PicketLink Reference Documentation

PicketLink [http://www.jboss.org/picketlink]

PicketLink Reference Documentation

by

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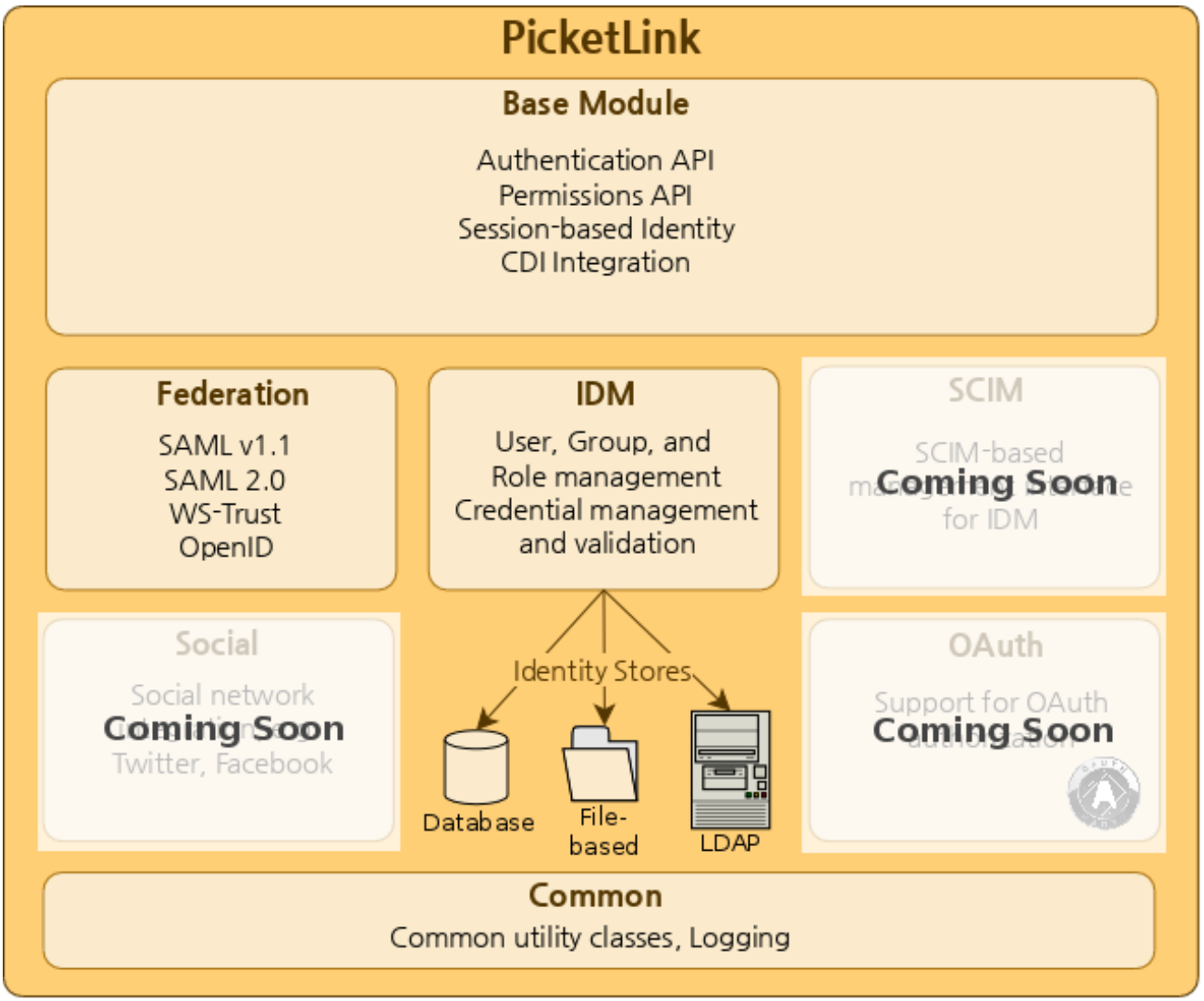
Chapter 1. Overview

1.1. What is PicketLink?

PicketLink is an Application Security Framework for Java EE applications. It provides features for authenticating users, authorizing access to the business methods of your application, managing your application's users, groups, roles and permissions, plus much more. The following diagram presents a high level overview of the PicketLink modules.



1.2. Modules

1.2.1. Base module

The base module provides the integration framework required to use PicketLink within a Java EE application. It defines a flexible authentication API that allows pluggable authentication mechanisms to be easy configured, with a sensible default authentication policy that delegates to

the identity management subsystem. It provides session-scoped authentication tracking for web applications and other session-capable clients, plus a customisable permissions SPI that supports a flexible range of authorization mechanisms for object-level security.

The base module libraries are as follows:

- `picketlink-api` - API for PicketLink's base module.
- `picketlink-impl` - Internal implementation classes for the base API.

1.2.2. Identity Management

The Identity Management module defines the base identity model; a collection of interfaces and classes that represent the identity constructs (such as users, groups and roles) used throughout PicketLink (see the Identity Management chapter for more details). As such, it is a required module and must always be included in any application deployments that use PicketLink for security. It also provides a uniform API for managing the identity objects within your application.

Libraries are as follows:

- `picketlink-idm-api` - PicketLink's Identity Management (IDM) API. This library defines the Identity Model central to all of PicketLink, and all of the identity management-related interfaces.
- `picketlink-idm-impl` - Internal implementation classes for the IDM API.

1.2.3. Federation

The Federation module is an optional module that implements a number of Federated Identity standards, such as SAML (both version 1.1 and 2.0), WS-Trust and OpenID.

1.3. License

PicketLink 3.0 is licensed under the Apache License Version 2, the terms and conditions of which can be found at apache.org [http://www.apache.org/licenses/LICENSE-2.0.html].

1.4. Maven Dependencies

The PicketLink libraries are available from the Maven Central Repository. To use PicketLink in your Maven-based project, it is recommended that you first define a version property for PicketLink in your project's `pom.xml` file like so:

```
<properties>
  <picketlink.version>2.5.0.Beta3</picketlink.version>
</properties>
```

For a typical application, it is suggested that you include the following PicketLink dependencies:

```
<dependencies>
  <dependency>
      <groupId>org.picketlink</groupId>
      <artifactId>picketlink-api</artifactId>
      <scope>compile</scope>
      <version>${picketlink.version}</version>
  </dependency>

  <dependency>
      <groupId>org.picketlink</groupId>
      <artifactId>picketlink-impl</artifactId>
      <scope>runtime</scope>
      <version>${picketlink.version}</version>
  </dependency>
```

The identity management library is a required dependency of the base module and so will be automatically included.

If you wish to use PicketLink's Identity Management features and want to include the default database schema (see the Identity Management chapter for more details) then configure the following dependency also:

```
  <dependency>
    <groupId>org.picketlink</groupId>
    <artifactId>picketlink-idm-schema</artifactId>
    <version>${picketlink.version}</version>
  </dependency>
```

Chapter 2. Authentication

2.1. Overview

Authentication is the act of verifying the identity of a user. PicketLink offers an extensible authentication API that allows for significant customization of the authentication process, while also providing sensible defaults for developers that wish to get up and running quickly. It also supports both synchronous and asynchronous user authentication, allowing for both a traditional style of authentication (such as logging in with a username and password), or alternatively allowing authentication via a federated identity service, such as OpenID, SAML or OAuth. This chapter will endeavour to describe the authentication API and the authentication process in some detail, and is a good place to gain a general overall understanding of authentication in PicketLink. However, please note that since authentication is a cross-cutting concern, various aspects (for example Identity Management-based authentication and Federated authentication) are documented in other chapters of this book.

2.2. The Authentication API

The `Identity` bean (which can be found in the `org.picketlink` package) is central to PicketLink's security API. This bean represents the authenticated user for the current session, and provides many useful methods for controlling the authentication process and querying the user's assigned privileges. In terms of authentication, the `Identity` bean provides the following methods:

```
AuthenticationResult login();

void logout();

boolean isLoggedIn();

Agent getAgent();
```

The `login()` method is the *primary* point of entry for the authentication process. Invoking this method will cause PicketLink to attempt to authenticate the user based on the credentials that they have provided. The `AuthenticationResult` type returned by the `login()` method is a simple enum that defines the following two values:

```
public enum AuthenticationResult {
    SUCCESS, FAILED
}
```

If the authentication process is successful, the `login()` method will return a result of `SUCCESS`, otherwise it will return a result of `FAILED`. By default, the `Identity` bean is session-scoped, which means that once a user is authenticated they will stay authenticated for the duration of the session.

> **Note**
>
> One significant point to note is the presence of the `@Named` annotation on the `Identity` bean, which means that its methods may be invoked directly from the view layer (if the view layer, such as JSF, supports it) via an EL expression.

One possible way to control the authentication process is by using an action bean, for example the following code might be used in a JSF application:

```
public @RequestScoped @Named class LoginAction {

    @Inject Identity identity;

    public void login() {
        AuthenticationResult result = identity.login();
        if (AuthenticationResult.FAILED.equals(result)) {
            FacesContext.getCurrentInstance().addMessage(null,
                new FacesMessage(
                   "Authentication was unsuccessful.  Please check your username and password " +
                        "before trying again."));
        }
    }
}
```

In the above code, the `Identity` bean is injected into the action bean via the CDI `@Inject` annotation. The `login()` method is essentially a wrapper method that delegates to `Identity.login()` and stores the authentication result in a variable. If authentication was unsuccessful, a `FacesMessage` is created to let the user know that their login failed. Also, since the bean is `@Named` it can be invoked directly from a JSF control like so:

```
<h:commandButton value="LOGIN" action="#{loginAction.login}"/>
```

The `isLoggedIn()` method may be used to determine whether there is a user logged in for the current session. It is typically used as an authorization check to control either an aspect of the user interface (for example, not displaying a menu item if the user isn't logged in), or to restrict certain business logic. While logged in, the `getAgent()` method can be used to retrieve the currently authenticated agent (or user). If the current session is not authenticated, then `getAgent()` will return `null`. The following example shows both the `isLoggedIn()` and `getAgent()` methods being used inside a JSF page:

```
<ui:fragment rendered="#{identity.loggedIn}">Welcome, #{identity.agent.loginName}
```

> **Note**
>
> If you're wondering what an `Agent` is, it is simply a representation of the external entity that is interacting with your application, whether that be a human user or some third party (non-human) system. The `Agent` interface is actually the superclass of `User` - see the Identity Management chapter for more details.

The `logout()` method allows the user to log out, thereby clearing the authentication state for their session. Also, if the user's session expires (for example due to inactivity) their authentication state will also be lost requiring the user to authenticate again.

The following JSF code example demonstrates how to render a log out button when the current user is logged in:

```
<ui:fragment rendered="#{identity.loggedIn}">
    <h:form>
        <h:commandButton value="Log out" action="#{identity.logout}"/>
    </h:form>
</ui:fragment>
```

While it is the `Identity` bean that controls the overall authentication process, the actual authentication "business logic" is defined by the `Authenticator` interface:

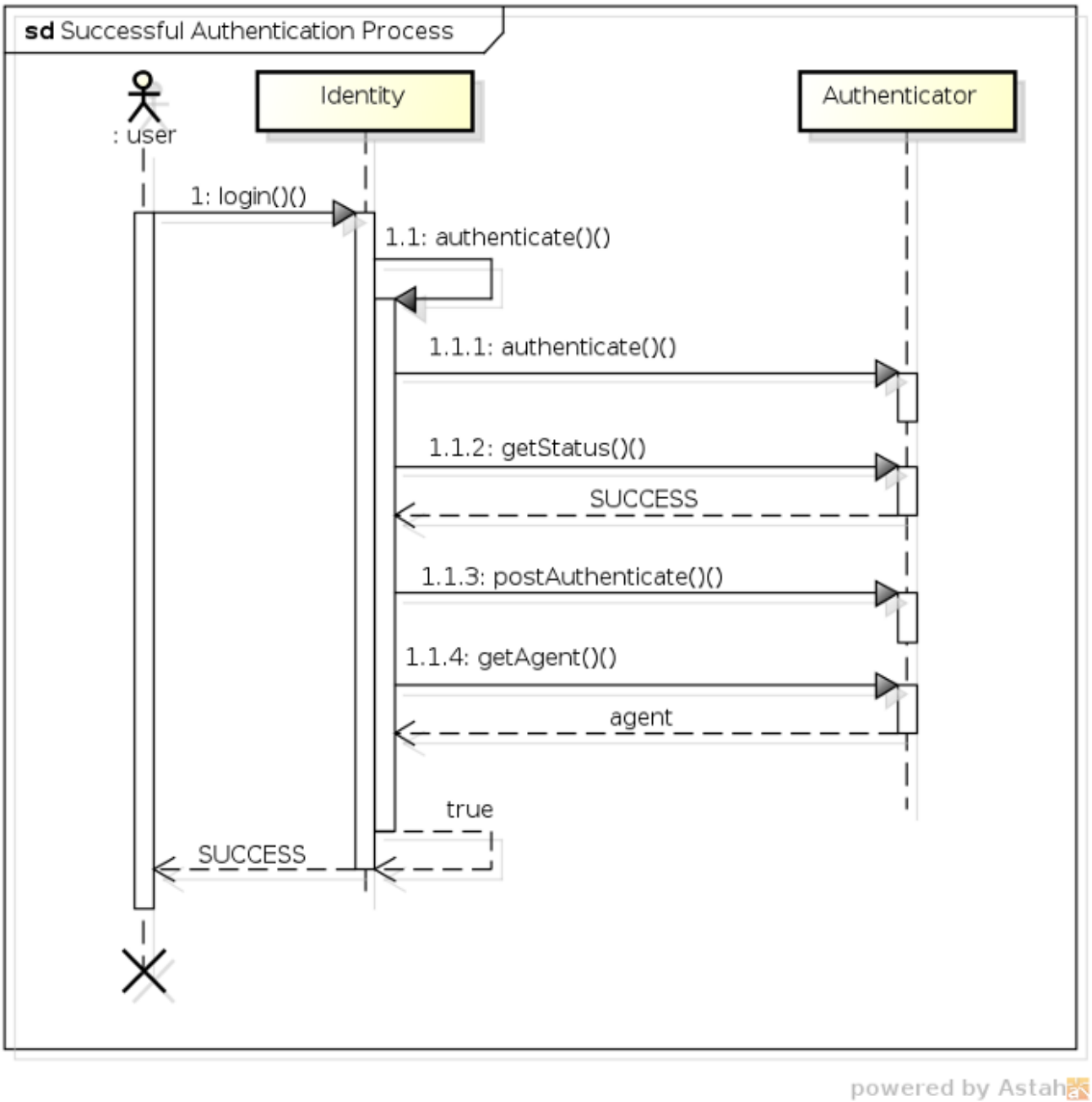
```
public interface Authenticator {
    public enum AuthenticationStatus {
        SUCCESS,
        FAILURE,
        DEFERRED
    }

    void authenticate();

    void postAuthenticate();

    AuthenticationStatus getStatus();

    Agent getAgent();
}
```

During the authentication process, the `Identity` bean will invoke the methods of the *active* `Authenticator` (more on this in a moment) to perform user authentication. The `authenticate()` method is the most important of these, as it defines the actual authentication logic. After `authenticate()` has been invoked by the `Identity` bean, the `getStatus()` method will reflect

the authentication status (either `SUCCESS`, `FAILURE` or `DEFERRED`). If the authentication process was a success, the `getAgent()` method will return the authenticated `Agent` object and the `postAuthenticate()` method will be invoked also. If the authentication was not a success, `getAgent()` will return `null`.

2.3. The Authentication Process

Now that we've looked at all the individual pieces, let's take a look at how they all work together to process an authentication request. For starters, the following sequence diagram shows the class interaction that occurs during a successful authentication:



- *1* - The user invokes the `login()` method of the `Identity` bean.
- *1.1* - The `Identity` bean (after performing a couple of validations) invokes its own `authenticate()` method.
- *1.1.1* - Next the `Identity` bean invokes the `Authenticator` bean's `authenticate()` method (which has a return value of `void`).
- *1.1.2* - To determine whether authentication was successful, the `Identity` bean invokes the `Authenticator`'s `getStatus()` method, which returns a `SUCCESS`.
- *1.1.3* - Upon a successful authentication, the `Identity` bean then invokes the `Authenticator`'s `postAuthenticate()` method to perform any post-authentication logic.
- *1.1.4* - The `Identity` bean then invokes the `Authenticator`'s `getAgent()` method, which returns an `Agent` object representing the authenticated agent, which is then stored as a private field in the `Identity` bean.

The authentication process ends when the `Identity.authenticate()` method returns a value of `true` to the `login()` method, which in turn returns an authentication result of `SUCCESS` to the invoking user.

2.3.1. A Basic Authenticator

Let's take a closer look at an extremely simple example of an `Authenticator`. The following code demonstrates an `Authenticator` implementation that simply tests the username and password credentials that the user has provided against hard coded values of `jsmith` for the username, and `abc123` for the password, and if they match then authentication is deemed to be a success:

```
@PicketLink
public class SimpleAuthenticator extends BaseAuthenticator {

    @Inject DefaultLoginCredentials credentials;

    @Override
    public void authenticate() {
        if ("jsmith".equals(credentials.getUserId()) &&
                "abc123".equals(credentials.getPassword())) {
            setStatus(AuthenticationStatus.SUCCESS);
            setUser(new SimpleUser("jsmith"));
        } else {
            setStatus(AuthenticationStatus.FAILURE);
            FacesContext.getCurrentInstance().addMessage(null, new FacesMessage(
                "Authentication Failure - The username or password you provided were invalid."));
        }
    }
}
```

The first thing we can notice about the above code is that the class is annotated with the `@PicketLink` annotation. This annotation indicates that this bean should be used for

the authentication process. The next thing is that the authenticator class extends something called `BaseAuthenticator`. This abstract base class provided by PicketLink implements the `Authenticator` interface and provides implementations of the `getStatus()` and `getAgent()` methods (while also providing matching `setStatus()` and `setAgent()` methods), and also provides an empty implementation of the `postAuthenticate()` method. By extending `BaseAuthenticator`, our `Authenticator` implementation simply needs to implement the `authenticate()` method itself.

We can see in the above code that in the case of a successful authentication, the `setStatus()` method is used to set the authentication status to `SUCCESS`, and the `setUser()` method is used to set the user (in this case by creating a new instance of `SimpleUser`). For an unsuccessful authentication, the `setStatus()` method is used to set the authentication status to `FAILURE`, and a new `FacesMessage` is created to indicate to the user that authentication has failed. While this code is obviously meant for a JSF application, it's possible to execute whichever suitable business logic is required for the view layer technology being used.

One thing that hasn't been touched on yet is the following line of code:

```
@Inject DefaultLoginCredentials credentials;
```

This line of code injects the credentials that have been provided by the user using CDI's `@Inject` annotation, so that our `Authenticator` implementation can query the credential values to determine whether they're valid or not. We'll take a look at credentials in more detail in the next section.

> **Note**
>
> You may be wondering what happens if you don't provide an `Authenticator` bean in your application. If this is the case, PicketLink will automatically authenticate via the identity management API, using a sensible default configuration. See the Identity Management chapter for more information.

2.3.2. Multiple Authenticator Support

If your application needs to support multiple authentication methods, you can provide the authenticator selection logic within a producer method annotated with `@PicketLink`, like so:

```
@RequestScoped
@Named
public class AuthenticatorSelector {

    @Inject Instance<CustomAuthenticator> customAuthenticator;
    @Inject Instance<IdmAuthenticator> idmAuthenticator;
```

```
    private String authenticator;

    public String getAuthenticator() {
        return authenticator;
    }

    public void setAuthenticator(String authenticator) {
        this.authenticator = authenticator;
    }

    @Produces
    @PicketLink
    public Authenticator selectAuthenticator() {
        if ("custom".equals(authenticator)) {
            return customAuthenticator.get();
        } else {
            return idmAuthenticator.get();
        }
    }
}
```

This `@Named` bean exposes an `authenticator` property that can be set by a user interface control in the view layer. If its value is set to "custom" then `CustomAuthenticator` will be used, otherwise `IdmAuthenticator` (the `Authenticator` used to authenticate using the identity management API) will be used instead. This is an extremely simple example but should give you an idea of how to implement a producer method for authenticator selection.

2.3.3. Credentials

Credentials are something that provides evidence of a user's identity; for example a username and password, an X509 certificate or some kind of biometric data such as a fingerprint. PicketLink has extensive support for a variety of credential types, and also makes it relatively simple to add custom support for credential types that PicketLink doesn't support out of the box itself.

In the previous section, we saw a code example in which a `DefaultLoginCredentials` (an implementation of the `Credentials` interface that supports a user ID and a credential value) was injected into the `SimpleAuthenticator` bean. The most important thing to know about the `Credentials` interface in relation to writing your own custom `Authenticator` implementation is that *you're not forced to use it*. *However*, while the `Credentials` interface is mainly designed for use with the Identity Management API (which is documented in a separate chapter) and its methods would rarely be used in a custom `Authenticator`, PicketLink provides some implementations which are suitably convenient to use as such, `DefaultLoginCredentials` being one of them.

So, in a custom `Authenticator` such as this:

```
public class SimpleAuthenticator extends BaseAuthenticator {

    @Inject DefaultLoginCredentials credentials;
```

```
    // code snipped
}
```

The credential injection is totally optional. As an alternative example, it is totally valid to create a request-scoped bean called `UsernamePassword` with simple getters and setters like so:

```
public @RequestScoped class UsernamePassword {
    private String username;
    private String password;

    public String getUsername() { return username; }
    public String getPassword() { return password; }

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

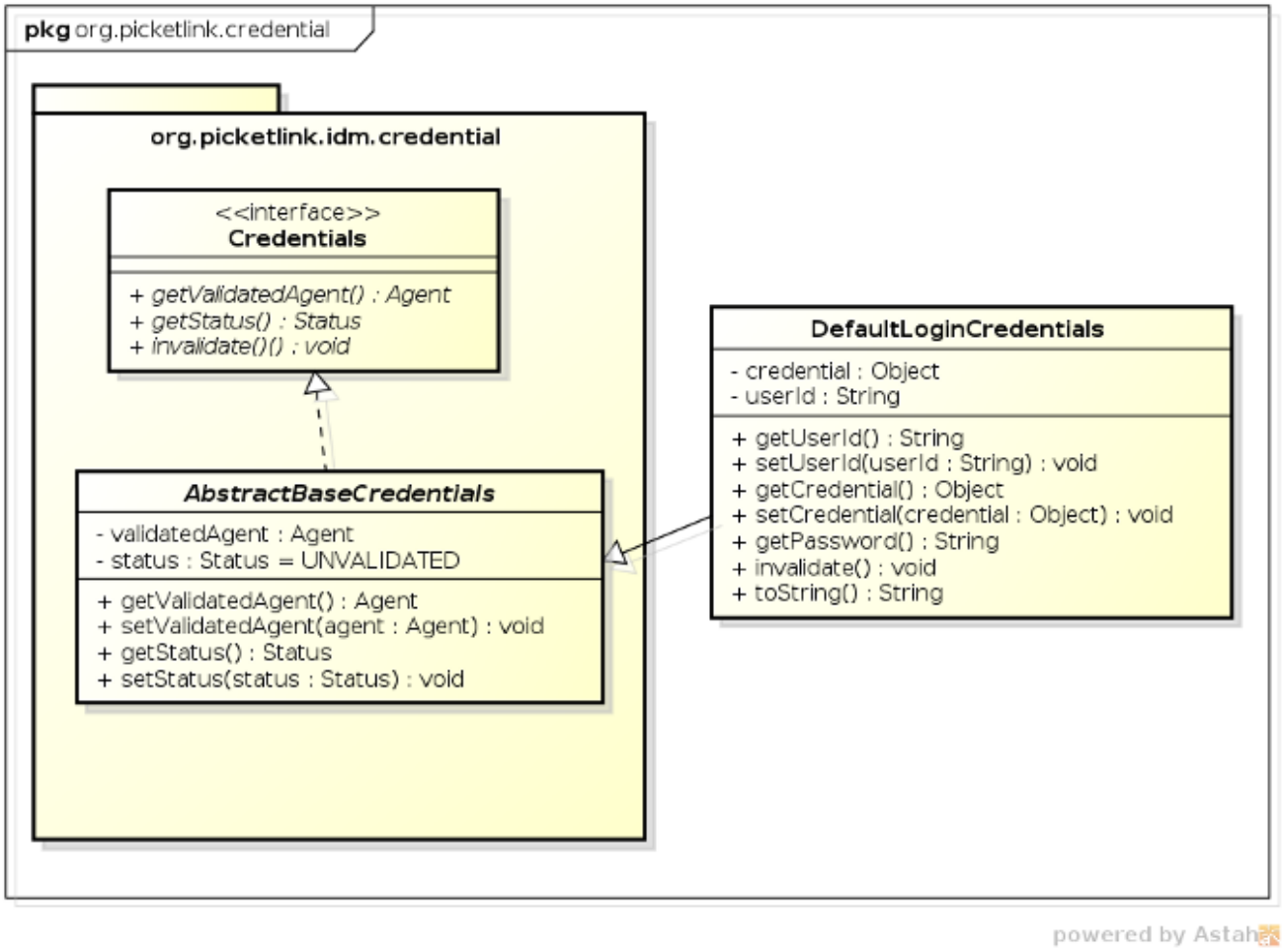
And then inject that into the `Authenticator` bean instead:

```
public class SimpleAuthenticator extends BaseAuthenticator {

    @Inject UsernamePassword usernamePassword;

    // code snipped
}
```

Of course it is not recommended that you actually do this, however this simplistic example serves adequately for demonstrating the case in point.

2.3.4. DefaultLoginCredentials

The `DefaultLoginCredentials` bean is provided by PicketLink as a convenience, and is intended to serve as a general purpose `Credentials` implementation suitable for a variety of use cases. It supports the setting of a `userId` and `credential` property, and provides convenience methods for working with text-based passwords. It is a request-scoped bean and is also annotated with `@Named` so as to make it accessible directly from the view layer.



A view technology with support for EL binding (such as JSF) can access the `DefaultLoginCredentials` bean directly via its bean name, `loginCredentials`. The following code snippet shows some JSF markup that binds the controls of a login form to `DefaultLoginCredentials`:

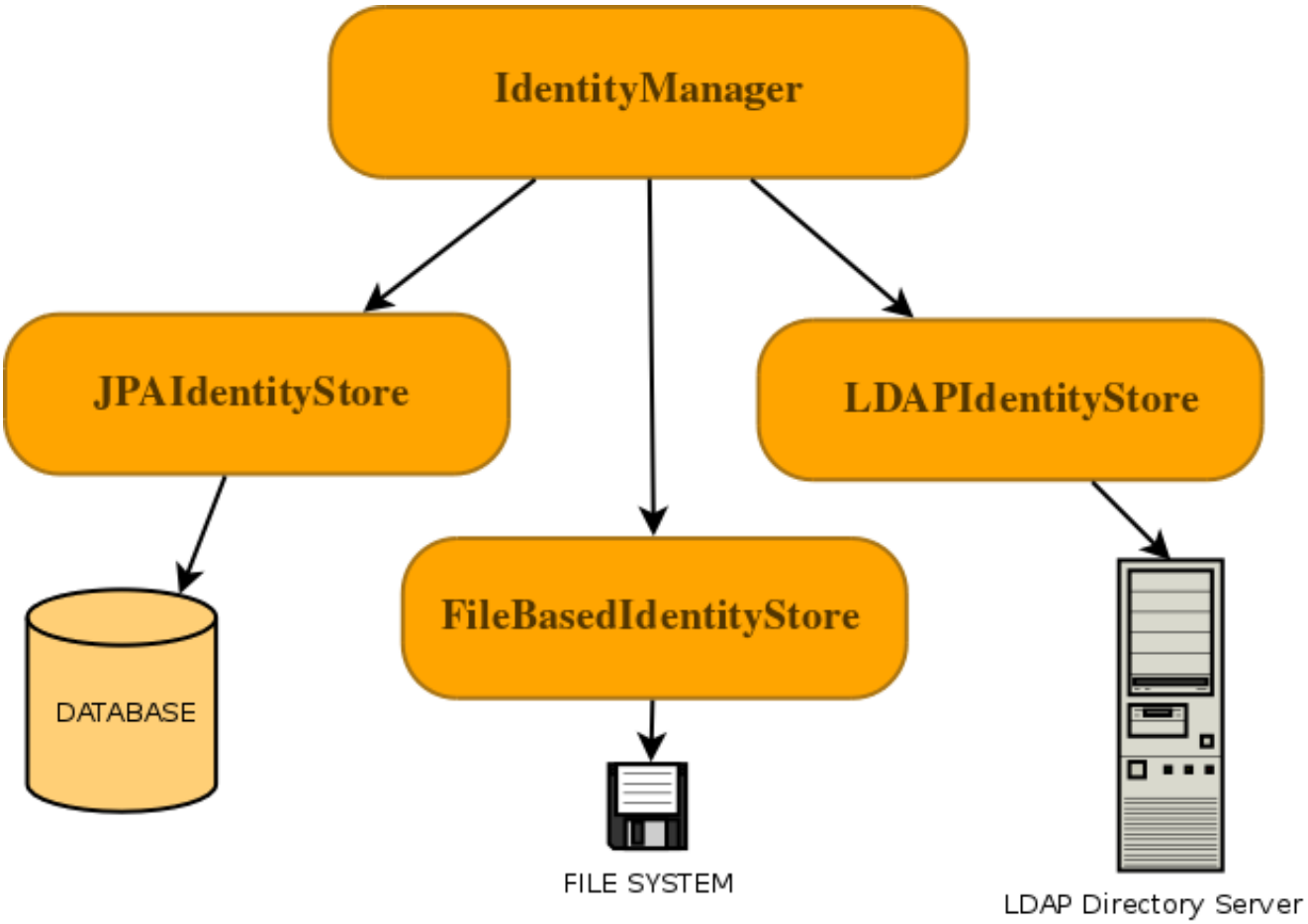
```
<div class="loginRow">
  <h:outputLabel for="name" value="Username" styleClass="loginLabel"/>
  <h:inputText id="name" value="#{loginCredentials.userId}"/>
</div>

<div class="loginRow">
  <h:outputLabel for="password" value="Password" styleClass="loginLabel"/>
  <h:inputSecret id="password" value="#{loginCredentials.password}" redisplay="true"/>
</div>
```

Chapter 3. Identity Management

3.1. Overview

PicketLink's Identity Management (IDM) features provide a rich and extensible API for managing the users, groups and roles of your applications and services. The `org.picketlink.idm.IdentityManager` interface declares all the methods required to create, update and delete Identity objects and create relationships between them such as group and role memberships.

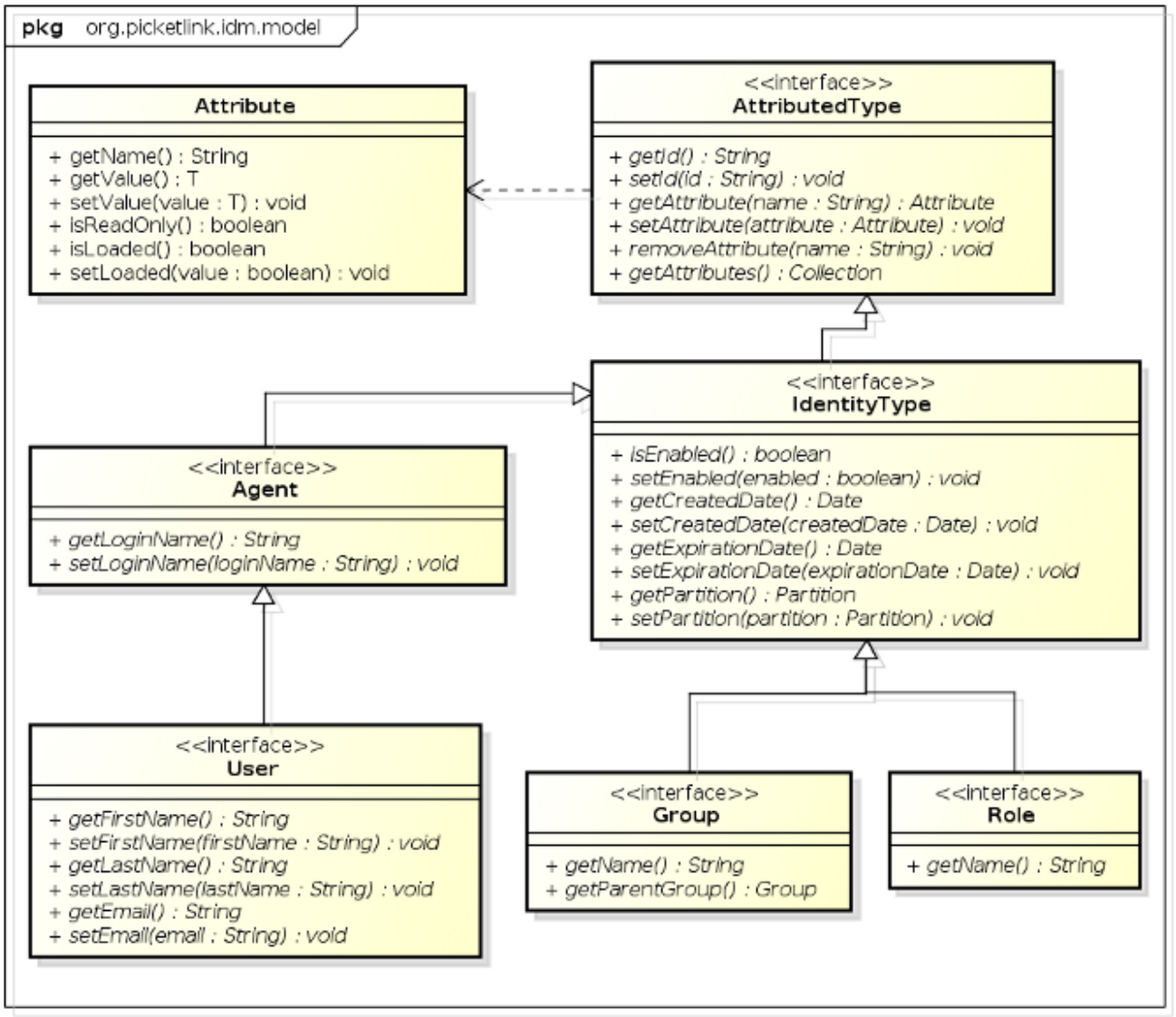
Interaction with the backend store that provides the persistent identity state is performed by configuring one or more `IdentityStore`s. PicketLink provides a few built-in `IdentityStore` implementations for storing identity state in a database, file system or LDAP directory server, and it is possible to provide your own custom implementation to support storing your application's identity data in other backends, or extend the built-in implementations to override their default behaviour.



Before PicketLink IDM can be used, it must first be configured. See the configuration section below for details on how to configure IDM for both Java EE and Java SE environments.

3.2. Identity Model

PicketLink's identity model consists of a number of core interfaces that define the fundamental identity types upon which much of the Identity Management API is based. The following class diagram shows the classes and interfaces in the `org.picketlink.idm.model` package that form the base identity model.

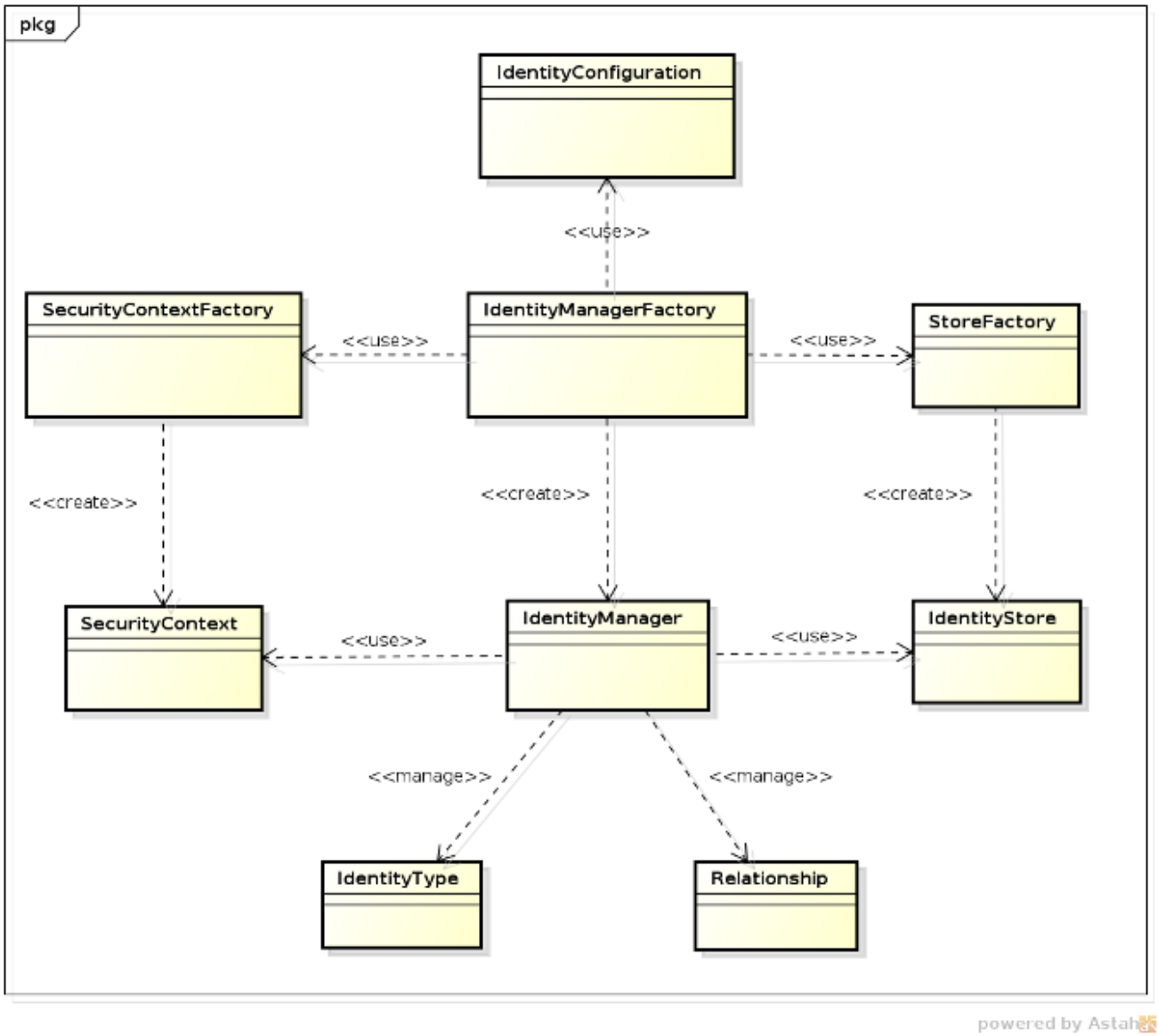


- `AttributedType` is the base interface for the identity model. It declares a number of methods for managing a set of attribute values, plus `getId()` and `setId()` methods for setting a unique UUID value.
- `Attribute` is used to represent an attribute value. An attribute has a name and a (generically typed) value, and may be marked as read-only. Attribute values that are expensive to load (such as large binary data) may be lazy-loaded; the `isLoaded()` method may be used to determine whether the Attribute has been loaded or not.

- `IdentityType` is the base interface for Identity objects. It declares properties that indicate whether the identity object is enabled or not, optional created and expiry dates, plus methods to read and set the owning `Partition`.
- `Agent` represents a unique entity that may access the services secured by PicketLink. In contrast to a user which represents a human, `Agent` is intended to represent a third party non-human (i.e. machine to machine) process that may authenticate and interact with your application or services. It declares methods for reading and setting the `Agent`'s login name.
- `User` represents a human user that accesses your application and services. In addition to the login name property defined by its parent interface `Agent`, the `User` interface declares a number of other methods for managing the user's first name, last name and e-mail address.
- `Group` is used to manage collections of identity types. Each `Group` has a name and an optional parent group.
- `Role` is used in various relationship types to designate authority to another identity type to perform various operations within an application. For example, a forum application may define a role called *moderator* which may be assigned to one or more `Users` or `Groups` to indicate that they are authorized to perform moderator functions.

3.2.1. Architectural Overview

The following diagram shows the main components that realize PicketLink Identity Management:



- `IdentityConfiguration` is the the class responsible for holding all PicketLink configuration options. This class is usually built using the Configuration Builder API, which we'll cover in the next sections. Once created and populated with the configuration options, an instance is used to create a `IdentityManagerFactory`.
- `IdentityManagerFactory` is the class from which `IdentityManager` instances are created for a specific *realm*, considering all configurations provided by a `IdentityConfiguration` instance.
- `SecurityContextFactory` is an interface that provides methods for creating `SecurityContext` instances. This component knows how to properly create and prepare the context that will be propagated during identity management operations.

- `SecurityContext` is the class that holds context data that will be used during the execution of identity management operations. Once created, the context is used to create `IdentityStore` instances and to invoke their methods.

  This component allows to share data between the `IdentityManager` and `IdentityStore` instances. And also provides direct access for some IDM subsystems such as: event handling, caching and so on.

  Beyond that, this component is critical when access to external resources are required, such as the current `EntityManager` when using a JPA-based store.

  Each `IdentityManager` instance is associated with a single `SecurityContext`.

- `StoreFactory` is an interface that provides methods for creating `IdentityStore` instances. Instances are created considering the *Feature Set* supported by each identity store and also the current `SecurityContext` instance.

- `IdentityStore` is an interface that provides a contract for implementations that store data using a specific repository such as: LDAP, databases, file system, etc.

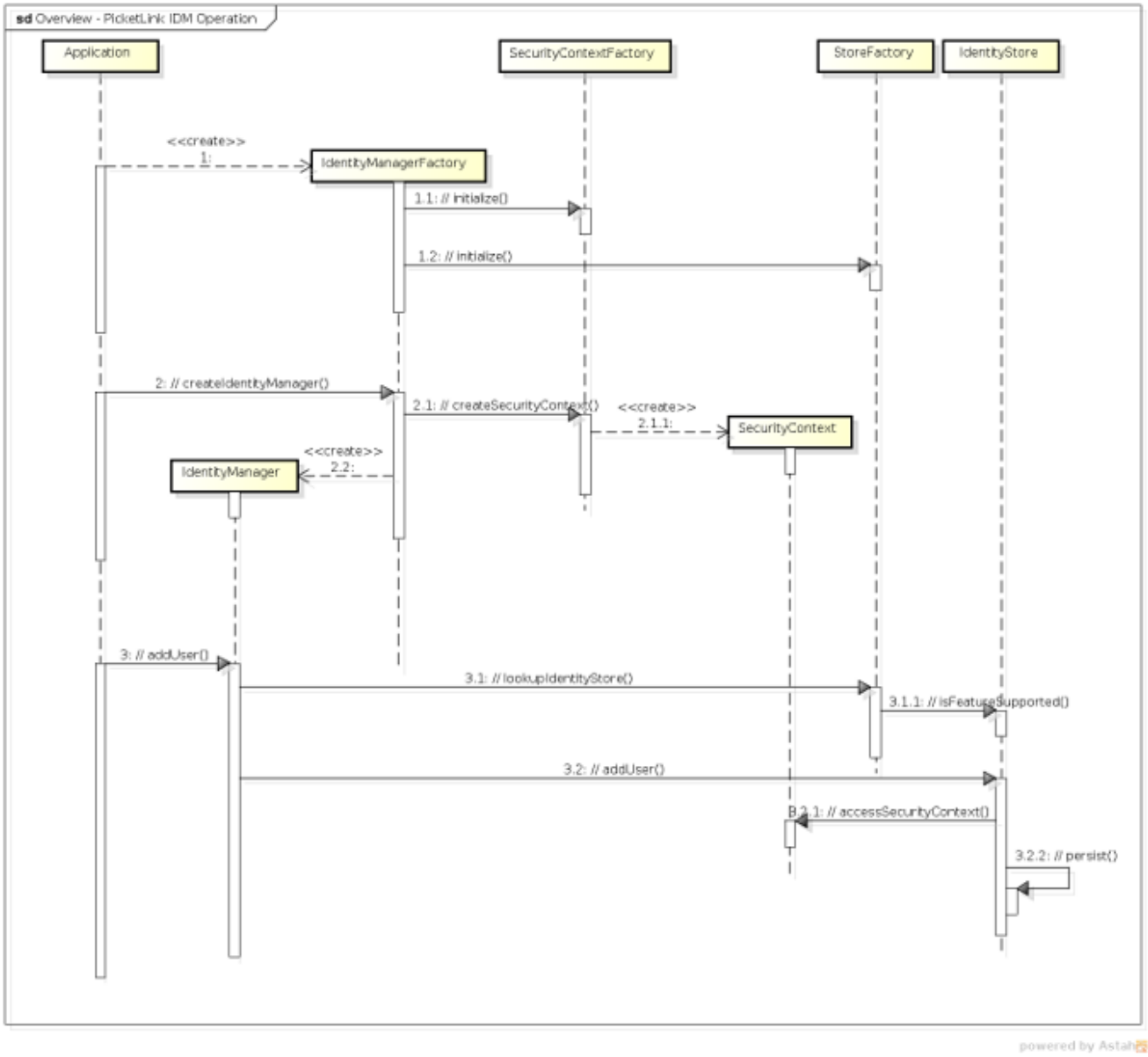
  It is a critical component as it provides all the necessary logic about how to store data.

- `IdentityManager` is an interface that provides a simple access for all identity management operations using one or more of the configured identity stores.

  All functionality provided by PicketLink is available from this interface, from where applications will interact most of the time.

For most use cases, users will only work with the `IdentityManagerFactory` and `IdentityManager` classes. Only advanced use cases may require a deep knowledge about other components in order to customize the default behaviour/implementation to suit a specific requirement.

The diagram below shows an overview about how a specific identity management operation is realized:



- *1* - The *Application* creates an `IdentityManagerFactory` instance from a previously created `IdentityConfiguration`. At this point, the factory reads the configuration and bootstraps the identity management ecosystem.
- *1.1* - The `IdentityManagerFactory` initializes the `SecurityContextFactory`.
- *1.2* - The `IdentityManagerFactory` initializes the `StoreFactory`.
- *2* - With a fully initialized `IdentityManagerFactory` instance, the *Application* is able to create `IdentityManager` instances and execute operations. `IdentityManager` instances are created for a specific *realm*, in this specific case we're creating an instance using the default realm.
- *2.1 and 2.1.1* - An `IdentityManager` instance is always associated with a `SecurityContext`. The `SecurityContext` is created and set into the `IdentityManager` instance. The same

security context is used during the entire lifecycle of the `IdentityManager`, it will be used to share state with the underlying identity stores and provide access to external resources (if necessary) in order to execute operations.

At this time, the `IdentityManager` is also configured to hold a reference to the `StoreFactory` in order to execute the operations against the underlying/configured `IdentityStore` instances.

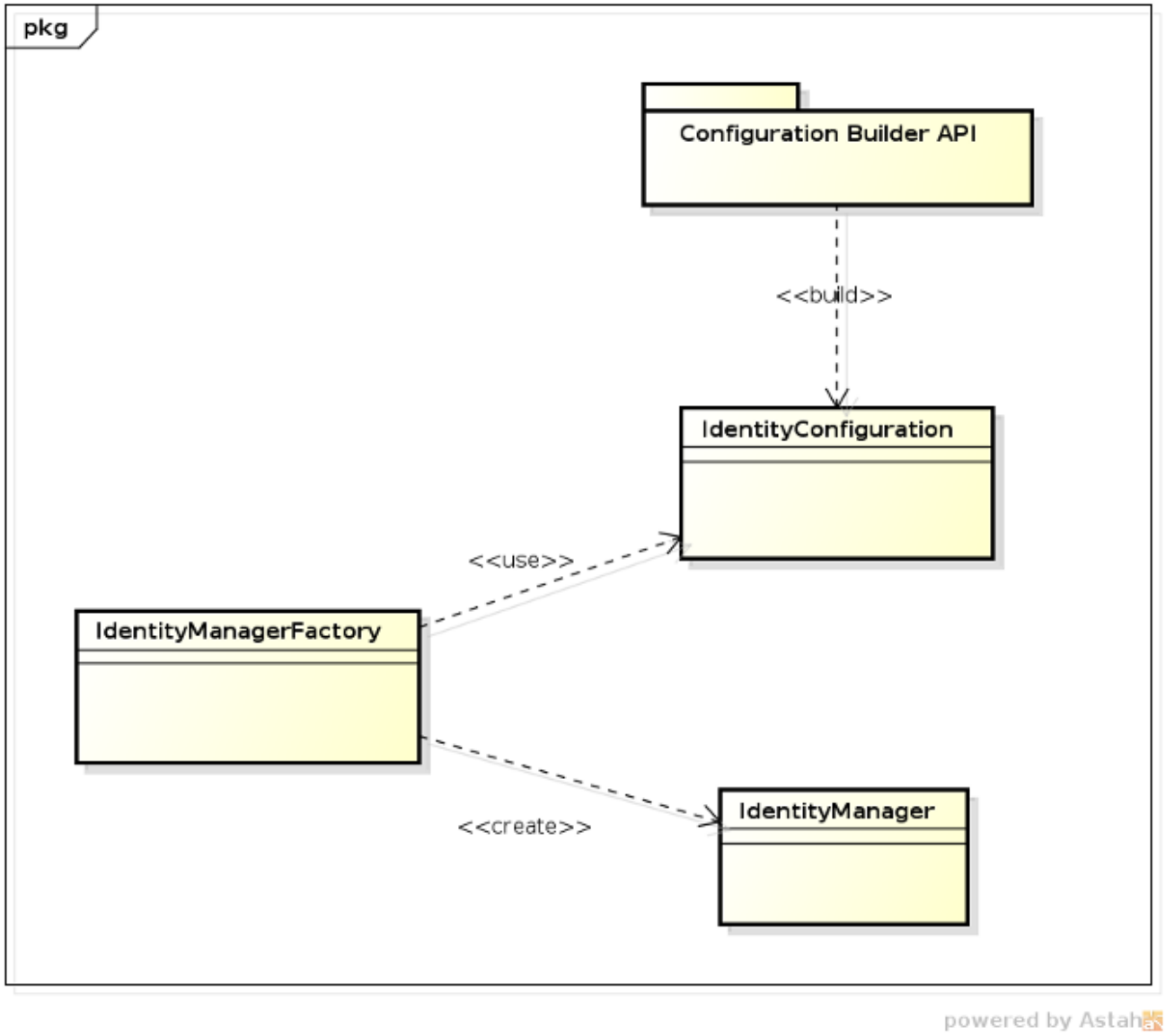
- *3* - Now the application holds a reference to the `IdentityManager` instance and it is ready to perform identity management operations (eg.: add an user, queries, validate credentials, etc).
- *3.1 and 3.1.1* - But before executing the operations, the `IdentityManager` needs to obtain from the `StoreFactory` the `IdentityStore` instance that should be used to execute a specific operation. Identity stores are selected by examining the configuration to see which store configuration supports a specific operation or feature.
- *3.2* - Now that the `IdentityManager` have selected which `IdentityStore` instance should be used, this last is invoked in order to process the operation.
- *3.2.1* - Usually, during the execution of an operation, the `IdentityStore` uses the current `SecurityContext`. The `SecurityContext` can hold some state that may be useful during the execution (eg.: the JPA store uses the security context to gain access to the current `EntityManager` instance) and also provide access for some IDM internal services like event handling, caching, etc.
- *3.2.2* - Finally, the `IdentityStore` executes the operation and persist or retrieve identity data from the underlying repository.

PicketLink IDM design is quite flexible and allows you to configure or even customize most of the behaviours described above. As stated earlier, most use cases require minimal knowledge about these details and the default implementation should be enough to satisfy the majority of requirements.

3.3. Configuration

3.3.1. Architectural Overview

Configuration in PicketLink is in essence quite simple; an `IdentityConfiguration` object must first be created to hold the PicketLink configuration options. Once all configuration options have been set, you just create a `IdentityManagerFactory` instance passing the previously created configuration. The `IdentityManagerFactory` can then be used to create `IdentityManager` instances via the `createIdentityManager()` method.



The `IdentityConfiguration` is usually created using a Configuration Builder API, which provides a rich and fluent API for every single aspect of PicketLink configuration.

> **Note**
>
> For now, all configuration is set programmatically using the Configuration Builder API only. Later versions will also support a declarative configuration in a form of XML documents.

Each `IdentityManager` instance has its own *security context*, represented by the `SecurityContext` class. The security context contains temporary state which is maintained for one or more identity management operations within the scope of a single realm or tier. The `IdentityManager` (and its associated `SecurityContext`) is typically modelled as a request-

scoped object (for environments which support such a paradigm, such as a servlet container), or alternatively as an actor within the scope of a transaction. In the latter case, the underlying resources being utilised by the configured identity stores (such as a JPA `EntityManager`) would participate in the active transaction, and changes made as a result of any identity management operations would either be committed or rolled back as appropriate for the logic of the encapsulating business method.

The following sections describe various ways that configuration may be performed in different environments.

3.3.2. Programmatic Configuration

Configuration for Identity Management can be defined programmatically using the Configuration Builder API. The aim of this API is to make it easier to chain coding of configuration options in order to speed up the coding itself and make the configuration more *readable*.

Let's assume that you want to quick start with PicketLink Identity Management features using a file-based Identity Store. First, a fresh instance of `IdentityConfiguration` is created using the `IdentityConfigurationBuilder` helper object, where we choose which identity store we want to use (in this case a file-based store) and any other configuration option, if necessary. Finally, we use the configuration to create a `IdentityManagerFactory` from where we can create `IdentityManager` instances and start to perform Identity Management operations:

```
IdentityConfigurationBuilder builder = new IdentityConfigurationBuilder();

builder
  .stores()
  .file()
  .supportAllFeatures();

IdentityConfiguration configuration = builder.build();

IdentityManagerFactory identityManagerFactory = new IdentityManagerFactory(configuration);

IdentityManager identityManager = identityManagerFactory.createIdentityManager();

User user = new SimpleUser("john");

identityManager.add(user);
```

3.3.2.1. IdentityConfigurationBuilder for Programmatic Configuration

The `IdentityConfigurationBuilder` is the entry point for PicketLink configuration. It is a very simple class with some meaningful methods for all supported configuration options.

```
IdentityConfigurationBuilder builder = new IdentityConfigurationBuilder();

builder
  .stores() // supported identity stores configuration
```

```
    .file()
      // file-based identity store configuration
    .jpa()
      // JPA-based identity store configuration
    .ldap()
      // LDAP-based identity store configuration
  .contextFactory(...); // for custom SecurityContextFactory implementations
```

In the next sections we'll cover each supported Identity Store and their specific configuration.

3.3.3. Security Context Configuration

The `SecurityContext` plays an important role in the PicketLink IDM achitecture. As discussed in the Architectural Overview, it is strongly used during the execution of operations. It carries very sensitive and contextual information for a specific operation and provides access for some of the IDM underlying services such as caching, event handling, UUID generator for `IdentityTpe` and `Relationship` instances, among others.

Operations are always executed by a specific `IdentityStore` in order to persist or store identity data using a specific repository (eg.: LDAP, databases, filesystem, etc). When executing a operation the identity store must be able to:

- Access the current `Partition`. All operations are executed for a specific `Realm` or `Tier`
- Access the current `IdentityManager` instance, from which the operation was executed.
- Access the *Event Handling API* in order to fire events such as when an user is created, updated, etc.
- Access the *Caching API* in order to cache identity data and increase performance.
- Access the *Credential Handler API* in order to be able to update and validate credentials.
- Access to external resources, provided before the operation is executed and initialized by a `ContextInitializer`.

3.3.3.1. Initializing the SecurityContext

Sometimes you may need to provide additional configuration or even references for external resources before the operation is executed by an identity store. An example is how you tell to the`JPAIdentityStore` which `EntityManager` instance should be used. When executing an operation, the `JPAIdentityStore` must be able to access the current `EntityManager` to persist or retrieve data from the database. You need someway to populate the `SecurityContext` with such information. When you're configuring an identity store, there is a configuration option that allows you to provide a `ContextInitializer` implementation.

```
public interface ContextInitializer {
```

```
    void initContextForStore(SecurityContext context, IdentityStore<?> store);
}
```

The method `initContextForStore` will be invoked for every single operation and before its execution by the identity store. It can be implemented to provide all the necessary logic to initialize and populate the `SecurityContext` for a specific `IdentityStore`.

The configuration is also very simple, you just need to provide the following configuration:

```
IdentityConfigurationBuilder builder = new IdentityConfigurationBuilder();

builder
  .stores()
    .file()
      .addContextInitializer(new MySecurityContextInitializer());
}
```

You can provide multiple initializers.

> **Note**
>
> Remember that initializers are executed for every single operation. Also, the same instance is used between operations which means your implementation should be "stateless". You should be careful about the implementation in order to not impact performance, concurrency or introduce unexpected behaviors.

3.3.3.2. Configuring how SecurityContext instances are created

`SecurityContext` instances are created by the `SecurityContextFactory`. If for some reason you need to change how `SecurityContext` instances are created, you can provide an implementation of this interface and configure it as follows:

```
IdentityConfigurationBuilder builder = new IdentityConfigurationBuilder();

builder
  .stores()
    .contextFactory(mew MySecurityContextFactory());
}
```

3.3.4. Identity Store Feature Set

When configuring identity stores you must tell which features and operations should be executed by them. Features and operations are a key concept if you want to mix stores in order to execute operations against different repositories.

PicketLink provides a Java `enum`, called `FeatureGroup`, in which are defined all supported features. The table bellow summarize them:

Table 3.1. Identity class fields

Feature	
`FeatureGroup.agent`	
`FeatureGroup.user`	
`FeatureGroup.role`	
`FeatureGroup.group`	
`FeatureGroup.relationship`	
`FeatureGroup.credential`	
`FeatureGroup.realm`	
`FeatureGroup.tier`	

The features are a determinant factor when choosing an identity store to execute a specific operation. For example, if an identity store is configured with `FeatureGroup.user` we're saying that all `User` operations should be executed by this identity store. The same goes for `FeatureGroup.credential`, we're just saying that credentials can also be updated and validated using the identity store.

Beside that, provide only the feature is not enough. We must also tell the identity store which operations are supported by a feature. For example, we can configure a identity store to support only read operations for users, which is very common when using the LDAP identity store against a read-only tree. Operations are also defined by an `enum`, called `FeatureOperation`, as follows:

Table 3.2. Identity class fields

Operation	
`Featureoperation.create`	
`Featureoperation.read`	
`Featureoperation.update`	
`Featureoperation.delete`	
`Featureoperation.validate`	

During the configuration you can provide which features and operations should be supported using the *Configuration API*. You don't need to be forced to specify them individually, if you want to support all features and operations for a particular identity store you can use:

```
IdentityConfigurationBuilder builder = new IdentityConfigurationBuilder();

builder
  .stores()
    .file()
```

```
      .supportAllFeatures();
}
```

For a more granular configuration you can also use:

```
IdentityConfigurationBuilder builder = new IdentityConfigurationBuilder();

builder
  .stores()
    .file()
      .supportFeature(
        FeatureGroup.agent,
        FeatureGroup.user,
        FeatureGroup.role,
        FeatureGroup.group)
}
```

The configuration above defines the features individually. In this case the configured features are also supporting all operations. If you want to specify which operation should be supported by a feature you can use:

```
IdentityConfigurationBuilder builder = new IdentityConfigurationBuilder();

builder
  .stores()
    .file()
      .supportFeature(FeatureGroup.agent, FeatureOperation.read)
      .supportFeature(FeatureGroup.user, FeatureOperation.read))
      .supportFeature(FeatureGroup.role, FeatureOperation.create))
      .supportFeature(FeatureGroup.role, FeatureOperation.read))
      .supportFeature(FeatureGroup.role, FeatureOperation.update))
      .supportFeature(FeatureGroup.role, FeatureOperation.delete))
      .supportFeature(FeatureGroup.group, FeatureOperation.create))
      .supportFeature(FeatureGroup.group, FeatureOperation.read))
      .supportFeature(FeatureGroup.group, FeatureOperation.update))
      .supportFeature(FeatureGroup.group, FeatureOperation.delete))
}
```

For a more complex configuration evolving multiple identity stores with a different feature set, look at the example bellow:

```
IdentityConfigurationBuilder builder = new IdentityConfigurationBuilder();

builder
  .stores()
    .ldap()
      .supportFeature(FeatureGroup.agent)
      .supportFeature(FeatureGroup.user)
      .supportFeature(FeatureGroup.credential)
    .jpa()
```

```
        .supportFeature(FeatureGroup.role)
        .supportFeature(FeatureGroup.group)
        .supportFeature(FeatureGroup.relationship)
}
```

The configuration above shows how to use LDAP to store only agents, users and credentials and database for roles, groups and relationships.

> **Note**
>
> Remember that identity stores must have their features and operations configured. If you don't provide them you won't be able to build the configuration.

3.3.5. Identity Store Configurations

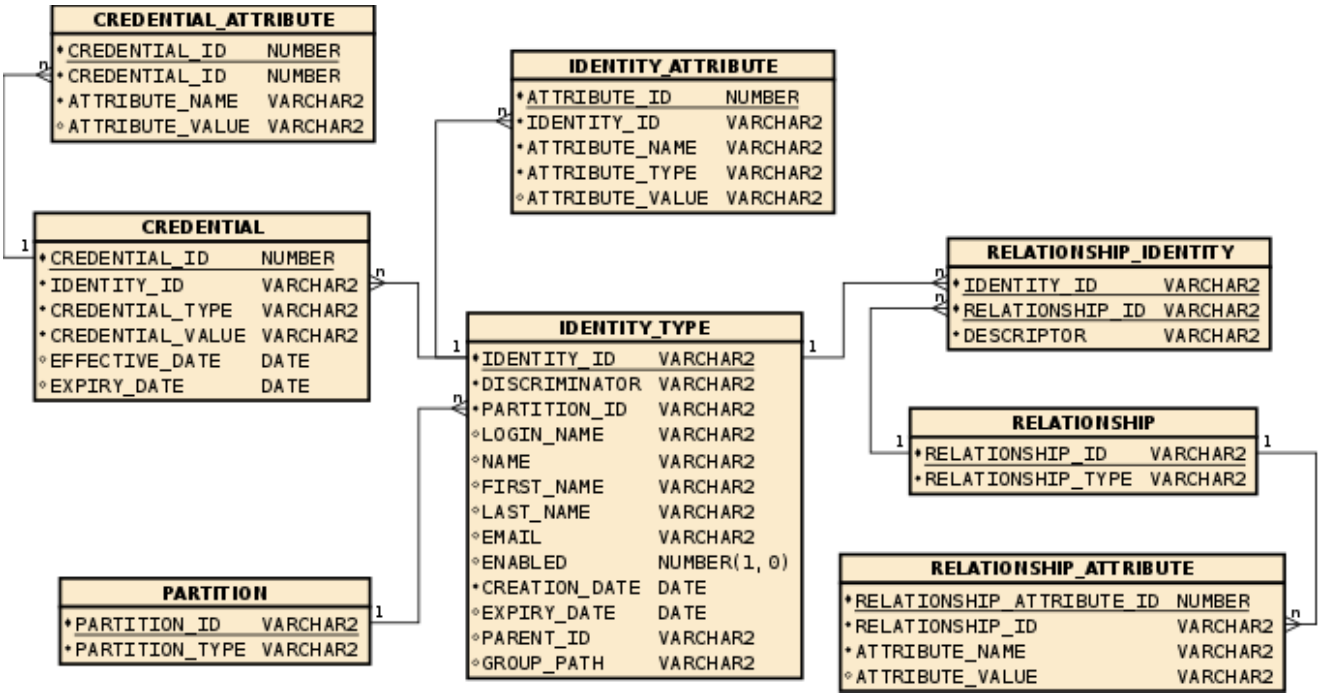
For each of the built-in `IdentityStore` implementations there is a corresponding `IdentityStoreConfiguration` implementation - the following sections describe each of these in more detail.

3.3.6. JPAIdentityStoreConfiguration

The JPA identity store uses a relational database to store identity state. The configuration for this identity store provides control over which entity beans are used to store identity data, and how their fields should be used to store various identity-related state. The entity beans that store the identity data must be configured using the annotations found in the `org.picketlink.jpa.annotations` package. All identity configuration annotations listed in the tables below are from this package.

3.3.6.1. Recommended Database Schema

The following schema diagram is an example of a suitable database structure for storing IDM-related data:



Please note that the data types shown in the above diagram might not be available in your RDBMS; if that is the case please adjust the data types to suit.

3.3.6.2. Default Database Schema

If you do not wish to provide your own JPA entities for storing IDM-related state, you may use the default schema provided by PicketLink in the `picketlink-idm-schema` module. This module contains a collection of entity beans suitable for use with `JPAIdentityStore`. To use this module, add the following dependency to your Maven project's `pom.xml` file:

```
<dependency>
    <groupId>org.picketlink</groupId>
    <artifactId>picketlink-idm-schema</artifactId>
    <version>${picketlink.version}</version>
</dependency>
```

In addition to including the above dependency, the default schema entity beans must be configured in your application's `persistence.xml` file. Add the following entries within the `persistence-unit` section:

```
<class>org.picketlink.idm.jpa.schema.IdentityObject</class>
<class>org.picketlink.idm.jpa.schema.PartitionObject</class>
<class>org.picketlink.idm.jpa.schema.RelationshipObject</class>
<class>org.picketlink.idm.jpa.schema.RelationshipIdentityObject</class>
<class>org.picketlink.idm.jpa.schema.RelationshipObjectAttribute</class>
<class>org.picketlink.idm.jpa.schema.IdentityObjectAttribute</class>
<class>org.picketlink.idm.jpa.schema.CredentialObject</class>
```

```
<class>org.picketlink.idm.jpa.schema.CredentialObjectAttribute</class>
```

3.3.6.3. Configuring an EntityManager

Before the JPA identity store can be used, it must be provided with an `EntityManager` so that it can connect to a database. In Java EE this can be done by providing a producer method within your application that specifies the `@org.picketlink.annotations.PicketLink` qualifier, for example like so:

```
@Produces
@PicketLink
@PersistenceContext(unitName = "picketlink")
private EntityManager picketLinkEntityManager;
```

3.3.6.4. Configuring the Identity class

The Identity class is the entity bean that is used to store the record for users, roles and groups. It should be annotated with `@IdentityType` and declare the following field values:

Table 3.3. Identity class fields

Property	Annotation	Description
ID	`@Identifier`	The unique identifier value for the identity (can also double as the primary key value)
Discriminator	`@Discriminator`	Indicates the identity type (i.e. user, agent, group or role) of the identity.
Partition	`@IdentityPartition`	The partition (realm or tier) that the identity belongs to
Login name	`@LoginName`	The login name for agent and user identities (for other identity types this will be null)
Name	`@IdentityName`	The name for group and role identities (for other identity types this will be null)
First Name	`@FirstName`	The first name of a user identity
Last Name	`@LastName`	The last name of a user identity
E-mail	`@Email`	The primary e-mail address of a user identity

Property	Annotation	Description
Enabled	`@Enabled`	Indicates whether the identity is enabled
Creation date	`@CreationDate`	The creation date of the identity
Expiry date	`@ExpiryDate`	The expiry date of the identity
Group parent	`@Parent`	The parent group (only used for Group identity types, for other types will be null)
Group path	`@GroupPath`	Represents the full group path (for Group identity types only)

The following code shows an example of an entity class configured to store Identity instances:

Example 3.1. Example Identity class

```
@IdentityType
@Entity
public class IdentityObject implements Serializable {

    @Discriminator
    private String discriminator;

    @ManyToOne
    @IdentityPartition
    private PartitionObject partition;

    @Identifier
    @Id
    private String id;

    @LoginName
    private String loginName;

    @IdentityName
    private String name;

    @FirstName
    private String firstName;

    @LastName
    private String lastName;

    @Email
    private String email;

    @Enabled
    private boolean enabled;

    @CreationDate
    @Temporal(TemporalType.TIMESTAMP)
    private Date creationDate;
```

```
    @ExpiryDate
    @Temporal(TemporalType.TIMESTAMP)
    private Date expiryDate;

    @ManyToOne
    @Parent
    private IdentityObject parent;

    @GroupPath
    private String groupPath;

    // getters and setters
}
```

3.3.6.5. Configuring the Attribute class

The Attribute class is used to store Identity attributes, and should be annotated with `@IdentityAttribute`

Table 3.4. Attribute class fields

Property	Annotation	Description
Identity	`@Parent`	The parent identity object to which the attribute value belongs
Name	`@AttributeName`	The name of the attribute
Value	`@AttributeValue`	The value of the attribute
Type	`@AttributeType`	The fully qualified classname of the attribute value class

Example 3.2. Example Attribute class

```
@Entity
@IdentityAttribute
public class IdentityAttribute implements Serializable {
    @Id @GeneratedValue private Long id;

    @ManyToOne @JoinColumn
    @Parent
    private IdentityObject identityObject;

    @AttributeName
    private String name;

    @AttributeValue
    private String value;

    @AttributeType
    private String type;
```

```
    // getters and setters
}
```

3.3.6.6. Configuring the Credential class

The credential entity is used to store user credentials such as passwords and certificates, and should be annotated with `@IdentityCredential`.

Table 3.5. Credential class fields

Property	Annotation	Description
Type	`@CredentialType`	The fully qualified classname of the credential type
Value	`@CredentialValue`	The value of the credential
Effective Date	`@EffectiveDate`	The effective date of the credential
Expiry Date	`@ExpiryDate`	The expiry date of the credential
Identity	`@Parent`	The parent identity to which the credential belongs

Example 3.3. Example Credential class

```
@Entity
@IdentityCredential
public class IdentityCredential implements Serializable {
    @Id @GeneratedValue private Long id;

    @CredentialType
    private String type;

    @CredentialValue
    private String credential;

    @EffectiveDate
    @Temporal (TemporalType.TIMESTAMP)
    private Date effectiveDate;

    @ExpiryDate
    @Temporal (TemporalType.TIMESTAMP)
    private Date expiryDate;

    @Parent
    @ManyToOne
    private IdentityObject identityType;

    // getters and setters
}
```

3.3.6.7. Configuring the Credential Attribute class

The Credential Attribute class is used to store arbitrary attribute values relating to the credential. It should be annotated with `@CredentialAttribute`.

Table 3.6. Credential Attribute class fields

Property	Annotation	Description
Credential Object	`@Parent`	The parent credential to which this attribute belongs
Attribute Name	`@AttributeName`	The name of the attribute
Attribute Value	`@AttributeValue`	The value of the attribute

Example 3.4. Example Credential Attribute class

```
@Entity
@CredentialAttribute
public class IdentityCredentialAttribute implements Serializable {
    @Id @GeneratedValue private Long id;

    @ManyToOne @JoinColumn
    @Parent
    private IdentityCredential credential;

    @AttributeName
    private String name;

    @AttributeValue
    private String value;

    // getters and setters
}
```

3.3.6.8. Configuring the Relationship class

Relationships are used to define typed associations between two or more identities. The Relationship class should be annotated with `@Relationship`.

Table 3.7. Relationship class fields

Property	Annotation	Description
Identifier	`@Identifier`	Unique identifier that represents the specific relationship (can also double as the primary key)
Relationship Class	`@RelationshipClass`	The fully qualified class name of the relationship type

Example 3.5. Example Relationship class

```
@Relationship
@Entity
public class Relationship implements Serializable {
    @Id
    @Identifier
    private String id;

    @RelationshipClass
    private String type;

    // getters and setters
}
```

3.3.6.9. Configuring the Relationship Identity class

The Relationship Identity class is used to store the specific identities that participate in a relationship. It should be annotated with `@RelationshipIdentity`.

Table 3.8. Relationship Identity class fields

Property	Annotation	Description
Relationship Descriptor	`@Discriminator`	Denotes the role of the identity in the relationship
Relationship Identity	`@Identity`	The identity that is participating in the relationship
Relationship	`@Parent`	The parent relationship object to which the relationship identity belongs

Example 3.6. Example Relationship Identity class

```
@RelationshipIdentity
@Entity
public class RelationshipIdentityObject implements Serializable {
    @Id @GeneratedValue private Long id;

    @Discriminator
    private String descriptor;

    @RelationshipIdentity
    @ManyToOne
    private IdentityObject identityObject;

    @Parent
    @ManyToOne
    private RelationshipObject relationshipObject;
```

```
    // getters and setters
}
```

3.3.6.10. Configuring the Relationship Attribute class

The Relationship Attribute class is used to store arbitrary attribute values that relate to a specific relationship. It should be annotated with `@RelationshipAttribute`.

Table 3.9. Relationship Attribute class fields

Property	Annotation	Description
Relationship	`@Parent`	The parent relationship object to which the attribute belongs
Attribute Name	`@AttributeName`	The name of the attribute
Attribute value	`@AttributeValue`	The value of the attribute

Example 3.7. Example Relationship Attribute class

```
@Entity
@RelationshipAttribute
public class RelationshipObjectAttribute implements Serializable {
    @Id @GeneratedValue private Long id;

    @ManyToOne @JoinColumn
    @Parent
    private Relationship relationship;

    @AttributeName
    private String name;

    @RelationshipValue
    private String value;

    // getters and setters
}
```

3.3.6.11. Configuring the Partition class

The Partition class is used to store information about partitions, i.e. Realms and Tiers. It should be annotated with `@Partition`.

Table 3.10. Partition class fields

Property	Annotation	Description
ID	`@Identifier`	The unique identifier value for the partition

Property	Annotation	Description
Type	`@Discriminator`	The type of partition, either Realm or Tier
Parent	`@Parent`	The parent partition (only used for Tiers)

Example 3.8. Example Partition class

```
@Entity
@Partition
public class PartitionObject implements Serializable {
    @Id @Identifier
    private String id;

    @Discriminator
    private String type;

    @ManyToOne
    @Parent
    private PartitionObject parent;

    // getters and setters
}
```

3.3.6.12. Providing a `EntityManager`

Sometimes you may need to configure how the `EntityManager` is provided to the `JPAIdentityStore`, like when your application is using CDI and you must run the operations in the scope of the current transaction by using a injected `EntityManager` instance.

In cases like that, you need to initialize the `SecurityContext` by providing a `ContextInitializer` implementation, as discussed in Security Context Configuration. The `JPAContextInitializer` is provided by PicketLink and can be used to initialize the security context with a specific `EntityManager` instance. You can always extend this class and provide your own way to obtain the `EntityManager` from your application's environment.

```
IdentityConfigurationBuilder builder = new IdentityConfigurationBuilder();

builder
  .stores()
    .file()
      .addContextInitializer(new JPAContextInitializer(emf) {
        @Override
        public EntityManager getEntityManager() {
          // logic goes here
        }
      });
}
```

By default, the `JPAContextInitializer` creates a `EntityManager` from the `EntityManagerFacatory` provided when creating a new instance.

3.3.7. LDAPIdentityStoreConfiguration

The LDAP identity store allows an LDAP directory server to be used to provide identity state. You can use this store in read-only or write-read mode, depending on your permissions on the server.

3.3.7.1. Configuration

The LDAP identity store can be configured by providing the following configuration:

```
IdentityConfigurationBuilder builder = new IdentityConfigurationBuilder();

builder
  .stores()
    .ldap()
      .baseDN("dc=jboss,dc=org")
      .bindDN("uid=admin,ou=system")
      .bindCredential("secret")
      .url("ldap://localhost:10389")
      .userDNSuffix("ou=People,dc=jboss,dc=org")
      .roleDNSuffix("ou=Roles,dc=jboss,dc=org")
      .groupDNSuffix("ou=Groups,dc=jboss,dc=org")
      .supportAllFeatures();
```

The following table describes all configuration options:

Table 3.11. LDAP Configuration Options

Option	Description	Required
`baseDN`	Sets the fixed DN of the context from where identity types are stored.	Yes
`bindDN`	Sets the the DN used to bind against the ldap server. If you want to perform write operations the DN must have permissions on the agent,user,role and group contexts.	Yes
`bindCredential`	Sets the password for the bindDN.	Yes
`url`	Sets the url that should be used to connect to the server. Eg.: ldap://<<server>>:389.	Yes

Option	Description	Required
`userDNSuffix`	Sets the fixed DN of the context where users should be read/stored from.	Yes
`agentDNSuffix`	Sets the fixed DN of the context where agents should be read/stored from. If not provided, will be used the context provided by the `setUserDNSuffix`	No
`roleDNSuffix`	Sets the fixed DN of the context where roles should be read/stored from.	Yes
`groupDNSuffix`	Sets the fixed DN of the context where groups should be read/stored from.	Yes

3.3.7.1.1. Mapping Groups to different contexts

Sometimes may be useful to map a specific group to a specific context or DN. By default, all groups are stored and read from the DN provided by the `setGroupDNSuffix` method, which means that you can not have groups with the same name.

The following configuration maps the group with path */QA Group* to *ou=QA,dc=jboss,dc=org*

```
LDAPIdentityStoreConfiguration ldapStoreConfig = new LDAPIdentityStoreConfiguration();

ldapStoreConfig
  .addGroupMapping("/QA Group", "ou=QA,dc=jboss,dc=org");
```

With this configuration you can have groups with the same name, but with different paths.

```
IdentityManager identityManager = getIdentityManager();
Group managers = new SimpleGroup("managers");

identityManager.add(managers); // group's path is /manager

Group qaGroup = identityManager.getGroup("QA Group");
Group managersQA = new SimpleGroup("managers", qaGroup);

// the QA Group is mapped to a different DN.
Group qaManagerGroup = identityManager.add(managersQA); // group's path is /QA Group/managers
```

3.3.8. FileIdentityStoreConfiguration

This identity store uses the file system to persist identity state. The configuration for this identity store provides control over where to store identity data and if the state should be preserved between initializatons.

Identity data is stored using the *Java Serialization API*.

3.3.8.1. Filesystem Structure

Identity data is stored in the filesystem using the following structure:

```
${WORKING_DIR}/
pl-idm-partitions.db
pl-idm-relationships.db
  <<partition_name_directory>>
    pl-idm.agents.db
    pl-idm.roles.db
    pl-idm.groups.db
    pl-idm.credentials.db
  <<another_partition_directory>>
    ...
```

By default, files are stored in the *${java.io.tmpdir}/pl-idm* directory. For each partition there is a corresponding directory where agents, roles groups and credentials are stored in specific files.

3.3.8.2. Configuration

The file identity store can be easily configured by providing the following configuration:

```
IdentityConfigurationBuilder builder = new IdentityConfigurationBuilder();

builder
  .stores()
  .file()
  .preserveState(false)
  .addRealm(Realm.DEFAULT_REALM, "Testing")
  .addTier("Application")
  .supportAllFeatures()
  .supportRelationshipType(CustomRelationship.class, Authorization.class);
```

3.3.8.2.1. Preserving State Between Initializations

By default, during the initialization, the working directory is re-created. If you want to preserve state between initializations you should use the following configuration:

```
builder
.stores()
  .file()
```

```
  .preserveState(true) // preserve data
  .supportAllFeatures();
```

3.3.8.2.2. Changing the Working Directory

If you want to change the working directory, where files are stored, you can use the following configuration:

```
builder
  .stores()
    .file()
      .workingDir("/tmp/pl-idm")
      .supportAllFeatures();
```

3.3.9. Providing a Custom IdentityStore

TODO

3.4. Java EE Environments

In Java EE 6.0 and higher environments, basic configuration is performed automatically with a set of sensible defaults. During application deployment, PicketLink will scan all deployed entity beans for any beans annotated with `@IDMEntity`, and if found will use a configuration based on the `JPAIdentityStore`. If no entity beans have been configured for identity management and no other configuration is provided, a file-based identity store will be automatically configured to provide basic identity management features backed by the file system.

3.5. Using the IdentityManager

The `org.picketlink.idm.IdentityManager` interface provides access to the bulk of the IDM features supported by PicketLink. To get access to the `IdentityManager` depends on which environment you are using. The following two sections describe how to access the `IdentityManager` in both Java EE and Java SE environments.

3.5.1. Accessing the `IdentityManager` in Java EE

In a Java EE environment, PicketLink provides a producer method for `IdentityManager`, so getting a reference to it is as simply as injecting it into your beans:

```
@Inject IdentityManager identityManager;
```

3.5.1.1. Configuring the Application Realm

By default, an `IdentityManager` for the *default* realm will be injected. If the application should use a realm other than the default, then this must be configured via a producer method with the

`@PicketLink` qualifier. The following code shows an example of a configuration bean that sets the application realm to *acme*:

```
@ApplicationScoped
public class RealmConfiguration {
    private Realm applicationRealm;

    @Inject IdentityManagerFactory factory;

    @Init
    public void init() {
        applicationRealm = factory.getRealm("acme");
    }

    @Produces
    @PicketLink
    public Realm getApplicationRealm() {
      return applicationRealm;
    }
}
```

3.5.2. Accessing the `IdentityManager` in Java SE

3.6. Managing Users, Groups and Roles

PicketLink IDM provides a number of basic implementations of the identity model interfaces for convenience, in the `org.picketlink.idm.model` package. The following sections provide examples that show these implementations in action.

3.6.1. Managing Users

The following code example demonstrates how to create a new user with the following properties:

- Login name - *jsmith*
- First name - *John*
- Last name - *Smith*
- E-mail - *jsmith@acme.com*

```
  User user = new SimpleUser("jsmith");
  user.setFirstName("John");
  user.setLastName("Smith");
  user.setEmail("jsmith@acme.com");
  identityManager.add(user);
```

Once the `User` is created, it's possible to look it up using its login name:

```
User user = identityManager.getUser("jsmith");
```

User properties can also be modified after the User has already been created. The following example demonstrates how to change the e-mail address of the user we created above:

```
User user = identityManager.getUser("jsmith");
user.setEmail("john@smith.com");
identityManager.update(user);
```

Users may also be deleted. The following example demonstrates how to delete the user previously created:

```
User user = identityManager.getUser("jsmith");
identityManager.remove("jsmith");
```

3.6.2. Managing Groups

The following example demonstrates how to create a new group called *employees*:

```
Group employees = new SimpleGroup("employees");
```

It is also possible to assign a parent group when creating a group. The following example demonstrates how to create a new group called *managers*, using the *employees* group created in the previous example as the parent group:

```
Group managers = new SimpleGroup("managers", employees);
```

To lookup an existing `Group`, the `getGroup()` method may be used. If the group name is unique, it can be passed as a single parameter:

```
Group employees = identityManager.getGroup("employees");
```

If the group name is not unique, the parent group must be passed as the second parameter (although it can still be provided if the group name is unique):

```
Group managers = identityManager.getGroup("managers", employees);
```

It is also possible to modify a `Group`'s name and other properties (besides its parent) after it has been created. The following example demonstrates how to disable the "employees" group we created above:

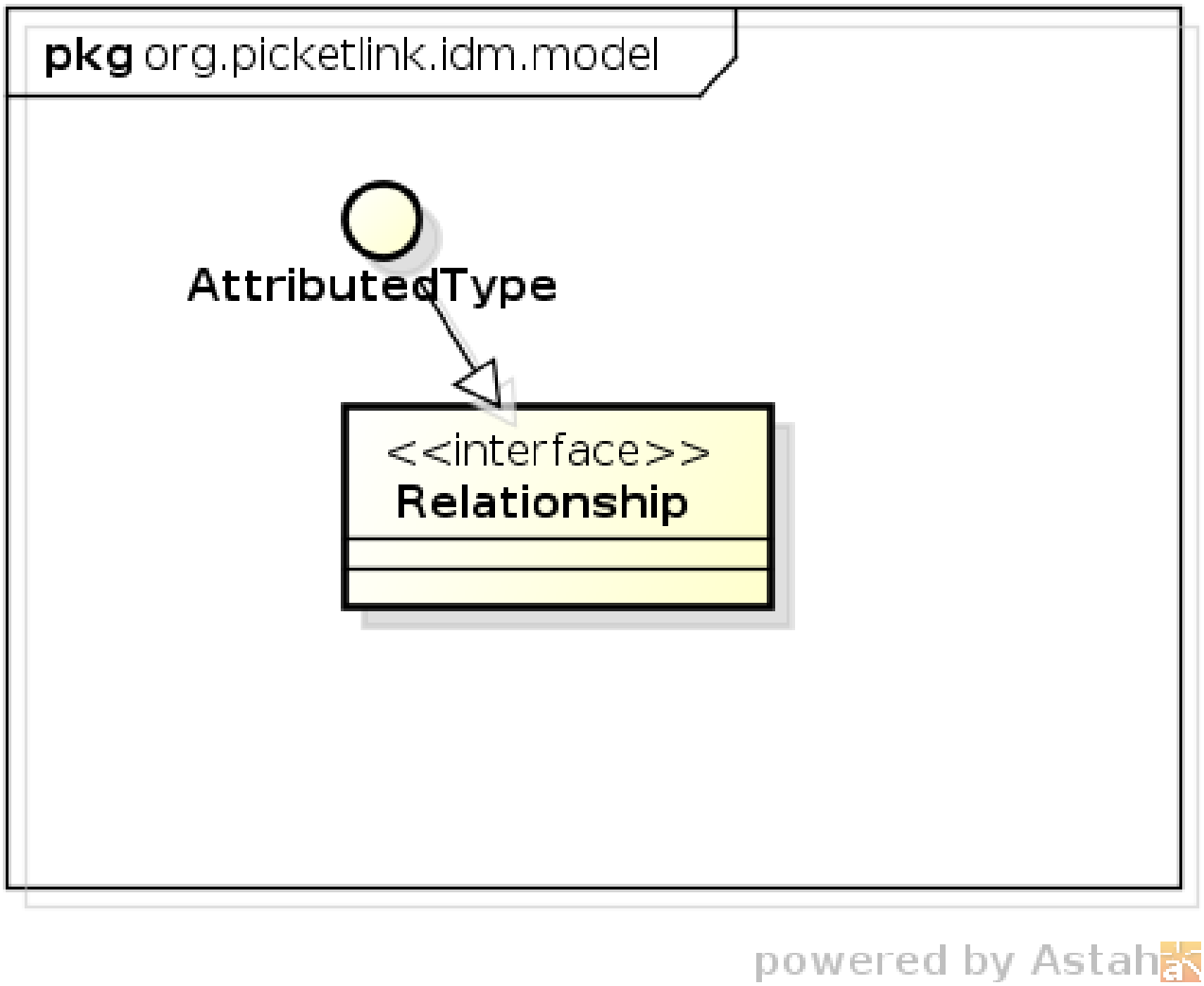
```
Group employees = identityManager.getGroup("employees");
employees.setEnabled(false);
identityManager.update(employees);
```

To remove an existing group, we can use the `remove()` method:

```
Group employees = identityManager.getGroup("employees");
identityManager.remove(employees);
```

3.7. Managing Relationships

Relationships are used to model *typed associations* between two or more identities. All concrete relationship types must implement the marker interface `org.picketlink.idm.model.Relationship`:



The `IdentityManager` interface provides three standard methods for managing relationships:

```
void add(Relationship relationship);
void update(Relationship relationship);
void remove(Relationship relationship);
```

- The `add()` method is used to create a new relationship.
- The `update()` method is used to update an existing relationship.

> **Note**
>
> Please note that the identities that participate in a relationship cannot be updated themselves, however the attribute values of the relationship can be updated. If

you absolutely need to modify the identities of a relationship, then delete the relationship and create it again.

- The `remove()` method is used to remove an existing relationship.

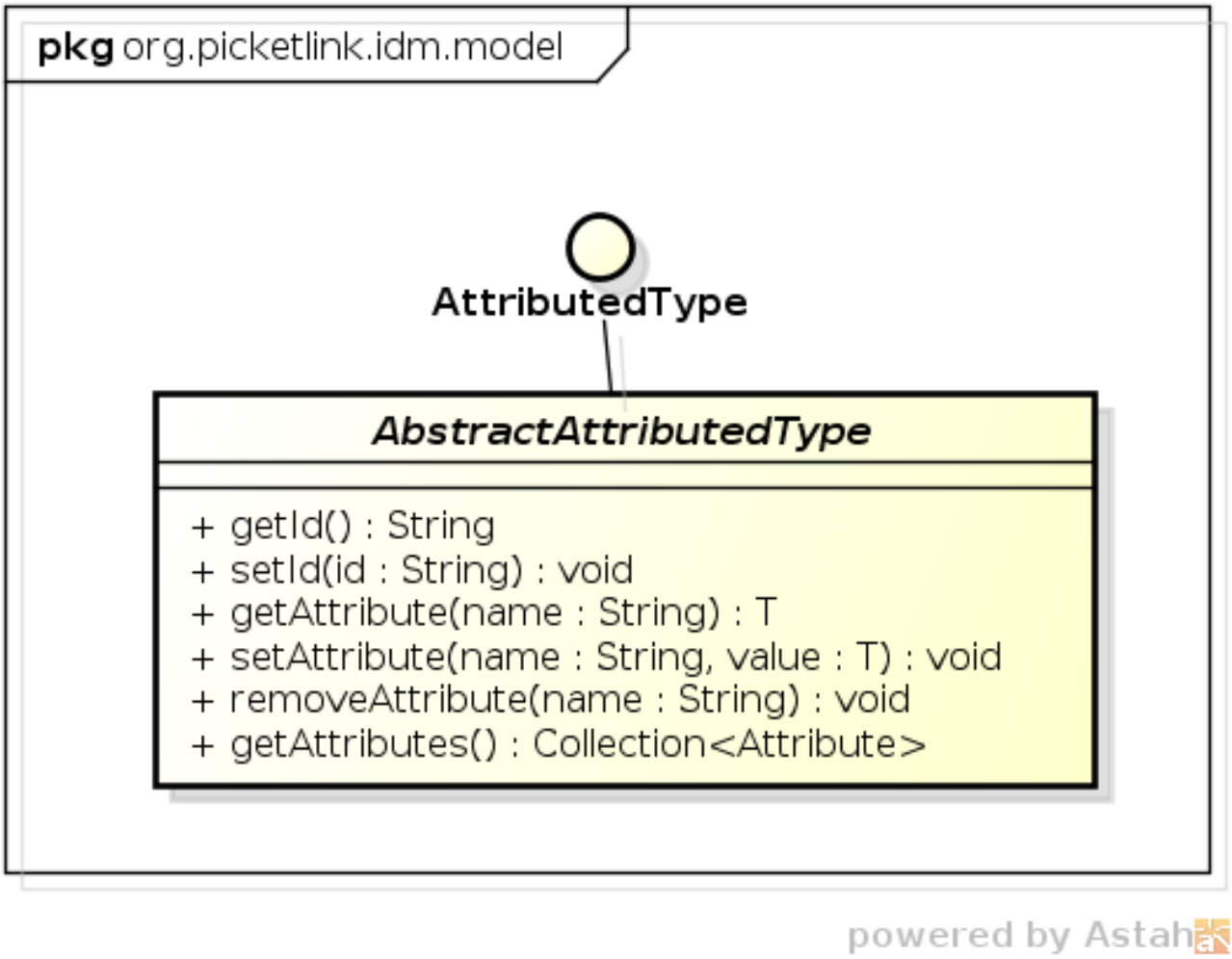
Note

To search for existing relationships between identity objects, use the Relationship Query API described later in this chapter.

Besides the above methods, `IdentityManager` also provides a number of convenience methods for managing many of the built-in relationship types. See the next section for more details.

3.7.1. Built In Relationship Types

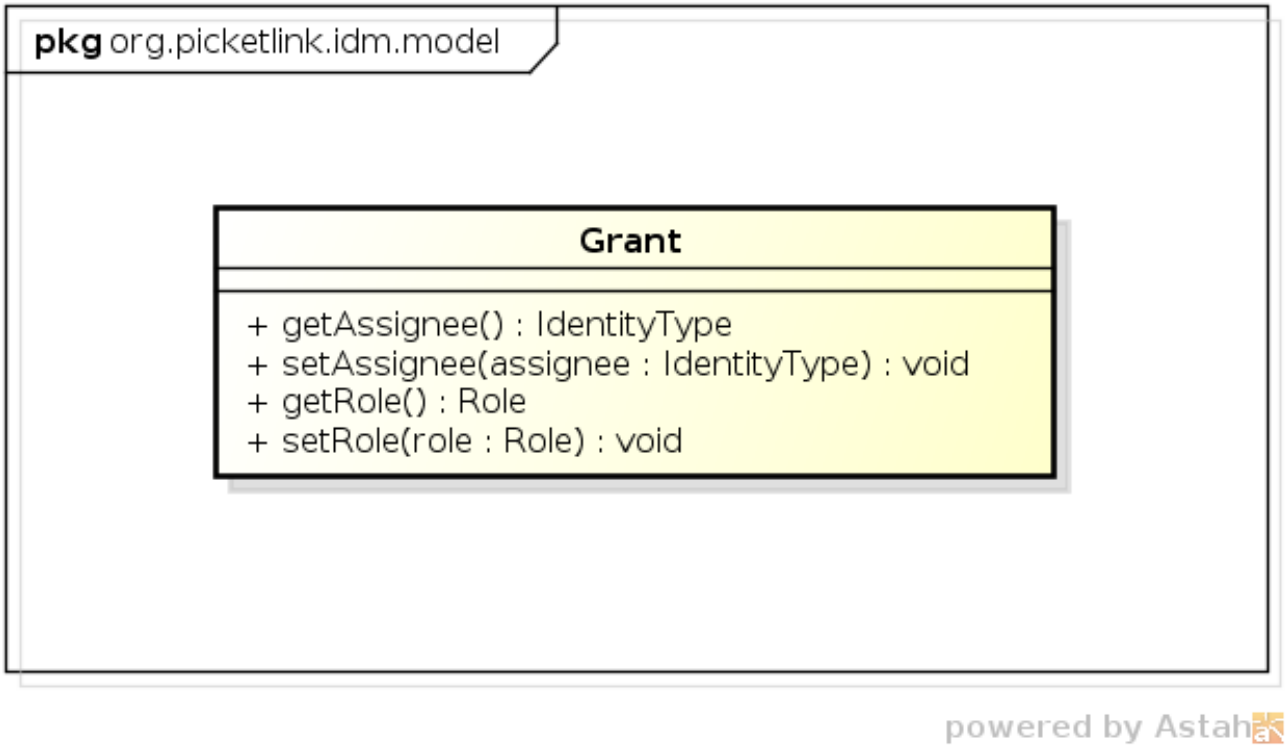
PicketLink provides a number of built-in relationship types, designed to address the most common requirements of a typical application. The following sections describe the built-in relationships and how they are intended to be used. Every built-in relationship type extends the `AbstractAttributedType` abstract class, which provides the basic methods for setting a unique identifier value and managing a set of attribute values:



What this means in practical terms, is that every single relationship is assigned and can be identified by, a unique identifier value. Also, arbitrary attribute values may be set for all relationship types, which is useful if you require additional metadata or any other type of information to be stored with a relationship.

3.7.1.1. Application Roles

Application roles are represented by the `Grant` relationship, which is used to assign application-wide privileges to a `User` or `Agent`.



The `IdentityManager` interface provides methods for directly granting a role. Here's a simple example:

```
User bob = identityManager.getUser("bob");
Role superuser = identityManager.getRole("superuser");
identityManager.grantRole(bob, superuser);
```

The above code is equivalent to the following:

```
User bob = identityManager.getUser("bob");
Role superuser = identityManager.getRole("superuser");
Grant grant = new Grant(bob, superuser);
identityManager.add(grant);
```

A granted role can also be revoked using the `revokeRole()` method:

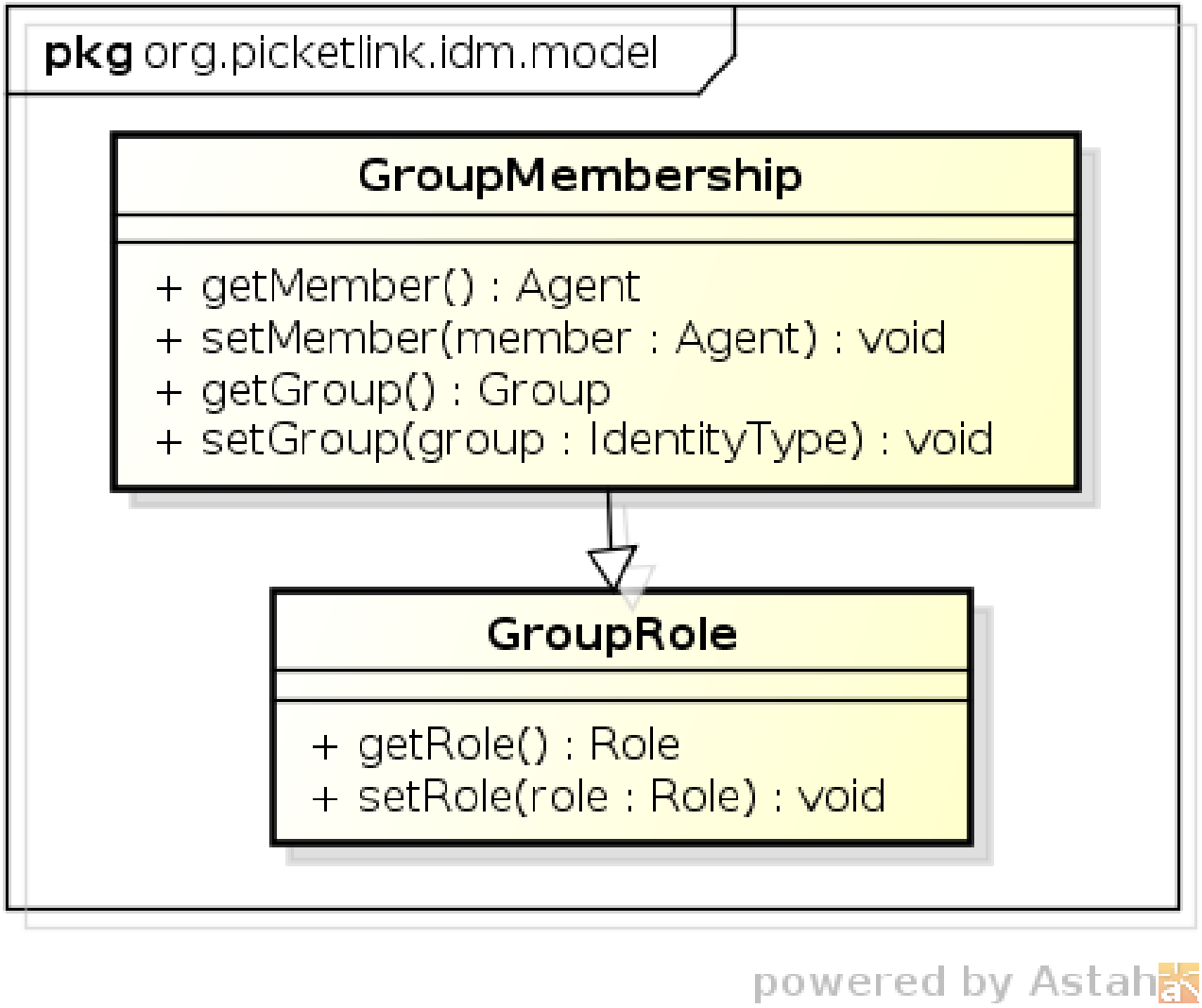
```
User bob = identityManager.getUser("bob");
Role superuser = identityManager.getRole("superuser");
identityManager.revokeRole(bob, superuser);
```

To check whether an identity has a specific role granted to them, we can use the `hasRole()` method:

```
User bob = identityManager.getUser("bob");
Role superuser = identityManager.getRole("superuser");
boolean isBobASuperUser = identityManager.hasRole(bob, superuser);
```

3.7.1.2. Groups and Group Roles

The `GroupMembership` and `GroupRole` relationships are used to represent a user's membership within a `Group`, and a user's role for a group, respectively.



Note

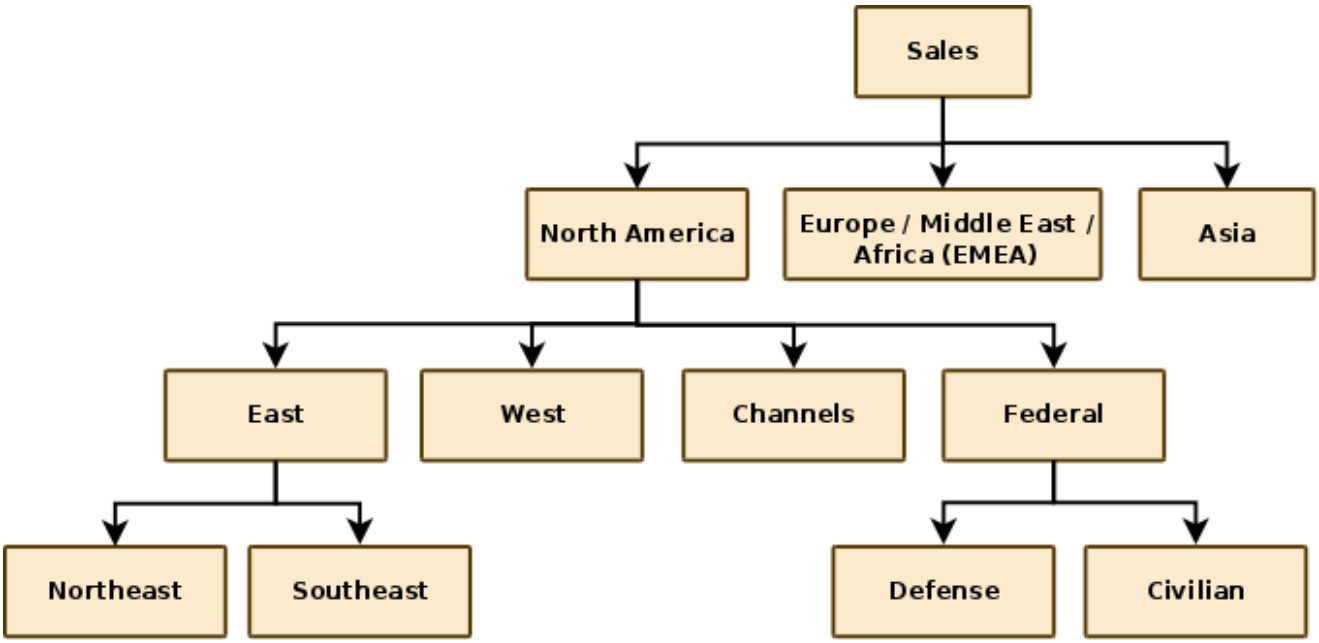
While the `GroupRole` relationship type extends `GroupMembership`, it does *not* mean that a member of a `GroupRole` automatically receives `GroupMembership`

membership also - these are two distinct relationship types with different semantics.

A `Group` is typically used to form logical collections of users. Within an organisation, groups are often used to mirror the organisation's structure. For example, a corporate structure might consist of a sales department, administration, management, etc. This structure can be modelled in PicketLink by creating corresponding groups such as *sales*, *administration*, and so forth. Users (who would represent the employees in a corporate structure) may then be assigned group memberships corresponding to their place within the company's organisational structure. For example, an employee who works in the sales department may be assigned to the *sales* group. Specific application privileges can then be blanket assigned to the *sales* group, and anyone who is a member of the group is free to access the application's features that require those privileges.

The `GroupRole` relationship type should be used when it is intended for an identity to perform a specific role for a group, but not be an actual member of the group itself. For example, an administrator of a group of doctors may not be a doctor themselves, but have an administrative role to perform for that group. If the intent is for an individual identity to both be a member of a group *and* have an assigned role in that group also, then the identity should have both `GroupRole` and `GroupMembership` relationships for that group.

Let's start by looking at a simple example - we'll begin by making the assumption that our organization is structured in the following way:



The following code demonstrates how we would create the hypothetical *Sales* group which is displayed at the head of the above organisational chart:

```
Group sales = new SimpleGroup("Sales");
identityManager.add(sales);
```

We can then proceed to create its subgroups:

```
identityManager.add(new SimpleGroup("North America", sales);
identityManager.add(new SimpleGroup("EMEA", sales);
identityManager.add(new SimpleGroup("Asia", sales);
// and so forth
```

The second parameter of the `SimpleGroup()` constructor is used to specify the group's parent group. This allows us to create a hierarchical group structure, which can be used to mirror either a simple or complex personnel structure of an organisation. Let's now take a look at how we assign users to these groups.

The following code demonstrates how to assign an *administrator* group role for the *Northeast* sales group to user *jsmith*. The *administrator* group role may be used to grant certain users the privilege to modify permissions and roles for that group:

```
Role admin = identityManager.getRole("administrator");
User user = identityManager.getUser("jsmith");
Group group = identityManager.getGroup("Northeast");
identityManager.grantGroupRole(user, admin, group);
```

A group role can be revoked using the `revokeGroupRole()` method:

```
identityManager.revokeGroupRole(user, admin, group);
```

To test whether a user has a particular group role, you can use the `hasGroupRole()` method:

```
boolean isUserAGroupAdmin = identityManager.hasGroupRole(user, admin, group);
```

Next, let's look at some examples of how to work with simple group memberships. The following code demonstrates how we assign sales staff *rbrown* to the *Northeast* sales group:

```
User user = identityManager.getUser("rbrown");
Group group = identityManager.getGroup("Northeast");
identityManager.addToGroup(user, group);
```

A `User` may also be a member of more than one `Group`; there are no built-in limitations on the number of groups that a `User` may be a member of.

We can use the `removeFromGroup()` method to remove the same user from the group:

```
identityManager.removeFromGroup(user, group);
```

To check whether a user is the member of a group we can use the `isMember()` method:

```
boolean isUserAMember = identityManager.isMember(user, group);
```

Relationships can also be created via the `add()` method. The following code is equivalent to assigning a group role via the `grantGroupRole()` method shown above:

```
Role admin = identityManager.getRole("administrator");
User user = identityManager.getUser("jsmith");
Group group = identityManager.getGroup("Northeast");
GroupRole groupRole = new GroupRole(user, group, admin);
identityManager.add(groupRole);
```

3.7.2. Creating Custom Relationships

One of the strengths of PicketLink is its ability to support custom relationship types. This extensibility allows you, the developer to create specific relationship types between two or more identities to address the domain-specific requirements of your own application.

> **Note**
>
> Please note that custom relationship types are not supported by all `IdentityStore` implementations - see the Identity Store section above for more information.

To create a custom relationship type, we start by creating a new class that implements the `Relationship` interface. To save time, we also extend the `AbstractAttributedType` abstract class which takes care of the identifier and attribute management methods for us:

```
public class Authorization extends AbstractAttributedType implements Relationship {

}
```

The next step is to define which identities participate in the relationship. Once we create our identity property methods, we also need to annotate them with the `org.picketlink.idm.model.annotation.RelationshipIdentity` annotation. This is done by creating a property for each identity type.

```
private User user;
private Agent application;
```

```
@RelationshipIdentity
public User getUser() {
  return user;
}

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

@RelationshipIdentity
public Agent getApplication() {
  return application;
}

public void setApplication(Agent application) {
  this.application = application;
}
```

We can also define some attribute properties, using the `@RelationshipAttribute` annotation:

```
private String accessToken;

@RelationshipAttribute
public String getAccessToken() {
  return accessToken;
}

public void setAccessToken(String accessToken) {
  this.accessToken = accessToken;
}
```

3.8. Authentication

> **Note**
>
> While the IDM module of PicketLink provides authentication features, for common use cases involving standard username and password based authentication in a Java EE environment, PicketLink provides a more streamlined method of authentication. Please refer to the authentication chapter of this documentation for more information.

PicketLink IDM provides an authentication subsystem that allows user credentials to be validated thereby confirming that an authenticating user is who they claim to be. The `IdentityManager` interface provides a single method for performing credential validation, as follows:

```
void validateCredentials(Credentials credentials);
```

The `validateCredentials()` method accepts a single `Credentials` parameter, which should contain all of the state required to determine who is attempting to authenticate, and the credential (such as a password, certificate, etc) that they are authenticating with. Let's take a look at the `Credentials` interface:

```
public interface Credentials {
    public enum Status {
        UNVALIDATED, IN_PROGRESS, INVALID, VALID, EXPIRED
    };

   Agent getValidatedAgent();

   Status getStatus();

   void invalidate();
}
```

- The `Status` enum defines the following values, which reflect the various credential states:
  - `UNVALIDATED` - The credential is yet to be validated.
  - `IN_PROGRESS` - The credential is in the process of being validated.
  - `INVALID` - The credential has been validated unsuccessfully
  - `VALID` - The credential has been validated successfully
  - `EXPIRED` - The credential has expired
- `getValidatedAgent()` - If the credential was successfully validated, this method returns the `Agent` object representing the validated user.
- `getStatus()` - Returns the current status of the credential, i.e. one of the above enum values.
- `invalidate()` - Invalidate the credential. Implementations of `Credential` should use this method to clean up internal credential state.

Let's take a look at a concrete example - `UsernamePasswordCredentials` is a `Credentials` implementation that supports traditional username/password-based authentication:

```
public class UsernamePasswordCredentials extends AbstractBaseCredentials {

    private String username;

    private Password password;
```

```
    public UsernamePasswordCredentials() { }

    public UsernamePasswordCredentials(String userName, Password password) {
        this.username = userName;
        this.password = password;
    }

    public String getUsername() {
        return username;
    }

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

    public Password getPassword() {
        return password;
    }

    public UsernamePasswordCredentials setPassword(Password password) {
        this.password = password;
        return this;
    }

    @Override
    public void invalidate() {
        setStatus(Status.INVALID);
        password.clear();
    }
}
```

The first thing we may notice about the above code is that the `UsernamePasswordCredentials` class extends `AbstractBaseCredentials`. This abstract base class implements the basic functionality required by the `Credentials` interface. Next, we can see that two fields are defined; `username` and `password`. These fields are used to hold the username and password state, and can be set either via the constructor, or by their associated setter methods. Finally, we can also see that the `invalidate()` method sets the status to `INVALID`, and also clears the password value.

Let's take a look at an example of the above classes in action. The following code demonstrates how we would authenticate a user with a username of "john" and a password of "abcde":

```
Credentials creds = new UsernamePasswordCredentials("john",
    new Password("abcde"));
identityManager.validate(creds);
if (Status.VALID.equals(creds.getStatus())) {
  // authentication was successful
}
```

We can also test if the credentials that were provided have expired (if an expiry date was set). In this case we might redirect the user to a form where they can enter a new password.

```
Credentials creds = new UsernamePasswordCredentials("john",
    new Password("abcde"));
identityManager.validate(creds);
if (Status.EXPIRED.equals(creds.getStatus())) {
  // password has expired, redirect the user to a password change screen
}
```

3.9. Managing Credentials

Updating user credentials is even easier than validating them. The `IdentityManager` interface provides the following two methods for updating credentials:

```
void updateCredential(Agent agent, Object credential);
void updateCredential(Agent agent, Object credential, Date effectiveDate, Date expiryDate);
```

Both of these methods essentially do the same thing; they update a credential value for a specified `Agent` (or `User`). The second overloaded method however also accepts `effectiveDate` and `expiryDate` parameters, which allow some temporal control over when the credential will be valid. Use cases for this feature include implementing a strict password expiry policy (by providing an expiry date), or creating a new account that might not become active until a date in the future (by providing an effective date). Invoking the first overloaded method will store the credential with an effective date of the current date and time, and no expiry date.

> **Note**
>
> One important point to note is that the `credential` parameter is of type `java.lang.Object`. Since credentials can come in all shapes and sizes (and may even be defined by third party libraries), there is no common base interface for credential implementations to extend. To support this type of flexibility in an extensible way, PicketLink provides an SPI that allows custom credential handlers to be configured that override or extend the default credential handling logic. Please see the next section for more information on how this SPI may be used.

PicketLink provides built-in support for the following credential types:

> **Warning**
>
> Not all built-in `IdentityStore` implementations support all credential types. For example, since the `LDAPIdentityStore` is backed by an LDAP directory server, only password credentials are supported. The following table lists the built-in `IdentityStore` implementations that support each credential type.

Table 3.12. Built-in credential types

Credential type	Description	Supported by
`org.picketlink.idm.credential.Digest`	Used for digest-based authentication	`JPAIdentityStore` `FileBasedIdentityStore`

`org.picketlink.idm.credential.Password`	A standard text-based password	`JPAIdentityStore`
		`FileBasedIdentityStore`
		`LDAPIdentityStore`

`java.security.cert.X509Certificate`	Used for X509 certificate based authentication	`JPAIdentityStore` `FileBasedIdentityStore`

Let's take a look at a couple of examples. Here's some code demonstrating how a password can be assigned to user "jsmith":

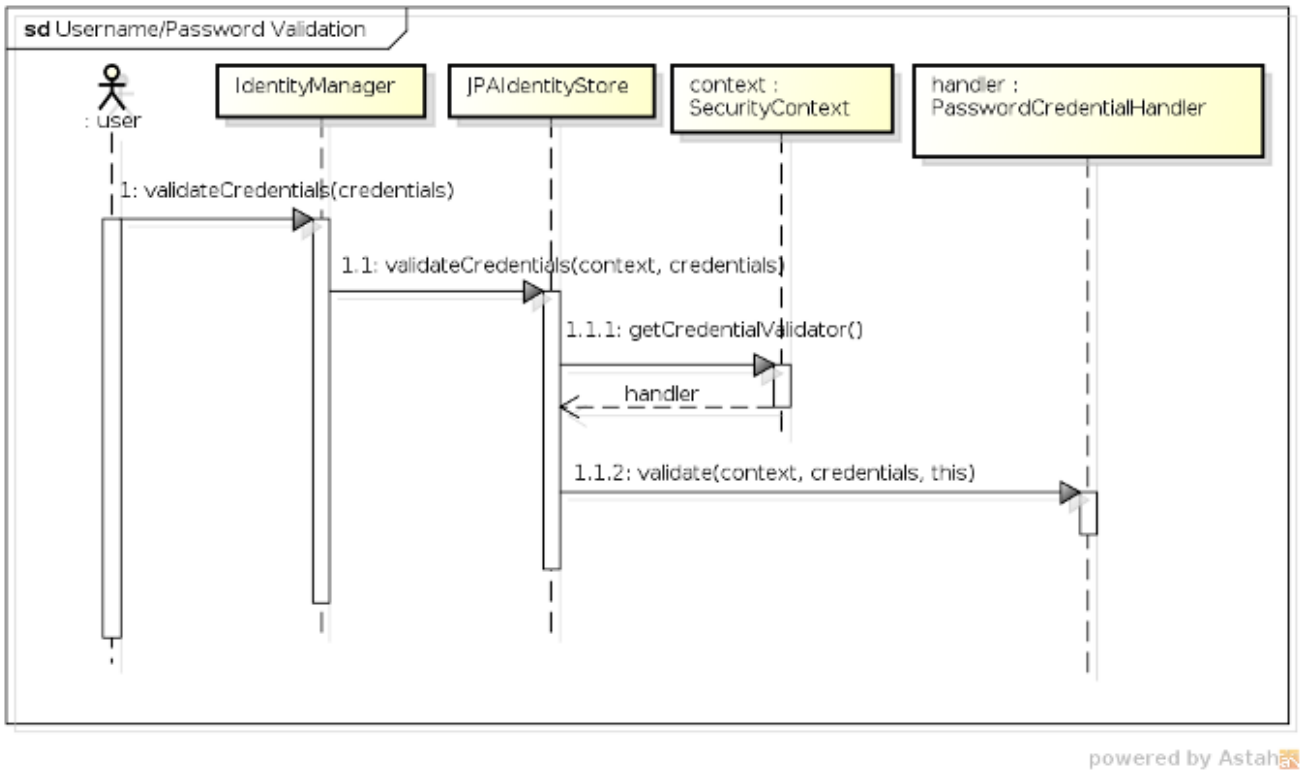
```
User user = identityManager.getUser("jsmith");
identityManager.updateCredential(user, new Password("abcd1234"));
```

This example creates a digest and assigns it to user "jdoe":

```
User user = identityManager.getUser("jdoe");
Digest digest = new Digest();
digest.setRealm("default");
digest.setUsername(user.getLoginName());
digest.setPassword("abcd1234");
identityManager.updateCredential(user, digest);
```

3.10. Credential Handlers

For `IdentityStore` implementations that support multiple credential types, PicketLink provides an optional SPI to allow the default credential handling logic to be easily customized and extended. To get a better picture of the overall workings of the Credential Handler SPI, let's take a look at the sequence of events during the credential validation process when validating a username and password against `JPAIdentityStore`:



- *1* - The user (or some other code) first invokes the `validateCredentials()` method on `IdentityManager`, passing in the `Credentials` instance to validate.
- *1.1* - After looking up the correct `IdentityStore` (i.e. the one that has been configured to validate credentials) the `IdentityManager` invokes the store's `validateCredentials()` method, passing in the `SecurityContext` and the credentials to validate.
- *1.1.1* - In `JPAIdentityStore`'s implementation of the `validateCredentials()` method, the `SecurityContext` is used to look up the `CredentialHandler` implementation that has been configured to process validation requests for usernames and passwords, which is then stored in a local variable called `handler`.
- *1.1.2* - The `validate()` method is invoked on the `CredentialHandler`, passing in the security context, the credentials value and a reference back to the identity store. The reference to the identity store is important as the credential handler may require it to invoke certain methods upon the store to validate the credentials.

The `CredentialHandler` interface declares three methods, as follows:

```
public interface CredentialHandler {
    void setup(IdentityStore<?> identityStore);

    void validate(SecurityContext context, Credentials credentials,
                  IdentityStore<?> identityStore);

    void update(SecurityContext context, Agent agent, Object credential,
```

```
                IdentityStore<?> identityStore, Date effectiveDate, Date expiryDate);

}
```

The `setup()` method is called once, when the `CredentialHandler` instance is first created. Credential handler instantiation is controlled by the `CredentialHandlerFactory`, which creates a single instance of each `CredentialHandler` implementation to service all credential requests for that handler. Each `CredentialHandler` implementation must declare the types of credentials that it is capable of supporting, which is done by annotating the implementation class with the `@SupportsCredentials` annotation like so:

```
@SupportsCredentials({ UsernamePasswordCredentials.class, Password.class })
public class PasswordCredentialHandler implements CredentialHandler {
```

Since the `validate()` and `update()` methods receive different parameter types (`validate()` takes a `Credentials` parameter value while `update()` takes an `Object` that represents a single credential value), the `@SupportsCredentials` annotation must contain a complete list of all types supported by that handler.

Similarly, if the `IdentityStore` implementation makes use of the credential handler SPI then it also must declare which credential handlers support that identity store. This is done using the `@CredentialHandlers` annotation; for example, the following code shows how `JPAIdentityStore` is configured to be capable of handling credential requests for usernames and passwords, X509 certificates and digest-based authentication:

```
@CredentialHandlers({ PasswordCredentialHandler.class,
          X509CertificateCredentialHandler.class, DigestCredentialHandler.class })
public class JPAIdentityStore implements IdentityStore<JPAIdentityStoreConfiguration>,
                                         CredentialStore {
```

3.10.1. The CredentialStore interface

For `IdentityStore` implementations that support multiple credential types (such as `JPAIdentityStore` and `FileBasedIdentityStore`), the implementation may choose to also implement the `CredentialStore` interface to simplify the interaction between the `CredentialHandler` and the `IdentityStore`. The `CredentialStore` interface declares methods for storing and retrieving credential values within an identity store, as follows:

```
public interface CredentialStore {
   void storeCredential(SecurityContext context, Agent agent,
                        CredentialStorage storage);
   <T extends CredentialStorage> T retrieveCurrentCredential(SecurityContext context,
                                                Agent agent, Class<T> storageClass);
   <T extends CredentialStorage> List<T> retrieveCredentials(SecurityContext context,
                                                Agent agent, Class<T> storageClass);
```

```
}
```

The `CredentialStorage` interface is quite simple and only declares two methods, `getEffectiveDate()` and `getExpiryDate()`:

```
public interface CredentialStorage {
   @Stored Date getEffectiveDate();
   @Stored Date getExpiryDate();
}
```

The most important thing to note above is the usage of the `@Stored` annotation. This annotation is used to mark the properties of the `CredentialStorage` implementation that should be persisted. The only requirement for any property values that are marked as `@Stored` is that they are serializable (i.e. they implement the `java.io.Serializable` interface). The `@Stored` annotation may be placed on either the getter method or the field variable itself. Here's an example of one of a `CredentialStorage` implementation that is built into PicketLink - `EncodedPasswordStorage` is used to store a password hash and salt value:

```
public class EncodedPasswordStorage implements CredentialStorage {

    private Date effectiveDate;
    private Date expiryDate;
    private String encodedHash;
    private String salt;

    @Override @Stored
    public Date getEffectiveDate() {
        return effectiveDate;
    }

    public void setEffectiveDate(Date effectiveDate) {
        this.effectiveDate = effectiveDate;
    }

    @Override @Stored
    public Date getExpiryDate() {
        return expiryDate;
    }

    public void setExpiryDate(Date expiryDate) {
        this.expiryDate = expiryDate;
    }

    @Stored
    public String getEncodedHash() {
        return encodedHash;
    }

    public void setEncodedHash(String encodedHash) {
        this.encodedHash = encodedHash;
    }
```

```
    @Stored
    public String getSalt() {
        return this.salt;
    }

    public void setSalt(String salt) {
        this.salt = salt;
    }

}
```

3.11. Built-in Credential Handlers

This section describes each of the built-in credential handlers, and any configuration parameters that may be set for them. Specific credential handler options can be set when creating a new `IdentityConfiguration`. Configured options are always specific to a particular identity store configuration, allowing different options to be specified between two or more identity stores. The `IdentityStoreConfiguration` interface provides a method called `getCredentialHandlersConfig()` that provides access to a `Map` which allows configuration options to be set for the identity store's credential handlers:

```
public interface IdentityStoreConfiguration {
    Map<String, Object> getCredentialHandlerProperties();
}
```

To gain access to the `IdentityStoreConfiguration` object before PicketLink is initialized, there are a couple of options. The first option is to provide an `IdentityConfiguration` object itself via a producer method.

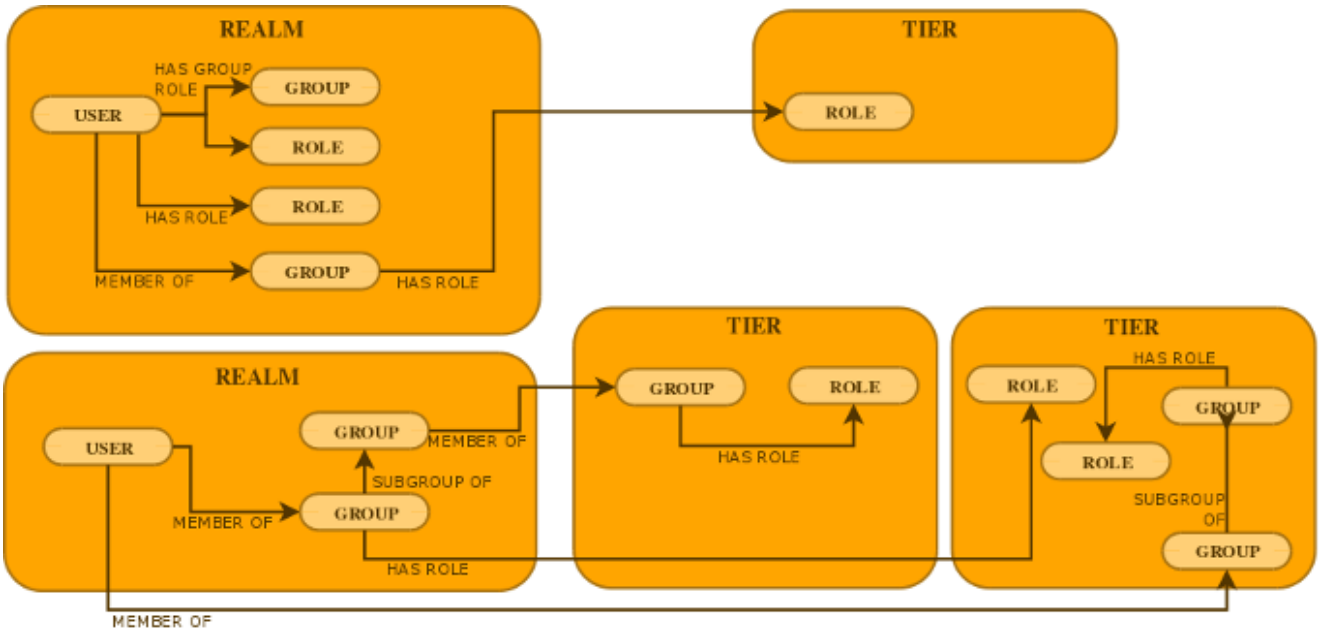
```

```

3.11.1.

3.12. Advanced Topics

3.12.1. Multi Realm Support

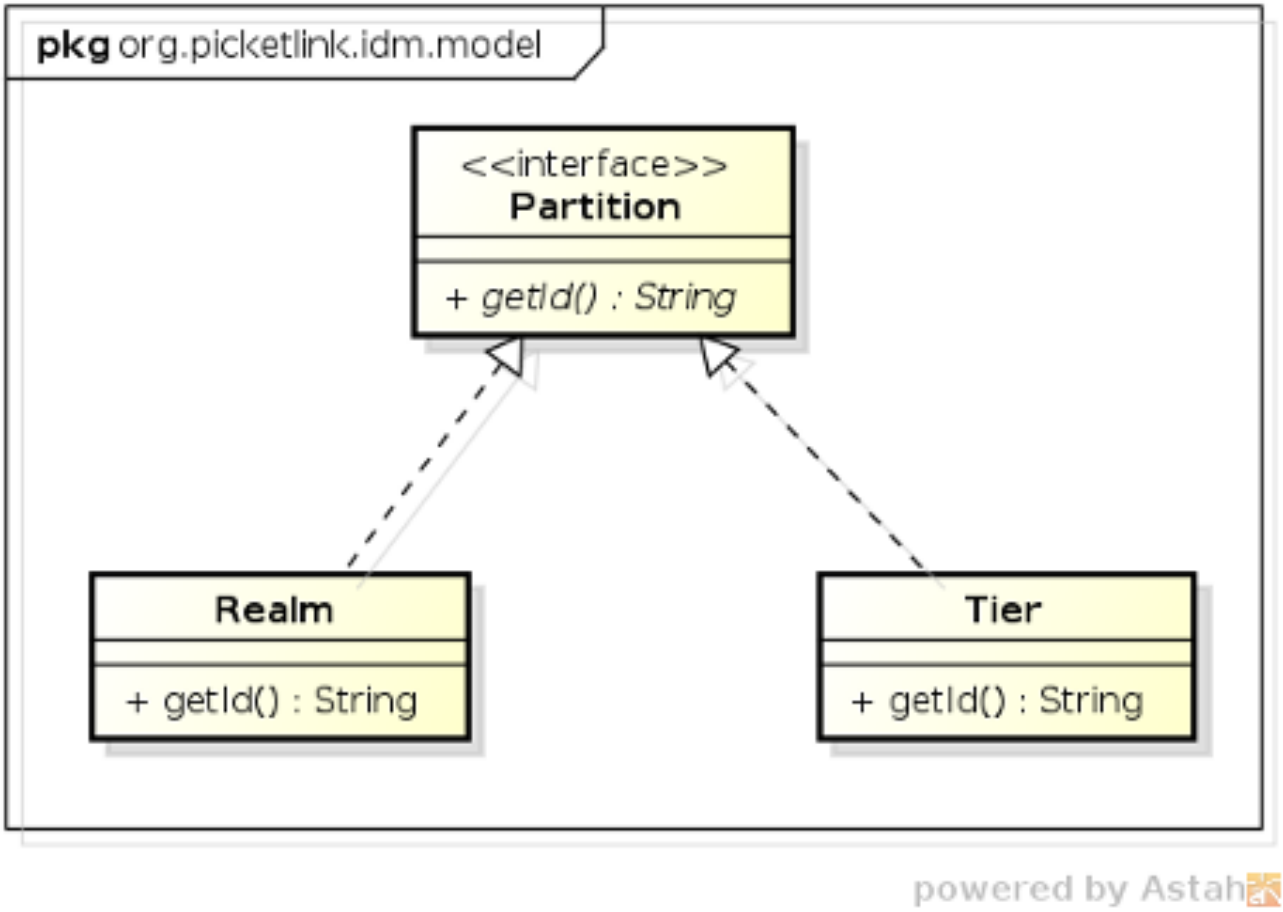
PicketLink has been designed from the ground up to support a system of *partitioning*, allowing the users, groups and roles of an application to be divided into *Realms* and *Tiers*.



A *Realm* is used to define a discrete set of users, groups and roles. A typical use case for realms is the segregation of corporate user accounts within a multi-tenant application, although it is not limited this use case only. As all identity management operations must be performed within the context of an *active partition*, PicketLink defines the concept of a *default realm* which becomes the active partition if no other partition has been specified.

A *Tier* is a more restrictive type of partition than a realm, as it only allows groups and roles to be defined (but not users). A Tier may be used to define a set of application-specific groups and roles, which may then be assigned to groups within the same Tier, or to users and groups within a separate Realm.

In terms of API, both the `Realm` and `Tier` classes implement the `Partition` interface, as shown in the following class diagram:



Selecting the specific partition that the identity management operations are performed in is controlled by specifying the partition when creating the `IdentityManager` via the `IdentityManagerFactory`'s overloaded `createIdentityManager()` methods:

```
IdentityManager createIdentityManager();
  IdentityManager createIdentityManager(Partition partition);
```

The first method (without parameters) will create an `IdentityManager` instance for the default realm. The second parameter allows a `Partition` object to be specified. Once the `IdentityManager` has been created, any identity management methods invoked on it will be performed within the selected partition. To look up the partition object, the `IdentityManagerFactory` provides two additional methods:

```
Realm getRealm(String id);
  Tier getTier(String id);
```

Here's an example demonstrating how a new user called "bob" is created in a realm called *acme*:

```
Realm acme = identityManagerFactory.getRealm("acme");
  IdentityManager im = identityManagerFactory.createIdentityManager(acme);
  im.add(new SimpleUser("bob"));
```

Chapter 4. Federation

4.1. Overview

In this chapter, we look at PicketLink `single sign on (SSO)` and `trust` features. We describe `SAML` SSO in detail.

4.2. SAML SSO

SAML is an `OASIS Standards Consortium` standard for single sign on. PicketLink suppors `SAML v2.0` and `SAML v1.1`.

PicketLink contains support for the following profiles of SAML specification.

- SAML Web Browser SSO Profile.
- SAML Global Logout Profile.

4.3. SAML Web Browser Profile

PicketLink supports the following standard bindings:

- SAML HTTP Redirect Binding
- SAML HTTP POST Binding

4.4. Additional Information

> **Note**
> Please refer to exhaustive documentation on PicketLink Confluence Site.
>
> - User Guide [https://docs.jboss.org/author/display/PLINK/User+Guide]