Red Hat Single Sign-On 7.4

Server Developer Guide

For Use with Red Hat Single Sign-On 7.4

Last Updated: 2023-02-14

Red Hat Single Sign-On 7.4 Server Developer Guide

For Use with Red Hat Single Sign-On 7.4

Enter your first name here. Enter your surname here.
Enter your organisation's name here. Enter your organisational division here.
Enter your email address here.

法律上の通知

概要

This guides consist of information for developers to customize Red Hat Single Sign-On 7.4

目次

MAKING OPEN SOURCE MORE INCLUSIVE

Red Hat is committed to replacing problematic language in our code, documentation, and web properties. We are beginning with these four terms: master, slave, blacklist, and whitelist. Because of the enormity of this endeavor, these changes will be implemented gradually over several upcoming releases. For more details, see our CTO Chris Wright’s message .

第1章 PREFACE

In some of the example listings, what is meant to be displayed on one line does not fit inside the available page width. These lines have been broken up. A '\' at the end of a line means that a break has been introduced to fit in the page, with the following lines indented. So:

```
Let's pretend to have an extremely \
long line that \
does not fit
This one is short
```

Is really:

```
Let's pretend to have an extremely long line that does not fit
This one is short
```

第2章 ADMIN REST API

Red Hat Single Sign-On comes with a fully functional Admin REST API with all features provided by the Admin Console.

To invoke the API you need to obtain an access token with the appropriate permissions. The required permissions are described in Server Administration Guide.

A token can be obtained by enabling authenticating to your application with Red Hat Single Sign-On; see the Securing Applications and Services Guide. You can also use direct access grant to obtain an access token.

For complete documentation see API Documentation.

2.1. EXAMPLE USING CURL

Obtain access token for user in the realm **master** with username **admin** and password **password**:

```
curl \
  -d "client_id=admin-cli" \
  -d "username=admin" \
  -d "password=password" \
  -d "grant_type=password" \
  "http://localhost:8080/auth/realms/master/protocol/openid-connect/token"
```

注記

By default this token expires in 1 minute

The result will be a JSON document. To invoke the API you need to extract the value of the **access_token** property. You can then invoke the API by including the value in the **Authorization** header of requests to the API.

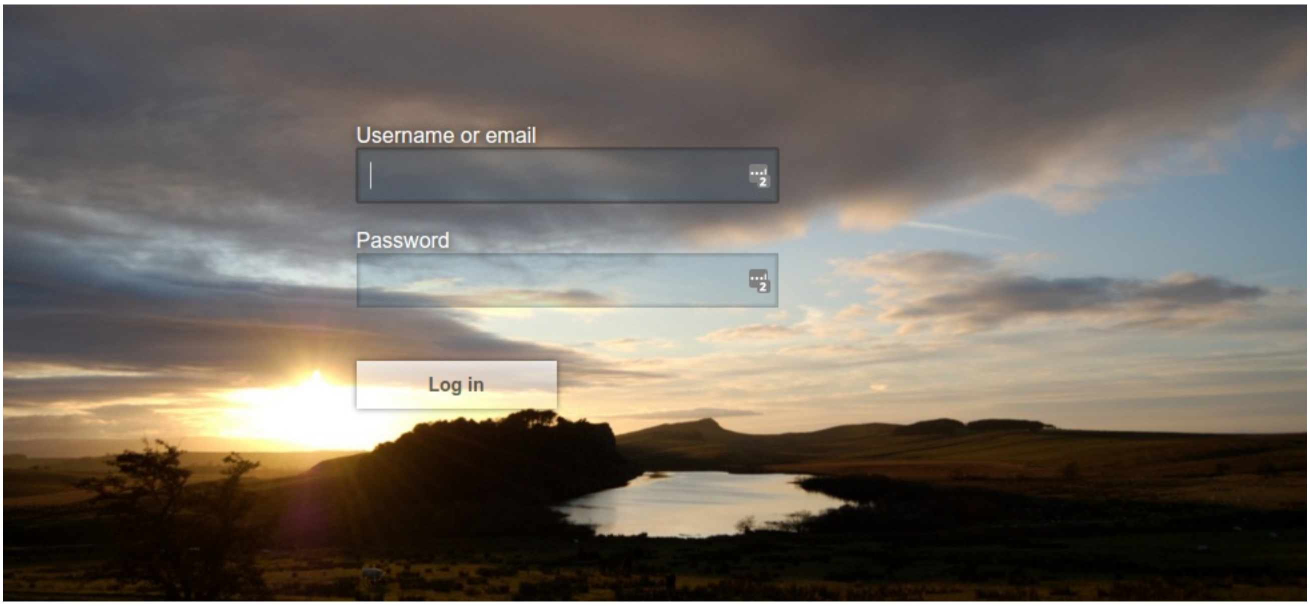
The following example shows how to get the details of the master realm:

```
curl \
  -H "Authorization: bearer eyJhbGciOiJSUz..." \
  "http://localhost:8080/auth/admin/realms/master"
```

第3章 THEMES

Red Hat Single Sign-On provides theme support for web pages and emails. This allows customizing the look and feel of end-user facing pages so they can be integrated with your applications.

図3.1 Login page with sunrise example theme



3.1. THEME TYPES

A theme can provide one or more types to customize different aspects of Red Hat Single Sign-On. The types available are:

- Account - Account management
- Admin - Admin console
- Email - Emails
- Login - Login forms
- Welcome - Welcome page

3.2. CONFIGURE THEME

All theme types, except welcome, are configured through the **Admin Console**. To change the theme used for a realm open the **Admin Console**, select your realm from the drop-down box in the top left corner. Under **Realm Settings** click **Themes**.

注記

To set the theme for the **master** admin console you need to set the admin console theme for the **master** realm. To see the changes to the admin console refresh the page.

To change the welcome theme you need to edit **standalone.xml**, **standalone-ha.xml**, or **domain.xml**.

Add **welcomeTheme** to the theme element, for example:

```
<theme>
    ...
    <welcomeTheme>custom-theme</welcomeTheme>
    ...
</theme>
```

If the server is running you need to restart the server for the changes to the welcome theme to take effect.

3.3. DEFAULT THEMES

Red Hat Single Sign-On comes bundled with default themes in the server’s root **themes** directory. To simplify upgrading you should not edit the bundled themes directly. Instead create your own theme that extends one of the bundled themes.

3.4. CREATING A THEME

A theme consists of:

- HTML templates (Freemarker Templates)
- Images
- Message bundles
- Stylesheets
- Scripts
- Theme properties

Unless you plan to replace every single page you should extend another theme. Most likely you will want to extend the Red Hat Single Sign-On theme, but you could also consider extending the base theme if you are significantly changing the look and feel of the pages. The base theme primarily consists of HTML templates and message bundles, while the Red Hat Single Sign-On theme primarily contains images and stylesheets.

When extending a theme you can override individual resources (templates, stylesheets, etc.). If you decide to override HTML templates bear in mind that you may need to update your custom template when upgrading to a new release.

While creating a theme it’s a good idea to disable caching as this makes it possible to edit theme resources directly from the **themes** directory without restarting Red Hat Single Sign-On. To do this edit **standalone.xml**. For **theme** set **staticMaxAge** to **-1** and both **cacheTemplates** and **cacheThemes** to **false**:

```
<theme>
    <staticMaxAge>-1</staticMaxAge>
    <cacheThemes>false</cacheThemes>
    <cacheTemplates>false</cacheTemplates>
    ...
</theme>
```

Remember to re-enable caching in production as it will significantly impact performance.

To create a new theme start by creating a new directory in the **themes** directory. The name of the directory becomes the name of the theme. For example to create a theme called **mytheme** create the directory **themes/mytheme**.

Inside the theme directory create a directory for each of the types your theme is going to provide. For example to add the login type to the **mytheme** theme create the directory **themes/mytheme/login**.

For each type create a file **theme.properties** which allows setting some configuration for the theme. For example to configure the theme **themes/mytheme/login** that we just created to extend the base theme and import some common resources create the file **themes/mytheme/login/theme.properties** with following contents:

```
parent=base
import=common/keycloak
```

You have now created a theme with support for the login type. To check that it works open the admin console. Select your realm and click on **Themes**. For **Login Theme** select **mytheme** and click **Save**. Then open the login page for the realm.

You can do this either by login through your application or by opening the Account Management console (**/realms/{realm name}/account**).

To see the effect of changing the parent theme, set **parent=keycloak** in **theme.properties** and refresh the login page.

3.4.1. Theme Properties

Theme properties are set in the file **<THEME TYPE>/theme.properties** in the theme directory.

- parent - Parent theme to extend
- import - Import resources from another theme
- styles - Space-separated list of styles to include
- locales - Comma-separated list of supported locales

There are a list of properties that can be used to change the css class used for certain element types. For a list of these properties look at the theme.properties file in the corresponding type of the keycloak theme (**themes/keycloak/<THEME TYPE>/theme.properties**).

You can also add your own custom properties and use them from custom templates.

When doing so, you can substitute system properties or environment variables by using these formats:

- **${some.system.property}** - for system properties
- **${env.ENV_VAR}** - for environment variables.

A default value can also be provided in case the system property or the environment variable is not found with **${foo:defaultValue}**.

注記

If no default value is provided and there's no corresponding system property or environment variable, then nothing is replaced and you end up with the format in your template.

Here's an example of what is possible:

```
javaVersion=${java.version}

unixHome=${env.HOME:Unix home not found}
windowsHome=${env.HOMEPATH:Windows home not found}
```

3.4.2. Stylesheets

A theme can have one or more stylesheets. To add a stylesheet create a file in the **<THEME TYPE>/resources/css** directory of your theme. Then add it to the **styles** property in **theme.properties**.

For example to add **styles.css** to the **mytheme** create **themes/mytheme/login/resources/css/styles.css** with the following content:

```
.login-pf body {
    background: DimGrey none;
}
```

Then edit **themes/mytheme/login/theme.properties** and add:

```
styles=css/styles.css
```

To see the changes open the login page for your realm. You will notice that the only styles being applied are those from your custom stylesheet. To include the styles from the parent theme you need to load the styles from that theme as well. Do this by editing **themes/mytheme/login/theme.properties** and changing **styles** to:

```
styles=node_modules/patternfly/dist/css/patternfly.css node_modules/patternfly/dist/css/patternfly-additions.css lib/zocial/zocial.css css/login.css css/styles.css
```

注記

To override styles from the parent stylesheets it's important that your stylesheet is listed last.

3.4.3. Scripts

A theme can have one or more scripts, to add a script create a file in the **<THEME TYPE>/resources/js** directory of your theme. Then add it to the **scripts** property in **theme.properties**.

For example to add **script.js** to the **mytheme** create **themes/mytheme/login/resources/js/script.js** with the following content:

```
alert('Hello');
```

Then edit **themes/mytheme/login/theme.properties** and add:

```
scripts=js/script.js
```

3.4.4. Images

To make images available to the theme add them to the **<THEME TYPE>/resources/img** directory of your theme. These can be used from within stylesheets or directly in HTML templates.

For example to add an image to the **mytheme** copy an image to **themes/mytheme/login/resources/img/image.jpg**.

You can then use this image from within a custom stylesheet with:

```
body {
   background-image: url('../img/image.jpg');
   background-size: cover;
}
```

Or to use directly in HTML templates add the following to a custom HTML template:

```
<img src="${url.resourcesPath}/img/image.jpg">
```

3.4.5. Messages

Text in the templates is loaded from message bundles. A theme that extends another theme will inherit all messages from the parent's message bundle and you can override individual messages by adding **<THEME TYPE>/messages/messages_en.properties** to your theme.

For example to replace **Username** on the login form with **Your Username** for the **mytheme** create the file **themes/mytheme/login/messages/messages_en.properties** with the following content:

```
usernameOrEmail=Your Username
```

Within a message values like **{0}** and **{1}** are replaced with arguments when the message is used. For example {0} in **Log in to {0}** is replaced with the name of the realm.

3.4.6. Internationalization

Red Hat Single Sign-On supports internationalization. To enable internationalization for a realm see Server Administration Guide. This section describes how you can add your own language.

To add a new language create the file **<THEME TYPE>/messages/messages_<LOCALE>.properties** in the directory of your theme. Then add it to the **locales** property in **<THEME TYPE>/theme.properties**. For a language to be available to users the realms **login**, **account** and **email** theme has to support the language, so you need to add your language for those theme types.

For example, to add Norwegian translations to the **mytheme** theme create the file **themes/mytheme/login/messages/messages_no.properties** with the following content:

```
usernameOrEmail=Brukernavn
password=Passord
```

All messages you don’t provide a translation for will use the default English translation.

Then edit **themes/mytheme/login/theme.properties** and add:

```
locales=en,no
```

You also need to do the same for the **account** and **email** theme types. To do this create **themes/mytheme/account/messages/messages_no.properties** and **themes/mytheme/email/messages/messages_no.properties**. Leaving these files empty will result in the English messages being used. Then copy **themes/mytheme/login/theme.properties** to **themes/mytheme/account/theme.properties** and **themes/mytheme/email/theme.properties**.

Finally you need to add a translation for the language selector. This is done by adding a message to the English translation. To do this add the following to **themes/mytheme/account/messages/messages_en.properties** and **themes/mytheme/login/messages/messages_en.properties**:

```
locale_no=Norsk
```

By default message properties files should be encoded using ISO-8859-1. It’s also possible to specify the encoding using a special header. For example to use UTF-8 encoding:

```
# encoding: UTF-8
usernameOrEmail=....
```

See Locale Selector on details on how the current locale is selected.

3.4.7. HTML Templates

Red Hat Single Sign-On uses Freemarker Templates in order to generate HTML. You can override individual templates in your own theme by creating **<THEME TYPE>/<TEMPLATE>.ftl**. For a list of templates used see **themes/base/<THEME TYPE>**.

When creating a custom template it is a good idea to copy the template from the base theme to your own theme, then applying the modifications you need. Bear in mind when upgrading to a new version of Red Hat Single Sign-On you may need to update your custom templates to apply changes to the original template if applicable.

For example to create a custom login form for the **mytheme** theme copy **themes/base/login/login.ftl** to **themes/mytheme/login** and open it in an editor. After the first line (<#import …>) add **<h1>HELLO WORLD!</h1>** like so:

```
<#import "template.ftl" as layout>
<h1>HELLO WORLD!</h1>
...
```

Check out the FreeMarker Manual for more details on how to edit templates.

3.4.8. Emails

To edit the subject and contents for emails, for example password recovery email, add a message bundle to the **email** type of your theme. There are three messages for each email. One for the subject, one for the plain text body and one for the html body.

To see all emails available take a look at **themes/base/email/messages/messages_en.properties**.

For example to change the password recovery email for the **mytheme** theme create **themes/mytheme/email/messages/messages_en.properties** with the following content:

```
passwordResetSubject=My password recovery
passwordResetBody=Reset password link: {0}
passwordResetBodyHtml=<a href="{0}">Reset password</a>
```

3.5. DEPLOYING THEMES

Themes can be deployed to Red Hat Single Sign-On by copying the theme directory to **themes** or it can be deployed as an archive. During development you can copy the theme to the **themes** directory, but in production you may want to consider using an **archive**. An **archive** makes it simpler to have a versioned copy of the theme, especially when you have multiple instances of Red Hat Single Sign-On for example with clustering.

To deploy a theme as an archive you need to create a JAR archive with the theme resources. You also need to add a file **META-INF/keycloak-themes.json** to the archive that lists the available themes in the archive as well as what types each theme provides.

For example for the **mytheme** theme create **mytheme.jar** with the contents:

- META-INF/keycloak-themes.json
- theme/mytheme/login/theme.properties
- theme/mytheme/login/login.ftl
- theme/mytheme/login/resources/css/styles.css
- theme/mytheme/login/resources/img/image.png
- theme/mytheme/login/messages/messages_en.properties
- theme/mytheme/email/messages/messages_en.properties

The contents of **META-INF/keycloak-themes.json** in this case would be:

```
{
    "themes": [{
        "name" : "mytheme",
        "types": [ "login", "email" ]
    }]
}
```

A single archive can contain multiple themes and each theme can support one or more types.

To deploy the archive to Red Hat Single Sign-On simply drop it into the **standalone/deployments/** directory of Red Hat Single Sign-On and it will be automatically loaded.

3.6. THEME SELECTOR

By default the theme configured for the realm is used, with the exception of clients being able to override the login theme. This behavior can be changed through the Theme Selector SPI.

This could be used to select different themes for desktop and mobile devices by looking at the user agent header, for example.

To create a custom theme selector you need to implement **ThemeSelectorProviderFactory** and **ThemeSelectorProvider**.

Follow the steps in Service Provider Interfaces for more details on how to create and deploy a custom provider.

3.7. THEME RESOURCES

When implementing custom providers in Red Hat Single Sign-On there may often be a need to add additional templates, resources and messages bundles.

The easiest way to load additional theme resources is to create a JAR with templates in **theme-resources/templates** resources in **theme-resources/resources** and messages bundles in **theme-resources/messages** and drop it into the **standalone/deployments/** directory of Red Hat Single Sign-On.

If you want a more flexible way to load templates and resources that can be achieved through the ThemeResourceSPI. By implementing **ThemeResourceProviderFactory** and **ThemeResourceProvider** you can decide exactly how to load templates and resources.

Follow the steps in Service Provider Interfaces for more details on how to create and deploy a custom provider.

3.8. LOCALE SELECTOR

By default, the locale is selected using the **DefaultLocaleSelectorProvider** which implements the **LocaleSelectorProvider** interface. English is the default language when internationalization is disabled. With internationalization enabled, the locale is resolved in the following priority:

1. **kc_locale** query parameter
2. **KEYCLOAK_LOCALE** cookie value
3. User's preferred locale if a user instance is available
4. **ui_locales** query parameter
5. **Accept-Language** request header
6. Realm's default language

This behaviour can be changed through the **LocaleSelectorSPI** by implementing the **LocaleSelectorProvider** and **LocaleSelectorProviderFactory**.

The **LocaleSelectorProvider** interface has a single method, **resolveLocale**, which must return a locale given a **RealmModel** and a nullable **UserModel**. The actual request is available from the **KeycloakSession#getContext** method.

Custom implementations can extend the **DefaultLocaleSelectorProvider** in order to reuse parts of the default behaviour. For example to ignore the **Accept-Language** request header, a custom implementation could extend the default provider, override it's **getAcceptLanguageHeaderLocale**, and return a null value. As a result the locale selection will fall back on the realms's default language.

Follow the steps in Service Provider Interfaces for more details on how to create and deploy a custom provider.

第4章 CUSTOM USER ATTRIBUTES

You can add custom user attributes to the registration page and account management console with a custom theme. This chapter describes how to add attributes to a custom theme, but you should refer to the Themes chapter on how to create a custom theme.

4.1. REGISTRATION PAGE

To be able to enter custom attributes in the registration page copy the template **themes/base/login/register.ftl** to the login type of your custom theme. Then open the copy in an editor.

As an example to add a mobile number to the registration page add the following snippet to the form:

```
<div class="form-group">
  <div class="${properties.kcLabelWrapperClass!}">
     <label for="user.attributes.mobile" class="${properties.kcLabelClass!}">Mobile number</label>
  </div>

  <div class="${properties.kcInputWrapperClass!}">
     <input type="text" class="${properties.kcInputClass!}" id="user.attributes.mobile"
name="user.attributes.mobile" value="${(register.formData['user.attributes.mobile']!'')}"/>
  </div>
</div>
```

Ensure the name of the input html element starts with **user.attributes.**. In the example above, the attribute will be stored by Keycloak with the name **mobile**.

To see the changes make sure your realm is using your custom theme for the login theme and open the registration page.

4.2. ACCOUNT MANAGEMENT CONSOLE

To be able to manage custom attributes in the user profile page in the account management console copy the template **themes/base/account/account.ftl** to the account type of your custom theme. Then open the copy in an editor.

As an example to add a mobile number to the account page add the following snippet to the form:

```
<div class="form-group">
  <div class="col-sm-2 col-md-2">
     <label for="user.attributes.mobile" class="control-label">Mobile number</label>
  </div>

  <div class="col-sm-10 col-md-10">
     <input type="text" class="form-control" id="user.attributes.mobile" name="user.attributes.mobile"
value="${(account.attributes.mobile!'')}"/>
  </div>
</div>
```

Ensure the name of the input html element starts with **user.attributes.**.

To see the changes make sure your realm is using your custom theme for the account theme and open the user profile page in the account management console.

第5章 IDENTITY BROKERING APIS

Red Hat Single Sign-On can delegate authentication to a parent IDP for login. A typical example of this is the case where you want users to be able to login through a social provider like Facebook or Google. Red Hat Single Sign-On also allows you to link existing accounts to a brokered IDP. This section talks about some APIs that your applications can use as it pertains to identity brokering.

5.1. RETRIEVING EXTERNAL IDP TOKENS

Red Hat Single Sign-On allows you to store tokens and responses from the authentication process with the external IDP. For that, you can use the **Store Token** configuration option on the IDP's settings page.

Application code can retrieve these tokens and responses to pull in extra user information, or to securely invoke requests on the external IDP. For example, an application might want to use the Google token to invoke on other Google services and REST APIs. To retrieve a token for a particular identity provider you need to send a request as follows:

```
GET /auth/realms/{realm}/broker/{provider_alias}/token HTTP/1.1
Host: localhost:8080
Authorization: Bearer <KEYCLOAK ACCESS TOKEN>
```

An application must have authenticated with Red Hat Single Sign-On and have received an access token. This access token will need to have the **broker** client-level role **read-token** set. This means that the user must have a role mapping for this role and the client application must have that role within its scope. In this case, given that you are accessing a protected service in Red Hat Single Sign-On, you need to send the access token issued by Red Hat Single Sign-On during the user authentication. In the broker configuration page you can automatically assign this role to newly imported users by turning on the **Stored Tokens Readable** switch.

These external tokens can be re-established by either logging in again through the provider, or using the client initiated account linking API.

5.2. CLIENT INITIATED ACCOUNT LINKING

Some applications want to integrate with social providers like Facebook, but do not want to provide an option to login via these social providers. Red Hat Single Sign-On offers a browser-based API that applications can use to link an existing user account to a specific external IDP. This is called client-initiated account linking. Account linking can only be initiated by OIDC applications.

The way it works is that the application forwards the user's browser to a URL on the Red Hat Single Sign-On server requesting that it wants to link the user's account to a specific external provider (i.e. Facebook). The server initiates a login with the external provider. The browser logs in at the external provider and is redirected back to the server. The server establishes the link and redirects back to the application with a confirmation.

There are some preconditions that must be met by the client application before it can initiate this protocol:

- The desired identity provider must be configured and enabled for the user's realm in the admin console.
- The user account must already be logged in as an existing user via the OIDC protocol
- The user must have an **account.manage-account** or **account.manage-account-links** role mapping.

- The application must be granted the scope for those roles within its access token
- The application must have access to its access token as it needs information within it to generate the redirect URL.

To initiate the login, the application must fabricate a URL and redirect the user's browser to this URL. The URL looks like this:

```
/{auth-server-root}/auth/realms/{realm}/broker/{provider}/link?client_id={id}&redirect_uri={uri}&nonce=
{nonce}&hash={hash}
```

Here's a description of each path and query param:

provider

This is the provider alias of the external IDP that you defined in the **Identity Provider** section of the admin console.

client_id

This is the OIDC client id of your application. When you registered the application as a client in the admin console, you had to specify this client id.

redirect_uri

This is the application callback URL you want to redirect to after the account link is established. It must be a valid client redirect URI pattern. In other words, it must match one of the valid URL patterns you defined when you registered the client in the admin console.

nonce

This is a random string that your application must generate

hash

This is a Base64 URL encoded hash. This hash is generated by Base64 URL encoding a SHA_256 hash of **nonce** + **token.getSessionState()** + **token.getIssuedFor()** + **provider**. The token variable are obtained from the OIDC access token. Basically you are hashing the random nonce, the user session id, the client id, and the identity provider alias you want to access.

Here's an example of Java Servlet code that generates the URL to establish the account link.

```
  KeycloakSecurityContext session = (KeycloakSecurityContext)
httpServletRequest.getAttribute(KeycloakSecurityContext.class.getName());
  AccessToken token = session.getToken();
  String clientId = token.getIssuedFor();
  String nonce = UUID.randomUUID().toString();
  MessageDigest md = null;
  try {
    md = MessageDigest.getInstance("SHA-256");
  } catch (NoSuchAlgorithmException e) {
    throw new RuntimeException(e);
  }
  String input = nonce + token.getSessionState() + clientId + provider;
  byte[] check = md.digest(input.getBytes(StandardCharsets.UTF_8));
  String hash = Base64Url.encode(check);
  request.getSession().setAttribute("hash", hash);
  String redirectUri = ...;
  String accountLinkUrl = KeycloakUriBuilder.fromUri(authServerRootUrl)
             .path("/auth/realms/{realm}/broker/{provider}/link")
             .queryParam("nonce", nonce)
```

```
                .queryParam("hash", hash)
                .queryParam("client_id", clientId)
                .queryParam("redirect_uri", redirectUri).build(realm, provider).toString();
```

Why is this hash included? We do this so that the auth server is guaranteed to know that the client application initiated the request and no other rogue app just randomly asked for a user account to be linked to a specific provider. The auth server will first check to see if the user is logged in by checking the SSO cookie set at login. It will then try to regenerate the hash based on the current login and match it up to the hash sent by the application.

After the account has been linked, the auth server will redirect back to the **redirect_uri**. If there is a problem servicing the link request, the auth server may or may not redirect back to the **redirect_uri**. The browser may just end up at an error page instead of being redirected back to the application. If there is an error condition and the auth server deems it safe enough to redirect back to the client app, an additional **error** query parameter will be appended to the **redirect_uri**.

警告

While this API guarantees that the application initiated the request, it does not completely prevent CSRF attacks for this operation. The application is still responsible for guarding against CSRF attacks target at itself.

5.2.1. Refreshing External Tokens

If you are using the external token generated by logging into the provider (i.e. a Facebook or GitHub token), you can refresh this token by re-initiating the account linking API.

第6章 SERVICE PROVIDER INTERFACES (SPI)

Red Hat Single Sign-On is designed to cover most use-cases without requiring custom code, but we also want it to be customizable. To achieve this Red Hat Single Sign-On has a number of Service Provider Interfaces (SPI) for which you can implement your own providers.

6.1. IMPLEMENTING AN SPI

To implement an SPI you need to implement its ProviderFactory and Provider interfaces. You also need to create a service configuration file.

For example, to implement the Theme Selector SPI you need to implement ThemeSelectorProviderFactory and ThemeSelectorProvider and also provide the file **META-INF/services/org.keycloak.theme.ThemeSelectorProviderFactory**.

Example ThemeSelectorProviderFactory:

```
package org.acme.provider;

import ...

public class MyThemeSelectorProviderFactory implements ThemeSelectorProviderFactory {

    @Override
    public ThemeSelectorProvider create(KeycloakSession session) {
        return new MyThemeSelectorProvider(session);
    }

    @Override
    public void init(Config.Scope config) {
    }

    @Override
    public void postInit(KeycloakSessionFactory factory) {
    }

    @Override
    public void close() {
    }

    @Override
    public String getId() {
        return "myThemeSelector";
    }
}
```

注記

Keycloak creates a single instance of provider factories which makes it possible to store state for multiple requests. Provider instances are created by calling create on the factory for each request so these should be light-weight object.

Example ThemeSelectorProvider:

```
package org.acme.provider;

import ...

public class MyThemeSelectorProvider implements ThemeSelectorProvider {

    public MyThemeSelectorProvider(KeycloakSession session) {
    }


    @Override
    public String getThemeName(Theme.Type type) {
        return "my-theme";
    }

    @Override
  public void close() {
    }
}
```

Example service configuration file (**META-INF/services/org.keycloak.theme.ThemeSelectorProviderFactory**):

```
org.acme.provider.MyThemeSelectorProviderFactory
```

You can configure your provider through **standalone.xml**, **standalone-ha.xml**, or **domain.xml**.

For example by adding the following to **standalone.xml**:

```
<spi name="themeSelector">
    <provider name="myThemeSelector" enabled="true">
        <properties>
            <property name="theme" value="my-theme"/>
        </properties>
    </provider>
</spi>
```

Then you can retrieve the config in the **ProviderFactory** init method:

```
public void init(Config.Scope config) {
    String themeName = config.get("theme");
}
```

Your provider can also lookup other providers if needed. For example:

```
public class MyThemeSelectorProvider implements ThemeSelectorProvider {

    private KeycloakSession session;

    public MyThemeSelectorProvider(KeycloakSession session) {
        this.session = session;
    }

    @Override
    public String getThemeName(Theme.Type type) {
        return session.getContext().getRealm().getLoginTheme();
    }
}
```

6.1.1. Show info from your SPI implementation in admin console

Sometimes it is useful to show additional info about your Provider to a Red Hat Single Sign-On administrator. You can show provider build time information (eg. version of custom provider currently installed), current configuration of the provider (eg. url of remote system your provider talks to) or some operational info (average time of response from remote system your provider talks to). Red Hat Single Sign-On admin console provides Server Info page to show this kind of information.

To show info from your provider it is enough to implement **org.keycloak.provider.ServerInfoAwareProviderFactory** interface in your **ProviderFactory**.

Example implementation for **MyThemeSelectorProviderFactory** from previous example:

```
package org.acme.provider;

import ...

public class MyThemeSelectorProviderFactory implements ThemeSelectorProviderFactory,
ServerInfoAwareProviderFactory {
    ...

    @Override
    public Map<String, String> getOperationalInfo() {
        Map<String, String> ret = new LinkedHashMap<>();
        ret.put("theme-name", "my-theme");
        return ret;
    }
}
```

6.2. REGISTERING PROVIDER IMPLEMENTATIONS

There are two ways to register provider implementations. In most cases the simplest way is to use the Red Hat Single Sign-On deployer approach as this handles a number of dependencies automatically for you. It also supports hot deployment as well as re-deployment.

The alternative approach is to deploy as a module.

If you are creating a custom SPI you will need to deploy it as a module, otherwise we recommend using the Red Hat Single Sign-On deployer approach.

6.2.1. Using the Red Hat Single Sign-On Deployer

If you copy your provider jar to the Red Hat Single Sign-On **standalone/deployments/** directory, your provider will automatically be deployed. Hot deployment works too. Additionally, your provider jar works similarly to other components deployed in a JBoss EAP environment in that they can use facilities like the **jboss-deployment-structure.xml** file. This file allows you to set up dependencies on other components and load third-party jars and modules.

Provider jars can also be contained within other deployable units like EARs and WARs. Deploying with a EAR actually makes it really easy to use third party jars as you can just put these libraries in the EAR's **lib/** directory.

6.2.2. Register a provider using Modules

To register a provider using Modules first create a module. To do this you can either use the jboss-cli script or manually create a folder inside **KEYCLOAK_HOME/modules** and add your jar and a **module.xml**. For example to add the event listener sysout example provider using the **jboss-cli** script execute:

```
KEYCLOAK_HOME/bin/jboss-cli.sh --command="module add --name=org.acme.provider --
resources=target/provider.jar --dependencies=org.keycloak.keycloak-core,org.keycloak.keycloak-
server-spi"
```

Or to manually create it start by creating the folder **KEYCLOAK_HOME/modules/org/acme/provider/main**. Then copy **provider.jar** to this folder and create **module.xml** with the following content:

```
<?xml version="1.0" encoding="UTF-8"?>
<module xmlns="urn:jboss:module:1.3" name="org.acme.provider">
   <resources>
      <resource-root path="provider.jar"/>
   </resources>
   <dependencies>
      <module name="org.keycloak.keycloak-core"/>
      <module name="org.keycloak.keycloak-server-spi"/>
   </dependencies>
</module>
```

Once you've created the module you need to register this module with Red Hat Single Sign-On. This is done by editing the keycloak-server subsystem section of **standalone.xml**, **standalone-ha.xml**, or **domain.xml**, and adding it to the providers:

```
<subsystem xmlns="urn:jboss:domain:keycloak-server:1.1">
   <web-context>auth</web-context>
   <providers>
      <provider>module:org.keycloak.examples.event-sysout</provider>
   </providers>
   ...
```

6.2.3. Disabling a provider

You can disable a provider by setting the enabled attribute for the provider to false in **standalone.xml**, **standalone-ha.xml**, or **domain.xml**. For example to disable the Infinispan user cache provider add:

```
<spi name="userCache">
   <provider name="infinispan" enabled="false"/>
</spi>
```

6.3. LEVERAGING JAVA EE

The service providers can be packaged within any Java EE component so long as you set up the **META-**

INF/services file correctly to point to your providers. For example, if your provider needs to use third party libraries, you can package up your provider within an ear and store these third party libraries in the ear's **lib/** directory. Also note that provider jars can make use of the **jboss-deployment-structure.xml** file that EJBs, WARS, and EARs can use in a JBoss EAP environment. See the JBoss EAP documentation for more details on this file. It allows you to pull in external dependencies among other fine grain actions.

ProviderFactory implementations are required to be plain java objects. But, we also currently support implementing provider classes as Stateful EJBs. This is how you would do it:

```
@Stateful
@Local(EjbExampleUserStorageProvider.class)
public class EjbExampleUserStorageProvider implements UserStorageProvider,
        UserLookupProvider,
        UserRegistrationProvider,
        UserQueryProvider,
        CredentialInputUpdater,
        CredentialInputValidator,
        OnUserCache
{
    @PersistenceContext
    protected EntityManager em;

    protected ComponentModel model;
    protected KeycloakSession session;

    public void setModel(ComponentModel model) {
        this.model = model;
    }

    public void setSession(KeycloakSession session) {
        this.session = session;
    }


    @Remove
    @Override
    public void close() {
    }
...
}
```

You have to define the **@Local** annotation and specify your provider class there. If you don't do this, EJB will not proxy the provider instance correctly and your provider won't work.

You must put the **@Remove** annotation on the **close()** method of your provider. If you don't, the stateful bean will never be cleaned up and you may eventually see error messages.

Implementations of **ProviderFactory** are required to be plain java objects. Your factory class would perform a JNDI lookup of the Stateful EJB in its **create()** method.

```
public class EjbExampleUserStorageProviderFactory
        implements UserStorageProviderFactory<EjbExampleUserStorageProvider> {

    @Override
    public EjbExampleUserStorageProvider create(KeycloakSession session, ComponentModel
model) {
        try {
            InitialContext ctx = new InitialContext();
            EjbExampleUserStorageProvider provider = (EjbExampleUserStorageProvider)ctx.lookup(
                     "java:global/user-storage-jpa-example/" +
EjbExampleUserStorageProvider.class.getSimpleName());
            provider.setModel(model);
            provider.setSession(session);
            return provider;
        } catch (Exception e) {
            throw new RuntimeException(e);
        }
    }
```

6.4. JAVASCRIPT PROVIDERS

Red Hat Single Sign-On has the ability to execute scripts during runtime in order to allow administrators to customize specific functionalities:

- Authenticator
- JavaScript Policy
- OpenID Connect Protocol Mapper

6.4.1. Authenticator

Authentication scripts must provide at least one of the following functions: **authenticate(..)**, which is called from **Authenticator#authenticate(AuthenticationFlowContext)action(..)**, which is called from **Authenticator#action(AuthenticationFlowContext)**

Custom **Authenticator** should at least provide the **authenticate(..)** function. You can use the **javax.script.Bindings** script within the code.

script

the **ScriptModel** to access script metadata

realm

the **RealmModel**

user

the current **UserModel**

session

the active **KeycloakSession**

authenticationSession

the current **AuthenticationSessionModel**

httpRequest

the current **org.jboss.resteasy.spi.HttpRequest**

LOG

a **org.jboss.logging.Logger** scoped to **ScriptBasedAuthenticator**

注記

You can extract additional context information from the **context** argument passed to the **authenticate(context) action(context)** function.

```
AuthenticationFlowError = Java.type("org.keycloak.authentication.AuthenticationFlowError");

function authenticate(context) {

  LOG.info(script.name + " --> trace auth for: " + user.username);

  if (   user.username === "tester"
      && user.getAttribute("someAttribute")
      && user.getAttribute("someAttribute").contains("someValue")) {

      context.failure(AuthenticationFlowError.INVALID_USER);
      return;
  }

  context.success();
}
```

6.4.2. Create a JAR with the scripts to deploy

注記

JAR files are regular ZIP files with a **.jar** extension.

In order to make your scripts available to Red Hat Single Sign-On you need to deploy them to the server. For that, you should create a **JAR** file with the following structure:

```
META-INF/keycloak-scripts.json

my-script-authenticator.js
my-script-policy.js
my-script-mapper.js
```

The **META-INF/keycloak-scripts.json** is a file descriptor that provides metadata information about the scripts you want to deploy. It is a JSON file with the following structure:

```
{
    "authenticators": [
        {
            "name": "My Authenticator",
            "fileName": "my-script-authenticator.js",
            "description": "My Authenticator from a JS file"
        }
    ],
    "policies": [
        {
            "name": "My Policy",
            "fileName": "my-script-policy.js",
            "description": "My Policy from a JS file"
        }
    ],
    "mappers": [
        {
            "name": "My Mapper",
            "fileName": "my-script-mapper.js",
            "description": "My Mapper from a JS file"
        }
    ]
}
```

This file should reference the different types of script providers that you want to deploy:

- **authenticators**
  For OpenID Connect Script Authenticators. You can have one or multiple authenticators in the same JAR file

- **policies**
  For JavaScript Policies when using Red Hat Single Sign-On Authorization Services. You can have one or multiple policies in the same JAR file

- **mappers**
  For OpenID Connect Script Protocol Mappers. You can have one or multiple mappers in the same JAR file

For each script file in your **JAR** file you must have a corresponding entry in **META-INF/keycloak-scripts.json** that maps your scripts files to a specific provider type. For that you should provide the following properties for each entry:

- **name**
  A friendly name that will be used to show the scripts through the Red Hat Single Sign-On Administration Console. If not provided, the name of the script file will be used instead

- **description**
  An optional text that better describes the intend of the script file

- **fileName**
  The name of the script file. This property is **mandatory** and should map to a file within the JAR.

6.4.3. Deploy the Script JAR

Once you have a JAR file with a descriptor and the scripts you want to deploy, you just need to copy the JAR to the to the Red Hat Single Sign-On **standalone/deployments/** directory.

6.4.4. Using Red Hat Single Sign-On Administration Console to upload scripts

注記

Ability to upload scripts through the admin console is deprecated and will be removed in a future version of Red Hat Single Sign-On

Administrators cannot upload scripts to the server. This behavior prevents potential harm to the system in case malicious scripts are accidentally executed. Administrators should always deploy scripts directly to the server using a JAR file to prevent attacks when you run scripts at runtime.

Ability to upload scripts can be explicitly enabled. This should be used with great care and plans should be created to deploy all scripts directly to the server as soon as possible.

For more details about how to enable the **upload_scripts** feature. Please, take a look at the Profiles.

6.5. AVAILABLE SPIS

If you want to see list of all available SPIs at runtime, you can check **Server Info** page in admin console as described in Admin Console section.

第7章 USER STORAGE SPI

You can use the User Storage SPI to write extensions to Red Hat Single Sign-On to connect to external user databases and credential stores. The built-in LDAP and ActiveDirectory support is an implementation of this SPI in action. Out of the box, Red Hat Single Sign-On uses its local database to create, update, and look up users and validate credentials. Often though, organizations have existing external proprietary user databases that they cannot migrate to Red Hat Single Sign-On's data model. For those situations, application developers can write implementations of the User Storage SPI to bridge the external user store and the internal user object model that Red Hat Single Sign-On uses to log in users and manage them.

When the Red Hat Single Sign-On runtime needs to look up a user, such as when a user is logging in, it performs a number of steps to locate the user. It first looks to see if the user is in the user cache; if the user is found it uses that in-memory representation. Then it looks for the user within the Red Hat Single Sign-On local database. If the user is not found, it then loops through User Storage SPI provider implementations to perform the user query until one of them returns the user the runtime is looking for. The provider queries the external user store for the user and maps the external data representation of the user to Red Hat Single Sign-On's user metamodel.

User Storage SPI provider implementations can also perform complex criteria queries, perform CRUD operations on users, validate and manage credentials, or perform bulk updates of many users at once. It depends on the capabilities of the external store.

User Storage SPI provider implementations are packaged and deployed similarly to (and often are) Java EE components. They are not enabled by default, but instead must be enabled and configured per realm under the **User Federation** tab in the administration console.

7.1. PROVIDER INTERFACES

When building an implementation of the User Storage SPI you have to define a provider class and a provider factory. Provider class instances are created per transaction by provider factories. Provider classes do all the heavy lifting of user lookup and other user operations. They must implement the **org.keycloak.storage.UserStorageProvider** interface.

```
package org.keycloak.storage;

public interface UserStorageProvider extends Provider {


    /**
     * Callback when a realm is removed.  Implement this if, for example, you want to do some
     * cleanup in your user storage when a realm is removed
     *
     * @param realm
     */
    default
    void preRemove(RealmModel realm) {

    }

    /**
     * Callback when a group is removed.  Allows you to do things like remove a user
     * group mapping in your external store if appropriate
     *
     * @param realm
     * @param group
     */
    default
    void preRemove(RealmModel realm, GroupModel group) {

    }

    /**
     * Callback when a role is removed.  Allows you to do things like remove a user
     * role mapping in your external store if appropriate

     * @param realm
     * @param role
     */
    default
    void preRemove(RealmModel realm, RoleModel role) {

    }

}
```

You may be thinking that the **UserStorageProvider** interface is pretty sparse? You'll see later in this chapter that there are other mix-in interfaces your provider class may implement to support the meat of user integration.

UserStorageProvider instances are created once per transaction. When the transaction is complete, the **UserStorageProvider.close()** method is invoked and the instance is then garbage collected. Instances are created by provider factories. Provider factories implement the **org.keycloak.storage.UserStorageProviderFactory** interface.

```
package org.keycloak.storage;

/**
 * @author <a href="mailto:bill@burkecentral.com">Bill Burke</a>
 * @version $Revision: 1 $
 */
public interface UserStorageProviderFactory<T extends UserStorageProvider> extends
ComponentFactory<T, UserStorageProvider> {

    /**
     * This is the name of the provider and will be shown in the admin console as an option.
     *
     * @return
     */
    @Override
    String getId();

    /**
     * called per Keycloak transaction.
     *
     * @param session
     * @param model
     * @return
     */
    T create(KeycloakSession session, ComponentModel model);
...
}
```

Provider factory classes must specify the concrete provider class as a template parameter when implementing the **UserStorageProviderFactory**. This is a must as the runtime will introspect this class to scan for its capabilities (the other interfaces it implements). So for example, if your provider class is named **FileProvider**, then the factory class should look like this:

```
public class FileProviderFactory implements UserStorageProviderFactory<FileProvider> {

    public String getId() { return "file-provider"; }

    public FileProvider create(KeycloakSession session, ComponentModel model) {
       ...
    }
```

The **getId()** method returns the name of the User Storage provider. This id will be displayed in the admin console's User Federation page when you want to enable the provider for a specific realm.

The **create()** method is responsible for allocating an instance of the provider class. It takes a **org.keycloak.models.KeycloakSession** parameter. This object can be used to look up other information and metadata as well as provide access to various other components within the runtime. The **ComponentModel** parameter represents how the provider was enabled and configured within a specific realm. It contains the instance id of the enabled provider as well as any configuration you may have specified for it when you enabled through the admin console.

The **UserStorageProviderFactory** has other capabilities as well which we will go over later in this chapter.

7.2. PROVIDER CAPABILITY INTERFACES

If you have examined the **UserStorageProvider** interface closely you might notice that it does not define any methods for locating or managing users. These methods are actually defined in other **capability interfaces** depending on what scope of capabilities your external user store can provide and execute on. For example, some external stores are read-only and can only do simple queries and credential validation. You will only be required to implement the **capability interfaces** for the features you are able to. You can implement these interfaces:

SPI	Description
org.keycloak.storage.user.UserLookupProvider	This interface is required if you want to be able to log in with users from this external store. Most (all?) providers implement this interface.
org.keycloak.storage.user.UserQueryProvider	Defines complex queries that are used to locate one or more users. You must implement this interface if you want to view and manage users from the administration console.
org.keycloak.storage.user.UserRegistrationProvider	Implement this interface if your provider supports adding and removing users.

SPI	Description
org.keycloak.storage.user.UserBulkUpdateProvider	Implement this interface if your provider supports bulk update of a set of users.
org.keycloak.credential.CredentialInputValidator	Implement this interface if your provider can validate one or more different credential types (for example, if your provider can validate a password).
org.keycloak.credential.CredentialInputUpdater	Implement this interface if your provider supports updating one or more different credential types.

7.3. MODEL INTERFACES

Most of the methods defined in the **capability interfaces** either return or are passed in representations of a user. These representations are defined by the **org.keycloak.models.UserModel** interface. App developers are required to implement this interface. It provides a mapping between the external user store and the user metamodel that Red Hat Single Sign-On uses.

```
package org.keycloak.models;

public interface UserModel extends RoleMapperModel {
    String getId();

    String getUsername();
    void setUsername(String username);

    String getFirstName();
    void setFirstName(String firstName);

    String getLastName();
    void setLastName(String lastName);

    String getEmail();
    void setEmail(String email);
...
}
```

UserModel implementations provide access to read and update metadata about the user including things like username, name, email, role and group mappings, as well as other arbitrary attributes.

There are other model classes within the **org.keycloak.models** package that represent other parts of the Red Hat Single Sign-On metamodel: **RealmModel**, **RoleModel**, **GroupModel**, and **ClientModel**.

7.3.1. Storage Ids

One important method of **UserModel** is the **getId()** method. When implementing **UserModel** developers must be aware of the user id format. The format must be:

```
"f:" + component id + ":" + external id
```

The Red Hat Single Sign-On runtime often has to look up users by their user id. The user id contains enough information so that the runtime does not have to query every single **UserStorageProvider** in the system to find the user.

The component id is the id returned from **ComponentModel.getId()**. The **ComponentModel** is passed in as a parameter when creating the provider class so you can get it from there. The external id is information your provider class needs to find the user in the external store. This is often a username or a uid. For example, it might look something like this:

```
f:332a234e31234:wburke
```

When the runtime does a lookup by id, the id is parsed to obtain the component id. The component id is used to locate the **UserStorageProvider** that was originally used to load the user. That provider is then passed the id. The provider again parses the id to obtain the external id and it will use to locate the user in external user storage.

7.4. PACKAGING AND DEPLOYMENT

User Storage providers are packaged in a JAR and deployed or undeployed to the Red Hat Single Sign-On runtime in the same way you would deploy something in the JBoss EAP application server. You can either copy the JAR directly to the **standalone/deployments/** directory of the server, or use the JBoss CLI to execute the deployment.

In order for Red Hat Single Sign-On to recognize the provider, you need to add a file to the JAR: **META-INF/services/org.keycloak.storage.UserStorageProviderFactory**. This file must contain a line-separated list of fully qualified classnames of the **UserStorageProviderFactory** implementations:

```
org.keycloak.examples.federation.properties.ClasspathPropertiesStorageFactory
org.keycloak.examples.federation.properties.FilePropertiesStorageFactory
```

Red Hat Single Sign-On supports hot deployment of these provider JARs. You'll also see later in this chapter that you can package it within and as Java EE components.

7.5. SIMPLE READ-ONLY, LOOKUP EXAMPLE

To illustrate the basics of implementing the User Storage SPI let's walk through a simple example. In this chapter you'll see the implementation of a simple **UserStorageProvider** that looks up users in a simple property file. The property file contains username and password definitions and is hardcoded to a specific location on the classpath. The provider will be able to look up the user by ID and username and also be able to validate passwords. Users that originate from this provider will be read-only.

7.5.1. Provider Class

The first thing we will walk through is the **UserStorageProvider** class.

```
public class PropertyFileUserStorageProvider implements
        UserStorageProvider,
        UserLookupProvider,
        CredentialInputValidator,
        CredentialInputUpdater
{
...
}
```

Our provider class, **PropertyFileUserStorageProvider**, implements many interfaces. It implements the **UserStorageProvider** as that is a base requirement of the SPI. It implements the **UserLookupProvider** interface because we want to be able to log in with users stored by this provider. It implements the **CredentialInputValidator** interface because we want to be able to validate passwords entered in using the login screen. Our property file is read-only. We implement the **CredentialInputUpdater** because we want to post an error condition when the user attempts to update his password.

```
    protected KeycloakSession session;
    protected Properties properties;
    protected ComponentModel model;
    // map of loaded users in this transaction
    protected Map<String, UserModel> loadedUsers = new HashMap<>();

    public PropertyFileUserStorageProvider(KeycloakSession session, ComponentModel model,
Properties properties) {
        this.session = session;
        this.model = model;
        this.properties = properties;
    }
```

The constructor for this provider class is going to store the reference to the **KeycloakSession**, **ComponentModel**, and property file. We'll use all of these later. Also notice that there is a map of loaded users. Whenever we find a user we will store it in this map so that we avoid re-creating it again within the same transaction. This is a good practice to follow as many providers will need to do this (that is, any provider that integrates with JPA). Remember also that provider class instances are created once per transaction and are closed after the transaction completes.

7.5.1.1. UserLookupProvider Implementation

```
    @Override
    public UserModel getUserByUsername(String username, RealmModel realm) {
        UserModel adapter = loadedUsers.get(username);
        if (adapter == null) {
            String password = properties.getProperty(username);
            if (password != null) {
                adapter = createAdapter(realm, username);
                loadedUsers.put(username, adapter);
            }
        }
        return adapter;
    }

    protected UserModel createAdapter(RealmModel realm, String username) {
        return new AbstractUserAdapter(session, realm, model) {
            @Override
            public String getUsername() {
                return username;
            }
        };
    }

    @Override
    public UserModel getUserById(String id, RealmModel realm) {
        StorageId storageId = new StorageId(id);
        String username = storageId.getExternalId();
        return getUserByUsername(username, realm);
    }

    @Override
    public UserModel getUserByEmail(String email, RealmModel realm) {
        return null;
    }
```

The **getUserByUsername()** method is invoked by the Red Hat Single Sign-On login page when a user logs in. In our implementation we first check the **loadedUsers** map to see if the user has already been loaded within this transaction. If it hasn't been loaded we look in the property file for the username. If it exists we create an implementation of **UserModel**, store it in **loadedUsers** for future reference, and return this instance.

The **createAdapter()** method uses the helper class **org.keycloak.storage.adapter.AbstractUserAdapter**. This provides a base implementation for **UserModel**. It automatically generates a user id based on the required storage id format using the username of the user as the external id.

```
"f:" + component id + ":" + username
```

Every get method of **AbstractUserAdapter** either returns null or empty collections. However, methods that return role and group mappings will return the default roles and groups configured for the realm for every user. Every set method of **AbstractUserAdapter** will throw a **org.keycloak.storage.ReadOnlyException**. So if you attempt to modify the user in the admininstration console, you will get an error.

The **getUserById()** method parses the **id** parameter using the **org.keycloak.storage.StorageId** helper class. The **StorageId.getExternalId()** method is invoked to obtain the username embeded in the **id** parameter. The method then delegates to **getUserByUsername()**.

Emails are not stored, so the **getUserByEmail()** method returns null.

7.5.1.2. CredentialInputValidator Implementation

Next let's look at the method implementations for **CredentialInputValidator**.

```
    @Override
    public boolean isConfiguredFor(RealmModel realm, UserModel user, String credentialType) {
        String password = properties.getProperty(user.getUsername());
        return credentialType.equals(CredentialModel.PASSWORD) && password != null;
    }

    @Override
    public boolean supportsCredentialType(String credentialType) {
        return credentialType.equals(CredentialModel.PASSWORD);
    }

    @Override
    public boolean isValid(RealmModel realm, UserModel user, CredentialInput input) {
        if (!supportsCredentialType(input.getType())) return false;

        String password = properties.getProperty(user.getUsername());
        if (password == null) return false;
        return password.equals(input.getChallengeResponse());
    }
```

The **isConfiguredFor()** method is called by the runtime to determine if a specific credential type is configured for the user. This method checks to see that the password is set for the user.

The **supportsCredentialType()** method returns whether validation is supported for a specific credential type. We check to see if the credential type is **password**.

The **isValid()** method is responsible for validating passwords. The **CredentialInput** parameter is really just an abstract interface for all credential types. We make sure that we support the credential type and also that it is an instance of **UserCredentialModel**. When a user logs in through the login page, the plain text of the password input is put into an instance of **UserCredentialModel**. The **isValid()** method checks this value against the plain text password stored in the properties file. A return value of **true** means the password is valid.

7.5.1.3. CredentialInputUpdater Implementation

As noted before, the only reason we implement the **CredentialInputUpdater** interface in this example is to forbid modifications of user passwords. The reason we have to do this is because otherwise the runtime would allow the password to be overridden in Red Hat Single Sign-On local storage. We'll talk more about this later in this chapter.

```
    @Override
    public boolean updateCredential(RealmModel realm, UserModel user, CredentialInput input) {
        if (input.getType().equals(CredentialModel.PASSWORD)) throw new ReadOnlyException("user is read only for this update");

        return false;
    }

    @Override
    public void disableCredentialType(RealmModel realm, UserModel user, String credentialType) {

    }

    @Override
    public Set<String> getDisableableCredentialTypes(RealmModel realm, UserModel user) {
        return Collections.EMPTY_SET;
    }
```

The **updateCredential()** method just checks to see if the credential type is password. If it is, a **ReadOnlyException** is thrown.

7.5.2. Provider Factory Implementation

Now that the provider class is complete, we now turn our attention to the provider factory class.

```
public class PropertyFileUserStorageProviderFactory
                 implements UserStorageProviderFactory<PropertyFileUserStorageProvider> {

    public static final String PROVIDER_NAME = "readonly-property-file";

    @Override
    public String getId() {
        return PROVIDER_NAME;
    }
```

First thing to notice is that when implementing the **UserStorageProviderFactory** class, you must pass in the concrete provider class implementation as a template parameter. Here we specify the provider class we defined before: **PropertyFileUserStorageProvider**.

> **警告**
>
> If you do not specify the template parameter, your provider will not function. The runtime does class introspection to determine the **capability interfaces** that the provider implements.

The **getId()** method identifies the factory in the runtime and will also be the string shown in the admin console when you want to enable a user storage provider for the realm.

7.5.2.1. Initialization

```
    private static final Logger logger =
Logger.getLogger(PropertyFileUserStorageProviderFactory.class);
    protected Properties properties = new Properties();

    @Override
    public void init(Config.Scope config) {
        InputStream is = getClass().getClassLoader().getResourceAsStream("/users.properties");

        if (is == null) {
            logger.warn("Could not find users.properties in classpath");
        } else {
            try {
                properties.load(is);
            } catch (IOException ex) {
                logger.error("Failed to load users.properties file", ex);
            }
        }
    }

    @Override
    public PropertyFileUserStorageProvider create(KeycloakSession session, ComponentModel
model) {
        return new PropertyFileUserStorageProvider(session, model, properties);
    }
```

The **UserStorageProviderFactory** interface has an optional **init()** method you can implement. When Red Hat Single Sign-On boots up, only one instance of each provider factory is created. Also at boot time, the **init()** method is called on each of these factory instances. There's also a **postInit()** method you can implement as well. After each factory's **init()** method is invoked, their **postInit()** methods are called.

In our **init()** method implementation, we find the property file containing our user declarations from the classpath. We then load the **properties** field with the username and password combinations stored there.

The **Config.Scope** parameter is factory configuration that can be set up within **standalone.xml**, **standalone-ha.xml**, or **domain.xml**.

For example, by adding the following to **standalone.xml**:

```
<spi name="storage">
    <provider name="readonly-property-file" enabled="true">
        <properties>
            <property name="path" value="/other-users.properties"/>
        </properties>
    </provider>
</spi>
```

We can specify the classpath of the user property file instead of hardcoding it. Then you can retrieve the configuration in the **PropertyFileUserStorageProviderFactory.init()**:

```
public void init(Config.Scope config) {
    String path = config.get("path");
    InputStream is = getClass().getClassLoader().getResourceAsStream(path);

    ...
}
```

7.5.2.2. Create Method

Our last step in creating the provider factory is the **create()** method.

```
    @Override
    public PropertyFileUserStorageProvider create(KeycloakSession session, ComponentModel
model) {
        return new PropertyFileUserStorageProvider(session, model, properties);
    }
```

We simply allocate the **PropertyFileUserStorageProvider** class. This create method will be called once per transaction.

7.5.3. Packaging and Deployment

The class files for our provider implementation should be placed in a jar. You also have to declare the provider factory class within the **META-INF/services/org.keycloak.storage.UserStorageProviderFactory** file.

```
org.keycloak.examples.federation.properties.FilePropertiesStorageFactory
```

Once you create the jar you can deploy it using regular JBoss EAP means: copy the jar into the **standalone/deployments/** directory or using the JBoss CLI.

7.5.4. Enabling the Provider in the Administration Console

You enable user storage providers per realm within the **User Federation** page in the administration console.

Select the provider we just created from the list: **readonly-property-file**. It brings you to the configuration page for our provider. We do not have anything to configure, so click **Save**.

When you go back to the main **User Federation** page, you now see your provider listed.

You will now be able to log in with a user declared in the **users.properties** file. This user will only be able to view the account page after logging in.

7.6. CONFIGURATION TECHNIQUES

Our **PropertyFileUserStorageProvider** example is bit contrived. It is hardcoded to a property file that is embedded in the jar of the provider, which is not terribly useful. We might want to make the location of this file configurable per instance of the provider. In other words, we might want to reuse this provider mulitple times in multiple different realms and point to completely different user property files. We'll also want to perform this configuration within the administration console UI.

The **UserStorageProviderFactory** has additional methods you can implement that handle provider configuration. You describe the variables you want to configure per provider and the administration console automatically renders a generic input page to gather this configuration. When implemented, callback methods also validate the configuration before it is saved, when a provider is created for the first time, and when it is updated. **UserStorageProviderFactory** inherits these methods from the **org.keycloak.component.ComponentFactory** interface.

```
  List<ProviderConfigProperty> getConfigProperties();

  default
  void validateConfiguration(KeycloakSession session, RealmModel realm, ComponentModel
model)
          throws ComponentValidationException
  {

  }

  default
  void onCreate(KeycloakSession session, RealmModel realm, ComponentModel model) {

  }

  default
  void onUpdate(KeycloakSession session, RealmModel realm, ComponentModel model) {

  }
```

The **ComponentFactory.getConfigProperties()** method returns a list of **org.keycloak.provider.ProviderConfigProperty** instances. These instances declare metadata that is needed to render and store each configuration variable of the provider.

7.6.1. Configuration Example

Let's expand our **PropertyFileUserStorageProviderFactory** example to allow you to point a provider instance to a specific file on disk.

PropertyFileUserStorageProviderFactory

```
public class PropertyFileUserStorageProviderFactory
                  implements UserStorageProviderFactory<PropertyFileUserStorageProvider> {

    protected static final List<ProviderConfigProperty> configMetadata;

    static {
        configMetadata = ProviderConfigurationBuilder.create()
                .property().name("path")
                .type(ProviderConfigProperty.STRING_TYPE)
                .label("Path")
                .defaultValue("${jboss.server.config.dir}/example-users.properties")
                .helpText("File path to properties file")
                .add().build();
    }

    @Override
    public List<ProviderConfigProperty> getConfigProperties() {
        return configMetadata;
    }
```

The **ProviderConfigurationBuilder** class is a great helper class to create a list of configuration properties. Here we specify a variable named **path** that is a String type. On the administration console configuration page for this provider, this configuration variable is labeled as **Path** and has a default value of **${jboss.server.config.dir}/example-users.properties**. When you hover over the tooltip of this configuration option, it displays the help text, **File path to properties file**.

The next thing we want to do is to verify that this file exists on disk. We do not want to enable an instance of this provider in the realm unless it points to a valid user property file. To do this, we implement the **validateConfiguration()** method.

```
    @Override
    public void validateConfiguration(KeycloakSession session, RealmModel realm, ComponentModel
config)
                   throws ComponentValidationException {
        String fp = config.getConfig().getFirst("path");
        if (fp == null) throw new ComponentValidationException("user property file does not exist");
        fp = EnvUtil.replace(fp);
        File file = new File(fp);
        if (!file.exists()) {
            throw new ComponentValidationException("user property file does not exist");
        }
    }
```

In the **validateConfiguration()** method we get the configuration variable from the **ComponentModel** and we check to see if that file exists on disk. Notice that we use the **org.keycloak.common.util.EnvUtil.replace()** method. With this method any string that has **${}** within it will replace that with a system property value. The **${jboss.server.config.dir}** string corresponds to the **configuration/** directory of our server and is really useful for this example.

Next thing we have to do is remove the old **init()** method. We do this because user property files are going to be unique per provider instance. We move this logic to the **create()** method.

```
    @Override
    public PropertyFileUserStorageProvider create(KeycloakSession session, ComponentModel
model) {
        String path = model.getConfig().getFirst("path");

        Properties props = new Properties();
        try {
            InputStream is = new FileInputStream(path);
            props.load(is);
            is.close();
        } catch (IOException e) {
            throw new RuntimeException(e);
        }

        return new PropertyFileUserStorageProvider(session, model, props);
    }
```

This logic is, of course, inefficient as every transaction reads the entire user property file from disk, but hopefully this illustrates, in a simple way, how to hook in configuration variables.

7.6.2. Configuring the Provider in the Administration Console

Now that the configuration is enabled, you can set the **path** variable when you configure the provider in the administration console.

7.7. ADD/REMOVE USER AND QUERY CAPABILITY INTERFACES

One thing we have not done with our example is allow it to add and remove users or change passwords. Users defined in our example are also not queryable or viewable in the administration console. To add these enhancements, our example provider must implement the **UserQueryProvider** and **UserRegistrationProvider** interfaces.

7.7.1. Implementing UserRegistrationProvider

To implement adding and removing users from this particular store, we first have to be able to save our properties file to disk.

PropertyFileUserStorageProvider

```
    public void save() {
        String path = model.getConfig().getFirst("path");
        path = EnvUtil.replace(path);
        try {
            FileOutputStream fos = new FileOutputStream(path);
            properties.store(fos, "");
            fos.close();
        } catch (IOException e) {
            throw new RuntimeException(e);
        }
    }
```

Then, the implementation of the **addUser()** and **removeUser()** methods becomes simple.

PropertyFileUserStorageProvider

```
  public static final String UNSET_PASSWORD="#$!-UNSET-PASSWORD";

  @Override
  public UserModel addUser(RealmModel realm, String username) {
    synchronized (properties) {
      properties.setProperty(username, UNSET_PASSWORD);
      save();
    }
    return createAdapter(realm, username);
  }

  @Override
  public boolean removeUser(RealmModel realm, UserModel user) {
    synchronized (properties) {
      if (properties.remove(user.getUsername()) == null) return false;
      save();
      return true;
    }
  }
```

Notice that when adding a user we set the password value of the property map to be **UNSET_PASSWORD**. We do this as we can't have null values for a property in the property value. We also have to modify the **CredentialInputValidator** methods to reflect this.

The **addUser()** method will be called if the provider implements the **UserRegistrationProvider** interface. If your provider has a configuration switch to turn off adding a user, returning **null** from this method will skip the provider and call the next one.

PropertyFileUserStorageProvider

```
  @Override
  public boolean isValid(RealmModel realm, UserModel user, CredentialInput input) {
    if (!supportsCredentialType(input.getType()) || !(input instanceof UserCredentialModel)) return
false;

    UserCredentialModel cred = (UserCredentialModel)input;
    String password = properties.getProperty(user.getUsername());
    if (password == null || UNSET_PASSWORD.equals(password)) return false;
    return password.equals(cred.getValue());
  }
```

Since we can now save our property file, it also makes sense to allow password updates.

PropertyFileUserStorageProvider

```
  @Override
  public boolean updateCredential(RealmModel realm, UserModel user, CredentialInput input) {
    if (!(input instanceof UserCredentialModel)) return false;
    if (!input.getType().equals(CredentialModel.PASSWORD)) return false;
    UserCredentialModel cred = (UserCredentialModel)input;
    synchronized (properties) {
      properties.setProperty(user.getUsername(), cred.getValue());
      save();
    }
    return true;
}
```

We can now also implement disabling a password.

PropertyFileUserStorageProvider

```
@Override
public void disableCredentialType(RealmModel realm, UserModel user, String credentialType) {
    if (!credentialType.equals(CredentialModel.PASSWORD)) return;
    synchronized (properties) {
        properties.setProperty(user.getUsername(), UNSET_PASSWORD);
        save();
    }

}

private static final Set<String> disableableTypes = new HashSet<>();

static {
    disableableTypes.add(CredentialModel.PASSWORD);
}

@Override
public Set<String> getDisableableCredentialTypes(RealmModel realm, UserModel user) {

    return disableableTypes;
}
```

With these methods implemented, you'll now be able to change and disable the password for the user in the administration console.

7.7.2. Implementing UserQueryProvider

Without implementing **UserQueryProvider** the administration console would not be able to view and manage users that were loaded by our example provider. Let's look at implementing this interface.

PropertyFileUserStorageProvider

```
@Override
public int getUsersCount(RealmModel realm) {
    return properties.size();
}

@Override
public List<UserModel> getUsers(RealmModel realm) {
    return getUsers(realm, 0, Integer.MAX_VALUE);
}

@Override
public List<UserModel> getUsers(RealmModel realm, int firstResult, int maxResults) {
    List<UserModel> users = new LinkedList<>();
    int i = 0;
    for (Object obj : properties.keySet()) {
      if (i++ < firstResult) continue;
      String username = (String)obj;
      UserModel user = getUserByUsername(username, realm);
      users.add(user);
      if (users.size() >= maxResults) break;
    }
    return users;
  }
```

The **getUsers()** method iterates over the key set of the property file, delegating to **getUserByUsername()** to load a user. Notice that we are indexing this call based on the **firstResult** and **maxResults** parameter. If your external store does not support pagination, you will have to do similar logic.

PropertyFileUserStorageProvider

```
  @Override
  public List<UserModel> searchForUser(String search, RealmModel realm) {
    return searchForUser(search, realm, 0, Integer.MAX_VALUE);
  }

  @Override
  public List<UserModel> searchForUser(String search, RealmModel realm, int firstResult, int
maxResults) {
    List<UserModel> users = new LinkedList<>();
    int i = 0;
    for (Object obj : properties.keySet()) {
      String username = (String)obj;
      if (!username.contains(search)) continue;
      if (i++ < firstResult) continue;
      UserModel user = getUserByUsername(username, realm);
      users.add(user);
      if (users.size() >= maxResults) break;
    }
    return users;
  }
```

The first declaration of **searchForUser()** takes a **String** parameter. This is supposed to be a string that you use to search username and email attributes to find the user. This string can be a substring, which is why we use the **String.contains()** method when doing our search.

PropertyFileUserStorageProvider

```
  @Override
  public List<UserModel> searchForUser(Map<String, String> params, RealmModel realm) {
    return searchForUser(params, realm, 0, Integer.MAX_VALUE);
  }

  @Override
  public List<UserModel> searchForUser(Map<String, String> params, RealmModel realm, int
firstResult, int maxResults) {
    // only support searching by username
    String usernameSearchString = params.get("username");
```

```
        if (usernameSearchString == null) return Collections.EMPTY_LIST;
        return searchForUser(usernameSearchString, realm, firstResult, maxResults);
    }
```

The **searchForUser()** method that takes a **Map** parameter can search for a user based on first, last name, username, and email. We only store usernames, so we only search based on usernames. We delegate to **searchForUser()** for this.

PropertyFileUserStorageProvider

```
    @Override
    public List<UserModel> getGroupMembers(RealmModel realm, GroupModel group, int firstResult,
int maxResults) {
        return Collections.EMPTY_LIST;
    }

    @Override
    public List<UserModel> getGroupMembers(RealmModel realm, GroupModel group) {
        return Collections.EMPTY_LIST;
    }

    @Override
    public List<UserModel> searchForUserByUserAttribute(String attrName, String attrValue,
RealmModel realm) {
        return Collections.EMPTY_LIST;
    }
```

We do not store groups or attributes, so the other methods return an empty list.

7.8. AUGMENTING EXTERNAL STORAGE

The **PropertyFileUserStorageProvider** example is really limited. While we will be able to login with users stored in a property file, we won't be able to do much else. If users loaded by this provider need special role or group mappings to fully access particular applications there is no way for us to add additional role mappings to these users. You also can't modify or add additional important attributes like email, first and last name.

For these types of situations, Red Hat Single Sign-On allows you to augment your external store by storing extra information in Red Hat Single Sign-On's database. This is called federated user storage and is encapsulated within the **org.keycloak.storage.federated.UserFederatedStorageProvider** class.

UserFederatedStorageProvider

```
package org.keycloak.storage.federated;

public interface UserFederatedStorageProvider extends Provider {

    Set<GroupModel> getGroups(RealmModel realm, String userId);
    void joinGroup(RealmModel realm, String userId, GroupModel group);
    void leaveGroup(RealmModel realm, String userId, GroupModel group);
    List<String> getMembership(RealmModel realm, GroupModel group, int firstResult, int max);

...
```

The **UserFederatedStorageProvider** instance is available on the **KeycloakSession.userFederatedStorage()** method. It has all different kinds of methods for storing attributes, group and role mappings, different credential types, and required actions. If your external store's datamodel cannot support the full Red Hat Single Sign-On feature set, then this service can fill in the gaps.

Red Hat Single Sign-On comes with a helper class **org.keycloak.storage.adapter.AbstractUserAdapterFederatedStorage** that will delegate every single **UserModel** method except get/set of username to user federated storage. Override the methods you need to override to delegate to your external storage representations. It is strongly suggested you read the javadoc of this class as it has smaller protected methods you may want to override. Specifically surrounding group membership and role mappings.

7.8.1. Augmentation Example

In our **PropertyFileUserStorageProvider** example, we just need a simple change to our provider to use the **AbstractUserAdapterFederatedStorage**.

PropertyFileUserStorageProvider

```
protected UserModel createAdapter(RealmModel realm, String username) {
   return new AbstractUserAdapterFederatedStorage(session, realm, model) {
      @Override
      public String getUsername() {
         return username;
      }

      @Override
      public void setUsername(String username) {
         String pw = (String)properties.remove(username);
         if (pw != null) {
            properties.put(username, pw);
            save();
         }
      }
   };
}
```

We instead define an anonymous class implementation of **AbstractUserAdapterFederatedStorage**. The **setUsername()** method makes changes to the properties file and saves it.

7.9. IMPORT IMPLEMENTATION STRATEGY

When implementing a user storage provider, there's another strategy you can take. Instead of using user federated storage, you can create a user locally in the Red Hat Single Sign-On built-in user database and copy attributes from your external store into this local copy. There are many advantages to this approach.

- Red Hat Single Sign-On basically becomes a persistence user cache for your external store. Once the user is imported you'll no longer hit the external store thus taking load off of it.

- If you are moving to Red Hat Single Sign-On as your official user store and deprecating the old external store, you can slowly migrate applications to use Red Hat Single Sign-On. When all applications have been migrated, unlink the imported user, and retire the old legacy external store.

There are some obvious disadvantages though to using an import strategy:

- Looking up a user for the first time will require multiple updates to Red Hat Single Sign-On database. This can be a big performance loss under load and put a lot of strain on the Red Hat Single Sign-On database. The user federated storage approach will only store extra data as needed and may never be used depending on the capabilities of your external store.

- With the import approach, you have to keep local Red Hat Single Sign-On storage and external storage in sync. The User Storage SPI has capability interfaces that you can implement to support synchronization, but this can quickly become painful and messy.

To implement the import strategy you simply check to see first if the user has been imported locally. If so return the local user, if not create the user locally and import data from the external store. You can also proxy the local user so that most changes are automatically synchronized.

This will be a bit contrived, but we can extend our **PropertyFileUserStorageProvider** to take this approach. We begin first by modifying the **createAdapter()** method.

PropertyFileUserStorageProvider

```
protected UserModel createAdapter(RealmModel realm, String username) {
    UserModel local = session.userLocalStorage().getUserByUsername(username, realm);
    if (local == null) {
        local = session.userLocalStorage().addUser(realm, username);
        local.setFederationLink(model.getId());
    }
    return new UserModelDelegate(local) {
        @Override
        public void setUsername(String username) {
            String pw = (String)properties.remove(username);
            if (pw != null) {
                properties.put(username, pw);
                save();
            }
            super.setUsername(username);
        }
    };
}
```

In this method we call the **KeycloakSession.userLocalStorage()** method to obtain a reference to local Red Hat Single Sign-On user storage. We see if the user is stored locally, if not, we add it locally. Do not set the **id** of the local user. Let Red Hat Single Sign-On automatically generate the **id**. Also note that we call **UserModel.setFederationLink()** and pass in the ID of the **ComponentModel** of our provider. This sets a link between the provider and the imported user.

注記

When a user storage provider is removed, any user imported by it will also be removed. This is one of the purposes of calling **UserModel.setFederationLink()**.

Another thing to note is that if a local user is linked, your storage provider will still be delegated to for methods that it implements from the **CredentialInputValidator** and **CredentialInputUpdater** interfaces. Returning **false** from a validation or update will just result in Red Hat Single Sign-On seeing if it can validate or update using local storage.

Also notice that we are proxying the local user using the **org.keycloak.models.utils.UserModelDelegate** class. This class is an implementation of **UserModel**. Every method just delegates to the **UserModel** it was instantiated with. We override the **setUsername()** method of this delegate class to synchronize automatically with the property file. For your providers, you can use this to **intercept** other methods on the local **UserModel** to perform synchronization with your external store. For example, get methods could make sure that the local store is in sync. Set methods keep the external store in sync with the local one. One thing to note is that the **getId()** method should always return the id that was auto generated when you created the user locally. You should not return a federated id as shown in the other non-import examples.

注記

If your provider is implementing the **UserRegistrationProvider** interface, your **removeUser()** method does not need to remove the user from local storage. The runtime will automatically perform this operation. Also note that **removeUser()** will be invoked before it is removed from local storage.

7.9.1. ImportedUserValidation Interface

If you remember earlier in this chapter, we discussed how querying for a user worked. Local storage is queried first, if the user is found there, then the query ends. This is a problem for our above implementation as we want to proxy the local **UserModel** so that we can keep usernames in sync. The User Storage SPI has a callback for whenever a linked local user is loaded from the local database.

```
package org.keycloak.storage.user;
public interface ImportedUserValidation {
    /**
     * If this method returns null, then the user in local storage will be removed
     *
     * @param realm
     * @param user
     * @return null if user no longer valid
     */
    UserModel validate(RealmModel realm, UserModel user);
}
```

Whenever a linked local user is loaded, if the user storage provider class implements this interface, then the **validate()** method is called. Here you can proxy the local user passed in as a parameter and return it. That new **UserModel** will be used. You can also optionally do a check to see if the user still exists in the external store. If **validate()** returns **null**, then the local user will be removed from the database.

7.9.2. ImportSynchronization Interface

With the import strategy you can see that it is possible for the local user copy to get out of sync with external storage. For example, maybe a user has been removed from the external store. The User Storage SPI has an additional interface you can implement to deal with this, **org.keycloak.storage.user.ImportSynchronization**:

```
package org.keycloak.storage.user;

public interface ImportSynchronization {
    SynchronizationResult sync(KeycloakSessionFactory sessionFactory, String realmId,
UserStorageProviderModel model);
```

```
    SynchronizationResult syncSince(Date lastSync, KeycloakSessionFactory sessionFactory, String
realmId, UserStorageProviderModel model);
}
```

This interface is implemented by the provider factory. Once this interface is implemented by the provider factory, the administration console management page for the provider shows additional options. You can manually force a synchronization by clicking a button. This invokes the **ImportSynchronization.sync()** method. Also, additional configuration options are displayed that allow you to automatically schedule a synchronization. Automatic synchronizations invoke the **syncSince()** method.

7.10. USER CACHES

When a user object is loaded by ID, username, or email queries it is cached. When a user object is being cached, it iterates through the entire **UserModel** interface and pulls this information to a local in-memory-only cache. In a cluster, this cache is still local, but it becomes an invalidation cache. When a user object is modified, it is evicted. This eviction event is propagated to the entire cluster so that the other nodes' user cache is also invalidated.

7.10.1. Managing the user cache

You can access the user cache by calling **KeycloakSession.userCache()**.

```
/**
 * All these methods effect an entire cluster of Keycloak instances.
 *
 * @author <a href="mailto:bill@burkecentral.com">Bill Burke</a>
 * @version $Revision: 1 $
 */
public interface UserCache extends UserProvider {
    /**
     * Evict user from cache.
     *
     * @param user
     */
    void evict(RealmModel realm, UserModel user);

    /**
     * Evict users of a specific realm
     *
     * @param realm
     */
    void evict(RealmModel realm);

    /**
     * Clear cache entirely.
     *
     */
    void clear();
}
```

There are methods for evicting specific users, users contained in a specific realm, or the entire cache.

7.10.2. OnUserCache Callback Interface

You might want to cache additional information that is specific to your provider implementation. The User Storage SPI has a callback whenever a user is cached: **org.keycloak.models.cache.OnUserCache**.

```
public interface OnUserCache {
    void onCache(RealmModel realm, CachedUserModel user, UserModel delegate);
}
```

Your provider class should implement this interface if it wants this callback. The **UserModel** delegate parameter is the **UserModel** instance returned by your provider. The **CachedUserModel** is an expanded **UserModel** interface. This is the instance that is cached locally in local storage.

```
public interface CachedUserModel extends UserModel {

    /**
     * Invalidates the cache for this user and returns a delegate that represents the actual data provider
     *
     * @return
     */
    UserModel getDelegateForUpdate();

    boolean isMarkedForEviction();

    /**
     * Invalidate the cache for this model
     *
     */
    void invalidate();

    /**
     * When was the model was loaded from database.
     *
     * @return
     */
    long getCacheTimestamp();

    /**
     * Returns a map that contains custom things that are cached along with this model.  You can write to this map.
     *
     * @return
     */
    ConcurrentHashMap getCachedWith();
}
```

This **CachedUserModel** interface allows you to evict the user from the cache and get the provider **UserModel** instance. The **getCachedWith()** method returns a map that allows you to cache additional information pertaining to the user. For example, credentials are not part of the **UserModel** interface. If you wanted to cache credentials in memory, you would implement **OnUserCache** and cache your user's credentials using the **getCachedWith()** method.

7.10.3. Cache Policies

On the administration console management page for your user storage provider, you can specify a unique cache policy.

7.11. LEVERAGING JAVA EE

The user storage providers can be packaged within any Java EE component if you set up the **META-INF/services** file correctly to point to your providers. For example, if your provider needs to use third-party libraries, you can package up your provider within an EAR and store these third-party libraries in the **lib**/ directory of the EAR. Also note that provider JARs can make use of the **jboss-deployment-structure.xml** file that EJBs, WARS, and EARs can use in a JBoss EAP environment. For more details on this file, see the JBoss EAP documentation. It allows you to pull in external dependencies among other fine-grained actions.

Provider implementations are required to be plain java objects. But we also currently support implementing **UserStorageProvider** classes as Stateful EJBs. This is especially useful if you want to use JPA to connect to a relational store. This is how you would do it:

```
@Stateful
@Local(EjbExampleUserStorageProvider.class)
public class EjbExampleUserStorageProvider implements UserStorageProvider,
        UserLookupProvider,
        UserRegistrationProvider,
        UserQueryProvider,
        CredentialInputUpdater,
        CredentialInputValidator,
        OnUserCache
{
    @PersistenceContext
    protected EntityManager em;

    protected ComponentModel model;
    protected KeycloakSession session;

    public void setModel(ComponentModel model) {
        this.model = model;
    }

    public void setSession(KeycloakSession session) {
        this.session = session;
    }


    @Remove
    @Override
    public void close() {
    }
...
}
```

You have to define the **@Local** annotation and specify your provider class there. If you do not do this, EJB will not proxy the user correctly and your provider won't work.

You must put the **@Remove** annotation on the **close()** method of your provider. If you do not, the stateful bean will never be cleaned up and you might eventually see error messages.

Implementations of **UserStorageProvider** are required to be plain Java objects. Your factory class would perform a JNDI lookup of the Stateful EJB in its create() method.

```
public class EjbExampleUserStorageProviderFactory
        implements UserStorageProviderFactory<EjbExampleUserStorageProvider> {

    @Override
    public EjbExampleUserStorageProvider create(KeycloakSession session, ComponentModel
model) {
        try {
            InitialContext ctx = new InitialContext();
            EjbExampleUserStorageProvider provider = (EjbExampleUserStorageProvider)ctx.lookup(
                     "java:global/user-storage-jpa-example/" +
EjbExampleUserStorageProvider.class.getSimpleName());
            provider.setModel(model);
            provider.setSession(session);
            return provider;
        } catch (Exception e) {
            throw new RuntimeException(e);
        }
    }
```

This example also assumes that you have defined a JPA deployment in the same JAR as the provider. This means a **persistence.xml** file as well as any JPA **@Entity** classes.

警告

When using JPA any additional datasource must be an XA datasource. The Red Hat Single Sign-On datasource is not an XA datasource. If you interact with two or more non-XA datasources in the same transaction, the server returns an error message. Only one non-XA resource is permitted in a single transaction. See the JBoss EAP manual for more details on deploying an XA datasource.

CDI is not supported.

7.12. REST MANAGEMENT API

You can create, remove, and update your user storage provider deployments through the administrator REST API. The User Storage SPI is built on top of a generic component interface so you will be using that generic API to manage your providers.

The REST Component API lives under your realm admin resource.

```
/admin/realms/{realm-name}/components
```

We will only show this REST API interaction with the Java client. Hopefully you can extract how to do this from **curl** from this API.

```
public interface ComponentsResource {
    @GET
    @Produces(MediaType.APPLICATION_JSON)
    public List<ComponentRepresentation> query();
    @GET
    @Produces(MediaType.APPLICATION_JSON)
    public List<ComponentRepresentation> query(@QueryParam("parent") String parent);

    @GET
    @Produces(MediaType.APPLICATION_JSON)
    public List<ComponentRepresentation> query(@QueryParam("parent") String parent,
@QueryParam("type") String type);

    @GET
    @Produces(MediaType.APPLICATION_JSON)
    public List<ComponentRepresentation> query(@QueryParam("parent") String parent,
                                               @QueryParam("type") String type,
                                               @QueryParam("name") String name);

    @POST
    @Consumes(MediaType.APPLICATION_JSON)
    Response add(ComponentRepresentation rep);

    @Path("{id}")
    ComponentResource component(@PathParam("id") String id);
}

public interface ComponentResource {
    @GET
    public ComponentRepresentation toRepresentation();

    @PUT
    @Consumes(MediaType.APPLICATION_JSON)
    public void update(ComponentRepresentation rep);

    @DELETE
    public void remove();
}
```

To create a user storage provider, you must specify the provider id, a provider type of the string **org.keycloak.storage.UserStorageProvider**, as well as the configuration.

```
import org.keycloak.admin.client.Keycloak;
import org.keycloak.representations.idm.RealmRepresentation;
...

Keycloak keycloak = Keycloak.getInstance(
    "http://localhost:8080/auth",
    "master",
    "admin",
    "password",
    "admin-cli");
RealmResource realmResource = keycloak.realm("master");
RealmRepresentation realm = realmResource.toRepresentation();

ComponentRepresentation component = new ComponentRepresentation();
component.setName("home");
component.setProviderId("readonly-property-file");
component.setProviderType("org.keycloak.storage.UserStorageProvider");
component.setParentId(realm.getId());
component.setConfig(new MultivaluedHashMap());
component.getConfig().putSingle("path", "~/users.properties");

realmResource.components().add(component);

// retrieve a component

List<ComponentRepresentation> components = realmResource.components().query(realm.getId(),
                                          "org.keycloak.storage.UserStorageProvider",
                                          "home");
component = components.get(0);

// Update a component

component.getConfig().putSingle("path", "~/my-users.properties");
realmResource.components().component(component.getId()).update(component);

// Remove a component

realmREsource.components().component(component.getId()).remove();
```

7.13. MIGRATING FROM AN EARLIER USER FEDERATION SPI

注記

This chapter is only applicable if you have implemented a provider using the earlier (and now removed) User Federation SPI.

In Keycloak version 2.4.0 and earlier there was a User Federation SPI. Red Hat Single Sign-On version 7.0, although unsupported, had this earlier SPI available as well. This earlier User Federation SPI has been removed from Keycloak version 2.5.0 and Red Hat Single Sign-On version 7.1. However, if you have written a provider with this earlier SPI, this chapter discusses some strategies you can use to port it.

7.13.1. Import vs. Non-Import

The earlier User Federation SPI required you to create a local copy of a user in the Red Hat Single Sign-On's database and import information from your external store to the local copy. However, this is no longer a requirement. You can still port your earlier provider as-is, but you should consider whether a non-import strategy might be a better approach.

Advantages of the import strategy:

- Red Hat Single Sign-On basically becomes a persistence user cache for your external store. Once the user is imported you'll no longer hit the external store, thus taking load off of it.

- If you are moving to Red Hat Single Sign-On as your official user store and deprecating the earlier external store, you can slowly migrate applications to use Red Hat Single Sign-On. When all applications have been migrated, unlink the imported user, and retire the earlier legacy external store.

There are some obvious disadvantages though to using an import strategy:

- Looking up a user for the first time will require multiple updates to Red Hat Single Sign-On database. This can be a big performance loss under load and put a lot of strain on the Red Hat Single Sign-On database. The user federated storage approach will only store extra data as needed and might never be used depending on the capabilities of your external store.

- With the import approach, you have to keep local Red Hat Single Sign-On storage and external storage in sync. The User Storage SPI has capability interfaces that you can implement to support synchronization, but this can quickly become painful and messy.

7.13.2. UserFederationProvider vs. UserStorageProvider

The first thing to notice is that **UserFederationProvider** was a complete interface. You implemented every method in this interface. However, **UserStorageProvider** has instead broken up this interface into multiple capability interfaces that you implement as needed.

UserFederationProvider.getUserByUsername() and **getUserByEmail()** have exact equivalents in the new SPI. The difference between the two is how you import. If you are going to continue with an import strategy, you no longer call **KeycloakSession.userStorage().addUser()** to create the user locally. Instead you call **KeycloakSession.userLocalStorage().addUser()**. The **userStorage()** method no longer exists.

The **UserFederationProvider.validateAndProxy()** method has been moved to an optional capability interface, **ImportedUserValidation**. You want to implement this interface if you are porting your earlier provider as-is. Also note that in the earlier SPI, this method was called every time the user was accessed, even if the local user is in the cache. In the later SPI, this method is only called when the local user is loaded from local storage. If the local user is cached, then the **ImportedUserValidation.validate()** method is not called at all.

The **UserFederationProvider.isValid()** method no longer exists in the later SPI.

The **UserFederationProvider** methods **synchronizeRegistrations()**, **registerUser()**, and **removeUser()** have been moved to the **UserRegistrationProvider** capability interface. This new interface is optional to implement so if your provider does not support creating and removing users, you don't have to implement it. If your earlier provider had switch to toggle support for registering new users, this is supported in the new SPI, returning **null** from **UserRegistrationProvider.addUser()** if the provider doesn't support adding users.

The earlier **UserFederationProvider** methods centered around credentials are now encapsulated in the **CredentialInputValidator** and **CredentialInputUpdater** interfaces, which are also optional to implement depending on if you support validating or updating credentials. Credential management used to exist in **UserModel** methods. These also have been moved to the **CredentialInputValidator** and **CredentialInputUpdater** interfaces. One thing to note that if you do not implement the **CredentialInputUpdater** interface, then any credentials provided by your provider can be overridden locally in Red Hat Single Sign-On storage. So if you want your credentials to be read-only, implement the **CredentialInputUpdater.updateCredential()** method and return a **ReadOnlyException**.

The **UserFederationProvider** query methods such as **searchByAttributes()** and **getGroupMembers()** are now encapsulated in an optional interface **UserQueryProvider**. If you do not implement this interface, then users will not be viewable in the admin console. You'll still be able to login though.

7.13.3. UserFederationProviderFactory vs. UserStorageProviderFactory

The synchronization methods in the earlier SPI are now encapsulated within an optional **ImportSynchronization** interface. If you have implemented synchronization logic, then have your new **UserStorageProviderFactory** implement the **ImportSynchronization** interface.

7.13.4. Upgrading to a New Model

The User Storage SPI instances are stored in a different set of relational tables. Red Hat Single Sign-On automatically runs a migration script. If any earlier User Federation providers are deployed for a realm, they are converted to the later storage model as is, including the **id** of the data. This migration will only happen if a User Storage provider exists with the same provider ID (i.e., "ldap", "kerberos") as the earlier User Federation provider.

So, knowing this there are different approaches you can take.

1. You can remove the earlier provider in your earlier Red Hat Single Sign-On deployment. This will remove the local linked copies of all users you imported. Then, when you upgrade Red Hat Single Sign-On, just deploy and configure your new provider for your realm.

2. The second option is to write your new provider making sure it has the same provider ID: **UserStorageProviderFactory.getId()**. Make sure this provider is in the **standalone/deployments/** directory of the new Red Hat Single Sign-On installation. Boot the server, and have the built-in migration script convert from the earlier data model to the later data model. In this case all your earlier linked imported users will work and be the same.

If you have decided to get rid of the import strategy and rewrite your User Storage provider, we suggest that you remove the earlier provider before upgrading Red Hat Single Sign-On. This will remove linked local imported copies of any user you imported.

第8章 VAULT SPI

8.1. VAULT PROVIDER

You can use a vault SPI from **org.keycloak.vault** package to write custom extension for Red Hat Single Sign-On to connect to arbitrary vault implementation.

The built-in **files-plaintext** provider is an example of the implementation of this SPI. In general the following rules apply:

- To prevent a secret from leaking across realms, you may want to isolate or limit the secrets that can be retrieved by a realm. In that case, your provider should take into account the realm name when looking up secrets, for example by prefixing entries with the realm name. For example, an expression **${vault.key}** would then evaluate generally to different entry names, depending on whether it was used in a realm **A** or realm **B**. To differentiate between realms, the realm needs to be passed to the created **VaultProvider** instance from **VaultProviderFactory.create()** method where it is available from the **KeycloakSession** parameter.

- The vault provider needs to implement a single method **obtainSecret** that returns a **VaultRawSecret** for the given secret name. That class holds the representation of the secret either in **byte[]** or **ByteBuffer** and is expected to convert between the two upon demand. Note that this buffer would be discarded after usage as explained below.

For details on how to package and deploy a custom provider refer to the Service Provider Interfaces chapter.

8.2. CONSUMING VALUES FROM VAULT

The vault contains sensitive data and Red Hat Single Sign-On treats the secrets accordingly. When accessing a secret, the secret is obtained from the vault and retained in JVM memory only for the necessary time. Then all possible attempts to discard its content from JVM memory is done. This is achieved by using the vault secrets only within **try**-with-resources statement as outlined below:

```
char[] c;
try (VaultCharSecret cSecret = session.vault().getCharSecret(SECRET_NAME)) {
    // ... use cSecret
    c = cSecret.getAsArray().orElse(null);
    // if c != null, it now contains password
}

// if c != null, it now contains garbage
```

The example uses **KeycloakSession.vault()** as the entrypoint for accessing the secrets. Using the **VaultProvider.obtainSecret** method directly is indeed also possible. However the **vault()** method has the benefit of ability to interpret the raw secret (which is generally a byte array) as a character array (via **vault().getCharSecret()**) or a **String** (via **vault().getStringSecret()**) in addition to obtaining the original uninterpreted value (via **vault().getRawSecret()** method).

Note that since **String** objects are immutable, their content cannot be discarded by overriding with random garbage. Even though measures have been taken in the default **VaultStringSecret** implementation to prevent internalizing **String**s, the secrets stored in **String** objects would live at least to the next GC round. Thus using plain byte and character arrays and buffers is preferrable.