam destroys all nested conversation contexts along with the outer context.

A conversation may be thought of as a *continuable state*. Nested conversations allow the application to capture a consistent continuable state at various points in a user interaction, thus insuring truly correct behavior in the face of backbuttoning and workspace management.

TODO: an example to show how a nested conversation prevents bad stuff happening when you backbutton.

3.3. Starting conversations with GET requests

JSF does not define any kind of action listener that is triggered when a page is accessed via a non-faces request (for example, a HTTP GET request). This can occur if the user bookmarks the page, or if we navigate to the page via an `<h:outputLink>`.

Sometimes we want to begin a conversation immediately the page is accessed. Since there is no JSF action method, we can't solve the problem in the usual way, by annotating the action with `@Begin`.

A further problem arises if the page needs some state to be fetched into a context variable. We've already seen two ways to solve this problem. If that state is held in a Seam component, we can fetch the state in a `@Create` method. If not, we can define a `@Factory` method for the context variable.

If none of these options works for you, Seam lets you define a *page action* in the `pages.xml` file.

```
<pages>
  <page view-id="/messageList.jsp" action="#{messageManager.list}" />
  ...
</pages>
```

This action method is called at the beginning of the render response phase, any time the page is about to be rendered. If a page action returns a non-null outcome, Seam will process any appropriate JSF navigation rules, possibly resulting in a completely different page being rendered.

If *all* you want to do before rendering the page is begin a conversation, you can use a built-in action method

that does just that:

```
<pages>
  <page view-id="/messageList.jsp" action="#{conversation.begin}" />
  ...
</pages>
```

Note that you can also call this built-in action from a JSF control, and, similarly, you can use `#{conversation.end}` to end conversations.

To solve the first problem, we now have four options:

- Annotate the `@Create` method with `@Begin`
- Annotate the `@Factory` method with `@Begin`
- Annotate the Seam page action method with `@Begin`
- Use `#{conversation.begin}` as the Seam page action method

3.4. Using `<s:link>`

JSF command links always perform a form submission via JavaScript, which breaks the web browser's "open in new window" or "open in new tab" feature. In plain JSF, you need to use an `<h:outputLink>` if you need this functionality. But there are two major limitations to `<h:outputLink>`.

- JSF provides no way to attach an action listener to an `<h:outputLink>`.
- JSF does not propagate the selected row of a `DataModel` since there is no actual form submission.

Seam provides the notion of a *page action* to help solve the first problem, but this does nothing to help us with the second problem. We *could* work around this by using the RESTful approach of passing a request parameter and requering for the selected object on the server side. In some cases—such as the Seam blog example application—this is indeed the best approach. The RESTful style supports bookmarking, since it does not require server-side state. In other cases, where we don't care about bookmarks, the use of `@DataModel` and `@DataModelSelection` is just so convenient and transparent!

To fill in this missing functionality, and to make conversation propagation even simpler to manage, Seam provides the `<s:link>` JSF tag.

The link may specify just the JSF view id:

```
<s:link view-id="/login.xhtml" value="Login" />
```

Or, it may specify an action method (in which case the action outcome determines the page that results):

```
<s:link action="#{login.logout}" value="Logout" />
```

If you specify *both* a JSF view id and an action method, the view-id will be used *unless* the action method returns a non-null outcome:

```
<s:link view-id="/loggedOut.xhtml" action="#{login.logout}" value="Logout" />
```

The link may be rendered as a button:

```
<s:link action="#{login.logout}" value="Logout" style="button"/>
```

The link automatically propagates the selected row of a `DataModel` using inside `<h:dataTable>`:

```
<s:link view-id="/hotel.xhtml" action="#{hotelSearch.selectHotel}" value="#{hotel.name}"/>
```

You can leave the scope of an existing conversation:

```
<s:link view-id="/main.xhtml" propagation="none"/>
```

You can begin, end, or nest conversations:

```
<s:link action="#{issueEditor.viewComment}" propagation="nest"/>
```

If the link begins a conversation, you can even specify a pageflow to be used:

```
<s:link action="#{documentEditor.getDocument}" propagation="begin"
        pageflow="EditDocument"/>
```

The `taskInstance` attribute is for use in jBPM task lists:

```
<s:link action="#{documentApproval.approveOrReject}" taskInstance="#{task}"/>
```

(See the DVD Store demo application for examples of this.)

3.5. Success messages

It is quite common to display a message to the user indicating success or failure of an action. It is convenient to use a JSF `FacesMessage` for this. Unfortunately, a successful action often requires a browser redirect, and JSF does not propagate faces messages across redirects. This makes it quite difficult to display success messages in plain JSF.

The built in conversation-scoped Seam component named `facesMessages` solves this problem. (You must have the Seam redirect filter installed.)

```
@Name("editDocumentAction")
@Stateless
public class EditDocumentBean implements EditDocument {
    @In(create=true) EntityManager em;
    @In Document document;
    @In(create=true) FacesMessages facesMessages;

    public String update() {
        em.merge(document);
        facesMessages.add("Document updated");
    }
}
```

Any message added to `facesMessages` is used in the very next render response phase for the current conversation. This even works when there is no long-running conversation since Seam preserves even temporary conversation contexts across redirects.

You can even include JSF EL expressions in a faces message summary:

```
facesMessages.add("Document #{document.title} was updated");
```

You may display the messages in the usual way, for example:

```
<h:messages globalOnly="true"/>
```

3.6. Workspace management

Workspace management is the ability to "switch" conversations in a single window. Seam makes workspace management completely transparent at the level of the Java code. To enable workspace management, all you need to do is:

- Provide *description* text for each view id (when using JSF navigation rules) or page node (when using jPDL pageflows). This description text is displayed to the user by the workspace switchers.
- Include one or more of the standard workspace switcher JSP or facelets fragments in your pages. The standard fragments support workspace management via a drop down menu, a list of conversations, or breadcrumbs.

3.6.1. Workspace management and JSF navigation

When you use JSF navigation rules, Seam switches to a conversation by restoring the current `view-id` for that conversation. The descriptive text for the workspace is defined in a file called `pages.xml` that Seam expects to find in the `WEB-INF` directory, right next to `faces-config.xml`:

```
<pages>
  <page view-id="/main.xhtml">Search hotels: #{hotelBooking.searchString}</page>
  <page view-id="/hotel.xhtml">View hotel: #{hotel.name}</page>
  <page view-id="/book.xhtml">Book hotel: #{hotel.name}</page>
  <page view-id="/confirm.xhtml">Confirm: #{booking.description}</page>
</pages>
```

Note that if this file is missing, the Seam application will continue to work perfectly! The only missing functionality will be the ability to switch workspaces.

3.6.2. Workspace management and jPDL pageflow

When you use a jPDL pageflow definition, Seam switches to a conversation by restoring the current jBPM process state. This is a more flexible model since it allows the same `view-id` to have different descriptions depending upon the current `<page>` node. The description text is defined by the `<page>` node:

```
<pageflow-definition name="shopping">

  <start-state name="start">
    <transition to="browse"/>
  </start-state>

  <page name="browse" view-id="/browse.xhtml">
    <description>DVD Search: #{search.searchPattern}</description>
    <transition to="browse"/>
    <transition name="checkout" to="checkout"/>
  </page>

  <page name="checkout" view-id="/checkout.xhtml">
    <description>Purchase: ${cart.total}</description>
    <transition to="checkout"/>
    <transition name="complete" to="complete"/>
  </page>
```

```

<page name="complete" view-id="/complete.xhtml">
  <end-conversation />
</page>

</pageflow-definition>

```

3.6.3. The conversation switcher

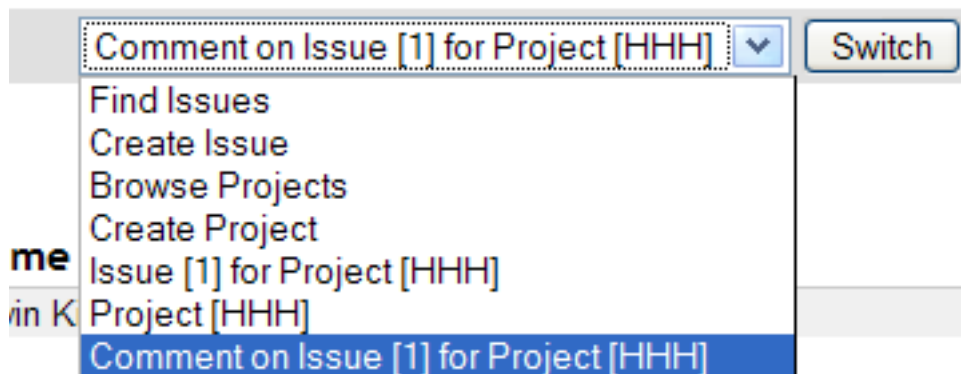
Include the following fragment in your JSP or facelets page to get a drop-down menu that lets you switch to any current conversation, or to any other page of the application:

```

<h:selectOneMenu value="#{switcher.conversationIdOrOutcome}">
  <f:selectItem itemLabel="Find Issues" itemValue="findIssue"/>
  <f:selectItem itemLabel="Create Issue" itemValue="editIssue"/>
  <f:selectItems value="#{switcher.selectItems}"/>
</h:selectOneMenu>
<h:commandButton action="#{switcher.select}" value="Switch"/>

```

In this example, we have a menu that includes an item for each conversation, together with two additional items that let the user begin a new conversation.



3.6.4. The conversation list

The conversation list is very similar to the conversation switcher, except that it is displayed as a table:

```

<h:dataTable value="#{conversationList}" var="entry"
  rendered="#{not empty conversationList}">
  <h:column>
    <f:facet name="header">Workspace</f:facet>
    <h:commandLink action="#{entry.select}" value="#{entry.description}"/>
    <h:outputText value="[current]" rendered="#{entry.current}"/>
  </h:column>
  <h:column>
    <f:facet name="header">Activity</f:facet>
    <h:outputText value="#{entry.startDatetime}">
      <f:convertDateTime type="time" pattern="hh:mm a"/>
    </h:outputText>
    <h:outputText value=" - "/>
    <h:outputText value="#{entry.lastDatetime}">
      <f:convertDateTime type="time" pattern="hh:mm a"/>
    </h:outputText>
  </h:column>
  <h:column>
    <f:facet name="header">Action</f:facet>
    <h:commandButton action="#{entry.select}" value="#{msg.Switch}"/>
    <h:commandButton action="#{entry.destroy}" value="#{msg.Destroy}"/>
  </h:column>
</h:dataTable>

```

```
</h:column>
</h:dataTable>
```

We imagine that you will want to customize this for your own application.

Workspace	Workspace activity	Action
Comment on Issue [1] for Project [HHH]	01:18 PM - 01:18 PM	<input type="button" value="Switch"/> <input type="button" value="Destroy"/>
Issue [1] for Project [HHH]	01:18 PM - 01:18 PM	<input type="button" value="Switch"/> <input type="button" value="Destroy"/>
Project [HHH]	01:18 PM - 01:18 PM	<input type="button" value="Switch"/> <input type="button" value="Destroy"/>

The conversation list is nice, but it takes up a lot of space on the page, so you probably don't want to put it on *every* page.

Notice that the conversation list lets the user destroy workspaces.

3.6.5. Breadcrumbs

Breadcrumbs are useful in applications which use a nested conversation model. The breadcrumbs are a list of links to conversations in the current conversation stack:

```
<t:dataList value="#{conversationStack}" var="entry">
  <h:outputText value=" | "/>
  <h:commandLink value="#{entry.description}" action="#{entry.select}"/>
</t:dataList>
```

Notice that here we are using the MyFaces `<t:dataList>` component, since JSF amazingly does not provide any standard component for looping.

[Home](#) | [Find Issues](#) | [Create Issue](#) | [Project \[HHH\]](#) | [Issue \[1\] for Project \[HHH\]](#)

Issue Attributes

Please refer to the Seam Issue Tracker demo to see all this functionality in action!

3.7. Seam and AJAX

AJAX requests from a JSF page are not processed by the JSF servlet, so Seam provides a servlet filter that can be applied to the servlet processing your AJAX calls (or, in fact, to any servlet at all).

```
<filter>
  <filter-name>Seam Servlet Filter</filter-name>
  <filter-class>org.jboss.seam.servlet.SeamServletFilter</filter-class>
</filter>

<filter-mapping>
  <filter-name>Seam Servlet Filter</filter-name>
  <url-pattern>*.ajax</url-pattern>
</filter-mapping>
```

This servlet filter is responsible for initializing all Seam contexts before passing control to the servlet. It expects to find the conversation id of any conversation context in a request parameter named `conversationId`. You are responsible for ensuring that it gets sent in the request.

You are also responsible for ensuring propagation of any new conversation id back to the client. Seam exposes the conversation id as a property of the built in component `conversation`.

Seam also provides the Seam Remoting framework, a simple way to expose any method of a Seam component for invocation by an asynchronous JavaScript request simply by annotating the methods that should be accessible in the client. See the Seam Remoting chapter for further information.

3.8. Seam and SOAP

TODO

Chapter 4. Pageflows and business processes

JBoss jBPM is a business process management engine for any Java SE or EE environment. jBPM lets you represent a business process or user interaction as a graph of nodes representing wait states, decisions, tasks, web pages, etc. The graph is defined using a simple, very readable, XML dialect called jPDL, and may be edited and visualised graphically using an eclipse plugin. jPDL is an extensible language, and is suitable for a range of problems, from defining web application page flow, to traditional workflow management, all the way up to orchestration of services in a SOA environment.

Seam applications use jBPM for two different problems:

- Defining the pageflow involved in complex user interactions. A jPDL process definition defines the page flow for a single conversation. A Seam conversation is considered to be a relatively short-running interaction with a single user.
- Defining the overarching business process. The business process may span multiple conversations with multiple users. Its state is persistent in the jBPM database, so it is considered long-running. Coordination of the activities of multiple users is a much more complex problem than scripting an interaction with a single user, so jBPM offers sophisticated facilities for task management and dealing with multiple concurrent paths of execution.

Don't get these two things confused ! They operate at very different levels or granularity. *Pageflow*, *conversation* and *task* all refer to a single interaction with a single user. A business process spans many tasks. Furthermore, the two applications of jBPM are totally orthogonal. You can use them together or independently or not at all.

You don't have to know jDPL to use Seam. If you're perfectly happy defining pageflow using JSF's navigation rules, and if your application is more data-driven than process-driven, you probably don't need jBPM. But we're finding that thinking of user interaction in terms of a well-defined graphical representation is helping us build more robust applications.

4.1. Pageflow in Seam

There are two ways to define pageflow in Seam:

- Using JSF navigation rules - the *stateless navigation model*
- Using jPDL - the *stateful navigation model*

Very simple applications will only need the stateless navigation model. Very complex applications will use both models in different places. Each model has its strengths and weaknesses!

4.1.1. The two navigation models

The stateless model defines a mapping from a set of named, logical outcomes of an event directly to the resulting page of the view. The navigation rules are entirely oblivious to any state held by the application other than what page was the source of the event. This means that your action listener methods must sometimes make decisions about the page flow, since only they have access to the current state of the application.

Here is an example page flow definition using JSF navigation rules:

```

<navigation-rule>
  <from-view-id>/numberGuess.jsp</from-view-id>

  <navigation-case>
    <from-outcome>guess</from-outcome>
    <to-view-id>/numberGuess.jsp</to-view-id>
    <redirect/>
  </navigation-case>

  <navigation-case>
    <from-outcome>win</from-outcome>
    <to-view-id>/win.jsp</to-view-id>
    <redirect/>
  </navigation-case>

  <navigation-case>
    <from-outcome>lose</from-outcome>
    <to-view-id>/lose.jsp</to-view-id>
    <redirect/>
  </navigation-case>
</navigation-rule>

```

If you find navigation rules overly verbose, you can return view ids directly from your action listener methods:

```

public String guess() {
    if (guess==randomNumber) return "/win.jsp";
    if (++guessCount==maxGuesses) return "/lose.jsp";
    return null;
}

```

Note that this results in a redirect. You can even specify parameters to be used in the redirect:

```

public String search() {
    return "/searchResults.jsp?searchPattern=#{searchAction.searchPattern}";
}

```

The stateful model defines a set of transitions between a set of named, logical application states. In this model, it is possible to express the flow of any user interaction entirely in the jPDL pageflow definition, and write action listener methods that are completely unaware of the flow of the interaction.

Here is an example page flow definition using jPDL:

```

<pageflow-definition name="numberGuess">

  <start-page name="displayGuess" view-id="/numberGuess.jsp">
    <redirect/>
    <transition name="guess" to="evaluateGuess">
      <action expression="#{numberGuess.guess}" />
    </transition>
  </start-page>

  <decision name="evaluateGuess" expression="#{numberGuess.correctGuess}">
    <transition name="true" to="win"/>
    <transition name="false" to="evaluateRemainingGuesses"/>
  </decision>

  <decision name="evaluateRemainingGuesses" expression="#{numberGuess.lastGuess}">
    <transition name="true" to="lose"/>
    <transition name="false" to="displayGuess"/>
  </decision>

  <page name="win" view-id="/win.jsp">
    <redirect/>
    <end-conversation />
  </page>
</pageflow-definition>

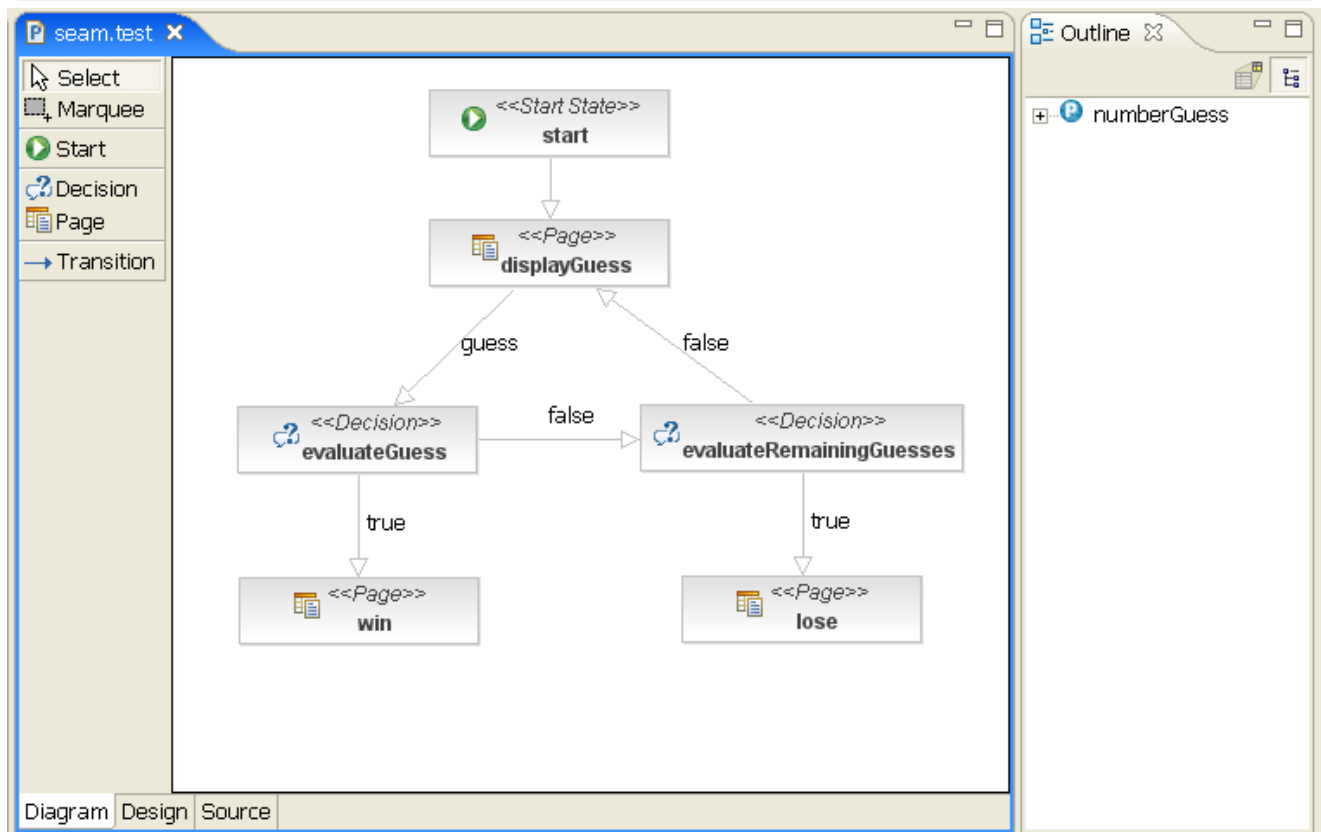
```

```

<page name="lose" view-id="/lose.jsp">
  <redirect/>
  <end-conversation />
</page>

</pageflow-definition>

```



There are two things we notice immediately here:

- The JSF navigation rules are *much* simpler. (However, this obscures the fact that the underlying Java code is more complex.)
- The jPDL makes the user interaction immediately understandable, without us needing to even look at the JSP or Java code.

In addition, the stateful model is more *constrained*. For each logical state (each step in the page flow), there are a constrained set of possible transitions to other states. The stateless model is an *ad hoc* model which is suitable to relatively unconstrained, freeform navigation where the user decides where he/she wants to go next, not the application.

The stateful/stateless navigation distinction is quite similar to the traditional view of modal/modeless interaction. Now, Seam applications are not usually modal in the simple sense of the word - indeed, avoiding application modal behavior is one of the main reasons for having conversations! However, Seam applications can be, and often are, modal at the level of a particular conversation. It is well-known that modal behavior is something to avoid as much as possible; it is very difficult to predict the order in which your users are going to want to do things! However, there is no doubt that the stateful model has its place.

The biggest contrast between the two models is the back-button behavior.

4.1.2. Seam and the back button

When JSF navigation rules are used, Seam lets the user freely navigate via the back, forward and refresh buttons. It is the responsibility of the application to ensure that conversational state remains internally consistent when this occurs. Experience with the combination of web application frameworks like Struts or WebWork - that do not support a conversational model - and stateless component models like EJB stateless session beans or the Spring framework has taught many developers that this is close to impossible to do! However, our experience is that in the context of Seam, where there is a well-defined conversational model, backed by stateful session beans, it is actually quite straightforward. Usually it is as simple as combining the use of the `@Conversational` annotation with null checks at the beginning of action listener methods. We consider support for freeform navigation to be almost always desirable.

On the other hand, in the stateful model, backbuttoning is interpreted as an undefined transition back to a previous state. Since the stateful model enforces a defined set of transitions from the current state, back buttoning is by default disallowed in the stateful model! Seam transparently detects the use of the back button, and blocks any attempt to perform an action from a previous, "stale" page, and simply redirects the user to the "current" page (and displays a faces message). Whether you consider this a feature or a limitation of the stateful model depends upon your point of view: as an application developer, it is a feature; as a user, it might be frustrating! You can enable backbutton navigation from a particular page node by setting `back="enabled"`.

```
<page name="checkout" view-id="/checkout.xhtml" back="enabled">
  <redirect/>
  <transition to="checkout"/>
  <transition name="complete" to="complete"/>
</page>
```

This allows backbuttoning *from* the `checkout` state to *any previous state*!

In practice, both navigation models have their place, and you'll quickly learn to recognize when to prefer one model over the other.

4.2. Using jPDL pageflows

4.2.1. Installing pageflows

We need to install the Seam jBPM-related components, and tell them where to find our pageflow definition. As usual, we can specify Seam configuration in either `web.xml` or `seam.properties`:

```
org.jboss.seam.core.init.componentClasses org.jboss.seam.core.Jbpm
org.jboss.seam.core.jbpm.pageflowDefinitions pageflow.jpdl.xml
```

The first line installs jBPM, the second points to a jPDL-based pageflow definition.

4.2.2. Starting pageflows

We "start" a jPDL-based pageflow by specifying the name of the process definition using a `@Begin`, `@BeginTask` or `@StartTask` annotation:

```
@Begin(pageflow="numberguess")
public void begin() { ... }
```

If we are beginning the pageflow during the `RENDER_RESPONSE` phase—during a `@Factory` or `@Create` method, for example—we consider ourselves to be already at the page being rendered, and use a `<start-page>` node as the first node in the pageflow, as in the example above.

But if the pageflow is begun as the result of an action listener invocation, the outcome of the action listener determines which is the first page to be rendered. In this case, we use a `<start-state>` as the first node in the pageflow, and declare a transition for each possible outcome:

```
<pageflow-definition name="viewEditDocument">

  <start-state name="start">
    <transition name="documentFound" to="displayDocument" />
    <transition name="documentNotFound" to="notFound" />
  </start-state>

  <page name="displayDocument" view-id="/document.jsp">
    <transition name="edit" to="editDocument" />
    <transition name="done" to="main" />
  </page>

  ...

  <page name="notFound" view-id="/404.jsp">
    <end-conversation/>
  </page>

</pageflow-definition>
```

4.2.3. Page nodes and transitions

Each `<page>` node represents a state where the system is waiting for user input:

```
<page name="displayGuess" view-id="/numberGuess.jsp">
  <redirect/>
  <transition name="guess" to="evaluateGuess">
    <action expression="#{numberGuess.guess}" />
  </transition>
</page>
```

The `view-id` is the JSF view id. The `<redirect/>` element has the same effect as `<redirect/>` in a JSF navigation rule: namely, a post-then-redirect behavior, to overcome problems with the browser's refresh button. (Note that Seam propagates conversation contexts over these browser redirects. So there is no need for a Ruby on Rails style "flash" construct in Seam!)

The transition name is the name of a JSF outcome triggered by clicking a command button or command link in `numberGuess.jsp`.

```
<h:commandButton type="submit" value="Guess" action="guess" />
```

When the transition is triggered by clicking this button, jBPM will activate the transition action by calling the `guess()` method of the `numberGuess` component. Notice that the syntax used for specifying actions in the jPDL is just a familiar JSF EL expression, and that the transition action handler is just a method of a Seam component in the current Seam contexts. So we have exactly the same event model for jBPM events that we already have for JSF events! (The *One Kind of Stuff* principle.)

In the case of a null outcome (for example, a command button with no `action` defined), Seam will signal the transition with no name if one exists, or else simply redisplay the page if all transitions have names. So we could slightly simplify our example pageflow and this button:

```
<h:commandButton type="submit" value="Guess" />
```

Would fire the following un-named transition:

```
<page name="displayGuess" view-id="/numberGuess.jsp">
  <redirect/>
  <transition to="evaluateGuess">
    <action expression="#{numberGuess.guess}" />
  </transition>
</page>
```

It is even possible to have the button call an action method, in which case the action outcome will determine the transition to be taken:

```
<h:commandButton type="submit" value="Guess" action="#{numberGuess.guess}" />
```

```
<page name="displayGuess" view-id="/numberGuess.jsp">
  <transition name="correctGuess" to="win"/>
  <transition name="incorrectGuess" to="evaluateGuess"/>
</page>
```

However, this is considered an inferior style, since it moves responsibility for controlling the flow out of the pageflow definition and back into the other components. It is much better to centralize this concern in the pageflow itself.

4.2.4. Controlling the flow

Usually, we don't need the more powerful features of jPDL when defining pageflows. We do need the `<decision>` node, however:

```
<decision name="evaluateGuess" expression="#{numberGuess.correctGuess}">
  <transition name="true" to="win"/>
  <transition name="false" to="evaluateRemainingGuesses"/>
</decision>
```

A decision is made by evaluating a JSF EL expression in the Seam contexts.

4.2.5. Ending the flow

We end the conversation using `<end-conversation>` or `@End`. (In fact, for readability, use of *both* is encouraged.)

```
<page name="win" view-id="/win.jsp">
  <redirect/>
  <end-conversation/>
</page>
```

Optionally, we can specify a transition name. In this case, Seam will signal the end of the current task in the overarching business process.

```
<page name="win" view-id="/win.jsp">
  <redirect/>
  <end-conversation transition="success"/>
</page>
```

4.3. Business process management in Seam

A business process is a well-defined set of tasks that must be performed by users or software systems according to well-defined rules about *who* can perform a task, and *when* it should be performed. Seam's jBPM integration

4.4.2. Initializing actor ids

We always need to know what user is currently logged in. jBPM "knows" users by their *actor id* and *group actor ids*. We specify the current actor ids using the built in Seam component named `actor`:

```
@In(create=true) Actor actor;

public String login() {
    ...
    actor.setId( user.getUserName() );
    actor.getGroupActorIds().addAll( user.getGroupNames() );
    ...
}
```

4.4.3. Initiating a business process

To initiate a business process instance, we use the `@CreateProcess` annotation:

```
@CreateProcess(definition="todo")
public void createTodo() { ... }
```

4.4.4. Task assignment

When a process starts, task instances are created. These must be assigned to users or user groups. We can either hardcode our actor ids, or delegate to a Seam component:

```
<task name="todo" description="#{todoList.description}">
    <assignment actor-id="#{actor.id}"/>
</task>
```

In this case, we have simply assigned the task to the current user. We can also assign tasks to a pool:

```
<task name="todo" description="#{todoList.description}">
    <assignment pooled-actors="employees"/>
</task>
```

4.4.5. Task lists

Several built-in Seam components make it easy to display task lists. The `pooledTaskInstanceList` is a list of pooled tasks that users may assign to themselves:

```
<h:dataTable value="#{pooledTaskInstanceList}" var="task">
    <h:column>
        <f:facet name="header">Description</f:facet>
        <h:outputText value="#{task.description}"/>
    </h:column>
    <h:column>
        <h:commandLink action="#{pooledTask.assignToCurrentActor}">
            <h:commandButton value="Assign"/>
            <f:param name="taskId" value="#{task.id}"/>
        </h:commandLink>
    </h:column>
</h:dataTable>
```

The `pooledTask` component is a built-in component that simply assigns the task to the current user.

The `taskInstanceListByType` component includes tasks of a particular type that are assigned to the current

user:

```
<h:dataTable value="#{taskInstanceListByType['todo']}" var="task">
  <h:column>
    <f:facet name="header">Description</f:facet>
    <h:outputText value="#{task.description}"/>
  </h:column>
  <h:column>
    <h:commandLink action="#{todoList.start}">
      <h:commandButton value="Start Work"/>
      <f:param name="taskId" value="#{task.id}"/>
    </h:commandLink>
  </h:column>
</h:dataTable>
```

4.4.6. Performing a task

To begin work on a task, we use either `@StartTask` or `@BeginTask` on the listener method:

```
@StartTask
public String start() { ... }
```

These annotations begin a special kind of conversation that has significance in terms of the overarching business process. Work done by this conversation has access to state held in the business process context.

If we end the conversation using `@EndTask`, Seam will signal the completion of the task:

```
@EndTask(transition="completed")
public String completed() { ... }
```

(Alternatively, we could have used `<end-conversation>` as shown above.)

At this point, jBPM takes over and continues executing the business process definition. (In more complex processes, several tasks might need to be completed before process execution can resume.)

Please refer to the jBPM documentation for a more thorough overview of the sophisticated features that jBPM provides for managing complex business processes.

Chapter 5. Internationalization

Seam makes it easy to build internationalized applications by providing several built-in components for handling multi-language UI messages.

5.1. Locales

Each user login session has an associated instance of `java.util.Locale` (available to the application as a session-scoped component named `locale`). Under normal circumstances, you won't need to do any special configuration to set the locale. Seam just delegates to JSF to determine the active locale:

- If there is a locale associated with the HTTP request (the browser locale), and that locale is in the list of supported locales from `faces-config.xml`, use that locale for the rest of the session.
- Otherwise, if a default locale was specified in the `faces-config.xml`, use that locale for the rest of the session.
- Otherwise, use the default locale of the server.

It is *possible* to set the locale manually via the Seam configuration properties `localeSelector.language`, `localeSelector.country` and `localeSelector.variant`, but we can't think of any good reason to ever do this.

It is, however, useful to allow the user to set the locale manually via the application user interface. Seam provides built-in functionality for overriding the locale determined by the algorithm above. All you have to do is add the following fragment to a form in your JSP or Facelets page:

```
<h:selectOneMenu value="#{localeSelector.language}">
  <f:selectItem itemLabel="English" itemValue="en"/>
  <f:selectItem itemLabel="Deutsch" itemValue="de"/>
  <f:selectItem itemLabel="Francais" itemValue="fr"/>
</h:selectOneMenu>
<h:commandButton action="#{localeSelector.select}" value="#{messages['ChangeLanguage']}"/>
```

Or, if you want a list of all supported locales from `jsf-config.xml`, just use:

```
<h:selectOneMenu value="#{localeSelector.localeString}">
  <f:selectItems value="#{localeSelector.supportedLocales}"/>
</h:selectOneMenu>
<h:commandButton action="#{localeSelector.select}" value="#{messages['ChangeLanguage']}"/>
```

When this user selects an item from the drop-down, and clicks the button, the Seam and JSF locales will be overridden for the rest of the session.

5.2. Labels

JSF supports internationalization of user interface labels and descriptive text via the use of `<f:loadBundle />`. You can use this approach in Seam applications. Alternatively, you can take advantage of the Seam `messages` component to display templated labels with embedded EL expressions.

Each login session has an associated instance of `java.util.ResourceBundle` (available to the application as a session-scoped component named `resourceBundle`). You'll need to make your internationalized labels available via this special resource bundle. By default, the resource bundle used by Seam is named `messages` and so

you'll need to define your labels in files named `messages.properties`, `messages_en.properties`, `messages_en_AU.properties`, etc. These files usually belong in the `WEB-INF/classes` directory.

So, in `messages_en.properties`:

```
Hello=Hello
```

And in `messages_en_AU.properties`:

```
Hello=G'day
```

You can select a different name for the resource bundle by setting the Seam configuration property named `resourceBundle.bundleName`.

If you define your labels in this special resource bundle, you'll be able to use them without having to type `<f:loadBundle ... />` on every page. Instead, you can simply type:

```
<h:outputText value="#{messages['Hello']}" />
```

or:

```
<h:outputText value="#{messages.Hello}" />
```

Even better, the messages themselves may contain EL expressions:

```
Hello=Hello, #{user.firstName} #{user.lastName}
```

```
Hello=G'day, #{user.firstName}
```

You can even use the messages in your code:

```
@In(create=true) private Map<String, String> messages;
```

```
@In("#{messages['Hello']}") private String helloMessage;
```

5.3. Faces messages

The `facesMessages` component is a super-convenient way to display success or failure messages to the user. The functionality we just described also works for faces messages:

```
@Name("hello")
@Stateless
public class HelloBean implements Hello {
    @In(create=true)
    FacesMessages facesMessages;

    public String sayIt() {
        facesMessages.addFromResourceBundle("Hello");
    }
}
```

This will display `Hello`, `Gavin King` or `G'day, Gavin`, depending upon the user's locale.

Chapter 6. Remoting

Seam provides a convenient method of remotely accessing components from a web page, using AJAX (Asynchronous Javascript and XML). The framework for this functionality is provided with almost no up-front development effort - your components only require simple annotating to become accessible via AJAX. This chapter describes the steps required to build an AJAX-enabled web page, then goes on to explain the features of the Seam Remoting framework in more detail.

6.1. Configuration

To use remoting, the Seam Remoting servlet must first be configured in your `web.xml` file:

```
<servlet>
  <servlet-name>Seam Remoting</servlet-name>
  <servlet-class>org.jboss.seam.remoting.SeamRemotingServlet</servlet-class>
</servlet>

<servlet-mapping>
  <servlet-name>Seam Remoting</servlet-name>
  <url-pattern>/seam/remoting/*</url-pattern>
</servlet-mapping>
```

The next step is to import the necessary Javascript into your web page. There are a minimum of two scripts that must be imported. The first one contains all the client-side framework code that enables remoting functionality:

```
<script type="text/javascript" src="seam/remoting/resource/remote.js">
  <!--
  // This space intentionally left blank
  //-->
</script>
```

The second script contains the stubs and type definitions for the components you wish to call. It is generated dynamically based on the local interface of your components, and includes type definitions for all of the classes that can be used to call the remotable methods of the interface. The name of the script reflects the name of your component. For example, if you have a stateless session bean annotated with `@Name("customerAction")`, then your script tag should look like this:

```
<script type="text/javascript" src="seam/remoting/interface.js?customerAction">
  <!--
  // This space intentionally left blank
  //-->
</script>
```

If you wish to access more than one component from the same page, then include them all as parameters of your script tag:

```
<script type="text/javascript" src="seam/remoting/interface.js?customerAction&accountAction">
  <!--
  // This space intentionally left blank
  //-->
</script>
```

6.2. The "Seam" object

Client-side interaction with your components is all performed via the `Seam Javascript` object. This object is defined in `remote.js`, and you'll be using it to make asynchronous calls against your component. It is split into two areas of functionality; `Seam.Component` contains methods for working with components and `Seam.Remoting` contains methods for executing remote requests. The easiest way to become familiar with this object is to start with a simple example.

6.2.1. A Hello World example

Let's step through a simple example to see how the `Seam` object works. First of all, let's create a new Seam component called `helloAction`.

```
@Stateless
@Name("helloAction")
@Scope(SESSION)
public class HelloAction implements HelloLocal {
    public String sayHello(String name) {
        return "Hello, " + name;
    }
}
```

You also need to create a local interface for our new component - take special note of the `@WebRemote` annotation, as it's required to make our method accessible via remoting:

```
@Local
public interface HelloLocal {
    @WebRemote
    public String sayHello(String name);
}
```

That's all the server-side code we need to write. Now for our web page - create a new page and import the following scripts:

```
<script type="text/javascript" src="seam/remoting/resource/remote.js">
  <!--
  // This space intentionally left blank
  //-->
</script>

<script type="text/javascript" src="seam/remoting/interface.js?helloAction">
```

```

<!--
// This space intentionally left blank
//-->
</script>

```

To make this a fully interactive user experience, let's add a button to our page:

```
<button onclick="javascript:sayHello()">Say Hello</button>
```

We'll also need to add some more script to make our button actually do something when it's clicked:

```

<script type="text/javascript">
  <![CDATA[

    function sayHello() {
      var name = prompt("What is your name?");
      Seam.Component.getInstance("helloAction").sayHello(name, sayHelloCallback);
    }

    function sayHelloCallback(result) {
      alert(result);
    }

    // ]]>
  </script>

```

We're done! Deploy your application and browse to your page. Click the button, and enter a name when prompted. A message box will display the hello message confirming that the call was successful. If you want to save some time, you'll find the full source code for this Hello World example in Seam's `/examples/remoting/helloworld` directory.

So what does the code of our script actually do? Let's break it down into smaller pieces. To start with, you can see from the Javascript code listing that we have implemented two methods - the first method is responsible for prompting the user for their name and then making a remote request. Take a look at the following line:

```
Seam.Component.getInstance("helloAction").sayHello(name, sayHelloCallback);
```

The first section of this line, `Seam.Component.getInstance("helloAction")` returns a proxy, or "stub" for our `helloAction` component. We can invoke the methods of our component against this stub, which is exactly what happens with the remainder of the line: `sayHello(name, sayHelloCallback);`.

What this line of code in its completeness does, is invoke the `sayHello` method of our component, passing in `name` as a parameter. The second parameter, `sayHelloCallback` isn't a parameter of our component's `sayHello` method, instead it tells the Seam Remoting framework that once it receives the response to our request, it should pass it to the `sayHelloCallback` Javascript method. This callback parameter is entirely optional, so feel free to leave it out if you're calling a method with a `void` return type or if you don't care about the result.

The `sayHelloCallback` method, once receiving the response to our remote request then pops up an alert mes-

sage displaying the result of our method call.

6.2.2. Seam.Component

The `Seam.Component` Javascript object provides a number of client-side methods for working with your Seam components. The two main methods, `newInstance()` and `getInstance()` are documented in the following sections however their main difference is that `newInstance()` will always create a new instance of a component type, and `getInstance()` will return a singleton instance.

Seam.Component.newInstance()

Use this method to create a new instance of an entity or Javabeen component. The object returned by this method will have the same getter/setter methods as its server-side counterpart, or alternatively if you wish you can access its fields directly. Take the following Seam entity component for example:

```
@Name("customer")
@Entity
public class Customer implements Serializable
{
    private Integer customerId;
    private String firstName;
    private String lastName;

    @Column public Integer getCustomerId() {
        return customerId;
    }

    public void setCustomerId(Integer customerId) {
        this.customerId = customerId;
    }

    @Column public String getFirstName() {
        return firstName;
    }

    public void setFirstName(String firstName) {
        this.firstName = firstName;
    }

    @Column public String getLastName() {
        return lastName;
    }

    public void setLastName(String lastName) {
        this.lastName = lastName;
    }
}
```

To create a client-side Customer you would write the following code:

```
var customer = Seam.Component.newInstance("customer");
```

Then from here you can set the fields of the customer object:

```
customer.setFirstName("John");
// Or you can set the fields directly
customer.lastName = "Smith";
```

Seam.Component.getInstance()

The `getInstance()` method is used to get a reference to a Seam session bean component stub, which can then be used to remotely execute methods against your component. This method returns a singleton for the specified component, so calling it twice in a row with the same component name will return the same instance of the component.

To continue our example from before, if we have created a new `customer` and we now wish to save it, we would pass it to the `saveCustomer()` method of our `customerAction` component:

```
Seam.Component.getInstance("customerAction").saveCustomer(customer);
```

Seam.Component.getComponentName()

Passing an object into this method will return its component name if it is a component, or `null` if it is not.

```
if (Seam.Component.getComponentName(instance) == "customer")
    alert("Customer");
else if (Seam.Component.getComponentName(instance) == "staff")
    alert("Staff member");
```

6.2.3. Seam.Remoting

Most of the client side functionality for Seam Remoting is contained within the `Seam.Remoting` object. While you shouldn't need to directly call most of its methods, there are a couple of important ones worth mentioning.

Seam.Remoting.createType()

If your application contains or uses Javabeen classes that aren't Seam components, you may need to create these types on the client side to pass as parameters into your component method. Use the `createType()` method to create an instance of your type. Pass in the fully qualified Java class name as a parameter:

```
var widget = Seam.Remoting.createType("com.acme.widgets.MyWidget");
```

Seam.Remoting.getTypeName()

This method is the equivalent of `Seam.Component.getComponentName()` but for non-component types. It will return the name of the type for an object instance, or `null` if the type is not known. The name is the fully qualified name of the type's Java class.

6.3. Client Interfaces

In the configuration section above, the interface, or "stub" for our component is imported into our page via `seam/remoting/interface.js`:

```
<script type="text/javascript" src="seam/remoting/interface.js?customerAction">
```



```
<!--  
  // This space intentionally left blank  
  //-->  
</script>
```

By including this script in our page, the interface definitions for our component, plus any other components or types that are required to execute the methods of our component are generated and made available for the remoting framework to use.

There are two types of client stub that can be generated, "executable" stubs and "type" stubs. Executable stubs are behavioural, and are used to execute methods against your session bean components, while type stubs contain state and represent the types that can be passed in as parameters or returned as a result.

The type of client stub that is generated depends on the type of your Seam component. If the component is a session bean, then an executable stub will be generated, otherwise if it's an entity or JavaBean, then a type stub will be generated. There is one exception to this rule; if your component is a JavaBean (ie it is not a session bean nor an entity bean) and any of its methods are annotated with `@WebRemote`, then an executable stub will be generated for it instead of a type stub. This allows you to use remoting to call methods of your JavaBean components in a non-EJB environment where you don't have access to session beans.

6.4. The Context

The Seam Remoting Context contains additional information which is sent and received as part of a remoting request/response cycle. At this stage it only contains the conversation ID but may be expanded in the future.

6.4.1. Setting and reading the Conversation ID

If you intend on using remote calls within the scope of a conversation then you need to be able to read or set the conversation ID in the Seam Remoting Context. To read the conversation ID after making a remote request call `Seam.Remoting.getContext().getConversationId()`. To set the conversation ID before making a request, call `Seam.Remoting.getContext().setConversationId()`.

6.5. Batch Requests

Seam Remoting allows multiple component calls to be executed within a single request. It is recommended that this feature is used wherever it is appropriate to reduce network traffic.

The method `Seam.Remoting.startBatch()` will start a new batch, and any component calls executed after starting a batch are queued, rather than being sent immediately. When all the desired component calls have been added to the batch, the `Seam.Remoting.executeBatch()` method will send a single request containing all of the queued calls to the server, where they will be executed in order. After the calls have been executed, a single response containing all return values will be returned to the client and the callback functions (if provided) triggered in the same order as execution.

If you start a new batch via the `startBatch()` method but then decide you don't want to send it, the `Seam.Remoting.cancelBatch()` method will discard any calls that were queued and exit the batch mode.

To see an example of a batch being used, take a look at `/examples/remoting/chatroom`.

6.6. Working with Data types

6.6.1. Primitives / Basic Types

This section describes the support for basic data types. On the server side these values are generally compatible with either their primitive type or their corresponding wrapper class.

String

Simply use Javascript String objects when setting String parameter values.

Number

There is support for all number types supported by Java. On the client side, number values are always serialized as their String representation and then on the server side they are converted to the correct destination type. Conversion into either a primitive or wrapper type is supported for Byte, Double, Float, Integer, Long and Short types.

Boolean

Booleans are represented client side by Javascript Boolean values, and server side by a Java boolean.

6.6.2. JavaBeans

In general these will be either Seam entity or JavaBean components, or some other non-component class. Use the appropriate method (either `Seam.Component.newInstance()` for Seam components or `Seam.Remoting.createType()` for everything else) to create a new instance of the object.

It is important to note that only objects that are created by either of these two methods should be used as parameter values, where the parameter is not one of the other valid types mentioned anywhere else in this section. In some situations you may have a component method where the exact parameter type cannot be determined, such as:

```
@Name("myAction")
public class MyAction implements MyActionLocal {
    public void doSomethingWithObject(Object obj) {
        // code
    }
}
```

In this case you might want to pass in an instance of your `myWidget` component, however the interface for `myAction` won't include `myWidget` as it is not directly referenced by any of its methods. To get around this, `MyWidget` needs to be explicitly imported:

```
<script type="text/javascript" src="seam/remoting/interface.js?myAction&myWidget">
  <!--
  // This space intentionally left blank
  //-->
</script>
```

This will then allow a `myWidget` object to be created with `Seam.Component.newInstance("myWidget")`, which can then be passed to `myAction.doSomethingWithObject()`.

6.6.3. Dates and Times

Date values are serialized into a String representation that is accurate to the millisecond. On the client side, use a Javascript Date object to work with date values. On the server side, use any `java.util.Date` (or descendent, such as `java.sql.Date` or `java.sql.Timestamp` class).

6.6.4. Enums

On the client side, enums are treated the same as Strings. When setting the value for an enum parameter, simply use the String representation of the enum. Take the following component as an example:

```
@Name("paintAction")
public class paintAction implements paintLocal {
    public enum Color {red, green, blue, yellow, orange, purple};

    public void paint(Color color) {
        // code
    }
}
```

To call the `paint()` method with the color `red`, pass the parameter value as a String literal:

```
Seam.Component.getInstance("paintAction").paint("red");
```

The inverse is also true - that is, if a component method returns an enum parameter (or contains an enum field anywhere in the returned object graph) then on the client-side it will be represented as a String.

6.6.5. Collections

Bags

Bags cover all collection types including arrays, collections, lists, sets, (but excluding Maps - see the next section for those), and are implemented client-side as a Javascript array. When calling a component method that accepts one of these types as a parameter, your parameter should be a Javascript array. If a component method returns one of these types, then the return value will also be a Javascript array. The remoting framework is clever enough on the server side to convert the bag to an appropriate type for the component method call.

Maps

As there is no native support for Maps within Javascript, a simple Map implementation is provided with the Seam Remoting framework. To create a Map which can be used as a parameter to a remote call, create a new `Seam.Remoting.Map` object:

```
var map = new Seam.Remoting.Map();
```

This Javascript implementation provides basic methods for working with Maps: `size()`, `isEmpty()`, `keySet()`, `values()`, `get(key)`, `put(key, value)`, `remove(key)` and `contains(key)`. Each of these methods are equivalent to their Java counterpart. Where the method returns a collection, such as `keySet()` and `values()`, a Javascript Array object will be returned that contains the key or value objects (respectively).

6.7. Debugging

To aid in tracking down bugs, it is possible to enable a debug mode which will display the contents of all the packets send back and forth between the client and server in a popup window. To enable debug mode, execute the `setDebug()` method:

```
Seam.Remoting.setDebug(true);
```

To turn off debugging, call `setDebug(false)`. If you want to write your own messages to the debug log, call `Seam.Remoting.log(message)`.

6.8. The Loading Message

The default loading message that appears in the top right corner of the screen can be modified, its rendering customised or even turned off completely.

6.8.1. Changing the message

To change the message from the default "Please Wait..." to something different, set the value of `Seam.Remoting.loadingMessage`:

```
Seam.Remoting.loadingMessage = "Loading...";
```

6.8.2. Hiding the loading message

To completely suppress the display of the loading message, override the implementation of `displayLoadingMessage()` and `hideLoadingMessage()` with functions that instead do nothing:

```
// don't display the loading indicator
Seam.Remoting.displayLoadingMessage = function() {};
Seam.Remoting.hideLoadingMessage = function() {};
```

6.8.3. A Custom Loading Indicator

It is also possible to override the loading indicator to display an animated icon, or anything else that you want. To do this override the `displayLoadingMessage()` and `hideLoadingMessage()` messages with your own implementation:

```
Seam.Remoting.displayLoadingMessage = function() {  
    // Write code here to display the indicator  
};  
  
Seam.Remoting.hideLoadingMessage = function() {  
    // Write code here to hide the indicator  
};
```

6.9. JMS Messaging

Seam Remoting provides experimental support for JMS Messaging. This section describes the JMS support that is currently implemented, but please note that this may change in the future. It is currently not recommended that this feature is used within a production environment.

6.9.1. Subscribing to a JMS Topic

The following example demonstrates how to subscribe to a JMS Topic:

```
function subscriptionCallback(message)  
{  
    if (message instanceof Seam.Remoting.TextMessage)  
        alert("Received message: " + message.getText());  
}  
  
Seam.Remoting.subscribe("topicName", subscriptionCallback);
```

The `Seam.Remoting.subscribe()` method accepts two parameters, the first being the name of the JMS Topic to subscribe to, the second being the callback function to invoke when a message is received.

There are two types of messages supported, Text messages and Object messages. If you need to test for the type of message that is passed to your callback function you can use the `instanceof` operator to test whether the message is a `Seam.Remoting.TextMessage` or `Seam.Remoting.ObjectMessage`. A `TextMessage` contains the text value in its `text` field (or alternatively call `getText()` on it), while an `ObjectMessage` contains its object value in its `object` field (or call its `getObject()` method).

6.9.2. Unsubscribing from a Topic

To unsubscribe from a topic, call `Seam.Remoting.unsubscribe()` and pass in the topic name:

```
Seam.Remoting.unsubscribe("topicName");
```

6.9.3. Tuning the Polling Process

There are two parameters which you can modify to control how polling occurs. The first one is `Seam.Remoting.pollInterval`, which controls how long to wait between subsequent polls for new messages. This parameter is expressed in seconds, and its default setting is 10.

The second parameter is `Seam.Remoting.pollTimeout`, and is also expressed as seconds. It controls how long a

request to the server should wait for a new message before timing out and sending an empty response. Its default is 0 seconds, which means that when the server is polled, if there are no messages ready for delivery then an empty response will be immediately returned.

The following example demonstrates how to configure the polling to occur much more aggressively. You should set these parameters to suitable values for your application:

```
// Only wait 1 second between receiving a poll response and sending the next poll request.
Seam.Remoting.pollInterval = 1;

// Wait up to 5 seconds on the server for new messages
Seam.Remoting.pollTimeout = 5;
```

Chapter 7. Configuring Seam

Configuration is a very boring topic and an extremely tedious pastime. Unfortunately, several lines of XML are required to integrate Seam into your JSF implementation and servlet container. There's no need to be too put off by the following sections; you'll never need to type any of this stuff yourself, since you can just copy and paste from the example applications!

7.1. Basic Seam configuration

First, let's look at the basic configuration that is needed whenever we use Seam with JSF.

7.1.1. Integrating Seam with JSF and your servlet container

Seam requires the following entry in your `web.xml` file:

```
<listener>
  <listener-class>org.jboss.seam.servlet.SeamListener</listener-class>
</listener>
```

This listener is responsible for bootstrapping Seam, and for destroying session and application contexts.

If you are using Seam in Apache MyFaces (and possibly some other JSF implementations), you *must* use client-side state saving. So you'll also need this in `web.xml`:

```
<context-param>
  <param-name>javax.faces.STATE_SAVING_METHOD</param-name>
  <param-value>client</param-value>
</context-param>
```

To integrate with the JSF request lifecycle, we also need a JSF `PhaseListener` registered in in the `faces-config.xml` file:

```
<lifecycle>
  <phase-listener>org.jboss.seam.jsf.SeamPhaseListener</phase-listener>
</lifecycle>
```

The actual listener class here varies depending upon how you want to manage transaction demarcation (more on this below).

7.1.2. Integrating Seam with your EJB container

We need to apply the `SeamInterceptor` to our Seam components. The simplest way to do this is to add the following interceptor binding to the `<assembly-descriptor>` in `ejb-jar.xml`:

```
<interceptor-binding>
  <ejb-name>*</ejb-name>
  <interceptor-class>org.jboss.seam.ejb.SeamInterceptor</interceptor-class>
</interceptor-binding>
```

Seam needs to know where to go to find session beans in JNDI. One way to do this is specify the `@JndiName` annotation on every session bean Seam component. However, this is quite tedious. A better approach is to specify a pattern that Seam can use to calculate the JNDI name from the EJB name. Unfortunately, there is no standard mapping to global JNDI defined in the EJB3 specification, so this mapping is vendor-specific. We

must specify a pattern using the configuration property named `org.jboss.seam.core.init.jndiPattern`.

For JBoss AS, the following pattern is correct:

```
<context-param>
  <param-name>org.jboss.seam.core.init.jndiPattern</param-name>
  <param-value>myEarName/#{ejbName}/local</param-value>
</context-param>
```

Where `myEarName` is the name of the EAR in which the bean is deployed. Outside the context of an EAR (when using the JBoss Embeddable EJB3 container), the following pattern is the one to use:

```
<context-param>
  <param-name>org.jboss.seam.core.init.jndiPattern</param-name>
  <param-value>#{ejbName}/local</param-value>
</context-param>
```

Note that this configuration setting may be specified in either `web.xml` or in `seam.properties`.

```
org.jboss.seam.core.init.jndiPattern #{ejbName}/local</param-value>
```

7.1.3. Enabling conversation propagation with redirects

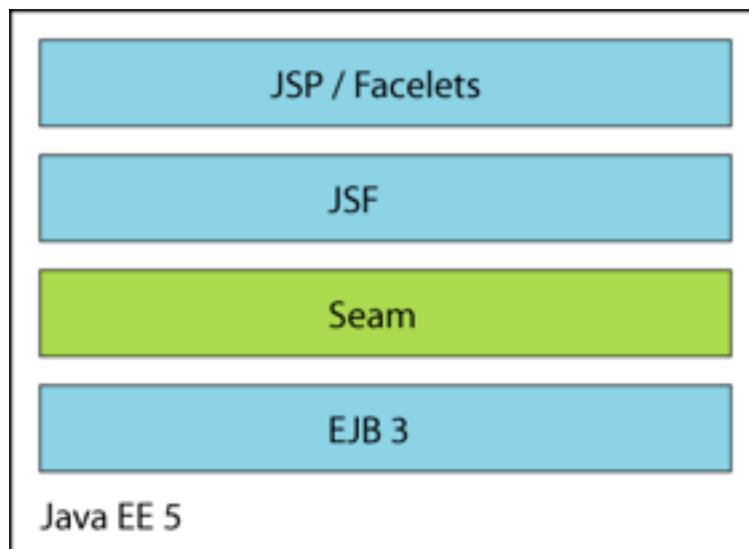
If you want to use post-then-redirect in JSF, and you want Seam to propagate the conversation context across the browser redirects, you need to register a servlet filter:

```
<filter>
  <filter-name>Seam Redirect Filter</filter-name>
  <filter-class>org.jboss.seam.servlet.SeamRedirectFilter</filter-class>
</filter>

<filter-mapping>
  <filter-name>Seam Redirect Filter</filter-name>
  <url-pattern>*.jsf</url-pattern>
</filter-mapping>
```

This filter intercepts any browser redirects and adds a request parameter that specifies the Seam conversation id.

7.2. Configuring Seam in Java EE 5



If you're running in a Java EE 5 environment, this is all the configuration required to start using Seam! But there is one final item you need to know about. You must place a `seam.properties` file in the root of any archive in which your Seam components are deployed (even an empty properties file will do). At startup, Seam will scan any archives with `seam.properties` files for seam components. If that doesn't work for you, you can also add components by listing them explicitly in the configuration property named `org.jboss.seam.core.init.componentClasses`.

7.2.1. Packaging

Once you've packaged all this stuff together into an EAR, the archive structure will look something like this:

```
my-application.ear/  
  jboss-seam.jar  
  META-INF/  
    MANIFEST.MF  
    application.xml  
  my-application.war/  
    META-INF/  
      MANIFEST.MF  
    WEB-INF/  
      web.xml  
      faces-config.xml  
    login.jsp  
    register.jsp  
    ...  
  my-application.jar/  
    META-INF/  
      MANIFEST.MF  
      persistence.xml  
      seam.properties  
    org/  
      jboss/  
        myapplication/  
          User.class  
          Login.class  
          LoginBean.class  
          Register.class  
          RegisterBean.class  
          ...
```

Make sure you reference `jboss-seam.jar` from manifests of the EJB-JAR and WAR.

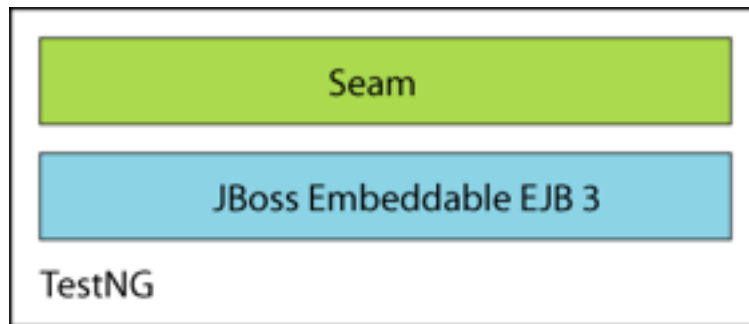
Seam ships with several example applications that are deployable in any Java EE container that supports EJB 3.0.

I really wish that was all there was to say on the topic of configuration but unfortunately we're only about a third of the way there. If you're too overwhelmed by all this tedious configuration stuff, feel free to skip over the rest of this section and come back to it later.

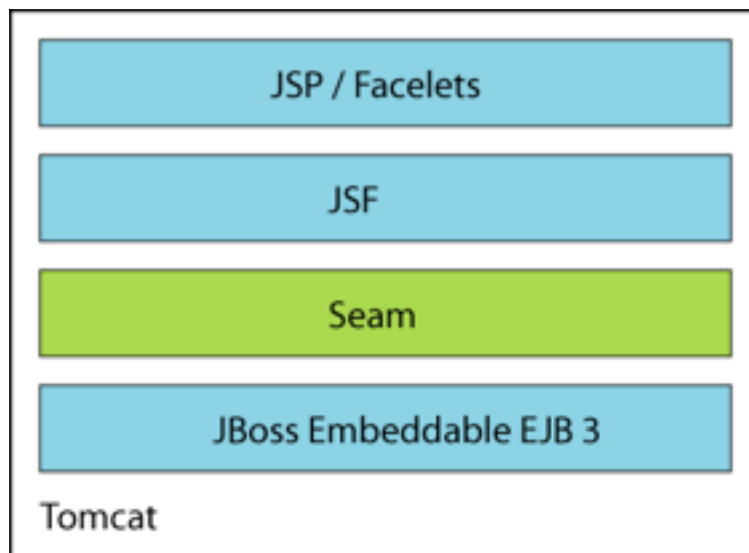
7.3. Configuring Seam with the JBoss Embeddable EJB3 container

The JBoss Embeddable EJB3 container lets you run EJB3 components outside the context of the Java EE 5 application server. This is especially, but not only, useful for testing.

The Seam booking example application includes a TestNG integration test suite that runs on the Embeddable EJB3 container.



The booking example application may even be deployed to Tomcat.



7.3.1. Installing the Embeddable EJB3 container

Seam ships with a build of the Embeddable EJB3 container in the `embedded-ejb` directory. To use the Embeddable EJB3 container with Seam, add the `embedded-ejb/conf` directory, and all jars in the `lib` and `embedded-ejb/lib` directories to your classpath. Then, add the following line to `seam.properties`:

```
org.jboss.seam.core.init.componentClasses org.jboss.seam.core.Ejb
```

Or, alternatively, add the following entry to `web.xml`:

```
<context-param>
  <param-name>org.jboss.seam.core.init.componentClasses</param-name>
  <param-value>org.jboss.seam.core.Ejb</param-value>
</context-param>
```

This setting installs the built-in component named `org.jboss.seam.core.ejb`. This component is responsible for bootstrapping the EJB container when Seam is started, and shutting it down when the web application is undeployed.

7.3.2. Configuring a datasource with the Embeddable EJB3 container

You should refer to the Embeddable EJB3 container documentation for more information about configuring the container. You'll probably at least need to set up your own datasource. Embeddable EJB3 is implemented using the JBoss Microcontainer, so it's very easy to add new services to the minimal set of services provided by default. For example, I can add a new datasource by putting this `jboss-beans.xml` file in my classpath:

```
<?xml version="1.0" encoding="UTF-8"?>
```

```

<deployment xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
             xsi:schemaLocation="urn:jboss:bean-deployer bean-deployer_1_0.xsd"
             xmlns="urn:jboss:bean-deployer">

  <bean name="bookingDatasourceBootstrap"
        class="org.jboss.resource.adapter.jdbc.local.LocalTxDataSource">
    <property name="driverClass">org.hsqldb.jdbcDriver</property>
    <property name="connectionURL">jdbc:hsqldb:./</property>
    <property name="userName">sa</property>
    <property name="jndiName">java:/bookingDatasource</property>
    <property name="minSize">0</property>
    <property name="maxSize">10</property>
    <property name="blockingTimeout">1000</property>
    <property name="idleTimeout">100000</property>
    <property name="transactionManager">
      <inject bean="TransactionManager"/>
    </property>
    <property name="cachedConnectionManager">
      <inject bean="CachedConnectionManager"/>
    </property>
    <property name="initialContextProperties">
      <inject bean="InitialContextProperties"/>
    </property>
  </bean>

  <bean name="bookingDatasource" class="java.lang.Object">
    <constructor factoryMethod="getDatasource">
      <factory bean="bookingDatasourceBootstrap"/>
    </constructor>
  </bean>

</deployment>

```

7.3.3. Packaging

The archive structure of a WAR-based deployment on an servlet engine like Tomcat will look something like this:

```

my-application.war/
  META-INF/
    MANIFEST.MF
  WEB-INF/
    web.xml
    faces-config.xml
    lib/
      jboss-seam.jar
      myfaces-api.jar
      myfaces-impl.jar
      jboss-ejb3.jar
      jboss-jca.jar
      jboss-j2ee.jar
      ...
      mc-conf.jar/
        ejb3-interceptors-aop.xml
        embedded-jboss-beans.xml
        default.persistence.properties
        jndi.properties
        login-config.xml
        security-beans.xml
        log4j.xml
      my-application.jar/
        META-INF/
          MANIFEST.MF
          persistence.xml
          jboss-beans.xml
        log4j.xml
        seam.properties

```

```

org/
  jboss/
    myapplication/
      User.class
      Login.class
      LoginBean.class
      Register.class
      RegisterBean.class
      ...
login.jsp
register.jsp
...

```

The `mc-conf.jar` just contains the standard JBoss Microcontainer configuration files for Embeddable EJB3. You won't usually need to edit these files yourself.

Most of the Seam example applications may be deployed to Tomcat by running `ant deploy.tomcat`.

7.4. Seam managed transactions

EJB session beans feature declarative transaction management. The EJB container is able to start a transaction transparently when the bean is invoked, and end it when the invocation ends. If we write a session bean method that acts as a JSF action listener, we can do all the work associated with that action in one transaction, and be sure that it is committed or rolled back when we finish processing the action. This is a great feature, and all that is needed by many Seam applications.

There is just one problem with this approach. ORM solutions like Hibernate and EJB 3.0 persistence support lazy fetching of entity associations inside a transaction context, but throw `LazyInitializationExceptions` if you try to access an unfetched association outside the context of a transaction. This is a problem if your view page tries to access data that was not fetched during the transaction. Hibernate users developed the *open session in view* pattern to work around this problem. This pattern is usually implemented as a transaction which spans the entire request. There are several problems with this idea, the most serious being that we can't be sure that a transaction has been successful until we commit it, but by the time we commit the transaction, we have already rendered the view. Furthermore, this is at best a partial solution to the problem, because we can still meet the dreaded `LazyInitializationException` if we try to re-use the entity object in the next request.

Seam *completely solves* the problem of unwanted `LazyInitializationExceptions`, while working around the biggest problem in the *open session in view* pattern. The solution comes in two parts:

- use an extended persistence context that is scoped to the conversation, instead of to the request
- use two transactions per request; the first spans the beginning of the update model values phase until the end of the invoke application phase; the second spans the render response phase

7.4.1. Enabling Seam-managed transactions

To make use of *Seam managed transactions*, you need to use `SeamExtendedManagedPersistencePhaseListener` in place of `SeamPhaseListener`.

```

<lifecycle>
  <phase-listener>
    org.jboss.seam.jsf.SeamExtendedManagedPersistencePhaseListener
  </phase-listener>
</lifecycle>

```

It's also a good idea to add a servlet filter to rollback uncommitted transactions when uncaught exceptions occur.

```
<filter>
  <filter-name>Seam Exception Filter</filter-name>
  <filter-class>org.jboss.seam.servlet.SeamExceptionFilter</filter-class>
</filter>

<filter-mapping>
  <filter-name>Seam Exception Filter</filter-name>
  <url-pattern>*.jsf</url-pattern>
</filter-mapping>
```

7.4.2. Using a Seam-managed persistence context

You'll need to use a *managed persistence context* (for EJB3) or *managed session* (for Hibernate) in your components. We'll see how to use a managed session later. Configuring a managed persistence context is easy. In `seam.properties`, we can write:

```
org.jboss.seam.core.init.managedPersistenceContexts bookingDatabase
bookingDatabase.persistenceUnitJndiName java:/EntityManagerFactories/bookingData
```

Or, in `web.xml`:

```
<context-param>
  <param-name>org.jboss.seam.core.init.managedPersistenceContexts</param-name>
  <param-value>bookingDatabase</param-value>
</context-param>

<context-param>
  <param-name>bookingDatabase.persistenceUnitJndiName</param-name>
  <param-value>java:/EntityManagerFactories/bookingData</param-value>
</context-param>
```

This configuration creates a conversation-scoped Seam component named `bookingDatabase` that manages the lifecycle of `EntityManager` instances for the persistence unit (`EntityManagerFactory` instance) with JNDI name `java:/EntityManagerFactories/bookingData`.

Of course, you need to make sure that you have bound the `EntityManagerFactory` into JNDI. In JBoss, you can do this by adding the following property setting to `persistence.xml`.

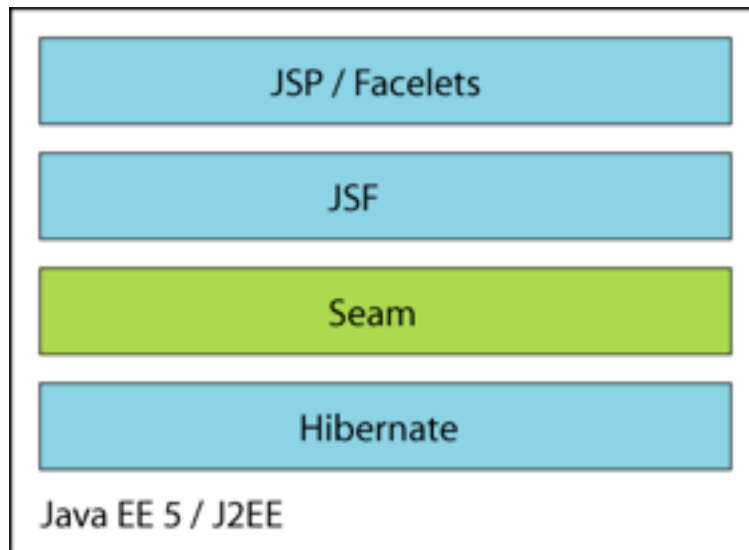
```
<property name="jboss.entity.manager.factory.jndi.name"
  value="java:/EntityManagerFactories/bookingData" />
```

Now we can have our `EntityManager` injected using:

```
@In(create=true) EntityManager bookingDatabase;
```

7.5. Configuring Seam with Hibernate in Java EE

Seam is useful even if you're not yet ready to take the plunge into EJB 3.0. In this case you would use `Hibernate3` instead of EJB 3.0 persistence, and plain `JavaBeans` instead of session beans. You'll miss out on some of the nice features of session beans but it will be very easy to migrate to EJB 3.0 when you're ready and, in the meantime, you'll be able to take advantage of Seam's unique declarative state management architecture.



Seam JavaBean components do not provide declarative transaction demarcation like session beans do. You *could* manage your transactions manually using the JTA `UserTransaction` (you could even implement your own declarative transaction management in a Seam interceptor). But most applications will use Seam managed transactions when using Hibernate with JavaBeans. Follow the instructions above to enable `SeamExtendedManagedPersistencePhaseListener`.

The Seam distribution includes a version of the booking example application that uses Hibernate and JavaBeans instead of EJB3. This example application is ready to deploy into any J2EE application server.

7.5.1. Bootstrapping Hibernate in Seam

Seam will bootstrap a Hibernate `SessionFactory` from your `hibernate.cfg.xml` file if you install the built-in component named `org.jboss.seam.core.hibernate`.

7.5.2. Using a Seam-managed Hibernate Session

We will also need to configure a *managed session* if we want a Seam managed Hibernate `Session` to be available via injection.

To configure our Seam components, as usual, we have a choice between `seam.properties` and `web.xml`. Let's show just the properties file this time:

```
org.jboss.seam.core.init.componentClasses org.jboss.seam.core.Hibernate
org.jboss.seam.core.init.managedSessions bookingDatabase
bookingDatabase.sessionFactoryJndiName java:/bookingSessionFactory
```

Where `java:/bookingSessionFactory` is the name of the session factory specified in `hibernate.cfg.xml`.

```
<session-factory name="java:/bookingSessionFactory">
  ...
</session-factory>
```

We can now have a managed Hibernate `Session` injected into our JavaBean components using the following code:

```
@In(create=true) Session bookingDatabase;
```

7.5.3. Packaging

We can package our application as a WAR, in the following structure:

```
my-application.war/
  META-INF/
    MANIFEST.MF
  WEB-INF/
    web.xml
    faces-config.xml
    lib/
      jboss-seam.jar
      hibernate3.jar
      ...
    my-application.jar/
      META-INF/
        MANIFEST.MF
      seam.properties
      hibernate.cfg.xml
      org/
        jboss/
          myapplication/
            User.class
            Login.class
            Register.class
            ...
    login.jsp
    register.jsp
    ...
```

If we want to deploy Hibernate in a non-J2EE environment like Tomcat or TestNG, we need to do a little bit more work.

7.6. Configuring Seam with Hibernate in Java SE

The Seam support for Hibernate requires JTA and a JCA datasource. If you are running in a non-EE environment like Tomcat or TestNG, you can run these services, and Hibernate itself, in the JBoss Microcontainer.

You can even deploy the Hibernate version of the booking example in Tomcat.



Seam ships with an example Microcontainer configuration in `microcontainer/conf/jboss-beans.xml` that provides all the things you need to run Seam with Hibernate in any non-EE environment. Just add the `microcontainer/conf` directory, and all jars in the `lib` and `microcontainer/lib` directories to your classpath. Refer to the documentation for the JBoss Microcontainer for more information.

7.6.1. Using Hibernate and the JBoss Microcontainer

The built-in Seam component named `org.jboss.seam.core.microcontainer` bootstraps the microcontainer. As before, we probably want to use a Seam managed session.

```
org.jboss.seam.core.init.componentClasses org.jboss.seam.core.Microcontainer
org.jboss.seam.core.init.managedSessions bookingDatabase
bookingDatabase.sessionFactoryJndiName java:/bookingSessionFactory
```

Where `java:/bookingSessionFactory` is the name of the Hibernate session factory specified in `hibernate.cfg.xml`.

You'll need to provide a `jboss-beans.xml` file that installs JNDI, JTA, and your JCA datasource into the microcontainer:

```
<?xml version="1.0" encoding="UTF-8"?>

<deployment xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:jboss:bean-deployer bean-deployer_1_0.xsd"
  xmlns="urn:jboss:bean-deployer">

  <bean name="Naming" class="org.jnp.server.SingletonNamingServer"/>

  <bean name="TransactionManagerFactory" class="org.jboss.seam.microcontainer.TransactionManagerFactory">
  <bean name="TransactionManager" class="java.lang.Object">
    <constructor factoryMethod="getTransactionManager">
      <factory bean="TransactionManagerFactory"/>
    </constructor>
  </bean>

  <bean name="bookingDatasourceFactory" class="org.jboss.seam.microcontainer.DataSourceFactory">
```



```

    <property name="driverClass">org.hsqldb.jdbcDriver</property>
    <property name="connectionUrl">jdbc:hsqldb:.</property>
    <property name="userName">sa</property>
    <property name="jndiName">java:/hibernateDatasource</property>
    <property name="minSize">0</property>
    <property name="maxSize">10</property>
    <property name="blockingTimeout">1000</property>
    <property name="idleTimeout">100000</property>
    <property name="transactionManager"><inject bean="TransactionManager"/></property>
  </bean>
  <bean name="bookingDatasource" class="java.lang.Object">
    <constructor factoryMethod="getDataSource">
      <factory bean="bookingDatasourceFactory"/>
    </constructor>
  </bean>

  <bean name="bookingDatabaseFactory" class="org.jboss.seam.microcontainer.HibernateFactory"/>
  <bean name="bookingDatabase" class="java.lang.Object">
    <constructor factoryMethod="getSessionFactory">
      <factory bean="bookingDatabaseFactory"/>
    </constructor>
    <depends>bookingDatasource</depends>
  </bean>
</deployment>

```

7.6.2. Packaging

The WAR could have the following structure:

```

my-application.war/
  META-INF/
    MANIFEST.MF
  WEB-INF/
    web.xml
    faces-config.xml
    lib/
      jboss-seam.jar
      hibernate3.jar
      ...
      jboss-microcontainer.jar
      jboss-jca.jar
      ...
      myfaces-api.jar
      myfaces-impl.jar
      mc-conf.jar/
        jndi.properties
        log4j.xml
      my-application.jar/
        META-INF/
          MANIFEST.MF
          jboss-beans.xml
          seam.properties
          hibernate.cfg.xml
          log4j.xml
        org/
          jboss/
            myapplication/
              User.class
              Login.class
              Register.class
              ...
    login.jsp
    register.jsp
    ...

```

7.7. Configuring jBPM in Seam

Seam's jBPM integration is not installed by default, so you'll need to enable jBPM by adding a built-in component to the list of installed components. In `seam.properties`:

```
org.jboss.seam.core.init.componentClasses org.jboss.seam.core.Jbpm
```

Or in `web.xml`:

```
<context-param>
  <param-name>org.jboss.seam.core.init.componentClasses</param-name>
  <param-value>org.jboss.seam.core.Jbpm</param-value>
</context-param>
```

You'll also need to explicitly list your process and pageflow definitions:

```
<context-param>
  <param-name>org.jboss.seam.core.jbpm.pageflowDefinitions</param-name>
  <param-value>
    createDocument.jpdl.xml
    editDocument.jpdl.xml
    approveDocument.jpdl.xml
  </param-value>
</context-param>

<context-param>
  <param-name>org.jboss.seam.core.jbpm.processDefinitions</param-name>
  <param-value>
    documentLifecycle.jpdl.xml
  </param-value>
</context-param>
```

Or:

```
org.jboss.seam.core.jbpm.pageflowDefinitions createDocument.jpdl.xml editDocument.jpdl.xml approveDocu
org.jboss.seam.core.jbpm.processDefinitions documentLifecycle.jpdl.xml
```

No further special configuration is needed if you only have pageflows. If you do have business process definitions, you need to provide a jBPM configuration, and a Hibernate configuration for jBPM. The Seam DVD Store demo includes example `jbpm.cfg.xml` and `hibernate.cfg.xml` files that will work with Seam:

```
<jbpm-configuration>

  <jbpm-context>
    <service name="persistence">
      <factory>
        <bean class="org.jbpm.persistence.db.DbPersistenceServiceFactory">
          <field name="isTransactionEnabled"><false/></field>
        </bean>
      </factory>
    </service>
    <service name="message" factory="org.jbpm.msg.db.DbMessageServiceFactory" />
    <service name="scheduler" factory="org.jbpm.scheduler.db.DbSchedulerServiceFactory" />
    <service name="logging" factory="org.jbpm.logging.db.DbLoggingServiceFactory" />
    <service name="authentication" factory="org.jbpm.security.authentication.DefaultAuthenticationSer
  </jbpm-context>

</jbpm-configuration>
```

The most important thing to notice here is that jBPM transaction control is disabled. Seam or EJB3 should control the JTA transactions.

7.7.1. Packaging

There is not yet any well-defined packaging format for jBPM configuration and process/pageflow definition files. In the Seam examples we've decided to simply package all these files into the root of the EAR. In future, we will probably design some other standard packaging format. So the EAR looks something like this:

```
my-application.ear/
  jboss-seam.jar
  jbp-3.1.jar
  META-INF/
    MANIFEST.MF
    application.xml
  my-application.war/
    META-INF/
      MANIFEST.MF
    WEB-INF/
      web.xml
      faces-config.xml
      login.jsp
      register.jsp
      ...
  my-application.jar/
    META-INF/
      MANIFEST.MF
      persistence.xml
      seam.properties
    org/
      jboss/
        myapplication/
          User.class
          Login.class
          LoginBean.class
          Register.class
          RegisterBean.class
          ...
  jbp-3.1.jar
  hibernate.cfg.xml
  createDocument.jpdl.xml
  editDocument.jpdl.xml
  approveDocument.jpdl.xml
  documentLifecycle.jpdl.xml
```

Remember to add `jbp-3.1.jar` to the manifest of your EJB-JAR and WAR.

7.8. Configuring Seam in a Portal

To run a Seam application as a portlet, you'll need to provide certain portlet metadata (`portlet.xml`, etc) in addition to the usual Java EE metadata. See the `examples/portal` directory for an example of the booking demo preconfigured to run on JBoss Portal.

In addition, you'll need to use a portlet-specific phase listener instead of `SeamPhaseListener` or `SeamExtendedManagedPersistencePhaseListener`. The `SeamPortletPhaseListener` and `SeamExtendedManagedPersistencePortletPhaseListener` are adapted to the portlet lifecycle.

Chapter 8. Seam annotations

When you write a Seam application, you'll use a lot of annotations. Seam lets you use annotations to achieve a declarative style of programming. Most of the annotations you'll use are defined by the EJB 3.0 specification. The annotations for data validation are defined by the Hibernate Validator package. Finally, Seam defines its own set of annotations, which we'll describe in this chapter.

All of these annotations are defined in the package `org.jboss.seam.annotations`.

8.1. Annotations for component definition

The first group of annotations lets you define a Seam component. These annotations appear on the component class.

`@Name`

```
@Name("componentName")
```

Defines the Seam component name for a class. This annotation is required for all Seam components.

`@Scope`

```
@Scope(ScopeType.CONVERSATION)
```

Defines the default context of the component. The possible values are defined by the `ScopeType` enumeration: `EVENT`, `PAGE`, `CONVERSATION`, `SESSION`, `BUSINESS_PROCESS`, `APPLICATION`, `STATELESS`.

When no scope is explicitly specified, the default depends upon the component type. For stateless session beans, the default is `STATELESS`. For entity beans and stateful session beans, the default is `CONVERSATION`. For JavaBeans, the default is `EVENT`.

`@Role`

```
@Role(name="roleName", scope=ScopeType.SESSION)
```

Allows a Seam component to be bound to multiple contexts variables. The `@Name/@Scope` annotations define a "default role". Each `@Role` annotation defines an additional role.

- `name` — the context variable name.
- `scope` — the context variable scope. When no scope is explicitly specified, the default depends upon the component type, as above.

`@Roles`

```
@Roles({
    @Role(name="user", scope=ScopeType.CONVERSATION),
    @Role(name="currentUser", scope=ScopeType.SESSION)
})
```

Allows specification of multiple additional roles.

@Intercept

```
@Intercept(InterceptionType.ALWAYS)
```

Determines when Seam interceptors are active. The possible values are defined by the `InterceptionType` enumeration: `ALWAYS`, `INVOKE_APPLICATION`, `NEVER`.

When no interception type is explicitly specified, the default depends upon the component type. For entity beans, the default is `NEVER`. For session beans and JavaBeans, the default is `INVOKE_APPLICATION` (interception only enabled during the JSF invoke application phase).

@JndiName

```
@JndiName("my/jndi/name")
```

Specifies the JNDI name that Seam will use to look up the EJB component. If no JNDI name is explicitly specified, Seam will use the JNDI pattern specified by `org.jboss.seam.core.init.jndiPattern`.

@Conversational

```
@Conversational(ifNotBegunOutcome="error")
```

Specifies that a conversation scope component is conversational, meaning that no method of the component can be called unless a long-running conversation started by this component is active (unless the method would begin a new long-running conversation).

- `ifNotBegunOutcome` — specifies a JSF outcome for the action when the component is invoked and no long-running conversation is active.

@Startup

```
@Startup(depends={"org.jboss.core.jndi", "org.jboss.core.jta"})
```

Specifies that an application scope component is started immediately at initialization time. This is mainly used for certain built-in components that bootstrap critical infrastructure such as JNDI, datasources, etc.

```
@Startup
```

Specifies that a session scope component is started immediately at session creation time.

- `depends` — specifies that the named components must be started first, if they are installed.

8.2. Annotations for bijection

The next two annotations control bijection. These attributes occur on component instance variables or property accessor methods.

@In

```
@In
```

Specifies that a component attribute is to be injected from a context variable at the beginning of each component invocation. If the context variable is null, an exception will be thrown.

```
@In(required=false)
```

Specifies that a component attribute is to be injected from a context variable at the beginning of each component invocation. The context variable may be null.

```
@In(create=true)
```

Specifies that a component attribute is to be injected from a context variable at the beginning of each component invocation. If the context variable is null, an instance of the component is instantiated by Seam.

```
@In(value="contextVariableName")
```

Specifies the name of the context variable explicitly, instead of using the annotated instance variable name.

```
@In(value="#{customer.addresses['shipping']}")
```

Specifies that a component attribute is to be injected by evaluating a JSF EL expression at the beginning of each component invocation.

- `value` — specifies the name of the context variable. Default to the name of the component attribute. Alternatively, specifies a JSF EL expression, surrounded by `#{...}`.
- `create` — specifies that Seam should instantiate the component with the same name as the context variable if the context variable is undefined (null) in all contexts. Default to false.
- `required` — specifies Seam should throw an exception if the context variable is undefined in all contexts.

@Out

```
@Out
```

Specifies that a component attribute that is a Seam component is to be outjected to a context variable at the end of the invocation. If the attribute is null, an exception is thrown.

```
@Out(required=false)
```

Specifies that a component attribute that is a Seam component is to be outjected to a context variable at the end of the invocation. The attribute may be null.

```
@Out(scope=ScopeType.SESSION)
```

Specifies that a component attribute that is not a Seam component is to be outjected to a specific scope at the end of the invocation.

```
@Out(value="contextVariableName")
```

Specifies the name of the context variable explicitly, instead of using the annotated instance variable name.

- `value` — specifies the name of the context variable. Default to the name of the component attribute.

- `required` — specifies Seam should throw an exception if the component attribute is null during outjection.

Note that it is quite common for these annotations to occur together, for example:

```
@In(create=true) @Out private User currentUser;
```

The next annotation supports the *manager component* pattern, where a Seam component manages the lifecycle of an instance of some other class that is to be injected. It appears on a component getter method.

`@Unwrap`

```
@Unwrap
```

Specifies that the object returned by the annotated getter method is the thing that is injected instead of the component instance itself.

The next annotation supports the *factory component* pattern, where a Seam component is responsible for initializing the value of a context variable. This is especially useful for initializing any state needed for rendering the response to a non-faces request. It appears on a component method.

`@Factory`

```
@Factory("processInstance")
```

Specifies that the method of the component is used to initialize the value of the named context variable, when the context variable has no value.

The last annotation lets you inject a request parameter value:

`@RequestParameter`

```
@RequestParameter("parameterName")
```

Specifies that a component attribute is to be injected with the value of a request parameter. Basic type conversions are performed automatically.

- `value` — specifies the name of the request parameter. Default to the name of the component attribute.

8.3. Annotations for component lifecycle methods

These annotations allow a component to react to its own lifecycle events. They occur on methods of the component. There may be only one of each per component class.

`@Create`

```
@Create
```

Specifies that the method should be called when an instance of the component is instantiated by Seam.

@Destroy

```
@Destroy
```

Specifies that the method should be called when the context ends and its context variables are destroyed.

Note that all stateful session bean components *must* define a method annotated @Destroy @Remove in order to guarantee destruction of the stateful bean when a context ends.

Destroy methods should be used only for cleanup. *Seam catches, logs and swallows any exception that propagates out of a destroy method.*

@Observer

```
@Observer("somethingChanged")
```

Specifies that the method should be called when a component-driven event of the specified type occurs.

8.4. Annotations for context demarcation

These annotations provide declarative conversation demarcation. They appear on methods of Seam components, usually action listener methods.

Every web request has a conversation context associated with it. Most of these conversations end at the end of the request. If you want a conversation that span multiple requests, you must "promote" the current conversation to a *long-running conversation* by calling a method marked with @Begin.

@Begin

```
@Begin
```

Specifies that a long-running conversation begins when this method returns a non-null outcome without exception.

```
@Begin(ifOutcome={"success", "continue"})
```

Specifies that a long-running conversation begins when this action listener method returns with one of the given outcomes.

```
@Begin(join=true)
```

Specifies that if a long-running conversation is already in progress, the conversation context is simply propagated.

```
@Begin(nested=true)
```

Specifies that if a long-running conversation is already in progress, a new *nested* conversation context begins. The nested conversation will end when the next @End is encountered, and the outer conversation will resume. It is perfectly legal for multiple nested conversations to exist concurrently in the same outer conversation.

```
@Begin(pageflow="process definition name")
```


Specifies a jBPM process definition name that defines the pageflow for this conversation.

- `ifOutcome` — specifies the JSF outcome or outcomes that result in a new long-running conversation context.
- `join` — determines the behavior when a long-running conversation is already in progress. If `true`, the context is propagated. If `false`, an exception is thrown. Default to `false`. This setting is ignored when `nested=true` is specified
- `nested` — specifies that a nested conversation should be started if a long-running conversation is already in progress.
- `pageflow` — a process definition name of a jBPM process definition deployed via `org.jboss.seam.core.jbpm.pageflowDefinitions`.

@End

```
@End
```

Specifies that a long-running conversation ends when this method returns a non-null outcome without exception.

```
@End(ifOutcome={"success", "error"}, evenIfException={SomeException.class, OtherException.class})
```

Specifies that a long-running conversation ends when this action listener method returns with one of the given outcomes or throws one of the specified classes of exception.

- `ifOutcome` — specifies the JSF outcome or outcomes that result in the end of the current long-running conversation.

@StartTask

```
@StartTask(taskIdParameter="taskId")
```

"Starts" a jBPM task. Specifies that a long-running conversation begins when this method returns a non-null outcome without exception. This conversation is associated with the jBPM task specified in the named request parameter. Within the context of this conversation, a business process context is also defined, for the business process instance of the task instance.

The jBPM `TaskInstance` will be available in a request context variable named `taskInstance`. The jBPM `ProcessInstance` will be available in a request context variable named `processInstance`. (Of course, these objects are available for injection via `@In`.)

- `taskIdParameter` — the name of a request parameter which holds the id of the task. Default to `"taskId"`, which is also the default used by the Seam `taskList` JSF component.

@BeginTask

```
@BeginTask(taskIdParameter="taskId")
```

Resumes work on an incomplete jBPM task. Specifies that a long-running conversation begins when this

method returns a non-null outcome without exception. This conversation is associated with the jBPM task specified in the named request parameter. Within the context of this conversation, a business process context is also defined, for the business process instance of the task instance.

The jBPM `TaskInstance` will be available in a request context variable named `taskInstance`. The jBPM `ProcessInstance` will be available in a request context variable named `processInstance`.

- `taskIdParameter` — the name of a request parameter which holds the id of the task. Default to "taskId", which is also the default used by the Seam `taskList` JSF component.

@EndTask

```
@EndTask
```

"Ends" a jBPM task. Specifies that a long-running conversation ends when this method returns a non-null outcome, and that the current task is complete. Triggers a jBPM transition. The actual transition triggered will be the default transition unless the application has called `Transition.setName()` on the built-in component named `transition`.

```
@EndTask(transition="transitionName")
```

Triggers the given jBPM transition.

```
@EndTask(ifOutcome={"success", "continue"})
```

Specifies that the task ends when this method returns one of the listed outcomes.

@CreateProcess

```
@CreateProcess(definition="process definition name")
```

Creates a new jBPM process instance when the method returns a non-null outcome without exception. The `ProcessInstance` object will be available in a context variable named `processInstance`.

- `definition` — the name of the jBPM process definition deployed via `org.jboss.seam.core.jpdm.processDefinitions`.

@ResumeProcess

```
@ResumeProcess(processIdParameter="processId")
```

Re-enters the scope of an existing jBPM process instance when the method returns a non-null outcome without exception. The `ProcessInstance` object will be available in a context variable named `processInstance`.

- `processIdParameter` — the name a request parameter holding the process id. Default to "processId".

8.5. Annotations for transaction demarcation

Seam provides an annotation that lets you force a rollback of the JTA transaction for certain action listener outcomes.

@Rollback

```
@Rollback(ifOutcome={"failure", "not-found"})
```

If the outcome of the method matches any of the listed outcomes, or if no outcomes are listed, set the transaction to rollback only when the method completes.

- `ifOutcome` — the JSF outcomes that cause a transaction rollback (no outcomes is interpreted to mean any outcome).

@Transactional

```
@Transactional
```

Specifies that a JavaBean component should have a similar transactional behavior to the default behavior of a session bean component. ie. method invocations should take place in a transaction, and if no transaction exists when the method is called, a transaction will be started just for that method. This annotation may be applied at either class or method level.

Seam applications usually use the standard EJB3 annotations for all other transaction demarcation needs.

8.6. Annotations for validation

This annotation triggers Hibernate Validator. It appears on a method of a Seam component, almost always an action listener method.

Please refer to the documentation for the Hibernate Annotations package for information about the annotations defined by the Hibernate Validator framework.

@IfInvalid

```
@IfInvalid(outcome="invalid", refreshEntities=true)
```

Specifies that Hibernate Validator should validate the component before the method is invoked. If the invocation fails, the specified outcome will be returned, and the validation failure messages returned by Hibernate Validator will be added to the `FacesContext`. Otherwise, the invocation will proceed.

- `outcome` — the JSF outcome when validation fails.
- `refreshEntities` — specifies that any invalid entity in the managed state should be refreshed from the database when validation fails. Default to `false`. (Useful with extended persistence contexts.)

8.7. Annotations for Seam Remoting

Seam Remoting requires that the local interface of a session bean be annotated with the following annotation:

@WebRemote

```
@WebRemote
```

Indicates that the annotated method may be called from client-side JavaScript.

8.8. Annotations for Seam interceptors

The following annotations appear on Seam interceptor classes.

Please refer to the documentation for the EJB 3.0 specification for information about the annotations required for EJB interceptor definition.

@Around

```
@Around({SomeInterceptor.class, OtherInterceptor.class})
```

Specifies that this interceptor is positioned higher in the stack than the given interceptors.

@Within

```
@Within({SomeInterceptor.class, OtherInterceptor.class})
```

Specifies that this interceptor is positioned deeper in the stack than the given interceptors.

8.9. Annotations for use with JSF `dataTable`

The following annotations make it easy to implement clickable lists backed by a stateful session bean. They appear on attributes.

@DataModel

```
@DataModel("variableName")
```

Exposes an attribute of type `List` as a JSF `DataModel` into the scope of the owning component (or the `EVENT` scope if the owning component is `STATELESS`).

- `value` — name of the conversation context variable. Default to the attribute name.
- `scope` — if `scope=ScopeType.PAGE` is explicitly specified, the `DataModel` will be kept in the `PAGE` context.

@DataModelSelection

```
@DataModelSelection
```

Injects the selected value from the JSF `DataModel`.

- `value` — name of the conversation context variable. Not needed if there is exactly one `@DataModel` in the component.

@DataModelSelectionIndex

```
@DataModelSelectionIndex
```

Exposes the selection index of the JSF `DataModel` as an attribute of the component.

- `value` — name of the conversation context variable. Not needed if there is exactly one `@DataModel` in the component.

8.10. Meta-annotations for databinding

These meta-annotations make it possible to implement similar functionality to `@DataModel` and `@DataModelSelection` for other datastructures apart from lists.

`@DataBinderClass`

```
@DataBinderClass(DataModelBinder.class)
```

Specifies that an annotation is a databinding annotation.

`@DataSelectorClass`

```
@DataSelectorClass(DataModelSelector.class)
```

Specifies that an annotation is a dataselection annotation.

Chapter 9. Built-in Seam components

This chapter describes Seam's built-in components, and their configuration properties.

Note that you can replace any of the built in components with your own implementations simply by specifying the name of one of the built in components on your own class using `@Name`.

9.1. Context injection components

The first set of built in components exist purely to support injection of various contextual objects. For example, the following component instance variable would have the Seam session context object injected:

```
@In private Context sessionContext;
```

`eventContext`

Manager component for the event context object

`pageContext`

Manager component for the page context object

`conversationContext`

Manager component for the conversation context object

`sessionContext`

Manager component for the session context object

`applicationContext`

Manager component for the application context object

`businessProcessContext`

Manager component for the business process context object

`statelessContext`

Manager component for the stateless context object

`facesContext`

Manager component for the `FacesContext` context object (not a true Seam context)

`uiComponent`

Allows access to a JSF `UIComponent` by its id from the EL. For example, we can write
`@In("#{uiComponent['myForm:address']}.value")`.

All of these components are always installed.

9.2. Utility components

These components are merely useful.

`facesMessages`

Allows faces success messages to propagate across a browser redirect.

- `add(FacesMessage facesMessage)` — add a faces message, which will be displayed during the next render response phase that occurs in the current conversation.
- `add(String messageTemplate)` — add a faces message, rendered from the given message template which may contain EL expressions.
- `add(Severity severity, String messageTemplate)` — add a faces message, rendered from the given message template which may contain EL expressions.
- `addFromResourceBundle(String key)` — add a faces message, rendered from a message template defined in the Seam resource bundle which may contain EL expressions.
- `addFromResourceBundle(Severity severity, String key)` — add a faces message, rendered from a message template defined in the Seam resource bundle which may contain EL expressions.
- `clear()` — clear all messages.

`redirect`

A convenient API for performing redirects with parameters (this is especially useful for bookmarkable search results screens).

- `redirect.viewId` — the JSF view id to redirect to.
- `redirect.parameters` — a map of request parameter name to value, to be passed in the redirect request.
- `execute()` — perform the redirect immediately.
- `captureCurrentRequest()` — stores the view id and request parameters of the current GET request (in the conversation context), for later use by calling `execute()`.

`httpError`

A convenient API for sending HTTP errors.

`interpolator`

An API for interpolating the values of JSF EL expressions in Strings.

- `interpolate(String template)` — scan the template for JSF EL expressions of the form `#{...}` and replace them with their evaluated values.

All of these components are always installed.

9.3. Components for internationalization

The next group of components make it easy to build internationalized user interfaces using Seam.

`locale`

The Seam locale. The locale is session scoped.

`resourceBundle`

The Seam resource bundle. The resource bundle is session scoped.

- `resourceBundle.bundleName` — the name of the bundle. Default to `messages`.

`localeSelector`

Supports selection of the locale either at configuration time, or by the user at runtime.

- `select()` — select the specified locale.
- `localeSelector.locale` — the actual `java.util.Locale`.
- `localeSelector.localeString` — the stringified representation of the locale.
- `localeSelector.language` — the language for the specified locale.
- `localeSelector.country` — the country for the specified locale.
- `localeSelector.variant` — the variant for the specified locale.
- `localeSelector.supportedLocales` — a list of `SelectItems` representing the supported locales listed in `jsf-config.xml`.

`messages`

A map containing internationalized messages rendered from message templates defined in the Seam resource bundle.

All of these components are always installed.

9.4. Components for controlling conversations

The next group of components allow control of conversations by the application or user interface.

`conversation`

API for application control of attributes of the current Seam conversation.

- `getId()` — returns the current conversation id
- `getParentId()` — returns the conversation id of the parent conversation
- `getRootId()` — returns the conversation id of the root conversation
- `setTimeout(int timeout)` — sets the timeout for the current conversation
- `setViewId(String outcome)` — sets the view id to be used when switching back to the current conversation from the conversation switcher, conversation list, or breadcrumbs.
- `setDescription(String description)` — sets the description of the current conversation to be displayed in the conversation switcher, conversation list, or breadcrumbs.
- `redirect()` — redirect to the last well-defined view id for this conversation (useful after login challenges).
- `leave()` — exit the scope of this conversation, without actually ending the conversation.
- `begin()` — begin a long-running conversation (equivalent to `@Begin`).

- `end()` — end a long-running conversation (equivalent to `@End`).
- `pop()` — pop the conversation stack, returning to the parent conversation.
- `root()` — return to the root conversation of the conversation stack.

`conversationList`

Manager component for the conversation list.

`conversationStack`

Manager component for the conversation stack (breadcrumbs).

`switcher`

The conversation switcher.

All of these components are always installed.

9.5. jBPM-related components

These components are for use with jBPM.

`actor`

API for application control of attributes of the jBPM actor associated with the current session.

- `setId(String actorId)` — sets the jBPM actor id of the current user.
- `getGroupActorIds()` — returns a `Set` to which jBPM actor ids for the current users groups may be added.

`transition`

API for application control of the jBPM transition for the current task.

- `setName(String transitionName)` — sets the jBPM transition name to be used when the current task is ended via `@EndTask`.

`taskInstance`

Manager component for the jBPM `TaskInstance`.

`processInstance`

Manager component for the jBPM `ProcessInstance`.

`jbpContext`

Manager component for an event-scoped `JbpContext`.

`taskInstanceList`

Manager component for the jBPM task list.

`pooledTaskInstanceList`

Manager component for the jBPM pooled task list.

`taskInstanceListForType`

Manager component for the jBPM task lists.

`pooledTask`

Action handler for pooled task assignment.

All of these components are installed whenever the component `org.jboss.seam.core.jbpm` is installed.

9.6. Infrastructural components

These components provide critical platform infrastructure. You can install a component by including its class name in the `org.jboss.seam.core.init.componentClasses` configuration property.

`org.jboss.seam.core.init`

Initialization settings for Seam. Always installed.

- `org.jboss.seam.core.init.componentClasses` — a list of class names of Seam components to be installed. (The class name, not the component name!)
- `org.jboss.seam.core.init.managedPersistenceContexts` — a list of component names of Seam managed persistence contexts to be installed.
- `org.jboss.seam.core.init.managedSessions` — a list of component names of Seam managed Hibernate sessions to be installed.
- `org.jboss.seam.core.init.jbpmSessionFactoryName` — the name of the jBPM session factory
- `org.jboss.seam.core.init.clientSideConversations` — if set to `true`, Seam will save conversation context variables in the client instead of in the `HttpSession`.

`org.jboss.seam.core.manager`

Internal component for Seam page and conversation context management. Always installed.

- `org.jboss.seam.core.manager.conversationTimeout` — the conversation context timeout in milliseconds.

`org.jboss.seam.core.process`

Internal component for Seam process management. Installed whenever `org.jboss.seam.core.jbpm` is installed.

`org.jboss.seam.core.pageflow`

Internal component for Seam pageflow management. Installed whenever `org.jboss.seam.core.jbpm` is installed.

`org.jboss.seam.core.pages`

Internal component for Seam workspace management. Always installed.

`org.jboss.seam.core.ejb`

Bootstraps the JBoss Embeddable EJB3 container. Install as class `org.jboss.seam.core.Ejb`. This is useful when using Seam with EJB components outside the context of a Java EE 5 application server.

The basic Embedded EJB configuration is defined in `jboss-embedded-beans.xml`. Additional microcontainer configuration (for example, extra datasources) may be specified by `jboss-beans.xml` or `META-INF/jboss-beans.xml` in the classpath.

`org.jboss.seam.core.microcontainer`

Bootstraps the JBoss microcontainer. Install as class `org.jboss.seam.core.Microcontainer`. This is useful when using Seam with Hibernate and no EJB components outside the context of a Java EE application server. The microcontainer can provide a partial EE environment with JNDI, JTA, a JCA datasource and Hibernate.

The microcontainer configuration may be specified by `jboss-beans.xml` or `META-INF/jboss-beans.xml` in the classpath.

`org.jboss.seam.core.hibernate`

Bootstraps a Hibernate `SessionFactory`. Install as class `org.jboss.seam.core.Hibernate`. This is most useful when using Seam with Hibernate inside a Java EE application server.

- `org.jboss.seam.core.hibernate.cfgResourceName` — the path to the configuration file. Default to `hibernate.cfg.xml`.

See the API JavaDoc for further configuration properties.

`org.jboss.seam.core.jbpm`

Bootstraps a `JbpmConfiguration`. Install as class `org.jboss.seam.core.Jbpm`.

- `org.jboss.seam.core.jbpm.processDefinitions` — a list of resource names of jPDL files to be used for orchestration of business processes.
- `org.jboss.seam.core.jbpm.pageflowDefinitions` — a list of resource names of jPDL files to be used for orchestration of conversation page flows.

`org.jboss.seam.debug.introspector`

Support for the Seam Debug Page.

`org.jboss.seam.debug.contexts`

Support for the Seam Debug Page.

9.7. Security-related components

These components relate to web-tier security.

`<varlistentry>userPrincipal`

Manager component for the current user Principal.

`</varlistentry>`

`<varlistentry>isUserInRole`

Allows JSF pages to choose to render a control, depending upon the roles available to the current principal.

`<h:commandButton value="edit" rendered="#{isUserInRole['admin']}" />`

`</varlistentry>`

9.8. Special components

Certain special Seam component classes are installable multiple times under names specified in the Seam configuration. For example, the following lines in `seam.properties` install and configure two Seam components:

```
org.jboss.seam.core.init.managedPersistenceContexts bookingDatabase, userDatabase
bookingDatabase.persistenceUnitJndiName java:/comp/emf/bookingPersistence
```

```
userDatabase.persistenceUnitJndiName java:/comp/emf/userPersistence
```

The Seam component names are `bookingDatabase` and `userDatabase`.

`<managedPersistenceContext>`

Manager component for a conversation scoped managed `EntityManager` with an extended persistence context. Installed via `org.jboss.seam.core.init.managedPersistenceContexts`.

- `<managedPersistenceContext>.persistenceUnitJndiName` — the JNDI name of the entity manager factory, default to `java: /<managedPersistenceContext>`.

`<managedSession>`

Manager component for a conversation scoped managed `Hibernate Session`. Installed via `org.jboss.seam.core.init.managedSessions`.

- `<managedSession>.sessionFactoryJndiName` — the JNDI name of the session factory, default to `java: /<managedSession>`.

Chapter 10. Testing Seam applications

Most Seam applications will need at least two kinds of automated tests: *unit tests*, which test a particular Seam component in isolation, and scripted *integration tests* which exercise all Java layers of the application (that is, everything except the view pages).

Both kinds of tests are very easy to write.

10.1. Unit testing Seam components

All Seam components are POJOs. This is a great place to start if you want easy unit testing. And since Seam emphasises the use of bijection for inter-component interactions and access to contextual objects, it's very easy to test a Seam component outside of its normal runtime environment.

Consider the following Seam component:

```
@Stateless
@Scope(EVENT)
@Name("register")
public class RegisterAction implements Register
{
    private User user;
    private EntityManager em;

    @In
    public void setUser(User user) {
        this.user = user;
    }

    @PersistenceContext
    public void setBookingDatabase(User em) {
        this.em = em;
    }

    @IfInvalid(outcome=Outcome.REDISPLAY)
    public String register()
    {
        List existing = em.createQuery("select username from User where username=:username")
            .setParameter("username", user.getUsername())
            .getResultList();
        if (existing.size()==0)
        {
            em.persist(user);
            return "success";
        }
        else
        {
            return null;
        }
    }
}
```

We could write a TestNG test for this component as follows:

```
public class RegisterActionTest
{
    @Test
    public testRegisterAction()
    {
```

```

    EntityManager em = getEntityManagerFactory().createEntityManager();
    em.getTransaction().begin();

    User gavin = new User();
    gavin.setName("Gavin King");
    gavin.setUserName("lovthafew");
    gavin.setPassword("secret");

    RegisterAction action = new RegisterAction();
    action.setUser(gavin);
    action.setBookingDatabase(em);

    assert "success".equals( action.register() );

    em.getTransaction().commit();
    em.close();
}

private EntityManagerFactory emf;

public EntityManagerFactory getEntityManagerFactory()
{
    return emf;
}

@Configuration(beforeTestClass=true)
public void init()
{
    emf = Persistence.createEntityManagerFactory("myResourceLocalEntityManager");
}

@Configuration(afterTestClass=true)
public void destroy()
{
    emf.close();
}
}

```

Seam components don't usually depend directly upon container infrastructure, so most unit testing is as easy as that!

10.2. Integration testing Seam applications

Integration testing is slightly more difficult. In this case, we can't eliminate the container infrastructure; indeed, that is part of what is being tested! At the same time, we don't want to be forced to deploy our application to an application server to run the automated tests. We need to be able to reproduce just enough of the container infrastructure inside our testing environment to be able to exercise the whole application, without hurting performance too much.

A second problem is emulating user interactions. A third problem is where to put our assertions. Some test frameworks let us test the whole application by reproducing user interactions with the web browser. These frameworks have their place, but they are not appropriate for use at development time.

The approach taken by Seam is to let you write tests that script your components while running inside a pruned down container environment (Seam, together with the JBoss Embeddable EJB container). The role of the test script is basically to reproduce the interaction between the view and the Seam components. In other words, you get to pretend you are the JSF implementation!

This approach tests everything except the view.

Let's consider a JSP view for the component we unit tested above:

```
<html>
<head>
  <title>Register New User</title>
</head>
<body>
  <f:view>
    <h:form>
      <table border="0">
        <tr>
          <td>Username</td>
          <td><h:inputText value="#{user.username}"/></td>
        </tr>
        <tr>
          <td>Real Name</td>
          <td><h:inputText value="#{user.name}"/></td>
        </tr>
        <tr>
          <td>Password</td>
          <td><h:inputSecret value="#{user.password}"/></td>
        </tr>
      </table>
      <h:messages/>
      <h:commandButton type="submit" value="Register" action="#{register.register}"/>
    </h:form>
  </f:view>
</body>
</html>
```

We want to test the registration functionality of our application (the stuff that happens when the user clicks the Register button). We'll reproduce the JSF request lifecycle in an automated TestNG test:

```
public class RegisterTest extends SeamTest
{
    @Test
    public void testRegister() throws Exception
    {
        new Script() {

            @Override
            protected void updateModelValues() throws Exception
            {
                User user = (User) Component.getInstance("user", true);
                assert user!=null;
                user.setUsername("lovthafew");
                user.setPassword("secret");
                user.setName("Gavin King");
            }

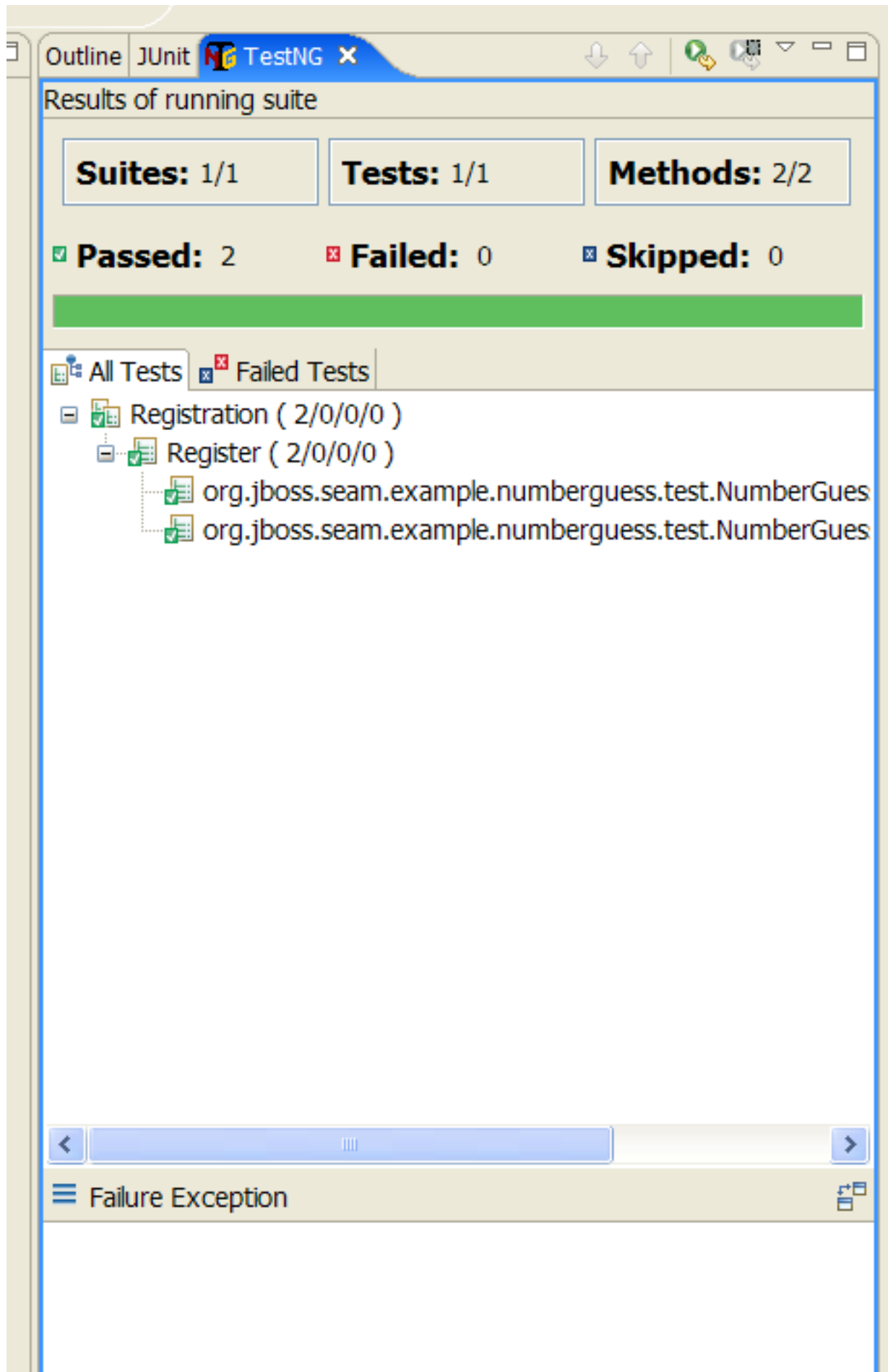
            @Override
            protected void invokeApplication()
            {
                Register register = (Register) Component.getInstance("register", true);
                String outcome = register.register();
                assert "success".equals( outcome );
            }

            @Override
            protected void renderResponse()
            {
                User user = (User) Component.getInstance("user", false);
                assert user!=null;
                assert user.getName().equals("Gavin King");
                assert user.getUsername().equals("lovthafew");
                assert user.getPassword().equals("secret");
            }
        }
    }
}
```

```
        }.run();  
    }  
    ...  
}
```

Notice that we've extended `SeamTest`, which provides a Seam environment for our components, and written our test script as an anonymous class that extends `SeamTest.Script`, which provides an emulated JSF request life-cycle. We've written our code in methods which are named for the various JSF phases, to emulate the calls that JSF would make to our components. Then we've thrown in various assertions.

You'll find plenty of integration tests for the Seam example applications which demonstrate more complex cases. There are instructions for running these tests using Ant, or using the TestNG plugin for eclipse:



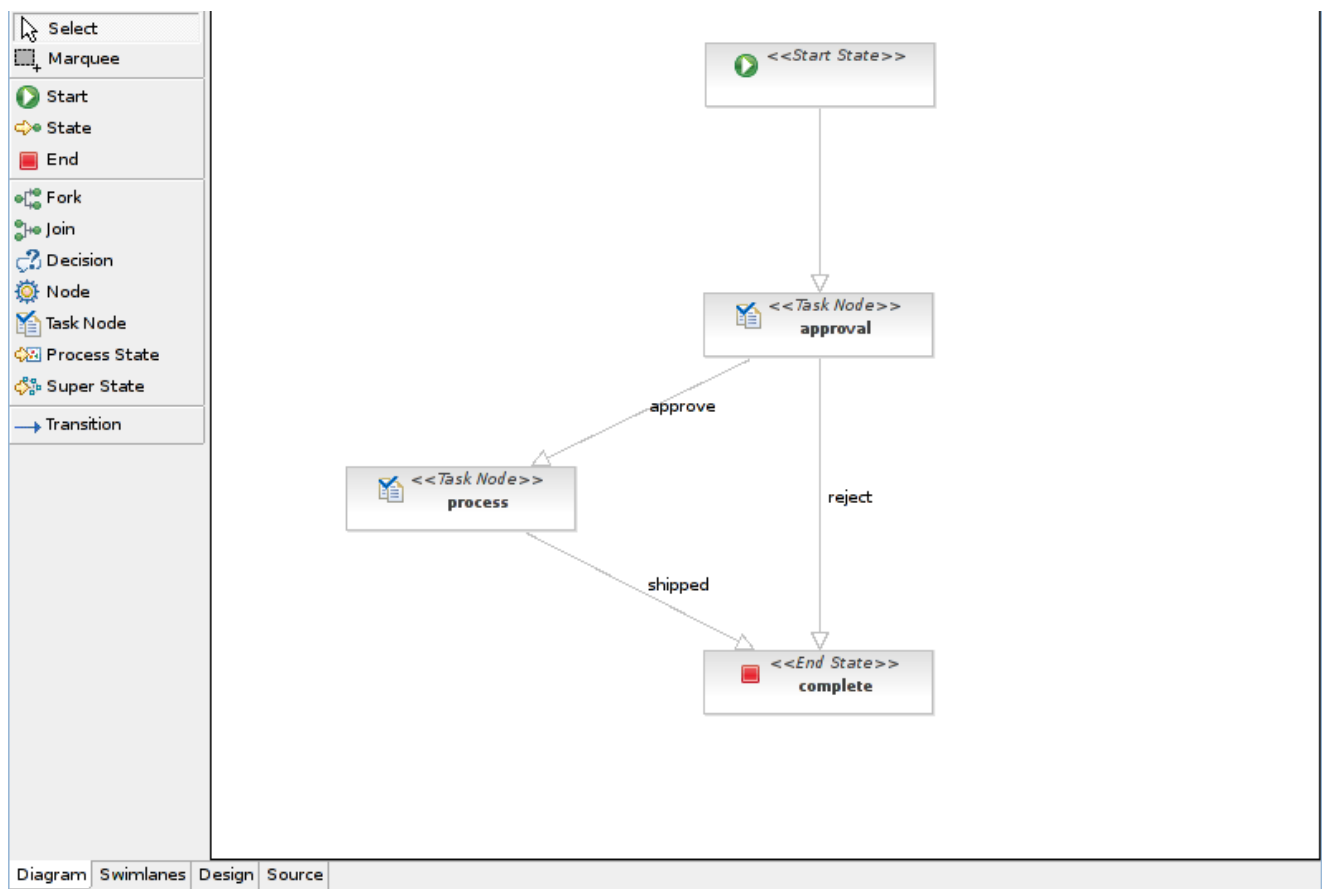
Chapter 11. Seam tools

11.1. jBPM designer and viewer

The jBPM designer and viewer will let you design and view in a nice way your business processes and your pageflows. This convenient tool is part of JBoss Eclipse IDE and more details can be found in the jBPM's documentation (<http://docs.jboss.com/jbpm/v3/gpd/>)

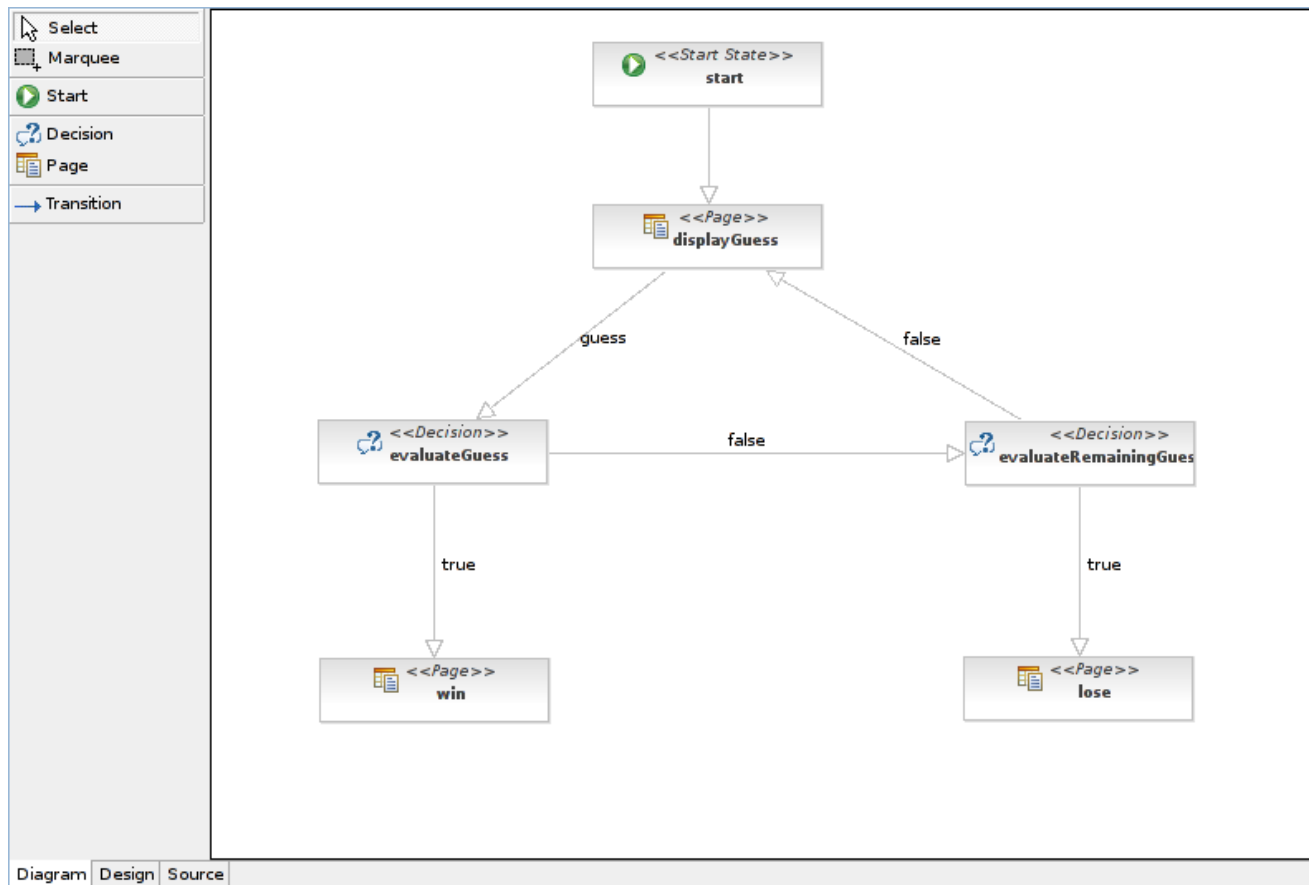
11.1.1. Business process designer

This tool lets you design your own business process in a graphical way.



11.1.2. Pageflow viewer

This tool let you design to some extend your pageflows and let you build graphical views of them so you can easily share and compare ideas on how it should be designed.



11.2. CRUD-application generator

This chapter, will give you a short overview of the support for Seam that is available in the Hibernate Tools. Hibernate Tools is a set of tools for working with Hibernate and related technologies, such as JBoss Seam and EJB3. The tools are available as a set of eclipse plugins and Ant tasks. You can download the Hibernate Tools from the JBoss Eclipse IDE or Hibernate Tools websites.

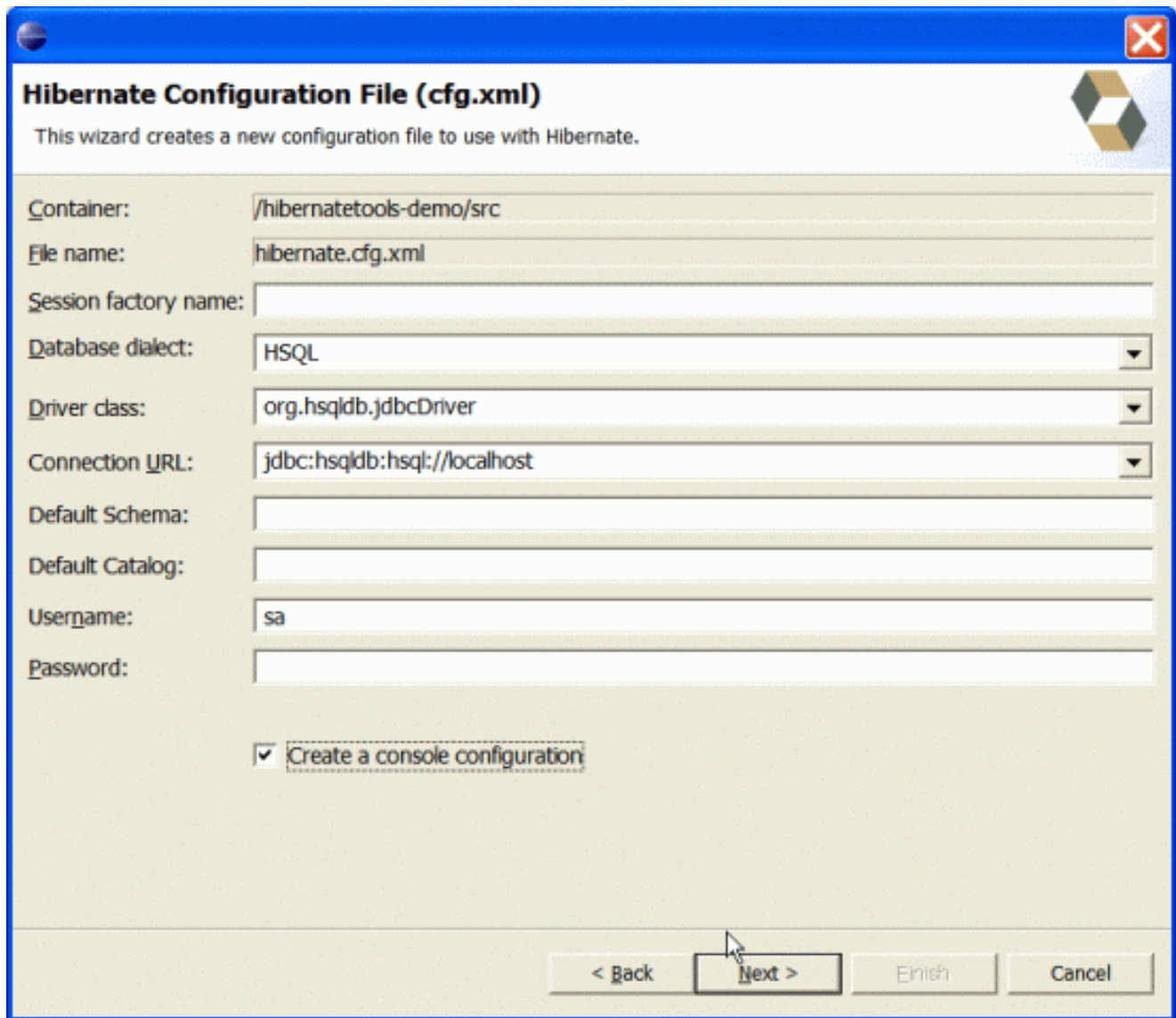
The specific support for Seam that is currently available is generation of a fully functional Seam based CRUD-application. The CRUD-application can be generated based on your existing Hibernate mapping files or EJB3 annotated POJO's or even fully reverse engineered from your existing database schema.

The following sections is focused on the features required to understand for usage with Seam. The content is derived from the the Hibernate Tools reference documentation. Thus if you need more detailed information please refer to the Hibernate Tools documentation.

11.2.1. Creating a Hibernate configuration file

To be able to reverse engineer and generate code a hibernate.properties or hibernate.cfg.xml file is needed. The Hibernate Tools provide a wizard for generating the hibernate.cfg.xml file if you do not already have such file.

Start the wizard by clicking "New Wizard" (Ctrl+N), select the Hibernate/Hibernate Configuration file (cfg.xml) wizard and press "Next". After selecting the wanted location for the hibernate.cfg.xml file, you will see the following page:



Tip: The contents in the combo boxes for the JDBC driver class and JDBC URL change automatically, depending on the Dialect and actual driver you have chosen.

Enter your configuration information in this dialog. Details about the configuration options can be found in Hibernate reference documentation.

Press "Finish" to create the configuration file, after optionally creating a Console onfiguration, the hibernate.cfg.xml will be automatically opened in an editor. The last option "Create Console Configuration" is enabled by default and when enabled i will automatically use the hibernate.cfg.xml for the basis of a "Console Configuration"

11.2.2. Creating a Hibernate Console configuration

A Console Configuration describes to the Hibernate plugin which configuration files should be used to configure hibernate, including which classpath is needed to load the POJO's, JDBC drivers etc. It is required to make usage of query prototyping, reverse engineering and code generation. You can have multiple named console configurations. Normally you would just need one per project, but more (or less) is definitely possible.

You create a console configuration by running the Console Configuration wizard, shown in the following screenshot. The same wizard will also be used if you are coming from the hibernate.cfg.xml wizard and had enabled "Create Console Configuration".

Create Hibernate Console Configuration

This wizard allows you to create a configuration for Hibernate Console.

Name:

Property file:

Configuration file:

Entity resolver:

☐ Enable hibernate ejb3/annotations (requires running eclipse with a Java 5 runtime)

Mapping files

Name

Classpath (only add path for POJO and driver - No Hibernate jars!)

Name
/hibernatetools-demo/build/eclipse
/hibernatetools-demo/lib/jdbc/hsqldb.jar

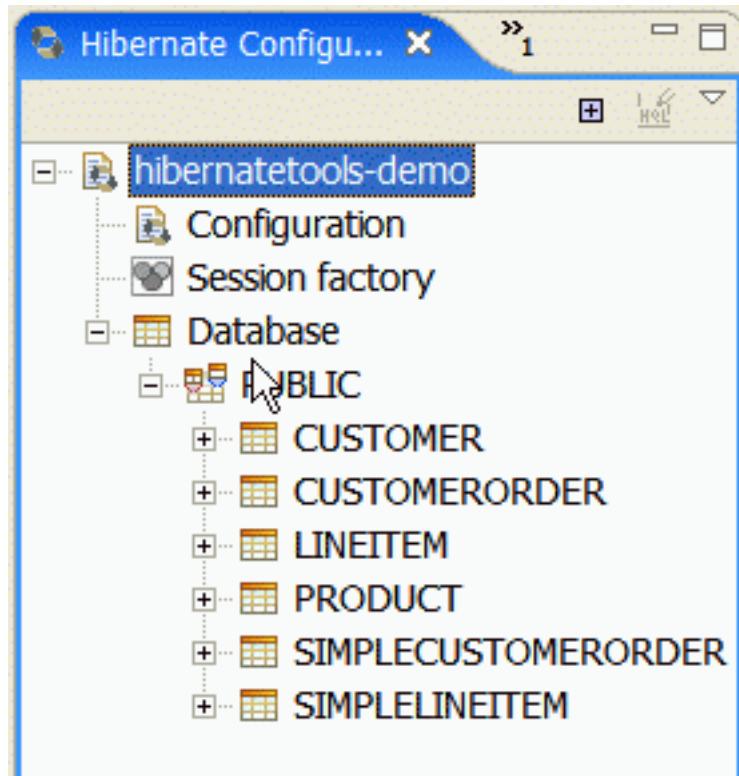
The following table describes the relevant settings. The wizard can automatically detect default values for most of these if you started the Wizard with the relevant java project selected

Table 11.1. Hibernate Console Configuration Parameters

Parameter	Description	Auto detected value
Name	The unique name of the configuration	Name of the selected project

Parameter	Description	Auto detected value
Property file	Path to a hibernate.properties file	First hibernate.properties file found in the selected project
Configuration file	Path to a hibernate.cfg.xml file	First hibernate.cfg.xml file found in the selected project
Enable Hibernate ejb3/annotations	Selecting this option enables usage of annotated classes. hbm.xml files are of course still possible to use too. This feature requires running the Eclipse IDE with a JDK 5 runtime, otherwise you will get classloading and/or version errors.	Not enabled
Mapping files	List of additional mapping files that should be loaded. Note: A hibernate.cfg.xml can also contain mappings. Thus if these are duplicated here, you will get "Duplicate mapping" errors when using the console configuration.	If no hibernate.cfg.xml file is found, all hbm.xml files found in the selected project
Classpath	The classpath for loading POJO and JDBC drivers. Do not add Hibernate core libraries or dependencies, they are already included. If you get ClassNotFoundException errors then check this list for possible missing or redundant directories/jars.	The default build output directory and any JARs with a class implementing java.sql.Driver in the selected project

Clicking "Finish" creates the configuration and shows it in the "Hibernate Configurations" view



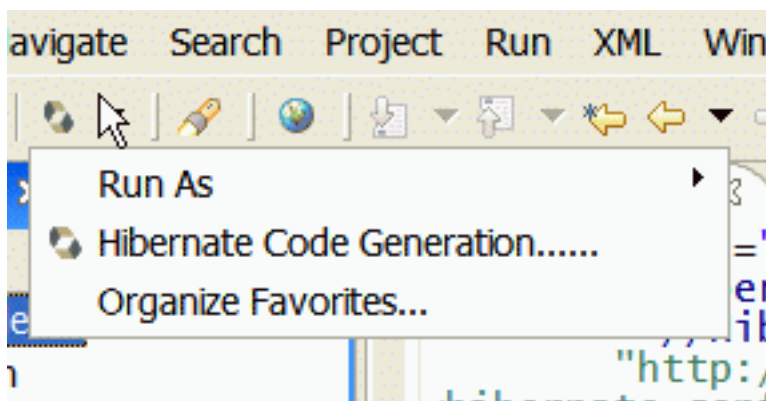
11.2.3. Reverse engineering and code generation

A very simple "click-and-generate" reverse engineering and code generation facility is available. It is this facility that allows you to generate the skeleton for a full Seam CRUD application.

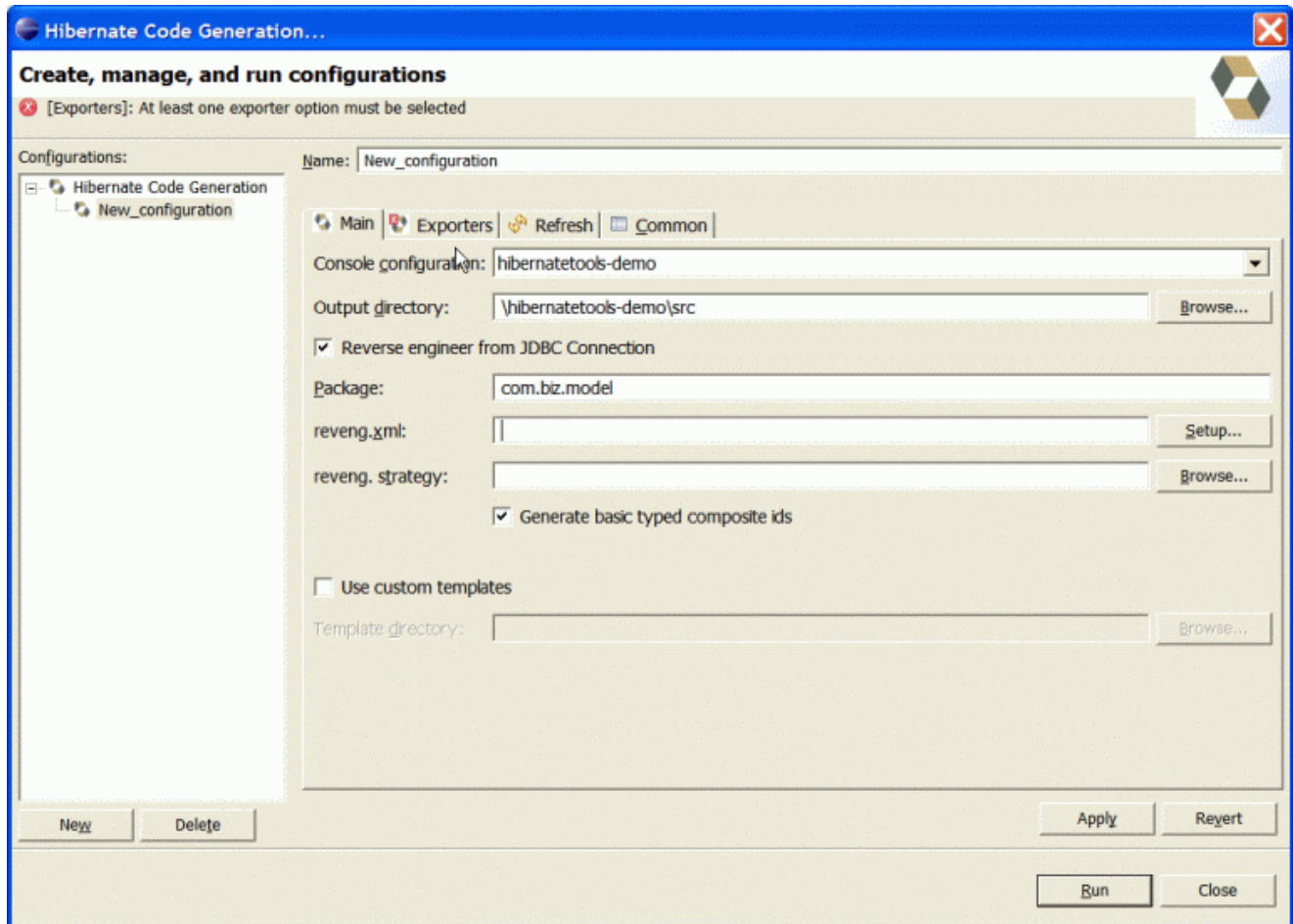
To start working with this process, start the "Hibernate Code Generation" which is available in the toolbar via the Hibernate icon or via the "Run/Hibernate Code Generation" menu item.

11.2.3.1. Code Generation Launcher

When you click on "Hibernate Code Generation" the standard Eclipse launcher dialog will appear. In this dialog you can create, edit and delete named Hibernate code generation "launchers".



The dialog has the standard tabs "Refresh" and "Common" that can be used to configure which directories should be automatically refreshed and various general settings launchers, such as saving them in a project for sharing the launcher within a team.



The first time you create a code generation launcher you should give it a meaningful name, otherwise the default prefix "New_Generation" will be used.

Note: The "At least one exporter option must be selected" is just a warning stating that for this launch to work you need to select an exporter on the Exporter tab. When an exporter has been selected the warning will disappear.

On the "Main" tab you the following fields:

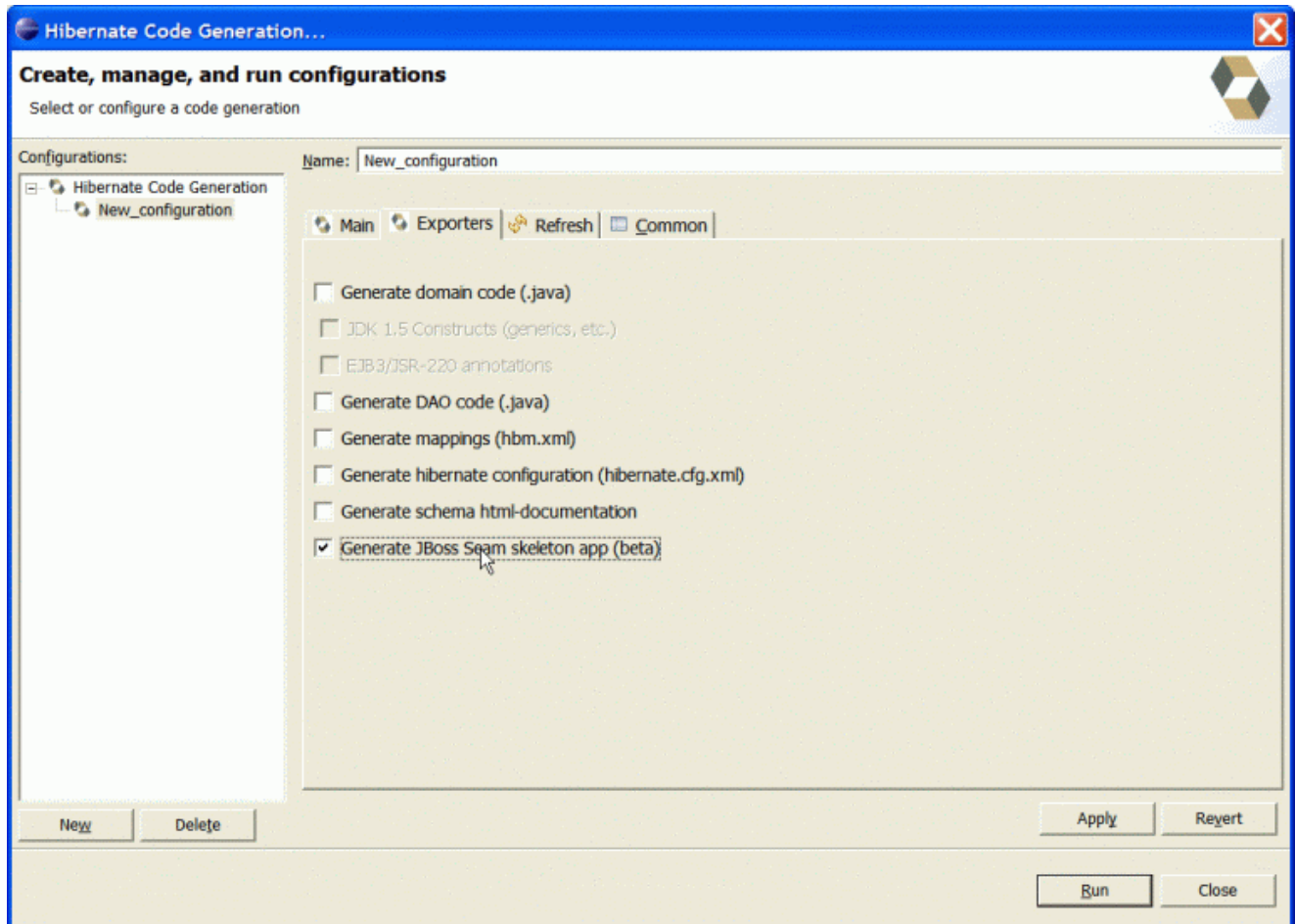
Table 11.2. Code generation "Main" tab fields

Field	Description
Console Configuration	The name of the console configuration which should be used when code generating.
Output directory	Path to a directory into where all output will be written by default. Be aware that existing files will be overwritten, so be sure to specify the correct directory.
Reverse engineer from JDBC Connection	If enabled the tools will reverse engineer the database available via the connection information in the selected Hibernate Console Configuration and generate code based on the database schema. If not enabled the code generation will just be based on the mappings already specified in the Hibernate Console configuration.

Field	Description
Package	The package name here is used as the default package name for any entities found when reverse engineering.
reveng.xml	Path to a reveng.xml file. A reveng.xml file allows you to control certain aspects of the reverse engineering. e.g. how jdbc types are mapped to hibernate types and especially important which tables are included/excluded from the process. Clicking "setup" allows you to select an existing reveng.xml file or create a new one..
reveng. strategy	If reveng.xml does not provide enough customization you can provide your own implementation of an ReverseEngineeringStrategy. The class need to be in the claspath of the Console Configuration, otherwise you will get class not found exceptions.
Generate basic typed composite ids	This field should always be enabled when generating the Seam CRUD application. A table that has a multi-colum primary key a <composite-id> mapping will always be created. If this option is enabled and there are matching foreign-keys each key column is still considered a 'basic' scalar (string, long, etc.) instead of a reference to an entity. If you disable this option a <key-many-to-one> instead. Note: a <many-to-one> property is still created, but is simply marked as non-updatable and non-insertable.
Use custom templates	If enabled, the Template directory will be searched first when looking up the velocity templates, allowing you to redefine how the individual templates process the hibernate mapping model.
Template directory	A path to a directory with custom velocity templates.

11.2.3.2. Exporters

The exporters tab is used to specify which type of code that should be generated. Each selection represents an "Exporter" that are responsible for generating the code, hence the name.



The following table describes in short the various exporters. The most relevant for Seam is of course the "JBoss Seam Skeleton app".

Table 11.3. Code generation "Exporter" tab fields

Field	Description
Generate domain code	Generates POJO's for all the persistent classes and components found in the given Hibernate configuration.
JDK 1.5 constructs	When enabled the POJO's will use JDK 1.5 constructs.
EJB3/JSR-220 annotations	When enabled the POJO's will be annotated according to the EJB3/JSR-220 persistence specification.
Generate DAO code	Generates a set of DAO's for each entity found.
Generate Mappings	Generate mapping (hbm.xml) files for each entity
Generate hibernate configuration file	Generate a hibernate.cfg.xml file. Used to keep the hibernate.cfg.xml uptodate with any new found mapping files.
Generate schema html-	Generates set of html pages that documents the database schema and some of the

Field	Description
documentation	mappings.
Generate JBoss Seam skeleton app (beta)	<p>Generates a complete JBoss Seam skeleton app. The generation will include annotated POJO's, Seam controller beans and a JSP for the presentation layer. See the generated readme.txt for how to use it.</p> <p>Note: this exporter generates a full application, including a build.xml thus you will get the best results if you use an output directory which is the root of your project.</p>

11.2.3.3. Generating and using the code

When you have finished filling out the settings, simply press "Run" to start the generation of code. This might take a little while if you are reverse engineering from a database.

When the generation have finished you should now have a complete skeleton Seam application in the output directory. In the output directory there is a `readme.txt` file describing the steps needed to deploy and run the example.

If you want to regenerate/update the skeleton code then simply run the code generation again by selecting the "Hibernate Code Generation" in the toolbar or "Run" menu. Enjoy.