Installation Guide

/ ForgeRock Access Management 5.5

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ForgeRock AS
201 Mission St, Suite 2900
San Francisco, CA 94105, USA
+1 415-599-1100 (US)
www.forgerock.com

Abstract

Guide showing you how to install ForgeRock® Access Management. ForgeRock Access Management provides authentication, authorization, entitlement, and federation software.

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Preface

This guide shows you how to install ForgeRock Access Management for access and federation management.

This guide covers the install, upgrade, and uninstall procedures that you theoretically perform only once per version. This guide aims to provide you with at least some idea of what happens behind the scenes when you perform the steps.

This guide is written for anyone installing Access Management to manage and federate access to web applications and web-based resources.

Almost anyone can learn something from this guide, though a background in access management and maintaining web application software can help. You do need some background in managing services on your operating systems and in your application servers. You can nevertheless get started with this guide, and then learn more as you go along.

Unless you are planning a throwaway evaluation or test installation, read the Release Notes before you get started.

About ForgeRock Identity Platform™ Software

ForgeRock Identity Platform™ serves as the basis for our simple and comprehensive Identity and Access Management solution. We help our customers deepen their relationships with their customers, and improve the productivity and connectivity of their employees and partners. For more information about ForgeRock and about the platform, see https://www.forgerock.com.

Chapter 1
Preparing for Installation

This chapter covers prerequisites for installing AM software, including how to prepare your environment, how to set up your application server to run AM, how to prepare directory servers to store configuration data, and how to prepare an identity repository to handle AM identities.

1.1. Preparing the Environment

This section covers setting up the environment in which to run AM.

The topics covered in this section are:

- Preparing a Fully Qualified Domain Name
- Preparing a Java Environment
- Setting Maximum File Descriptors and Processes Per User

For more information about supported operating systems and Java requirements, see "Operating System Requirements" and "Java Requirements" in the *Release Notes*.

1.1.1. Preparing a Fully Qualified Domain Name

AM requires that you provide a fully qualified domain name (FQDN) when you configure it. Before you set up AM, be sure that your system has an FQDN, such as `openam.example.com`. For evaluation purposes, you can give your system an alias using the `/etc/hosts` file on UNIX systems or `%SystemRoot%\system32\drivers\etc\hosts` on Windows. For production deployments, make sure the FQDN is properly assigned using DNS.

Do not use the hostname `localhost` for AM, not even for testing purposes. AM relies on browser cookies, which are returned based on the domain name. You can set the cookie domain name value to an empty string for host-only cookies or to any non-top level domain. For example, if you install AM and use `openam.example.com` as the host, you can set the cookie domain name as `example.com`.

Important

Do not configure a top-level domain as your cookie domain as browsers will reject them.

Top-level domains are browser-specific. Some browsers, like Firefox, also consider special domains like Amazon's web service (for example, ap-southeast-2.compute.amazonaws.com) to be a top-level domain.

> Check the effective top-level domain list at *https://publicsuffix.org/list/effective_tld_names.dat* to ensure that you do not set your cookie to a domain in the list.

1.1.2. Preparing a Java Environment

AM software depends on a Java runtime environment. Check the output of the **java -version** command to make sure your version is supported according to "Java Requirements" in the *Release Notes*.

The suggestions in this section pertain to AM deployments with the following characteristics:

- The deployment has a dedicated DS server for the Core Token Service. The host running this directory server is a high-end server with a large amount of memory and multiple CPUs.
- The AM server is configured to use CTS-based, stateful sessions.

> **Important**
>
> It is important to keep your Java software up-to-date with the latest supported version. Make sure that your `JAVA_HOME` environment variable always points to the latest supported Java version.

1.1.2.1. Settings For Oracle Java Environments

When using an Oracle Java environment set at least the following options:

`-server`

Use `-server` rather than `-client`.

`-Xmx1g` (minimum)

AM requires at least a 1 GB heap. If you are including the embedded DS, AM requires at least a 2 GB heap, as 50% of that space is allocated to DS. Higher volume and higher performance deployments require additional heap space.

`-XX:MetaspaceSize=256m`

Set the metaspace memory size to 256 MB.

`-XX:MaxMetaspaceSize=256m`

Set the maximum metaspace memory size to 256 MB.

For additional JVM tuning and security recommendations, see "Tuning Java Virtual Machine Settings".

1.1.2.2. Settings For IBM Java Environments

When using an IBM Java environment, set at least the following options:

`-DamCryptoDescriptor.provider=IBMJCE`
`-DamKeyGenDescriptor.provider=IBMJCE`

Use the IBM Java Cryptography Extensions.

`-Xmx1g` **(minimum)**

AM requires at least a 1 GB heap. If you are including the embedded DS, AM requires at least a 2 GB heap, as 50% of that space is allocated to DS. Higher volume and higher performance deployments require additional heap space.

1.1.2.3. Settings for OpenJDK Java Environment

When using an OpenJDK Java environment set at least the following options.

`-Xmx1024m` **(minimum)**

AM requires at least a 1 GB heap. If you are including the embedded DS, AM requires at least a 2 GB heap, as 50% of that space is allocated to DS. Higher volume and higher performance deployments require additional heap space. Recommended: `-Xmx2048m`.

`-XX:MetaspaceSize=256m`

Set the initial metadata space size to 256 MB.

1.1.2.4. Tuning Java Virtual Machine Settings

This section gives some initial guidance on configuring the JVM for running AM. These settings provide a strong foundation to the JVM before a more detailed garbage collection tuning exercise, or as best practice configuration for production:

Heap Size Settings

JVM Parameters	Suggested Value	Description
`-Xms` & `-Xmx`	At least 1 GB (2 GB with embedded DS), in production environments at least 2 GB to 3 GB. This setting depends on the available physical memory, and on whether a 32- or 64-bit JVM is used.	-
`-server`	-	Ensures the server JVM is used
`-XX:MetaspaceSize` & `-XX:MaxMetaspaceSize`	Set both to 256 MB	Controls the size of the metaspace in the JVM
`-Dsun.net.client.defaultReadTimeout`	60000	Controls the read timeout in the Java HTTP client implementation

JVM Parameters	Suggested Value	Description
		This applies only to the Sun/ Oracle HotSpot JVM.
`-Dsun.net.client.defaultConnectTimeout`	High setting: 30000 (30 seconds)	Controls the connect timeout in the Java HTTP client implementation When you have hundreds of incoming requests per second, reduce this value to avoid a huge connection queue. This applies only to the Sun/ Oracle HotSpot JVM.

Security Settings

JVM Parameters	Suggested Value	Description
`-Dhttps.protocols`	`TLSv1,TLSv1.1,TLSv1.2`	Controls the protocols used for outbound HTTPS connections from AM. Specify one or more of the following values, separated by commas: • TLSv1 • TLSv1.1 • TLSv1.2 This setting applies only to Sun/Oracle Java environments.
`-Dorg.forgerock.openam.ldap.secure.protocol.version`	-	Controls the protocol AM uses to connect to various external resources. Specify one or more of the following values, separated by commas: • TLSv1 • TLSv1.1 • TLSv1.2

Note

For `-Dhttps.protocols`, specify the protocol version(s) Java clients can use to connect to AM.

For `-Dorg.forgerock.openam.ldap.secure.protocol.version`, see "Securing Communications" for a list of external resources to which communication is affected.

Specify a single protocol if AM will only use that protocol when connecting to affected external resources. For example, a value of `TLSv1.2` configures AM to only use the TLSv1.2 protocol to connect.

Specify a comma-separated list with multiple protocols if AM will use the most secure protocol supported by the external resources. For example, a value of `TLSv1,TLSv1.1,TLSv1.2` configures AM to attempt to use the TLSv1.2 protocol to connect to external configuration and user data stores. If a TLSv1.2 connection is not supported, AM attempts to use TLSv1.1 to connect. If TLSv1.1 is not supported, AM uses TLSv1.

Garbage Collection Settings

JVM Parameters	Suggested Value	Description
`-verbose:gc`	-	Verbose garbage collection reporting
`-Xloggc:`	`$CATALINA_HOME/logs/gc.log`	Location of the verbose garbage collection log file
`-XX:+PrintClassHistogram`	-	Prints a heap histogram when a SIGTERM signal is received by the JVM
`-XX:+PrintGCDetails`	-	Prints detailed information about garbage collection
`-XX:+PrintGCTimeStamps`	-	Prints detailed garbage collection timings
`-XX:+HeapDumpOnOutOfMemoryError`	-	Out of Memory errors generate a heap dump automatically
`-XX:HeapDumpPath`	`$CATALINA_HOME/logs/heapdump.hprof`	Location of the heap dump
`-XX:+UseConcMarkSweepGC`	-	Use the concurrent mark sweep garbage collector
`-XX:+UseCMSCompactAtFullCollection`	-	Aggressive compaction at full collection
`-XX:+CMSClassUnloadingEnabled`	-	Allow class unloading during CMS sweeps

1.1.3. Setting Maximum File Descriptors and Processes Per User

AM is not file-descriptor intensive. However, each DS instance in your environment should have access to, at least, 65,536 file descriptors to handle multiple client connections.

Ensure that every DS instance is allocated enough file descriptors. For example, use the **ulimit -n** command to check the limits for a particular user:

```
$ su - opendj
$ ulimit -n
65536
```

The embedded DS runs inside the AM process space. When AM is configured with the embedded DS instance, you must ensure that the user running the AM processes has, at least, 65,536 file descriptors.

It may also be neccessary to increase the number of processes available to the user running the AM processes.

For example, use the **ulimit -u** command to check the process limits for a user:

```
$ su - openam
$ ulimit -u
2048
```

> **Important**
>
> Before increasing the file descriptors for the DS instance, ensure that the total amount of file descriptors configured for the operating system is higher than 65,536.
>
> Otherwise, if the DS instance uses all of the file descriptors, the operating system will run out of file descriptors. This may prevent other services from working, including those required for logging in the system.

Refer to your operating system's documentation for instructions on how to display and increase the file descriptors or process limits for the operating system and for a given user.

For more information about setting up your environment for DS, see *Choosing an Operating System* in the *Directory Services ${platform.version} Release Notes*.

1.1.4. Enabling RSA SecurID Support

To use the SecurID authentication module, you must first build an AM war file that includes the supporting library, for example `authapi-2005-08-12.jar`, which you must obtain from RSA. The `authapi-2005-08-12.jar` file also requires a dependency file, `crypto.jar`, which you can also obtain from RSA.

1. Unpack the AM `.war` file. For example:

   ```
   $ mkdir /tmp/openam
   $ cd /tmp/openam/
   $ jar -xf ~/Downloads/openam/AM-5.5.2.war
   ```

2. Obtain the `authapi.jar` (for example, `authapi-2005-08-12.jar`) and its dependency file, `crypto.jar` from RSA. Then, copy `authapi-2005-08-12.jar` into the `WEB-INF/lib` directory. For example:

   ```
   $ cp /path/to/authapi-2005-08-12.jar WEB-INF/lib/
   ```

3. Pack up the AM `.war` file. For example:

   ```
   $ jar -cf ../openam.war *
   ```

4. Deploy the new `.war` file. For more information, see "Deploying".

   In this example, the `.war` file to deploy is `/tmp/openam.war`.

1.2. Preparing a Web Application Container

This section covers setting up a web application container in which to run AM.

The topics covered in this section are:

- Preparing Apache Tomcat
- Preparing for JBoss and WildFly
- Preparing Oracle WebLogic
- Preparing IBM WebSphere
- Enabling CORS Support
- Preparing AES Key Wrap Encryption

> **Note**
>
> If a Java Security Manager is enabled for your web application container, add permissions before installing AM.

For a list of supported web application containers, see "Web Application Container Requirements" in the *Release Notes*.

1.2.1. Preparing Apache Tomcat

AM examples often use Apache Tomcat (Tomcat) as the deployment container. Tomcat is installed on `openam.example.com`, and listens on the default ports without a Java Security Manager enabled.

JVM start up

AM core services require a minimum JVM heap size of 1 GB, and a metadata space size of up to 256 MB. If you are including the embedded DS, AM requires at least a 2 GB heap, as 50% of that space is allocated to DS. See "Preparing a Java Environment" for details.

Set the `CATALINA_OPTS` environment variable in Tomcat's start-up script or service with the appropriated tuning for your environment. For example:

```
CATALINA_OPTS="-server -Xmx2g -XX:MetaspaceSize=256m -XX:MaxMetaspaceSize=256m"
```

Some versions of Internet Explorer and Microsoft Edge support the `Expires` header attribute instead of the `Max-Age` header attribute, which may cause SAML 2.0 and agent logout sequences to fail.

If you have set the `org.apache.catalina.STRICT_SERVLET_COMPLIANCE` Tomcat property to `true`, add the `org.apache.tomcat.util.http.ServerCookie.ALWAYS_ADD_EXPIRE` property to Tomcat's start-up sequence to add the `Expires` attribute to the headers:

```
CATALINA_OPTS="-server -Xmx2g -XX:MetaspaceSize=256m -XX:MaxMetaspaceSize=256m \
                -Dorg.apache.tomcat.util.http.ServerCookie.ALWAYS_ADD_EXPIRES=true"
```

Slashes in Resource Names

Some AM resources have names that can contain slash characters (/), for example, in policy names, application names, and SAML v2.0 entities. These slash characters can cause unexpected behavior when running AM on Tomcat.

One possible workaround is to configure Tomcat to allow encoded slash characters by adding the `org.apache.tomcat.util.buf.UDecoder.ALLOW_ENCODED_SLASH=true` property to the `CATALINA_OPTS` variable; however, this is not recommended for production deployments (see the warning below). For example:

```
CATALINA_OPTS= "-server -Xmx2g -XX:MetaspaceSize=256m -XX:MaxMetaspaceSize=256m \
                -Dorg.apache.tomcat.util.buf.UDecoder.ALLOW_ENCODED_SLASH=true"
```

> **Warning**
>
> It is strongly recommended that you do *not* enable `org.apache.tomcat.util.buf.UDecoder.ALLOW_ENCODED_SLASH` when running AM in production as it introduces a security risk.
>
> For more information, see How do I safely enable the org.apache.tomcat.util.buf.UDecoder.ALLOW_ENCODED_SLASH setting in AM/OpenAM (All Versions)? in the *ForgeRock Knowledge Base*.

Cookie Domains

You can set the cookie domain name value to an empty string for host-only cookies or to any non-top level domain. For example, if you install AM and use `openam.example.com` as the host, you can set the cookie domain name as `example.com`. For information about configuring the cookie domain during installation, see "To Custom Configure an Instance".

Encoding and Security

ForgeRock recommends that you edit the Tomcat <Connector> configuration to set `URIEncoding="UTF-8"`. UTF-8 URI encoding ensures that URL-encoded characters in the paths of URIs are correctly decoded by the container. This is particularly useful if your applications use the AM REST APIs and some identifiers, such as user names, contain special characters.

You should also ensure the `sslProtocol` property is set to `TLS`, which disables the potentially vulnerable SSL v3.0 protocol.

<Connector> configuration elements are found in the configuration file, `/path/to/tomcat/conf/server.xml`. The following excerpt shows an example <Connector> with the `URIEncoding` and `sslProtocol` attributes set appropriately:

```
<Connector port="8443" protocol="HTTP/1.1" SSLEnabled="true"
 maxThreads="150" scheme="https" secure="true"
 clientAuth="false" sslProtocol="TLS" URIEncoding="UTF-8" />
```

Embedded DS

When you set up AM with the embedded DS, make sure that Tomcat's `autoDeploy` attribute is set to `false`. If `autoDeploy` is set to `true`, the host dynamically deploys and updates any web application, for example, when a new `.war` file is dropped into the `appBase`.

1.2.2. Preparing for JBoss and WildFly

You can deploy AM on JBoss AS, JBoss EAP, and WildFly. The procedures listed here provide steps for configuring JBoss AS, JBoss EAP, and WildFly for AM.

After configuring JBoss or WildFly, you then prepare AM for deployment by making a few changes to the contents of the AM `.war` archive.

- "To Prepare JBoss or WildFly"
- "To Prepare for JBoss and WildFly"

To Prepare JBoss or WildFly

1. Stop JBoss or WildFly.
2. The default JVM settings do not allocate sufficient memory to AM. This step shows one method that you can use to modify the JVM settings. For other methods, see either the *JBoss Application Server Official Documentation Page* or the *JVM Settings* page in the WildFly documentation
    a. Open the `standalone.conf` file in the `/path/to/jboss/bin` directory for JBoss or WildFly in standalone mode.

    b. Check the JVM settings associated with `JAVA_OPTS`.

       Change the JVM heap size to `-Xmx1g`. The default JVM heap size for some versions of JBoss might already exceed the recommended value. If you are using the embedded version of DS, the minimum heap size may be higher. For details on the JVM options to use, see "Preparing a Java Environment".

       Change the metaspace size to `-XX:MaxMetaspaceSize=256m` if the default size does not exceed this amount.

    c. Set the following JVM `JAVA_OPTS` setting in the same file:

       ```
       -Dorg.apache.tomcat.util.http.ServerCookie.ALWAYS_ADD_EXPIRES=true
       ```

       Verify that the headers include the `Expires` attribute rather than only `Max-Age`, as some versions of Internet Explorer and Microsoft Edge do not support `Max-Age`.
3. Now deploy the `openam.war` file into the appropriate deployment directory. The directory varies depending on whether you are running in standalone or domain mode.

To Prepare for JBoss and WildFly

To prepare AM to run with JBoss or WildFly, you should make a change to the AM `war` file. JBoss and WildFly deploy applications from different temporary directories every time you restart the container, which would require reconfiguring AM. To avoid problems, change the AM `war` file as follows:

1. If you have not already done so, create a temporary directory and expand the `AM-5.5.2.war` file. For example:

   ```
   $ cd /tmp
   $ mkdir /tmp/openam ; cd /tmp/openam
   $ jar xvf ~/Downloads/AM-5.5.2.war
   ```

2. Locate the `bootstrap.properties` file in the `WEB-INF/classes` directory of the expanded `war` archive. Update the `# configuration.dir=` line in this file to specify a path with read and write permissions, and then save the change.

   ```

   # This property should also be used when the system user that
   # is running the web/application server process does not have
   # a home directory. i.e. System.getProperty("user.home") returns
   # null.

   configuration.dir=/my/readwrite/config/dir
   ```

3. If you are deploying AM on JBoss AS or JBoss EAP, remove the `jboss-all.xml` file from the `WEB-INF` directory of the expanded `war` archive.

   Be sure *not* to remove this file if you are deploying AM on WildFly.

4. Rebuild the `openam.war` file.

   ```
   $ jar cvf ../openam.war *
   ```

5. If you plan to deploy multiple cookie domains with WildFly, you must configure the `com.sun.identity.authentication.setCookieToAllDomains` property after you have installed the AM server. See "Handling Multiple Cookie Domains When Using Wildfly" for more information.

1.2.3. Preparing Oracle WebLogic

To deploy AM in Oracle WebLogic, perform the following steps:

1. Update the JVM options as described in "Preparing a Java Environment".

2. Customize the `AM-5.5.2.war` file as described in "To Prepare for Oracle WebLogic".

To Prepare for Oracle WebLogic

To prepare AM to run in Oracle WebLogic, you must change the AM `war` file. Be sure to make these changes whenever you deploy a new `war` file, or as part of an AM upgrade.

Prepare for deployment in Oracle WebLogic as follows:

1. Create a temporary directory and expand the `AM-5.5.2.war` file. For example:

   ```
   $ cd /tmp
   $ mkdir /tmp/openam ; cd /tmp/openam
   $ jar xvf ~/Downloads/AM-5.5.2.war
   ```

2. Ensure the installer is able to locate configuration files by specifying a folder which the user running Oracle WebLogic can read and write:

   a. Locate the `bootstrap.properties` file in the `WEB-INF/classes` directory of the expanded `war` file.

   b. Update the `# configuration.dir=` line in the `bootstrap.properties` file to specify a path with read and write permissions. For example:

      ```

      # This property should also be used when the system user that
      # is running the web/application server process does not have
      # a home directory. i.e. System.getProperty("user.home") returns
      # null.

      configuration.dir=/my/readwrite/config/dir
      ```

      If installing on Windows, the specified path should have slashes **/** and not backslashes \.

3. Rebuild the `AM-5.5.2.war` file:

   ```
   $ jar cvf ../Edited-AM-5.5.2.war *
   ```

4. Ensure Oracle WebLogic passes responsibility for account management over to AM, as follows:

   a. Ensure Oracle WebLogic is not running.

   b. Navigate to the Oracle WebLogic `config.xml` configuration file for the domain in which AM runs.

      For example, `$HOME/Oracle/Middleware/Oracle_Home/user_projects/domains/base_domain/config/config.xml`.

   c. In the `<security-configuration>` section, add the following line before the closing `</security-configuration>` tag:

      ```
      <enforce-valid-basic-auth-credentials>false</enforce-valid-basic-auth-credentials>
      ```

      For example:

      ```
          <enforce-valid-basic-auth-credentials>false</enforce-valid-basic-auth-credentials>
      </security-configuration>
      ```

5. Configure the Oracle WebLogic domain to use the canonical path of resource files by performing the following steps:

   a. In the Oracle WebLogic console, in the Domain Structure panel, click the name of the domain. For example, `base_domain`.

   b. On the Configuration tab, click the Web Applications tab, and then enable the Archived Real Path Enabled property.

   c. Save your changes, and restart Oracle WebLogic for them to take effect.

6. You can now deploy your `Edited-AM-5.5.2.war` in Oracle WebLogic.

1.2.4. Preparing IBM WebSphere

To deploy AM in IBM WebSphere, perform the following steps:

1. Update the JVM options as described in "Preparing a Java Environment".

2. Customize the `AM-5.5.2.war` file as described in "To Prepare for Oracle WebLogic".

3. After deploying AM, configure WebLogic as described in "To Prepare WebSphere".

To Prepare for IBM WebSphere

To prepare AM to run in WebSphere, change the AM `war` file to ensure that the AM upgrade process is able to find the AM configuration files. Be sure to make this change whenever you deploy a new `war` file as part of an AM upgrade.

Change the AM `war` file as follows:

> **Note**
>
> If installing on Windows, the specified paths should have slashes **/** and not backslashes \.

1. Create a temporary directory and expand the `AM-5.5.2.war` file. For example:

```
$ cd /tmp
$ mkdir /tmp/openam ; cd /tmp/openam
$ jar xvf ~/Downloads/AM-5.5.2.war
```

2. Locate the `bootstrap.properties` file in the `WEB-INF/classes` directory of the expanded `war` file.

   Update the `# configuration.dir=` line in the `bootstrap.properties` file to specify a path with read and write permissions. For example:

```

# This property should also be used when the system user that
# is running the web/application server process does not have
# a home directory. i.e. System.getProperty("user.home") returns
# null.

configuration.dir=/my/readwrite/config/dir
```

3. (Optional) If you are using an IBM JDK, replace the default `WEB-INF/template /keystore/keystore.jceks` keystore file with one generated using the IBM JDK, by performing the following steps:

    a. Generate a new, empty `keystore.jceks` keystore file in IBM JDK format:

    ```
    $ keytool -genkey -storetype jceks -keystore keystore.jceks -storepass changeit -keypass changeit
    ```

    b. Copy the new `keystore.jceks` keystore file into the expanded .war file, overwriting the existing `WEB-INF/template/keystore/keystore.jceks` keystore file:

    ```
    $ cp keystore.jceks /tmp/openam/WEB-INF/template/keystore/keystore.jceks
    ```

4. Rebuild the `AM-5.5.2.war` file:

    ```
    $ jar cvf ../AM-5.5.2.war *
    ```

To Prepare WebSphere

In addition to preparing the AM .war file, perform the following steps to configure WebSphere for AM *after you deploy AM into WebSphere*:

1. Load classes from AM bundled libraries before loading classes from libraries delivered with WebSphere:

    a. In the WebSphere administration console, navigate to Application > Application Type > WebSphere enterprise applications > *AM Name* > Class loading and update detection.

    b. Set Class loader order > Classes loaded with local class loader first (parent last).

    c. Ensure that the value of the *WAR class loader policy* property is set to the default value: `Class loader for each WAR file in application`.

    d. Save your work.

2. (Optional) If your environment uses SOAP of Java agents earlier than version 5, perform the following steps to add SOAP-related properties to the JVM:

    a. In the WebSphere administration console, select Servers.

    b. Expand Server Type, and select WebSphere application servers.

    c. Select your WebSphere server name.

    d. Expand Java and Process Management, and select Process Definition.

    e. Under the Additional Properties section, select Java Virtual Machine.

    f. Locate the Generic JVM argument box and add the following properties:

```
-
Djavax.xml.soap.MessageFactory=com.sun.xml.internal.messaging.saaj.soap.ver1_1.SOAPMessageFactory1_1Impl
-Djavax.xml.soap.SOAPFactory=com.sun.xml.internal.messaging.saaj.soap.ver1_1.SOAPFactory1_1Impl
-
Djavax.xml.soap.SOAPConnectionFactory=com.sun.xml.internal.messaging.saaj.client.p2p.HttpSOAPConnectionFact
-Djavax.xml.soap.MetaFactory=com.sun.xml.internal.messaging.saaj.soap.SAAJMetaFactoryImpl
-Dcom.ibm.websphere.webservices.DisableIBMJAXWSEngine=true
```

g. Save your work.

1.2.5. Enabling CORS Support

Cross-origin resource sharing (CORS) allows requests to be made across domains from user agents. AM supports CORS, but CORS is not enabled by default.

To enable CORS support, edit the deployment descriptor file before deploying AM. CORS support is implemented as a servlet filter, and so you add the filter's configuration to the deployment descriptor file.

To Enable CORS Support

1. If you have not yet deployed AM:

   a. Unpack the AM `.war` file. For example:

   ```
   $ mkdir /tmp/openam
   $ cd /tmp/openam/
   $ jar -xf ~/Downloads/openam/AM-5.5.2.war
   ```

   b. Open the deployment descriptor file `WEB-INF/web.xml` in a text editor.

2. If you have already deployed AM:

   - Open the deployment descriptor file `web.xml` in a text editor. The location of the file depends on your web application container, for example in Tomcat it might be located at: `/path/to/tomcat/webapps/openam/WEB-INF/web.xml`.

3. In the deployment descriptor file, add a `<filter-mapping>` element containing the name and a URL pattern for the filter. The URL pattern specifies the endpoints to which AM applies the CORS filter.

   To enable CORS support for all endpoints, use the following example:

   ```
   <filter-mapping>
       <filter-name>CORSFilter</filter-name>
       <url-pattern>/*</url-pattern><!-- CORS support for all endpoints -->
   </filter-mapping>
   ```

   To enable CORS support for individual endpoints instead of all endpoints, add multiple `<filter-mapping>` elements, one for each endpoint:

```
<filter-mapping>
  <filter-name>CORSFilter</filter-name>
  <url-pattern>/uma/*</url-pattern>
</filter-mapping>

<filter-mapping>
  <filter-name>CORSFilter</filter-name>
  <url-pattern>/json/*</url-pattern>
</filter-mapping>

<filter-mapping>
  <filter-name>CORSFilter</filter-name>
  <url-pattern>/oauth2/*</url-pattern>
</filter-mapping>
```

4. In the deployment descriptor file, add a `<filter>` element to configure the filter.

   The available parameters for the `<filter>` element are as follows:

   `<filter-name>`

   Specifies the name for the filter. Must match the name specified in the `<filter-mapping>` elements.

   `<filter-class>`

   Specifies the Java class the implements the CORS filter. Should be set to the default `org.forgerock.openam.cors.CORSFilter`.

   `methods` (required)

   A comma-separated list of HTTP methods allowed when making CORS requests to AM.

   Example: `GET,POST,PUT,PATCH,OPTIONS,DELETE`

   `origins` (required)

   A comma-separated list of the origins allowed when making CORS requests to AM. Wildcards are not supported - each value should be an exact match for the origin of the CORS request.

   Example: `http://example.com,https://example.org:8433`

> **Tip**
>
> During development you may not be using fully-qualified domain names as the origin of a CORS request, for example using the `file://` protocol locally. If so, you can add these non-FQDN origins to the list. For example, `http://example.com,https://example.org:8433,file://,null`.

`allowCredentials` (optional)

Whether to take allow requests with credentials in either HTTP cookies or HTTP authentication information. Accepts `false` (the default) or `true`.

Set to `true` if you send `Authorization` headers as part of the CORS requests, or need to include information in cookies when making requests.

`headers` (optional)

A comma-separated list of request header names allowed when making CORS requests to AM.

Example: `iPlanetDirectoryPro,X-OpenAM-Username,X-OpenAM-Password,Accept-API-Version,Content-Type,If-Match,If-None-Match`

By default, the following simple headers are explicitly allowed:

- `Cache-Control`
- `Content-Language`
- `Expires`
- `Last-Modified`
- `Pragma`

If you do not specify a value for this property, the presence of any header in the CORS request, other than the simple headers listed above, will cause the request to be rejected.

Headers commonly used when accessing an AM server include the following:

Commonly Used Headers

Header	Information
`iPlanetDirectoryPro`	Used for session information. See "Implementing Session State" in the *Authentication and Single Sign-On Guide*.
`X-OpenAM-Username`,`X-OpenAM-Password`	Used to pass credentials in REST calls that use the HTTP POST method.

Header	Information
	See "Authentication and Logout" in the *Authentication and Single Sign-On Guide*.
`Accept-API-Version`	Used to request a specific AM endpoint version. See "REST API Versioning" in the *Authentication and Single Sign-On Guide*.
`Content-Type`	Required for cross-origin calls to AM REST API endpoints.
`If-Match`,`If-None-Match`	Used to ensure the correct version of a resource will be affected when making a REST call, for example when updating an UMA resource set. See "To Update an UMA Resource Set" in the *User-Managed Access (UMA) 2.0 Guide* .

Caution

If you need to accept all origins by allowing the use of `Access-Control-Allowed-Origin=*` headers, do not allow `Content-Type` headers. Allowing the use of both types of headers exposes AM to cross-site request forgery (CSRF) attacks.

`expectedHostname` (optional)

The name of the host expected in the `Host` header of CORS requests to AM. The request will be refused if the specified value does not match.

If not specified, any host value is accepted.

If the AM server is behind a load-balancer, specify the public name of the load balancer.

Example: `openam.example.com:8080`

`exposeHeaders` (optional)

A comma-separated list of response header names that AM returns in the `Access-Control-Expose-Headers` header.

User agents can make use of any headers that are listed in this property, as well as the simple response headers, which are as follows:

- `Cache-Control`
- `Content-Language`
- `Expires`
- `Last-Modified`

- `Pragma`
- `Content-Type`

User agents must filter out all other response headers.

Example: `Access-Control-Allow-Origin,Access-Control-Allow-Credentials,Set-Cookie`

`maxAge` (optional)

The maximum length of time that the browser is allowed to cache the pre-flight response, in seconds.

The default is `600`.

The following is an example excerpt from a configured `web.xml` file that could be used during testing and development:

```
<filter-mapping>
  <filter-name>CORSFilter</filter-name>
  <url-pattern>/uma/*</url-pattern>
</filter-mapping>

<filter-mapping>
  <filter-name>CORSFilter</filter-name>
  <url-pattern>/json/*</url-pattern>
</filter-mapping>

<filter-mapping>
  <filter-name>CORSFilter</filter-name>
  <url-pattern>/oauth2/*</url-pattern>
</filter-mapping>

<filter>
  <filter-name>CORSFilter</filter-name>
  <filter-class>org.forgerock.openam.cors.CORSFilter</filter-class>
  <init-param>
    <param-name>methods</param-name>
    <param-value>POST,PUT,OPTIONS</param-value>
  </init-param>
  <init-param>
    <param-name>origins</param-name>
    <param-value>http://localhost:8000,null,file://,https://example.org:8433</param-value>
  </init-param>
  <init-param>
    <param-name>allowCredentials</param-name>
    <param-value>true</param-value>
  </init-param>
  <init-param>
    <param-name>headers</param-name>
    <param-value>X-OpenAM-Username,X-OpenAM-Password,X-Requested-With,Accept,iPlanetDirectoryPro</
param-value>
  </init-param>
  <init-param>
```

```
    <param-name>expectedHostname</param-name>
    <param-value>openam.example.com:8080</param-value>
  </init-param>
  <init-param>
    <param-name>exposeHeaders</param-name>
    <param-value>Access-Control-Allow-Origin,Access-Control-Allow-Credentials,Set-Cookie</param-value>
  </init-param>
  <init-param>
    <param-name>maxAge</param-name>
    <param-value>1800</param-value>
  </init-param>
</filter>
```

5. Save your changes.

6. If you have not yet deployed AM:

   a. Pack up the AM `.war` file to deploy.

      ```
      $ jar -cf ../openam.war *
      ```

   b. Deploy the new `.war` file.

      In this example, the `.war` file to deploy is `/tmp/openam.war`.

      For more information, see "Deploying".

7. If you have already deployed AM:

   - Restart AM or the web container where it runs.

For more details on CORS, see the *Cross-Origin Resource Sharing* specification.

1.2.6. Preparing AES Key Wrap Encryption

By default, AM uses the Java Cryptography Extension (JCE) encryption class to encrypt and decrypt system password and keys in the configuration store and by other components, such as agents.

If your deployment requires a more secure encryption algorithm, AM supports the Advanced Encryption Standard (AES) Key Wrap algorithm (RFC3394). AM's implementation of AES Key Wrap uses the Password-Based Key Derivation Function 2 (PBKDF2) (RFC2898) with HMAC-SHA1. This allows administrators to choose key size hash algorithms, such as SHA256, SHA384, or SHA512.

Important

The AES Key Wrap Encryption algorithm is only enabled when installing AM. There is no current upgrade path for existing installations.

The Security Token Service (STS) feature does not support the AES Key Wrap Encryption algorithm. Make sure that you do not deploy this feature in an AM instance configured to use the AES Key Wrap Encryption algorithm.

You will also need to update **ssoadm** command to work with AES key wrap encryption. See "To Configure ssoadm for AES Key Wrap Encryption".

Warning

When implementing AES Key Wrap Encryption, take special care when selecting your encryption key iteration count.

If you select a large iteration count of 20,000, for example, you can effectively slow down a brute-force attack when passwords are of low quality (less than 20 characters and non-randomized). The trade off is that an iteration count of 20,000 can also negatively impact AM startup times if there are many agents in your deployment.

AM requires at least 10,000 iterations. Determine the optimal iteration count for your deployment based on your security and performance requirements. Set the iteration count to 20,000 only if absolutely necessary.

To Configure AES Key Wrap Encryption for Tomcat

- Edit your container startup scripts, for example `setenv.sh`, to set the following JVM system properties in Tomcat:

  ```
  JAVA_OPTS="$JAVA_OPTS -Dcom.iplanet.security.encryptor=org.forgerock.openam.shared.security.crypto
  .AESWrapEncryption"
  JAVA_OPTS="$JAVA_OPTS -Dorg.forgerock.openam.encryption.key.iterations=10000"
  JAVA_OPTS="$JAVA_OPTS -Dorg.forgerock.openam.encryption.key.size=256"
  JAVA_OPTS="$JAVA_OPTS -Dorg.forgerock.openam.encryption.key.digest=SHA512"
  ```

  Only the first line in the example is required. The other lines are configurable to meet the needs of your deployment. Key sizes greater than 128 bits require that the JCE Unlimited Strength policy files be installed in your system. PBKDF2 using SHA256, SHA384, and SHA512 is only available on Java 8.

  Note

  You cannot change these configuration parameters once AM has been installed.

To Configure ssoadm for AES Key Wrap Encryption

After you enable AES key wrap encryption, you will also need to update the **ssoadm** command for it to work with the new encryption settings.

- Add the following properties to the `/path/to/ssoadm/setup` and `/path/to/ssoadm/bin/ssoadm` commands:

  ```
  -Dcom.iplanet.security.encryptor=org.forgerock.openam.shared.security.crypto.AESWrapEncryption -Dorg
  .forgerock.openam.encryption.key.iterations=20000 -Dorg.forgerock.openam.encryption.key.size=256 -Dorg
  .forgerock.openam.encryption.key.digest=SHA512
  ```

1.3. Downloading and Deploying

This section covers acquiring the AM software and deploying it into a web application container.

The topics covered in this section are:

- Obtaining Software
- Deploying

1.3.1. Obtaining Software

The *ForgeRock BackStage* website hosts downloads, including a `.zip` file with all of the AM components, the `.war` file, AM tools, the configurator, web and Java agents, Identity Gateway, and documentation. Verify that you review the Software License and Subscription Agreement presented before you download AM files.

For each release of the AM, you can download the entire package as a `.zip` file, only the AM `.war` file, or only the administrative tools as a `.zip` archive. The Archives only have the AM source code used to build the release.

After you download the `.zip` file, create a new directory for AM, and unzip the `.zip` file to access the content.

```
$ cd ~/Downloads
$ mkdir openam ; cd openam
$ unzip ~/Downloads/AM-5.5.2.zip
```

When you unzip the archive of the entire package, you get ldif, license, and legal directories in addition to the following files:

Distribution Files

File	Description
`AM-5.5.2.war`	The distribution `.war` file includes the core server code with an embedded DS server, which stores configuration data and simplifies deployments. The distribution includes an administrative graphical user interface (GUI) Web console. During installation, the `.war` file accesses properties to obtain the fully qualified domain name, port, context path, and the location of the configuration folder. These properties can be obtained from the `boot.json` file in the AM installation directory, from environment variables, or from a combination of the two. This file is also available to download individually.
`Fedlet-5.5.2.zip`	AM provides an AM Fedlet, a light-weight SAML v2.0 service provider. The Fedlet lets you set up a federated deployment without the need of a fully-featured service provider.
`IDPDiscovery-5.5.2.war`	AM provides an IdP Discovery Profile (SAMLv2 binding profile) for its IdP Discovery service. The profile keeps track of the identity providers for each user.

File	Description
`AM-Soap-STS-Server-5.5.2.war`	AM provides a SOAP-based security token service (STS) server that issues tokens based on the WS-Security protocol[a].
`SSOAdminTools-5.1.1.8.zip`	AM provides an `ssoadm` command-line tool that allows administrators to configure and maintain AM as well as create their own configuration scripts. The `zip` distribution file contains binaries, properties file, script templates, and setup scripts for UNIX and windows servers.
`SSOConfiguratorTools-5.1.1.8.zip`	AM provides configuration and upgrade tools for installing and maintaining your server. The `zip` distribution file contains libraries, legal notices, and supported binaries for these configuration tools. Also, you can view example configuration and upgrade properties files that can be used as a template for your deployments.

[a] AM also provides REST-based STS service endpoints, which you can directly utilize on the AM server.

1.3.2. Deploying

After you have downloaded AM software, deploy it to your installed application container.

Note that deploying AM only extracts the files into the application container, prior to installation and configuration. Deploying AM also makes LDIF files available, which can be used to prepare external data stores for use with AM.

To Deploy an Instance

The `AM-5.5.2.war` file contains the AM server. How you deploy the `.war` file depends on your web application container.

1. Deploy the `.war` file on your container.

   For example, copy the file to deploy on Apache Tomcat.

   ```
   $ cp AM-5.5.2.war /path/to/tomcat/webapps/openam.war
   ```

   During trials or development, you can change the file name to `openam.war` when deploying in Tomcat, so that the deployment URI is `/openam`.

   When installing AM in a production environment, do not use a predictable deployment URI such as `/openam` or `/opensso`.

Note

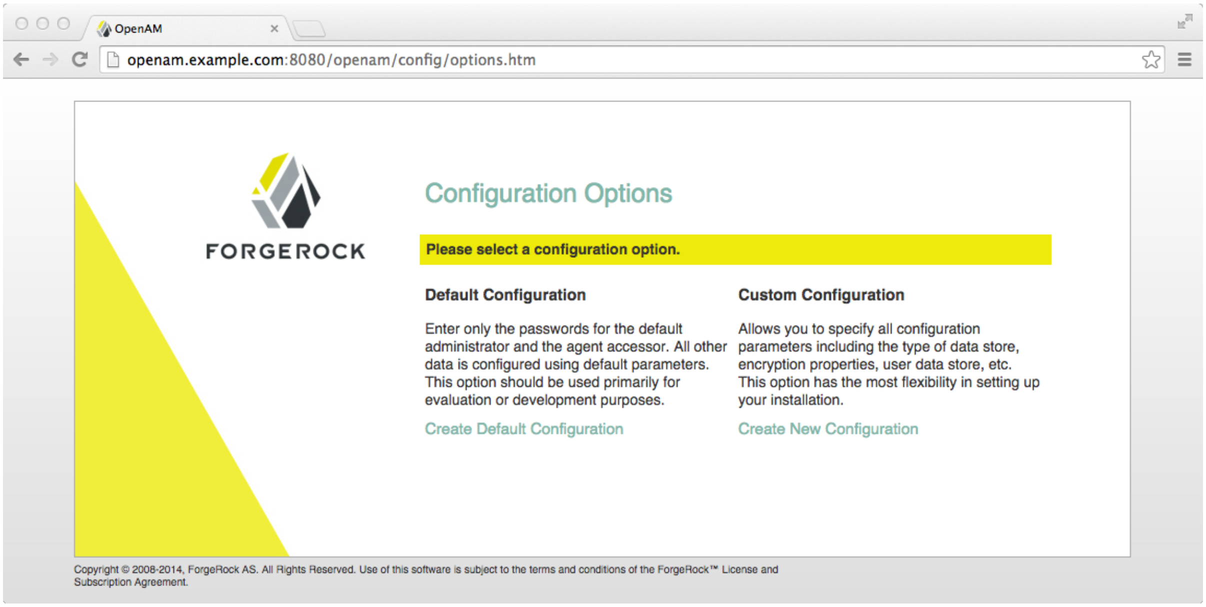
You change the file name to something other than openam.war when deploying in Tomcat so that the deployment URI is not /openam. For helpful hints on avoiding obvious deployment defaults, see "Avoiding Obvious Defaults".

Important

To properly configure AM, AM requires a deployment URI with a non-empty string after /. Do not deploy AM at the root context. Do not rename the .war file to ROOT.war before deploying on Tomcat, for example.

It can take several seconds for AM to be deployed in your container.

2. Navigate to the initial configuration screen, for example http://openam.example.com:8080/openam.



Configuration Options

Please select a configuration option.

Default Configuration

Enter only the passwords for the default administrator and the agent accessor. All other data is configured using default parameters. This option should be used primarily for evaluation or development purposes.

Create Default Configuration

Custom Configuration

Allows you to specify all configuration parameters including the type of data store, encryption properties, user data store, etc. This option has the most flexibility in setting up your installation.

Create New Configuration

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AM is now ready for installation. To proceed, take on of the following actions:

- Configure external data stores using the files created during deployment. See "Preparing External Data Stores".
- Use the embedded data stores for evaluation purposes, and skip ahead to installing AM. See "Installing a Single Server".

1.4. Preparing External Data Stores

This section covers setting up external data stores for configuration or identity data.

AM includes embedded data stores for configuration and identity data that can be used for evaluation and testing purposes. In production environments, external data stores are preferred.

The topics covered in this section are:

- Preparing an External Identity Repository
- Preparing an External Configuration Data Store

For a list of supported data stores, see "Data Store Requirements" in the *Release Notes*.

1.4.1. Preparing an External Identity Repository

AM accesses user identity data from one or more identity repositories. AM ships with an embedded DS server that you can install as part of the AM configuration process.

In most deployments, AM connects to existing LDAP directory servers for user identity data, as it shares data in an identity repository with other applications.

If you are configuring AM to share data with other applications, or if you expect your deployment will have a large amount of users, connect AM to an external identity repository. For a list of supported external identity repositories, see "Data Store Requirements" in the *Release Notes*.

1.4.1.1. Important Considerations for Using External Identity Repositories

AM connects to an external directory by binding to it as a user that you specify in the AM data store configuration. This user is known as the *AM data store administrator*.

Specifying the directory administrator, for example, `cn=Directory Manager` as the AM data store administrator is not recommended for production deployments as it will give AM directory administrator privileges to the identity repository.

Instead, create a separate AM administrator account with fewer access privileges than the directory administrator so that you can assign the appropriate level of privileges for the AM data store administrator.

You need to consider two areas of privileges for the AM data store administrator:

Schema Update Privileges

> AM needs to update the directory schema when you configure a new identity repository and when you upgrade AM software. If the AM data store administrator has schema update privileges, AM can update the schema dynamically during data store configuration and during AM upgrades. If the AM data store administrator does not have schema update privileges, you must update the schema manually before configuring a new identity repository and before upgrading AM.

Directory Read and Write Access Privileges

> If you want AM to create, update, and delete user entries, then the AM data store administrator must have full read and write access to the identity data in the directory. If you are using an external identity repository as a read-only user directory, then the AM data store administrator needs read privileges only.

The level of access privileges you give the AM data store administrator is specific to each AM deployment. Work with your directory server administrator to determine the appropriate level of privileges as part of the process of preparing an external identity repository.

> **Note**
>
> You should not configure more than one writeable identity repository in a single realm. AM will try to perform write operations on each identity repository configured in a realm, and there is no way to configure which repository is written to.
>
> To manage identities and reconcile differences between multiple identity repositories, use ForgeRock Identity Management.

1.4.1.2. Preparing Your External Identity Repository

The steps for preparing an external identity repository vary depending on the schema update privileges given to the AM data store administrator.

- If the AM data store administrator has schema update privileges, follow the procedure in "Preparing an Identity Repository With Dynamic Schema Updates".
- If the AM data store administrator does not have schema update privileges, follow the procedure in "Preparing an Identity Repository With Manual Schema Updates".

After you have completed one of these two procedures, continue by configuring your external identity repository as an AM data store as described in "Configuring Data Stores That Access External Identity Repositories".

> **Note**
>
> Example commands throughout this section use default values for user IDs and port numbers. When running similar commands, be sure to use appropriate values for your directory server.
>
> When running the **ldapmodify** command, you might need to specify the `--trustAll` argument to trust server certificates if your directory server uses self-signed certificates and StartTLS or SSL.

1.4.1.2.1. Preparing an Identity Repository With Dynamic Schema Updates

If the AM data store administrator has schema update privileges, you can configure the AM data store using dynamic schema updates. With dynamic schema updates, AM automatically updates the directory server schema of the external identity repository as needed. Schema updates might occur when you configure a data store as part of initial AM configuration, when you configure a data store after initial AM configuration, or when you upgrade AM.

The following procedure shows you how to prepare an identity repository with dynamic schema updates. The procedure assumes that you have already created an identity repository in DS and populated it with user data. The instructions that follow do not include steps to install DS, configure directory server backends, and implement replication. For external identity repositories other than DS, you must perform tasks that are analogous to the ones in the example procedure. Consult the documentation for your directory server software to determine the appropriate actions to take.

To Prepare an External Directory Services Identity Repository with Dynamic Schema Updates

1. Create the AM data store administrator account.

   This example uses `uid=openam,ou=admins,dc=example,dc=com` as the AM data store administrator. It is assumed that the `dc=example,dc=com` suffix already exists in the directory.

   First, create an LDIF file that defines the AM data store administrator account and gives the account the following privileges:

   - `update-schema`. Allows the account to update the directory schema.

   - `subentry-write`. Allows the account to make directory subentry updates.

   - `password-reset`. Allows the account to reset other users' passwords. Required for the AM forgotten password feature. This privilege is not required for deployments where the AM data store will not modify user entries.

   ```
   dn: ou=admins,dc=example,dc=com
   objectClass: top
   objectClass: organizationalunit
   ou: AM Administrator

   dn: uid=openam,ou=admins,dc=example,dc=com
   objectClass: top
   objectClass: person
   objectClass: organizationalPerson
   objectClass: inetOrgPerson
   cn: AM Administrator
   sn: AM
   userPassword: changeMe
   ds-privilege-name: update-schema
   ds-privilege-name: subentry-write
   ds-privilege-name: password-reset
   ```

   Then, run the **ldapmodify** command to create the user. The following example assumes that you are using OpenDJ 4.0 and later:

```
$ ldapmodify \
 --hostname opendj.example.com \
 --port 1389 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 openam-ds-admin-account.ldif

 Processing ADD request for ou=admins,dc=example,dc=com
 ADD operation successful for DN ou=admins,dc=example,dc=com
 Processing ADD request for uid=openam,ou=admins,dc=example,dc=com
 ADD operation successful for DN uid=openam,ou=admins,dc=example,dc=com
```

2. Add a global ACI that lets the AM administrator account modify the directory schema.

```
$ dsconfig set-access-control-handler-prop \
 --hostname opendj.example.com \
 --port 4444 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --no-prompt \
 --add \
 'global-aci:(target="ldap:///cn=schema")(targetattr="attributeTypes||objectClasses")
 (version 3.0; acl "Modify schema"; allow (write)
 userdn="ldap:///uid=openam,ou=admins,dc=example,dc=com";)'
```

If you copy the text from the preceding example, make sure that the value starting with `'global-aci` is all on a single line.

To verify that you have added the global ACI correctly, list the global ACIs.

```
$ dsconfig get-access-control-handler-prop \
 --port 4444 \
 --hostname opendj.example.com \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --property global-aci
```

The global ACI that allows the AM administrator account to modify schema definitions should appear in the list of global ACIs:

```
"(target="ldap:///cn=schema")(targetattr="attributeTypes||
 objectClasses") (version 3.0; acl "Modify schema"; allow
 (write) userdn="ldap:///uid=openam,ou=admins,dc=example,dc=com");"
```

3. Allow AM to read the directory schema. AM needs to read the directory schema to ensure that changes made to identities stored in identity repositories remain compliant with the directory schema.

   For DS, no actions are required. Simply retain the default "User-Visible Schema Operational Attributes" global ACI.

4. Give the AM data store administrator appropriate access rights on the directory. When AM connects to an external identity repository, it binds as the AM data store administrator.

For deployments in which AM will read and write user entries, the AM data store administrator needs privileges to create, modify, delete, search, read, and perform persistent searches on user entries in the directory. For deployments in which AM only reads user entries, the AM data store administrator needs privileges to only read, search, and perform persistent searches on user entries in the directory.

To grant the AM data store administrator account privileges to read and write user entries in DS, create a file with the following LDIF:

```
dn: dc=example,dc=com
changetype: modify
add: aci
aci: (targetattr="* || aci")(version 3.0;acl "Allow identity modification";
 allow (write)(userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
aci: (targetattr!="userPassword||authPassword")(version 3.0;
 acl "Allow identity search"; allow (search, read)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
aci: (targetcontrol="2.16.840.1.113730.3.4.3")
 (version 3.0;acl "Allow persistent search"; allow (search, read)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
aci: (version 3.0;acl "Add or delete identities"; allow (add, delete)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
aci: (targetcontrol="1.3.6.1.4.1.42.2.27.8.5.1")(version 3.0;acl "Allow behera draft control"; allow
 (read)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
```

To grant the AM data store administrator account privileges to read (but not write) user entries in DS, create a file with the following LDIF:

```
dn: dc=example,dc=com
changetype: modify
add: aci
aci: (targetattr!="userPassword||authPassword")(version 3.0;
 acl "Allow identity search"; allow (search, read)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
aci: (targetcontrol="2.16.840.1.113730.3.4.3")
 (version 3.0;acl "Allow persistent search"; allow (search, read)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
```

Then, run the **ldapmodify** command to implement the ACIs. The following example assumes that you are using OpenDJ 4.0 and later:

```
$ ldapmodify \
 --hostname opendj.example.com \
 --port 1389 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 add-acis-for-openam-ds-admin-access.ldif

 Processing MODIFY request for dc=example,dc=com
 MODIFY operation successful for DN dc=example,dc=com
```

Continue by configuring your external identity repository as an AM data store as described in "Configuring Data Stores That Access External Identity Repositories".

1.4.1.2.2. Preparing an Identity Repository With Manual Schema Updates

If the AM data store administrator does not have schema update privileges, you must configure the AM data store by using manual schema updates. To do this, update the directory server schema of the external identity repository manually before you configure a data store as part of initial AM configuration, before you configure a data store after initial AM configuration, and whenever you upgrade AM.

The following procedure shows you how to prepare an identity repository with manual schema updates. The procedure assumes that you have already deployed DS as a identity repository and populated it with user data. It therefore does not include steps to install DS, configure directory server backends, and implement replication. For external identity repositories other than DS, you must perform tasks that are analogous to the ones in the example procedure. Consult the documentation for your directory server software to determine the appropriate actions to take.

To Prepare an External Directory Services Identity Repository With Manual Schema Updates

1. Create the AM data store administrator account.

   This example uses uses `uid=openam,ou=admins,dc=example,dc=com` as the AM data store administrator. It is assumed that the `dc=example,dc=com` suffix already exists in the directory.

   First, create an LDIF file that defines the AM data store administrator account and gives the account the following privilege:

   - `password-reset`. Allows the account to reset other users' passwords. Required for the AM forgotten password feature. For deployments in which AM will not modify user entries, the AM data store administrator does not require this privilege.

   ```
   dn: ou=admins,dc=example,dc=com
   objectClass: top
   objectClass: organizationalunit
   ou: AM Administrator

   dn: uid=openam,ou=admins,dc=example,dc=com
   objectClass: top
   objectClass: person
   objectClass: organizationalPerson
   objectClass: inetOrgPerson
   cn: AM Administrator
   sn: AM
   userPassword: changeMe
   ds-privilege-name: password-reset
   ```

   Then, run the **ldapmodify** command to create the user. The following example assumes that you are using OpenDJ 4.0 and later:

```
$ ldapmodify \
 --hostname opendj.example.com \
 --port 1389 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 openam-ds-admin-account.ldif

 Processing ADD request for ou=admins,dc=example,dc=com
 ADD operation successful for DN ou=admins,dc=example,dc=com
 Processing ADD request for uid=openam,ou=admins,dc=example,dc=com
 ADD operation successful for DN uid=openam,ou=admins,dc=example,dc=com
```

2. Using the directory administrator account, add the AM schema extensions to your external identity repository.

   First, identify the path that contains LDIF file for AM schema extensions. The path is `/path/to/openam/WEB-INF/template/ldif/directory_type`, where *`directory_type`* is one of the following:

   - `ad` for Microsoft Active Directory
   - `adam` for Microsoft Active Directory Lightweight Directory Services
   - `odsee` for Oracle Directory Server Enterprise Edition
   - `opendj` for ForgeRock Directory Services and Oracle Unified Directory
   - `tivoli` for IBM Tivoli Directory Server

   Run the **ldapmodify** command to import the user, device print, and dashboard schema extensions. (For more information on the supported LDIF files, see "*Supported LDIF Files*".) For example, add schema extensions to DS by running the following **ldapmodify** commands. The following examples assume that you are using OpenDJ 4.0 and later:

```
$ cd /path/to/openam/WEB-INF/template/ldif/opendj

$ ldapmodify \
 --hostname opendj.example.com \
 --port 1389 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 opendj_user_schema.ldif

$ ldapmodify \
 --hostname opendj.example.com \
 --port 1389 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 opendj_deviceprint.ldif

$ ldapmodify \
 --hostname opendj.example.com \
 --port 1389 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 opendj_dashboard.ldif
```

3. Allow AM to read the directory schema. AM needs to read the directory schema to ensure that changes made to identities stored in identity repositories remain compliant with the directory schema.

   For DS, no actions are required. Simply retain the default User-Visible Schema Operational Attributes global ACI.

4. Give the AM data store administrator appropriate access rights on the directory. When AM connects to an external identity repository, it binds as the AM data store administrator.

   For deployments in which AM will read and write user entries, the AM data store administrator needs privileges to create, modify, delete, search, read, and perform persistent searches on user entries in the directory. For deployments in which AM only reads user entries, the AM data store administrator needs privileges to only read, search, and perform persistent searches on user entries in the directory.

   To grant the AM data store administrator account privileges to read and write user entries in DS, create a file with the following LDIF:

```
dn: dc=example,dc=com
changetype: modify
add: aci
aci: (targetattr="* || aci")(version 3.0;acl "Allow identity modification";
 allow (write)(userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
aci: (targetattr!="userPassword||authPassword")(version 3.0;
 acl "Allow identity search"; allow (search, read)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
aci: (targetcontrol="2.16.840.1.113730.3.4.3")
 (version 3.0;acl "Allow persistent search"; allow (search, read)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
aci: (version 3.0;acl "Add or delete identities"; allow (add, delete)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
aci: (targetcontrol="1.3.6.1.4.1.42.2.27.8.5.1")(version 3.0;acl "Allow behera draft control"; allow
 (read)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
```

To grant the AM data store administrator account privileges to read (but not write) user entries in DS, create a file with the following LDIF:

```
dn: dc=example,dc=com
changetype: modify
add: aci
aci: (targetattr!="userPassword||authPassword")(version 3.0;
 acl "Allow identity search"; allow (search, read)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
aci: (targetcontrol="2.16.840.1.113730.3.4.3")(version 3.0;
 acl "Allow persistent search"; allow (search, read)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
```

Run the **ldapmodify** command to implement the ACIs:

```
$ ldapmodify \
 --hostname opendj.example.com \
 --port 1389 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 add-acis-for-openam-ds-admin-access.ldif

 Processing MODIFY request for dc=example,dc=com
 MODIFY operation successful for DN dc=example,dc=com
```

1.4.1.3. Configuring Data Stores That Access External Identity Repositories

Now that you have prepared your external identity repository, you can configure the directory as an AM data store by using one of the following methods:

- By specifying your user directory in the User Data Store Settings dialog box when installing AM core services.

  If you are using dynamic schema updates, the AM configurator loads required schema definitions into your user directory. If you are using manual schema updates, you already loaded the required schema definitions into your user directory.

For more information about running the AM configurator, see "Installing a Single Server".

- By defining a data store after you have installed AM core services.

  If you are using dynamic schema updates and you specify the Load schema when finished option, AM loads required schema definitions into your user directory. If you are using manual schema updates, you will have already loaded the required schema definitions into your user directory.

  For more information about defining AM data stores, see "*Setting Up Identity Data Stores*" in the *Setup and Maintenance Guide*.

1.4.1.4. Indexing External Identity Repositories Attributes

After you have configured a data store to access an external identity repository, you must complete identity repository preparation by indexing several attributes.

To Index External Identity Repository Attributes

- Create equality indexes for the `iplanet-am-user-federation-info-key` and `sun-fm-saml2-nameid-infokey` attributes. To create the indexes, run the **dsconfig** command twice. Bind to your user directory as the directory administrator.

  The **dsconfig** subcommand used to create the index depends on the version of DS.

  - Use the following commands with OpenDJ 2.6:

    ```
    $ dsconfig \
     create-local-db-index \
     --port 4444 \
     --hostname opendj.example.com \
     --bindDN "cn=Directory Manager" \
     --bindPassword password \
     --backend-name userRoot \
     --index-name iplanet-am-user-federation-info-key \
     --set index-type:equality \
     --no-prompt

    $ dsconfig \
     create-local-db-index \
     --port 4444 \
     --hostname opendj.example.com \
     --bindDN "cn=Directory Manager" \
     --bindPassword password \
     --backend-name userRoot \
     --index-name sun-fm-saml2-nameid-infokey \
     --set index-type:equality \
     --no-prompt
    ```

  - Use the following commands with OpenDJ 3 and later:

```
$ dsconfig \
 create-backend-index \
 --port 4444 \
 --hostname opendj.example.com \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --backend-name userRoot \
 --index-name iplanet-am-user-federation-info-key \
 --set index-type:equality \
 --no-prompt

$ dsconfig \
 create-backend-index \
 --port 4444 \
 --hostname opendj.example.com \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --backend-name userRoot \
 --index-name sun-fm-saml2-nameid-infokey \
 --set index-type:equality \
 --no-prompt
```

1.4.1.5. Testing External Identity Repository Access

Prior to working actively with external identity repositories, you should verify that you have configured the repository and administrator privileges correctly. You can test configuration as follows:

- Attempt to create an AM user by navigating to Realms > *Realm Name* > Identities in the AM console. Run this test only if you have given the AM data store administrator write privileges to your identity repository.

  For example, create a `demo` user. When you use the embedded identity repository to evaluate AM software, the setup process creates a `demo` user that is used in many examples in the AM documentation. This user does not exist by default in an external identity repository. When creating a `demo` user's account, set the fields as follows:

Demo User Account Settings

Field	Value
ID	`demo`
First Name	Leave this field blank.
Last Name	`demo`
Full Name	`demo`
Password	`changeit`
User Status	Active

- Attempt to access an AM user from the Realms > *Realm Name* > Subjects tab in the AM console.

If you receive an LDAP error code 65 while attempting to create a user, it indicates that you did not correctly prepare the external identity repository. Error code 65 is an LDAP object class violation and often indicates a problem with the directory schema. Common reasons for this error while attempting to create a user include the following:

- If you configured the external data store after initial configuration, you might have simply forgotten to check the "Load schema when finished" option. In this case, select this option and resave the data store configuration.
- The AM administrator account might not have adequate rights to update the directory schema. Review the DS `access` log and locate the log records for the schema update operation to determine DS's access rights.

1.4.2. Preparing an External Configuration Data Store

AM stores its configuration in an LDAP directory server. AM ships with an embedded DS server that you can install as part of the AM configuration process. By default, AM installs the embedded directory server and its configuration settings in the `$HOME` directory of the user running AM and runs the embedded directory server in the same JVM memory space as AM.

AM connects to the embedded DS server as directory superuser, bypassing access control evaluation because AM manages the directory as its private store. Be aware that you cannot configure directory failover and replication when using the embedded store.

When AM starts up, it requires the password of the `cn="Directory Manager"` user to unlock the configuration data store. This password is stored in AM's JCEKS keystore as the `configstorepwd` password-protected string alias, and it must be updated every time the `cn="Directory Manager"` user's password changes. For more information about the `configstorepwd` alias, see "Configuring Password String Aliases" in the *Setup and Maintenance Guide*.

By default, AM also stores data managed by the Core Token Service (CTS) pertaining to user logins —AM stateful sessions, logout blacklists, and several types of authentication tokens—in the same embedded DS server that holds the AM configuration. You can choose to create a separate directory store for CTS data. For information about creating a separate directory store for CTS data, see the chapter, "*Implementing the Core Token Service*".

Before deploying AM in production, measure the impact of using the embedded directory not only for relatively static configuration data, but also for volatile session and token data. Your tests should subject AM to the same load patterns you expect in production. If it looks like a better choice to use an external directory server, then deploy AM with an external configuration store.

Tip

If you are the directory administrator and do not yet know directory servers very well, take some time to read the documentation for your directory server, especially the sections covering directory schema and procedures on how to configure access to directory data.

To Install an External OpenDJ Directory Server

The following example procedure shows how to prepare a single DS server as an external configuration data store. The DS instance implements a single backend for the AM configuration data. The procedure assumes that you have also prepared an external identity repository and an external CTS store, separate from the configuration data store.

Note

Example commands throughout this section use example values for user IDs and port numbers. When running similar commands, be sure to use appropriate values for your directory server.

When running the **ldapmodify** or **dsconfig** commands, you might need to specify the `--trustAll` argument to trust server certificates if your directory server uses self-signed certificates and StartTLS or SSL.

1. Prepare your DS installation, then download the DS software. See the DS documentation about Installing OpenDJ Servers.

```
$ cd /path/to/opendj
$ ./setup --cli
```

Example options are as follows:

Example DS Setup Parameters

Parameter	Example Inputs
`Accept License`	Yes
`Root User DN`	cn=Directory Manager
`Root User DN Password`	(arbitrary)
`Fully Qualified Domain Name`	opendj.example.com
`LDAP Port`	1389
`Administration Connector Port`	4444
`Create Base DN`	No. This will be created in a later step.
`Enable SSL`	If you choose this option, make sure that AM can trust the DS certificate.
`Enable TLS`	If you choose this option, make sure that AM can trust the DS certificate.
`Start Server After Config`	Yes

2. Change to the directory containing DS's binaries.

   ```
   $ cd /path/to/opendj/bin
   ```

3. Create a directory server backend, and call it `cfgStore`.

   The **dsconfig** command used to create the backend depends on the version of DS.

   - Use the following command with OpenDJ 2.6:

     ```
     $ dsconfig create-backend \
      --backend-name cfgStore \
      --set base-dn:dc=example,dc=com \
      --set enabled:true \
      --type local-db \
      --port 4444 \
      --bindDN "cn=Directory Manager" \
      --bindPassword password \
      --no-prompt
     ```

   - Use the following command with OpenDJ 3.0 and later to create a backend:

     ```
     $ dsconfig create-backend \
      --backend-name cfgStore \
      --set base-dn:dc=example,dc=com \
      --set enabled:true \
      --type je \
      --port 4444 \
      --bindDN "cn=Directory Manager" \
      --bindPassword password \
      --no-prompt
     ```

4. Create an LDIF file to add the initial entries for the configuration store, and save the file as `add-config-entries.ldif`. The entries include the base DN suffix, an organizational unit entry, and the AM user entry needed to access the directory server.

   When AM connects as `uid=openam,ou=admins,dc=example,dc=com` to an external directory server to store its data, it requires read, write, persistent search, and server-side sorting access privileges. You add these privileges by setting access control instructions (ACIs) on the base distinguished name (DN) entry (`dc=example,dc=com`). If your AM user has a DN other than `uid=openam,ou=admins,dc=example,dc=com`, adjust the ACIs where appropriate.

   You must also give privileges to the AM user to modify the schema and write to subentries, such as the schema entry. To grant these privileges, you include the following attributes on the AM user entry: `ds-privilege-name: subentry-write` and `ds-privilege-name: update-schema`.

```
dn: dc=example,dc=com
objectclass: top
objectclass: domain
dc: example
aci: (targetattr="*")(version 3.0;acl "Allow CRUDQ operations";
 allow (search, read, write, add, delete)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
aci: (targetcontrol="2.16.840.1.113730.3.4.3")(version 3.0;
 acl "Allow persistent search"; allow (search, read)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)
aci: (targetcontrol="1.2.840.113556.1.4.473")(version 3.0;
 acl "Allow server-side sorting"; allow (read)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)

dn: ou=admins,dc=example,dc=com
objectclass: top
objectclass: organizationalUnit
ou: admins

dn: uid=openam,ou=admins,dc=example,dc=com
objectclass: top
objectclass: person
objectclass: organizationalPerson
objectclass: inetOrgPerson
cn: openam
sn: openam
uid: openam
userPassword: secret12
ds-privilege-name: subentry-write
ds-privilege-name: update-schema
```

5. Add the initial entries LDIF file using the **ldapmodify** command. The following example assumes that you are using OpenDJ 4.0 and later:

   If you are having trouble with the preceding LDIF file, consider removing the line feeds for the ACI attributes and let it wrap to the next line. If you are still having trouble using the **ldapmodify** command, you can use the **import-ldif** command, although you may have to re-apply the `targetcontrol` ACI attribute.

   ```
   $ bin/ldapmodify \
    --port 1389 \
    --bindDN "cn=Directory Manager" \
    --bindPassword password \
    add-config-entries.ldif
   ```

6. Add the Global Access Control Instruction (ACI) to the access control handler. The Global ACI gives AM the privileges to modify the schema definitions for the custom configuration where the AM entry has DN `uid=openam,ou=admins,dc=example,dc=com`.

Note

These access rights are only required during configuration, and only if the directory administrator does not add the AM directory schema definitions manually.

If you copy the text from the following example, make sure that the value of `global-aci` is all on a single line.

```
$ bin/dsconfig set-access-control-handler-prop \
 --add global-aci:'(target = "ldap:///cn=schema")(targetattr = "attributeTypes ||
 objectClasses")(version 3.0; acl "Modify schema"; allow (write)
 (userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com");)'
 --port 4444 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --no-prompt
```

7. (Optional) If the DS server was set up with the `--productionMode` option, grant the additional access that AM requires.

   When DS servers are set up with the `--productionMode` option, many settings are hardened for a more secure default installation. Compared to evaluation mode, production mode significantly restricts access for non-admin users. For details, see *Directory Server Setup Parameters* in the *ForgeRock Directory Services Installation Guide*.

   The following example grants the additional required ACIs:

```
$ ./dsconfig \
 set-access-control-handler-prop \
 --port 4444 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --add 'global-aci: (extop="1.3.6.1.4.1.26027.1.6.1 || 1.3.6.1.4.1.26027.1.6.3 || 1.3.6.1.4.1.4203.1
.11.1 || 1.3.6.1.4.1.1466.20037 || 1.3.6.1.4.1.4203.1.11.3")(version 3.0; acl "AM extended operation
 access"; allow(read) userdn="ldap:///uid=openam,ou=admins,dc=example,dc=com";)' \
 --add 'global-aci: (targetcontrol="2.16.840.1.113730.3.4.2 || 2.16.840.1.113730.3.4.17 || 2.16.840.1
.113730.3.4.19 || 1.3.6.1.4.1.4203.1.10.2 || 1.3.6.1.4.1.42.2.27.8.5.1 || 2.16.840.1.113730.3.4.16 ||
 1.2.840.113556.1.4.1413 || 1.3.6.1.4.1.36733.2.1.5.1 || 1.3.6.1.1.12 || 1.3.6.1.1.13.1 || 1.3.6.1.1
.13.2 || 1.2.840.113556.1.4.319 || 1.2.826.0.1.3344810.2.3 || 2.16.840.1.113730.3.4.18 || 2.16.840.1
.113730.3.4.9 || 1.2.840.113556.1.4.473 || 1.3.6.1.4.1.42.2.27.9.5.9")(version 3.0; acl "AM extended
 operation access"; allow(read) userdn="ldap:///uid=openam,ou=admins,dc=example,dc=com";)' \
 --add 'global-aci: (targetattr="createTimestamp||creatorsName||modifiersName||modifyTimestamp||
entryDN||entryUUID||subschemaSubentry||etag||governingStructureRule||structuralObjectClass||
hasSubordinates||numSubordinates||isMemberOf")(version 3.0; acl "AM Operational Attributes"; allow
 (read,search,compare) userdn="ldap:///uid=openam,ou=admins,dc=example,dc=com";)' \
 --add 'global-aci: (targetcontrol="1.3.6.1.1.12 || 1.3.6.1.1.13.1")(version 3.0; acl "Allow assertion
 control";allow (read) userdn = "ldap:///uid=openam,ou=admins,dc=example,dc=com";)' \
 --trustAll \
 --no-prompt
```

8. At this point, deploy the AM server if you have not done so already. For additional details on deploying AM, see "Deploying".

9. AM requires additional schema definitions for attributes used to search for user and configuration data:

Configuration Data Store Attributes

Attribute	Index Type	Description
CTS attributes		Specifies the CTS attributes required for stateful session high availability and persistence. Located in the `WEB-INF/template/ldif/sfha/cts-add-schema.ldif` file.
`iplanet-am-user-federation-info-key`	equality	Specifies a configuration setting to store an account's federation information key, which is used internally. Located in `WEB-INF/template/ldif/opendj/opendj_user_schema.ldif` file.
`sun-fm-saml2-nameid-infokey`	equality	Specifies an information key common to an IdP and SP to link accounts. Located in `WEB-INF/template/ldif/opendj/opendj_user_schema.ldif` file.
`sunxmlkeyvalue`	equality, substring	Stores configuration values that may be looked up through searches. Located in `WEB-INF/template/ldif/opendj/opendj_config_schema.ldif`.

Add the required CTS schema definitions. You can find the CTS schema definitions at `/path/to/tomcat/webapps/openam/WEB-INF/template/ldif/sfha/cts-add-schema.ldif`.

```
$ cp /path/to/tomcat/webapps/openam/WEB-INF/template/ldif/sfha/cts-add-schema.ldif /tmp
```

10. Add the schema file to the directory server.

```
$ bin/ldapmodify \
 --port 1389 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 /tmp/cts-add-schema.ldif
```

11. Add the required user store schema definitions. You can find the schema definitions at `/path/to/tomcat/webapps/openam/WEB-INF/template/ldif/opendj/opendj_user_schema.ldif`.

```
$ cp /path/to/tomcat/webapps/openam/WEB-INF/template/ldif/opendj/opendj_user_schema.ldif /tmp
```

12. Add the schema file to the directory server.

```
$ bin/ldapmodify \
 --port 1389 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 /tmp/opendj_user_schema.ldif
```

13. Add the schema definitions to the configuration repository. You can find the schema definitions at `/path/to/tomcat/webapps/openam/WEB-INF/template/ldif/opendj/opendj_config_schema.ldif`.

    ```
    $ cp /path/to/tomcat/webapps/openam/WEB-INF/template/ldif/opendj/opendj_config_schema.ldif /tmp
    ```

14. Add the schema file to the directory server.

    ```
    $ bin/ldapmodify \
     --port 1389 \
     --bindDN "cn=Directory Manager" \
     --bindPassword password \
     /tmp/opendj_config_schema.ldif
    ```

15. AM uses the attributes in "Configuration Data Store Attributes" to search for configuration data. On the DS server, use the **dsconfig** command to add these indexes to your external configuration store. Repeat this step to index the `iplanet-am-user-federation-info-key` and `sun-fm-saml2-nameid-infokey` attributes if you are deploying federation.

    The **dsconfig** subcommand used to create the index depends on the version of DS.

    - Use the following commands with OpenDJ 2.6.x:

      ```
      $ dsconfig create-local-db-index \
       --port 4444 \
       --hostname opendj.example.com \
       --bindDN "cn=Directory Manager" \
       --bindPassword password \
       --backend-name cfgStore \
       --index-name sunxmlkeyvalue \
       --set index-type:equality \
       --set index-type:substring \
       --no-prompt

      $ dsconfig create-local-db-index \
       --port 4444 \
       --hostname opendj.example.com \
       --bindDN "cn=Directory Manager" \
       --bindPassword password \
       --backend-name cfgStore \
       --index-name iplanet-am-user-federation-info-key \
       --set index-type:equality \
       --no-prompt

      $ dsconfig create-local-db-index \
       --port 4444 \
       --hostname opendj.example.com \
       --bindDN "cn=Directory Manager" \
       --bindPassword password \
       --backend-name cfgStore \
       --index-name sun-fm-saml2-nameid-infokey \
       --set index-type:equality \
       --no-prompt
      ```

    - Use the following commands with OpenDJ 3 and later:

```
$ dsconfig create-backend-index \
 --port 4444 \
 --hostname opendj.example.com \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --backend-name cfgStore \
 --index-name sunxmlkeyvalue \
 --set index-type:equality \
 --set index-type:substring \
 --no-prompt

$ dsconfig create-backend-index \
 --port 4444 \
 --hostname opendj.example.com \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --backend-name cfgStore \
 --index-name iplanet-am-user-federation-info-key \
 --set index-type:equality \
 --no-prompt

$ dsconfig create-backend-index \
 --port 4444 \
 --hostname opendj.example.com \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --backend-name cfgStore \
 --index-name sun-fm-saml2-nameid-infokey \
 --set index-type:equality \
 --no-prompt
```

16. Rebuild the indexes using the `rebuild-index` command. You can stop the server and run `rebuild-index` in offline mode by specifying the `--offline` option, or you can run `rebuild-index` online using a task as follows:

    ```
    $ bin/rebuild-index --port 4444 --hostname opendj.example.com \
     --bindDN "cn=Directory Manager" --bindPassword password \
     --baseDN dc=example,dc=com --rebuildAll \
     --start 0
    ```

17. Verify the indexes. Note that if you are running OpenDJ 3 and later, you need to stop the server before running this command.

    ```
    $ bin/verify-index --baseDN dc=example,dc=com
    ```

    You have successfully installed and prepared the directory server for an external configuration store. When installing the AM server, you need to specify the host name, port and root suffix of the external directory server on the Configuration Data Store Settings screen of the AM Configurator. See "To Custom Configure an Instance" for more information.

1.4.3. Setting the Configuration Store Heartbeat

AM supports heartbeat monitoring for the configuration data store to prevent idle connections. Idle connections may occur if the external data store is behind a load balancer or firewall. Once the connection is in an idle state, AM no longer receive notification of configuration changes and may become out-of-sync with other servers sharing the configuration store.

By default, AM issues a heartbeat every ten seconds to monitor for idle connections to the configuration data store.

Two JVM options can be used to override the default heartbeat interval or to disable it completely:

- **org.forgerock.openam.ldap.sm.heartbeat.interval**. Sets the heartbeat interval. The default interval is 10 seconds. If you set the JVM property to 0, it will disable the heartbeat.
- **org.forgerock.openam.ldap.sm.heartbeat.unit**. Sets the time unit of the heartbeat interval. Default is `SECONDS`. Possible values also include: `DAYS`, `HOURS`, `MICROSECONDS`, `MILLISECONDS`, `MINUTES`, `NANOSECONDS`, and `SECONDS`.

> **Important**
>
> You must grant access permissions to all heartbeat requests to the configuration stores that go through firewalls or load balancers.

To Set the Heartbeat Interval

1. Set the heartbeat interval using the JVM startup property `org.forgerock.openam.ldap.sm.heartbeat.interval` in your container.

   For example, to set the heartbeat interval to 20 seconds, edit `%CATALINA_HOME%/bin/setenv.sh` (Unix) or `%CATALINA_HOME%\bin\setenv.bat` (Windows) on Tomcat by adding the following line:

   ```
   set CATALINA_OPTS=-Dorg.forgerock.openam.ldap.sm.heartbeat.interval=20
   ```

2. Make sure that the heartbeat requests have the permissions necessary for a firewall or load balancer.

To Disable the Heartbeat Interval

- Disable the heartbeat interval by setting the JVM startup property `org.forgerock.openam.ldap.sm.heartbeat.interval` to 0.

  For example, edit `%CATALINA_HOME%/bin/setenv.sh` (Unix) or `%CATALINA_HOME%\bin\setenv.bat` (Windows) on Tomcat by adding the following line:

  ```
  set CATALINA_OPTS=-Dorg.forgerock.openam.ldap.sm.heartbeat.interval=0
  ```

1.4.4. Preventing Anonymous Access to an External Configuration Store

By default, DS allows unauthenticated or anonymous connections to directory servers. For external configuration stores, this default is a security vulnerability.

In production deployments, you want to allow unauthenticated connections to the root entry only, so that LDAP clients can obtain server information for the DS server, while at the same time, denying anonymous connections to all directory server instances.

You can prevent anonymous access from LDAP clients to the DS server while allowing unauthenticated access to the root entry by configuring access control instructions (ACIs) and removing global ACIs from the directory server instances.

To Prevent Anonymous Access in External Configuration Stores

1. To allow unauthenticated access to the DS root entry, set the `global-aci` using the **dsconfig** command:

   ```
   $ ./dsconfig set-access-control-handler-prop --add 'global-aci:(target="ldap:///")(targetscope="base")
   (targetattr="objectClass||namingContexts||supportedAuthPasswordSchemes||supportedControl||
   supportedExtension||supportedFeatures||supportedLDAPVersion||supportedSASLMechanisms||vendorName||
   vendorVersion")(version 3.0; acl "User-Visible Root DSE Operational Attributes"; allow (read,search
   ,compare) userdn="ldap:///anyone";)' --hostname server.example.com --port 4444 --bindDN "cn=Directory
    Manager" --bindPassword password --trustAll --no-prompt
   ```

2. Remove the default access to anonymous users using the **dsconfig** command:

   - On DS 3.x or later:

     ```
     $ ./dsconfig set-access-control-handler-prop --remove 'global-aci:(targetattr!="userPassword||
     authPassword||debugsearchindex||changes||changeNumber||changeType||changeTime||targetDN||newRDN||
     newSuperior||deleteOldRDN")(version 3.0; acl "Anonymous read access"; allow (read,search,compare)
      userdn="ldap:///anyone";)' --hostname server.example.com --port 4444 --bindDN "cn=Directory
      Manager" --bindPassword password --trustAll --no-prompt
     ```

   - On OpenDJ 2.6.x:

     ```
     $ ./dsconfig set-access-control-handler-prop --remove 'global-aci:(targetattr!="userPassword||
     authPassword||changes||changeNumber||changeType||changeTime||targetDN||newRDN||newSuperior||
     deleteOldRDN")(version 3.0; acl "Anonymous read access"; allow (read,search,compare)
      userdn="ldap:///anyone";)' --hostname server.example.com --port 4444 --bindDN "cn=Directory
      Manager" --bindPassword password --trustAll --no-prompt
     ```

3. If you have other custom ACIs that affect anonymous users, review them and update as necessary. To generate a list of ACIs, run the following command:

   ```
   $ ./ldapsearch --hostname openam.example.com --port 1389 --bindDN "cn=Directory manager" \
    --bindPassword "password" --baseDN "cn=config" --searchScope sub "cn=Access Control Handler"
   ```

4. Repeat these steps for all appropriate DS instances.

For additional information, see How do I prevent anonymous access in DS/OpenDJ (All version) in the *ForgeRock Knowledge Base*.

Chapter 2
Installing and Starting Servers

This chapter covers installation and startup.

The chapter includes procedures for installing AM on a single server, installing AM on multiple servers, and installing AM's administrative tools. It also covers how to start AM, including overriding default startup options.

The following table contains a list of activities you might perform while installing and starting AM:

Installation Options

Installation Action	Documentation Reference
Install quickly for evaluation using default settings	"To Configure With Defaults" Alternatively, follow the full example in Quick Start Guide.
Install AM server, choosing settings	"To Custom Configure an Instance"
Start an AM server	"Starting Servers"
Erase the configuration and start over	"To Delete a Configuration Before Redeploying"
Add an AM server to a site	"To Add a Server to a Site"
Implement the Core Token Service	"*Implementing the Core Token Service*"
Troubleshoot an AM installation	"To Troubleshoot an Installation"
Install **ssoadm** for CLI configuration	"Installing and Using the Tools"
Perform a command-line install	"Installing Silently"
Removing AM	"*Removing Installations*"

This chapter does not cover installation for enforcing policies on resource servers. To manage access to resources on other servers, you can use IG or AM web and Java agents.

ForgeRock Identity Gateway is a high-performance reverse proxy server with specialized session management and credential replay functionality. It can function as a standards-based policy enforcement point.

AM web and Java agents provide policy enforcement on supported web servers and Java containers, and are tightly integrated with AM. See the *ForgeRock Access Management Web Agents User Guide*, or the *ForgeRock Access Management Java Agents User Guide* for instructions on installing AM web or Java agents in supported web servers and Java application containers.

2.1. Installing a Single Server

This section covers tasks required to install a single AM server.

To Configure With Defaults

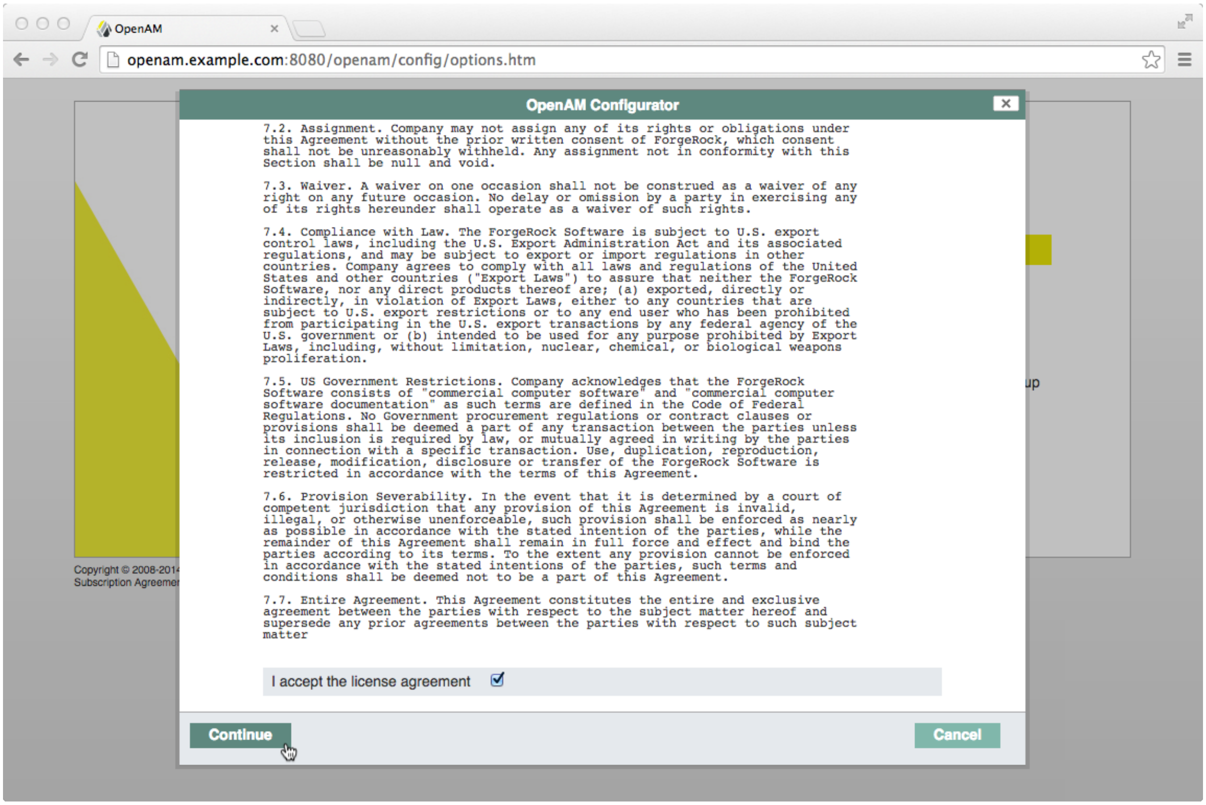
The default configuration option configures the embedded DS server using default ports. If the ports are already in use, AM uses free ports as both configuration store and identity store.

The default configuration sets the cookie domain based on the full URL that was used to access the configurator.

Configuration settings are saved to the home directory of the user running the web application container in a directory named after the deployment URI. In other words if AM is deployed under `/openam`, then the configuration is saved under `$HOME/openam/`.

1. In the initial configuration screen, click Create Default Configuration under Default Configuration.

2. Review the software license agreement. If you agree to the license, click "I accept the license agreement", and then click Continue.



7.2. Assignment. Company may not assign any of its rights or obligations under this Agreement without the prior written consent of ForgeRock, which consent shall not be unreasonably withheld. Any assignment not in conformity with this Section shall be null and void.

7.3. Waiver. A waiver on one occasion shall not be construed as a waiver of any right on any future occasion. No delay or omission by a party in exercising any of its rights hereunder shall operate as a waiver of such rights.

7.4. Compliance with Law. The ForgeRock Software is subject to U.S. export control laws, including the U.S. Export Administration Act and its associated regulations, and may be subject to export or import regulations in other countries. Company agrees to comply with all laws and regulations of the United States and other countries ("Export Laws") to assure that neither the ForgeRock Software, nor any direct products thereof are; (a) exported, directly or indirectly, in violation of Export Laws, either to any countries that are subject to U.S. export restrictions or to any end user who has been prohibited from participating in the U.S. export transactions by any federal agency of the U.S. government or (b) intended to be used for any purpose prohibited by Export Laws, including, without limitation, nuclear, chemical, or biological weapons proliferation.

7.5. US Government Restrictions. Company acknowledges that the ForgeRock Software consists of "commercial computer software" and "commercial computer software documentation" as such terms are defined in the Code of Federal Regulations. No Government procurement regulations or contract clauses or provisions shall be deemed a part of any transaction between the parties unless its inclusion is required by law, or mutually agreed in writing by the parties in connection with a specific transaction. Use, duplication, reproduction, release, modification, disclosure or transfer of the ForgeRock Software is restricted in accordance with the terms of this Agreement.

7.6. Provision Severability. In the event that it is determined by a court of competent jurisdiction that any provision of this Agreement is invalid, illegal, or otherwise unenforceable, such provision shall be enforced as nearly as possible in accordance with the stated intention of the parties, while the remainder of this Agreement shall remain in full force and effect and bind the parties according to its terms. To the extent any provision cannot be enforced in accordance with the stated intentions of the parties, such terms and conditions shall be deemed not to be a part of this Agreement.

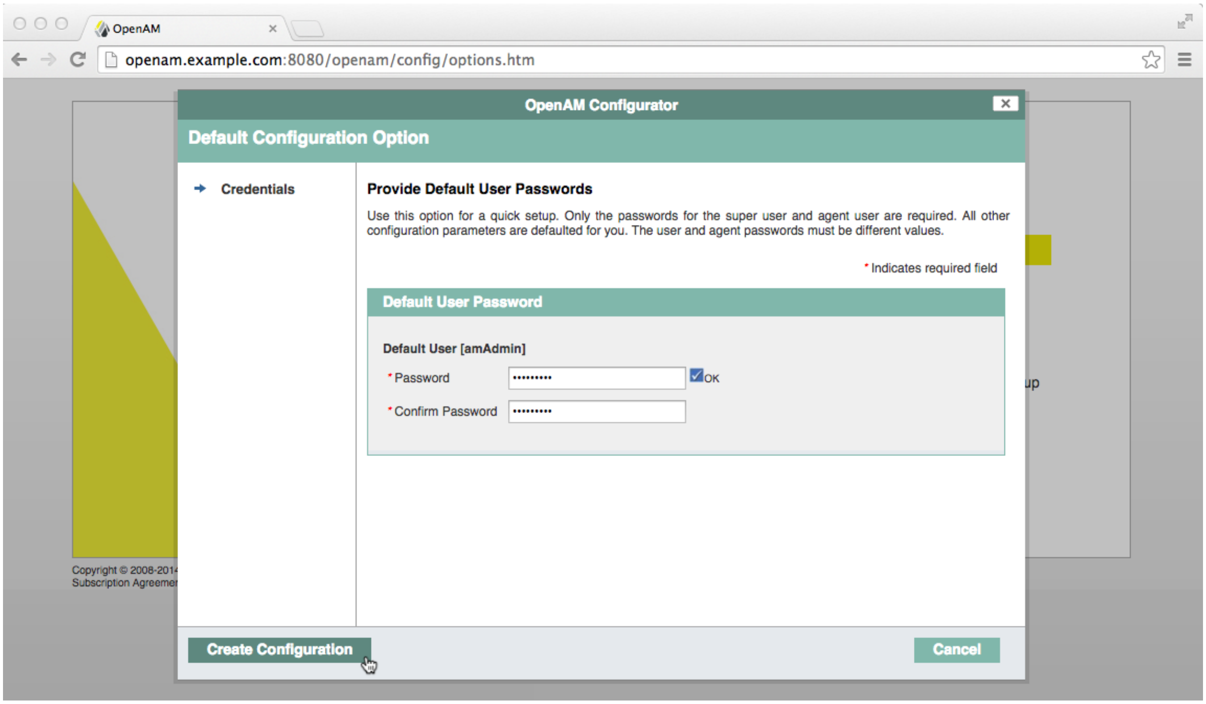
7.7. Entire Agreement. This Agreement constitutes the entire and exclusive agreement between the parties with respect to the subject matter hereof and supersede any prior agreements between the parties with respect to such subject matter

I accept the license agreement ☑

Continue

Cancel

3. Provide the password for the default AM administrator, `amadmin`.



OpenAM
openam.example.com:8080/openam/config/options.htm
OpenAM Configurator
Default Configuration Option
Credentials

Provide Default User Passwords

Use this option for a quick setup. Only the passwords for the super user and agent user are required. All other configuration parameters are defaulted for you. The user and agent passwords must be different values.

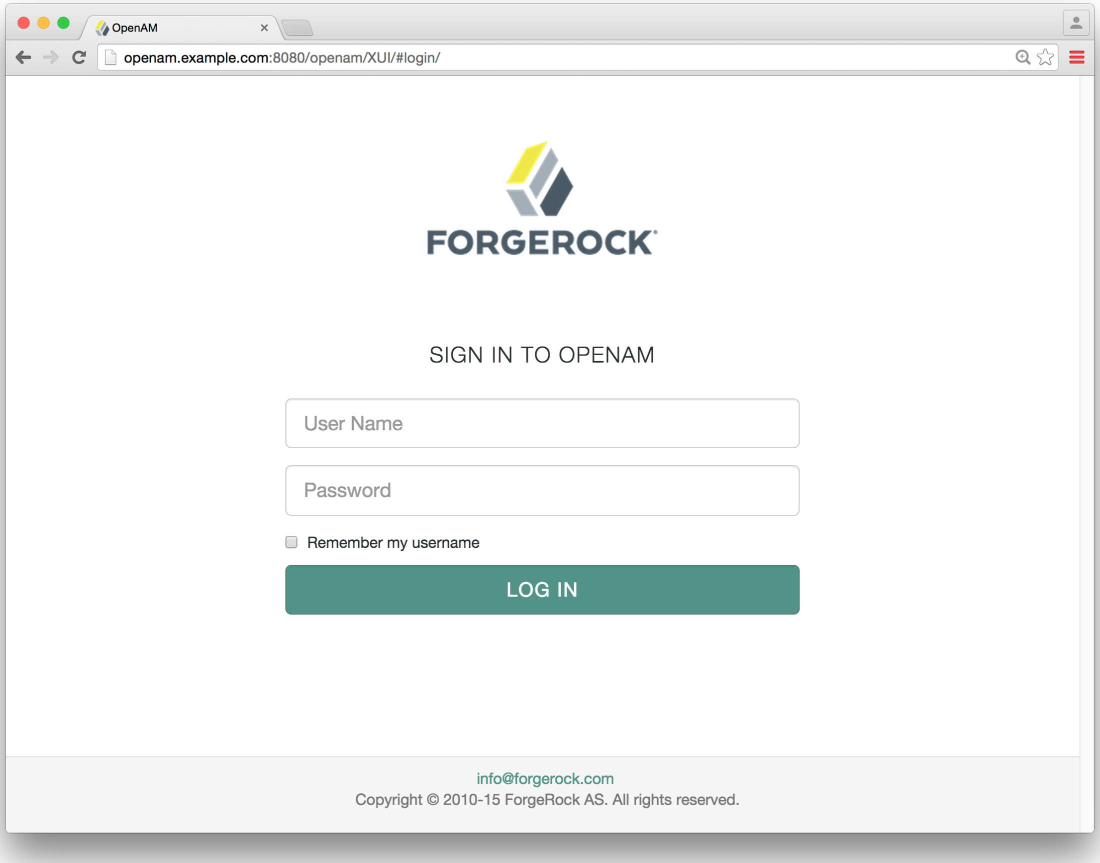
* Indicates required field

Default User Password

Default User [amAdmin]

* Password	••••••••• ☑ OK
* Confirm Password	•••••••••

4. When the configuration completes, click Proceed to Login, and then login as the AM administrator, `amAdmin`.



OpenAM

openam.example.com:8080/openam/XUI/#login/

SIGN IN TO OPENAM

User Name

Password

□ Remember my username

LOG IN

info@forgerock.com

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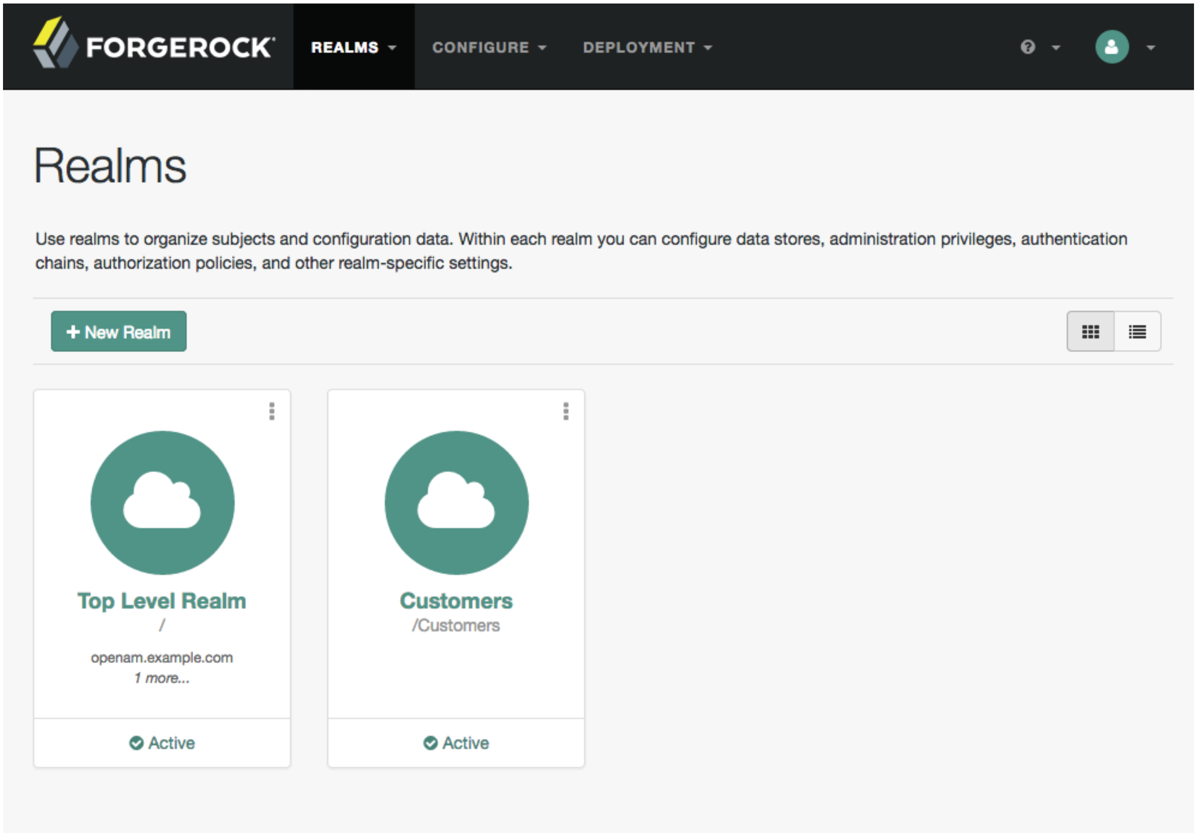
After successful login, AM redirects you to AM Realms.



Realms

Use realms to organize subjects and configuration data. Within each realm you can configure data stores, administration privileges, authentication chains, authorization policies, and other realm-specific settings.

Top Level Realm
/
openam.example.com
1 more...
Active

Customers
/Customers
Active

To Delete a Configuration Before Redeploying

If you need to delete your configuration and start the process from the beginning, follow these steps.

1. Stop the AM web application to clear the configuration held in memory.

   The following example shuts down Apache Tomcat (Tomcat) for example.

```
$ /path/to/tomcat/bin/shutdown.sh
Password:
Using CATALINA_BASE:   /path/to/tomcat
Using CATALINA_HOME:   /path/to/tomcat
Using CATALINA_TMPDIR: /path/to/tomcat/temp
Using JRE_HOME:        /path/to/jdk/jre
Using CLASSPATH:
       /path/to/tomcat/bin/bootstrap.jar:/path/to/tomcat/bin/tomcat-juli.jar
```

2. Delete AM configuration files, by default under the `$HOME` of the user running the web application container.

```
$ rm -rf $HOME/openam $HOME/.openamcfg
```

When using the internal AM configuration store, this step deletes the embedded directory server and all of its contents. This is why you stop the application server before removing the configuration.

If you use an external configuration store, delete the entries under the configured AM suffix (by default dc=openam,dc=forgerock,dc=org).

3. Delete any cached files from the container. For example, on Tomcat, files are cached in a folder named after the deployment path, such as `/path/to/tomcat/work/Catalina/localhost/deployment path`. Use a command such as the following to delete these cached files:

   ```
   $ rm -rf /path/to/tomcat/work/Catalina/localhost/openam
   ```

4. Restart the AM web application.

   The following example starts the Tomcat container.

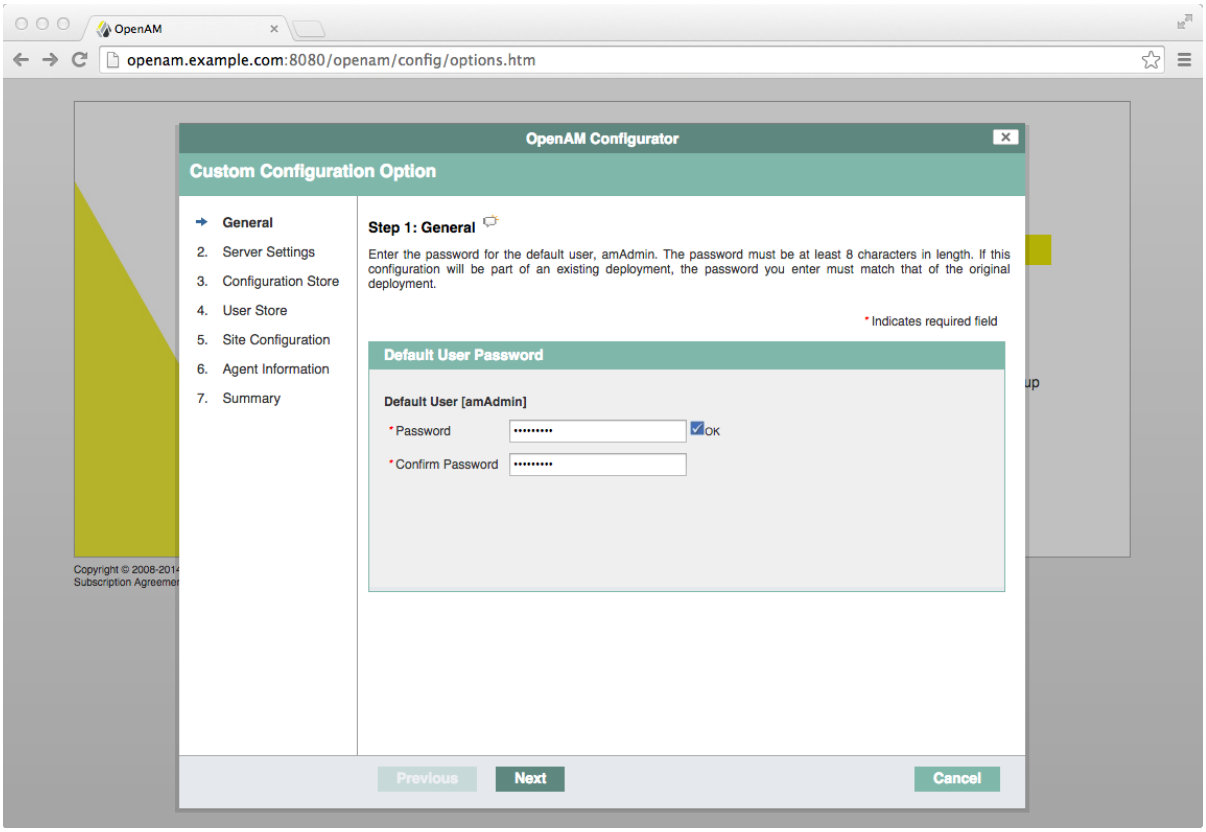
   ```
   $ /path/to/tomcat/bin/startup.sh
   Password:
   Using CATALINA_BASE:   /path/to/tomcat
   Using CATALINA_HOME:   /path/to/tomcat
   Using CATALINA_TMPDIR: /path/to/tomcat/temp
   Using JRE_HOME:        /path/to/jdk/jre
   Using CLASSPATH:
          /path/to/tomcat/bin/bootstrap.jar:/path/to/tomcat/bin/tomcat-juli.jar
   ```

To Custom Configure an Instance

1. In the initial configuration screen, click Create New Configuration under Custom Configuration.

2. Read the license agreement. If you agree to the license, click "I agree to the license agreement", and then click Continue.

3. On the Default User Password page, provide a password with at least eight characters for the AM Administrator, `amadmin`.



Step 1: General

Enter the password for the default user, amAdmin. The password must be at least 8 characters in length. If this configuration will be part of an existing deployment, the password you enter must match that of the original deployment.

* Indicates required field

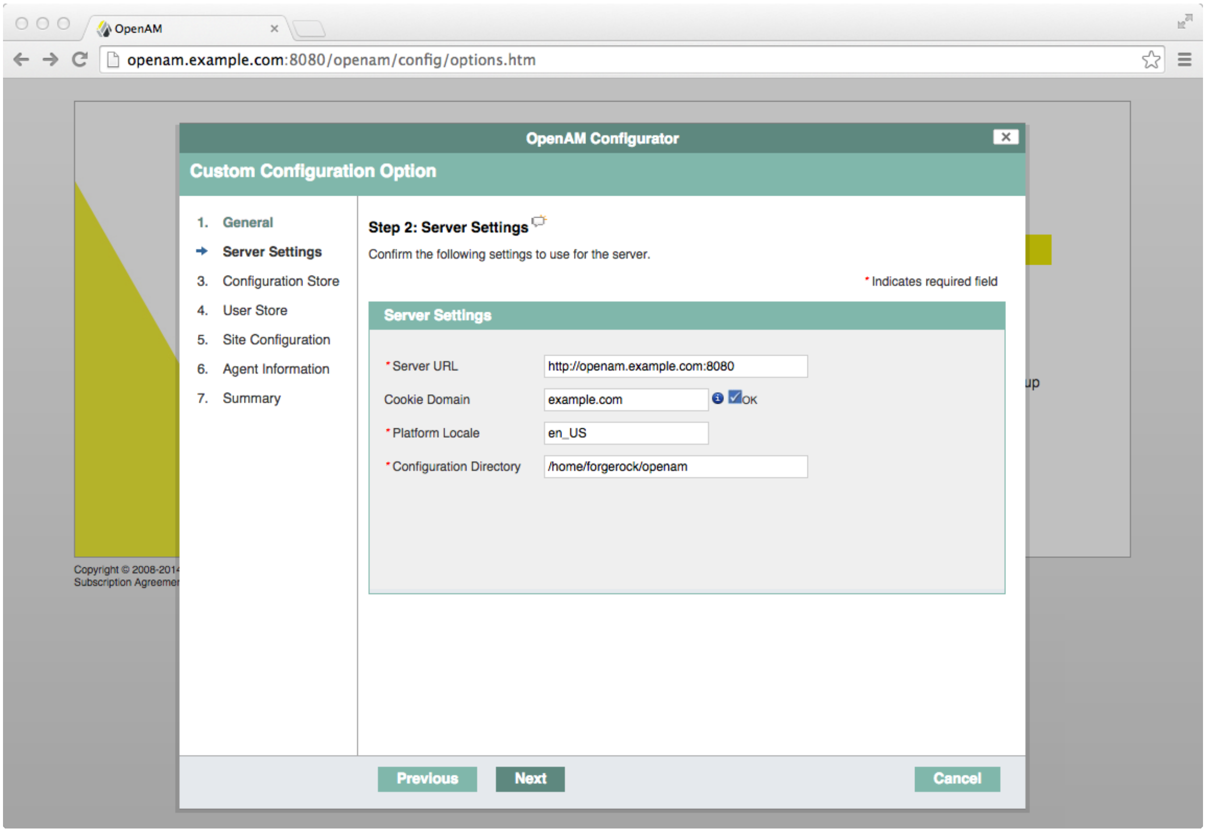
Default User Password

Default User [amAdmin]

* Password •••••••• ☑ OK

* Confirm Password ••••••••

4. Verify that the server settings are valid for your configuration.



OpenAM Configurator

Custom Configuration Option

1. General
2. Server Settings
3. Configuration Store
4. User Store
5. Site Configuration
6. Agent Information
7. Summary

Step 2: Server Settings

Confirm the following settings to use for the server.

* Indicates required field

Server Settings

* Server URL	http://openam.example.com:8080
Cookie Domain	example.com ☑OK
* Platform Locale	en_US
* Configuration Directory	/home/forgerock/openam

Server URL

Provide a valid URL to the base of your AM web container, including a FQDN.

In a test environment, you can simulate the FQDN by adding it to your `/etc/hosts` as an alias. The following excerpt shows lines from the `/etc/hosts` file on a Linux system where AM is installed.

```
127.0.0.1 localhost.localdomain localhost
::1 localhost6.localdomain6 localhost6
127.0.1.1 openam openam.example.com
```

Cookie Domain

Domain that created cookies will be valid for, for example `example.com`.

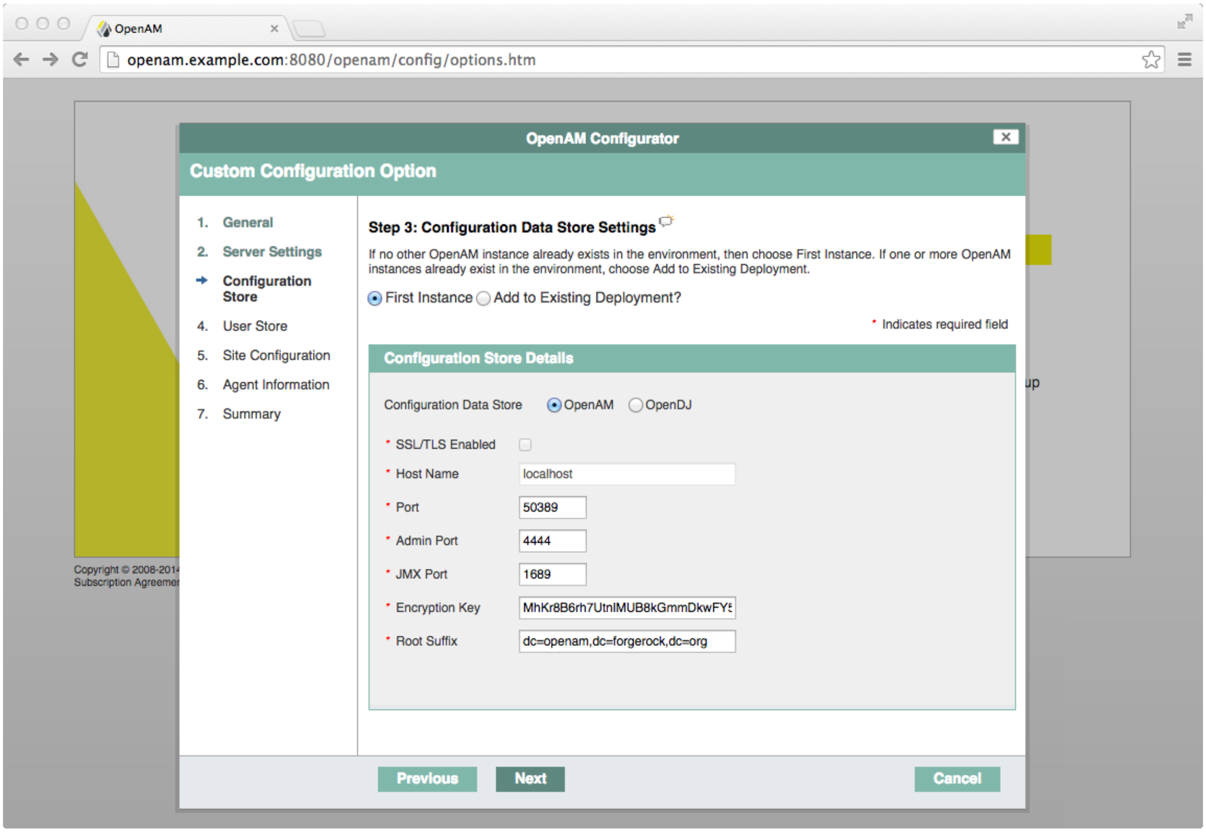
Platform Locale

Supported locales include en_US (English), de (German), es (Spanish), fr (French), ja (Japanese), ko (Korean), zh_CN (Simplified Chinese), and zh_TW (Traditional Chinese).

Configuration Directory

Location on server for AM configuration files. AM must be able to write to this directory.

5. In the Configuration Store screen, you can accept the defaults to allow AM to store configuration data in an embedded directory. The embedded directory can be configured separately to replicate data for high availability if necessary.



Step 3: Configuration Data Store Settings

If no other OpenAM instance already exists in the environment, then choose First Instance. If one or more OpenAM instances already exist in the environment, choose Add to Existing Deployment.

● First Instance ○ Add to Existing Deployment?

* Indicates required field

Configuration Store Details

Configuration Data Store ● OpenAM ○ OpenDJ

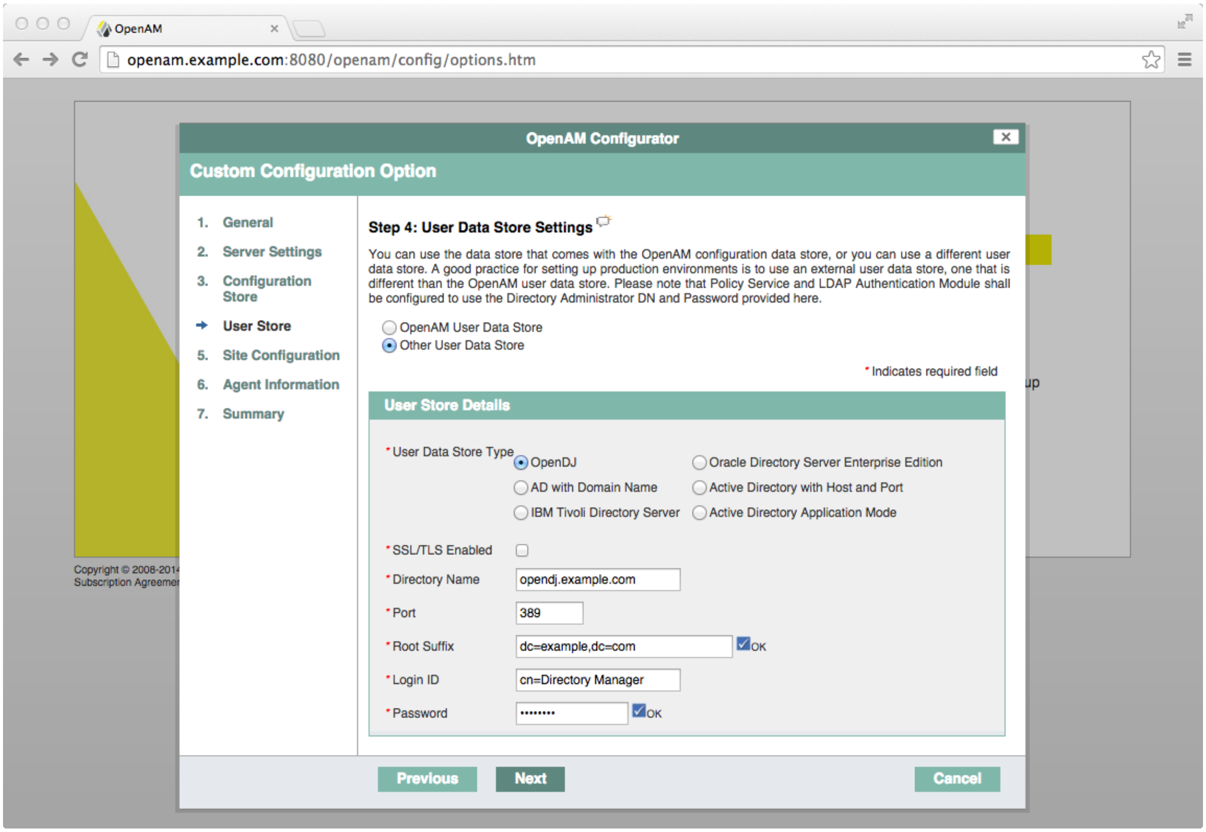
* SSL/TLS Enabled	□
* Host Name	localhost
* Port	50389
* Admin Port	4444
* JMX Port	1689
* Encryption Key	MhKr8B6rh7UtnIMUB8kGmmDkwFY
* Root Suffix	dc=openam,dc=forgerock,dc=org

You can also add this AM installation to an existing deployment, providing the URL of the site. See "To Add a Server to a Site" for details.

Alternatively, if you already manage an existing DS deployment, you can store AM configuration data in your existing directory service. You must, however, create the suffix to store configuration data on the directory server before you configure AM. AM does not create the suffix when you use an external configuration store. For instructions to create a configuration store backend, see Step 3 in "To Install an External OpenDJ Directory Server".

6. In the User Store screen, you configure where AM looks for user identities.

   AM must have write access to the directory service you choose, as it adds to the directory schema needed to allow AM to manage access for users in the user store.



Step 4: User Data Store Settings

You can use the data store that comes with the OpenAM configuration data store, or you can use a different user data store. A good practice for setting up production environments is to use an external user data store, one that is different than the OpenAM user data store. Please note that Policy Service and LDAP Authentication Module shall be configured to use the Directory Administrator DN and Password provided here.

○ OpenAM User Data Store
● Other User Data Store

* Indicates required field

User Store Details

* User Data Store Type ● OpenDJ ○ Oracle Directory Server Enterprise Edition ○ AD with Domain Name ○ Active Directory with Host and Port ○ IBM Tivoli Directory Server ○ Active Directory Application Mode

* SSL/TLS Enabled □

* Directory Name opendj.example.com

* Port 389

* Root Suffix dc=example,dc=com ☑ OK

* Login ID cn=Directory Manager

* Password •••••••• ☑ OK

User Data Store Type

If you have already provisioned a directory service with users in a supported user data store, then select that type of directory from the options available.

SSL/TLS Enabled

To use a secure connection, check this box, then make sure the port you define corresponds to the port the directory server listens to for StartTLS or SSL connections. When using this option you also need to make sure the trust store used by the JVM running AM has the necessary certificates installed.

Directory Name

FQDN for the host housing the directory service.

Port

LDAP directory port. The default for LDAP and LDAP with StartTLS to protect the connection is port 389. The default for LDAP over SSL is port 636. Your directory service might use a different port.

Root Suffix

Base distinguished name (DN) where user data is stored.

Login ID

Directory administrator user DN. The administrator must be able to update the schema and user data.

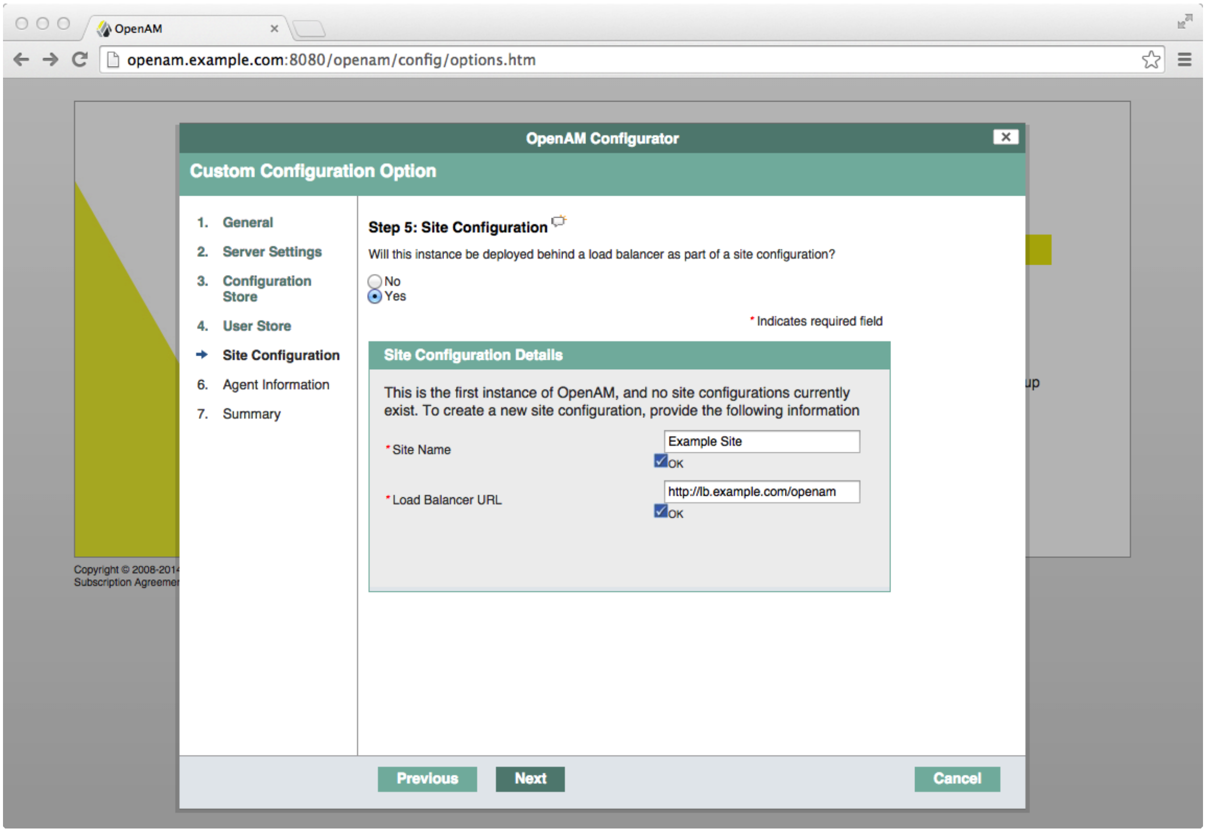
Password

Password for the directory administrator user.

7. In the Site Configuration screen, you can set up AM as part of a site where the load is balanced across multiple AM servers.

   When you deploy multiple servers, AM automatically enables session high availability.[1] AM stores session data in a directory service that is shared by multiple AM servers. The shared storage means that if an AM server fails, other AM servers in the deployment have access to the user's session data and can serve requests about that user. As a result, the user does not have to log in again.

[1] You can configure AM to store sessions *statefully* or *statelessly*. Stateful sessions are stored in the Core Token Service; stateless sessions are stored in HTTP cookies on the client. Because stateless sessions reside in HTTP cookies, they do not need to be retrieved from a persistent data store in the event of a server failure—they can be retrieved from the cookies. AM does not store stateless sessions in the CTS store. For more information about stateful and stateless sessions, see "Session State" in the *Authentication and Single Sign-On Guide*.



Step 5: Site Configuration

Will this instance be deployed behind a load balancer as part of a site configuration?

○ No
● Yes

* Indicates required field

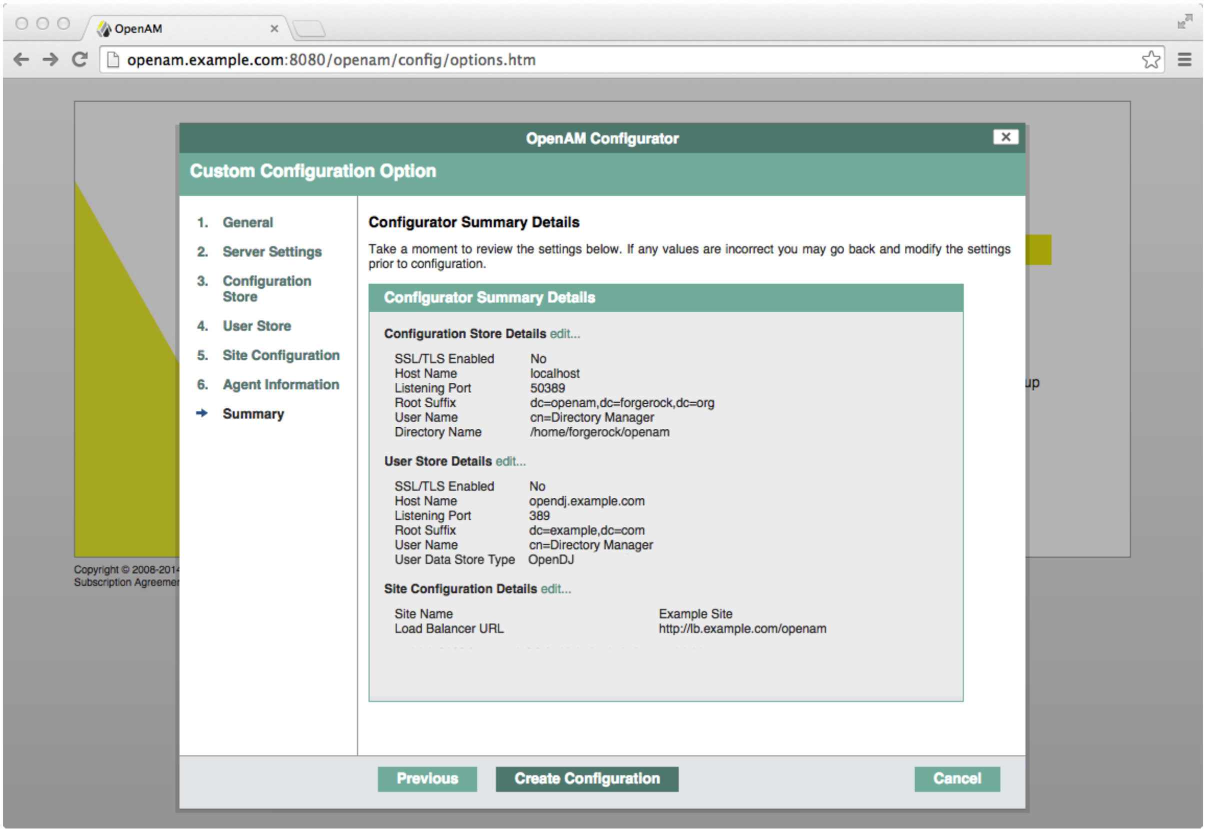
Site Configuration Details

This is the first instance of OpenAM, and no site configurations currently exist. To create a new site configuration, provide the following information

* Site Name	Example Site ☑ OK
* Load Balancer URL	http://lb.example.com/openam ☑ OK

It is possible to set up a site after initial installation and configuration. See "Deployment Configuration" in the *Reference* for more information.

8. Check the summary screen, and if necessary, click Previous to return to earlier screens to fix any configuration errors as needed.



Configurator Summary Details

Take a moment to review the settings below. If any values are incorrect you may go back and modify the settings prior to configuration.

Configurator Summary Details

Configuration Store Details edit...

SSL/TLS Enabled	No
Host Name	localhost
Listening Port	50389
Root Suffix	dc=openam,dc=forgerock,dc=org
User Name	cn=Directory Manager
Directory Name	/home/forgerock/openam

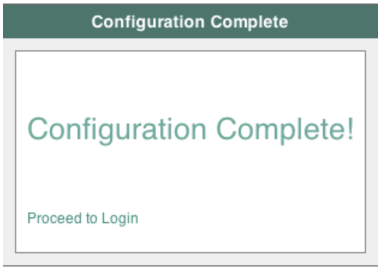
User Store Details edit...

SSL/TLS Enabled	No
Host Name	opendj.example.com
Listening Port	389
Root Suffix	dc=example,dc=com
User Name	cn=Directory Manager
User Data Store Type	OpenDJ

Site Configuration Details edit...

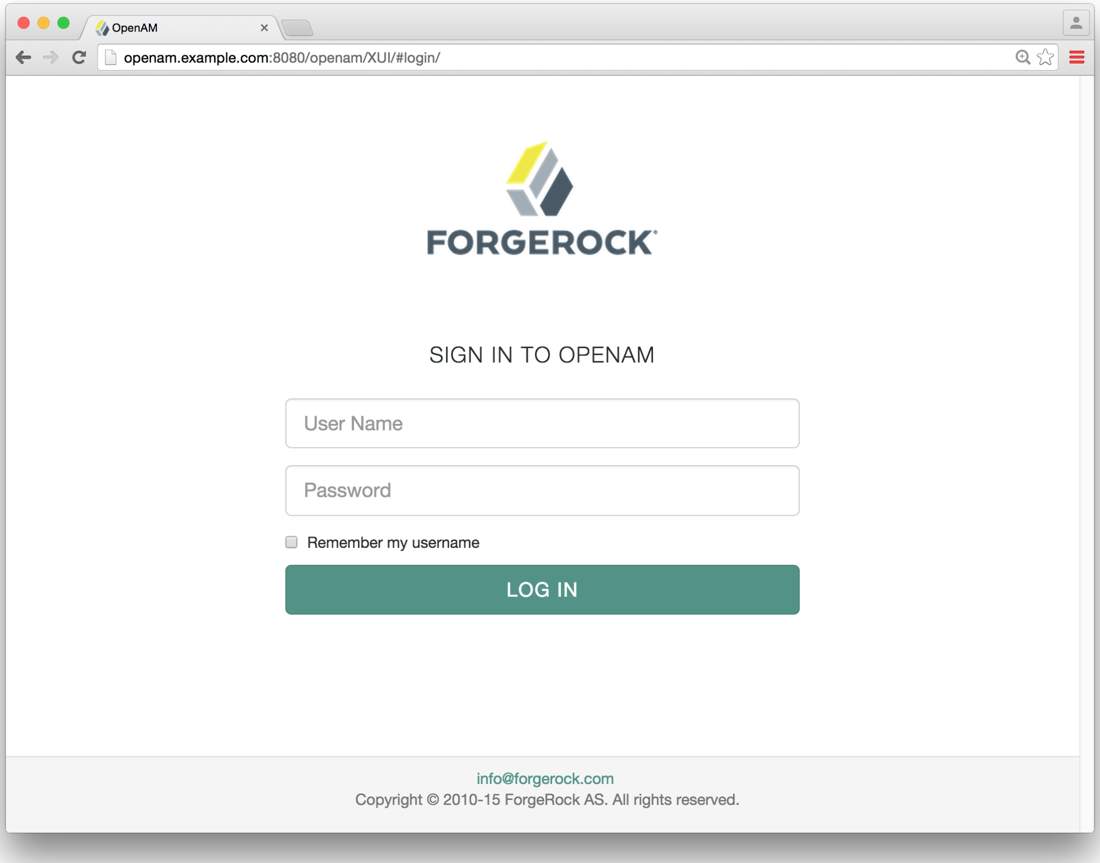
Site Name	Example Site
Load Balancer URL	http://lb.example.com/openam

After you click Create Configuration in the summary screen, configuration proceeds, logging progress that you can read in your browser and later, in the installation log. The process ends, and AM shows the Proceed to Login prompt.



Configuration Complete!

9. When the configuration completes, click Proceed to Login, and then login as the AM administrator, `amadmin`.



OpenAM

openam.example.com:8080/openam/XUI/#login/

SIGN IN TO OPENAM

User Name

Password

□ Remember my username

LOG IN

info@forgerock.com

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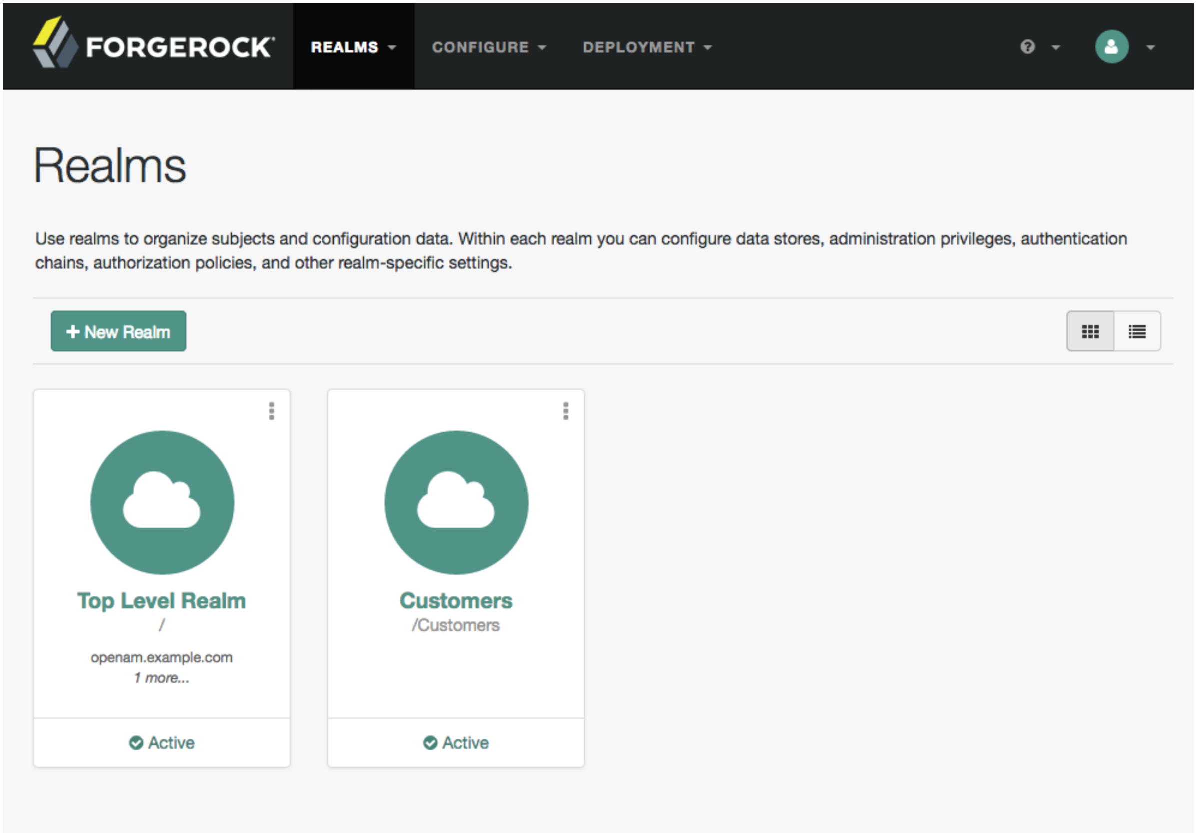
After login, AM redirects you to the AM Realms page.



FORGEROCK
REALMS
CONFIGURE
DEPLOYMENT
Realms
Use realms to organize subjects and configuration data. Within each realm you can configure data stores, administration privileges, authentication chains, authorization policies, and other realm-specific settings.
+ New Realm
Top Level Realm
/
openam.example.com
1 more...
Active
Customers
/Customers
Active

You can also access the AM console by browsing to the console URL, for example `http://openam.example.com:8080/openam/console`.

10. Restrict permissions to the configuration directory (by default, `$HOME/openam`, where $HOME corresponds to the user who runs the web container). Prevent other users from accessing files in the configuration directory.

11. If you specified the Other User Data Store option in the User Data Store Settings screen, you must index several attributes in your external identity repository. See "To Index External Identity Repository Attributes" for more information.

2.2. Installing Multiple Servers

This chapter covers what to do when installing multiple AM servers.

2.2.1. Things to Consider When Installing Multiple Servers

When installing multiple servers, consider the following points:

- You generally install multiple servers to provide service availability. If one server is down for any reason, another server can respond instead. This means that you need some type of component, such as a load balancer or a proxying server, between incoming traffic and AM to route around servers that are down.

  AM uses a *site* for this purpose. In an AM site, multiple AM servers are configured in the same way, and accessed through a load balancer layer.[2] The load balancer can be implemented in hardware or software, but it is separate and independent from AM software. When installed properly, a site configuration improves service availability, as the load balancer routes around AM servers that are down, sending traffic to other servers in the site.

  > **Important**
  >
  > In a multi-AM server with load balancer deployment, sticky load balancing is required during authentication regardless if you are using stateful or stateless sessions. For example, whether you use a single authentication module or multiple authentication modules in a chain, you must implement sticky load balancing using the `amlbcookie`, so that the load balancer can route the appropriate authentication requests to a target server. For more information, see "Configuring Site Sticky Load Balancing". For more information on sessions, see "About Sessions" in the *Authentication and Single Sign-On Guide*.

- The cookie domain is set to the server's full URL that was used to access the configurator, such as `example.net`, `server.west.example.com`, or `helloexample.local`.

- You can use a load balancer layer to protect AM services as well. The load balancer can restrict access to AM services, throttle traffic, offload HTTPS encryption, and so forth.

  As an alternative, or in addition, you can use a separate reverse proxy.

- When you are protecting AM with a load balancer or proxy service, configure your container so that AM can trust the load balancer or proxy service.

- AM authentication can depend on information about the user to authenticate, such as the IP address where the request originated. When AM is accessed through a load balancer or proxy layer, pass this information along using request headers. Also, configure AM to consume and to forward the headers as necessary. See "Handling HTTP Request Headers" for details.

2.2.2. Configuring Sites

The most expedient way to configure a server in a site is to set the site up during the initial AM configuration. In the GUI configurator, this is done in the Site Configuration screen.

[2] Technically, it is possible to configure a site with only one AM server.

To Add a Server to a Site

High availability requires redundant servers in case of failure. With AM, you configure an AM site with multiple servers in a pool behind a load balancing service that exposes a single URL as an entry point to the site.

Follow these steps to configure a server to an existing site:

1. If the site is already using keystore keys in the configuration, such as for signing stateless cookies, SAML v2.0 assertions, and others, copy the keystore from any of the servers of the site to the configuration directory of the new instance:

    a. Create the configuration directory of the new instance, for example, `/path/to/openam/openam`. This directory must be the same as the configuration directory used by other AM servers in the site.

    b. Log in to the AM console and navigate to Deployment > Servers > *Server Name* > Security > Key Store and find the following properties:

    - Keystore File

    - Keystore Password File

    - Private Key Password File

    These properties configure the name and path of the keystore files you need to copy to the new instance. By default, they are located in the `/path/to/openam/openam` directory.

    c. Copy the keystore files from one of the instances of the site to the `/path/to/openam/openam` directory created for the new instance.

2. Navigate to the deployment URL of the new instance. You should see the AM configurator page.

3. In the initial configuration screen, under Custom Configuration, click Create New Configuration.

4. In the first screen, enter the same password entered for the AM Administrator, `amadmin`, when you configured the first server in the site.

5. Configure server settings as required.

    The cookie domain should be identical to that of the first server in the site.

6. In the configuration store screen, select Add to Existing Deployment, and enter the URL of the first AM server in the site.

    The directory used to store configuration data should use the same directory service used for this purpose by other AM servers in the site. If you use the embedded DS server, for example, you can set up the configurator for data replication with embedded directory servers used by other servers in the site.

Settings for the user store are then shared with the existing server, so the corresponding wizard screen is skipped.

7. In the site configuration screen, select `Yes` and enter the same site configuration details as for the first server in the site.

   Settings for agent information are also shared with the existing server, so the corresponding wizard screen is skipped.

8. In the summary screen, verify the settings you chose, and then click Create Configuration.

9. When the configuration process finishes, click Proceed to Login, and then login as the AM administrator to access the AM console.

It is also possible to configure a site separately. If you did not set up a site during initial configuration, perform the following steps to configure a site:

To Configure a Site With the First Server

The following steps show how to set up the site for the first AM server.

1. Log in to the AM console as administrator, by default `amadmin`, and then navigate to Deployment > Sites.

2. Click New to start configuring the new site.

3. On the New Site page enter the site name, and set the Primary URL to the load balancer URL that is the entry point for the site, such as `https://lb.example.com/openam`.

   The site URL is the URL to the load balancer in front of the AM servers in the site. For example, if your load balancer listens for HTTPS on host `lb.example.com` and port `443` with AM under `/openam`, then your site URL is `https://lb.example.com/openam`.

   Client applications and web or Java agents access the servers in the site through the site URL.

4. Click Save to keep the site configuration.

5. Navigate to Deployment > Servers > *Server Name* > General.

6. Set the Parent Site to the name of the site you just created, and then select Save Changes.

   At this point, the server is part of the new site you have configured.

   For all additional servers in the AM site, add them to the site at configuration time as described in "To Add a Server to a Site".

2.2.3. Configuring Load Balancing for a Site

The following table shows load balancer requirements for the different sessions:

Load Balancing Requirements by Session Type

Session Type	Load Balancing Requirement	Comments
Stateful Sessions (Stored in the CTS token Store)	Session stickiness required only during authentication, and recommended for performance.	During authentication, sessions are stored in the memory of the AM server that is handling the authentication process. If a request is sent to a different AM server, the authentication flow will start anew. Although the CTS token store is the authoritative source for stateful sessions, AM servers cache sessions when: • Authenticating a user • Satisfying a session request An AM site configured to use stateful sessions achieves the best performance when the server that originally authenticated a user continually manages that user's session, since it does not need to retrieve it from the CTS token store.
Stateless Sessions (Stored at the client)	Session stickiness required only during authentication, and recommended for performance.	During authentication, sessions are stored in the memory of the AM server that is handling the authentication process. If a request is sent to a different AM server, the authentication flow will start anew. Although the user's session or authentication session resides in a JWT stored on the client which is passed to AM server along with the request, stateless sessions should be signed and/or encrypted for security reasons. Because decrypting and verifying the session on each request may be an expensive operation depending on the algorithms configured, AM caches the decrypt sequence in memory to improve performance. Therefore, an AM site configured to use stateless sessions achieves best performance when the same server manages every request for the same session or authentication session.

For more information about AM session types, see "Session State" in the *Authentication and Single Sign-On Guide*.

2.2.3.1. Configuring Site Sticky Load Balancing

Configure your load balancer for sticky sessions as follows:

To Configure Site Load Balancing

1. For each AM server in the site, navigate to Deployment > Servers > *Server Name* > General and set Parent Site to the site you created. Then, save your work.

2. Ensure that the `amlbcookie` cookie has a unique value for each AM server:

   a. For each AM server in the site, navigate to Deployment > Servers > *Server Name* > Advanced and review the value of the `com.iplanet.am.lbcookie.value` property. By default, the cookie value is set to the AM server ID.

      Keep the value of the `amlbcookie` cookie set to the AM server ID to improve server performance when using:

      - Web Agents 5

      - Web Agents 4.1.x with CDSSO mode enabled

      If you have replaced the value of the this property and you need to match the AM server URLs with their corresponding server IDs, query the `global-config/servers` endpoint. For example:

```
$ curl -X GET
 \
--header 'Accept: application/json'
 \
--header "iPlanetDirectoryPro: AQIC5...NDU1*" \
'https://openam.example.com:8443/openam/json/global-config/servers?_queryFilter=true'
"result": [
 {
   "_id": "01",
   "_rev": "-1541617246",
   "siteName": null,
   "url": "https://openam.example.com:8443/openam"
 }
],
"resultCount": 1,
"totalPagedResults": -1,
"totalPagedResultsPolicy": "NONE"
}
```

      In the example above, the server ID for server `https://openam.example.com:8443/openam` is `01`.

      Changes take effect only after you restart the AM server.

   b. Restart each AM server where you changed the cookie value. You can then check the cookie value by logging in to the AM console, and examining the `amlbcookie` cookie in your browser.

3. Configure your load balancer to perform sticky load balancing based on the `amlbcookie` value.

   In other words, the load balancer layer must keep track of which `amlbcookie` cookie value corresponds to which AM server.

   When the load balancer receives a request, it inspects the value of the `amlbcookie` cookie, and then forwards the request to the corresponding AM server.

2.2.3.2. Load Balancer Termination

When traffic to and from the load balancer is protected with HTTPS, the approach described in "To Configure Site Load Balancing" requires that you terminate the connection on the load balancer. You then either re-encrypt the traffic from the load balancer to AM, or make connections from the load balancer to AM over HTTP.

2.2.3.3. Request Forwarding Caveats

Sticky load balancing based on the value of the `amlbcookie` cookie does not guarantee request forwarding to the corresponding AM server in all cases. For example, ForgeRock Common REST API calls do not typically use cookies. Therefore, load balancers are not able to route these calls to the AM server on which a user's session is cached.

The AM server that does not hold the user's session in cache must locate the user's session by retrieving it from the Core Token Service's token store.

2.2.4. Handling HTTP Request Headers

HTTP requests can include information needed for access management, such as the client IP address used for adaptive risk-based authentication.

Configure your load balancer or proxy to pass the information to AM by using request headers. For example, the load balancer or proxy can send the client IP address by using the `X-Forwarded-For` HTTP request header.

Also configure AM to consume and to forward the headers as necessary. For example, to configure AM to look for the client IP address in the `X-Forwarded-For` request header, set the advanced configuration property `com.sun.identity.authentication.client.ipAddressHeader` to `X-Forwarded-For` under Deployment > Servers > *Server Name* > Advanced.

In a site configuration where one AM server can forward requests to another AM server, you can retain the header by adding it to the advanced configuration property `openam.retained.http.request.headers`. If `X-Forwarded-For` is the only additional header to retain, set `openam.retained.http.request.headers` to `X-DSAMEVersion,X-Forwarded-For`, for example.

Configure these properties under Deployment > Servers > *Server Name* > Advanced.

2.2.5. Handling Multiple Cookie Domains When Using Wildfly

If you are using Wildfly as the AM web container with multiple cookie domains, you must set the advanced server property, `com.sun.identity.authentication.setCookieToAllDomains`, to `false`.

Set this property in the AM console under Configure > Server Defaults > Advanced.

2.3. Installing and Using the Tools

The tools are found in `.zip` files where you unpacked the archive of the entire package, such as `~/Downloads/openam`.

The `.zip` files containing AM tools are:

`SSOAdminTools-5.1.1.8.zip`

Administration tools: **ampassword**, **ssoadm**, and **amverifyarchive**

See "Setting Up Administration Tools".

`SSOConfiguratorTools-5.1.1.8.zip`

Configuration and upgrade tools, alternatives to using the GUI configuration wizard

See "Setting up Configuration Tools" and "Installing Silently".

2.3.1. Setting Up Administration Tools

The **ssoadm** administration tool requires access to AM configuration files, and therefore must be installed on the same host as AM core services.

To Set Up Administration Tools

1. Verify that AM is installed and running before proceeding.
2. Verify that the `JAVA_HOME` environment variable is set properly:

   ```
   $ echo $JAVA_HOME
   /path/to/jdk
   ```

3. Create a file system directory to unpack the tools:

   ```
   $ mkdir -p /path/to/openam-tools/admin
   ```

4. Unpack the tools:

   ```
   $ cd /path/to/openam-tools/admin
   $ unzip ~/Downloads/openam/SSOAdminTools-5.1.1.8.zip
   ```

5. Add `--acceptLicense` to the **java** command at the end of the **setup** or **setup.bat** script if you want to auto-accept the license agreement and suppress the license acceptance screen to the user:

   ```
   $JAVA_HOME/bin/java -D"load.config=yes" \
                       -D"help.print=$help_print" \
                       -D"path.AMConfig=$path_AMConfig" \
                       -D"path.debug=$path_debug" \
                       -D"path.log=$path_log" \
                       -cp "$CLASSPATH" com.sun.identity.tools.bundles.Main \
                       --acceptLicense
   ```

6. (Optional) If you use IBM Java, add `-D"amCryptoDescriptor.provider=IBMJCE"` and `-D"amKeyGenDescriptor.provider=IBMJCE"` options to the **setup** or **setup.bat** script before you install the tools.

   The options should be set for the **java** command at the end of the script:

   ```
   $ tail setup
   CLASSPATH="$CLASSPATH:resources"

   $JAVA_HOME/bin/java -D"load.config=yes" \
                       -D"help.print=$help_print" \
                       -D"path.AMConfig=$path_AMConfig" \
                       -D"path.debug=$path_debug" \
                       -D"path.log=$path_log" \
                       -D"amCryptoDescriptor.provider=IBMJCE" \
                       -D"amKeyGenDescriptor.provider=IBMJCE" \
                       -cp "$CLASSPATH" \
                       com.sun.identity.tools.bundles.Main
   ```

7. Run the **setup** utility (**setup.bat** on Windows), providing paths to the directories where AM configuration files are located, and where debug and log information will be located:

   ```
   $ ./setup
   Path to config files of OpenAM server [/home/user/openam]:
   Debug Directory [/path/to/openam-tools/admin/debug]:
   Log Directory [/path/to/openam-tools/admin/log]:
   The scripts are properly setup under directory:
    /path/to/openam-tools/admin/openam
   Debug directory is /path/to/openam-tools/admin/debug.
   Log directory is /path/to/openam-tools/admin/log.
   The version of this tools.zip is: version and date
   The version of your server instance is: OpenAM version and date
   ```

   After setup, the tools are located under a directory named after the instance of AM:

   ```
   $ ls openam/bin/
   ampassword  amverifyarchive  ssoadm
   ```

   On Windows, these files are `.bat` scripts.

8. (Optional) If your web container uses a self-signed certificate as described in "To Set Up With HTTPS and Self-Signed Certificates", then the **ssoadm** command will not trust the certificate when connecting to AM over HTTPS, or when AM connects to the configuration store over LDAPS.

   To allow the **ssoadm** command to trust the certificate, add the `-D"javax.net.ssl.trustStore=/path/to/tomcat/conf/keystore.jks"` option to the **ssoadm** or **ssoadm.bat** script before using the script.

   The option should be set before the call to `com.sun.identity.cli.CommandManager` at the end of the script:

   ```
   $ tail -2 /path/to/openam-tools/admin/openam/bin/ssoadm
       -D"javax.net.ssl.trustStore=/path/to/tomcat/conf/keystore.jks" \
       com.sun.identity.cli.CommandManager "$@"
   ```

> **Note**
>
> In non-production environments, you can configure the **ssoadm** command to trust all server certificates. For more information, see Q. How do I configure ssoadm to trust all certificates? in the *ForgeRock Knowledge Base*.

9. (Optional) If you use IBM Java, add `-D"amCryptoDescriptor.provider=IBMJCE"` and `-D"amKeyGenDescriptor.provider=IBMJCE"` options to the **ssoadm** or **ssoadm.bat** script before using the script.

   The options should be set before the call to `com.sun.identity.cli.CommandManager` at the end of the script:

   ```
   $ tail -3 /path/to/openam-tools/admin/openam/bin/ssoadm
       -D"amCryptoDescriptor.provider=IBMJCE" \
       -D"amKeyGenDescriptor.provider=IBMJCE" \
       com.sun.identity.cli.CommandManager "$@"
   ```

10. Check that the **ssoadm** command works properly:

    a. Create a text file, for example `$HOME/.pwd.txt`, containing the AM administrative user's password string in cleartext on a single line.

    b. Make the text file read-only:

    ```
    $ chmod 400 $HOME/.pwd.txt
    ```

    c. Run the **ssoadm** command to list the configured servers:

    ```
    $ cd /path/to/openam-tools/admin/openam/bin/
    $ ./ssoadm list-servers -u amadmin -f $HOME/.pwd.txt
    http://openam.example.com:8080/openam
    ```

11. If you have deployed AM in a site configuration, edit the **ssoadm** (**ssoadm.bat** on Windows) script to map the site URL to the AM server URL.

    To do this, set the `com.iplanet.am.naming.map.site.to.server` system property as a **java** command option in the script. The option takes the following form:

    ```
    -D"com.iplanet.am.naming.map.site.to.server=lb-url=openam-url[,
     other-lb-url=openam-url ...]"
    ```

    The property maps each *lb-url* key to an *openam-url* value, where *lb-url* is the URL to a site load balancer, and *openam-url* is the URL to the AM server against which you set up the **ssoadm** command.

> **Important**
>
> The **ssoadm** command is dependent on the AM server against which you set it up, so always map site load balancer URLs to that server's *openam-url*.

For example, if your site is behind `https://lb.example.com:443/openam`, and the AM server against which you set up the **ssoadm** command is at `http://openam.example.com:8080/openam`, then add the following property to the **java** command (all on one line without spaces):

```
-D"com.iplanet.am.naming.map.site.to.server=
 https://lb.example.com:443/openam=http://openam.example.com:8080/openam"
```

Repeat this step for each AM server in your site configuration. You can install all your instances of **ssoadm** on the same host, but in each case the command should manage only one AM server.

2.3.2. Setting up Configuration Tools

This section covers setting up the configuration and upgrade tools, which are alternatives to using the GUI configuration wizard.

To Set up Configuration Tools

1. Verify that the `JAVA_HOME` environment variable is properly set:

   ```
   $ echo $JAVA_HOME
   /path/to/jdk
   ```

2. Create a file system directory to unpack the tools:

   ```
   $ mkdir -p /path/to/openam-tools/config
   ```

3. Unpack the tools from where you unzipped AM:

   ```
   $ cd /path/to/openam-tools/config
   $ unzip ~/Downloads/openam/SSOConfiguratorTools-5.1.1.8.zip
   Archive:  ~/Downloads/openam/SSOConfiguratorTools-5.1.1.8.zip
      creating: legal-notices/
     inflating: legal-notices/LICENSE.DOM-software.html
     inflating: legal-notices/NOTICE.resolver.txt
     inflating: legal-notices/LICENSE.DOM-documentation.html
           ... (more output) ...
    extracting: lib/xml-apis-2.11.0.jar
    extracting: openam-configurator-tool-14.1.1.8.jar
    extracting: lib/servlet-api-2.5.jar
   ```

2.3.3. Installing Silently

Use the AM configurator tool, `openam-configurator-tool-14.1.1.8.jar`, to silently install AM. The AM server must be deployed and running, but not yet configured, when you use the tool.

To Silently Install

Perform the following steps:

1. Verify that the `JAVA_HOME` environment variable is properly set:

   ```
   $ echo $JAVA_HOME
   /path/to/jdk
   ```

2. The configurator tool relies on a property file to specify the configuration for the AM server. For property file options, see configurator.jar(1).

   Copy the sample configuration property file provided with AM, and then modify properties as needed:

   ```
   $ cd /path/to/openam-tools/config
   $ cp sampleconfiguration config.properties
   $ grep -v "^#" config.properties | grep -v "^$"
   SERVER_URL=http://openam.example.com:8080
   DEPLOYMENT_URI=/openam
   BASE_DIR=/home/openam/openam
   locale=en_US
   PLATFORM_LOCALE=en_US
   AM_ENC_KEY=
   ADMIN_PWD=password
   COOKIE_DOMAIN=openam.example.com
   ACCEPT_LICENSES=true
   DATA_STORE=embedded
   DIRECTORY_SSL=SIMPLE
   DIRECTORY_SERVER=openam.example.com
   DIRECTORY_PORT=50389
   DIRECTORY_ADMIN_PORT=4444
   DIRECTORY_JMX_PORT=1689
   ROOT_SUFFIX=dc=openam,dc=forgerock,dc=org
   DS_DIRMGRDN=cn=Directory Manager
   DS_DIRMGRPASSWD=password
   ```

   When setting options in the property file, note the following:

   - If you include the `ACCEPT_LICENSES=true` property, AM auto-accepts the software licensing agreement and suppresses display of the license acceptance screen during silent installation.

   - When installing AM to support HTTPS, make sure the `SERVER_URL` property specifies a URL with HTTPS, and set the `DIRECTORY_SSL` property to `SIMPLE`.

3. Run the AM configurator tool, `openam-configurator-tool-14.1.1.8.jar`:

   ```
   java -jar openam-configurator-tool-14.1.1.8.jar --file config.properties
   ```

   If required, you can specify additional run-time options on the command line:

- With the `--acceptLicense` option, the installer auto-accepts the software licensing agreement and suppresses the display of the license acceptance screen, resulting in the same behavior as specifying `ACCEPT_LICENSES=true` in the configuration property file.

- The `-Djavax.net.ssl.trustStore=PATH_TO_JKS_TRUSTSTORE` option is required when installing AM to support HTTPS. Specify the AM web container's trust store for `PATH_TO_JKS_TRUSTSTORE`.

Output similar to the following appears:

```
$ java -jar openam-configurator-tool-14.1.1.8.jar --file config.properties
Checking license acceptance...License terms accepted.
Checking configuration directory /home/openam/openam....Success.
Installing OpenAM configuration store...Success RSA/ECB/OAEPWithSHA1AndMGF1...
Extracting OpenDJ, please wait...Complete
Running OpenDJ setupSetup command: --cli --adminConnectorPort 4444
 --baseDN dc=openam,dc=forgerock,dc=org --rootUserDN cn=Directory Manager
 --ldapPort 50389 --skipPortCheck --rootUserPassword xxxxxxx --jmxPort 1689
 --no-prompt --doNotStart --hostname openam.example.com ..
.
...Success
Installing OpenAM configuration store in /home/openam/openam/... ...Success.
Creating OpenAM suffixImport+task+ ... ...Success
Tag swapping schema files....Success.
Loading Schema opendj_config_schema.ldif...Success.

...

...Success.
Reinitializing system properties....Done
Registering service dashboardService.xml...Success.

...

Configuring system....Done
Configuring server instance....Done
Creating demo user....Done
Creating Web Service Security Agents....Done
Setting up monitoring authentication file.
Configuration complete!
```

2.4. Starting Servers

AM is a web application installed in a web container, such as Apache Tomcat. Starting the web container starts the AM application.

At the beginning of its startup process, AM performs an operation called *bootstrapping*, during which AM obtains startup settings from a bootstrap file in its configuration directory, then uses those settings to initiate its operation. AM creates the bootstrap file during installation, based on values you provide when you run the AM configurator.

After every successful startup, AM rewrites the bootstrap file with its initial contents.

2.4.1. Overriding Startup Settings

Users who deploy AM with DevOps tooling—for example, Docker and Kubernetes—might want to launch multiple AM servers from a single image, providing startup settings dynamically when AM starts up instead of reading the settings from the bootstrap file created during AM installation.

You can replace the bootstrap file and provide your own static and dynamic startup settings. The following sections describe how to override the bootstrap file created during AM installation:

- "Replacing the Bootstrap File" covers how to specify a custom bootstrap file, and describes all the startup settings in the bootstrap file.
- "Overriding Startup Settings by Using Environment Variables" covers how to dynamically override startup settings in the bootstrap file with environment variables.
- "Overriding Startup Settings by Using Java Properties" covers how to dynamically override startup settings in the bootstrap file with Java properties.

2.4.1.1. Replacing the Bootstrap File

AM's bootstrap file is located at the path `/path/to/openam/boot.json`, where `/path/to/openam` is the AM configuration directory. The AM configuration directory is specified during during AM installation, as follows:

- In the Configuration Directory field on the Server Settings page when using GUI installation. See "To Custom Configure an Instance" for details.
- In the `BASE_DIR` property in the installation configuration file when using command-line installation. See configurator.jar(1) for more information.

To override AM's startup configuration, modify the bootstrap file, `boot.json`, and then overwrite the existing bootstrap file with your modified file *prior to every AM restart*. You must overwrite the file each time you start AM because after startup, AM overwrites the bootstrap file with the initial startup settings created during AM installation, removing any modifications you might have made to startup settings in the bootstrap file.

Make changes to supporting files and passwords before changing bootstrap file properties—AM will fail to start up when bootstrap file properties do not correspond to actual configuration. For example, if you change the value of the `keyStorePasswordFile` property to a file that does not exist, AM will not be able to start up.

The following is an example AM bootstrap file:

```
{
  "instance" : "http://openam.example.com:8080/openam",
  "dsameUser" : "cn=dsameuser,ou=DSAME Users,dc=openam,dc=forgerock,dc=org",
  "keystores" : {
    "default" : {
      "keyStorePasswordFile" : "/home/openam/openam/.storepass",
      "keyPasswordFile" : "/home/openam/openam/.keypass",
      "keyStoreType" : "JCEKS",
      "keyStoreFile" : "/home/openam/openam/keystore.jceks"
    }
  },
  "configStoreList" : [ {
    "baseDN" : "dc=openam,dc=forgerock,dc=org",
    "dirManagerDN" : "cn=Directory Manager",
    "ldapHost" : "opendj.example.com",
    "ldapPort" : 1389,
    "ldapProtocol" : "ldap"
  } ]
}
```

The AM bootstrap file has the following properties:

Startup Settings in the Bootstrap File

Property	**Description and Derivation**
`instance`	AM server URL. Defaults to the Server URL field on the Server Settings page (GUI configurator) or the `SERVER_URL` configuration property (command-line configurator). This property's value is the URL for directly accessing an AM server instance, *not* an AM site using a load balancer URL. Do not modify this bootstrap file property. If you need to change the AM server URL, reinstall AM.
`dsameUser`	Special AM user. The first part of the user's DN is always created initially as `cn=dsameuser,ou=DSAME Users`. The second part of the DN defaults to the Root Suffix field on the Configuration Data Store Settings page (GUI configurator) or the `ROOT_SUFFIX` configuration property (command-line configurator).
`keystores.default`	The AM keystore. Currently, no other keystores are referenced in the bootstrap file.
`keystores.default.keyStorePasswordFile`	Path to the file that contains the password required to open the AM keystore. Always created initially as `/path/to/openam/openam/.storepass`. When creating a new `.storepass` file, ensure that there are no hidden trailing characters after the password. For example, use the **echo -n** command to add the password to the new file.

Property	Description and Derivation
`keystores.default.keyPasswordFile`	Path to the file that contains the password used to encrypt individual keystore entries. Always created initially as `/path/to/openam/openam/.keypass`. When creating a new `.keypass` file, ensure that there are no hidden trailing characters after the password. For example, use the **echo -n** command to add the password to the new file.
`keystores.default.keyStoreType`	AM key store type. Currently, the only valid value is `JCEKS`.
`keystores.default.keyStoreFile`	Path to the AM keystore. Always created initially as `/path/to/openam/openam/keystore.jceks`. The AM keystore is required for startup because it contains the password of the directory manager user of the AM configuration store.
`configStoreList[*]`	Array of one or more objects that describe AM configuration stores. The initial object in the array is mandatory and defines the primary configuration store. Additional objects are optional and define failover configuration stores.
`configStoreList[*].baseDN`	Root suffix of the AM configuration store. Defaults to the Root Suffix field on the Configuration Data Store Settings page (GUI configurator) or the `ROOT_SUFFIX` configuration property (command-line configurator).
`configStoreList[*].dirManagerDN`	DN of the configuration store directory manager user. Defaults to `cn=Directory Manager` (GUI configurator) or the `DS_DIRMGRDN` configuration property (command-line configurator).
`configStoreList[*].ldapHost`	Fully-qualified domain name (FQDN) of the configuration store's host. Defaults to the Host Name field on the Configuration Data Store Settings page (GUI configurator) or the `DIRECTORY_SERVER` configuration property (command-line configurator).
`configStoreList[*].ldapPort`	LDAP or LDAPS port number on which to access the configuration store. Defaults to the Port field on the Configuration Data Store Settings page (GUI configurator) or the `DIRECTORY_PORT` configuration property (command-line configurator).
`configStoreList[*].ldapProtocol`	Protocol with which to access the directory service running the configuration store. The value can be `ldap` or `ldaps`. Defaults to the SSL/TLS Enabled field on the Configuration Data Store Settings page (GUI configurator) or the `DIRECTORY_SSL` configuration property (command-line configurator).

2.4.1.2. Overriding Startup Settings by Using Environment Variables

You can dynamically override startup settings in the bootstrap file by defining environment variables in the shell that starts AM and referencing the variables in a modified version of the bootstrap file.

Specify JSON properties that reference environment variables in a modified bootstrap file that uses the notation `${env.MY_ENVIRONMENT_VARIABLE}`.

For example, you could dynamically change the AM instance URL as follows:

To Override Startup Settings by Using Environment Variables

1. Set an environment variable named `MY_INSTANCE` in the shell that starts AM.
2. Create a modified version of the bootstrap file with the following line:

   ```
   "instance" : "${env.MY_INSTANCE}",
   ```

3. Overwrite the initial bootstrap file with the modified bootstrap file.
4. Start AM.

2.4.1.3. Overriding Startup Settings by Using Java Properties

You can dynamically override startup settings in the bootstrap file by referencing Java system properties in a modified version of the bootstrap file. You can reference both built-in Java system properties and properties specified with the `-D` option in the web container that runs AM.

Specify JSON properties that reference Java properties in a modified bootstrap file that uses the notation `${MY_JAVA_PROPERTY}`.

For example, you could dynamically change the AM keystore's path to the user's home directory as follows:

To Override Startup Settings by Using Java Properties

1. Create a modified version of the bootstrap file, specifying the default AM keystore as follows:

   ```
   "keystores" : {
       "default" : {
         "keyStorePasswordFile" : "${user.home}/.storepass",
         "keyPasswordFile" : "${user.home}/.keypass",
         "keyStoreType" : "JCEKS",
         "keyStoreFile" : "${user.home}/keystore.jceks"
       }
     },
   ```

2. Overwrite the initial bootstrap file with the modified bootstrap file.
3. Start AM.

Chapter 3

Implementing the Core Token Service

AM's Core Token Service (CTS) provides generalized, persistent, and highly available storage for sessions and tokens used by AM. AM uses CTS as the authoritative source for stateful sessions and caches these stateful sessions in its memory heap to improve performance.[1]

CTS supports *session high availability*, which lets AM manage a session as long as one of the AM servers in a clustered deployment is available. After a user has successfully authenticated, AM creates a stateful session and stores it in the CTS. Any AM instance that is configured to use the same CTS can retrieve the session and allow access to it. The user does not need to log in again unless the entire deployment goes down.[2]

CTS provides storage for the following:

- AM stateful sessions
- OAuth 2.0
- UMA 2.0
- Session blacklist (if enabled for stateless sessions)
- SAML v2.0 (if enabled for Security Token Service token validation and cancellation)
- OAuth 2.0 stateless sessions and session blacklist
- Push notification during authentication
- Cluster-wide notification

3.1. CTS Deployment Architectures

You can deploy CTS token stores in a number of deployment architectures depending on your system requirements. In particular, four types of deployment exist for CTS:

- "CTS Token Store Deployment Using Embedded Configuration Store"
- "CTS Active-Passive Deployment"
- "CTS Affinity Deployment"
- "CTS Site Deployment"

[1] Prior to AM 5, the authoritative source for stateful sessions was the memory heap of AM's web container.
[2] Prior to AM 5, session high availability, formerly referred to as session failover, was optional. Starting with AM 5, session high availability is the default behavior in AM and cannot be disabled.

3.1.1. CTS Token Store Deployment Using Embedded Configuration Store

By default, AM writes CTS entries in the AM configuration store: either an embedded or external configuration store. If you configured AM to use an embedded configuration store, limit your use of this default deployment to very small-scale, single-server test deployments—in multi-server deployments with load balancing, the active-active topology used by multiple embedded configuration stores can lead to write collisions.

Important

Do not use this deployment in production environments.

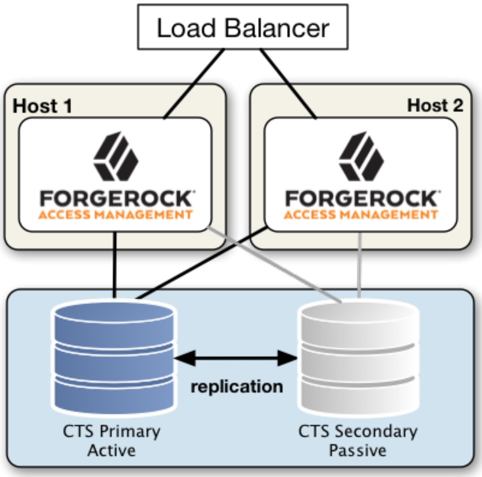
3.1.2. CTS Active-Passive Deployment

An active-passive CTS deployment consists of an active DS instance that receives all requests from the AM servers, and one or more passive DS instances on standby. If the active instance becomes unreachable, one of the passive instances takes over and continues to process transactions. Active-passive clusters provide flexible deployment options with AM and are best suited for small to medium-sized deployments.

The following example shows an active-passive DS cluster configured as CTS token stores. The active DS instances use multimaster replication across the CTS cluster to ensure data is up-to-date.

Prioritize the connections to the primary directory server instance on the AM console and designate additional DS instances for failover using the Connection String(s) property in the CTS configuration. This property allows you to configure multiple DS servers for your CTS token stores without a load balancer.

A CTS Active-Passive Deployment



Important

Do not deploy CTS token stores behind a load balancer using a random or round-robin algorithm.

When AM writes to a directory server in the external CTS store, directory server replication pushes the write to other directory servers in the same replication group. Under load, operations in an AM server can happen more quickly than the network can push replication updates. Therefore, balancing the LDAP traffic from AM to the CTS store using a random or round-robin algorithm leads to errors where a read operation arrives at a replica before the expected write operation can cross the network.

If you need to deploy CTS behind a load balancer, make sure that it is configured for session stickiness.

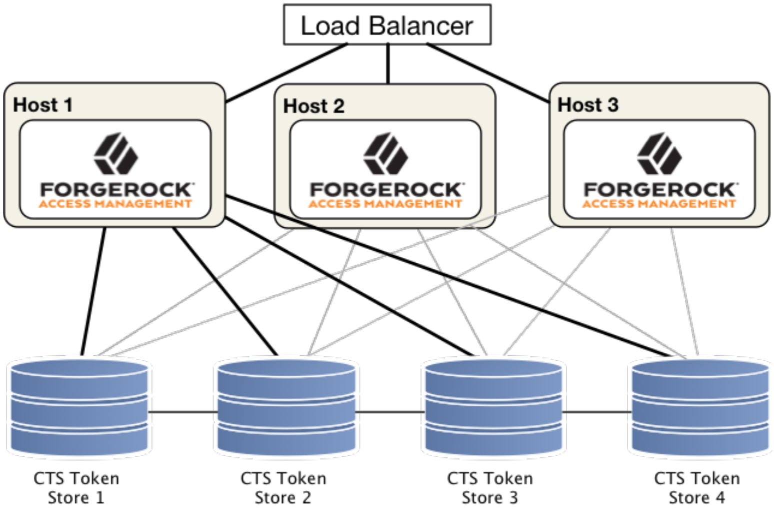
For more information on the Connection String(s) property, see "External Store Configuration" in the *Reference*.

3.1.3. CTS Affinity Deployment

In an *affinity* deployment, AM connects to one or more writable directory servers to spread tokens equally to the CTS token stores across multiple directory server instances. For any CTS token, AM uses a sharding algorithm to determine the token's affinity to a specific DS instance and attempts to retrieve the token from that designated server. Affinity deployments are best suited for deployments with many AM servers and provides a highly scalable solution for multiple CTS token stores.

Use AM's Connection String(s) property on the AM console to configure server affinity without a load balancer. For more information on the Connection String(s) property, see "External Store Configuration" in the *Reference*.

A CTS Affinity Deployment



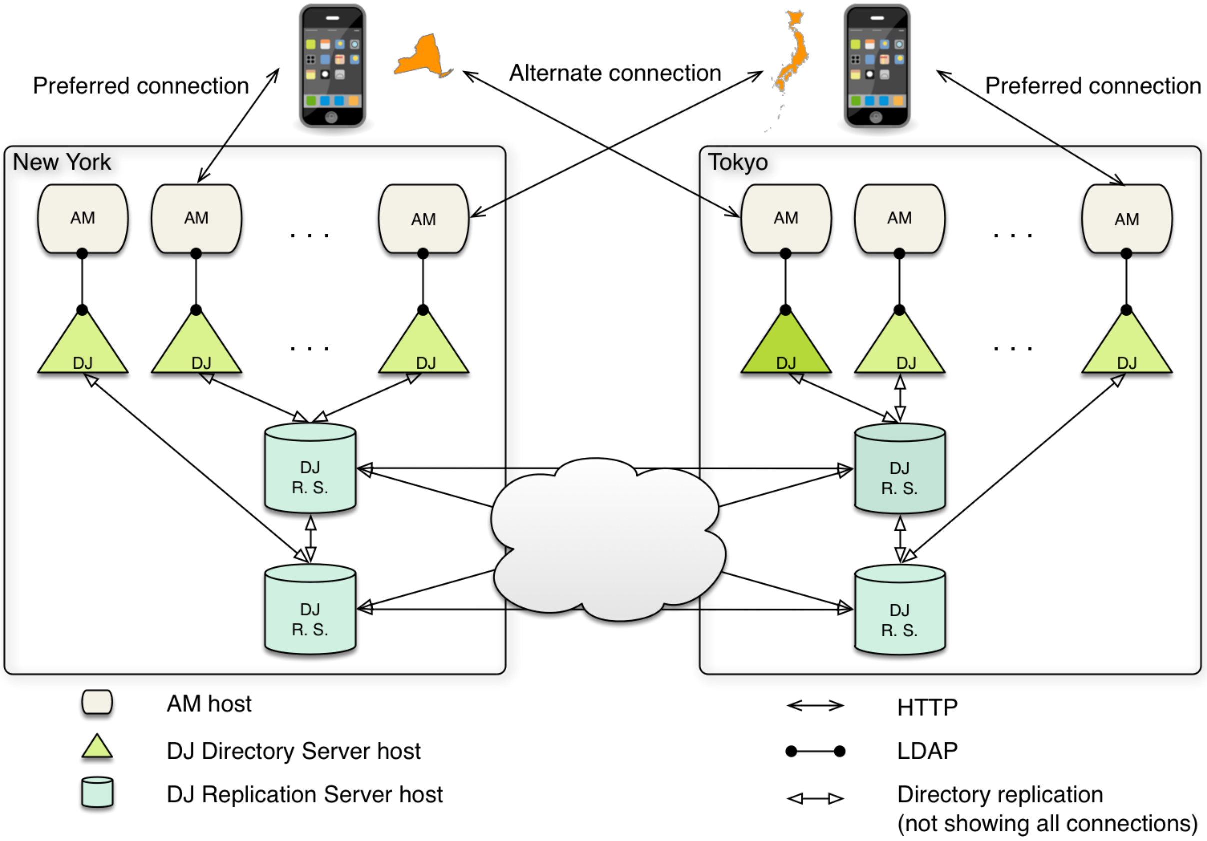
For more information on CTS affinity deployments, see Best practice for using Core Token Service (CTS) Affinity based load balancing in AM (All versions) and OpenAM 13.5.1 in the *ForgeRock Knowledge Base*.

3.1.4. CTS Site Deployment

CTS supports uninterrupted session availability in deployments with multiple sites if all sites use the same global underlying CTS store replicated across all sites. If an entire site fails or becomes unavailable, AM servers in another site can detect the failure of the site's load balancer and attempt to use sessions from the global Core Token Service.

In the event of a failure, client applications can connect to an AM server in an active data center as shown in "Core Token Service For Global Session Failover":

Core Token Service For Global Session Failover



For more information on CTS for global session high availability with DS server, see the DS documentation on *Managing Data Replication*.

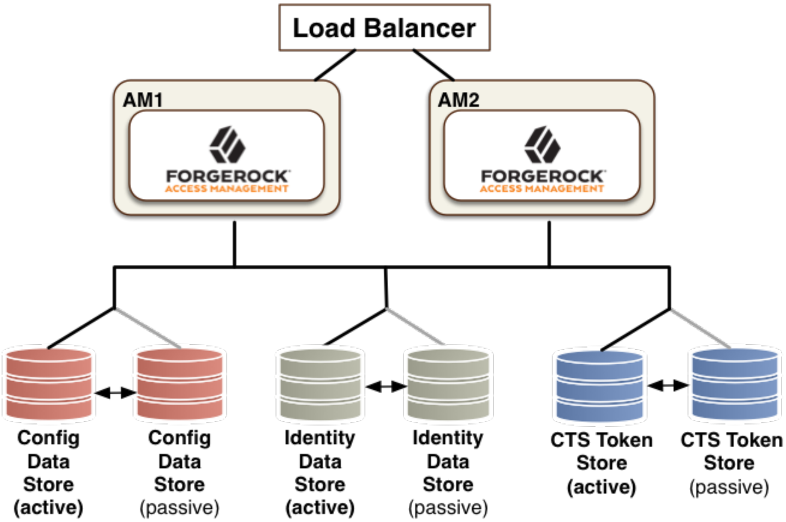
3.2. General Recommendations for CTS Configuration

CTS helps your deployment avoid single points of failure (SPOF). To reduce the impact of any given failure, consider the following recommendations:

- **Configure External CTS Stores for High Volumes**. If you require a higher-level performance threshold, you may want to move the CTS token storage to one or more dedicated systems, as CTS generally causes much more replication traffic than less volatile configuration data. The CTS token store is the primary source for session tokens and will experience both high read and write activity depending on session usage. Dedicated external CTS stores provide an extra level of control over the amount of global replication that is occurring.

- **Isolate the Different Stores**. CTS entries are large, around 5KB, but are short-lived, whereas configuration data is static and long-lived. User entries are more dynamic than configuration data but much less volatile than CTS data. Therefore, isolating the user, configuration, and CTS data from AM into separate stores allow for different tuning and storage settings per token store type.

Isolate the Datastores


Load Balancer
AM1
FORGEROCK ACCESS MANAGEMENT
AM2
FORGEROCK ACCESS MANAGEMENT
Config Data Store (active)
Config Data Store (passive)
Identity Data Store (active)
Identity Data Store (passive)
CTS Token Store (active)
CTS Token Store (passive)

- **Properly Tune Your DS Servers**. To improve performance, ensure that you have properly-sized directory servers for your external CTS stores. In addition, you can enable token compression as discussed in "Managing CTS Tokens". When enabled, token compression reduces load requirements on the network connection between token stores in exchange for processing time-compressing tokens.

- **Consider Dedicated Replication Servers**. Once configured, the DS server replicates CTS data transmitted from AM servers to connected DS servers. The amount of replication traffic can be significant, especially if replication proceeds over a WAN. You can limit this replication traffic by separating DS instances into directory and replication servers as seen in "Core Token Service For Global Session Failover". For more information on how this is done with DS, see the DS documentation on *Standalone Replication Servers*.

3.3. CTS Deployment Steps

The Default Configuration option installs AM with an embedded DS server that stores both configuration and CTS data. The default option is suitable for AM evaluation purposes, or for single site or smaller-scale environments where lower volume write loads and replication traffic occur.

In general, CTS causes more volatile replication traffic due to the nature of its short-lived tokens compared to regular configuration data. To handle the data volatility, you can configure AM to use the embedded directory server as a dedicated configuration token store, while using an external DS server instance as a CTS store. This type of deployment is useful if you have multiple AM instances in a fully-replicated topology communicating with an external CTS token store over a WAN.

You can deploy CTS using an external directory server by running the instructions in the following sections:

- "Installing and Configuring Directory Services for CTS"
- "Import CTS Files"
- "Non-Admin User Creation and ACI Import"
- "CTS Index Import and Build"
- "CTS Configuration"
- "Testing Session High Availability"

This section assumes that you have deployed two AM instances in a site. If you have not completed these steps, see "To Configure Site Load Balancing". It is also assumed that both AM instances communicate with the CTS instance, `cts.example.com` on port 1389.

3.3.1. Installing and Configuring Directory Services for CTS

The following instructions show how to download, install, and set up the DS server.

To Download and Install Directory Services

1. Go to the ForgeRock BackStage website, and then download a supported version of DS server.

2. Unzip the DS distribution and run the **setup** command.

3. Install DS with the installation parameters required for your deployment. Note, however, that SSL may be required in production deployments. This example uses the following parameters:

```
Accept license?: yes
Initial Root User DN for the Directory Server: cn=Directory Manager
Password for the Initial Root User: <password value>
Fully Qualified Hostname: cts.example.com
LDAP Listening Port: 1389
Administration Connector Port: 4444
Create Base DNs: yes
Backend Type*: JE Backend ([1])
Base DN for Directory Data: cn=cts,ou=famrecords,ou=openam-session,ou=tokens
Option for Populating Database: Option 2 - Only create base entry
Do You Want to Enable SSL: no (may be required for your deployment)
Do You Want to Enable StartTLS: no (may be required for your deployment)
Do You Want To Start The Server: yes
What Would You Like To Do: 1 - Set up server with parameters above
```

* The Backend Type choice is available for OpenDJ 3.0 directory server and later.

3.3.2. Import CTS Files

Once the DS installation is complete and the instance is operational, import the schema, multivalue, index and container files for CTS as shown in the procedure below.

To Import the CTS Configuration

1. Copy the CTS schema and then add it the repository.

```
$ TOMCAT_OPENAM_WEBAPP=/path/to/tomcat/webapps/openam
$ T=/tmp/ldif
$ rm -rf $T
$ mkdir $T
$ cp $TOMCAT_OPENAM_WEBAPP/WEB-INF/template/ldif/sfha/cts-add-schema.ldif $T/cts-add-schema.ldif
```

If you are using OpenDJ 4.0 or later:

```
$ ./ldapmodify
 \
--port 1389
 \
--bindDN "cn=Directory Manager"
 \
--bindPassword password \
$T/cts-add-schema.ldif
```

If DS runs in production mode, then you must use the `--useStartTls` option to authenticate as Directory Manager on the LDAP port. This applies to the example above, and to other examples in this chapter.

If you are using OpenDJ 3.5 or earlier:

```
$ ./ldapmodify
 \
--port 1389
 \
--bindDN "cn=Directory Manager"
 \
--bindPassword password
 \
--filename $T/cts-add-schema.ldif
```

The output should be:

```
# Processing MODIFY request for cn=schema
# MODIFY operation successful for DN cn=schema
```

2. Copy the multivalue file and then add it to the repository.

```
$ cp $TOMCAT_OPENAM_WEBAPP/WEB-INF/template/ldif/sfha/cts-add-multivalue.ldif $T/cts-add-multivalue
.ldif
```

If you are using OpenDJ 4.0 or later:

```
$ ./ldapmodify
 \
--port 1389
 \
--bindDN "cn=Directory Manager"
 \
--bindPassword password \
$T/cts-add-multivalue.ldif
```

If you are using OpenDJ 3.5 or earlier:

```
$ ./ldapmodify
 \
--port 1389
 \
--bindDN "cn=Directory Manager"
 \
--bindPassword password
 \
--filename $T/cts-add-multivalue.ldif
```

3. Copy the multivalue index file, and then replace the `@DB_NAME@` variable with your repository in the file. Then, add the file to the repository.

```
$ cat $TOMCAT_OPENAM_WEBAPP/WEB-INF/template/ldif/sfha/cts-add-multivalue-indices.ldif \
 | sed -e 's/@DB_NAME@/userRoot/' > $T/cts-add-multivalue-indices.ldif
```

If you are using OpenDJ 4.0 or later:

```
$ ./ldapmodify
 \
--port 1389
 \
--bindDN "cn=Directory Manager"
 \
--bindPassword password \
$T/cts-add-multivalue-indices.ldif
```

If you are using OpenDJ 3.5 or earlier:

```
$ ./ldapmodify
 \
--port 1389
 \
--bindDN "cn=Directory Manager"
 \
--bindPassword password
 \
--filename $T/cts-add-multivalue-indices.ldif
```

4. Copy the CTS index file, and then replace the `@DB_NAME@` variable with your repository in the file. Then, add the file to the repository.

```
$ cat $TOMCAT_OPENAM_WEBAPP/WEB-INF/template/ldif/sfha/cts-indices.ldif \
| sed -e 's/@DB_NAME@/userRoot/' > $T/cts-indices.ldif
```

If you are using OpenDJ 4.0 or later:

```
$ ./ldapmodify
 \
--port 1389
 \
--bindDN "cn=Directory Manager"
 \
--bindPassword password \
$T/cts-indices.ldif
```

If you are using OpenDJ 3.5 or earlier:

```
$ ./ldapmodify
 \
--port 1389
 \
--bindDN "cn=Directory Manager"
 \
--bindPassword password
 \
--filename $T/cts-indices.ldif
```

5. Copy the container file, and then replace the `@SM_CONFIG_ROOT_SUFFIX@` variable with the base DN defined during the external DS installation procedure, for example, `cn=cts,ou=famrecords,ou=openam-session,ou=tokens`. Then, add the file to the repository.

```
$ ROOT_SUFFIX="cn=cts,ou=famrecords,ou=openam-session,ou=tokens"
$ cat $TOMCAT_OPENAM_WEBAPP/WEB-INF/template/ldif/sfha/cts-container.ldif | sed -e 's/
@SM_CONFIG_ROOT_SUFFIX@/$ROOT_SUFFIX/' > $T/cts-container.ldif
```

If you are using OpenDJ 4.0 or later:

```
$ ./ldapmodify
 \
--port 1389
 \
--bindDN "cn=Directory Manager"
 \
--bindPassword password \
$T/cts-container.ldif
```

If you are using OpenDJ 3.5 or earlier:

```
$ ./ldapmodify
 \
--port 1389
 \
--bindDN "cn=Directory Manager"
 \
--bindPassword password
 \
--filename $T/cts-container.ldif
```

The output should be:

```
Processing ADD request for ou=tokens,cn=cts,ou=famrecords,ou=openam-session,ou=tokens
ADD operation successful for DN ou=tokens,cn=cts,ou=famrecords,ou=openam-session,ou=tokens
Processing ADD request for ou=openam-session,ou=tokens,cn=cts,ou=famrecords,ou=openam-session
,ou=tokens
ADD operation successful for DN ou=openam-session,ou=tokens,cn=cts,ou=famrecords,ou=openam-session
,ou=tokens
Processing ADD request for ou=famrecords,ou=openam-session,ou=tokens,cn=cts,ou=famrecords,ou=openam-
session,ou=tokens
ADD operation successful for DN ou=famrecords,ou=openam-session,ou=tokens,cn=cts,ou=famrecords
,ou=openam-session,ou=tokens
```

6. If AM is binding to CTS as the Directory Manager user, you can jump to section "CTS Index Import and Build".

   To create a non-admin user, follow the instructions in the next section.

3.3.3. Non-Admin User Creation and ACI Import

As a best practice, the use of `cn=Directory Manager` is not recommended. Instead, you can create a new user with limited privileges as shown below. For additional examples creating user entries with DS tools, see *Adding Entries* in the *ForgeRock Directory Services Developer's Guide*.

To Create a Non-Admin User

1. Create an LDIF file called `cts_user.ldif` that defines the CTS non-admin user. The following sample LDIF creates a user called `openam_cts` and assigns the `update-schema`, `subentry-write`, and `password-reset` privileges.

   The LDIF file also overrides the default lookthrough limit of 5000 for this non-admin user to unlimited (0) and sets the maximum number of entries returned for a search to 5000 (default, 1000). The `ds-rlim-size-limit: 5000` is arbitrary and can be any value larger than the default maximum number of entries returned for a search, for example, value >= 1001. Setting the max number of entries for a search to 5000 ensures that the CTS reaper can properly delete returned tokens when large bursts of CTS tokens (> 5000 per interval between CTS reaping) are returned. For more information on DS resource limits, see *Setting Resource Limits* in the *ForgeRock Directory Services Administration Guide*.

   If there are more than 100K of expired tokens in the CTS, the search from the CTS reaper will be treated as non-indexed and will fail if the non-admin user does not have the `unindexed-search` privilege. Therefore, you should add the `unindexed-search` privilege to the user's entry.

   Finally, make sure that you replace the `userPassword` value, shown as *password* in the LDIF, with your actual password:

   ```
   dn: ou=admins,cn=cts,ou=famrecords,ou=openam-session,ou=tokens
   objectClass: top
   objectClass: organizationalunit
   ou: OpenAM Administrator

   dn: uid=openam_cts,ou=admins,cn=cts,ou=famrecords,ou=openam-session,ou=tokens
   objectClass: top
   objectClass: person
   objectClass: organizationalPerson
   objectClass: inetOrgPerson
   cn: OpenAM Non-Admin-User
   sn: OpenAM
   userPassword: password
   ds-privilege-name: update-schema
   ds-privilege-name: subentry-write
   ds-privilege-name: password-reset
   ds-privilege-name: unindexed-search
   ds-rlim-lookthrough-limit: 0
   ds-rlim-size-limit: 5000
   ```

2. Add the new user to the CTS repository. The following example assumes that you are using OpenDJ 4.0 and later:

   ```
   $ ./ldapmodify \
    --port 1389 \
    --bindDN "cn=Directory Manager" \
    --bindPassword password \
    cts_user.ldif
   ```

   If you are using OpenDJ 3.5 or earlier:

```
$ ./ldapmodify \
 --defaultAdd
 --port 1389 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --filename cts_user.ldif
```

The output should be:

```
Processing ADD request for ou=admins,cn=cts,ou=famrecords,ou=openam-session,ou=tokens
ADD operation successful for DN ou=admins,cn=cts,ou=famrecords,ou=openam-session,ou=tokens
Processing ADD request for uid=openam_cts,ou=admins,cn=cts,ou=famrecords,ou=openam-session,ou=tokens
ADD operation successful for DN uid=openam_cts,ou=admins,cn=cts,ou=famrecords,ou=openam-session
,ou=tokens
```

3. Add a global ACI to allow the `openam_cts` user to modify schema:

```
$ ./dsconfig \
 set-access-control-handler-prop \
 --no-prompt \
 --hostname cts.example.com \
 --port 4444 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --add 'global-aci:(target = "ldap:///cn=schema")(targetattr = "attributeTypes ||
  objectClasses")(version 3.0; acl "Modify schema"; allow (write)
  userdn = "ldap:///uid=openam_cts,ou=admins,cn=cts,ou=famrecords,ou=openam-session,ou=tokens";)'
```

4. Use **dsconfig** to check that the global ACI has been applied:

```
$ ./dsconfig \
 get-access-control-handler-prop \
 --hostname cts.example.com \
 --port 4444 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --no-prompt \
 --property global-aci
```

Verify that the following entry is present:

```
"(target = "ldap:///cn=schema")(targetattr = "attributeTypes || objectClasses")
 (version 3.0; acl "Modify schema"; allow (write) userdn =
"ldap:///uid=openam_cts,ou=admins,cn=cts,ou=famrecords,ou=openam-session,ou=tokens";)",
```

5. Create an LDIF file called `cts_acis.ldif` to add the ACIs to allow the CTS user to create, search, modify, delete, and allow persistent search to the CTS repository:

```
dn: cn=cts,ou=famrecords,ou=openam-session,ou=tokens
changetype: modify
add: aci
aci: (targetattr="*")(version 3.0;acl "Allow entry search";
 allow (search, read) userdn = "ldap:///uid=openam_cts,ou=admins,cn=cts,ou=famrecords,ou=openam-
session,ou=tokens";)
aci: (targetattr="*")(version 3.0;acl "Modify entries"; allow (write)
 userdn = "ldap:///uid=openam_cts,ou=admins,cn=cts,ou=famrecords,ou=openam-session,ou=tokens";)
aci: (targetcontrol="2.16.840.1.113730.3.4.3")(version 3.0;
 acl "Allow persistentsearch";allow (search, read)
 userdn = "ldap:///uid=openam_cts,ou=admins,cn=cts,ou=famrecords,ou=openam-session,ou=tokens";)
aci: (version 3.0;acl "Add config entry"; allow (add) userdn =
 "ldap:///uid=openam_cts,ou=admins,cn=cts,ou=famrecords,ou=openam-session,ou=tokens";)
aci: (version 3.0;acl "Delete entries"; allow (delete) userdn =
 "ldap:///uid=openam_cts,ou=admins,cn=cts,ou=famrecords,ou=openam-session,ou=tokens";)
```

6. Import the ACIs into the CTS repository:

   ```
   $ ./ldapmodify \
    --hostname cts.example.com \
    --port 1389 \
    --bindDN "cn=Directory Manager" \
    --bindPassword password \
    cts_acis.ldif
   ```

   If you are using OpenDJ 3.5 or earlier:

   ```
   $ ./ldapmodify \
    --hostname cts.example.com \
    --port 1389 \
    --bindDN "cn=Directory Manager" \
    --bindPassword password \
    --filename cts_acis.ldif
   ```

   The output should be:

   ```
   # Processing MODIFY request for cn=cts,ou=famrecords,ou=openam-session,ou=tokens
   # MODIFY operation successful for DN cn=cts,ou=famrecords,ou=openam-session,ou=tokens
   ```

7. If the DS server was set up with the `--productionMode` option, grant the additional access that AM requires.

   When DS servers are set up with the `--productionMode` option, many settings are hardened for a more secure default installation. Compared to evaluation mode, production mode significantly restricts access for non-admin users. For details, see *Directory Server Setup Parameters* in the *ForgeRock Directory Services Installation Guide*.

   The following example grants the same permissions as evaluation mode to the AM non-admin user that you created:

```
$ ./dsconfig \
 set-access-control-handler-prop \
 --hostname cts.example.com \
 --port 4444 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --add 'global-aci: (extop="1.3.6.1.4.1.26027.1.6.1 || 1.3.6.1.4.1.26027.1.6.3 || 1.3.6.1.4.1.4203.1
.11.1 || 1.3.6.1.4.1.1466.20037 || 1.3.6.1.4.1.4203.1.11.3")(version 3.0; acl "AM extended operation
 access"; allow(read) userdn="ldap:///uid=openam_cts,ou=admins,cn=cts,ou=famrecords,ou=openam-session
,ou=tokens";)' \
 --add 'global-aci: (targetcontrol="2.16.840.1.113730.3.4.2 || 2.16.840.1.113730.3.4.17 || 2.16.840
.1.113730.3.4.19 || 1.3.6.1.4.1.4203.1.10.2 || 1.3.6.1.4.1.42.2.27.8.5.1 || 2.16.840.1.113730.3.4.16
 || 1.2.840.113556.1.4.1413 || 1.3.6.1.4.1.36733.2.1.5.1 || 1.3.6.1.1.12 || 1.3.6.1.1.13.1 || 1.3.6
.1.1.13.2 || 1.2.840.113556.1.4.319 || 1.2.826.0.1.3344810.2.3 || 2.16.840.1.113730.3.4.18 || 2.16
.840.1.113730.3.4.9 || 1.2.840.113556.1.4.473 || 1.3.6.1.4.1.42.2.27.9.5.9")(version 3.0; acl "AM
 extended operation access"; allow(read) userdn="ldap:///uid=openam_cts,ou=admins,cn=cts,ou=famrecords
,ou=openam-session,ou=tokens";)' \
 --add 'global-aci: (targetattr="createTimestamp||creatorsName||modifiersName||modifyTimestamp||
entryDN||entryUUID||subschemaSubentry||etag||governingStructureRule||structuralObjectClass||
hasSubordinates||numSubordinates||isMemberOf")(version 3.0; acl "AM Operational Attributes"; allow
 (read,search,compare) userdn="ldap:///uid=openam_cts,ou=admins,cn=cts,ou=famrecords,ou=openam-session
,ou=tokens";)' \
 --add 'global-aci: (targetcontrol="1.3.6.1.1.12 || 1.3.6.1.1.13.1")(version 3.0; acl "Allow assertion
 control";allow (read) userdn = "ldap:///uid=openam_cts,ou=admins,cn=cts,ou=famrecords,ou=openam-
session,ou=tokens";)' \
 --trustAll \
 --no-prompt
```

3.3.4. CTS Index Import and Build

To Import and Rebuild the CTS Indexes

1. (Optional) If you have not yet imported CTS index files as described in "To Import the CTS Configuration", open the `/tomcat/webapps/openam/WEB-INF/template/ldif/sfha/cts-indices.ldif` file. Apply each index to the CTS repository using the **dsconfig** command. Note that these indexes may require further tuning depending on environmental load testing.

   For example, you can apply the first index `coreTokenExpirationDate` as shown below. Then, apply the other indexes individually in the same manner:

   ```
   $ ./dsconfig  \
    --port 4444 \
    --bindDN "cn=Directory Manager" \
    --bindPassword password \
    --backend-name userRoot \
    --index-name coreTokenExpirationDate \
    --set index-type:ordering \
    --trustAll \
    --no-prompt
   ```

   Or, you can obtain a copy of a **dsconfig** batch file, which adds all of your indexes to the CTS repository at one time. Copy the `cts-add-indexes.txt` in "*Supported Scripts*", save it locally, then run **dsconfig** in batch mode:

```
$ ./dsconfig  \
 --port 4444 \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --batchFilePath cts-add-indexes.txt \
 --trustAll \
 --no-prompt
```

2. Stop the DS instance.

```
$ ./stop-ds
```

3. Rebuild all indexes and then verify them:

```
$ ./rebuild-index --baseDN "cn=cts,ou=famrecords,ou=openam-session,ou=tokens" \
 --rebuildAll --offline
$ ./verify-index --baseDN "cn=cts,ou=famrecords,ou=openam-session, ou=tokens"
. . . msg=Checked 6 entries and found 0 error(s) in 0 seconds . . .
```

4. Restart the DS instance.

```
$ ./start-ds
```

3.3.5. CTS Configuration

At this stage, you have successfully set up the external DS server. You must now set up the CTS repository on AM using the AM console.

To Configure CTS

> **Important**
>
> If AM cannot access the CTS token store, you will be unable to log in to the AM console.
>
> Back up your deployment before making any changes to your CTS token store configuration.

Perform the following steps to configure an external CTS token store:

1. Open the AM console and navigate to Configure > Server Defaults, and then click CTS.

2. On the CTS Token Store tab, configure the parameters as follows:

CTS Token Store Parameters

Parameter	Value	Notes
Store Mode	`External Token Store`	
Root Suffix	`cn=cts,ou=famrecords,ou=openam-session,ou=tokens`	

Parameter	Value	Notes
Max Connections	`17`	For production, this value needs to be tuned. Consider 2^n+1, where n=4, 5, 6, and so on. For example, try setting this to 17, 33, 65, and test performance under load.

3. On the External Store Configuration tab, configure the parameters as follows:

External Store Configuration Parameters

Parameter	Value	Notes
SSL/TLS Enabled	False	When connecting to a DS server in production mode, enable secure connections. When you enable SSL/TLS, make sure the AM server can trust the DS server certificate and that the certificate matches the CTS store FQDN.
Connection String(s)	`cts.example.com:1389`	
Login ID	`uid=openam_cts,ou=admins,cn=cts,ou=famrecords,ou=openam-session,ou=tokens`	
Password	*password*	
Heartbeat	`10`	For production, this value needs to be tuned.

4. Click Save Changes.

5. Restart AM or the web container where it runs for the changes to take effect.

3.3.6. Testing Session High Availability

To test session high availability, use two browsers: Chrome and Firefox. You can use any two browser types, or run the browsers in incognito mode. You can also view tokens using an LDAP browser.

To Test Session High Availability

1. In Chrome, log in to the second AM instance with the `amadmin` user, select the realm, and then click on `sessions`.

2. In Firefox, log in to the first AM instance with a test user.

3. In Chrome, verify that the test user exists in the first AM instance's session list and not in the second instance.

4. Shut down the first AM instance.

5. In Firefox, rewrite the URL to point to the second AM instance. If successful, the browser should not prompt for login.

6. Confirm the session is still available. In Chrome, list the sessions on the second instance, the test user's session should be present.

7. Restart the first AM instance to complete the testing.

3.4. CTS Backups and Directory Services Replication Purge Delay

Replication is the process of copying updates between directory servers to help all servers converge to identical copies of directory, token, session, SAML v2.0, and OAuth 2.0 data. DS uses advanced data replication methods to ensure that directory services remain available in the event of a server crash or network interruption.

The historical information needed to resolve the latest changes is periodically purged to prevent it from becoming an unmanageable size. The age at which the information is purged is known as the `replication-purge-delay`.

With CTS, the default `replication-purge-delay` for DS is 3 days. Unless you have configured a separate DS server for CTS data, you may have to balance the needs for backups, the requirements for replication, disk space, and different useful lifetimes for CTS tokens and other DS data. Adjustments may be required. One way to set a new period for `replication-purge-delay` of *n* hours is with the following command:

```
$ ./dsconfig \
 set-replication-server-prop \
 --port 4444 \
 --hostname opendj-cts.example.org \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --provider-name "Multimaster Synchronization" \
 --set replication-purge-delay:n \
 --no-prompt \
 --trustStorePath /path/to/truststore
```

At this point, you need to understand whether CTS data backups are important in your deployment. Session, SAML v2.0, and OAuth 2.0 token data is often short-lived. In some deployments, the worst-case scenario is that users have to log in again.

If CTS data backups are important in your deployment, note that DS backups that are older than the `replication-purge-delay` are useless and must be discarded. You can use the DS **backup** to schedule backups. For example, the following command uses `crontab` format to configure daily backups for a hypothetical Base DN of `ctsData` at x minutes after every hour:

```
$ ./backup \
 --port 4444 \
 --bindDN "cn="Directory Manager" \
 --bindPassword password \
 --backendID ctsData \
 --backupDirectory /path/to/opendj/backup \
 --recurringTask "x * * * *" \
 --completionNotify backupadmin@example.com \
 --errorNotify backupadmin@example.com
```

If you adjust the time periods associated with `replication-purge-delay` and backups, you need to backup more frequently so that the change log records required to restore date are not lost.

3.5. Managing CTS Tokens

The following properties are associated with token encryption, compression, and token cleanup frequency, which are disabled by default. The properties are as follows:

`com.sun.identity.session.repository.enableEncryption`

Supports encryption of CTS tokens. Default: `false`.

`com.sun.identity.session.repository.enableCompression`

Enables GZip-based compression of CTS tokens. Default: `false`.

`com.sun.identity.session.repository.enableAttributeCompression`

Supports compression over and above the GZip-based compression of CTS tokens. Default: `false`.

To enable the encryption/compression options, navigate to Configure > Server Defaults > Advanced. On the Advanced page, you will see these entries in the `Property Name` column with the corresponding value in the `Property Value` column. To enable them, change `false` to `true` in the Property Value column associated with the desired property, and click Save.

Note

If you want to enable compression or encryption, you must enable the same property on every AM instance within the site, otherwise they will not function correctly together. You must also restart the servers for the changes to take effect.

Warning

When encryption or compression properties are changed, all previous tokens in the LDAP store will be unreadable; thus, invalidating any user's sessions. As a result, the user will be required to log in again.

3.6. CTS Tuning Considerations

There are several CTS tuning considerations that you can make for the efficient processing of your CTS token store: reaper cache size, queue size and timeout, and virtual attributes.

3.6.1. Reaper Cache Size

AM implements a reaper service that deletes expired tokens from the CTS store.

When an AM server modifies a token in the CTS store, it also takes the responsibility to delete it when it expires. To reduce the number of relatively slow queries to the CTS store to determine which tokens have expired, each AM server maintains a local cache of which tokens to delete, and when.

Use of the local reaper cache means fewer searches of the CTS store to determine expired tokens to delete, improving overall cluster performance. A search of the CTS store for expired tokens is still performed as a fail safe, to ensure expired tokens are not missed when a server in the cluster goes down.

The size of the reaper cache is controlled by the `org.forgerock.services.cts.reaper.cache.size` advanced property. The default size is `500000` tokens.

If an AM server is under sustained heavy load, the reaper cache may reach capacity, causing degraded performance due to the additional slower searches of the CTS store. If the reaper cache is full, messages are logged in the `Session` debug log, such as the following:

```
The CTS token reaper cache is full. This will result in degraded performance.
You should increase the cache size by setting the advanced server property
'org.forgerock.services.cts.reaper.cache.size' to a number higher than 500000.
```

If this debug message appears frequently in the debug logs, increase the value of the `org.forgerock.services.cts.reaper.cache.size` property. To alter the value, in the AM console, navigate to Configure > Server Defaults > Advanced, and add the property and increased value to the list.

Increasing the size of the reaper cache causes higher memory usage on the AM server. If a cache of the default size of 500000 entries is nearly full, the server memory used could be up to approximately 100 megabytes.

3.6.2. Queue Size and Timeout

One tuning consideration is to manage the CTS queue size and timeout for efficient throughput. AM makes CTS requests from the following components:

- AM stateful sessions
- OAuth 2.0
- UMA
- Session blacklist (if enabled for stateless sessions)
- SAML v2.0 (if enabled for Security Token Service token validation and cancellation)
- OAuth 2.0 stateless sessions and session blacklist
- Push notification during authentication
- Cluster-wide notification

Every create, update, and delete requests to CTS are placed into an asynchronous buffer before being handled by an asynchronous processor. This ensures that callers performing write operations can continue without waiting for CTS to complete processing.

Once the queue is full, all new operations are "blocked" before being placed in the queue. Once the queue is frees up, the caller can continue as normal.

CTS is designed to automatically throttle throughput when the buffer fills up with requests. Therefore, if you require a balance between performance versus system memory, AM provides two properties that can be used to tune CTS, queue size and queue timeout.

`org.forgerock.services.cts.async.queue.size`

> Default size: 5000. Determines the amount of request operations that can be buffered before the queue size becomes full, after which the caller will be required to wait for the buffered requests to complete processing. All CRUDQ operations are converted to tasks, which are placed on the queue, ensuring that operations happen in the correct sequence.

`org.forgerock.services.cts.async.queue.timeout`

> Default timeout is 120 seconds. Determines the length of time a caller will wait when the buffer is full. If the timeout expires, the caller receives an error. The timeout property is used in any system configuration where the LDAP server throughput is considerably slower than the AM server, which can result in blocked requests as the backlog increases.

To set the queue size and timeout properties in the AM console, navigate to Configure > Server Defaults > Advanced, enter the key name and value, and then click Add.

For additional information on tuning CTS, see "Tuning CTS LDAP Connection Settings" in the *Setup and Maintenance Guide*.

3.6.3. Virtual Attributes

DS supports a number of virtual attributes, which dynamically generate entry values that are not persisted in the token store. By default, the following DS virtual attributes are enabled at install:

- collective-attribute-subentries
- entity-tag
- entry-dn
- entry-uuid
- governing-structure-rule
- has-subordinates
- is-member-of
- num-subordinates
- password-expiration-time
- password-policy-subentry
- structural-object-class
- subschema-subentry

To improve CTS throughput, you can disable your virtual attributes using the **dsconfig** command, *except* for the Entity Tag virtual attribute, which must remain enabled else it will lead to an inoperable server.

To disable a virtual attribute, use the **dsconfig** command on DS to disable, for example, the Collective Attribute Subentries virtual attribute:

```
./dsconfig set-virtual-attribute-prop \
 --name=collective-attribute-subentries-virtual-attribute \
 --set enabled: false \
 --hostname localhost \
 --port 4444 \
 --bindDN "cn=Directory manager" \
 --bindPassword password \
 --no-prompt
```

Important

The DS `entity-tag-virtual-attribute` is required and should never be disabled.

Chapter 4
Securing Installations

This chapter identifies best practices for securing your AM installation.

4.1. Avoiding Obvious Defaults

AM includes default settings to make it easier for you to evaluate the software. Avoid these default settings in production deployments:

- When connecting to LDAP, bind with a specific administrative account rather than a root DN account, if possible.
- Change the default `iPlanetDirectoryPro` cookie name both in AM (`com.iplanet.am.cookie.name`) and in your agent profiles (`com.sun.identity.agents.config.cookie.name`).
- When installing AM, do not use `/openam` or `/opensso` as the deployment URI.
- Create an administrator in the Top Level Realm with a different ID than the default `amadmin`.
- Create specific administrator users to track better who makes configuration changes.
- Remove the demo user account. For example, if you configure the embedded DS server as a configuration and CTS store, the default demo user account gets created during the installation process. You should remove the user using the AM console under Realms > Top Level Realm > Subjects > User.
- Set the list of Valid `goto` URL Resources. By default, AM redirects the user to the URL specified in the `goto` and `gotoOnFail` query string parameters supplied to the authentication interface in the login URL.

  To increase security against possible phishing attacks through open redirect, you can specify a list of valid URL resources against which AM validates these URLs. AM only redirects a user if the `goto` and `gotoOnFail` URL matches any of the resources specified in this setting. If no setting is present, it is assumed that the `goto` or `gotoOnFail` URL is valid.

  To set the Valid `goto` URL Resources, use the AM console, and navigate to Realms > *Realm Name* > Services. Click Add a Service, select Validation Service, and add one or more valid `goto` URLs, and then click Create.

  When setting valid `goto` URLs, you can use the "*" wildcard, where "*" matches all characters except "?". For more specific patterns, use resource names with wildcards as described in the procedure, "Constraining Post-Login Redirects" in the *Authentication and Single Sign-On Guide*.

- Disable module based authentication for all AM realms. Module based authentication lets users authenticate using the `module=module-name` login parameter. To disable module based authentication for a realm, select the realm in the AM console, then select Authentication > Settings > Security and clear the Module Based Authentication check box.

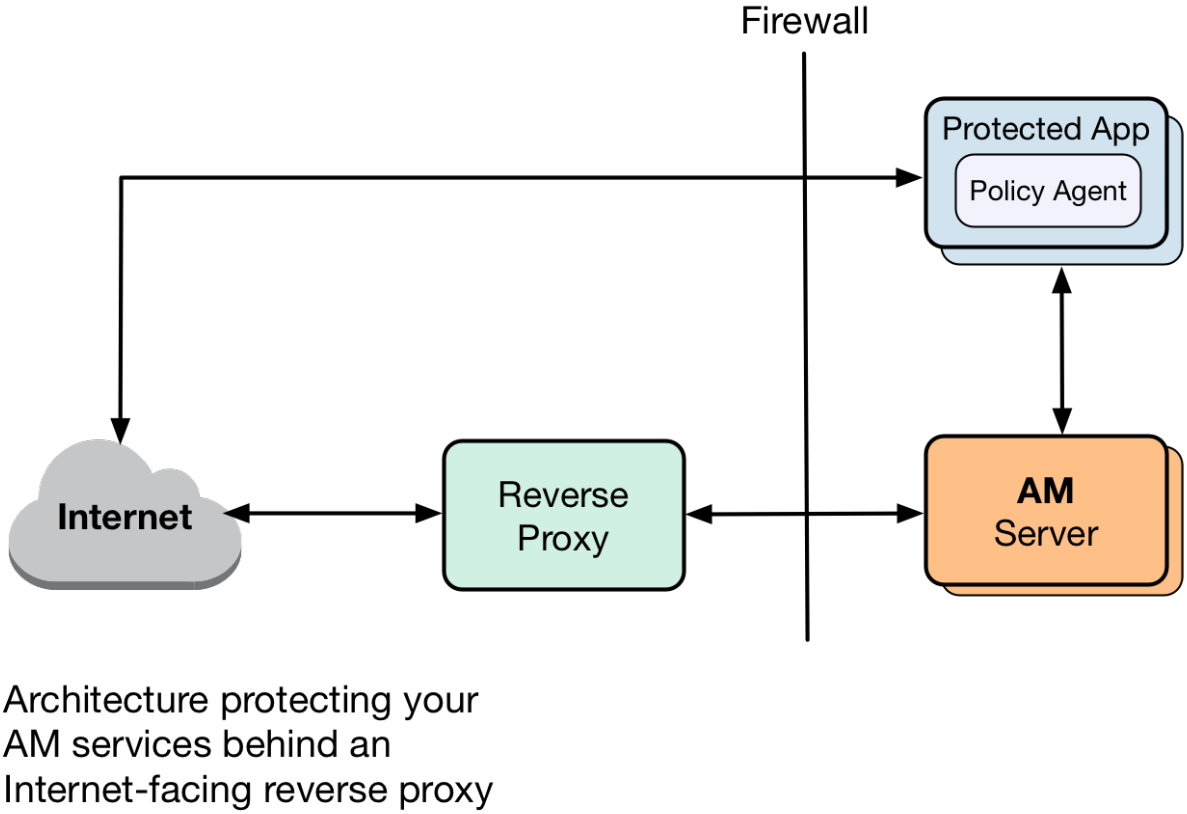
4.2. Protecting Network Access

Anytime users interact with a web service, there are risks. With AM, you can reduce those risks by limiting what is exposed through the firewall using the following strategy:

- Use a reverse proxy in front of AM to allow access only to the necessary URLs. A reverse proxy exposes only those endpoints needed for an application. For example, if you need to expose the OAuth2/OpenID Connect endpoints and REST interface, then you should implement a reverse proxy.

  The following figure shows the recommended architecture with a reverse proxy.

Exposing Only a Reverse Proxy to the Internet


Firewall
Protected App
Policy Agent
Internet
Reverse Proxy
AM Server
Architecture protecting your AM services behind an Internet-facing reverse proxy

- If possible in your deployment, control access to the AM console by network address, such that administrators can only connect from well-known systems and networks.
- Restrict access to URIs that you do not use, and prevent internal endpoints, such as `/sessionservice` from being reachable over the Internet.

  For a full list of endpoints, see "*Service Endpoints*" in the *Reference*.

4.2.1. Restricting Endpoint Caching

To help protect against snooping of data on public computers, you should configure AM instances to disallow browsers to cache user-submitted information.

You can prevent a browser from caching data by including the following headers in responses from endpoints:

```
Cache-Control: no-cache, no-store, must-revalidate
Pragma: no-cache
Expires: 0
```

It is also recommended to set `Cache-Control: private` on all endpoints that contain `/json/` in their path, but not the following endpoints:

- `/serverinfo/*`
- `/serverinfo/version`
- `/serverinfo/cookieDomains`

You can apply these headers to the specified endpoints by configuring your reverse proxy or gateway, or you can use the AM `SetHeaderFilter` feature in your web containers' `web.xml` file, as follows:

To Restrict Endpoint Caching by using SetHeaderFilter

1. Open the deployment descriptor file `web.xml` in a text editor. The location of the file depends on your web application container, for example in Tomcat it might be located at: `/path/to/tomcat/webapps/openam/WEB-INF/web.xml`.

2. In the deployment descriptor file, add the following filter and filter mapping, which applies `Cache-Control: private` to the correct endpoints:

```
<filter>
    <filter-name>CachePrivate</filter-name>
    <filter-class>org.forgerock.openam.headers.SetHeadersFilter</filter-class>
    <init-param>
        <param-name>Cache-Control</param-name>
        <param-value>private</param-value>
    </init-param>
    <init-param>
        <param-name>excludes</param-name>
        <param-value>/serverinfo/*,/serverinfo/version,/serverinfo/cookieDomains</param-value>
    </init-param>
</filter>
<filter-mapping>
    <filter-name>CachePrivate</filter-name>
    <url-pattern>/json/*</url-pattern>
</filter-mapping>
```

3. Restart your web container for the changes to take effect.

4.3. Securing Administration

Create realms for your organization(s) and separate administrative users from end users. For instructions, see "*Setting Up Realms*" in the *Setup and Maintenance Guide*.

- To direct relevant users to the correct realms in AM, you can then either:
  - Use the `realm=realm-name` query string parameter.
  - Create fully qualified domain name DNS aliases for the realms.
- When customizing `config/auth/default*/Login.jsp`, make sure that you do not introduce any security vulnerabilities, such as cross-site scripting due to unvalidated input.
- Create an agent profile for each web or Java agent. See "*Setting Up Agent Profiles*" in the *Setup and Maintenance Guide* for instructions.

4.4. Securing Communications

Keep communications secure by using encryption, properly configured cookies, and request and response signatures:

- Protect network traffic by using HTTPS and LDAPS where possible.
- When using HTTPS, use secure cookies, which are transmitted only over secured connections.

  To configure AM server to use secure cookies, in the AM console, navigate to Configure > Server Defaults > Security. On the Cookie tab, select Secure Cookie, and then click Save Changes.

  HttpOnly cookies are meant to be transmitted only over HTTP and HTTPS, and not through non-HTTP methods, such as JavaScript functions.

  You can configure the AM server to use `HttpOnly` cookies by navigating to Configure > Server Defaults > Advanced, and setting the `com.sun.identity.cookie.httponly` property's value to `true`. Save your changes.
- Specify an appropriate TLS protocol for communication between AM and one or more of the following:
  - An external AM configuration store
  - An external CTS token store
  - An external user store
  - An Active Directory repository used for AM authentication with the Active Directory module
  - An LDAP repository used for AM authentication with the LDAP module
  - A repository used for AM certificate authentication with the certificate module

  To specify the TLS protocol, use the `-Dorg.forgerock.openam.ldap.secure.protocol.version` JVM setting. For more information, see "Security Settings".

- Where possible, use subdomain cookies, and control subdomains in a specific DNS master.
- Use cookie hijacking protection with restricted tokens, where each web or Java agent uses different SSO tokens for the same user. See "Protecting Against Cookie Hijacking" in the *Authentication and Single Sign-On Guide* for instructions.
- Use your own key, not the `test` key provided with AM, to sign:
  - SAML 2.0 authentication requests, authentication responses, and single logout requests
  - XUI authentication IDs

  See "Changing Default Key Aliases" in the *Setup and Maintenance Guide* for instructions.
- When using SAML v2.0, if the other entities in your circle of trust can handle encryption, then use encryption in addition to signing requests and responses.

4.4.1. About Certificates

Digital signatures are constructed and verified as follows:

- The signer computes a hash of the data to sign, and encrypts the hash using a private key to get the signature.
- The signer then attaches the signature to the data, and sends the message with the recipient.
- To validate the digital signature on the message, the recipient decrypts the signature using the public key certificate that corresponds to the private key of the signer.
- The recipient computes the hash of the data, then checks that the decrypted signature (the decrypted hash) matches the computed hash.

Parties signing requests, responses, or assertions must share the public key certificates for signing keys. The certificates can either be shared in advance and imported into the trusted partners' trust stores, then referenced in the configuration by their trust store aliases, or shared in each signed message.

You should not have to concern yourself with certificates when working with AM. AM's core services and Java agents depend on the certificates installed for use with the web application container in which they run. AM web agents depend on the certificates installed for use with the web server. Each certificate has been signed by a well-known certificate authority (CA), whose certificate is already installed in the Java CA certificates trust store (`$JAVA_HOME/jre/lib/security/cacerts`, default password `changeit`) and in browsers, and so is recognized by other software used without you having to configure anything.

However, you may want to configure AM advanced features such as SAML v2.0, OpenID Connect 1.0, and others, which require certificates and key aliases to be maintained in a keystore whose location is configured in AM.

4.4.2. Using Self-Signed Certificates

You can use either CA or self-signed certificates with AM, although you should have in mind that you will need to configure your applications to trust your self-signed certificates. For more information about installing AM in a secure container with a self-signed certificate, see "To Set Up With HTTPS and Self-Signed Certificates". For more information about sharing self-signed certificates among applications, see "To Share Self-Signed Certificates".

To Set Up With HTTPS and Self-Signed Certificates

The container in which you install AM requires a certificate in order to set up secure connections. Perform the following steps to set up Apache Tomcat 8.0 (Tomcat) with an HTTPS connector, using the Java **keytool** command to create a self-signed key pair:

1. Stop Tomcat.

2. Create a certificate and store it in a new keystore:

```
$ cd /path/to/tomcat/conf/
$ keytool -genkey -alias openam.example.com -storetype
 JCEKS
-keyalg RSA -keystore keystore.jceks
Enter keystore password:
 What is your first and last name?
 [Unknown]:  openam.example.com
What is the name of your organizational unit?
 [Unknown]:  Eng
What is the name of your organization?
 [Unknown]:  ForgeRock.com
What is the name of your City or Locality?
 [Unknown]:  Grenoble
What is the name of your State or Province?
 [Unknown]:  Isere
What is the two-letter country code for this unit?
 [Unknown]:  FR
Is CN=openam.example.com, OU=Eng, O=ForgeRock.com, L=Grenoble, ST=Isere,
 C=FR correct?
 [no]:  yes

Enter key password for <openam.example.com>
 (RETURN if same as keystore password):
```

3. Uncomment the SSL connector configuration in Tomcat's `conf/server.xml`, and specify your keystore file, type, and password:

```
<!-- Define a SSL HTTP/1.1 Connector on port 8443
This connector uses the JSSE configuration, when using APR, the
connector should be using the OpenSSL style configuration
described in the APR documentation -->
<!--
-->
<Connector port="8443" protocol="org.apache.coyote.http11.Http11NioProtocol"
 SSLEnabled="true" maxThreads="150" scheme="https" secure="true"
 keystoreFile="/path/to/tomcat/conf/keystore.jceks"
 keystorePass="changeit"
 keystoreType="JCEKS"
 clientAuth="false" sslProtocol="TLS" />
```

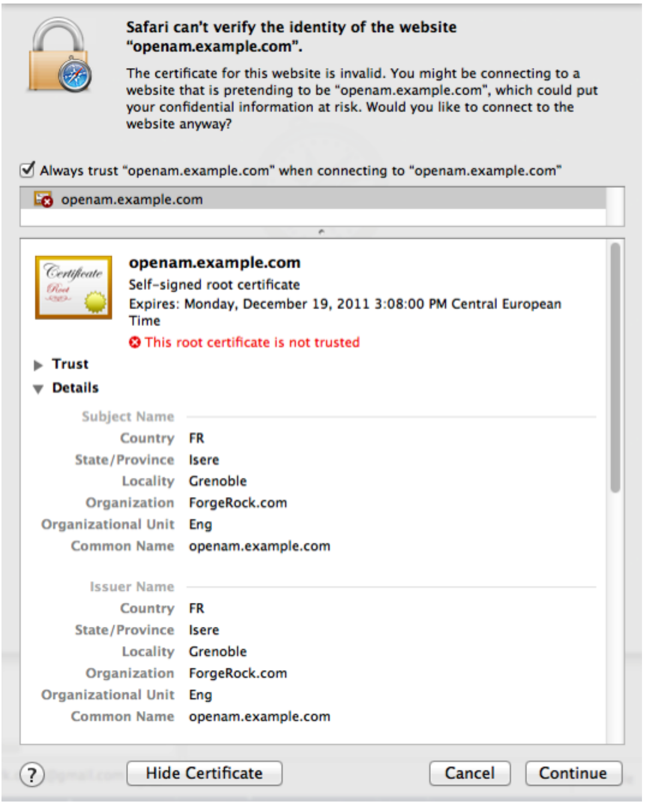
You may need different settings depending on your configuration and version of Apache Tomcat. See the documentation for your version for more information.

4. Start Tomcat.

5. Verify that you can connect to Tomcat on port 8443 over HTTPS.

   Your browser does not trust the certificate, because the certificate is self-signed and not signed by any of the CAs stored in your browser.

Unknown Certificate



Safari can't verify the identity of the website "openam.example.com".

The certificate for this website is invalid. You might be connecting to a website that is pretending to be "openam.example.com", which could put your confidential information at risk. Would you like to connect to the website anyway?

☑ Always trust "openam.example.com" when connecting to "openam.example.com"

openam.example.com

openam.example.com
Self-signed root certificate
Expires: Monday, December 19, 2011 3:08:00 PM Central European Time
This root certificate is not trusted

▶ **Trust**
▼ **Details**

Subject Name	
Country	FR
State/Province	Isere
Locality	Grenoble
Organization	ForgeRock.com
Organizational Unit	Eng
Common Name	openam.example.com
Issuer Name	
Country	FR
State/Province	Isere
Locality	Grenoble
Organization	ForgeRock.com
Organizational Unit	Eng
Common Name	openam.example.com

You recognize the subject and issuer of your certificate, and so can choose to trust the certificate, saving it into your browser's trust store.

6. Deploy and configure AM.

7. To share the self-signed certificate in your container with other applications or servers, see "To Share Self-Signed Certificates".

To Share Self-Signed Certificates

How you configure the containers where AM and your applications run to use self-signed certificates depends on your web application server or web server software. The following basic principles apply:

- First, your container requires its own certificate for setting up secure connections.

- Second, the clients connecting must be able to trust the container's certificate. Generally, this means that clients recognize the container's certificate because they have a copy of the public certificate stored somewhere the client trusts.

- Third, if you use certificate authentication in AM, AM must also be able to find a copy of the client's public certificate to trust the client, most likely by finding a match with the certificate stored in the client profile from the identity repository. How you include client certificates in their identity repository entries depends on your identity repository more than it depends on AM.

Some client applications let you trust certificates blindly. This can be helpful when working in your lab or test environment with self-signed certificates. For example, you might want to use HTTPS with the AM RESTful API without having the client recognize the self-signed server certificate:

```
$ curl \
"https://openam.example.com:8443/openam/identity/authenticate?username=bjensen&password=hifalutin"
curl: (60) Peer certificate cannot be authenticated with known CA certificates
More details here: http://curl.haxx.se/docs/sslcerts.html

curl performs SSL certificate verification by default, using a "bundle"
of Certificate Authority (CA) public keys (CA certs). If the default
bundle file isnt adequate, you can specify an alternate file
using the --cacert option.
If this HTTPS server uses a certificate signed by a CA represented in
the bundle, the certificate verification probably failed due to a
problem with the certificate (it might be expired, or the name might
not match the domain name in the URL).
If you'd like to turn off curl's verification of the certificate, use
the -k (or --insecure) option.

$ curl \
--insecure \
"https://openam.example.com:8443/openam/identity/authenticate?username=bjensen&password=hifalutin"
token.id=AQIC5wM2LY4SfczMax8jegpSiaigB96NOWylLilsd0PUMjY.*AAJTSQACMDE.*
```

When you use a self-signed certificate for your container, clients connecting must be able to trust the container certificate. Your browser makes this an easy, but manual process. For other client applications, you must import the certificate into the trust store used by the client. By default, Java applications can use the `$JAVA_HOME/jre/lib/security/cacerts` store. The default password is `changeit`.[1] The steps that follow demonstrate how to import a self-signed certificate into the Java `cacerts` store:

1. Export the certificate from the keystore:

```
$ cd /path/to/tomcat/conf/
$ keytool \
 -exportcert \
 -alias openam.example.com \
 -file openam.crt \
 -storetype JCEKS
 -keystore keystore.jceks
Enter keystore password:
Certificate stored in file <openam.crt>
```

[1] Alternatively, you can specify the trust store for a Java application, such as `-Djavax.net.ssl.trustStore=/path/to/truststore.jks -Djavax.net.ssl.trustStorePassword=changeit`.

2. Import the certificate into the trust store:

```
$ keytool \
 -importcert \
 -alias openam.example.com \
 -file openam.crt
 -trustcacerts \
 -keystore $JAVA_HOME/jre/lib/security/cacerts
Enter keystore password:
Owner: CN=openam.example.com, OU=Eng, O=ForgeRock.com, L=Grenoble, ST=Isere,
C=FR
Issuer: CN=openam.example.com, OU=Eng, O=ForgeRock.com, L=Grenoble, ST=Isere,
C=FR
Serial number: 4e789e40
Valid from: Tue Sep 20 16:08:00 CEST 2011 until: Mon Dec 19 15:08:00 CET 2011
Certificate fingerprints:
MD5:  31:08:11:3B:15:75:87:C2:12:08:E9:66:00:81:61:8D
SHA1: AA:90:2F:42:0A:F4:A9:A5:0C:90:A9:FC:69:FD:64:65:D9:78:BA:1D
Signature algorithm name: SHA1withRSA
Version: 3
Trust this certificate? [no]:  yes
Certificate was added to keystore
```

Chapter 5 Removing Installations

This chapter shows you how to uninstall AM.

For instructions on removing AM agents, see the *ForgeRock Access Management Web Agents User Guide*, or the *ForgeRock Access Management Java Agent User Guide*.

To Remove an Instance

After you have deployed and configured AM, you may have as many as four locations where AM files are stored on your system.

Following the steps below removes the AM software and the internal configuration store. If you used an external configuration store, you can remove AM configuration data after removing all the software.

1. Shut down the web application container in which you deployed AM.

```
$ /etc/init.d/tomcat stop
Password:
Using CATALINA_BASE:   /path/to/tomcat
Using CATALINA_HOME:   /path/to/tomcat
Using CATALINA_TMPDIR: /path/to/tomcat/temp
Using JRE_HOME:        /path/to/jdk/jre
Using CLASSPATH:       /path/to/tomcat/bin/bootstrap.jar:
 /path/to/tomcat/bin/tomcat-juli.jar
```

2. Unconfigure AM by removing the configuration files found in the $HOME directory of the user running the web application container.

   A full uninstall of AM and configuration files consists of removing the following directories:

   - The configuration directory, by default `$HOME/openam`. If you did not use the default configuration location, check the value of the Base installation directory property under Deployment > Servers > *Server Name* > General > System.

   - The hidden directory that holds a file pointing to the configuration directory. For example, if you are using Apache Tomcat as the web container, this file could be `$HOME/.openamcfg/AMConfig_path_to_tomcat_webapps_openam_` OR `$HOME/.openssocfg/AMConfig_path_to_tomcat_webapps_openam_`.

```
$ rm -rf $HOME/openam $HOME/.openamcfg
```

   Or:

```
$ rm -rf $HOME/openam $HOME/.openssocfg
```

If you used an external configuration store, you must remove the configuration manually from your external directory server. The default base DN for the AM configuration is `dc=openam,dc=forgerock,dc=org`.

> **Note**
>
> At this point, you can restart the web container and configure AM anew if you only want to start over with a clean configuration rather than removing AM completely.

3. Undeploy the AM web application.

   For example, if you are using Apache Tomcat as the web container, remove the `.war` file and expanded web application from the container.

   ```
   $ cd /path/to/tomcat/webapps/
   $ rm -rf openam.war openam/
   ```

Chapter 6
Troubleshooting Installations

AM can capture information in debug log files that are useful when troubleshooting AM problems. "Debug Logging" in the *Setup and Maintenance Guide* describes how to enable debug logging after AM has been started.

It is also possible to capture debug logs while installing AM. This can be useful if you need to troubleshoot an installation problem.

To Troubleshoot an Installation

Follow these steps to capture debug logs while installing AM on Tomcat:

1. If Tomcat is already started, stop it.
2. Specify the `-Dcom.iplanet.services.debug.level=message` option in the `CATALINA_OPTS` environment variable:

   ```
   $ export CATALINA_OPTS=-Dcom.iplanet.services.debug.level=message
   ```

   There are several ways that you can specify the `CATALINA_OPTS` environment variable. You can set the variable:

   - In the `/path/to/tomcat/bin/setenv.sh` file
   - In the login shell of the user who runs Tomcat
3. Run the AM installation. Debug log files containing troubleshooting information appear in the `/path/to/openam/openam/debug` directory.
4. When you have completed AM installation and no longer need to capture debug logs, stop Tomcat, revert the debug logging options, and restart Tomcat.

Chapter 7
Reference

This reference section covers settings and other information relating to installing AM.

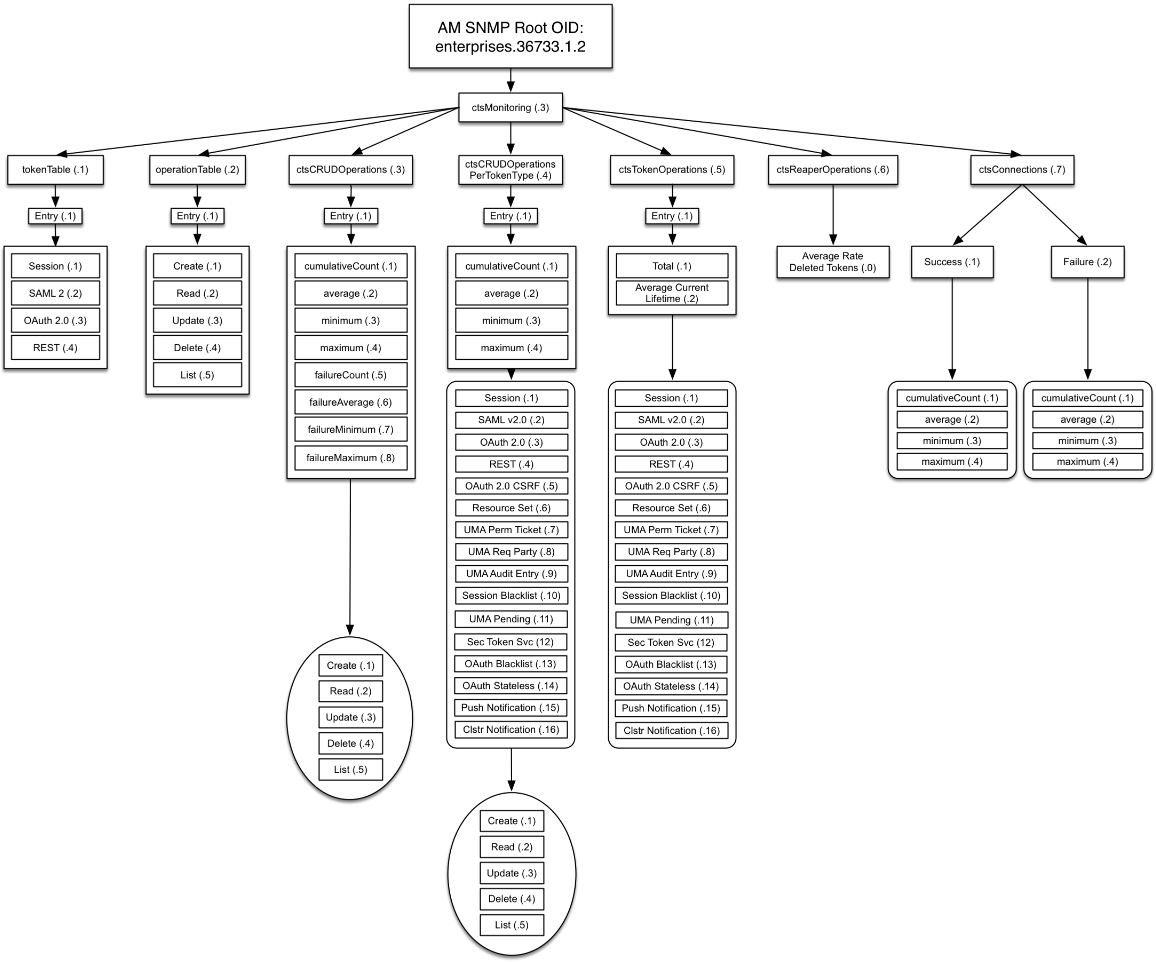
7.1. Core Token Service (CTS) Object Identifiers

The OIDs related to SNMP monitoring of CTS follow guidance described in RFC 1271.

The OIDs listed in this section include the prefix assigned to ForgeRock, `enterprises.36733`. They also include the entries associated with AM (1), SNMP (2), and CTS monitoring (3): `1.2.3`.

Therefore, the root OID for all CTS monitored components is `enterprises.36733.1.2.3`. All individual monitored CTS components are suffixes that are consistent with the image shown here.

Diagram of CTS OIDs



7.1.1. CTS Token Type OIDs

The table below shows how OIDs are split into different token types. Do not forget the prefix. For example, the complete OID for monitoring SAML v2.0 tokens is `enterprises.36733.1.2.3.1.1.2`

The options for the token table are shown in the following table. For example, the token table OID for SAML v2.0 is based on the entries associated with ForgeRock, `enterprises.36733`, AM `1`, SNMP `2`, CTS Monitoring `3`, token table `1`, entry `1`, and SAML v2.0 `2`, which is `enterprises.36733.1.2.3.1.1.2`.

CTS Monitoring OID Categories

OID, by Token Type	Description
`enterprises.36733.1.2.3.1.1.1`	Session
`enterprises.36733.1.2.3.1.1.2`	SAML v2.0
`enterprises.36733.1.2.3.1.1.3`	OAuth 2.0
`enterprises.36733.1.2.3.1.1.4`	REST
`enterprises.36733.1.2.3.1.1.5`	OAuth 2.0 CSRF Protection
`enterprises.36733.1.2.3.1.1.6`	Resource Set
`enterprises.36733.1.2.3.1.1.7`	UMA Permission Ticket
`enterprises.36733.1.2.3.1.1.8`	UMA Requesting Party
`enterprises.36733.1.2.3.1.1.9`	UMA Audit Entry
`enterprises.36733.1.2.3.1.1.10`	Session Blacklist
`enterprises.36733.1.2.3.1.1.11`	UMA Pending Request
`enterprises.36733.1.2.3.1.1.12`	Security Token Service
`enterprises.36733.1.2.3.1.1.13`	OAuth 2.0 Blacklist
`enterprises.36733.1.2.3.1.1.14`	OAuth 2.0 Stateless
`enterprises.36733.1.2.3.1.1.15`	Push Notification
`enterprises.36733.1.2.3.1.1.16`	Cluster-wide Notification

7.1.2. CTS Monitoring Operation Types

OIDs related to CTS monitoring operations are based on basic CRUD operations (plus list).

The options for the operation table are shown in the following table.

CTS Monitoring Operation Types

OID, by Operation	Description
`enterprises.36733.1.2.3.2.1.1`	Create
`enterprises.36733.1.2.3.2.1.2`	Read
`enterprises.36733.1.2.3.2.1.3`	Update
`enterprises.36733.1.2.3.2.1.4`	Delete
`enterprises.36733.1.2.3.2.1.5`	List

7.1.3. CTS Monitoring Entry Data Types

CTS monitoring entries use the following data types:

`Counter64`

A 64-bit, unsigned integer type.

`Counter64` is a standard data type returned by SNMP OIDs. For more information, see Structure of Management Information Version 2.

`Float2dp`

A floating point number with the value `d-2` in the `DISPLAY-HINT` clause. SNMP clients that handle the `DISPLAY-HINT` clause will correctly display the value as a floating point number with two decimal places. Other types of clients that do not handle the `DISPLAY-HINT` clause will incorrectly display the value as an integer that is one hundred times larger than the correct value.

`Float2dp` is a custom data type returned by some ForgeRock CTS OIDs.

7.1.4. CTS CRUD Operation Entries

The OIDs in this table relate to all CRUD (and list) operations.

The options for the CRUD operations table are shown in the following tables. Each value is associated with CRUD and list operations.

CTS CRUD Operation Entries

OID, by Operation Entry	Data Type	Description
`enterprises.36733.1.2.3.3.1.1`	`Counter64`	Cumulative count
`enterprises.36733.1.2.3.3.1.2`	`Float2dp`	Average (in period)
`enterprises.36733.1.2.3.3.1.3`	`Counter64`	Minimum (in period)
`enterprises.36733.1.2.3.3.1.4`	`Counter64`	Maximum (in period)
`enterprises.36733.1.2.3.3.1.5`	`Counter64`	Cumulative failure count
`enterprises.36733.1.2.3.3.1.6`	`Float2dp`	Average failures (in period)
`enterprises.36733.1.2.3.3.1.7`	`Counter64`	Minimum failures (in period)
`enterprises.36733.1.2.3.3.1.8`	`Counter64`	Maximum failures (in period)

Each of the options in this table can be divided into CRUD and list related operations. The suffix OID for such operations is as follows:

- 1: Create
- 2: Read
- 3: Update
- 4: Delete
- 5: List

For example, since the OID for cumulative count is `enterprises.36733.1.2.3.3.1.1`, the OID for the cumulative count of delete operations is `enterprises.36733.1.2.3.3.1.1.4`

CTS CRUD Operation Table Cumulative Operations

Cumulative Count Operations OID	Data Type	Description
`enterprises.36733.1.2.3.3.1.1.1`	`Counter64`	Cumulative count of CREATE operations
`enterprises.36733.1.2.3.3.1.1.2`	`Counter64`	Cumulative count of READ operations
`enterprises.36733.1.2.3.3.1.1.3`	`Counter64`	Cumulative count of UPDATE operations
`enterprises.36733.1.2.3.3.1.1.4`	`Counter64`	Cumulative count of DELETE operations
`enterprises.36733.1.2.3.3.1.1.5`	`Counter64`	Cumulative count of LIST operations

CTS CRUD Operation Table Average Operations (In Period)

Average Number Operations OID	Data Type	Description
`enterprises.36733.1.2.3.3.1.2.1`	`Float2dp`	Average number of CREATE operations (in period)
`enterprises.36733.1.2.3.3.1.2.2`	`Float2dp`	Average number of READ operations (in period)
`enterprises.36733.1.2.3.3.1.2.3`	`Float2dp`	Average number of UPDATE operations (in period)
`enterprises.36733.1.2.3.3.1.2.4`	`Float2dp`	Average number of DELETE operations (in period)
`enterprises.36733.1.2.3.3.1.2.5`	`Float2dp`	Average number of LIST operations (in period)

CTS CRUD Operation Table Minimum Operations (In Period)

Minimum Number Operations OID	Data Type	Description
`enterprises.36733.1.2.3.3.1.3.1`	`Counter64`	Minimum number of CREATE operations (in period)
`enterprises.36733.1.2.3.3.1.3.2`	`Counter64`	Minimum number of READ operations (in period)
`enterprises.36733.1.2.3.3.1.3.3`	`Counter64`	Minimum number of UPDATE operations (in period)
`enterprises.36733.1.2.3.3.1.3.4`	`Counter64`	Minimum number of DELETE operations (in period)
`enterprises.36733.1.2.3.3.1.3.5`	`Counter64`	Minimum number of LIST operations (in period)

CTS CRUD Operation Table Maximum Operations (In Period)

Maximum Number Operations OID	Data Type	Description
`enterprises.36733.1.2.3.3.1.4.1`	`Counter64`	Maximum number of CREATE operations (in period)
`enterprises.36733.1.2.3.3.1.4.2`	`Counter64`	Maximum number of READ operations (in period)
`enterprises.36733.1.2.3.3.1.4.3`	`Counter64`	Maximum number of UPDATE operations (in period)
`enterprises.36733.1.2.3.3.1.4.4`	`Counter64`	Maximum number of DELETE operations (in period)
`enterprises.36733.1.2.3.3.1.4.5`	`Counter64`	Maximum number of LIST operations (in period)

CTS CRUD Operation Table Cumulative Failure Operations

Cumulative Failure Operations OID	Data Type	Description
`enterprises.36733.1.2.3.3.1.5.1`	`Counter64`	Cumulative Failure of CREATE operations (in period)
`enterprises.36733.1.2.3.3.1.5.2`	`Counter64`	Cumulative Failure of READ operations (in period)
`enterprises.36733.1.2.3.3.1.5.3`	`Counter64`	Cumulative Failure of UPDATE operations (in period)
`enterprises.36733.1.2.3.3.1.5.4`	`Counter64`	Cumulative Failure of DELETE operations (in period)

Cumulative Failure Operations OID	Data Type	Description
`enterprises.36733.1.2.3.3.1.5.5`	`Counter64`	Cumulative Failure of LIST operations (in period)

CTS CRUD Operation Table Average Failure Operations in Period

Average Number, Failure Operations OID	Data Type	Description
`enterprises.36733.1.2.3.3.1.6.1`	`Float2dp`	Average number of CREATE operations failures (in period)
`enterprises.36733.1.2.3.3.1.6.2`	`Float2dp`	Average number of READ operations failures (in period)
`enterprises.36733.1.2.3.3.1.6.3`	`Float2dp`	Average number of UPDATE operations failures (in period)
`enterprises.36733.1.2.3.3.1.6.4`	`Float2dp`	Average number of DELETE operations failures (in period)
`enterprises.36733.1.2.3.3.1.6.5`	`Float2dp`	Average number of LIST operations failures (in period)

CTS CRUD Operation Table Minimum Operations Failures in Period

Minimum Number, Operations Failures OID	Data Type	Description
`enterprises.36733.1.2.3.3.1.7.1`	`Counter64`	Minimum number of CREATE operations failures (in period)
`enterprises.36733.1.2.3.3.1.7.2`	`Counter64`	Minimum number of READ operations failures (in period)
`enterprises.36733.1.2.3.3.1.7.3`	`Counter64`	Minimum number of UPDATE operations failures (in period)
`enterprises.36733.1.2.3.3.1.7.4`	`Counter64`	Minimum number of DELETE operations failures (in period)
`enterprises.36733.1.2.3.3.1.7.5`	`Counter64`	Minimum number of LIST operations failures (in period)

CTS CRUD Operation Table Maximum Operations Failures in Period

Maximum Number, Operations Failures OID	Data Type	Description
`enterprises.36733.1.2.3.3.1.8.1`	`Counter64`	Maximum number of CREATE operations failures (in period)
`enterprises.36733.1.2.3.3.1.8.2`	`Counter64`	Maximum number of READ operations failures (in period)

Maximum Number, Operations Failures OID	Data Type	Description
enterprises.36733.1.2.3.3.1.8.3	Counter64	Maximum number of UPDATE operations failures (in period)
enterprises.36733.1.2.3.3.1.8.4	Counter64	Maximum number of DELETE operations failures (in period)
enterprises.36733.1.2.3.3.1.8.5	Counter64	Maximum number of LIST operations failures (in period)

7.1.5. CTS CRUD Operations Per Token Type

OIDs that start with `enterprises.36733.1.2.3.4.1` are labels for CTS CRUD operations per token type.

Tokens of each type can be created, read, updated, deleted, and listed. Each of these types can be measured cumulatively. They can also be measured over a period of time (default=10 seconds), as an average, minimum, and maximum.

OID suffixes for CRUD operations are defined according to the following rules.

The first part of the OID is `enterprises.36733.1.2.3.4.1`.

The next OID suffix specifies a metric:

CTS CRUD Operation Metrics

OID Suffix	Data Type	Metric
1	Counter64	Cumulative count
2	Float2dp	Average (in period)
3	Counter64	Minimum (in period)
4	Counter64	Maximum (in period)

The next OID suffix specifies a token type:

CTS CRUD Operation Token Types

OID Suffix	Token Type
1	Session
2	SAML v2.0
3	OAuth 2
4	REST
5	OAuth 2.0 CSRF Protection
6	Resource Set

OID Suffix	Token Type
7	UMA Permission Ticket
8	UMA Requesting Party
9	UMA Audit Entry
10	Session Blacklist
11	UMA Pending Request
12	Security Token Service
13	OAuth 2.0 Blacklist
14	OAuth 2.0 Stateless
15	Push Notification
16	Cluster-wide Notification

The final OID suffix specifies an operation:

CTS CRUD Operations

OID Suffix	Operation
1	Create
2	Read
3	Update
4	Delete
5	List

The following examples illustrate OID construction for CTS CRUD operations per token type.

OID Examples for CTS CRUD Operations Per Token Type

OID	Data Type	Description
`enterprises.36733.1.2.3.4.1.1.1.3`	`Counter64`	Cumulative count of updated Session tokens
`enterprises.36733.1.2.3.4.1.4.3.4`	`Counter64`	Maximum deleted OAuth 2.0 tokens (in period)
`enterprises.36733.1.2.3.4.1.2.10.5`	`Float2dp`	Average listed Session Blacklist tokens (in period)

7.1.6. CTS Token Operation Status

The CTS token OIDs defined in this section specify the total number of tokens of each type and their average current lifetimes.

The options for token operations are shown in the following tables. Total and average current lifetimes are associated with each CTS token type.

CTS Total Tokens, by Type

Total Tokens, by Type	Data Type	Description
`enterprises.36733.1.2.3.5.1.1.1`	`Counter64`	Total number of Session tokens
`enterprises.36733.1.2.3.5.1.1.2`	`Counter64`	Total number of SAML v2.0 tokens
`enterprises.36733.1.2.3.5.1.1.3`	`Counter64`	Total number of OAuth 2.0 tokens
`enterprises.36733.1.2.3.5.1.1.4`	`Counter64`	Total number of REST tokens
`enterprises.36733.1.2.3.5.1.1.5`	`Counter64`	Total number of OAuth 2.0 CSRF Protection tokens
`enterprises.36733.1.2.3.5.1.1.6`	`Counter64`	Total number of Resource Set tokens
`enterprises.36733.1.2.3.5.1.1.7`	`Counter64`	Total number of UMA Permission Ticket tokens
`enterprises.36733.1.2.3.5.1.1.8`	`Counter64`	Total number of UMA Requesting Party tokens
`enterprises.36733.1.2.3.5.1.1.9`	`Counter64`	Total number of UMA Audit Entry tokens
`enterprises.36733.1.2.3.5.1.1.10`	`Counter64`	Total number of Session Blacklist tokens
`enterprises.36733.1.2.3.5.1.1.11`	`Counter64`	Total number of UMA Pending Request tokens
`enterprises.36733.1.2.3.5.1.1.12`	`Counter64`	Total number of Security Token Service tokens
`enterprises.36733.1.2.3.5.1.1.13`	`Counter64`	Total number of OAuth 2.0 Blacklist tokens
`enterprises.36733.1.2.3.5.1.1.14`	`Counter64`	Total number of OAuth 2.0 Stateless tokens
`enterprises.36733.1.2.3.5.1.1.15`	`Counter64`	Total number of Push Notification tokens
`enterprises.36733.1.2.3.5.1.1.16`	`Counter64`	Total number of Cluster-wide Notification tokens

CTS Token Average Lifetime, by Type

Average Token Lifetime, by Type	Data Type	Description
`enterprises.36733.1.2.3.5.1.2.1`	`Counter64`	Average lifetime of Session tokens in seconds
`enterprises.36733.1.2.3.5.1.2.2`	`Counter64`	Average lifetime of SAML v2.0 tokens in seconds
`enterprises.36733.1.2.3.5.1.2.3`	`Counter64`	Average lifetime of OAuth 2.0 tokens in seconds
`enterprises.36733.1.2.3.5.1.2.4`	`Counter64`	Average lifetime of REST tokens in seconds
`enterprises.36733.1.2.3.5.1.2.5`	`Counter64`	Average lifetime of OAuth 2.0 CSRF Protection tokens in seconds
`enterprises.36733.1.2.3.5.1.2.6`	`Counter64`	Average lifetime of Resource Set tokens in seconds
`enterprises.36733.1.2.3.5.1.2.7`	`Counter64`	Average lifetime of UMA Permission Ticket tokens in seconds
`enterprises.36733.1.2.3.5.1.2.8`	`Counter64`	Average lifetime of UMA Requesting Party tokens in seconds
`enterprises.36733.1.2.3.5.1.2.9`	`Counter64`	Average lifetime of UMA Audit Entry tokens in seconds
`enterprises.36733.1.2.3.5.1.2.10`	`Counter64`	Average lifetime of Session Blacklist tokens in seconds
`enterprises.36733.1.2.3.5.1.2.11`	`Counter64`	Average lifetime of UMA Pending Request tokens in seconds
`enterprises.36733.1.2.3.5.1.2.12`	`Counter64`	Average lifetime of Security Token Service tokens in seconds
`enterprises.36733.1.2.3.5.1.2.13`	`Counter64`	Average lifetime of OAuth 2.0 Blacklist tokens in seconds
`enterprises.36733.1.2.3.5.1.2.14`	`Counter64`	Average lifetime of OAuth 2.0 Stateless tokens in seconds
`enterprises.36733.1.2.3.5.1.2.15`	`Counter64`	Average lifetime of Push Notification tokens in seconds
`enterprises.36733.1.2.3.5.1.2.16`	`Counter64`	Average lifetime of Cluster-wide Notification tokens in seconds

7.1.7. CTS Reaper Run Information

The CTS reaper deletes unused or expired tokens. Unless AM is in a shutdown cycle, the CTS reaper is designed to run continuously. By default, the CTS reaper runs in fixed intervals, unless AM is in the process of shutting down.

A single OID, `enterprises.36733.1.2.3.6.0`, relates to the CTS reaper. This OID:

- Specifies the average rate of deleted tokens per CTS reaper run
- Has the `Float2dp`data type.

7.1.8. CTS Connection Factory OIDs

Every request for a CTS token is a request to the `CTSConnectionFactory`. Such requests can either succeed or fail. The following OIDs provide measures for both such connections. The CTSConnectionFactory OIDs are also measured using a rate window system, similar to all the other CTS OIDs, except the CTS Reaper.

As there are no indexes required to look up the value of CTSConnectionFactory OIDs, they end in 0. Success or failure of these OIDs are not specific to any operation or token type.

The following tables list the OIDs related to the CTSConnectionFactory.

CTSConnectionFactory, Successful Connections

Successes, CTSConnectionFactory	Data Type	Description
`enterprises.36733.1.2.3.7.1.1.0`	`Counter64`	Cumulative number of successful connections
`enterprises.36733.1.2.3.7.1.2.0`	`Float2dp`	Average number of successful connections (in period)
`enterprises.36733.1.2.3.7.1.3.0`	`Counter64`	Minimum number of successful connections (in period)
`enterprises.36733.1.2.3.7.1.4.0`	`Counter64`	Maximum number of successful connections (in period)

CTSConnectionFactory, Failed Connections

Failures, CTSConnectionFactory	Data Type	Description
`enterprises.36733.1.2.3.7.2.1.0`	`Counter64`	Cumulative number of failed connections
`enterprises.36733.1.2.3.7.2.2.0`	`Float2dp`	Average number of failed connections (in period)

Failures, CTSConnectionFactory	Data Type	Description
`enterprises.36733.1.2.3.7.2.3.0`	`Counter64`	Minimum number of failed connections (in period)
`enterprises.36733.1.2.3.7.2.4.0`	`Counter64`	Maximum number of failed connections (in period)

7.2. Command-line Tool Reference

Name

configurator.jar — install or upgrade AM using a configuration file

Synopsis

`configurator.jar` {options}

Description

This executable .jar file, openam-configurator-tool-14.1.1.8.jar, lets you perform silent installation, configuring a deployed AM server by applying settings from a configuration file.

Options

The following options are supported.

`-f | --file` ***`configuration-file`***

Configure a deployed AM web application archive using the specified configuration file. Installation and upgrade configuration files are described in the sections below.

`--acceptLicense`

Auto-accept the software license agreement and suppress the display of the licence acceptance screen to the user. If the configuration file contains the `ACCEPT_LICENSES` property, it will have precedence over the command-line option.

`-? | --help`

Display the usage message.

Installation Configuration File

Base your configuration on the `sampleconfiguration` file delivered with AM, and using the hints in this section, or the comments included in the file.

Server Properties

These properties pertain to the AM server instance.

SERVER_URL

URL to the web container where you want AM to run, such as `http://openam.example.com:8080`

DEPLOYMENT_URI

URI where you want to deploy AM on the web container, such as `/openam`

BASE_DIR

Configuration directory where AM stores files and embedded configuration directory servers, such as `$HOME/openam`

locale

The user locale, such as `en_GB`

PLATFORM_LOCALE

The locale of the AM server, such as `en_US`

AM_ENC_KEY

The password encryption key, which must be the same on all servers in a multi-server installation, such as `O6QWwHPO4os+zEz3Nqn/2daAYWyiFE32`. If left blank, installing AM generates a random password encryption key that you can view in the AM console under Deployment > Servers > *Server Name* > Security.

ADMIN_PWD

Password of the AM administrator user `amadmin`, which must be at least 8 characters in length and must match that of other servers in a multiserver deployment

COOKIE_DOMAIN

Name of the trusted DNS domain AM returns to a browser when it grants a session ID to a user. By default, it is set to the full URL that was used to access the configurator, such as `example.com`.

ACCEPT_LICENSES

Optional boolean property that can be set to always auto-accept the software license agreement and suppress the display of the license acceptance screen to the user. A value of `true` auto-accepts the license; any other value will be assumed to equal `false`, resulting in the presentation of the license. Default value is `false`. This property takes precedence over the `--acceptLicense` option, which can also be passed in to the application with the openam-configurator-tool-14.1.1.8.jar file.

Configuration Store Properties

These properties pertain to the directory server where AM stores its configuration.

DATA_STORE

Type of the configuration data store. The value `embedded` means set up AM with an embedded, DS configuration store. The value `dirServer` means an external directory server, such as ForgeRock Directory Services, or Oracle Directory Server Enterprise Edition. If you set this to `dirServer`, and the configuration store contains the configuration of other AM servers, then the server is added to the existing multiserver installation.

DIRECTORY_SSL

To use LDAP without SSL, set this to `SIMPLE`. To use LDAP with SSL, set this to `SSL`.

DIRECTORY_SERVER

Fully qualified domain name of the configuration store directory server host, such as `opendj.example.com`

DIRECTORY_PORT

LDAP or LDAPS port number for the configuration store directory server, such as 389 or 636

DIRECTORY_ADMIN_PORT

Administration port number for the configuration store directory server, such as 4444

DIRECTORY_JMX_PORT

Java Management eXtension port number, such as `1689`, used with the DS embedded configuration store

ROOT_SUFFIX

Root suffix distinguished name (DN) for the configuration store, such as `o=openam`

DS_DIRMGRDN

Distinguished name of the directory manager of the configuration store, such as `cn=Directory Manager`

DS_DIRMGRPASSWD

Password for the directory manager of the configuration store

User Data Store Properties

These properties pertain to the directory server where AM stores user profiles. If you do not include these properties, or you leave these properties commented out, then AM uses the same directory server as it uses for the configuration store.

USERSTORE_TYPE

The type of directory server used. Valid values include the following.

- `LDAPv3ForOpenDS`: ForgeRock OpenDJ or Sun OpenDS
- `LDAPv3ForAD`: Active Directory with host and port settings
- `LDAPv3ForADDC`: Active Directory with a Domain Name setting

- `LDAPv3ForADAM`: Active Directory Application Mode
- `LDAPv3ForODSEE`: Sun Java System Directory Server
- `LDAPv3ForTivoli`: IBM Tivoli Directory Server

USERSTORE_SSL

To use LDAP without SSL, set this to `SIMPLE`. To use LDAP with SSL, set this to `SSL`.

USERSTORE_DOMAINNAME

If `USERSTORE_TYPE` is `LDAPv3ForADDC`, you set this to the Active Directory Domain Name, such as `ad.example.com`, and then set only the `USERSTORE_SSL`, `USERSTORE_MGRDN`, and `USERSTORE_PASSWD` additional parameters. This lets Active Directory use DNS to retrieve service locations. Otherwise, do not use.

USERSTORE_HOST

Fully qualified domain name of the user data store directory server, such as `opendj.example.com`

USERSTORE_PORT

Port number of the user data store. Default for LDAP is 389, and for LDAP over SSL is 636.

USERSTORE_SUFFIX

Root suffix distinguished name for the user data in the directory, such as `dc=example,dc=com`

USERSTORE_MGRDN

Distinguished name of the directory manager of the user data store, such as `cn=Directory Manager`

USERSTORE_PASSWD

Password for the directory manager of the user data store

Site Properties

These properties pertain when you configure multiple AM servers in a site deployment, where a load balancer spreads request across multiple servers. Use the `DS_EMB_REPL*` and `existingserverid` properties only for the second and subsequent servers in a site configuration.

LB_SITE_NAME

The name of the AM site

LB_PRIMARY_URL

The load balancer URL for the site, such as `http://lb.example.com:80/openam`.

DS_EMB_REPL_FLAG

Enable use of the embedded configuration store by setting this parameter to `embReplFlag`, only if the `DATA_STORE` parameter is set to `embedded`. Use the other `DS_EMB_REPL*` parameters in this section to set up configuration store data replication.

DS_EMB_REPL_REPLPORT1

Replication port number for the new AM server you are installing, such as 58989

DS_EMB_REPL_HOST2

Host name of an existing AM server housing the configuration store directory server with which to replicate, such as `openam1.example.com`

DS_EMB_REPL_ADMINPORT2

Administration port number for the configuration store directory server used by the existing AM server, such as 4444

DS_EMB_REPL_REPLPORT2

Replication port number for the configuration store directory server used by the existing AM server, such as 50899

existingserverid

Full URL of the existing AM server, such as `http://server1.example.com:8080/openam`

Upgrade Configuration File

Base your configuration on the `sampleconfiguration` file delivered with AM, and using the hints in this section, or the comments included in the file.

Upgrade Properties

SERVER_URL

URL to the web container where AM runs, such as `http://openam.example.com:8080`

DEPLOYMENT_URI

URI where AM is deployed on the web container, such as `/openam`

ACCEPT_LICENSES

Optional boolean property that can be set to always auto-accept the software license agreement and suppress displaying the license acceptance screen to the user. A value of `true` auto-accepts the license; any other value will be assumed to equal `false`, resulting in the presentation of the license. Default value is `false`. This property takes precedence over the `--acceptLicense` option, which can also be passed in to the application with the openam-configurator-tool-14.1.1.8.jar file.

Examples

The following example shows a configuration file to install a server with an external user data store.

```
# Server properties, AM_ENC_KEY="" means generate random key
SERVER_URL=http://openam.example.com:8080
DEPLOYMENT_URI=/openam
BASE_DIR=$HOME/openam
locale=en_US
PLATFORM_LOCALE=en_US
AM_ENC_KEY=
ADMIN_PWD=change3me
COOKIE_DOMAIN=openam.example.com
ACCEPT_LICENSES=true

# Embedded configuration data store
DATA_STORE=embedded
DIRECTORY_SSL=SIMPLE
DIRECTORY_SERVER=openam.example.com
DIRECTORY_PORT=50389
DIRECTORY_ADMIN_PORT=4444
DIRECTORY_JMX_PORT=1689
ROOT_SUFFIX=o=openam
DS_DIRMGRDN=cn=Directory Manager
DS_DIRMGRPASSWD=chang3me

# External OpenDJ based user data store
USERSTORE_TYPE=LDAPv3ForOpenDS
USERSTORE_SSL=SIMPLE
#USERSTORE_DOMAINNAME=ad.example.com
USERSTORE_HOST=opendj.example.com
USERSTORE_PORT=389
USERSTORE_SUFFIX=dc=example,dc=com
USERSTORE_MGRDN=cn=Directory Manager
USERSTORE_PASSWD=secret12

# Uncomment to specify the site for the first server in a site configuration
#LB_SITE_NAME=lb
#LB_PRIMARY_URL=http://lb.example.com:80/openam
```

The following example shows a configuration file to install the second server in a site configuration.

```
# Server properties, AM_ENC_KEY from first server
SERVER_URL=http://server2.example.com:8080
DEPLOYMENT_URI=/openam
BASE_DIR=$HOME/openam
locale=en_US
PLATFORM_LOCALE=en_US
AM_ENC_KEY=O6QWwHPO4os+zEz3Nqn/2daAYWyiFE32
ADMIN_PWD=change3me
AMLDAPUSERPASSWD=secret12
COOKIE_DOMAIN=openam.example.com
ACCEPT_LICENSES=true
```

```
# Embedded configuration data store
DATA_STORE=embedded
DIRECTORY_SSL=SIMPLE
DIRECTORY_SERVER=server2.example.com
DIRECTORY_PORT=50389
DIRECTORY_ADMIN_PORT=4444
DIRECTORY_JMX_PORT=1689
ROOT_SUFFIX=o=openam
DS_DIRMGRDN=cn=Directory Manager
DS_DIRMGRPASSWD=chang3me

# External OpenDJ based user data store
USERSTORE_TYPE=LDAPv3ForOpenDS
USERSTORE_SSL=SIMPLE
#USERSTORE_DOMAINNAME=ad.example.com
USERSTORE_HOST=opendj.example.com
USERSTORE_PORT=389
USERSTORE_SUFFIX=dc=example,dc=com
USERSTORE_MGRDN=cn=Directory Manager
USERSTORE_PASSWD=secret12

# Site properties
LB_SITE_NAME=lb
LB_PRIMARY_URL=http://lb.example.com:80/openam
DS_EMB_REPL_FLAG=embReplFlag
DS_EMB_REPL_REPLPORT1=58989
DS_EMB_REPL_HOST2=server1.example.com
DS_EMB_REPL_ADMINPORT2=4444
DS_EMB_REPL_REPLPORT2=50889
existingserverid=http://server1.example.com:8080/openam
```

The following example shows a configuration file to upgrade an AM server.

```
SERVER_URL=https://openam.example.com:8080
DEPLOYMENT_URI=/openam
ACCEPT_LICENSES=true
```

The following example uses a configuration file with the `--acceptLicense` option on the command line.

```
$ java \
 -jar openam-configurator-tool-14.1.1.8.jar \
 -f config.file \
 --acceptLicense
```

Appendix A. Getting Support

For more information or resources about AM and ForgeRock Support, see the following sections:

A.1. Accessing Documentation Online

ForgeRock publishes comprehensive documentation online:

- The ForgeRock Knowledge Base offers a large and increasing number of up-to-date, practical articles that help you deploy and manage ForgeRock software.

  While many articles are visible to community members, ForgeRock customers have access to much more, including advanced information for customers using ForgeRock software in a mission-critical capacity.

- ForgeRock product documentation, such as this document, aims to be technically accurate and complete with respect to the software documented. It is visible to everyone and covers all product features and examples of how to use them.

A.2. Using the ForgeRock.org Site

The ForgeRock.org site has links to source code for ForgeRock open source software, as well as links to the ForgeRock forums and technical blogs.

If you are a *ForgeRock customer*, raise a support ticket instead of using the forums. ForgeRock support professionals will get in touch to help you.

A.3. Getting Support and Contacting ForgeRock

ForgeRock provides support services, professional services, training through ForgeRock University, and partner services to assist you in setting up and maintaining your deployments. For a general overview of these services, see https://www.forgerock.com.

ForgeRock has staff members around the globe who support our international customers and partners. For details on ForgeRock's support offering, including support plans and service level agreements (SLAs), visit https://www.forgerock.com/support.

Appendix B. Supported Scripts

This appendix presents sample scripts to install a Core Token Service (CTS) token store for AM.

B.1. CTS Installation Script

You can use the following script to install a CTS token store. If you are using OpenDJ 3.0.0, use the following installation script:

```
#!/bin/bash
#
#  cts-install.txt
#
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#  with the fields enclosed by brackets [] replaced by
#  your own identifying information:
#  "Portions Copyrighted [year] [name of copyright owner]"
#
```

```
USER="cn=Directory Manager"
PASS="password"
SERVER_PORT=3389
TOMCAT_OPENAM_WEBAPP=/root/am-war
ROOT_SUFFIX="cn=cts,ou=famrecords,ou=openam-session,ou=tokens"
T=/tmp/ldif
rm -rf $T
mkdir $T
cp $TOMCAT_OPENAM_WEBAPP/WEB-INF/template/ldif/sfha/cts-add-multivalue.ldif
$T/cts-add-multivalue.ldif
cat $TOMCAT_OPENAM_WEBAPP/WEB-INF/template/ldif/sfha/cts-add-multivalue-indices.ldif |
   sed -e 's/@DB_NAME@/userRoot/' > $T/cts-add-multivalue-indices.ldif

bin/ldapmodify --port $SERVER_PORT --bindDN "$USER" --bindPassword "$PASS" --fileName $T/cts-add-
multivalue.ldif
bin/ldapmodify --port $SERVER_PORT --bindDN "$USER" --bindPassword "$PASS" --defaultAdd --fileName $T/cts-
add-multivalue-indices.ldif

bin/stop-ds
bin/rebuild-index --baseDN $ROOT_SUFFIX --rebuildAll --offline
bin/verify-index --baseDN $ROOT_SUFFIX
bin/start-ds
```

If you are using DS 4.0.0, the **ldapmodify** commands are slightly different (no `--defaultAdd` option):

```
bin/ldapmodify --port $SERVER_PORT --bindDN "$USER" --bindPassword "$PASS" --fileName $T/cts-add-
multivalue.ldif
bin/ldapmodify --port $SERVER_PORT --bindDN "$USER" --bindPassword "$PASS" --fileName $T/cts-add-
multivalue-indices.ldif
```

B.2. CTS Indexing

Use the following script, `cts-add-indexes.txt`, to add required indexes to the CTS token store using **dsconfig** batch mode:

```

#!/bin/bash
#
#  cts-add-indexes.txt
#
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#  of the Common Development and Distribution License
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#  Header Notice in each file and include the License file
#  at http://forgerock.org/license/CDDLv1.0.html
#  If applicable, add the following below the CDDL Header,
#  with the fields enclosed by brackets [] replaced by
#  your own identifying information:
#  "Portions Copyrighted [year] [name of copyright owner]"
#

#  dsconfig batch file to add CTS indexes
#  1. Save this file locally.
#  2. On OpenDJ server, run:
#     dsconfig -p 4444 -D "cn=Directory Manager" -w password \
#     -F cts-add-indexes.txt -X -n

create-backend-index --backend-name userRoot --index-name coreTokenExpirationDate \
   --set index-type:ordering
create-backend-index --backend-name userRoot --index-name coreTokenUserId \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenString01 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenString02 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenString03 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenString08 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenString09 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenString10 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenString14 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenString15 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenInteger01 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenInteger02 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenInteger03 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenInteger04 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenInteger05 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenInteger08 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenInteger09 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenInteger10 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenDate01 \
   --set index-type:ordering
create-backend-index --backend-name userRoot --index-name coreTokenDate02 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenDate03 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenDate04 \
   --set index-type:equality
create-backend-index --backend-name userRoot --index-name coreTokenDate05 \
    --set index-type:equality
```

Appendix C. Supported LDIF Files

AM installation deploys several LDIF files that can be used to create the schemas required by AM in an external configuration data store. LDIF files are available for Microsoft Active Directory, Microsoft Active Directory Lightweight Directory Services, Oracle Directory Server Enterprise Edition, ForgeRock Directory Services, Oracle Unified Directory, and IBM Tivoli Directory Server.

The following tables provide descriptions for each LDIF file:

Microsoft Active Directory LDIF Files

LDIF File	Description
ad_config_schema.ldif	LDIF for the configuration schema.
ad_dashboard.ldif	LDIF to support the dashboard service.
ad_deviceprint.ldif	LDIF to support the device print service.
ad_kba.ldif	LDIF to support the User Self Service's knowledge-based questions and answers service.
ad_oathdevices.ldif	LDIF to support registered devices for the OATH authentication service.
ad_pushdevices.ldif	LDIF to support registered devices for the PUSH notification service.
ad_user_schema.ldif	LDIF for the user schema.

Microsoft Active Directory Lightweight Directory Services LDIF Files

LDIF File	Description
adam_dashboard.ldif	LDIF to support the dashboard service.

LDIF File	Description
adam_deviceprint.ldif	LDIF to support the device print service.
adam_kba.ldif	LDIF to support the User Self Service's knowledge-based questions and answers.
adam_oathdevices.ldif	LDIF to support registered devices for the OATH authentication service.
adam_pushdevices.ldif	LDIF to support registered devices for the PUSH notification service.
adam_user_schema.ldif	LDIF for the user schema.

Oracle Directory Server Enterprise Edition LDIF Files

LDIF File	Description
amsdk_plugin	Folder containg the AM SDK LDIF files: amsdk_init_template.ldif and amsdk_sunone_schema2.ldif.
odsee_config_index.ldif	LDIF for the ODSEE configuration indexes.
odsee_config_schema.ldif	LDIF for the ODSEE configuration schema.
odsee_dashboard.ldif	LDIF to support the dashboard service.
odsee_deviceprint.ldif	LDIF to support the device print service.
odsee_kba.ldif	LDIF to support the User Self Service's knowledge-based questions and answers.
odsee_oathdevices.ldif	LDIF to support registered devices for the OATH authentication service.
odsee_pushdevices.ldif	LDIF to support registered devices for the PUSH notification service.
odsee_user_index.ldif	LDIF for the user respository indexes.
odsee_user_schema.ldif	LDIF for the user repository schema.
odsee_userinit.ldif	LDIF for the setting up user session initialization.

DS LDIF Files

LDIF File	Description
oath_2fa.ldif	LDIF for the OATH two-factor authentication service.
opendj_aci_lift_user_password_restriction.ldif	LDIF to add an ACI entry to the root suffix to allow users to modify the user password attribute.
opendj_aci_remove_blanket_deny_all.ldif	LDIF to lift any user password restrictions for upgrade.
opendj_config_schema.ldif	LDIF for the DS configuration schema.
opendj_dashboard.ldif	LDIF to support the dashboard service.
opendj_deviceprint.ldif	LDIF to support the device print service.

LDIF File	Description
opendj_embinit.ldif	LDIF for the DS user management and SMS/configuration datastore schema for embedded DS deployments.
opendj_kba.ldif	LDIF to support the User Self Service's knowledge-based questions and answers.
opendj_oathdevices.ldif	LDIF to support registered devices for the OATH authentication service.
opendj_pushdevices.ldif	LLDIF to support registered devices for the PUSH notification service.
opendj_remove_config_schema.ldif	LDIF to remove the configuration schema.
opendj_remove_user_schema.ldif	LDIF to remove the user schema.
opend_uma_audit.ldif	LDIF to add auditing capabilities for the UMA service.
opend_uma_labels_schema.ldif	LDIF to add a schema for the UMA service labels.
opend_uma_pending_requests.ldif	LDIF to add pending requests for the UMA service.
opend_uma_resource_set_labels.ldif	LDIF to add labels for the UMA service resource sets.
opend_uma_resource_sets.ldif	LDIF to add resource sets to the UMA service resource.
opendj_user_index.ldif	LDIF for the user respository indexes.
opendj_user_schema.ldif	LDIF for the user repository schema.
opendj_userinit.ldif	LDIF for the setting up user session initialization.

Tivoli LDIF Files

LDIF File	Description
tivoli_dashboard.ldif	LDIF to support the dashboard service.
tivoli_deviceprint.ldif	LDIF to support the device print service.
tivoli_kba.ldif	LDIF to support the User Self Service's knowledge-based questions and answers.
tivoli_oathdevices.ldif	LDIF to support registered devices for the OATH authentication service.
tivoli_pushdevices.ldif	LDIF to support registered devices for the PUSH notification service.
tivoli_user_schema.ldif	LDIF for the user repository schema.

Glossary

Access control

Control to grant or to deny access to a resource.

Account lockout

The act of making an account temporarily or permanently inactive after successive authentication failures.

Actions

Defined as part of policies, these verbs indicate what authorized subjects can do to resources.

Advice

In the context of a policy decision denying access, a hint to the policy enforcement point about remedial action to take that could result in a decision allowing access.

Agent administrator

User having privileges only to read and write agent profile configuration information, typically created to delegate agent profile creation to the user installing a web or Java agent.

Agent authenticator

Entity with read-only access to multiple agent profiles defined in the same realm; allows an agent to read web service profiles.

Application

In general terms, a service exposing protected resources.

In the context of AM policies, the application is a template that constrains the policies that govern access to protected resources. An application can have zero or more policies.

Application type

Application types act as templates for creating policy applications.

Application types define a preset list of actions and functional logic, such as policy lookup and resource comparator logic.

Application types also define the internal normalization, indexing logic, and comparator logic for applications.

Attribute-based access control (ABAC)

Access control that is based on attributes of a user, such as how old a user is or whether the user is a paying customer.

Authentication

The act of confirming the identity of a principal.

Authentication chaining

A series of authentication modules configured together which a principal must negotiate as configured in order to authenticate successfully.

Authentication level

Positive integer associated with an authentication module, usually used to require success with more stringent authentication measures when requesting resources requiring special protection.

Authentication module

AM authentication unit that handles one way of obtaining and verifying credentials.

Authorization

The act of determining whether to grant or to deny a principal access to a resource.

Authorization Server

In OAuth 2.0, issues access tokens to the client after authenticating a resource owner and confirming that the owner authorizes the client to access the protected resource. AM can play this role in the OAuth 2.0 authorization framework.

Auto-federation

Arrangement to federate a principal's identity automatically based on a common attribute value shared across the principal's profiles at different providers.

Bulk federation

Batch job permanently federating user profiles between a service provider and an identity provider based on a list of matched user identifiers that exist on both providers.

Circle of trust

Group of providers, including at least one identity provider, who have agreed to trust each other to participate in a SAML v2.0 provider federation.

Client

In OAuth 2.0, requests protected web resources on behalf of the resource owner given the owner's authorization. AM can play this role in the OAuth 2.0 authorization framework.

Conditions

Defined as part of policies, these determine the circumstances under which which a policy applies.

Environmental conditions reflect circumstances like the client IP address, time of day, how the subject authenticated, or the authentication level achieved.

	Subject conditions reflect characteristics of the subject like whether the subject authenticated, the identity of the subject, or claims in the subject's JWT.
Configuration datastore	LDAP directory service holding AM configuration data.
Cross-domain single sign-on (CDSSO)	AM capability allowing single sign-on across different DNS domains.
Delegation	Granting users administrative privileges with AM.
Entitlement	Decision that defines which resource names can and cannot be accessed for a given subject in the context of a particular application, which actions are allowed and which are denied, and any related advice and attributes.
Extended metadata	Federation configuration information specific to AM.
Extensible Access Control Markup Language (XACML)	Standard, XML-based access control policy language, including a processing model for making authorization decisions based on policies.
Federation	Standardized means for aggregating identities, sharing authentication and authorization data information between trusted providers, and allowing principals to access services across different providers without authenticating repeatedly.
Fedlet	Service provider application capable of participating in a circle of trust and allowing federation without installing all of AM on the service provider side; AM lets you create Java Fedlets.
Hot swappable	Refers to configuration properties for which changes can take effect without restarting the container where AM runs.
Identity	Set of data that uniquely describes a person or a thing such as a device or an application.
Identity federation	Linking of a principal's identity across multiple providers.
Identity provider (IdP)	Entity that produces assertions about a principal (such as how and when a principal authenticated, or that the principal's profile has a specified attribute value).
Identity repository	Data store holding user profiles and group information; different identity repositories can be defined for different realms.
Java agent	Java web application installed in a web container that acts as a policy enforcement point, filtering requests to other applications in the container with policies based on application resource URLs.

Metadata

Federation configuration information for a provider.

Policy

Set of rules that define who is granted access to a protected resource when, how, and under what conditions.

Policy agent

Java, web, or custom agent that intercepts requests for resources, directs principals to AM for authentication, and enforces policy decisions from AM.

Policy Administration Point (PAP)

Entity that manages and stores policy definitions.

Policy Decision Point (PDP)

Entity that evaluates access rights and then issues authorization decisions.

Policy Enforcement Point (PEP)

Entity that intercepts a request for a resource and then enforces policy decisions from a PDP.

Policy Information Point (PIP)

Entity that provides extra information, such as user profile attributes that a PDP needs in order to make a decision.

Principal

Represents an entity that has been authenticated (such as a user, a device, or an application), and thus is distinguished from other entities.

When a Subject successfully authenticates, AM associates the Subject with the Principal.

Privilege

In the context of delegated administration, a set of administrative tasks that can be performed by specified subjects in a given realm.

Provider federation

Agreement among providers to participate in a circle of trust.

Realm

AM unit for organizing configuration and identity information.

Realms can be used for example when different parts of an organization have different applications and user data stores, and when different organizations use the same AM deployment.

Administrators can delegate realm administration. The administrator assigns administrative privileges to users, allowing them to perform administrative tasks within the realm.

Resource

Something a user can access over the network such as a web page.

Defined as part of policies, these can include wildcards in order to match multiple actual resources.

Resource owner

In OAuth 2.0, entity who can authorize access to protected web resources, such as an end user.

Resource server

In OAuth 2.0, server hosting protected web resources, capable of handling access tokens to respond to requests for such resources.

Response attributes

Defined as part of policies, these allow AM to return additional information in the form of "attributes" with the response to a policy decision.

Role based access control (RBAC)

Access control that is based on whether a user has been granted a set of permissions (a role).

Security Assertion Markup Language (SAML)

Standard, XML-based language for exchanging authentication and authorization data between identity providers and service providers.

Service provider (SP)

Entity that consumes assertions about a principal (and provides a service that the principal is trying to access).

Session

The interval that starts with the user authenticating through AM and ends when the user logs out, or when their session is terminated. For browser-based clients, AM manages user sessions across one or more applications by setting a session cookie. See also Stateful session and Stateless session.

Session high availability

Capability that lets any AM server in a clustered deployment access shared, persistent information about users' sessions from the CTS token store. The user does not need to log in again unless the entire deployment goes down.

Session token

Unique identifier issued by AM after successful authentication. For a Stateful session, the session token is used to track a principal's session.

Single log out (SLO)

Capability allowing a principal to end a session once, thereby ending her session across multiple applications.

Single sign-on (SSO)

Capability allowing a principal to authenticate once and gain access to multiple applications without authenticating again.

Site

Group of AM servers configured the same way, accessed through a load balancer layer.

The load balancer handles failover to provide service-level availability. Use sticky load balancing based on `amlbcookie` values to improve site performance.

The load balancer can also be used to protect AM services.

Standard metadata

Standard federation configuration information that you can share with other access management software.

Stateful session

An AM session that resides in the Core Token Service's token store. Stateful sessions might also be cached in memory on one or more

AM servers. AM tracks stateful sessions in order to handle events like logout and timeout, to permit session constraints, and to notify applications involved in SSO when a session ends.

Stateless session

An AM session for which state information is encoded in AM and stored on the client. The information from the session is not retained in the CTS token store. For browser-based clients, AM sets a cookie in the browser that contains the session information.

Subject

Entity that requests access to a resource

When a subject successfully authenticates, AM associates the subject with the Principal that distinguishes it from other subjects. A subject can be associated with multiple principals.

User data store

Data storage service holding principals' profiles; underlying storage can be an LDAP directory service or a custom `IdRepo` implementation.

Web Agent

Native library installed in a web server that acts as a policy enforcement point with policies based on web page URLs.