Integrator's Guide

/ OpenIDM 3.1

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Abstract

Guide to configuring and integrating OpenIDM into identity management solutions. The OpenIDM project offers flexible, open source services for automating management of the identity life cycle.

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Preface

This guide shows you how to integrate OpenIDM as part of a complete identity management solution.

1. Who Should Use this Guide

This guide is written for systems integrators building identity management solutions based on OpenIDM services. This guide describes OpenIDM, and shows you how to set up OpenIDM as part of your identity management solution.

You do not need to be an OpenIDM wizard to learn something from this guide, though a background in identity management and building identity management solutions can help.

2. Formatting Conventions

Most examples in the documentation are created in GNU/Linux or Mac OS X operating environments. If distinctions are necessary between operating environments, examples are labeled with the operating environment name in parentheses. To avoid repetition file system directory names are often given only in UNIX format as in `/path/to/server`, even if the text applies to `C:\path\to\server` as well.

Absolute path names usually begin with the placeholder `/path/to/`. This path might translate to `/opt/`, `C:\Program Files\`, or somewhere else on your system.

Command-line, terminal sessions are formatted as follows:

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

Command output is sometimes formatted for narrower, more readable output even though formatting parameters are not shown in the command.

Program listings are formatted as follows:

```
class Test {
    public static void main(String [] args)  {
        System.out.println("This is a program listing.");
    }
}
```

3. 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.

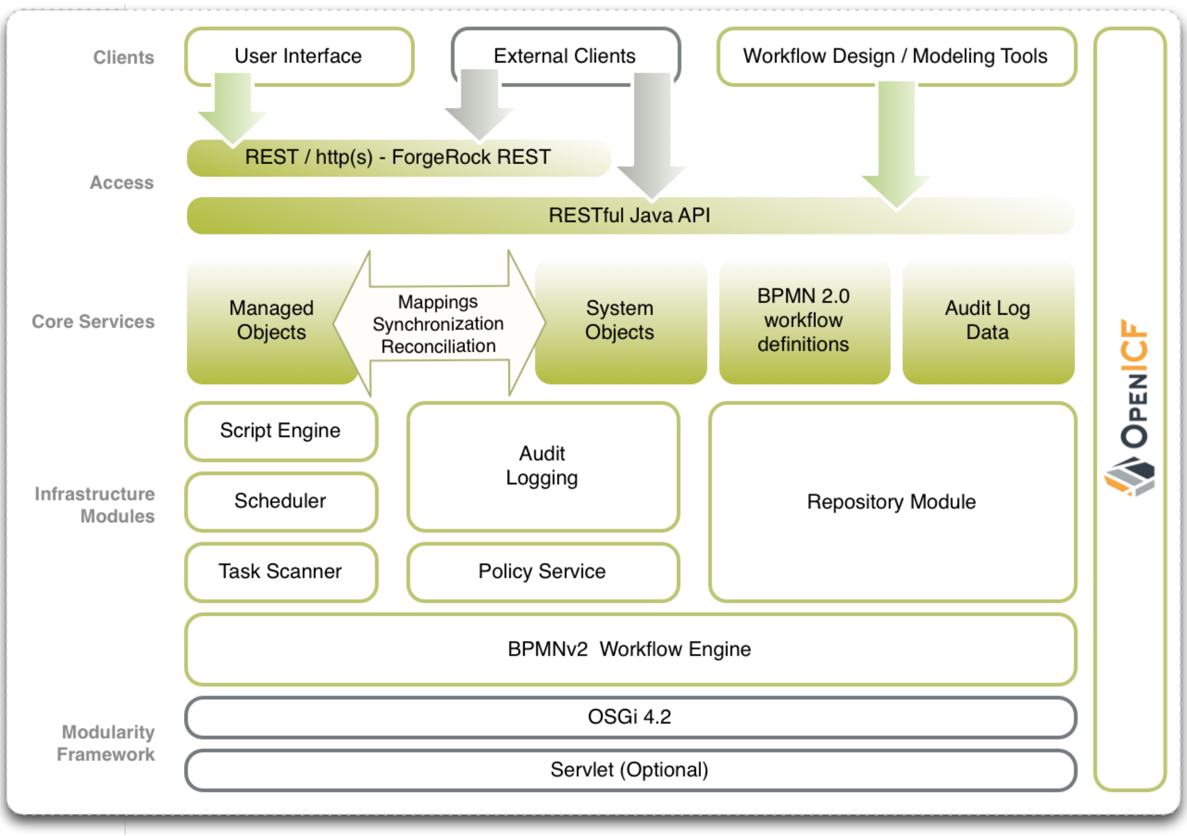
4. Using the ForgeRock.org Site

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.

Chapter 1
Architectural Overview

The following figure provides an overview of the OpenIDM architecture, which is covered in more detail in subsequent sections of this chapter.



1.1. OpenIDM Modular Framework

The OpenIDM framework is based on OSGi.

OSGi

OSGi is a module system and service platform for the Java programming language that implements a complete and dynamic component model. For a good introduction, see the OSGi site. While OpenIDM services are designed to run in any OSGi container, OpenIDM currently runs in Apache Felix.

Servlet

The optional Servlet layer provides RESTful HTTP access to the managed objects and services. While the Servlet layer can be provided by many different engines, OpenIDM embeds Jetty by default.

1.2. Infrastructure Modules

OpenIDM infrastructure modules provide the underlying features needed for core services.

BPMN 2.0 Workflow Engine

OpenIDM provides an embedded workflow and business process engine based on Activiti and the Business Process Model and Notation (BPMN) 2.0 standard.

For more information, see Chapter 17, "*Integrating Business Processes and Workflows*".

Task Scanner

OpenIDM provides a task scanning mechanism that enables you to perform a batch scan for a specified date in OpenIDM data, on a scheduled interval, and then to execute a task when this date is reached.

For more information, see Section 13.5, "Scanning Data to Trigger Tasks".

Scheduler

The scheduler provides a **cron**-like scheduling component implemented using the Quartz library. Use the scheduler, for example, to enable regular synchronizations and reconciliations.

For details, see Chapter 13, "*Scheduling Tasks and Events*".

Script Engine

The script engine is a pluggable module that provides the triggers and plugin points for OpenIDM. OpenIDM currently supports JavaScript and Groovy.

Policy Service

OpenIDM provides an extensible policy service that enables you to apply specific validation requirements to various components and properties.

For more information, see Chapter 9, "*Using Policies to Validate Data*".

Audit Logging

Auditing logs all relevant system activity to the configured log stores. This includes the data from reconciliation as a basis for reporting, as well as detailed activity logs to capture operations on the internal (managed) and external (system) objects.

For details, see Chapter 18, "*Using Audit Logs*".

Repository

The repository provides a common abstraction for a pluggable persistence layer. OpenIDM 3.1 supports use of MySQL to back the repository. Yet, plugin repositories can include NoSQL and relational databases, LDAP, and even flat files. The repository API operates using a JSON-based object model with RESTful principles consistent with the other OpenIDM services. The default, embedded implementation for the repository is the NoSQL database OrientDB, making it easy to evaluate OpenIDM out of the box before using MySQL in your production environment.

1.3. Core Services

The core services are the heart of the OpenIDM resource oriented unified object model and architecture.

Object Model

Artifacts handled by OpenIDM are Java object representations of the JavaScript object model as defined by JSON. The object model supports interoperability and potential integration with many applications, services and programming languages. As OpenIDM is a Java-based product, these representations are instances of classes: `Map`, `List`, `String`, `Number`, `Boolean`, and `null`.

OpenIDM can serialize and deserialize these structures to and from JSON as required. OpenIDM also exposes a set of triggers and functions that system administrators can define, in either JavaScript or Groovy, which can natively read and modify these JSON-based object model structures. OpenIDM is designed to support other scripting and programming languages.

Managed Objects

A *managed object* is an object that represents the identity-related data managed by OpenIDM. Managed objects are configurable, JSON-based data structures that OpenIDM stores in its pluggable repository. The default configuration of a managed object is that of a user, but you can define any kind of managed object, for example, groups or roles.

You can access managed objects over the REST interface with a query similar to the following:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/managed/..."
```

System Objects

System objects are pluggable representations of objects on external systems. For example, a user entry that is stored in an external LDAP directory is represented as a system object in OpenIDM.

System objects follow the same RESTful resource-based design principles as managed objects. They can be accessed over the REST interface with a query similar to the following:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/system/..."
```

There is a default implementation for the OpenICF framework, that allows any connector object to be represented as a system object.

Mappings

Mappings define policies between source and target objects and their attributes during synchronization and reconciliation. Mappings can also define triggers for validation, customization, filtering, and transformation of source and target objects.

For details, see Chapter 12, "*Configuring Synchronization*".

Synchronization & Reconciliation

Reconciliation enables on-demand and scheduled resource comparisons between the OpenIDM managed object repository and source or target systems. Comparisons can result in different actions, depending on the mappings defined between the systems.

Synchronization enables creating, updating, and deleting resources from a source to a target system, either on demand or according to a schedule.

For details, see Chapter 12, "*Configuring Synchronization*".

1.4. Secure Commons REST Commands

As noted in Appendix E, "*REST API Reference*", Representational State Transfer (REST) is a software architecture style for exposing resources, using the technologies and protocols of the World Wide Web.

REST interfaces are commonly tested with a **curl** command. Many of these commands are used in this document. They work with the standard ports associated with Java EE communications, 8080 and 8443.

To run **curl** over the secure port, 8443, you must include either the **--insecure** option, or follow the instructions shown in Section 16.2.2, "Restrict REST Access to the HTTPS Port". You can use those instructions with the self-signed certificate generated when OpenIDM starts, or with a `*.crt` file provided by a certificate authority.

In many cases in this guide, **curl** commands to the secure port are depicted with a `--cacert self-signed.crt` option. Instructions for creating that `self-signed.crt` file are shown in Section 16.2.2, "Restrict REST Access to the HTTPS Port".

1.5. Access Layer

The access layer provides the user interfaces and public APIs for accessing and managing the OpenIDM repository and its functions.

RESTful Interfaces

OpenIDM provides REST APIs for CRUD operations and invoking synchronization and reconciliation for both HTTP and Java.

For details, see Appendix E, "*REST API Reference*".

User Interfaces

User interfaces provide password management, registration, self-service, and workflow services.

Chapter 2
Starting and Stopping OpenIDM

This chapter covers the scripts provided for starting and stopping OpenIDM, and describes how to verify the *health* of a system, that is, that all requirements are met for a successful system startup.

2.1. To Start and Stop OpenIDM

By default you start and stop OpenIDM in interactive mode.

To start OpenIDM interactively, open a terminal or command window, change to the `openidm` directory, and run the startup script:

- **startup.sh** (UNIX)
- **startup.bat** (Windows)

The startup script starts OpenIDM, and opens an OSGi console with a `->` prompt where you can issue console commands.

To stop OpenIDM interactively in the OSGi console, enter the **shutdown** command.

```
-> shutdown
```

You can also start OpenIDM as a background process on UNIX, Linux, and Mac OS X. Follow these steps *before starting OpenIDM for the first time*.

1. If you have already started OpenIDM, then shut down OpenIDM and remove the Felix cache files under `openidm/felix-cache/`.

   ```
   -> shutdown
   ...
   $ rm -rf felix-cache/*
   ```

2. Start OpenIDM in the background.

   ```
   $ ./startup.sh &
   ```

   Alternatively, use the **nohup** command to keep OpenIDM running after you log out.

   ```
   $ nohup ./startup.sh &
   [2] 394
   $ appending output to nohup.out
   $
   ```

To stop OpenIDM running as a background process, use the **shutdown.sh** script.

```
$ ./shutdown.sh
./shutdown.sh
Stopping OpenIDM (454)
```

If you start OpenIDM in the background, and the job stops immediately after startup, see Section 23.1, "OpenIDM Stopped in Background".

To disable `ConsoleHandler` logging, see Chapter 10, "*Configuring Server Logs*".

2.2. Specifying the OpenIDM Startup Configuration

By default, OpenIDM starts up with the configuration and script files that are located in the `openidm/conf` and `openidm/script` directories, and with the binaries that are in the default install location. You can launch OpenIDM with a different configuration and set of script files, and even with a different set of binaries, in order to test a new configuration, manage multiple different OpenIDM projects, or to run one of the included samples.

The `startup.sh` script enables you to specify the following elements of a running OpenIDM instance.

- project location (`-p`)

  The project location specifies the configuration and default scripts with which OpenIDM will run.

  If you specify the project location, OpenIDM does not try to locate configuration objects in the default location. All configuration objects and any artifacts that are not in the bundled defaults (such as custom scripts) *must* be provided in the project location. This includes everything that is in the default `openidm/conf` and `openidm/script` directories.

  The following command starts OpenIDM with the configuration of sample 1:

  ```
  $ ./startup.sh -p /path/to/openidm/samples/sample1
  ```

  If an absolute path is not provided, the path is relative to the system property, `user.dir`. If no project location is specified, OpenIDM is launched with the default configuration in `/path/to/openidm/conf`.

- working location (`-w`)

  The working location specifies the directory to which OpenIDM writes its database cache and audit logs. The working location includes everything that is in the default `db` and `audit` directories.

  The following command specifies that OpenIDM writes its database cache and audit data to `/Users/admin/openidm/storage`:

  ```
  $ ./startup.sh -w /Users/admin/openidm/storage
  ```

  If an absolute path is not provided, the path is relative to the system property, `user.dir`. If no working location is specified, OpenIDM writes this data to the `openidm/db` and `openidm/audit` directories.

Note that this property does not affect the location of the OpenIDM system logs, or the Felix cache. To change the location of the OpenIDM logs, edit the `conf/logging.properties` file. To change the location of the Felix cache, edit the `conf/config.properties` file. Instructions are available in those respective files.

- startup configuration file (`-c`)

  A customizable startup configuration file (named `launcher.json`) enables you to specify how the OSGi Framework is started.

  Unless you are working with a highly customized deployment, you should not modify the default framework configuration. This option is therefore described in more detail in Chapter 24, "*Advanced Configuration*".

By default, properties files are loaded in the following order, and property values are resolved in the reverse order:

1. `system.properties`
2. `config.properties`
3. `boot.properties`

If both system and boot properties define the same attribute, the property substitution process locates the attribute in `boot.properties` and does not attempt to locate the property in `system.properties`.

You can use variable substitution in any `.json` configuration file with the install, working and project locations described previously. The following properties can be substituted:

`install.location`
`install.url`
`working.location`
`working.url`
`project.location`
`project.url`

Property substitution takes the following syntax:

```
&{launcher.property}
```

For example, to specify the location of the OrientDB database, you can set the `dbUrl` property in `repo.orientdb.json` as follows:

```
"dbUrl" : "local:&{launcher.working.location}/db/openidm",
```

The database location is then relative to a working location defined in the startup configuration.

Note that property substitution does not work for connector reference properties. So, for example, the following configuration would not be valid:

```
"connectorRef" : {
    "connectorName" : "&{connectorName}",
    "bundleName" : "org.forgerock.openicf.connectors.ldap-connector",
    "bundleVersion" : "&{LDAP.BundleVersion}"
    ...
```

The `"connectorName"` must be the precise string from the connector configuration. If you need to specify multiple connector version numbers, use a range of versions, for example:

```
"connectorRef" : {
    "connectorName" : "org.identityconnectors.ldap.LdapConnector",
    "bundleName" : "org.forgerock.openicf.connectors.ldap-connector",
    "bundleVersion" : "[1.4.0.0,2.0.0.0)",
    ...
```

2.3. Obtaining Information About an OpenIDM Instance

OpenIDM includes a customizable information service that provides detailed information about a running OpenIDM instance. The information can be accessed over the REST interface, under the context `https://localhost:8443/openidm/info`.

By default, OpenIDM provides the following information:

- Basic information about the health of the system.

  This information can be accessed over REST at `https://localhost:8443/openidm/info/ping`. For example:

  ```
  $ curl \
  --cacert self-signed.crt \
  --header "X-OpenIDM-Username: openidm-admin" \
  --header "X-OpenIDM-Password: openidm-admin" \
  --request GET \
  "https://localhost:8443/openidm/info/ping"


  {"state":"ACTIVE_READY","shortDesc":"OpenIDM ready"}
  ```

  The information is provided by the script `openidm/bin/defaults/script/info/ping.js`.

- Information about the current OpenIDM session.

  This information can be accessed over REST at `https://localhost:8443/openidm/info/login`. For example:

```
$ curl \
--cacert self-signed.crt \
--header "X-OpenIDM-Username: openidm-admin" \
--header "X-OpenIDM-Password: openidm-admin" \
--request GET \
"https://localhost:8443/openidm/info/login"
```


```
{
  "authenticationId": "openidm-admin",
  "class": "org.forgerock.json.resource.SecurityContext",
  "parent": {
    "class": "org.forgerock.json.resource.RootContext",
    "parent": null,
    "id": "6f1709ce-75bd-4f9b-b1ad-d4592be37361"
  },
  "authorizationId": {
    "roles": [
      "openidm-admin",
      "openidm-authorized"
    ],
    "component": "repo/internal/user",
    "id": "openidm-admin"
  }
}
```


The information is provided by the script `openidm/bin/defaults/script/info/login.js`.

You can extend or override the default information that is provided by creating your own script file and its corresponding configuration file in `openidm/conf/info-name.json`. Custom script files can be located anywhere, although a best practice is to place them in `openidm/script/info`. A sample customized script file for extending the default ping service is provided in `openidm/samples/infoservice/script/info/customping.js`. The corresponding configuration file is provided in `openidm/samples/infoservice/conf/info-customping.json`.

The configuration file has the following syntax:

```
{
    "infocontext" : "ping",
    "type" : "text/javascript",
    "file" : "script/info/customping.js"
}
```

The parameters in the configuration file are as follows:

- `"infocontext"` specifies the relative name of the info endpoint under the info context. The information can be accessed over REST at this endpoint, for example, setting `"infocontext"` to `"mycontext/myendpoint"` would make the information accessible over REST at `https://localhost:8443/openidm/info/mycontext/myendpoint`.
- `"type"` specifies the type of the information source. Javascript (`"type" : "text/javascript"`) and Groovy (`"type" : "groovy"`) are supported.

- `"file"` specifies the path to the Javascript or Groovy file, if you do not provide a `"source"` parameter.
- `"source"` specifies the actual Javascript or Groovy script, if you have not provided a `"file"` parameter.

Additional properties can be passed to the script as depicted in this configuration file (`openidm/samples/infoservice/conf/info-name.json`).

Script files in `openidm/samples/infoservice/script/info/` have access to the following objects:

- `request` - the request details, including the method called and any parameters passed.
- `healthinfo` - the current health status of the system.
- `openidm` - access to the JSON resource API.
- Any additional properties that are depicted in the configuration file (`openidm/samples/infoservice/conf/info-name.json`.)

2.4. Verifying the Health of an OpenIDM System

Due to the highly modular, configurable nature of OpenIDM, it is often difficult to assess whether a system has started up successfully, or whether the system is ready and stable after dynamic configuration changes have been made.

OpenIDM provides a configurable health check service that verifies that the required modules and services for an operational system are up and running. During system startup, OpenIDM checks that these modules and services are available and reports on whether any requirements for an operational system have not been met. If dynamic configuration changes are made, OpenIDM rechecks that the required modules and services are functioning so that system operation is monitored on an ongoing basis.

The health check service reports on the state of the OpenIDM system and outputs this state to the console and to the log files. The system can be in one of the following states:

`STARTING` - OpenIDM is starting up
`ACTIVE_READY` - all of the specified requirements have been met to consider the OpenIDM system ready
`ACTIVE_NOT_READY` - one or more of the specified requirements have not been met and the OpenIDM system is not considered ready
`STOPPING` - OpenIDM is shutting down

OpenIDM checks all required modules and services. Examples of those services are shown here.

Required Modules (examples)

```
"org.forgerock.openicf.framework.connector-framework"
"org.forgerock.openicf.framework.connector-framework-internal"
"org.forgerock.openicf.framework.connector-framework-osgi"
"org.forgerock.openidm.audit"
"org.forgerock.openidm.core"
"org.forgerock.openidm.enhanced-config"
"org.forgerock.openidm.external-email"

   ...

"org.forgerock.openidm.system"
"org.forgerock.openidm.ui"
"org.forgerock.openidm.util"
"org.forgerock.commons.org.forgerock.json.resource"
"org.forgerock.commons.org.forgerock.json.resource.restlet"
"org.forgerock.commons.org.forgerock.restlet"
"org.forgerock.commons.org.forgerock.util"
"org.forgerock.openidm.security-jetty"
"org.forgerock.openidm.jetty-fragment"
"org.forgerock.openidm.quartz-fragment"
"org.ops4j.pax.web.pax-web-extender-whiteboard"
"org.forgerock.openidm.scheduler"
"org.ops4j.pax.web.pax-web-jetty-bundle"
"org.forgerock.openidm.repo-jdbc"
"org.forgerock.openidm.repo-orientdb"
"org.forgerock.openidm.config"
"org.forgerock.openidm.crypto"
```

Required Services (examples)

```
"org.forgerock.openidm.config"
"org.forgerock.openidm.provisioner"
"org.forgerock.openidm.provisioner.openicf.connectorinfoprovider"
"org.forgerock.openidm.external.rest"
"org.forgerock.openidm.audit"
"org.forgerock.openidm.policy"
"org.forgerock.openidm.managed"
"org.forgerock.openidm.script"
"org.forgerock.openidm.crypto"
"org.forgerock.openidm.recon"
"org.forgerock.openidm.info"
"org.forgerock.openidm.router"
"org.forgerock.openidm.scheduler"
"org.forgerock.openidm.scope"
"org.forgerock.openidm.taskscanner"
```

You can replace this list, or add to it, by adding the following lines to the `openidm/conf/boot/boot.properties` file:

`"openidm.healthservice.reqbundles"` - overrides the default required bundles. Bundles are specified as a list of symbolic names, separated by commas.
`"openidm.healthservice.reqservices"` - overrides the default required services. Services are specified as a list of symolic names, separated by commas.

`"openidm.healthservice.additionalreqbundles"` - specifies required bundles (in addition to the default list). Bundles are specified as a list of symbolic names, separated by commas.
`"openidm.healthservice.additionalreqservices"` - specifies required services (in addition to the default list). Services are specified as a list of symbolic names, separated by commas.

By default, OpenIDM gives the system ten seconds to start up all the required bundles and services, before the system readiness is assessed. Note that this is not the total start time, but the time required to complete the service startup after the framework has started. You can change this default by setting the value of the `servicestartmax` property (in miliseconds) in the `openidm/conf/boot/boot.properties` file. This example sets the startup time to five seconds.

```
openidm.healthservice.servicestartmax=5000
```

The health check service works in tandem with the scriptable information service. For more information see Section 2.3, "Obtaining Information About an OpenIDM Instance".

Do not use the health check service to monitor the status of external resources, such as LDAP servers, or external databases. Rather, monitor these resources over the REST interface, as described in Section 11.7, "Checking the Status of External Systems Over REST".

2.5. Displaying Information About Installed Modules

On a running OpenIDM instance, you can list the installed modules and their states by typing the following command in the Felix administration console. (The output will vary by configuration.)

```
-> scr list

   Id   State          Name
[  12] [active       ] org.forgerock.openidm.endpoint
[  13] [active       ] org.forgerock.openidm.endpoint
[  14] [active       ] org.forgerock.openidm.endpoint
[  15] [active       ] org.forgerock.openidm.endpoint
[  16] [active       ] org.forgerock.openidm.endpoint

      ...

[  34] [active       ] org.forgerock.openidm.taskscanner
[  20] [active       ] org.forgerock.openidm.external.rest
[   6] [active       ] org.forgerock.openidm.router
[  33] [active       ] org.forgerock.openidm.scheduler
[  19] [unsatisfied  ] org.forgerock.openidm.external.email
[  11] [active       ] org.forgerock.openidm.sync
[  25] [active       ] org.forgerock.openidm.policy
[   8] [active       ] org.forgerock.openidm.script
[  10] [active       ] org.forgerock.openidm.recon
[   4] [active       ] org.forgerock.openidm.http.contextregistrator
[   1] [active       ] org.forgerock.openidm.config
[  18] [active       ] org.forgerock.openidm.endpointservice
[  30] [unsatisfied  ] org.forgerock.openidm.servletfilter
[  24] [active       ] org.forgerock.openidm.infoservice
[  21] [active       ] org.forgerock.openidm.authentication
->
```

To display additional information about a particular module or service, run the following command, substituting the `Id` of that module from the preceding list.

```
-> scr info Id
```

The following example displays additional information about the router service:

```
-> scr info 6

ID: 6
Name: org.forgerock.openidm.router
Bundle: org.forgerock.openidm.core (41)
State: active
Default State: enabled
Activation: immediate
Configuration Policy: optional
Activate Method: activate (declared in the descriptor)
Deactivate Method: deactivate (declared in the descriptor)
Modified Method: modified
Services: org.forgerock.json.resource.JsonResource
Service Type: service
Reference: ref_JsonResourceRouterService_ScopeFactory
    Satisfied: satisfied
    Service Name: org.forgerock.openidm.scope.ScopeFactory
    Multiple: single
    Optional: mandatory
    Policy: dynamic
Properties:
    component.id = 6
    component.name = org.forgerock.openidm.router
    felix.fileinstall.filename = file:/openidm/samples/sample1/conf/router.json
    jsonconfig = {
    "filters" : [
        {
            "onRequest" : {
                "type" : "text/javascript",
                "file" : "bin/defaults/script/router-authz.js"
            }
        },
        {
            "onRequest" : {
                "type" : "text/javascript",
                "file" : "bin/defaults/script/policyFilter.js"
            },
            "methods" : [
                "create",
                "update"
            ]
        }
    ]
}
    openidm.restlet.path = /
    service.description = OpenIDM internal JSON resource router
    service.pid = org.forgerock.openidm.router
    service.vendor = ForgeRock AS
->
```

2.6. Starting OpenIDM in Debug Mode

To debug custom libraries, you can start OpenIDM with the option to use the Java Platform Debugger Architecture (JPDA).

- Start OpenIDM with the `jpda` option:

```
$ cd /path/to/openidm
$ ./startup.sh jpda

Executing ./startup.sh...
Using OPENIDM_HOME:   /path/to/openidm
Using OPENIDM_OPTS:   -Xmx1024m -Xms1024m -Denvironment=PROD -Djava.compiler=NONE
   -Xnoagent -Xdebug -Xrunjdwp:transport=dt_socket,address=5005,server=y,suspend=n
Using LOGGING_CONFIG:
   -Djava.util.logging.config.file=/path/to/openidm/conf/logging.properties
Listening for transport dt_socket at address: 5005
Using boot properties at /path/to/openidm/conf/boot/boot
.properties
-> OpenIDM version "3.1.0-6" (revision: xxxx)
OpenIDM ready
```

  The relevant JPDA options are outlined in the startup script (`startup.sh`).

- In your IDE, attach a Java debugger to the JVM via socket, on port 5005.

Caution

This interface is internal and subject to change. If you depend on this interface, contact ForgeRock support.

2.7. Running OpenIDM as a Service on Linux Systems

OpenIDM provides a script that generates an initialization script to run OpenIDM as a service on Linux systems. You can start the script as the root user, or configure it to start during the boot process.

When OpenIDM runs as a service, logs are written to the directory in which OpenIDM was installed.

To run OpenIDM as a service, take the following steps:

1. If you have not already done so, install and set up OpenIDM, as described in Chapter 1, "*Installing OpenIDM Services*" in the *Installation Guide*.

2. Run the RC script.

```
$ cd /path/to/openidm/bin
$ ./create-openidm-rc.sh
```

3. As a user with administrative privileges, copy the `openidm` script to the `/etc/init.d` directory.

```
$ sudo cp openidm /etc/init.d/
```

4. If you run Linux with SELinux enabled, change the file context of the newly copied script with the following command:

```
$ sudo restorecon /etc/init.d/openidm
```

   You can verify the change to SELinux contexts with the `ls -Z /etc/init.d` command. For consistency, change the user context to match other scripts in the same directory with the `sudo chcon -u system_u /etc/init.d/openidm` command.

5. - On Red Hat-based systems, run the following commands to add OpenIDM to the list of RC services, in appropriate runlevels:

   ```
   $ sudo chkconfig --add openidm
   ```

   ```
   $ sudo chkconfig openidm on
   ```

   - On Debian/Ubuntu systems, run the following command. Note the output, as Debian/Ubuntu adds start and kill scripts to appropriate runlevels:

   ```
   $ sudo update-rc.d openidm defaults
           Adding system startup for /etc/init.d/openidm ...
           /etc/rc0.d/K20openidm -> ../init.d/openidm
           /etc/rc1.d/K20openidm -> ../init.d/openidm
           /etc/rc6.d/K20openidm -> ../init.d/openidm
           /etc/rc2.d/S20openidm -> ../init.d/openidm
           /etc/rc3.d/S20openidm -> ../init.d/openidm
           /etc/rc4.d/S20openidm -> ../init.d/openidm
           /etc/rc5.d/S20openidm -> ../init.d/openidm
   ```

   When you run the command, you may get the following warning message: `update-rc.d: warning: /etc/init.d/openidm missing LSB information`. You can safely ignore that message.

6. As an administrative user, start the OpenIDM service.

```
$ sudo /etc/init.d/openidm start
```

   Alternatively, reboot the system to start the OpenIDM service automatically.

7. (Optional) The following commands stops and restarts the service:

```
$ sudo /etc/init.d/openidm stop
```

```
$ sudo /etc/init.d/openidm restart
```

Chapter 3
OpenIDM Command-Line Interface

OpenIDM includes a basic command-line interface that provides a number of utilities for managing the OpenIDM instance.

All of the utilities are subcommands of the `cli.sh` (UNIX) or `cli.bat` (Windows) scripts. To use the utilities, you can either run them as subcommands, or launch the **cli** script first, and then run the utility. For example, to run the **encrypt** utility on a UNIX system:

```
$ cd /path/to/openidm
$ ./cli.sh

Using boot properties at /path/to/openidm/conf/boot/boot.properties
openidm# encrypt ....
```

or

```
$ cd /path/to/openidm
$ ./cli.sh encrypt ...
```

By default, the command-line utilities run with the properties defined in `/path/to/openidm/conf/boot/boot.properties`.

If you run the **cli.sh** command by itself, it opens an OpenIDM-specific shell prompt:

```
openidm#
```

The startup and shutdown scripts are not discussed in this chapter. For information about these scripts, see Chapter 2, "*Starting and Stopping OpenIDM*".

The following sections describe the subcommands and their use. Examples assume that you are running the commands on a UNIX system. For Windows systems, use **cli.bat** instead of **cli.sh**.

For a list of subcommands available from the `openidm#` prompt, run the **cli.sh help** command. The **help** and **exit** options shown below are self-explanatory. The other subcommands are explained in the subsections that follow.

```
local:keytool  Export or import a SecretKeyEntry.
    The Java Keytool does not allow for exporting or importing SecretKeyEntries.
local:encrypt    Encrypt the input string.
local:validate   Validates all json configuration files in the configuration
    (default: /conf) folder.
basic:help   Displays available commands.
basic:exit   Exit from the console.
remote:configureconnector   Generate connector configuration.
remote:configexport         Exports all configurations.
remote:configimport         Imports the configuration set from local file/directory.
```

The **configexport**, **configimport**, and **configconnector** subcommands support up to four options:

-u or --user USER[:PASSWORD]

Allows you to specify the server user and password. Specifying a username is mandatory. If you do not specify a username, the following error is output to the console: `Remote operation failed: Unauthorized`. If you do not specify a password, you are prompted for one. This option is used by all three subcommands.

--url URL

The URL of the OpenIDM REST service. The default URL is `http://localhost:8080/openidm/`. This can be used to import configuration files from a remote running instance of OpenIDM. This option is used by all three subcommands. commands.

-P or --port PORT

The port number associated with the OpenIDM REST service. If specified, this option overrides any port number specified with the **--url** option. The default port is 8080. This option is used by all three subcommands.

-r or --replaceall or --replaceAll

Replaces the entire list of configuration files with the files in the specified backup directory. This option is used with only the **configimport** command.

3.1. configexport

The **configexport** subcommand exports all configuration objects to a specified location, enabling you to reuse a system configuration in another environment. For example, you can test a configuration in a development environment, then export it and import it into a production environment. This subcommand also enables you to inspect the active configuration of an OpenIDM instance.

OpenIDM must be running when you execute this command.

Usage is as follows:

```
$ ./cli.sh configexport --user username:passsword export-location
```

For example:

```
$ ./cli.sh configexport --user openidm-admin:openidm-admin /tmp/conf
```

On Windows systems, the *export-location* must be provided in quotation marks, for example:

```
C:\openidm\cli.bat configexport --user openidm-admin:openidm-admin "C:\temp\openidm"
```

Configuration objects are exported, as `.json` files, to the specified directory. The command creates the directory if needed. Configuration files that are present in this directory are renamed as backup files, with a timestamp, for example, `audit.json.2014-02-19T12-00-28.bkp`, and are not overwritten. The following configuration objects are exported:

- The internal repository configuration (`repo.orientdb.json` or `repo.jdbc.json`)
- Default and custom configuration directories (`script.json`)
- The log configuration (`audit.json`)
- The authentication configuration (`authentication.json`)
- The cluster configuration (`cluster.json`)
- The configuration of a connected SMTP email server (`external.email.json)`
- Custom configuration information (`info-name.json`)
- The managed object configuration (`managed.json`)
- The connector configuration (`provisioner.openicf-*.json`)
- The router service configuration (`router.json`)
- The scheduler service configuration (`scheduler.json`)
- Any configured schedules (`schedule-*.json`)
- The synchronization mapping configuration (`sync.json`)
- If workflows are defined, the configuration of the workflow engine (`workflow.json`) and the workflow access configuration (`process-access.json`)
- Any configuration files related to the user interface (`ui-*.json`)
- The configuration of any custom endpoints (`endpoint-*.json`)
- The configuration of servlet filters (`servletfilter-*.json`)
- The policy configuration (`policy.json`)

3.2. configimport

The **configimport** subcommand imports configuration objects from the specified directory, enabling you to reuse a system configuration from another environment. For example, you can test a configuration in a development environment, then export it and import it into a production environment.

The command updates the existing configuration from the *import-location* over the OpenIDM REST interface. By default, if configuration objects are present in the *import-location* and not in the existing configuration, these objects are added. If configuration objects are present in the existing location but not in the *import-location*, these objects are left untouched in the existing configuration.

If you include the `--replaceAll` parameter, the command wipes out the existing configuration and replaces it with the configuration in the *import-location*. Objects in the existing configuration that are not present in the *import-location* are deleted.

Usage is as follows:

```
$ ./cli.sh configimport --user username:password [--replaceAll] import-location
```

For example:

```
$ ./cli.sh configimport --user openidm-admin:openidm-admin --replaceAll /tmp/conf
```

On Windows systems, the *import-location* must be provided in quotation marks, for example:

```
C:\openidm\cli.bat configimport --user openidm-admin:openidm-admin --replaceAll "C:\temp\openidm"
```

Configuration objects are imported, as `.json` files, from the specified directory to the `conf` directory. The configuration objects that are imported are outlined in the corresponding export command, described in the previous section.

3.3. configureconnector

The **configureconnector** subcommand generates a configuration for an OpenICF connector.

Usage is as follows:

```
$ ./cli.sh configureconnector --user username:password connector-name
```

Select the type of connector that you want to configure. The following example configures a new XML connector.

```
$ ./cli.sh configureconnector --user openidm-admin:openidm-admin myXmlConnector
 Starting shell in /path/to/openidm
Using boot properties at /path/to/openidm/conf/boot/boot.properties
0. CSV File Connector version 1.1.0.2
1. Database Table Connector version 1.1.0.1
2. Scripted Poolable Groovy Connector version 1.4.1.0
3. Scripted Groovy Connector version 1.4.1.0
4. Scripted CREST Connector version 1.4.1.0
5. Scripted SQL Connector version 1.4.1.0
6. Scripted REST Connector version 1.4.1.0
7. LDAP Connector version 1.4.0.1
8. XML Connector version 1.1.0.2
9. Exit
Select [0..9]: 8
Edit the configuration file and run the command again. The configuration was
saved to /openidm/temp/provisioner.openicf-myXmlConnector.json
```

The basic configuration is saved in a file named `/openidm/temp/provisioner.openicf-connector-name.json`. Edit the `configurationProperties` parameter in this file to complete the connector configuration. For an XML connector, you can use the schema definitions in sample 1 for an example configuration.

```
  "configurationProperties" : {
    "xmlFilePath" : "samples/sample1/data/resource-schema-1.xsd",
    "createFileIfNotExists" : false,
    "xsdFilePath" : "samples/sample1/data/resource-schema-extension.xsd",
    "xsdIcfFilePath" : "samples/sample1/data/xmlConnectorData.xml"
  },
```

For more information about the connector configuration properties, see Section 11.3, "Configuring Connectors".

When you have modified the file, run the **configureconnector** command again so that OpenIDM can pick up the new connector configuration.

```
$ ./cli.sh configureconnector --user openidm-admin:openidm-admin myXmlConnector
Executing ./cli.sh...
Starting shell in /path/to/openidm
Using boot properties at /path/to/openidm/conf/boot/boot.properties
Configuration was found and read from: /path/to/openidm/temp/provisioner.openicf-myXmlConnector.json
```

You can now copy the new `provisioner.openicf-myXmlConnector.json` file to the `conf/` subdirectory.

You can also configure connectors over the REST interface. For more information, see Section 11.6, "Creating Default Connector Configurations".

3.4. encrypt

The **encrypt** subcommand encrypts an input string, or JSON object, provided at the command line. This subcommand can be used to encrypt passwords, or other sensitive data, to be stored in the

OpenIDM repository. The encrypted value is output to standard output and provides details of the cryptography key that is used to encrypt the data.

Usage is as follows:

```
$ ./cli.sh encrypt [-j] string
```

The `-j` option specifies that the string to be encrypted is a JSON object. If you do not enter the string as part of the command, the command prompts for the string to be encrypted. If you enter the string as part of the command, any special characters, for example quotation marks, must be escaped.

The following example encrypts a normal string value:

```
$ ./cli.sh encrypt mypassword

Executing ./cli.sh
Starting shell in /path/to/openidm
Using boot properties at /path/to/openidm/conf/boot/boot.properties
Activating cryptography service of type: JCEKS provider:  location: security/keystore.jceks
Available cryptography key: openidm-sym-default
Available cryptography key: openidm-localhost
CryptoService is initialized with 2 keys
.
-----BEGIN ENCRYPTED VALUE-----
{
  "$crypto" : {
    "value" : {
      "iv" : "M2913T5ZADlC2ip2imeOyg==",
      "data" : "DZAAAM1nKjQM1qpLwh3BgA==",
      "cipher" : "AES/CBC/PKCS5Padding",
      "key" : "openidm-sym-default"
    },
    "type" : "x-simple-encryption"
  }
}
------END ENCRYPTED VALUE------
```

The following example encrypts a JSON object. The input string must be a valid JSON object.

```
$ ./cli.sh encrypt -j {\"password\":\"myPassw0rd\"}

Starting shell in /path/to/openidm
Using boot properties at /path/to/openidm/conf/boot/boot.properties
Activating cryptography service of type: JCEKS provider:  location: security/keystore.jceks
Available cryptography key: openidm-sym-default
Available cryptography key: openidm-localhost
CryptoService is initialized with 2 keys
.
-----BEGIN ENCRYPTED VALUE-----
{
  "$crypto" : {
    "value" : {
      "iv" : "M2913T5ZADlC2ip2imeOyg==",
      "data" : "DZAAAM1nKjQM1qpLwh3BgA==",
      "cipher" : "AES/CBC/PKCS5Padding",
      "key" : "openidm-sym-default"
    },
    "type" : "x-simple-encryption"
  }
}
------END ENCRYPTED VALUE------
```

The following example prompts for a JSON object to be encrypted. In this case, you need not escape the special characters.

```
$ ./cli.sh encrypt -j

Using boot properties at /path/to/openidm/conf/boot/boot.properties
Enter the Json value

> Press ctrl-D to finish input
Start data input:
{"password":"myPassw0rd"}
^D

Activating cryptography service of type: JCEKS provider:  location: security/keystore.jceks
Available cryptography key: openidm-sym-default
Available cryptography key: openidm-localhost
CryptoService is initialized with 2 keys
.
-----BEGIN ENCRYPTED VALUE-----
{
  "$crypto" : {
    "value" : {
      "iv" : "6e0RK8/4F1EK5FzSZHwNYQ==",
      "data" : "gwHSdDTmzmUXeD6Gtfn6JFC8cAUiksiAGfvzTsdnAqQ=",
      "cipher" : "AES/CBC/PKCS5Padding",
      "key" : "openidm-sym-default"
    },
    "type" : "x-simple-encryption"
  }
}
------END ENCRYPTED VALUE------
```

3.5. keytool

The **keytool** subcommand exports or imports secret key values.

The Java **keytool** command enables you to export and import public keys and certificates, but not secret or symmetric keys. The OpenIDM **keytool** subcommand provides this functionality.

Usage is as follows:

```
./cli.sh keytool [--export, --import] alias
```

For example, to export the default OpenIDM symmetric key, run the following command:

```
$ ./cli.sh keytool --export openidm-sym-default

Using boot properties at /openidm/conf/boot/boot.properties
Use KeyStore from: /openidm/security/keystore.jceks
Please enter the password:
[OK] Secret key entry with algorithm AES
AES:606d80ae316be58e94439f91ad8ce1c0
```

The default keystore password is `changeit`. You should change this password after installation.

To import a new secret key named *my-new-key*, run the following command:

```
$ ./cli.sh keytool --import my-new-key

Using boot properties at /openidm/conf/boot/boot.properties
Use KeyStore from: /openidm/security/keystore.jceks
Please enter the password:
Enter the key:
AES:606d80ae316be58e94439f91ad8ce1c0
```

If a secret key of that name already exists, OpenIDM returns the following error:

```
"KeyStore contains a key with this alias"
```

3.6. validate

The **validate** subcommand validates all .json configuration files in the `openidm/conf/` directory.

Usage is as follows:

```
$ ./cli.sh validate

Executing ./cli.sh
Starting shell in /path/to/openidm
Using boot properties at /path/to/openidm/conf/boot/boot
.properties
...................................................................
[Validating] Load JSON configuration files from:
[Validating]  /path/to/openidm/conf
[Validating] audit.json .................................. SUCCESS
[Validating] authentication.json ......................... SUCCESS

    ...

[Validating] sync.json ................................... SUCCESS
[Validating] ui-configuration.json ....................... SUCCESS
[Validating] ui-countries.json ........................... SUCCESS
[Validating] ui-secquestions.json ........................ SUCCESS
[Validating] workflow.json ............................... SUCCESS
```

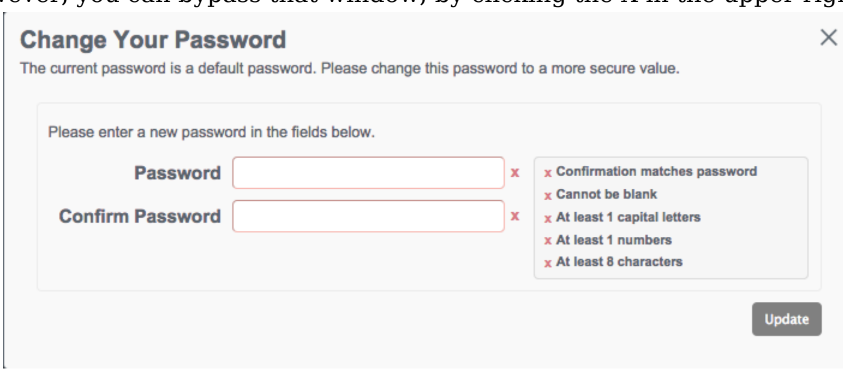
Chapter 4
OpenIDM Web-based User Interfaces

OpenIDM provides a customizable, browser-based user interface, known as the User View UI. To take full advantage of this interface, you can configure OpenIDM managed objects (see Section C.1, "Managed Objects") under `managed/user`. Most of the OpenIDM samples demonstrate how you can deploy OpenIDM with managed users.

The User View UI interface enables administrative users to create, modify, and delete user accounts. It provides role-based access to tasks based on BPMN2 workflows, and allows users to manage certain aspects of their own accounts, including configurable self-service registration. When OpenIDM starts, you can access the User View UI at `https://localhost:8443/openidmui`.

OpenIDM also provides a configurable administrative user interface (Admin UI) that allows you to configure connectors, customize managed objects, set up attribute mappings, and more. When OpenIDM starts, you can access the Admin UI at `https://localhost:8443/admin`.

The first time you log into either UI as the `openidm-admin` administrative user, the default password is `openidm-admin`. As that default password is not secure, we recommend that you change that password in production. However, you can bypass that window, by clicking the X in the upper right corner.



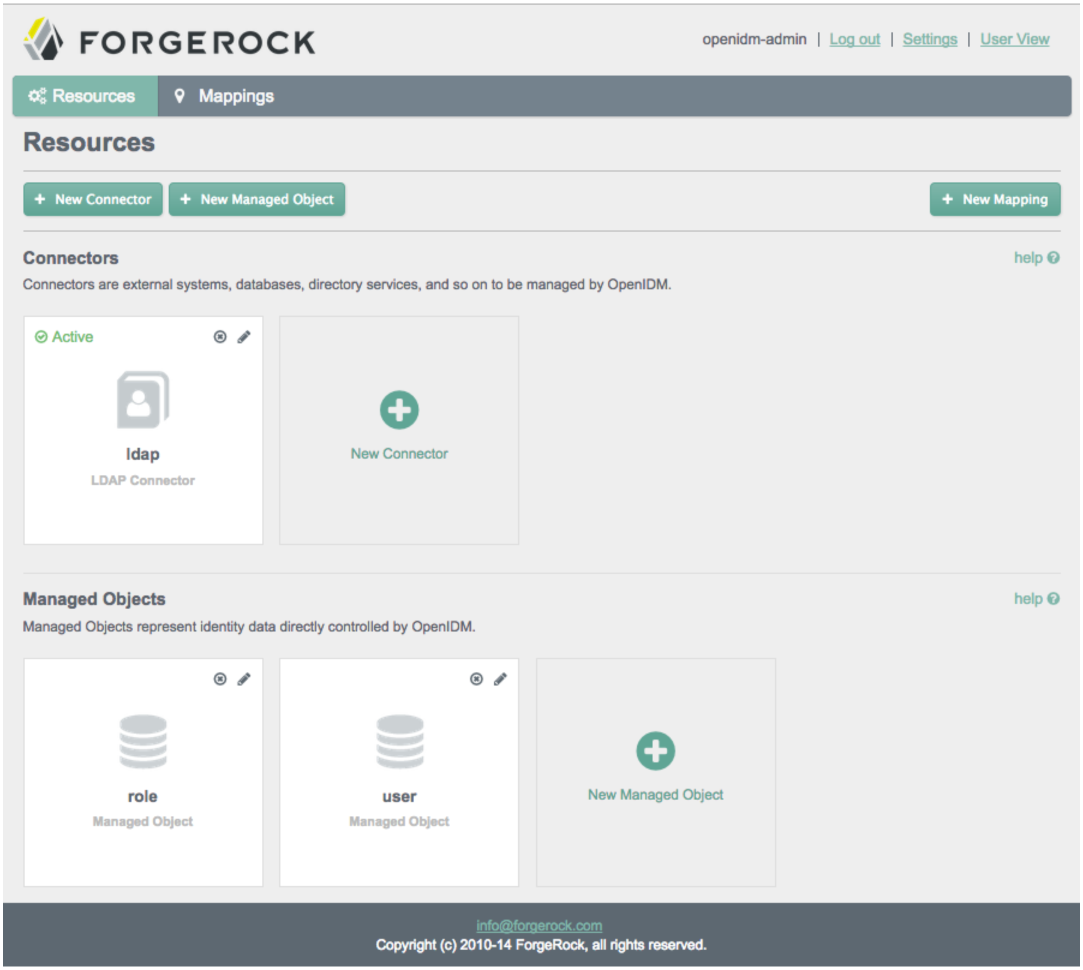
4.1. Configuring OpenIDM from the Admin UI

You can set up a basic configuration for OpenIDM with the Administrative User Interface (Admin UI).

Through the Admin UI, you can connect to resources, configure attribute mapping, and set up managed objects, reconciled on a defined schedule.

You can customize the configuration of connectors, managed objects, mapping between resources, and more. You can add and edit properties to be synchronized, configure correlation queries, and enable LiveSync.

To access the initial Admin UI screen, navigate to `https://localhost:8443/admin`.



The information that appears in the initial Admin UI screen depends on how you started OpenIDM. For example, if you start OpenIDM with one of the OpenIDM samples (see Chapter 3, "*More OpenIDM Samples*" in the *Installation Guide*), your first Resources screen will display connectors and managed objects as configured in the selected sample.

As shown in the initial screen, the Admin UI supports connecting to external resources (see Chapter 11, "*Connecting to External Resources*") and managing users, groups, and roles (see Chapter 8, "*Managing Users, Groups, and Roles*").

Scroll up and down the Admin UI screen. Review configured connectors and managed objects. The screenshots in this section assume that you have started OpenIDM with the configuration for Sample 2b (Section 3.4, "Sample 2b - LDAP Two Way" in the *Installation Guide*).

> **Note**
>
> While a connector is not a resource, it provides a connection to remote resources such as LDAP data stores, XML files, and other databases.

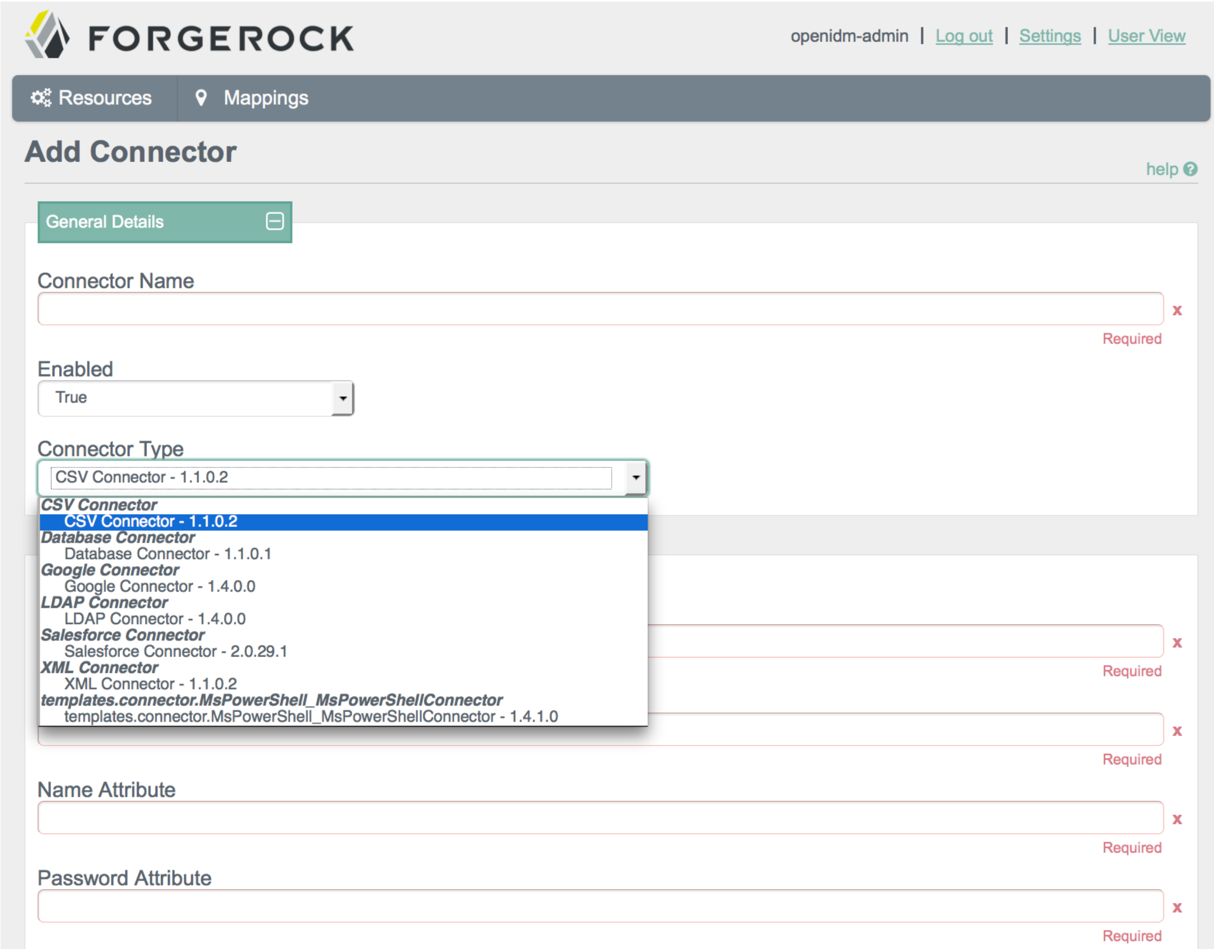
Connectors are used to communicate with remote resources, such as a database, an identity store, or another organized data store.

Once you connect one or more data stores and managed objects, you can create a mapping between two resources. You can then configure property mapping between those resources, for later synchronization.

4.1.1. Administering Connectors from the UI

You can include several different connectors in an OpenIDM configuration. Select the option to create a new connector. Try some of the different connector types in the screen that appears. Observe as the Admin UI changes the configuration options to match the requirements of the connector type.

Remember, every connector serves as a conduit to an external data store.



If you are not sure what to enter in a specific Add Connector text box, review the list of connectors supported with OpenIDM (Section 11.5, "Connectors Supported With OpenIDM 3.1"). You should be able to find guidance and or examples on how each supported connector is configured.

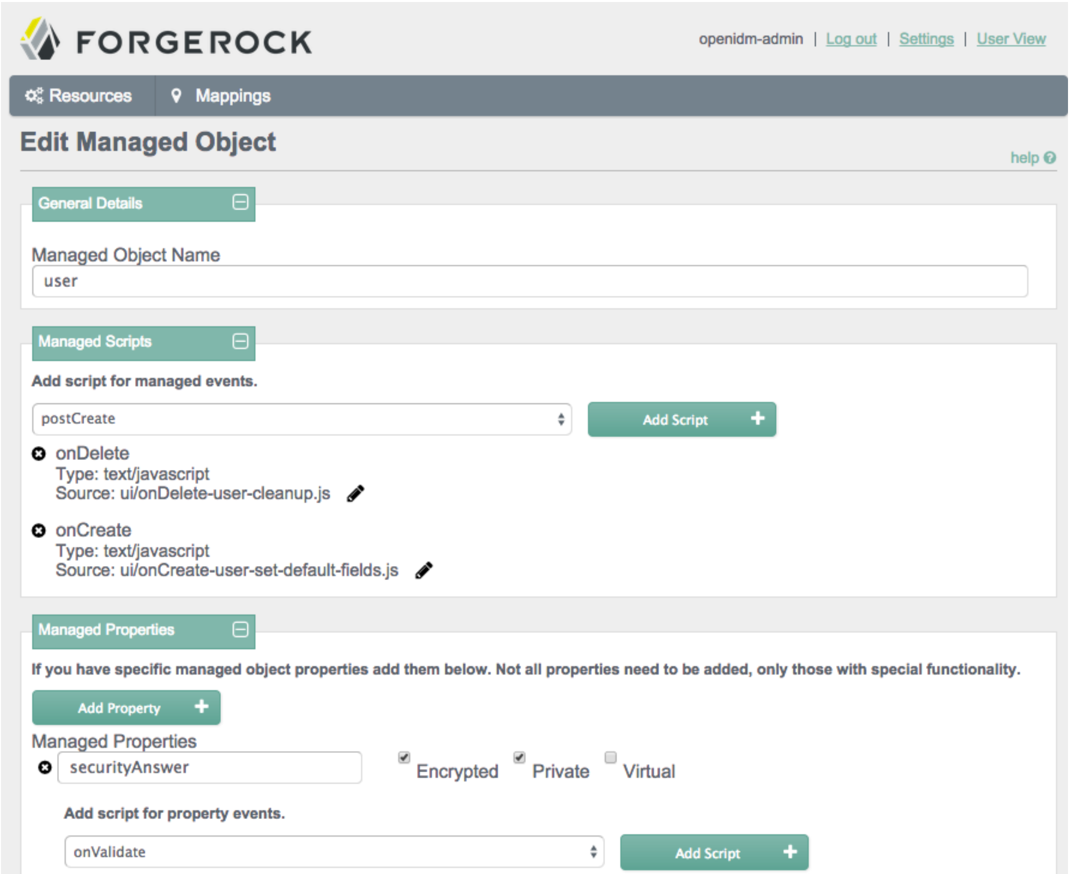
For additional guidance, review sample connector files in the `samples/provisioners/` subdirectory.

Once you fill in all required text boxes, the Admin UI allows you to validate the connector configuration.

4.1.2. Administering Managed Objects from the UI

You can set up Managed Objects in a similar way to how you set up connectors. Typically, OpenIDM uses managed objects as described in Chapter 8, "*Managing Users, Groups, and Roles*".

To access the details of a Managed Object, go to the Resources screen. Select the Edit icon associated with the Managed Object that you want to change, such as user, group, or role.



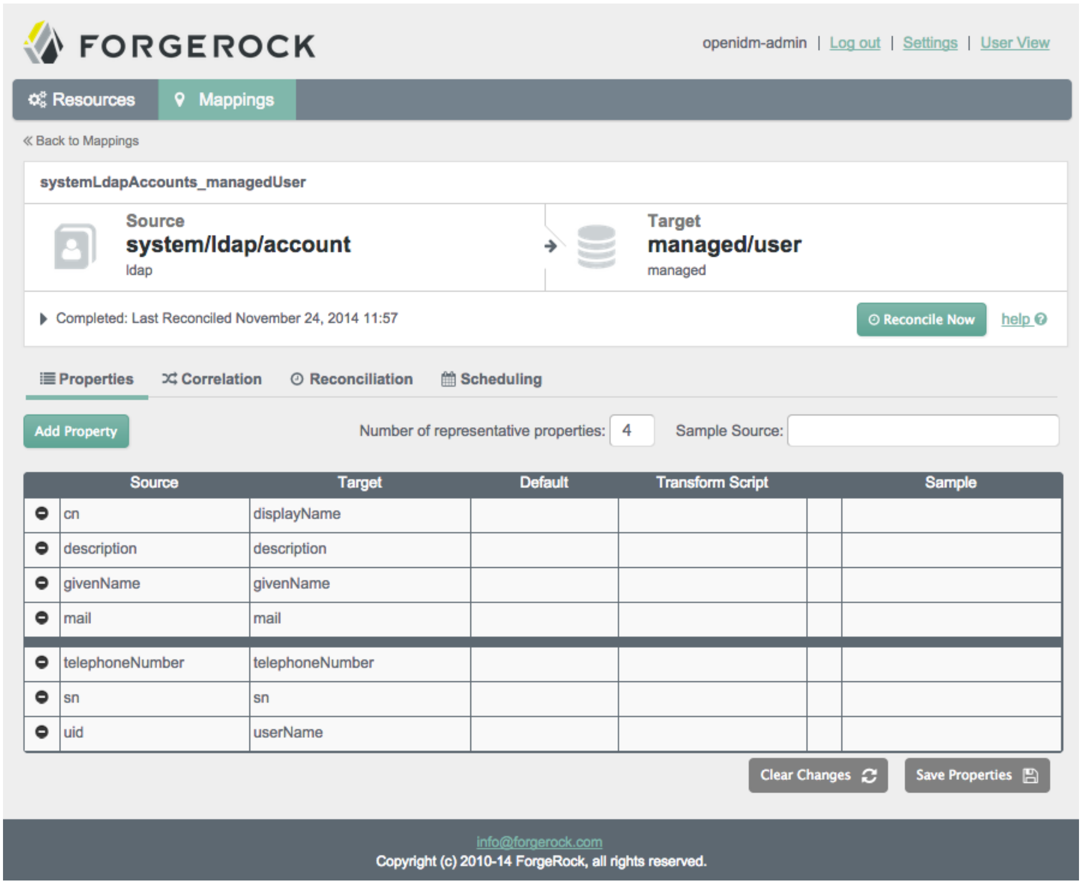
4.1.3. Configuring a Resource Mapping from the UI

You may have multiple connectors and managed objects. You can configure a mapping between any two of these resources. Connectors represent an external data store, as specified in Section 11.3, "Configuring Connectors". In contrast, managed objects represents a data store internal to OpenIDM.

Resource mapping requires a source and a target. Generally, each resource includes properties such as username, address, surname, and title. Resource mapping can go beyond user information to other types of data.

Once you create a mapping, you can identify properties that you wish to control in the target. With this part of the Admin UI, you can configure how OpenIDM uses matching properties in the source.

The following screenshot illustrates a property mapping between two resources. Every resource includes identifiers for each attribute. For example, different resources may use one of the following identifiers for usernames: un, uid, user, sAMAccountName, and account. For more information on property mappings, see Section 12.3.2, "Synchronization Mappings File".



The bold black line is used solely by the UI to determine what data is shown from these data stores. It does not affect reconciliation. In the Admin UI, you can change the location of the line, or move a property above or below the line.

4.1.4. Configuring Reconciliation from the UI

Reconciliation changes data on a target system to match the corresponding data on a source system. You can customize how OpenIDM performs reconciliation in several ways.

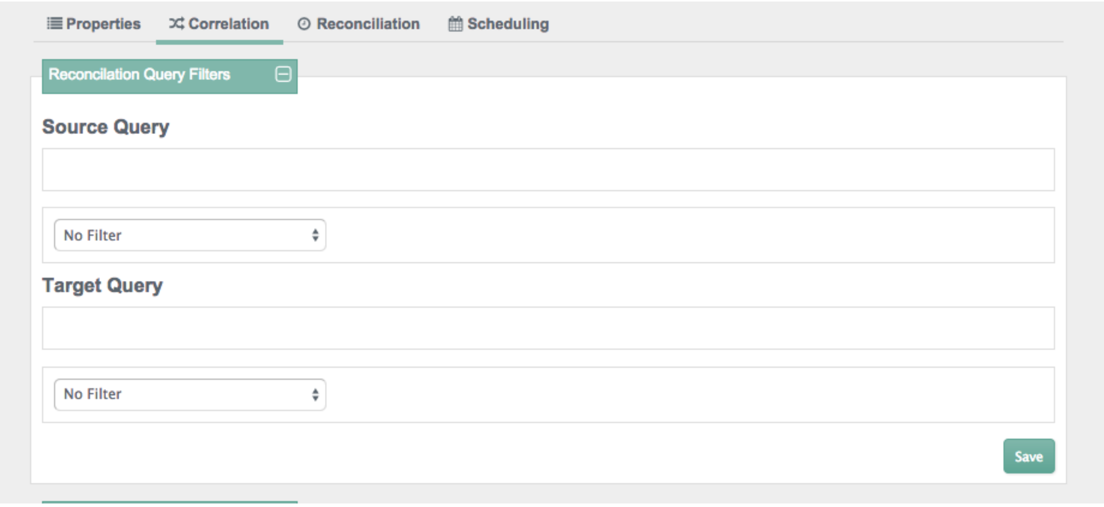
4.1.4.1. Correlation Options

OpenIDM can match existing records on the target system to records on the source system. This matching is known as correlation.

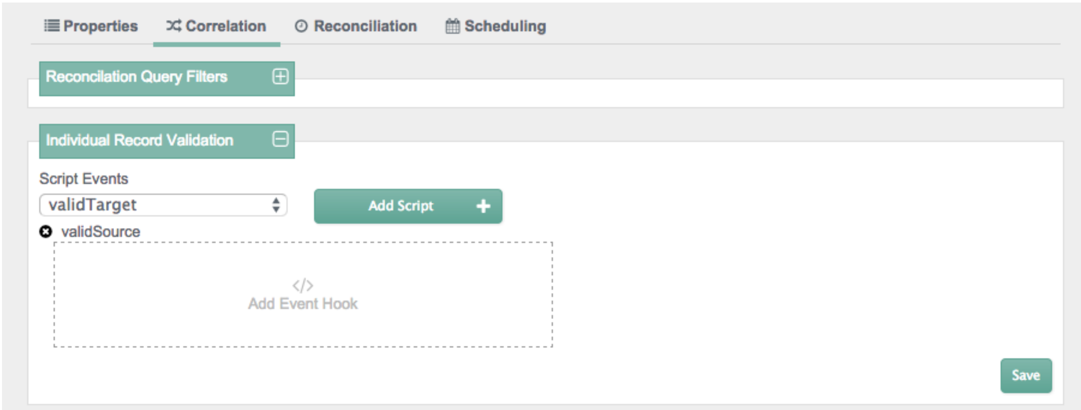
Before activating reconciliation, you may choose to configure various correlation options, including reconciliation query filters, individual record validation, association rules, and data association management.

For more information on correlation, see Section 12.17, "Correlation Queries".

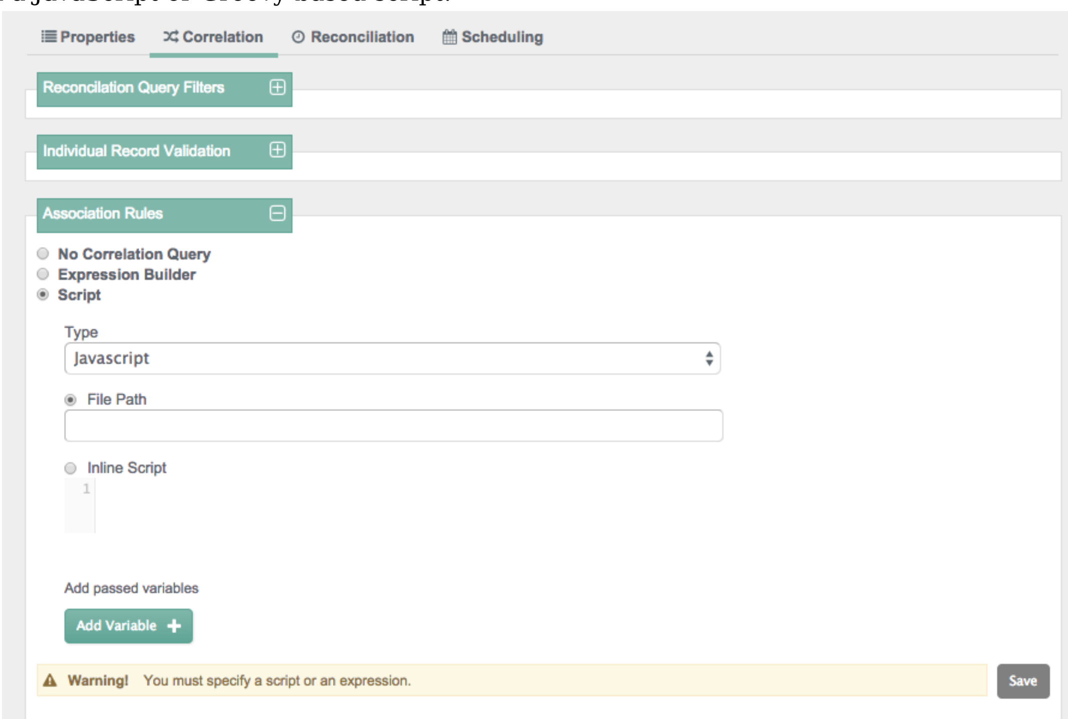
You can add reconciliation query filters, with queries on the source and target objects. For more information, see Section 7.3.4, "Constructing Queries". You can set up queries on properties such as `userName` and parameters such as `Smith`.



You can add individual record validation scripts, based on the `validSource` and `validTarget` script objects. For more information on these objects, see Section D.1, "Object-Mapping Objects". With these scripts, you can set up criteria for OpenIDM to validate source and target objects for reconciliation.

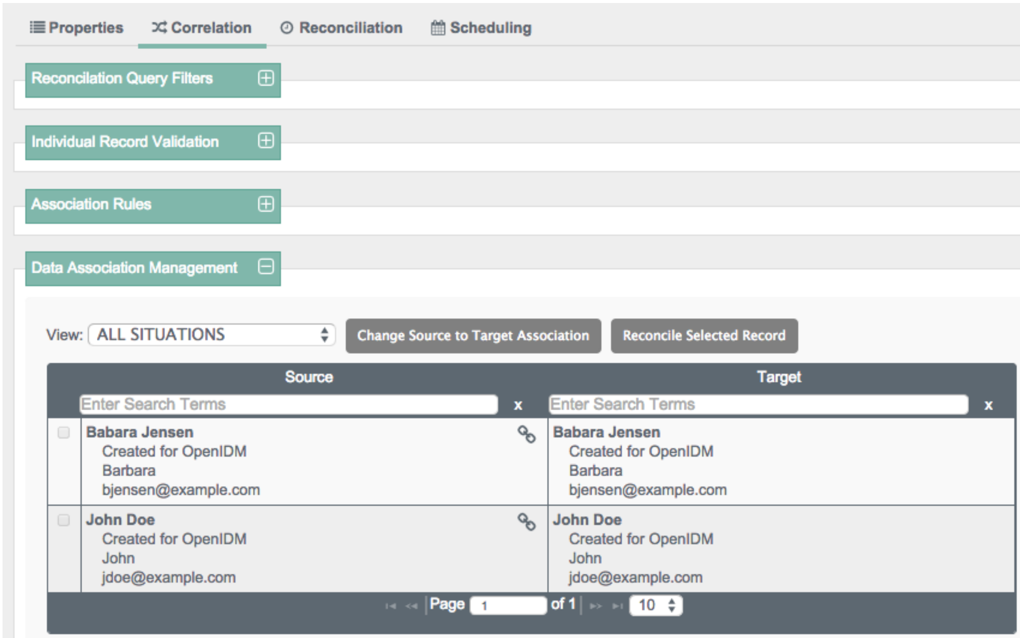


You can set up correlation queries (Section 12.17, "Correlation Queries") with an expression builder or with a JavaScript or Groovy-based script.



When a reconciliation operation finds a matching target entry, the process creates a link between the source and the target entries. This is also known as a Data Association. Data associations serve two purposes - they speed up future reconciliation operations, and they serve as a record of the relationship between a source and a target entry.

You can set up such data associations for individual entries, as well as different situations shown in Section 12.13.1, "Synchronization Situations".



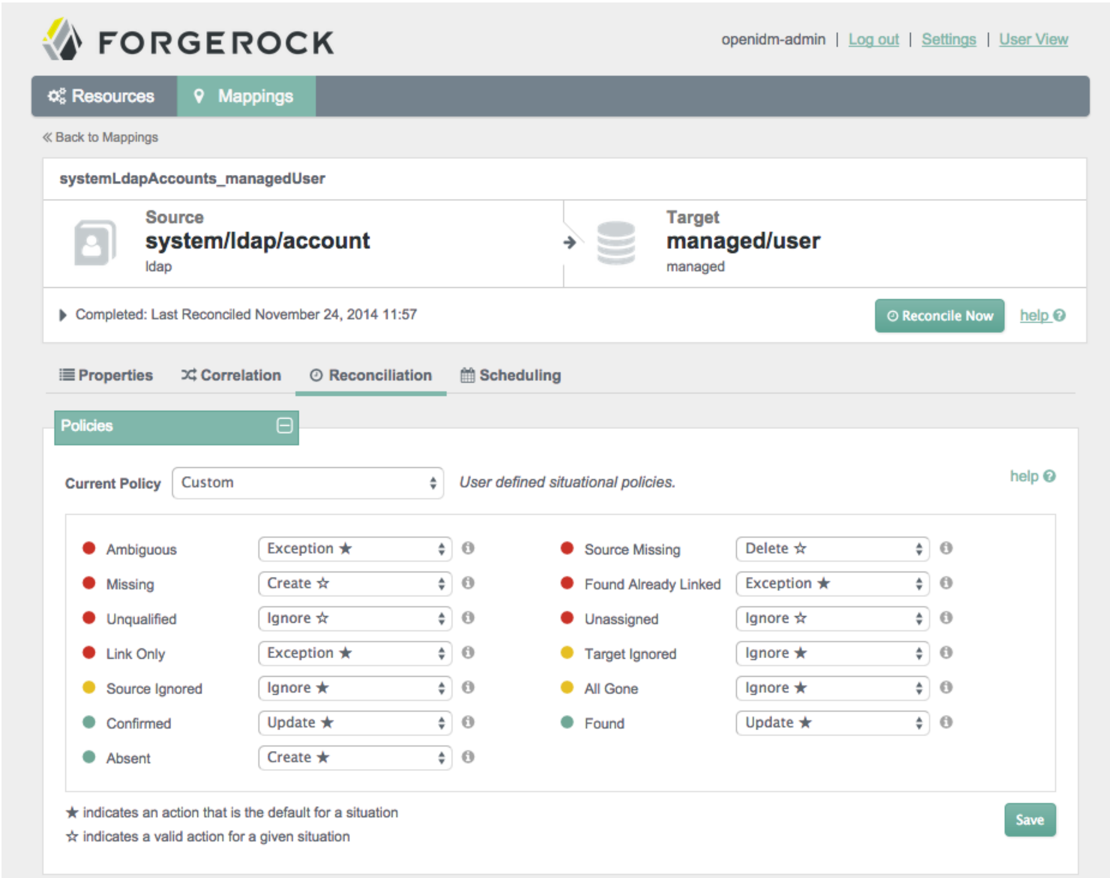
4.1.4.2. Reconciliation Options

Before activating reconciliation, you may choose to configure situational policies, situational event scripts, and reconciliation scripts.

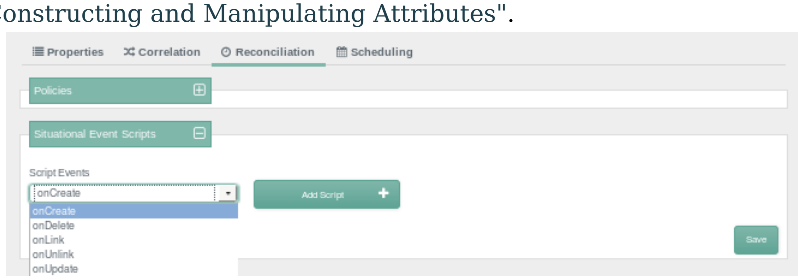
You may want to configure situational policies. By default, the policies associated with mappings are set to "read-only". As such, OpenIDM does not change anything on the target system, unless you make changes to situational policies.

With situational policies, you can define actions relevant for situations shown in the screenshot below. For a full list of available policies, see Section 12.13, "Synchronization Situations and Actions".

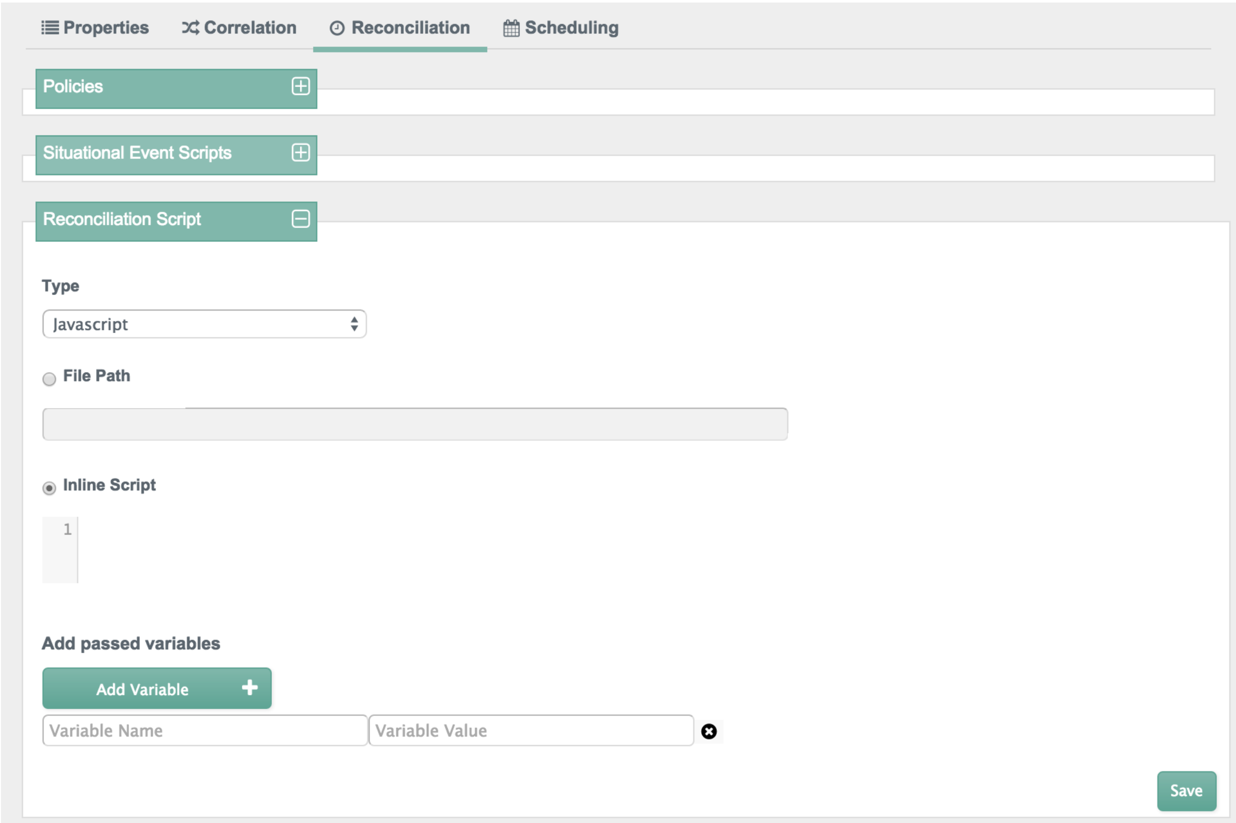
To access the following screen, select the Mapping of your choice and select edit. In the sub-tabs that appear, select Reconciliation.



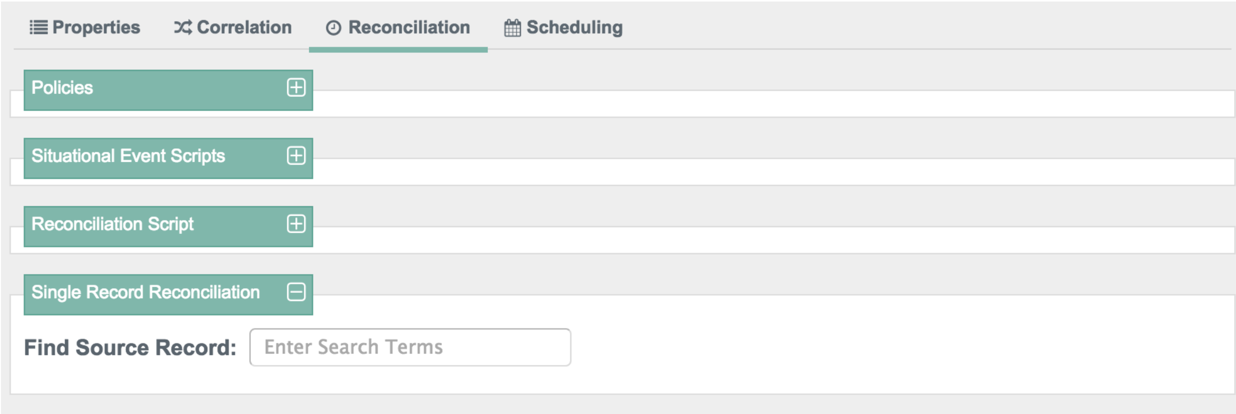
You can configure situational event scripts. Each of the script events shown `onCreate`, `onDelete`, `onLink`, `onUnlink`, and `onUpdate`, can help you with constructing attributes. For more information, see Section 12.3.5, "Constructing and Manipulating Attributes".



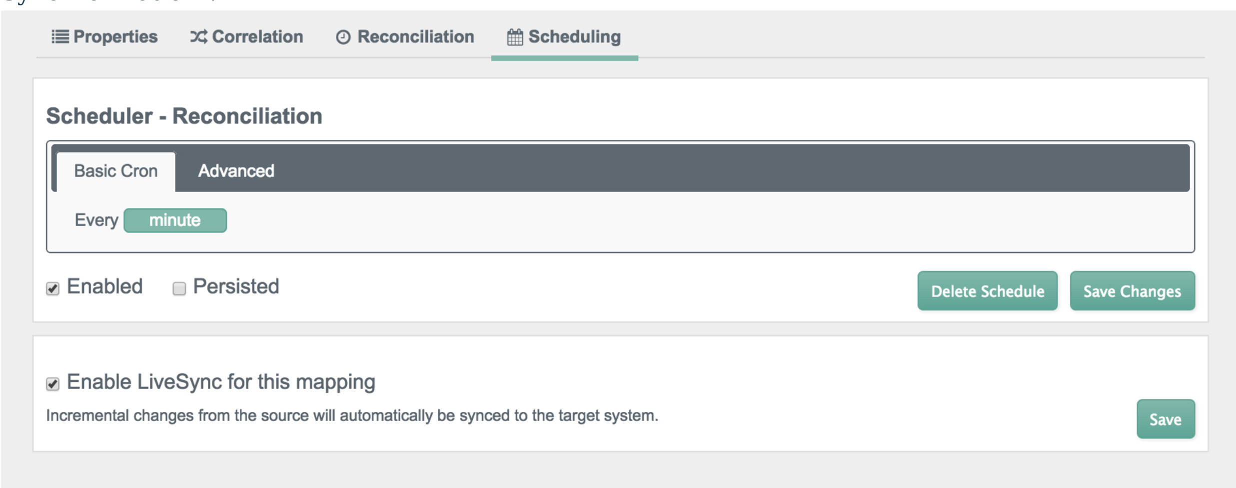
You can configure scripts that are triggered on reconciliation, as part of the dataflow configuration (see Section 12.18, "Advanced Data Flow Configuration".



You can choose to test the overall process with a single record reconciliation. In other words, you need not test these policies and scripts against the entire data set. For example, you can restrict reconciliation to a specific ID (see Section 12.6, "Restricting Reconciliation to a Specific ID").



Finally, you should set up a schedule, as described in Section 12.19.1, "Configuring Scheduled Synchronization".



You can also configure LiveSync, which captures the changes that happen on a remote system, and then pushes those changes to OpenIDM.

For more information on Reconciliation and LiveSync, see Section 12.1, "Types of Synchronization".

You can manage reconciliation and liveSync with the embedded Quartz scheduler. For more information, see Chapter 13, "*Scheduling Tasks and Events*".

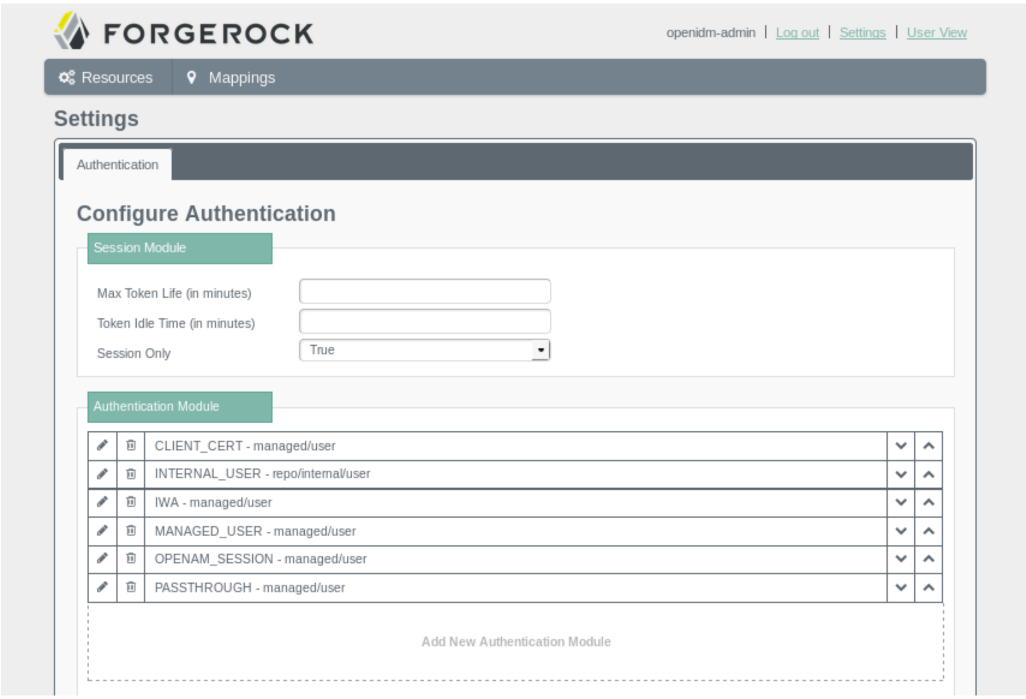
Once you've set up Reconciliation based on configured properties, correlation queries, and a synchronization schedule, you can start the synchronization process. Try it out! You'll see the results in the target data store.

Once you have taken the steps required to configure OpenIDM through the Admin UI, you can start the synchronization process from a source to a target. Once a synchronization is complete, you can review the results in this window.

4.1.5. Configuring Authentication Modules from the UI

You can also configure authentication modules from the Admin UI. To access those modules, click Settings.

The page shown here displays several available modules, based on the ForgeRock Common Authentication Framework. For more information on each module, see Section 15.3, "Supported Authentication Modules".



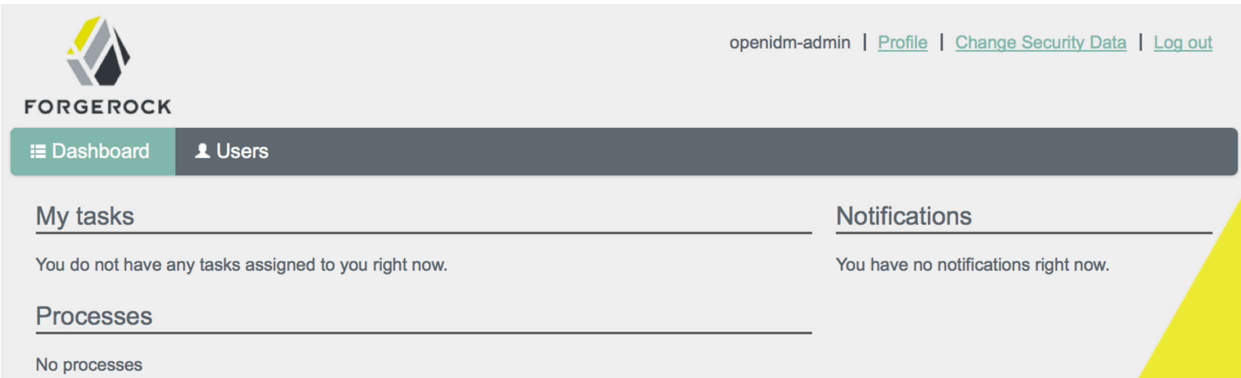
4.2. Overview of the User View UI

For all users, the User View UI includes a Dashboard tab, which lists any tasks assigned to the user who as logged in, processes available to be invoked, and any notifications for that user.

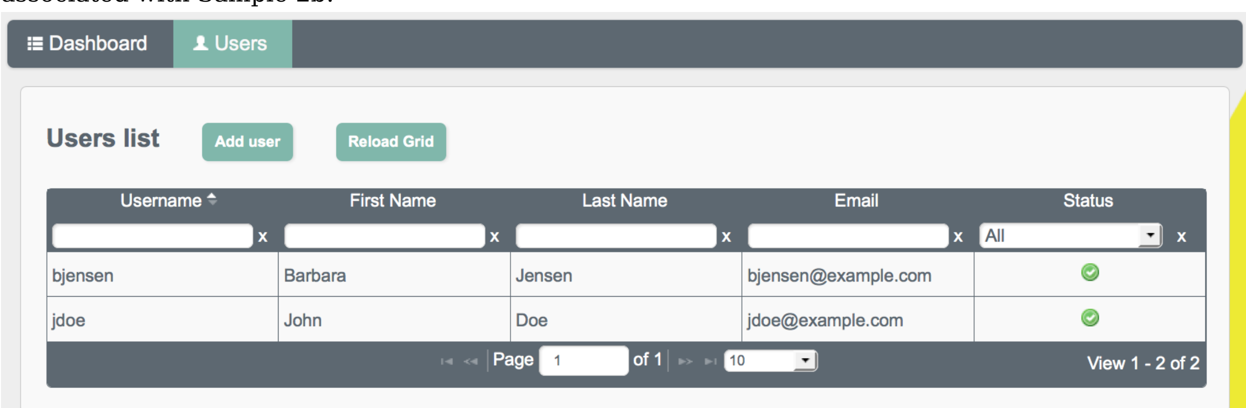
For the administrative user, (role `openidm-admin`), the User View UI also includes a Users tab, which provides an interface for user entries, if you have configured managed users in the OpenIDM repository.

To access the User View UI, install and start OpenIDM, then point your browser to https://localhost:8443/openidmui. If you have not installed a certificate that is trusted by a certificate authority, you are prompted with an "Untrusted Connection" warning the first time you log in to the UI.

The following image shows the Dashboard tab for the administrative user when no tasks, processes, or notifications are available.



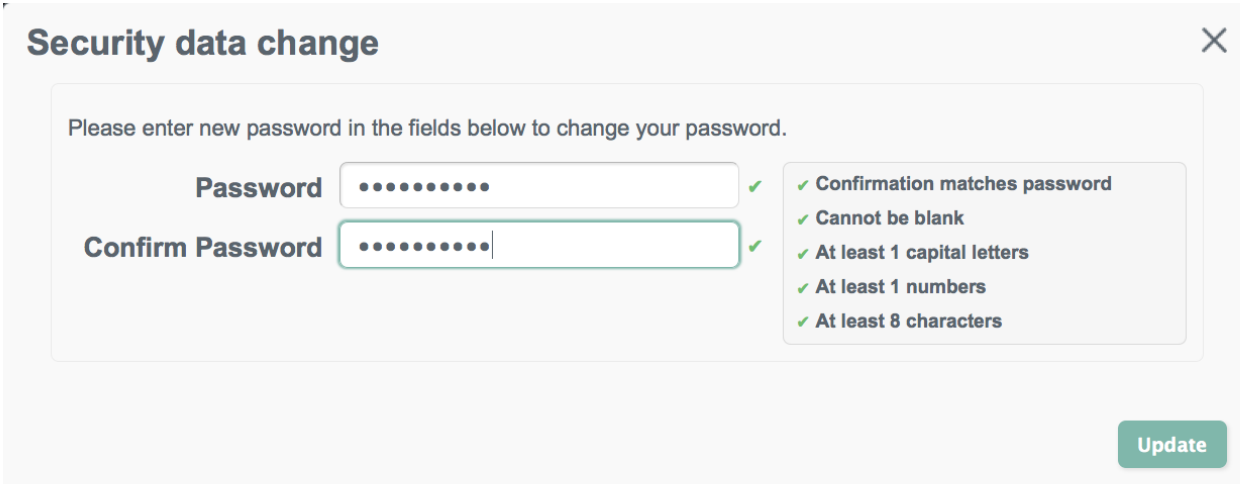
The following image shows the Users tab, populated with two sample users, after a reconciliation associated with Sample 2b.



You can sort the list of users alphabetically, by any of the column values. Click on the column title to sort.

The `Profile` link enables the user to modify his username or password. The `Change Security Data` link, accessed from the top of the screen, or from the user's Profile page enables the user to change his password and, if this functionality has been enabled, to select a new security question.

Password changes are subject to the default password policy, as shown in the following password update screen.



For a regular user (role `openidm-authorized`), the Users tab is not displayed. By default, regular users cannot manage user accounts, except for certain aspects of their own accounts.

4.3. Configuring the User View UI

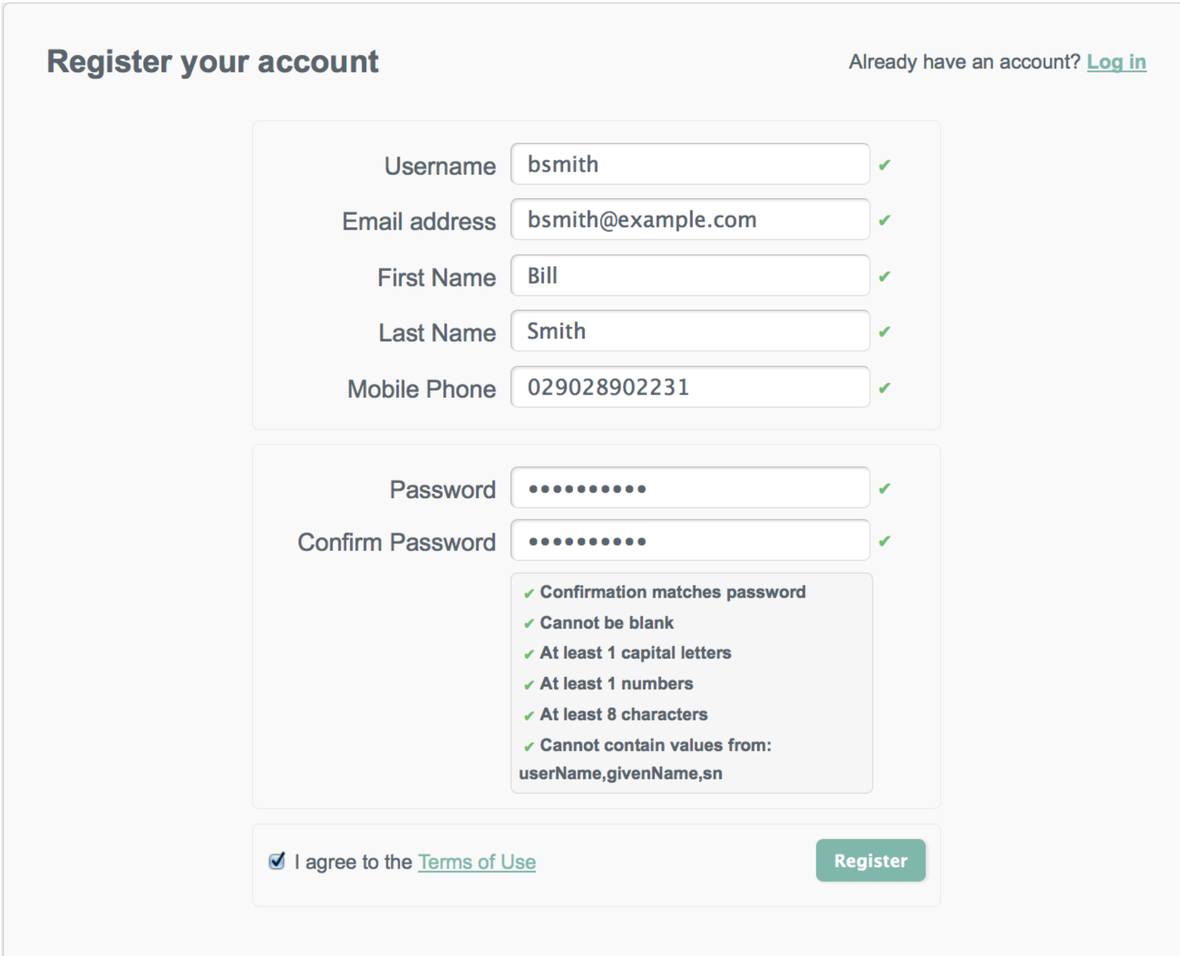
The following sections outline the configurable aspects of the User View UI.

4.3.1. Enabling Self-Registration

Self-registration (the ability for new users to create their own accounts) is disabled by default. To enable self-registration, set `"selfRegistration"` to `true` in the UI configuration file (`conf/ui-configuration.json`).

```
{
    "configuration" : {
        "selfRegistration" : true,
...
```

When self-registration is enabled, a "Register your account" link is provided on the login page. When a user creates an account on the account registration page, a managed object is created in the OpenIDM repository. The default policies for managed objects are applied during account creation.



User objects created using self-registration automatically have the role `openidm-authorized`.

4.3.2. Configuring Security Questions

In the event that a user forgets his password, a password reset function enables registered users to reset their own passwords. To guard against unauthorized access, you can specify that users be prompted with one or more security questions when they request a password reset.

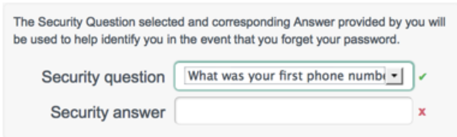
Security questions are disabled by default. To enable them, set `"securityQuestions"` to `true` in the UI configuration file (`conf/ui-configuration.json`).

```
{
    "configuration" : {
        "securityQuestions" : true,
...
```

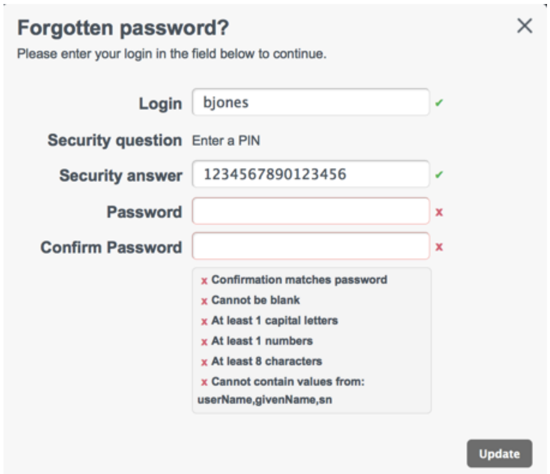
A default set of questions is provided, but you can add to these, or overwrite them. Specify the list of questions to be asked in the `conf/ui-secquestions.json` file.

Refresh your browser after this configuration change for the change to be picked up by the UI.

When security questions are enabled, the following panel is included on the self registration page.



In addition, a "Reset your password" link is provided on the login page. When a user attempts to reset her password, she is prompted for the response to the security question that she set up during registration.



Note

If security questions are enabled *after* a specific user has registered, that particular user will be unable to use the password reset functionality.

4.3.3. Minimum Length Security Answers

The password, passphrase, and security answer are all associated with some minimum length. To change that minimum, edit the `conf/policy.json` file, setting the `minLength` property to the required minimum.

For example, the following excerpt from the `conf/policy.json` file shows a default `minLength` of 16 associated with the security answer.

```
{
    "policyId" : "minimum-length",
    "params" : {
        "minLength" : 16
    }
},
```

4.3.4. Enabling Site Identification

To ensure that users are entering their details onto the correct site, you can enable site identification. Site identification provides a preventative measure against phishing.

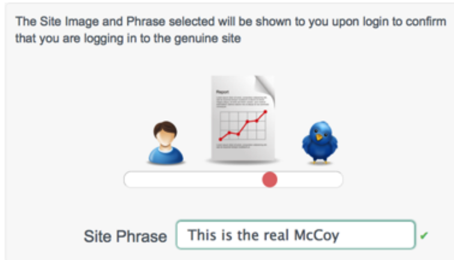
With site identification enabled, a user is presented with a range of images from which he can select when he registers his account, and prompted to specify his own *site phrase*. The selected site image and phrase are displayed on login, to confirm that the user is logging in to the legitimate site.

To enable site identification, set `"siteIdentification"` to `true` in the UI configuration file (`conf/ui-configuration.json`).

```
{
    "configuration" : {
        "siteIdentification" : true,
...
```

Refresh your browser after this configuration change for the change to be picked up by the UI.

When site identification is enabled, the following panel is included on the self registration page.



A default list of four images is presented for site identification. The images are defined in the `siteImages` property in the `conf/ui-configuration.json` file:

```
"siteImages" : [
"images/passphrase/mail.png",
"images/passphrase/user.png",
"images/passphrase/report.png",
"images/passphrase/twitter.png"
],
...
```

You can change the default images, and include additional images, by placing image files in the `ui/extension/images` folder and modifying the `siteImages` property in the `ui-configuration.json` file to point to the new images. Refresh your browser for the change to take effect.

The following example assumes an image file named `my-new-image.jpg`, located in `ui/extension/images`.

```
"siteImages" : [
"images/passphrase/mail.png",
"images/passphrase/user.png",
"images/passphrase/report.png",
"images/passphrase/twitter.png",
"images/my-new-image.jpg"
],
...
```

Note that the default image files are located in `ui/default/enduser/public/images/passphrase`.

4.3.5. Configuring the Country List

The default user profile includes the ability to select the user's country and state or province. To specify the countries, and the associated states or provinces, that appear in these drop down lists, edit the `conf/ui-countries.json` file. For example, to add Norway to the list of countries, you would add the following to the `conf/ui-countries.json` file:

```
{
    "key" : "norway",
    "value" : "Norway",
    "states" : [
        {
            "key" : "akershus",
            "value" : "Akershus"
        },
        {
            "key" : "aust-agder",
            "value" : "Aust-Agder"
        },
        {
            "key" : "buskerud",
            "value" : "Buskerud"
        },
...
```

Refresh your browser after this configuration change for the change to be picked up by the UI.

4.4. Managing User Accounts With the User View UI

Only administrative users (with the role `openidm-admin`) can add, modify, and delete user accounts. Regular users can modify certain aspects of their own accounts.

Procedure 4.1. To Add a User Account

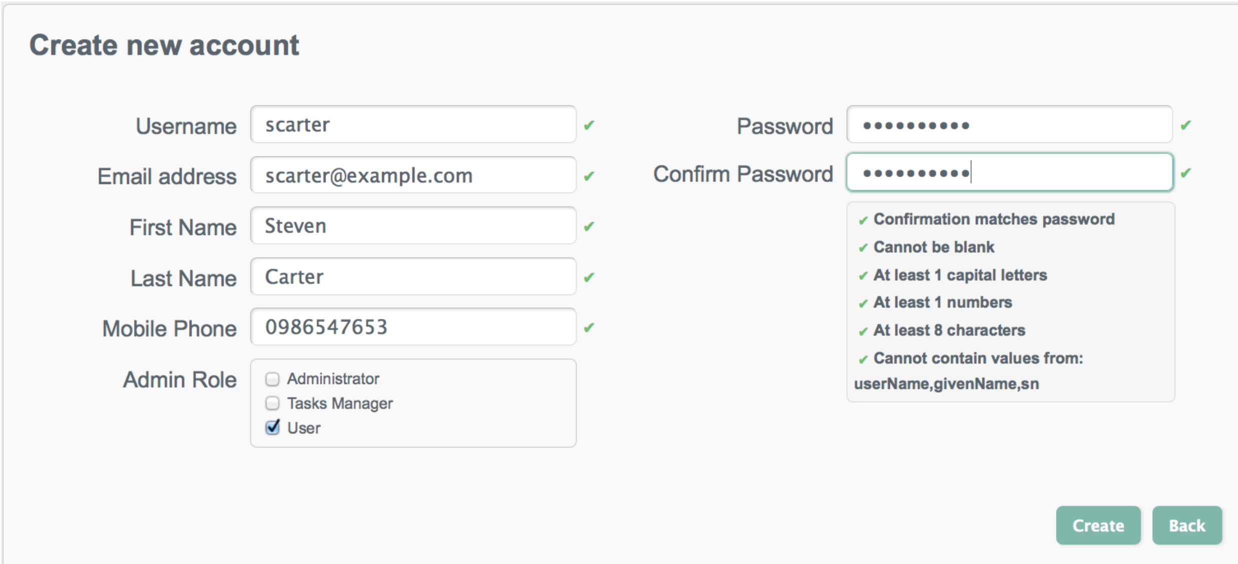
1. Log into the user interface as an administrative user.
2. Select the Users tab.
3. Click Add User.
4. Complete the fields on the Create new account page.

   Most of these fields are self-explanatory. Be aware that the user interface is subject to policy validation, as described in Chapter 9, "*Using Policies to Validate Data*". So, for example, the Email address must be of valid email address format, and the Password must comply with the password validation settings that are indicated in the panel to the right.

   The Admin Role field reflects the roles that are defined in the `ui-configuration.json` file, as well as any managed roles that have been added. By default, the roles are mapped as follows:

   ```
   "roles" : {
       "openidm-admin" : "Administrator",
       "openidm-authorized" : "User",
       "openidm-tasks-manager" : "Tasks Manager"
   },
   ```

A user can be assigned more than one role. Only users with the `tasks-manager` role can assign tasks to any candidate user for that task.



Procedure 4.2. To Update a User Account

1. Log into the User View UI at `https://localhost:8443/openidmui` as an administrative user.
2. Select the Users tab.
3. Click the Username of the user that you want to update.
4. On the user's profile page, modify the fields you want to change and click Update.

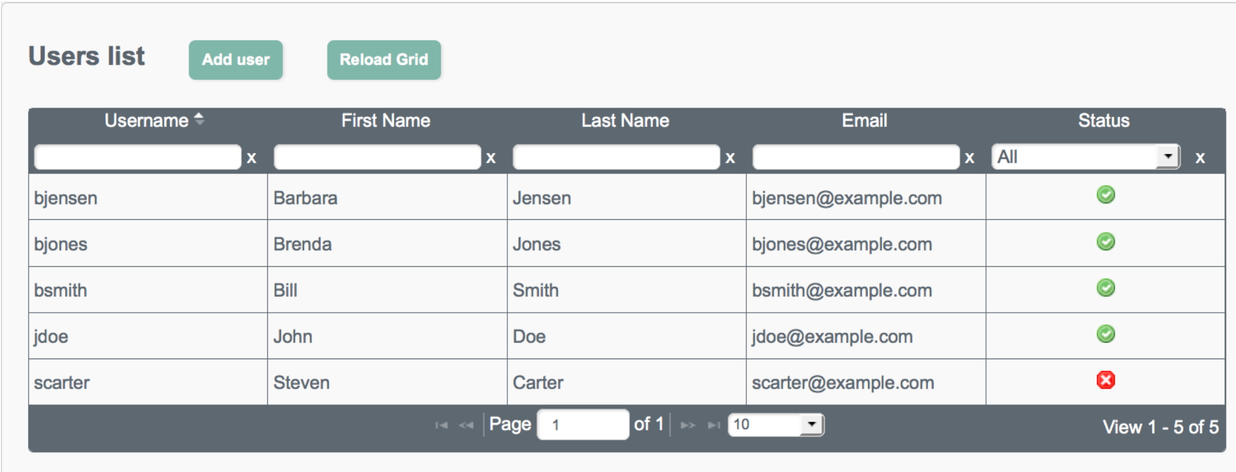
   The user account is updated in the OpenIDM repository.

Procedure 4.3. To Deactivate a User Account

1. Follow steps 1-3 in Procedure 4.2, "To Update a User Account".
2. On the user's profile page, select Inactive from the Account status list.
3. Click Update.

   The user account is deactivated and the user can no longer log in to the system.

   Inactive users are indicated with a X icon in the Status column of the Users page. The following image shows that Steven Carter's account has been deactivated.



Procedure 4.4. To Reset a User's Password

Users can change their own passwords by following the Change Security Data link in their profiles. This process requires that users know their existing passwords.

In a situation where a user forgets his password, an administrator can reset the password of that user without knowing the user's existing password.

1. Follow steps 1-3 in Procedure 4.2, "To Update a User Account".
2. On the user's profile page, click Change password.
3. Enter a new password that conforms to the password policy and click Update.

   The user password is updated in the repository.

Procedure 4.5. To Delete a User Account

1. Log into the user interface as an administrative user.
2. Select the Users tab.
3. Click the Username of the user that you want to delete.
4. On the user's profile page, click Delete.
5. Click OK to confirm the deletion.

   The user is deleted from the internal repository.

Procedure 4.6. To View a User's Account in External Resources

The User View UI displays the details of the user account in the OpenIDM repository (managed/user). When a mapping has been configured between the repository and one or more external resources, you can view what that user account looks like in any of the systems to which it is linked. Note that this view is read-only - you cannot update a user record in a linked system from within the User View UI.

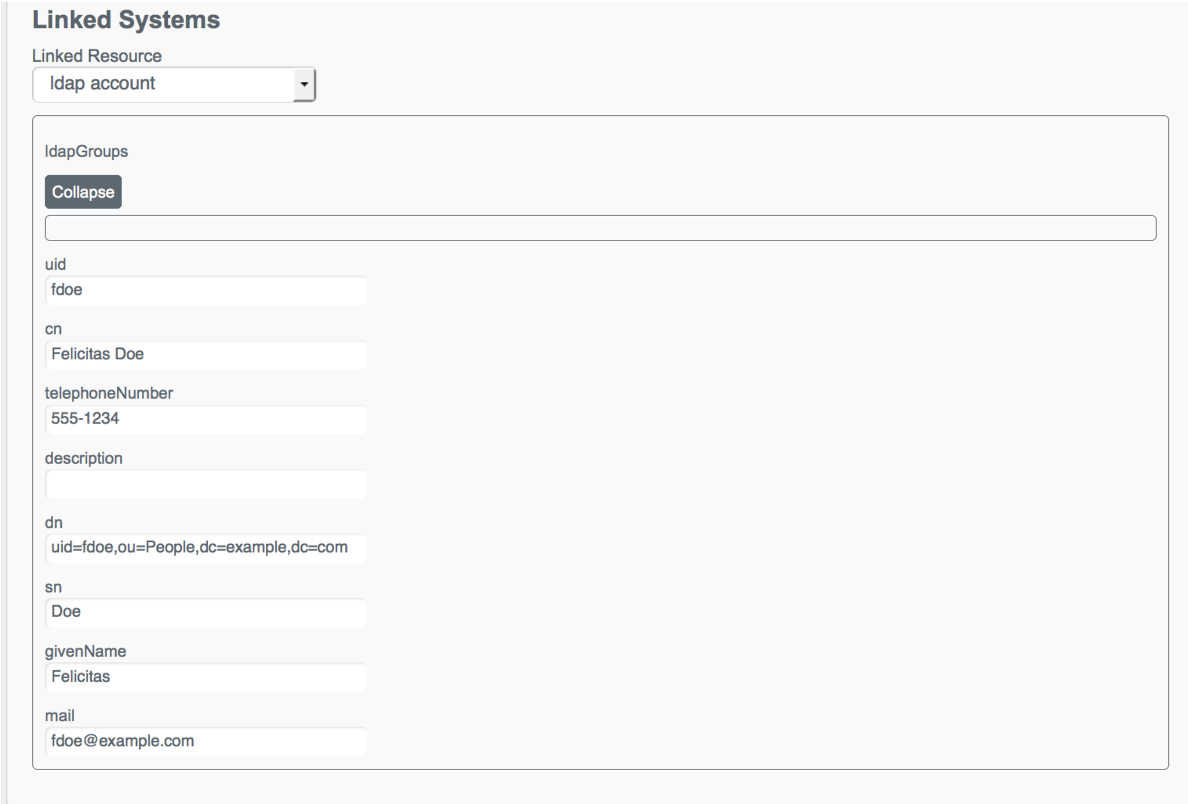
By default, *implicit synchronization* is enabled for mappings *from* the `managed/user` repository *to* any external resource. This means that when you update a managed object, any mappings defined in the `sync.json` file that have the managed object as the source are automatically executed to update the target system. You can see these changes in the Linked Systems section of a user's profile.

To view a user's linked accounts:

1. Log into the User View UI as an administrative user.
2. Select the Users tab.
3. Click the Username of the user whose accounts you want to view.
4. At the bottom of the user profile, the Linked Systems panel indicates the external resource or resources to which this user entry is mapped. .
5. Select the resource in which you want to view the account, from the Linked Resource list.

   The user record in the linked resource is displayed.

   The following image shows the user account for a user `fdoe`, as it exists in the LDAP directory to which the managed user repository is mapped.



4.5. Managing Workflows From the User View UI

The User View UI is integrated with the embedded Activiti worfklow engine, enabling users to interact with workflows. Available workflows are displayed under the Processes item on the Dashboard. In order for a workflow to be displayed here, the workflow definition file must be present in the `openidm/workflow` directory.

A sample workflow integration with the User View UI is provided in `openidm/samples/workflow`, and documented in Section 17.5.2, "Sample Workflow - Provisioning User Accounts". Follow the steps in that sample for an understanding of how the workflow integration works.

Access to workflows is based on OpenIDM roles, and is configured in the file `conf/process-access.json`. By default all users with the role `openidm-authorized` or `openidm-admin` can invoke any available workflow. The default `process-access.json` file is as follows:

```
{
    "workflowAccess" : [
        {
            "propertiesCheck" : {
                "property" : "_id",
                "matches" : ".*",
                "requiresRole" : "openidm-authorized"
            }
        },
        {
            "propertiesCheck" : {
                "property" : "_id",
                "matches" : ".*",
                "requiresRole" : "openidm-admin"
            }
        }
    ]
}
```

`"property"`

Specifies the property used to identify the process definition. By default, process definitions are identified by their `_id`.

`"matches"`

A regular expression match is performed on the process definitions, according to the specified property. The default (`"matches" : ".*"`) implies that all process definition IDs match.

`"requiresRole"`

Specifies the OpenIDM role that is required for users to have access to the matched process definition IDs. In the default file, users with the role `openidm-authorized` or `openidm-admin` have access.

To extend the process action definition file, identify the processes to which users should have access, and specify the qualifying user roles. For example, if you wanted to restrict access to a process definition whose ID was `567`, to users with the role `ldap` you would add the following to the `process-access.json` file:

```
{
    "propertiesCheck" : {
        "property" : "_id",
        "matches" : "567",
        "requiresRole" : "ldap"
    }
}
```

4.6. Changing the UI Theme

You can customize the theme of the user interface with your own branding. One way to adjust the UI theme, is to edit the properties in the UI theme configuration file (`/path/to/openidm/conf/ui-themeconfig.json`). This file stores detailed color values, background image paths, and a number of other common styling options. Because the UI theme configuration file is part of the configuration store, it is shared by all nodes in a cluster. Changes made to this file do not have to be replicated manually across nodes.

To change theme elements that are not included in the UI theme configuration file, you can create a custom theme in the `openidm/ui/extension` directory. By default the user interface reads the stylesheets and images from the `openidm/ui/default` directory. Do not modify the files in this default directory as there is no guarantee that your changes will not be overwritten in the next OpenIDM release. Modifications made in the `openidm/ui/extension` directory can be maintained across product upgrades. The UI searches the `extension` directory first and applies any styles or images located in this directory. Note that files added to the `extension` directory must be manually copied between every node in a cluster.

If you want to update the view logic of the UI, you cannot simply add files to the extensions folder. It is assumed that if your deployment requires that level of control of the user interface, you are no longer going to want to be automatically upgraded with subsequent releases. As such, you need to take on the task of maintaining a fork of the UI.

4.6.1. Changing the Default Stylesheet

Most changes to the UI stylesheets can be made in the UI theme configuration file (`conf/ui-themeconfig.json`).

If you make the following change to that file, that changes the background color of the UI to dark grey.

```
$ grep "background-color" /path/to/openidm/conf/ui-themeconfig.json
"background-color" : "#ababab",
```

Refresh your browser window for the change to appear.

The default stylesheets are located in the `openidm/ui/default/enduser/public/css` directory. To customize the stylesheets beyond the properties available in the UI theme configuration file, copy the default stylesheets to `openidm/ui/extension/css`, and edit them according to your requirements.

4.6.2. Changing the Default Logo

The default logo is located in the `openidm/ui/default/enduser/public/images` directory. Any file named `logo.png`, added to the directory `openidm/ui/extension/images`, will replace the default logo when the browser is refreshed.

To specify a different file name, or to control the size, and other properties of the image file that is used for the logo, adjust the `logo` property in the UI theme configuration file (`conf/themeconfig.json`).

The following change to the UI theme configuration file points to an image file named `example-logo.png`, in the `openidm/ui/extension/images` directory.

```
...
   "logo" : {
       "src" : "images/example-logo.png",
       "title" : "Example.com",
       "alt" : "Example.com",
       "height" : "80",
       "width" : "120"
   },
...
```

Refresh your browser window for the new logo to appear.

4.6.3. Changing the Language of the UI

Currently, the UI is provided only in US English. You can translate the UI and specify that your own locale is used. The following example shows how to translate the UI into French.

1. Copy the default locale to a new folder in the same location (`openidm/ui/default/enduser/public/locales`):

   ```
   $ cd /path/to/openidm/ui/default/enduser/public/locales
   $ cp -R en/ fr/
   ```

   The new locale (`fr`) now contains the default `translation.json` file.

   ```
   $ ls fr/
   translation.json
   ```

2. Translate the values of the properties in the `fr/translate.json` file. Do *not* translate the property names. For example:

   ```
   ...
   "UserMessages" : {
       "changedPassword" : "Mot de passe a été modifié",
       "profileUpdateFailed" : "Problème lors de la mise à jour du profil",
       "profileUpdateSuccessful" : "Profil a été mis à jour",
       "userNameUpdated" : "Nom d'utilisateur a été modifié",
   ....
   ```

3. Change the UI configuration to use the new locale by setting the value of the `lang` property in the `/path/to/openidm/conf/ui-configuration.json` file, as follows:

   ```
   "lang" : "fr",
   ```

4. Refresh your browser window for the modification to be applied.

4.6.4. Creating a Project-Specific UI Theme

You can create specific UI themes for different projects and then point a particular UI instance to use a defined theme on startup. To create a complete custom theme, follow these steps:

1. Shut down the OpenIDM instance, if it is running. In the Felix administration console, type:

```
shutdown
->
```

2. Clear the `felix-cache` directory.

```
$ rm -rf felix-cache
```

3. Copy the entire default UI theme to an accessible location. For example:

```
$ cd /path/to/openidm/ui
$ cp -r default ../new-project-theme
```

4. In the copied theme, modify the required elements, as described in the previous sections. Note that nothing is copied to the extension folder in this case - changes are made in the copied theme.

5. In the `openidm/conf/boot/boot.properties` file, add the following line, specifying the location of the new theme. The path is relative to the installation root of the OpenIDM instance.

```
openidm.ui.fileinstall.dir=new-project-theme
```

6. Restart OpenIDM.

```
$ cd /path/to/openidm
$ ./startup.sh
```

7. Relaunch the UI in your browser. The UI is displayed with the new custom theme.

4.7. Using an External System for Password Reset

By default, the password reset mechanism is handled internally, in OpenIDM. You can reroute password reset in the event that a user has forgotten his password, by specifying an external URL to which password reset requests are sent. Note that this URL applies to the password reset link on the login page only, not to the security data change facility that is available after a user has logged in.

To set an external URL to handle password reset, set the `passwordResetLink` parameter in the UI configuration file (`conf/ui-configuration.json`) file. The following example sets the `passwordResetLink` to `https://accounts.example.com/account/reset-password`.

```
passwordResetLink: "https://accounts.example.com/reset-password"
```

The `passwordResetLink` parameter takes either an empty string as a value (which indicates that no external link is used) or a full URL to the external system that handles password reset requests.

Note

External password reset and security questions for internal password reset are mutually exclusive. Therefore, if you set a value for the `passwordResetLink` parameter, users will not be prompted with any security questions, regardless of the setting of the `securityQuestions` parameter.

4.8. Providing a Logout URL to External Applications

By default, a UI session is invalidated when a user clicks on the Log out link. In certain situations your external applications might require a distinct logout URL to which users can be routed, to terminate their UI session.

The logout URL is `#logout`, appended to the UI URL, for example, `https://localhost:8443/openidmui/index.html#logout/`.

The logout URL effectively performs the same action as clicking on the Log out link of the UI.

4.9. Changing the UI Path

By default, the UI is registered at a specific URL (*context-root*`/openidmui`). To override the default URL and specify your own path, edit the `openidm/conf/ui.context-enduser.json` file, setting the `urlContextRoot` property to the new URL. For example, to change the path to *context-root*`/exampleui`, edit the file as follows:

```
"urlContextRoot" : "/exampleui",
```

4.10. Disabling the UI

The UI is packaged as a separate bundle that can be disabled in the configuration before server startup. To disable the registration of the UI servlet, edit the `openidm/conf/ui.context-enduser.json` file, setting the `enabled` property to false:

```
"enabled" : false,
```

Chapter 5
Managing the OpenIDM Repository

OpenIDM stores managed objects, internal users, and configuration objects in a repository. By default, OpenIDM uses OrientDB for its internal repository. In production, you must replace OrientDB with a supported JDBC repository, as described in Chapter 4, "*Installing a Repository For Production*" in the *Installation Guide*.

This chapter describes the JDBC repository configuration, the use of mappings in the repository, and how to configure a connection to the repository over SSL. It also describes how to interact with the OpenIDM repository over the REST interface.

5.1. Understanding the JDBC Repository Configuration File

OpenIDM provides a specific configuration file for each supported JDBC repository, as well as example configurations for other repositories. These configuration files are located in `/path/to/openidm/db/database` and are named `repo.jdbc.json`. Copy the configuration file for your specific database type to `/path/to/openidm/conf/`.

The repository configuration file includes the connection details for the repository, a number of predefined queries, and a mapping between OpenIDM resources and the tables in the repository.

An excerpt from an example repository configuration follows.

```
{
    "connection" : {
        "dbType" : "MYSQL",
        "jndiName" : "",
        "driverClass" : "com.mysql.jdbc.Driver",
        "jdbcUrl" : "jdbc:mysql://localhost:3306/openidm?characterEncoding=utf8",
        "username" : "openidm",
        "password" : "openidm",
        "defaultCatalog" : "openidm",
        "maxBatchSize" : 100,
        "maxTxRetry" : 5,
        "enableConnectionPool" : true,
        "connectionTimeoutInMs" : 30000
    },
    "queries" : {...},
    "resourceMapping" : {...}
}
```

`"dbType" : string, optional`

The type of database. The database type might affect the queries used and other optimizations. Supported database types include `MYSQL`, `SQLSERVER`, and `ORACLE`.

`"driverClass"`, `"jndiName"`, or `"jtaName"`

Depending on the mechanism you use to acquire the data source, set *one* of these properties.

- `"driverClass" : string`

  To use the JDBC driver manager to acquire a data source, set this property, as well as `"jdbcUrl"`, `"username"`, and `"password"`. The driver class must be the fully qualified class name of the database driver to use for your database.

  Using the JDBC driver manager to acquire a data source is the most likely option, and the only one supported "out of the box". The remaining options in the sample repository configuration file assume that you are using a JDBC driver manager.

  Example: `"driverClass" : "com.mysql.jdbc.Driver"`

- `"jndiName" : string`

  If you use JNDI to acquire the data source, set this property to the JNDI name of the data source.

  This option might be relevant if you want to run OpenIDM inside your own web container.

  Example: `"jndiName" : "jdbc/my-datasource"`

- `"jtaName" : string`

  If you use an OSGi service to acquire the data source, set this property to a stringified version of the OsgiName.

  This option would only be relevant in a highly customized deployment, for example, if you wanted to develop your own connection pool.

  Example: `"jtaName" : "osgi:service/javax.sql.DataSource/(osgi.jndi.service.name=jdbc/openidm)"`

`"jdbcUrl"`

The connection URL to the JDBC database. The URL should include all of the parameters required by your database. For example, to specify the encoding in MySQL use `'characterEncoding=utf8'`.

Example: `"jdbcUrl" : "jdbc:mysql://localhost:3306/openidm?characterEncoding=utf8"`

`"username"`

The username with which to access the JDBC database.

`"password"`

The password with which to access the JDBC database. OpenIDM automatically encrypts clear string passwords. To replace an existing encrypted value, replace the whole `crypto-object` value, including the brackets, with a string of the new password.

`"defaultCatalog"`

The database schema to use for OpenIDM. By default, no schema prefix is used for queries.

`"maxBatchSize"`

The maximum number of SQL statements that will be batched together. This parameter allows you to optimize the time taken to execute multiple queries. Certain databases do not support batching, or limit how many statements can be batched. A value of `1` disables batching.

`"queries"`

Enables you to create pre-defined queries that can be referenced from the configuration. The queries are divided between those for `"genericTables"` and those for `"explicitTables"`.

The following sample extract from the default MySQL configuration file shows two credential queries, one for a generic mapping, and one for an explicit mapping. Note that the lines have been broken here for legibility only. In a real configuration file, the query would be all on one line.

```
"queries" : {
    "genericTables" : {
        "credential-query" : "SELECT fullobject FROM ${_dbSchema}.${_mainTable}
          obj INNER JOIN ${_dbSchema}.${_propTable} prop ON
          obj.id = prop.${_mainTable}_id INNER JOIN ${_dbSchema}.objecttypes
          objtype ON objtype.id = obj.objecttypes_id WHERE prop.propkey='/userName'
          AND prop.propvalue = ${username} AND objtype.objecttype = ${_resource}",
        ...
    "explicitTables" : {
        "credential-query" : "SELECT * FROM ${_dbSchema}.${_table}
          WHERE objectid = ${username} and accountStatus = 'active'",
        ...
    }
}
```

Options supported for query parameters include the following:

- A default string parameter, for example:

  ```
  openidm.query("managed/user", { "_queryId": "for-userName", "uid": "jdoe" });
  ```

- A list parameter (`${list:propName}`).

  Use this parameter to specify a set of indeterminate size as part of your query. For example:

```
WHERE targetObjectId IN (${list:filteredIds})
```

- An integer parameter (`${int:propName}`).

  Use this parameter if you need query for non-string values in the database. This is particularly useful with explicit tables.

`"resourceMapping"`

Defines the mapping between OpenIDM resource URIs (for example, `managed/user`) and JDBC tables. The structure of the resource mapping is as follows:

```
"resourceMapping" : {
    "default" : {
        "mainTable" : "genericobjects",
        "propertiesTable" : "genericobjectproperties",
        "searchableDefault" : true
    },
    "genericMapping" : {...},
    "explicitMapping" : {...}
}
```

The default mapping object represents a default generic table in which any resource that does not have a more specific mapping is stored.

The generic and explicit mapping objects are described in the following section.

5.2. Using Explicit or Generic Object Mapping With a JDBC Repository

For JDBC repositories, there are two ways of mapping OpenIDM objects to the database tables.

- *Generic mapping*, which allows arbitrary objects to be stored without special configuration or administration.
- *Explicit mapping*, which allows for optimized storage and queries by explicitly mapping objects to tables and columns in the database.

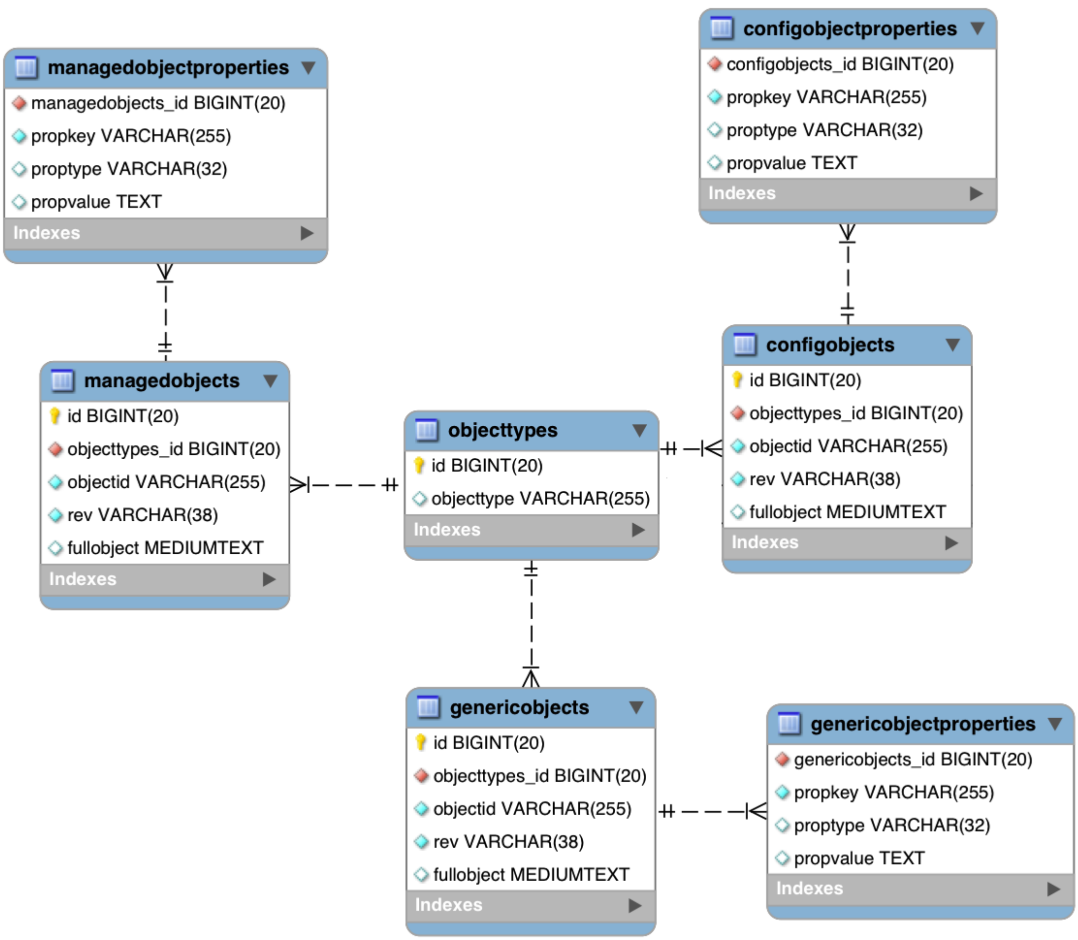
These two mapping strategies are discussed in the following sections.

5.2.1. Using Generic Mappings

Generic mapping speeds up development, and can make system maintenance more flexible by providing a more stable database structure. However, generic mapping can have a performance impact and does not take full advantage of the database facilities (such as validation within the database and flexible indexing). In addition, queries can be more difficult to set up.

In a generic table, the entire object content is stored in a single large-character field named `"fullobject"` in the `"mainTable"` for the object. To search on specific fields, you can read them by referring to them in the corresponding `properties table` for that object. The disadvantage of generic objects is that, because every property you might like to filter by is stored in a separate table, you must join to that table each time you need to filter by anything.

The following diagram shows a pared down database structure for the default generic table, and indicates the relationship between the main table and the corresponding properties table for each object.



These separate tables can make the query syntax particularly complex. For example, a simple query to return user entries based on a user name would need to be implemented as follows:

```
SELECT fullobject FROM ${_dbSchema}.${_mainTable} obj INNER JOIN ${_dbSchema}.${_propTable} prop
    ON obj.id = prop.${_mainTable}_id INNER JOIN ${_dbSchema}.objecttypes objtype
    ON objtype.id = obj.objecttypes_id WHERE prop.propkey='/userName' AND prop.propvalue = ${uid}
    AND objtype.objecttype = ${_resource}",
```

The query can be broken down as follows:

- Select the full object from the main table

  ```
  SELECT fullobject FROM ${_dbSchema}.${_mainTable} obj
  ```

- Join to the properties table and locate the object with the corresponding ID.

  ```
  INNER JOIN ${_dbSchema}.${_propTable} prop  ON obj.id = prop.${_mainTable}_id
  ```

- Join to the object types table to restrict returned entries to objects of a specific type. For example, you might want to restrict returned entries to `managed/user` objects, or `managed/role` objects.

  ```
  INNER JOIN ${_dbSchema}.objecttypes objtype ON objtype.id = obj.objecttypes_id
  ```

- Filter records by the `userName` property, where the userName is equal to the specified `uid` and the object type is the specified type (in this case, managed/user objects).

  ```
  WHERE prop.propkey='/userName'
  AND prop.propvalue = ${uid}
  AND objtype.objecttype = ${_resource}",
  ```

  The value of the `uid` field is provided as part of the query call, for example:

  ```
  openidm.query("managed/user", { "_queryId": "for-userName", "uid": "jdoe" });
  ```

Tables for user definable objects use a generic mapping by default.

The following sample generic mapping object illustrates how `managed/` objects are stored in a generic table.

```
"genericMapping" : {
    "managed/*" : {
        "mainTable" : "managedobjects",
        "propertiesTable" : "managedobjectproperties",
        "searchableDefault" : true,
        "properties" : {
            "/picture" : {
                "searchable" : false
            }
        }
    }
},
```

`"mainTable"` **(string, mandatory)**

Indicates the main table in which data is stored for this resource.

The complete object is stored in the `fullobject` column of this table. The table includes an `entityType` foreign key, that is used to distinguish the different objects stored within the table. In addition, the revision of each stored object is tracked, in the `rev` column of the table, enabling multi version concurrency control (MVCC). For more information, see Section C.1.6.3, "Manipulating Managed Objects Programmatically".

`"propertiesTable"` **(string, mandatory)**

Indicates the properties table, used for searches.

The contents of the properties table is a defined subset of the properties, copied from the character large object (CLOB) that is stored in the `fullobject` column of the main table. The properties are stored in a one-to-many style separate table. The set of properties stored here is determined by the properties that are defined as `"searchable"`.

The stored set of searchable properties makes these values available as discrete rows that can be accessed with SQL queries, specifically, with `WHERE` clauses. It is not otherwise possible to query specific properties of the full object.

The properties table includes the following columns:

- `${_mainTable}_id` corresponds to the `id` of the full object in the main table, for example, `manageobjects_id`, or `genericobjects_id`.
- `propkey` is the name of the searchable property, stored in JSON pointer format (for example `/mail`. For more information about JSON pointer syntax, see RFC 6901.
- `proptype` is the data type of the property, for example `java.lang.String`. The property type is obtained from the Class associated with the value.
- `propvalue` is the value of property, extracted from the full object that is stored in the main table.

  Regardless of the property data type, this value is stored as a string, so queries against it should treat it as such.

`"searchableDefault"` **(boolean, optional)**

Specifies whether all properties of the resource should be searchable by default. Properties that are searchable are stored and indexed. You can override the default for individual properties in the `"properties"` element of the mapping. The preceding example indicates that all properties are searchable, with the exception of the `"picture"` property.

For large, complex objects, having all properties searchable implies a substantial performance impact. In such a case, a separate insert statement is made in the properties table for each element in the object, every time the object is updated. Also, because these are indexed fields, the recreation of these properties incurs a cost in the maintenance of the index. You should therefore enable `"searchable"` only for those properties that must be used as part of a WHERE clause in a query.

`"properties"`

Lists any individual properties for which the searchable default should be overridden.

Note that if an object was originally created with a subset of `"searchable"` properties, changing this subset (by adding a new `"searchable"` property in the configuration, for example) will not cause the existing values to be updated in the properties table for that object. To add the new property to the properties table for that object, you must update or recreate the object.

5.2.2. Improving Search Performance for Generic Mappings

By default, all properties in a generic mapping are searchable. Although there are no individual indexes in a generic mapping, you can improve search performance by setting only those properties that you need to search as `"searchable"`. Properties that are searchable are created within the corresponding properties table. The properties table exists only for searches or look-ups, and has a composite index, based on the resource, then the property name.

To restrict searches to specific properties, set the `"searchableDefault"` to false for the mapping, and then explicitly set `"searchable"` to true for each property that should be searched. The following sample extract from `repo.jdbc.json` indicates searches restricted to the `"userName"` property.

```
"genericMapping" : {
    "managed/user" : {
        "mainTable" : "manageduserobjects",
        "propertiesTable" : "manageduserobjectproperties",
        "searchableDefault" : false,
        "properties" : {
            "/userName" : {
            "searchable" : true
            }
        }
    }
},
```

With this configuration, OpenIDM creates entries in the properties table only for `"userName"` properties of managed user objects.

If the global `"searchableDefault"` is set to false, properties that do not have a searchable attribute explicitly set to true are not written in the properties table.

5.2.3. Using Explicit Mappings

Explicit mapping is more difficult to set up and maintain, but can take complete advantage of the native database facilities.

An explicit table offers better performance and simpler queries. There is less work in the reading and writing of data, since the data is all in a single row of a single table. In addition, it is easier to create different types of indexes that apply to only specific fields in an explicit table. The disadvantage of explicit tables is the additional work required in creating the table in the schema. Also, because rows in a table are inherently more simple, it is more difficult to deal with complex objects. Any non-simple key:value pair in an object associated with an explicit table is converted to a JSON string and stored in the cell in that format. This makes the value difficult to use, from the perspective of a query attempting to search within it.

Note that it is possible to have a generic mapping configuration for most managed objects, *and* to have an explicit mapping that overrides the default generic mapping in certain cases. The sample configuration provided in `/path/to/openidm/db/mysql/conf/repo.jdbc-mysql-explicit-managed-user.json` has a generic mapping for managed objects, but an explicit mapping for managed user objects.

OpenIDM uses explicit mapping for internal system tables, such as the tables used for auditing.

Depending on the types of usage your system is supporting, you might find that an explicit mapping performs better than a generic mapping. Operations such as sorting and searching (such as those performed in the default UI) tend to be faster with explicitly-mapped objects, for example.

The following sample explicit mapping object illustrates how `internal/user` objects are stored in an explicit table.

```
"explicitMapping" : {
    "internal/user" : {
        "table" : "internaluser",
        "objectToColumn" : {
            "_id" : "objectid",
            "_rev" : "rev",
            "password" : "pwd",
            "roles" : "roles"
        }
    },
    ...
}
```

`"<resource-uri>"` **(string, mandatory)**

Indicates the URI for the resources to which this mapping applies, for example, `"internal/user"`.

`"table"` **(string, mandatory)**

The name of the database table in which the object (in this case internal users) is stored.

`"objectToColumn"` **(string, mandatory)**

The way in which specific managed object properties are mapped to columns in the table.

The mapping can be a simple one to one mapping, for example `"userName": "userName",` or a more complex JSON map or list. When a column is mapped to a JSON map or list, the syntax is as shown in the following examples:

```
"messageDetail" : { "column" : "messagedetail", "type" : "JSON_MAP" }
```

or

```
"roles": { "column" : "roles", "type" : "JSON_LIST" }
```

5.3. Configuring SSL with a JDBC Repository

To configure SSL with a JDBC repository, you need to import the CA certificate file for the server into the OpenIDM truststore. That certificate file could have a name like `ca-cert.pem`. If you have a different genuine or self-signed certificate file, substitute accordingly.

To import the CA certificate file into the OpenIDM truststore, use the **keytool** command native to the Java environment, typically located in the `/path/to/jre-version/bin` directory. On some UNIX-based systems, **/usr/bin/keytool** may link to that command.

Procedure 5.1. Preparing OpenIDM for SSL with a JDBC Repository

1. Import the `ca-cert.pem` certificate into the OpenIDM truststore file with the following command:

```
$ keytool \
 -importcert \
 -trustcacerts \
 -file ca-cert.pem \
 -alias "DB cert" \
 -keystore /path/to/openidm/security/truststore
```

2. Open the repository configuration file, `repo.jdbc.json`.

   Look for the `"jdbcUrl"` properties. You should see a `jdbc` URL. Add a `?characterEncoding=utf8&useSSL=true` to the end of that URL.

   The `"jdbcUrl"` that you configure depends on your JDBC repository. The following entries correspond to appropriate `"jdbcURL"` properties for MySQL, MSSQL, PostgreSQL, and Oracle DB, respectively.

```
"jdbcUrl" : "jdbc:mysql://localhost:3306/openidm?characterEncoding=utf8&useSSL=true"
```

```
"jdbcUrl" : "jdbc:sqlserver://localhost:1433;instanceName=default;
     databaseName=openidm;applicationName=OpenIDM?characterEncoding=utf8&useSSL=true"
```

```
"jdbcUrl" : "jdbc:postgresql://localhost:5432/openidm"
```

```
"jdbcUrl" : "jdbc:oracle:thin:@//localhost:1521/openidm?characterEncoding=utf8&useSSL=true"
```

3. Open the `/path/to/openidm/conf/config.properties` file. Find the `org.osgi.framework.bootdelegation` property. Make sure that property includes a reference to the `javax.net.ssl` option. If you started with the default version of `config.properties` that line should now read as follows:

```
org.osgi.framework.bootdelegation=sun.*,com.sun.*,apple.*,com.apple.*,javax.net.ssl
```

4. Open the `/path/to/openidm/conf/system.properties` file. Add the following line to that file. If appropriate, substitute the path to your own truststore:

```
# Set the truststore
javax.net.ssl.trustStore=/path/to/openidm/security/truststore
```

Even if you are setting up this instance of OpenIDM as part of a cluster, you still need to configure this initial truststore. After this instance joins a cluster, the SSL keys in this particular truststore are replaced. For more information on clustering, see Chapter 19, "*Configuring OpenIDM to Work in a Cluster*".

5. - If you are not using MySQL, you're done!

   - If you are including MySQL as a repository, you need to take the following additional steps to add the client certificate and key to the OpenIDM keystore:

   - Create the client certificate file, `client.packet`, with the following command:

```
$ openssl \
 pkcs12 \
 -export \
 -inkey client-key.pem \
 -in client-cert.pem \
 -out client.packet
```

   In this case, the **openssl** command imports a client key, `client-key.pem`, with input data from the same file, exporting output to a client certificate file named `client.packet`, in PKCS12 format.

   - You can then add the client certificate to the OpenIDM keystore with the following command:

```
$ keytool \
 -importkeystore \
 -srckeystore client.packet \
 -srcstoretype pkcs12 \
 -destkeystore /path/to/openidm/security/keystore.jceks \
 -storetype JCEKS
```

5.4. Interacting With the Repository Over REST

The OpenIDM repository is accessible over the REST interface, at the `openidm/repo` endpoint.

In general, you must ensure that external calls to the `openidm/repo` endpoint are protected. Native queries and free-form command actions on this endpoint are disallowed by default, as the endpoint is vulnerable to injection attacks. For more information, see Section 5.4.2, "Running Queries and Commands on the Repository".

5.4.1. Changing the Repository Password

In the case of an embedded OrientDB repository, the default username and password are `admin` and `admin`. You can change the default password, by sending the following POST request on the `repo` endpoint:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/repo?_action=updateDbCredentials&user=admin&password=newPassword"
```

You must restart OpenIDM for the change to take effect.

5.4.2. Running Queries and Commands on the Repository

Free-form commands and native queries on the repository are disallowed by default and should remain so in production to reduce the risk of injection attacks.

Common filter expressions, called with the `_queryFilter` keyword, enable you to form arbitrary queries on the repository, using a number of supported filter operations. For more information on these filter operations, see Section 7.3.4, "Constructing Queries". Parameterized or pre-defined queries and commands (using the `_queryId` and `_commandId` keywords) can be authorized on the repository for external calls if necessary. For more information, see Section 7.3.2, "Parameterized Queries".

Running commands on the repository is supported primarily from scripts. Certain scripts that interact with the repository are provided by default, for example, the scripts that enable you to purge the repository of reconciliation audit records.

You can define your own commands, and specify them in the repository configuration file (either `repo.orientdb.json` or `repo.jdbc.json`). In the following simple example, a command is called to clear out UI notification entries from the repository, for specific users.

The command is defined in the repository configuration file, as follows:

```
"commands" : {
"delete-notifications-by-id" : "DELETE FROM ui_notification WHERE receiverId = ${username}"
...
},
```

The command can be called from a script, as follows:

```
openidm.action("repo/ui/notification", "command", {},
{ "commandId" : "delete-notifications-by-id", "userName" : "scarter"});
```

Exercise caution when allowing commands to be run on the repository over the REST interface, as there is an attached risk to the underlying data.

Chapter 6
Configuring OpenIDM

OpenIDM configuration is split between `.properties` and container configuration files, and also dynamic configuration objects. The majority of OpenIDM configuration files are stored under `openidm/conf/`, as described in Appendix A, "*File Layout*".

OpenIDM stores configuration objects in its internal repository. You can manage the configuration by using either the REST access to the configuration objects, or by using the JSON file based views.

6.1. OpenIDM Configuration Objects

OpenIDM exposes internal configuration objects in JSON format. Configuration elements can be either single instance or multiple instance for an OpenIDM installation.

Single Instance Configuration Objects

Single instance configuration objects correspond to services that have at most one instance per installation.

JSON file views of these configuration objects are named *`object-name`*`.json`.

- The `audit` configuration specifies how audit events are logged.
- The `authentication` configuration controls REST access.
- The `cluster` configuration defines how one OpenIDM instance can be configured in a cluster.
- The `endpoint` configuration controls any custom REST endpoints.
- The `info` configuration points to script files for the customizable information service.
- The `managed` configuration defines managed objects and their schemas.
- The `policy` configuration defines the policy validation service.
- The `process access` configuration defines access to any configured workflows.
- The `repo.`*`repo-type`* configuration such as `repo.orientdb` or `repo.jdbc` configures the internal repository.
- The `router` configuration specifies filters to apply for specific operations.
- The `script` configuration defines default and custom configuration directories.

- The `sync` configuration defines the mappings that OpenIDM uses when synchronizing and reconciling managed objects.
- The `ui` configuration defines the configurable aspects of the default user interface.
- The `workflow` configuration defines the configuration of the workflow engine.

Multiple Instance Configuration Objects

Multiple instance configuration objects correspond to services that can have many instances per installation. Configuration objects are named `objectname/instancename`, for example, `provisioner.openicf/xml`.

JSON file views of these configuration objects are named `objectname-instancename.json`, for example, `provisioner.openicf-xml.json.`

- Multiple `schedule` configurations can run reconciliations and other tasks on different schedules.
- Multiple `provisioner.openicf` configurations correspond to the resources connected to OpenIDM.
- Multiple `servletfilter` configurations can be used for different servlet filters such as the Cross Origin and GZip filters.

6.2. Changing the Default Configuration

When you change OpenIDM's configuration objects, take the following points into account.

- OpenIDM's authoritative configuration source is the internal repository. JSON files provide a view of the configuration objects, but do not represent the authoritative source.

  OpenIDM updates JSON files after making configuration changes, whether those changes are made through REST access to configuration objects, or through edits to the JSON files.
- OpenIDM recognizes changes to JSON files when it is running. OpenIDM *must* be running when you delete configuration objects, even if you do so by editing the JSON files.
- Avoid editing configuration objects directly in the internal repository. Rather edit the configuration over the REST API, or in the configuration JSON files to ensure consistent behavior and that operations are logged.
- OpenIDM stores its configuration in the internal database by default. If you remove an OpenIDM instance and do not specifically drop the repository, the configuration remains in effect for a new OpenIDM instance that uses that repository. For testing or evaluation purposes, you can disable this *persistent configuration* in the `conf/system.properties` file by uncommenting the following line:

  ```
  # openidm.config.repo.enabled=false
  ```

Disabling persistent configuration means that OpenIDM will store its configuration in memory only. You should not disable persistent configuration in a production environment.

6.3. Configuring an OpenIDM System for Production

Out of the box, OpenIDM is configured to make it easy to install and evaluate. Specific configuration changes are required before you deploy OpenIDM in a production environment.

6.3.1. Configuring a Production Repository

By default, OpenIDM uses OrientDB for its internal repository so that you do not have to install a database in order to evaluate OpenIDM. Before you use OpenIDM in production, you must replace OrientDB with a supported repository.

For more information, see Chapter 4, "*Installing a Repository For Production*" in the *Installation Guide*.

6.3.2. Disabling Automatic Configuration Updates

By default, OpenIDM polls the JSON files in the `conf` directory periodically for any changes to the configuration. In a production system, it is recommended that you disable automatic polling for updates to prevent untested configuration changes from disrupting your identity service.

To disable automatic polling for configuration changes, edit the `conf/system.properties` file by uncommenting the following line:

```
# openidm.fileinstall.enabled=false
```

This setting also disables the file-based configuration view, which means that OpenIDM reads its configuration only from the repository.

Before you disable automatic polling, you must have started the OpenIDM instance at least once to ensure that the configuration has been loaded into the repository.

Note if automatic polling is enabled, changes to scripts that are called from a JSON configuration file are taken into account immediately.

6.4. Configuring OpenIDM Over REST

OpenIDM exposes configuration objects under the `/openidm/config` context path.

You can list the configuration on the local host by performing a GET `https://localhost:8443/openidm/config`. The following example shows excerpts of the default configuration for an OpenIDM instance started with Sample 1.

```
$ curl \
```

```
 --request GET \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --cacert self-signed.crt \
 https://localhost:8443/openidm/config
   {
   "configurations": [
      {
         "factoryPid": "servletfilter",
         "pid": "servletfilter.ec099f08-bfd4-4ab4-8537-78e5b956c7cc",
         "_id": "servletfilter/gzip"
      },
      {
         "factoryPid": null,
         "pid": "router",
         "_id": "router"
      },

   ...

      {
         "factoryPid": "endpoint",
         "pid": "endpoint.7e9ec068-bb4a-4fa0-ae15-1706bb4a3a07",
         "_id": "endpoint/jqgrid"
      },
      {
         "factoryPid": "endpoint",
         "pid": "endpoint.47978983-0411-425d-8f53-4022175e146a",
         "_id": "endpoint/gettasksview"
      },

   ...

      {
         "factoryPid": "ui",
         "pid": "ui.b10eb4cb-83e3-4a4b-9d29-d91d90eb3053",
         "_id": "ui/countries"
      },
      {
         "factoryPid": "process",
         "pid": "process.9863529c-60e0-42e3-b5d5-c5c704016e95",
         "_id": "process/access"
      }
   ]
}
```

Single instance configuration objects are located under `openidm/config/object-name`. The following example shows the default `audit` configuration.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 "https://localhost:8443/openidm/config/audit"
{
   "eventTypes": {
     "recon": {},
     "activity": {
       "filter": {
```

```
          "actions": [
            "create",
            "update",
            "delete",
            "patch",
            "action"
          ]
        },
        "passwordFields": [
          "password"
        ],
        "watchedFields": []
      }
    },
    "exceptionFormatter": {
      "file": "bin/defaults/script/audit/stacktraceFormatter.js",
      "type": "text/javascript"
    },
    "logTo": [
      {
        "recordDelimiter": ";",
        "logType": "csv",
        "location": "audit"
      },
      {
        "useForQueries": true,
        "logType": "repository"
      }
    ]
}
```

Multiple instance configuration objects are found under `openidm/config/object-name/instance-name`.

The following example shows the configuration for the XML connector provisioner, based on the first IDM sample described in Chapter 2, "*First OpenIDM Sample*" in the *Installation Guide*.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 "https://localhost:8443/openidm/config/provisioner.openicf/xml"
{
    "operationTimeout": {
      "SCRIPT_ON_CONNECTOR": -1,
      "VALIDATE": -1,
      "SYNC": -1,
      "DELETE": -1,
      "TEST": -1,
      "UPDATE": -1,
      "CREATE": -1,
      "AUTHENTICATE": -1,
      "SEARCH": -1,
      "GET": -1,
      "SCRIPT_ON_RESOURCE": -1,
      "SCHEMA": -1
    },
    "connectorRef": {
      "connectorName": "org.forgerock.openicf.connectors.xml.XMLConnector",
```

```
      "bundleVersion": "1.1.0.2",
      "bundleName": "org.forgerock.openicf.connectors.xml-connector"
    },
    "connectorPoolingSupported": true,
    "syncFailureHandler": {
      "maxRetries": 5,
      "postRetryAction": "logged-ignore"
    },
    "configurationProperties": {
      "xsdFilePath": "samples/sample1/data/resource-schema-extension.xsd",
      "xsdIcfFilePath": "samples/sample1/data/resource-schema-1.xsd",
      "xmlFilePath": "samples/sample1/data/xmlConnectorData.xml"
    },
    "objectTypes": {
      "account": {
        "nativeType": "__ACCOUNT__",
        "$schema": "http://json-schema.org/draft-03/schema",
        "type": "object",
        "properties": {
          "securityAnswer": {
            "nativeType": "string",
            "nativeName": "securityAnswer",
            "required": true,
            "type": "string"
          },
          "securityQuestion": {
            "nativeType": "string",
            "nativeName": "securityQuestion",
            "required": true,
            "type": "string"
          },
          "password": {
            "nativeType": "string",
            "nativeName": "password",
            "type": "string"
          },
          "mobileTelephoneNumber": {
            "nativeType": "string",
            "nativeName": "mobileTelephoneNumber",
            "required": true,
            "type": "string"
          },
          "_id": {
            "nativeName": "__UID__",
            "type": "string"
          },
          "email": {
            "nativeType": "string",
            "nativeName": "email",
            "type": "string"
          },
          "description": {
            "nativeType": "string",
            "nativeName": "__DESCRIPTION__",
            "type": "string"
          },
          "name": {
            "nativeType": "string",
            "nativeName": "__NAME__",
```

```
            "required": true,
            "type": "string"
          },
          "roles": {
            "nativeType": "string",
            "nativeName": "roles",
            "required": false,
            "type": "string"
          },
          "lastname": {
            "nativeType": "string",
            "nativeName": "lastname",
            "required": true,
            "type": "string"
          },
          "firstname": {
            "nativeType": "string",
            "nativeName": "firstname",
            "type": "string"
          }
        },
        "id": "__ACCOUNT__"
      }
    },
    "operationOptions": {},
    "name": "xmlfile",
    "producerBufferSize": 100,
    "poolConfigOption": {
      "maxObjects": 10,
      "minEvictableIdleTimeMillis": 120000,
      "maxIdle": 10,
      "minIdle": 1,
      "maxWait": 150000
    }
  }
```


You can change the configuration over REST by using an HTTP PUT request to modify the required configuration object. Note that HTTP PATCH is not supported on the `/config` endpoint.

The following example modifies the `router.json` file to remove all filters, effectively bypassing any policy validation.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PUT \
 --data '{
   "filters" : [
     {
       "onRequest" : {
         "type" : "text/javascript",
         "file" : "bin/defaults/script/router-authz.js"
       }
     }
   ]
   }' \
 "https://localhost:8443/openidm/config/router"
{
  "filters": [
    {
      "onRequest": {
        "file": "bin/defaults/script/router-authz.js",
        "type": "text/javascript"
      }
    }
  ]
}
```

For more information about using the REST API to update objects, see Appendix E, "*REST API Reference*".

6.5. Using Property Value Substitution in the Configuration

In an environment where you have more than one OpenIDM instance, you might require a configuration that is similar, but not identical, across the different OpenIDM hosts. OpenIDM supports variable replacement in its configuration which means that you can modify the effective configuration according to the requirements of a specific environment or OpenIDM instance.

Property substitution enables you to achieve the following:

- Define a configuration that is specific to a single OpenIDM instance, for example, setting the location of the keystore on a particular host.
- Define a configuration whose parameters vary between different environments, for example, the URLs and passwords for test, development, and production environments.
- Disable certain capabilities on specific nodes. For example, you might want to disable the workflow engine on specific instances.

When OpenIDM starts up, it combines the system configuration, which might contain specific environment variables, with the defined OpenIDM configuration properties. This combination makes up the effective configuration for that OpenIDM instance. By varying the environment properties, you can change specific configuration items that vary between OpenIDM instances or environments.

Property references are contained within the construct `&{ }`. When such references are found, OpenIDM replaces them with the appropriate property value, defined in the `boot.properties` file.

Example 6.1.

The following example defines two separate OpenIDM environments - a development environment and a production environment. You can specify the environment at startup time and, depending on the environment, the database URL is set accordingly.

The environments are defined by adding the following lines to the `conf/boot.properties` file:

```
PROD.location=production
DEV.location=development
```

The database URL is then specified as follows in the `repo.orientdb.json` file:

```
{
    "dbUrl" : "plocal:./db/&{&{environment}.location}-openidm",
    ...
}
```

The effective database URL is determined by setting the `OPENIDM_OPTS` environment variable when you start OpenIDM. To use the production environment, start OpenIDM as follows:

```
$ export OPENIDM_OPTS="-Xmx1024m -Xms1024m -Denvironment=PROD"
$ ./startup.sh
```

To use the development environment, start OpenIDM as follows:

```
$ export OPENIDM_OPTS="-Xmx1024m -Xms1024m -Denvironment=DEV"
$ ./startup.sh
```

6.5.1. Using Property Value Substitution With System Properties

You can use property value substitution in conjunction with the system properties, to modify the configuration according to the system on which the OpenIDM instance runs.

Example 6.2. Custom Audit Log Location

The following example modifies the `audit.json` file so that the log file is written to the user's directory. The `user.home` property is a default Java System property.

```
{
    "logTo" : [
        {
            "logType" : "csv",
            "location" : "&{user.home}/audit",
            "recordDelimiter" : ";"
        }
    ]
}
```

You can define *nested* properties (that is a property definition within another property definition) and you can combine system properties and boot properties.

Example 6.3.

The following example uses the `user.country` property, a default Java System property. The example defines specific LDAP ports, depending on the country (identified by the country code) in the `boot.properties` file. The value of the LDAP port (set in the `provisioner.openicf-ldap.json` file) depends on the value of the `user.country` System property.

The port numbers are defined in the `boot.properties` file as follows:

```
openidm.NO.ldap.port=2389
openidm.EN.ldap.port=3389
openidm.US.ldap.port=1389
```

The following extract from the `provisioner.openicf-ldap.json` file shows how the value of the LDAP port is eventually determined, based on the System property:

```
"configurationProperties" :
   {
      "credentials" : "Passw0rd",
      "port" : "&{openidm.&{user.country}.ldap.port}",
      "principal" : "cn=Directory Manager",
      "baseContexts" :
         [
            "dc=example,dc=com"
         ],
      "host" : "localhost"
   }
```

6.5.2. Limitations of Property Value Substitution

Note the following limitations when you use property value substitution:

- You cannot reference complex objects or properties with syntaxes other than String. Property values are resolved from the `boot.properties` file or from the System properties and the value of these properties is always in String format.

  Property substitution of boolean values is currently only supported in stringified format, that is, resulting in `"true"` or `"false"`.

- Substitution of encrypted property values is currently not supported.

6.6. Adding Custom Endpoints

You can customize OpenIDM to meet the specific requirements of your deployment by adding your own RESTful endpoints. Endpoints are configured in files named `conf/endpoint-name.json`, where *name* generally describes the purpose of the endpoint.

A sample custom endpoint configuration is provided in the `openidm/samples/customendpoint` directory. The use of this sample is described in Section 6.6.6, "Custom Endpoint Example". Custom endpoints in OpenIDM can be written either in JavaScript or Groovy. The sample includes three files:

conf/endpoint-echo.json

Provides the configuration for the endpoint.

script/echo.js

Supports an endpoint script written in JavaScript.

script/echo.groovy

Supports an endpoint script written in Groovy.

Endpoint configuration files have a certain structure. They may cite scripts written in JavaScript or Groovy.

The cited scripts include defined `request` and `context` global variables.

6.6.1. The Components of an Endpoint Configuration File

The sample custom endpoint configuration (`/path/to/openidm/samples/customendpoint/conf/endpoint-echo.json`) depicts a typical endpoint, configured to use a Groovy script that is specified in the `script/echo.groovy` file. The structure of the sample configuration is as follows:

```
{
  "file" : "echo.groovy",
  "type" : "groovy",
  "_file" : "echo.js",
  "_type" : "text/javascript"
}
```

The `"_file"` and `"_type"` properties are comments, which you can change to accommodate an endpoint written in JavaScript.

If appropriate, you can also include a `context` property in this file. The following example shows how the `context` is used to display routing to an endpoint.

```
  "context" : "endpoint/echo",
```

The endpoint configuration can specify the route on which the endpoint is available. For an example, look at the `conf/endpoint-linkedView.json` file. The code shown declares the route on which the endpoint is available.

```
{
  "context": "endpoint/linkedView/*",
  "type" : "text/javascript",
  "source" : "require('linkedView').fetch(request.resourceName);"
}
```

The following list describes each property in the custom endpoint configuration file:

`"type"`

string, required

Specifies the type of script to be executed. Supported types include `"text/javascript"` and `"groovy"`.

`"file"` or `"source"`

The actual script, inline, or a path to the file that contains the script. The script files associated with this sample, `echo.js` and `echo.groovy`, support requests using all ForgeRock RESTful CRUD operations (including PATCH, ACTION, and QUERY).

`context`

Requests are dispatched, routed, handled, processed, and more, in a `context`.

6.6.2. Context Component Access Methods

For both JavaScript and Groovy, the context consists of a chain of structures that provide different levels of detail. The detail varies depending on the context type:

`security`

Provides authentication / authorization data.

`http`

Provides data from the HTTP request.

`router`

Provides data on where the information is sent.

JavaScript and Groovy access these context structures in different ways. The term shown is the JavaScript access method; the definition includes the Groovy access method.

`context.current`

In Groovy, known simply as `context`

The current context in which the request is handled by a script or a script-hook.

context.http

In Groovy, known as one of the following:

`context.asContext(org.forgerock.json.resource.servlet.HttpContext.class)`
`context.getContext("http")`

The HTTP context.

context.security

In Groovy, known as one of the following:

`context.asContext(org.forgerock.json.resource.SecurityContext.class)`
`context.getContext("security")`

The security context.

6.6.3. Custom Endpoints and `request` Objects

The endpoint configuration file specifies a script (either inline with the `"source"` property, or in a referenced file with the `"file"` property). The script is invoked with a global `request` variable in its scope.

All processes within OpenIDM are initiated with a request. Requests can come either from the REST API, as shown in Appendix E, "*REST API Reference*", or internally, from a script, using the `openidm` router object, as described in Appendix G, "*Router Service Reference*". Regardless of how the process is initiated, the details of the request are represented in the same way - within an object named `request`.

Most request types include a complex object that stores the details required for that particular request. For example, when you start an `action` process over the REST interface, you might want to include certain detailed information for that action. You include this information as a JSON string in the POST body. The HTTP request header `Content-type` describes this string as `application/json`.

Consider the following REST request:

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data { "name": "bob"} \
 "https://localhost:8443/openidm/endpoint/test?_action=myAction"
```

This request includes the string `'{ "name": "bob"}'` as the HTTP post body. OpenIDM expects this to be a JSON string, and will deserialize it into an object. The object is accessed using `request.content`.

Depending on the type of `request`, the associated content may include the following properties:

`method`

The requested operation, which may be `create`, `read`, `update`, `delete`, `patch`, `query` or `action`.

`resourceName`

The local identifier, without the `endpoint/` prefix, such as `echo`.

`newResourceId`

An identifier associated with a new resource, associated with the `create` method.

`additionalParameters`

The sample code returns request parameters from an HTTP GET with `?param=x`, as `"params":{"param":"x"}`.

`revision`

The revision level associated with the method used, relative to a `newResourceId`.

`content`

Content based on the latest version of the object, using `getObject`.

`context`

Based on a JSON object that contains nested attributes. The object with the attributes, defines the request, based on the operations listed in Section E.4, "Supported Operations".

6.6.4. Custom Endpoints, Contexts, and Chains

Custom endpoints include contexts that may be wrapped in various layers, analogous to the way network packets can be wrapped at ascending network levels.

As an example, start with a request such as the following:

```
GET https://localhost:8443/openidm/endpoint/echo?queryId=query-all-ids&_para=foo
```

A request at an endpoint starts with a root context, associated with a specific context ID, and the `org.forgerock.json.resource.RootContext` context.

The root context is wrapped in the security context that holds the authentication and authorization detail for the request. The associated class is `org.forgerock.json.resource.SecurityContext`, with an `authenticationId` user name such as `openidm-admin`, and associated roles such as `openidm-authorized`.

That security context is further wrapped by the HTTP context, with the target URI. The class is `org.forgerock.json.resource.HttpContext`, and it is associated with the normal parameters of a REST call, including a user agent, authorization token, and method.

The HTTP context is then further wrapped by one or more server / router context(s). That class is `org.forgerock.json.resource.RouterContext`, with an endpoint URI. You may see several layers of server and router contexts.

6.6.5. Additional Custom Endpoint Parameters

A couple of additional parameters are shown with the `query` request method. You can review how this works in Section 3.5, "Sample 2c - Synchronizing LDAP Group Membership" in the *Installation Guide*.

The final statement in the script is the return value. In the following example, there is no `return` keyword, and the value of the last statement (`x`) is returned.

```
var x = "Sample return";
functioncall();
x
```

6.6.6. Custom Endpoint Example

The following example uses the sample provided in the `openidm/samples/customendpoint` directory, copied to the `openidm/conf` and `openidm/script` directories. The output from the query shows the complete request structure.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/endpoint/echo?_queryId=query-all-ids"

     {
 "result" : [ {
     "method" : "query",
     "resourceName" : "",
     "pagedResultsCookie" : null,
     "pagedResultsOffset" : 0,
     "pageSize" : 0,
     "queryExpression" : null,
     "queryId" : "query-all-ids",
     "queryFilter" : "null",
     "parameters" : { },
     "context" : {
       "parent" : {
         "parent" : {
           "parent" : {
             "parent" : {
               "parent" : {
                 "parent" : null,
                 "contextName" : "root",
                 "rootContext" : true,
                 "id" : "43576021-fe54-4468-8d10-09b14af2a36d"
               },
               "contextName" : "security",
               "authenticationId" : "openidm-admin",
               "authorizationId" : {
                 "id" : "openidm-admin",
                 "component" : "repo/internal/user",
                 "roles" : [ "openidm-admin", "openidm-authorized" ]
               },
               "rootContext" : false,
```

```
                "id" : "43576021-fe54-4468-8d10-09b14af2a36d"
              },
              "headers" : {
                "X-OpenIDM-Username" : [ "openidm-admin" ],
                "Host" : [ "localhost:8443" ],
                "Accept" : [ "*/*" ],
                "X-OpenIDM-Password" : [ "openidm-admin" ],
                "User-Agent" : [ "curl/7.19.7 (x86_64-redhat-linux-gnu)
                  libcurl/7.19.7 NSS/3.14.0.0 zlib/1.2.3 libidn/1.18
                  libssh2/1.4.2" ]
              },
              "parameters" : {
                "_queryId" : [ "query-all-ids" ],
                "_prettyPrint" : [ "true" ]
              },
              "external" : true,
              "contextName" : "http",
              "method" : "GET",
              "path" : "https://localhost:8443/openidm/endpoint/echo",
              "rootContext" : false,
              "id" : "43576021-fe54-4468-8d10-09b14af2a36d"
            },
            "contextName" : "apiInfo",
            "apiVersion" : "2.3.1-SNAPSHOT",
            "apiName" : "org.forgerock.commons.json-resource-servlet",
            "rootContext" : false,
            "id" : "43576021-fe54-4468-8d10-09b14af2a36d"
          },
          "contextName" : "server",
          "rootContext" : false,
          "id" : "43576021-fe54-4468-8d10-09b14af2a36d"
        },
        "uriTemplateVariables" : { },
        "contextName" : "router",
        "matchedUri" : "endpoint/echo",
        "baseUri" : "endpoint/echo",
        "rootContext" : false,
        "id" : "43576021-fe54-4468-8d10-09b14af2a36d"
      }
  } ],
  "resultCount" : 1,
  "pagedResultsCookie" : null,
  "remainingPagedResults" : -1
}
```


You must protect access to any custom endpoints by configuring the appropriate authorization for those contexts. For more information, see Section 15.7, "Authorization" section.

6.7. Default and Custom Configuration Directories

You can set up custom configuration files in directories as defined in the `openidm/conf/script.json` file.

The following portion of the `script.json` file points to sources in installation and project directories. As described in Section 2.2, "Specifying the OpenIDM Startup Configuration", the `launcher.project.location` is the directory cited if you start OpenIDM with a specific project directory.

```
...
"sources" : {
  "default" : {
    "directory" : "&{launcher.install.location}/bin/defaults/script"
  },
  "install" : {
    "directory" : "&{launcher.install.location}"
  },
  "project" : {
    "directory" : "&{launcher.project.location}"
  },
  "project-script" : {
    "directory" : "&{launcher.project.location}/script"
  }
...
```

For example, if you start OpenIDM from the `/path/to/openidm` directory with the following command:

```
$ ./startup.sh -p /path/to/openidm/customconfig
```

The `launcher.project.location` directory would be `/path/to/openidm/customconfig`.

The `script.json` file also refers to a `launcher.install.location` directory, which is `/path/to/openidm`.

Thus, based on the way the `script.json` file is configured for `project` and `project-script`, you can add custom configuration and script files to the `/path/to/openidm/customconfig` and the `/path/to/openidm/customconfig/script` directories.

Chapter 7
Accessing Data Objects

OpenIDM supports a variety of objects that can be addressed via a URL or URI. You can access data objects by using scripts (through the Resource API) or by using direct HTTP calls (through the REST API).

The following sections describe these two methods of accessing data objects, and provide information on constructing and calling data queries.

7.1. Accessing Data Objects by Using Scripts

OpenIDM's uniform programming model means that all objects are queried and manipulated in the same way, using the Resource API. The URL or URI that is used to identify the target object for an operation depends on the object type. For an explanation of object types, see Appendix C, "*Data Models and Objects Reference*". For more information about scripts and the objects available to scripts, see Appendix F, "*Scripting Reference*".

You can use the Resource API to obtain managed objects, configuration objects, and repository objects, as follows:

```
val = openidm.read("managed/organization/mysampleorg")
val = openidm.read("config/custom/mylookuptable")
val = openidm.read("repo/custom/mylookuptable")
```

For information about constructing an object ID, see Section E.1, "URI Scheme".

You can update entire objects with the `update()` function, as follows.

```
openidm.update("managed/organization/mysampleorg", mymap)
openidm.update("config/custom/mylookuptable", mymap)
openidm.update("repo/custom/mylookuptable", mymap)
```

For managed objects, you can partially update an object with the `patch()` function.

```
openidm.patch("managed/organization/mysampleorg", rev, value)
```

The `create()`, `delete()`, and `query()` functions work the same way.

7.2. Accessing Data Objects by Using the REST API

OpenIDM provides RESTful access to data objects via a REST API. To access objects over REST, you can use a browser-based REST client, such as the *Simple REST Client* for Chrome, or *RESTClient* for Firefox. Alternatively you can use the curl command-line utility.

For a comprehensive overview of the REST API, see Appendix E, "*REST API Reference*".

To obtain a managed object through the REST API, depending on your security settings and authentication configuration, perform an HTTP GET on the corresponding URL, for example `https://localhost:8443/openidm/managed/organization/mysampleorg`.

By default, the HTTP GET returns a JSON representation of the object.

7.3. Defining and Calling Queries

OpenIDM supports an advanced query model that enables you to define queries, and to call them over the REST or Resource API. Three types of queries are supported, on both managed, and system objects:

- Common filter expressions
- Parameterized, or predefined queries
- Native query expressions

Each of these mechanisms is discussed in the following sections.

7.3.1. Common Filter Expressions

The ForgeRock REST API defines common filter expressions, that enable you to form arbitrary queries using a number of supported filter operations. This query capability is the standard way to query data if no predefined query exists, and is supported for all managed and system objects.

Common filter expressions are useful in that they do not require knowledge of how the object is stored and do not require additions to the repository configuration.

Common filter expressions are called with the `_queryFilter` keyword. The following example uses a common filter expression to retrieve managed user objects whose user name is Smith.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 "https://localhost:8443/openidm/managed/user?_queryFilter=userName%20eq%20%22smith%22"
```

The filter is URL encoded in this example. The corresponding filter using the resource API would be:

```
openidm.query("managed/user", { "_queryFilter" : '/userName eq "smith"' });
```

Note that, this JavaScript invocation is internal and is not subject to the same URL-encoding requirements that a GET request would be. Also, because JavaScript supports the use of single quotes, it is not necessary to escape the double quotes in this example.

For a list of supported filter operations, see Section 7.3.4, "Constructing Queries".

Note that using common filter expressions to retrieve values from arrays is currently not supported. If you need to search within an array you should set up a predefined (parameterized) in your repository configuration. For more information, see Section 7.3.2, "Parameterized Queries".

7.3.2. Parameterized Queries

Managed objects in the supported OpenIDM repositories can be accessed using a parameterized query mechanism. Parameterized queries on repositories are defined in the repository configuration (`repo.*.json`) and are called by their `_queryId`.

Parameterized queries provide precise control over the query that is executed. Such control might be useful for tuning, or for performing database operations such as aggregation (which is not possible with a common filter expression.)

Parameterized queries provide security and portability for the query call signature, regardless of the back-end implementation. Queries that are exposed over the REST interface *must* be parameterized queries to guard against injection attacks and other misuse. Queries on the officially supported repositories have been reviewed and hardened against injection attacks.

For system objects, support for parameterized queries is restricted to `_queryId=query-all-ids`. There is currently no support for user-defined parameterized queries on system objects. Typically, parameterized queries on system objects are not called directly over the REST interface, but are issued from internal calls, such as correlation queries.

A typical query definition is as follows:

```
"query-all-ids" : "select _openidm_id from ${unquoted:_resource}"
```

To call this query, you would reference its ID, as follows:

```
?_queryId=query-all-ids
```

The following example calls `query-all-ids` over the REST interface:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 "https://localhost:8443/openidm/managed/user?_queryId=query-all-ids"
```

7.3.3. Native Query Expressions

Native query expressions are supported for all managed objects and system objects, and can be called directly, rather than being defined in the repository configuration.

Native queries are intended specifically for internal callers, such as custom scripts, and should be used only in situations where the common filter or parameterized query facilities are insufficient. For example, native queries are useful if the query needs to be generated dynamically.

The query expression is specific to the target resource. For repositories, queries use the native language of the underlying data store. For system objects that are backed by OpenICF connectors, queries use the applicable query language of the system resource.

Native queries on the repository are made using the `_queryExpression` keyword. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 "https://localhost:8443/openidm/managed/user?_queryExpression=select+from+managed_user"
```

Unless you have specifically enabled native queries, the previous command returns a 403 access denied error message. Native queries should not be enabled in production environments, as they are not portable and do not guard against injection attacks.

Such query expressions should therefore not be used or made accessible over the REST interface or over HTTP, other than for development, and should be used only via the internal Resource API. If you want to enable such native queries for development, see Section 16.2.7, "Protect Sensitive REST Interface URLs".

Alternatively, if you really need to expose native queries over HTTP, in a selective manner, you can design a custom endpoint to wrap such access.

7.3.4. Constructing Queries

The `openidm.query` function enables you to query OpenIDM managed and system objects. The query syntax is `openidm.query(id, params)`, where `id` specifies the object on which the query should be performed and `params` provides the parameters that are passed to the query, either `_queryFilter` or `_queryID`. For example:

```
var params = {
    '_queryFilter' : 'givenName co "' + sourceCriteria + '" or ' + 'sn co "'
                     + sourceCriteria + '"'
};
var results = openidm.query("system/ScriptedSQL/account", params)
```

Over the REST interface, the query filter is specified as `_queryFilter=filter`, for example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET
 'https://localhost:8443/openidm/managed/user?_queryFilter=userName+eq+"Smith"'
```

When called over REST, you must URL encode the filter expression. The following examples show the filter expressions using the resource API and the REST API, but do not show the URL encoding, to make them easier to read.

Note that, for generic mappings, any fields that are included in the query filter (for example `userName` in the previous query), must be explicitly defined as *searchable*, if you have set the global `searchableDefault` to false. For more information, see Section 5.2.2, "Improving Search Performance for Generic Mappings".

The *filter* expression is constructed from the building blocks shown in this section. In these expressions the simplest *json-pointer* is a field of the JSON resource, such as `userName` or `id`. A json-pointer can, however, point to nested elements as described in the JSON Pointer RFC.

Comparison expressions

The following examples show how you can build filters using comparison expressions.

json-pointer* eq *json-value

Matches when the pointer equals the value, for example:

```
"_queryFilter" : '/givenName eq "Dan"'
```

The following REST call returns the user name and given name of all managed users whose first name (`givenName`) is "Dan".

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'https://localhost:8443/openidm/managed/user?_queryFilter=givenName+eq+"Dan"&_fields=userName
,givenName'
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 3,
  "result": [
    {
      "givenName": "Dan",
      "userName": "dlangdon"
    },
    {
      "givenName": "Dan",
      "userName": "dcope"
    },
    {
      "givenName": "Dan",
      "userName": "dlanoway"
    }
}
```

json-pointer `co` *json-value*

Matches when the pointer contains the value, for example:

```
"_queryFilter" : '/givenName co "smi"'
```

The following REST call returns the user name and given name of all managed users whose first name (`givenName`) contains "Da".

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'https://localhost:8443/openidm/managed/user?_queryFilter=givenName+co+"Da"&_fields=userName
,givenName'
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 10,
  "result": [
    {
      "givenName": "Dave",
      "userName": "djensen"
    },
    {
      "givenName": "David",
      "userName": "dakers"
    },
```

```
    {
      "givenName": "Dan",
      "userName": "dlangdon"
    },
    {
      "givenName": "Dan",
      "userName": "dcope"
    },
    {
      "givenName": "Dan",
      "userName": "dlanoway"
    },
    {
      "givenName": "Daniel",
      "userName": "dsmith"
    }
,
...
}
```

json-pointer* sw *json-value

Matches when the pointer starts with the value, for example:

```
"_queryFilter" : '/sn sw "Jen"'
```

The following REST call returns the user names of all managed users whose last name (`sn`) starts with "Jen".

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8443/openidm/managed/user?_queryFilter=sn+sw+"Jen"&_fields=userName'
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 4,
  "result": [
    {
      "userName": "bjensen"
    },
    {
      "userName": "djensen"
    },
    {
      "userName": "cjenkins"
    },
    {
      "userName": "mjennings"
    }
  ]
}
```

json-pointer lt *json-value*

Matches when the pointer is less than the value, for example:

```
"_queryFilter" : '/employeeNumber lt 5000'
```

The following REST call returns the user names of all managed users whose `employeeNumber` is lower than 5000.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8443/openidm/managed/user?_queryFilter=employeeNumber+lt+5000&_fields=userName
,employeeNumber'
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 4999,
  "result": [
    {
      "employeeNumber": 4907,
      "userName": "jnorris"
    },
    {
      "employeeNumber": 4905,
      "userName": "afrancis"
    },
    {
      "employeeNumber": 3095,
      "userName": "twhite"
    },
    {
      "employeeNumber": 3921,
      "userName": "abasson"
    },
    {
      "employeeNumber": 2892,
      "userName": "dcarter"
    }
...
  ]
}
```

json-pointer le *json-value*

Matches when the pointer is less than or equal to the value, for example:

```
"_queryFilter" : '/employeeNumber le 5000'
```

The following REST call returns the user names of all managed users whose `employeeNumber` is 5000 or lower.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8443/openidm/managed/user?_queryFilter=employeeNumber+le+5000&_fields=userName
,employeeNumber'
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 5000,
  "result": [
    {
      "employeeNumber": 4907,
      "userName": "jnorris"
    },
    {
      "employeeNumber": 4905,
      "userName": "afrancis"
    },
    {
      "employeeNumber": 3095,
      "userName": "twhite"
    },
    {
      "employeeNumber": 3921,
      "userName": "abasson"
    },
    {
      "employeeNumber": 2892,
      "userName": "dcarter"
    }
...
  ]
}
```

json-pointer* gt *json-value

Matches when the pointer is greater than the value, for example:

```
"_queryFilter" : '/employeeNumber gt 5000'
```

The following REST call returns the user names of all managed users whose `employeeNumber` is higher than 5000.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8443/openidm/managed/user?_queryFilter=employeeNumber+gt+5000&_fields=userName
,employeeNumber'
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
```

```
  "resultCount": 1458,
  "result": [
    {
      "employeeNumber": 5003,
      "userName": "agilder"
    },
    {
      "employeeNumber": 5011,
      "userName": "bsmith"
    },
    {
      "employeeNumber": 5034,
      "userName": "bjensen"
    },
    {
      "employeeNumber": 5027,
      "userName": "cclarke"
    },
    {
      "employeeNumber": 5033,
      "userName": "scarter"
    }
...
  ]
}
```

json-pointer ge *json-value*

Matches when the pointer is greater than or equal to the value for example:

```
"_queryFilter" : '/employeeNumber ge 5000'
```

The following REST call returns the user names of all managed users whose `employeeNumber` is 5000 or higher.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8443/openidm/managed/user?_queryFilter=employeeNumber+ge+5000&_fields=userName
,employeeNumber'
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 1457,
  "result": [
    {
      "employeeNumber": 5000,
      "userName": "agilder"
    },
    {
      "employeeNumber": 5011,
      "userName": "bsmith"
    },
```

```
    {
      "employeeNumber": 5034,
      "userName": "bjensen"
    },
    {
      "employeeNumber": 5027,
      "userName": "cclarke"
    },
    {
      "employeeNumber": 5033,
      "userName": "scarter"
    }
...
  ]
}
```

Presence expression

`json-pointer pr` matches any object in which the *json-pointer* is present, for example:

```
"_queryFilter" : '/mail pr'
```

The following REST call returns the mail addresses for all managed users who have a `mail` property in their entry.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8443/openidm/managed/user?_queryFilter=mail+pr&_fields=mail'
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 2,
  "result": [
    {
      "mail": "jdoe@exampleAD.com"
    },
    {
      "mail": "bjensen@example.com"
    }
  ]
}
```

The presence filter is not currently supported for system objects. To query for presence on a system object, specify any attribute that exists for all entries, such as the `uid` on an LDAP system, and use the starts with (`sw`) filter, with an empty value. For example, the following query returns the `uid` of all users in an LDAP system.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8443/openidm/system/ldap/account?_queryFilter=uid+sw+""&_fields=uid'
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 2,
  "result": [
    {
      "uid": "jdoe"
    },
    {
      "uid": "bjensen"
    }
  ]
}
```

Literal expressions

`true` matches any object in the resource.

`false` matches no object in the resource.

For example, you can list the `_id` of all managed objects as follows:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET
 'https://localhost:8443/openidm/managed/user?_queryFilter=true&_fields=_id'
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 2,
  "result": [
    {
      "_id": "d2e29d5f-0d74-4d04-bcfe-b1daf508ad7c"
    },
    {
      "_id": "709fed03-897b-4ff0-8a59-6faaa34e3af6"
    }
  ]
}
```

Complex expressions

You can combine expressions using the boolean operators `and`, `or`, and `!` (not). The following example queries managed user objects located in London, with last name Jensen.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 https://localhost:8443/openidm/managed/user?_queryFilter=city+eq+"London"+and+sn+eq
+"Jensen"&_fields=userName,givenName,sn'&_fields=userName'
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 3,
  "result": [
    {
      "sn": "Jensen",
      "givenName": "Clive",
      "userName": "cjensen"
    },
    {
      "sn": "Jensen",
      "givenName": "Dave",
      "userName": "djensen"
    },
    {
      "sn": "Jensen",
      "givenName": "Margaret",
      "userName": "mjensen"
    }
  ]
}
```

7.3.5. Paging Query Results

The common filter query mechanism supports paged query results for managed and system objects.

The following filtered query returns the first two records in an LDAP repository, whose `uid` starts with `b`.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/system/ldap/account?_queryFilter=uid%20sw%20%22b%22&_pageSize=2"


{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 2,
  "result": [
    {
      "_id": "uid=bjensen,ou=People,dc=example,dc=com",
      "sn": "Jensen",
      "dn": "uid=bjensen,ou=People,dc=example,dc=com",
      "givenName": "Barbara",
      "description": "Created for OpenIDM",
```

```
      "cn": "Babara Jensen",
      "uid": "bjensen",
      "ldapGroups": [
        "cn=openidm2,ou=Groups,dc=example,dc=com"
      ],
      "mail": "bjensen@example.com",
      "telephoneNumber": "1-360-229-7105"
    },
    {
      "_id": "cn=bsmith,ou=People,dc=example,dc=com",
      "sn": "Smith",
      "dn": "cn=bsmith,ou=People,dc=example,dc=com",
      "givenName": "Bill",
      "description": null,
      "cn": "bsmith",
      "uid": "bsmith",
      "ldapGroups": [],
      "mail": "bsmith@example.com",
      "telephoneNumber": "0987362837"
    }
  ]
}
```

Predefined queries also provide some support for paged results, useful, for example, for UI display purposes. Predefined queries must be configured to support paging, in the repository configuration. For example:

```
"query-all-ids" : "select _openidm_id from ${unquoted:_resource} SKIP ${unquoted:_pagedResultsOffset}
 LIMIT ${unquoted:_pageSize}",
```

This query configuration enables the paging parameters to be used, for example, in a query such as the following:

```
$ curl \
  --cacert self-signed.crt \
  --header "X-OpenIDM-Username: openidm-admin" \
  --header "X-OpenIDM-Password: openidm-admin" \
  --header "Content-Type: application/json" \
  --request GET \
  "https://localhost:8443/openidm/managed/user?_queryId=query-all-ids&_pageSize=2&_pagedResultsOffset=3"
 {
   "remainingPagedResults": 2,
   "pagedResultsCookie": "5",
   "resultCount": 2,
   "result": [
     {
       "_rev": "0",
       "_id": "b980999e-aa5c-4655-b2a0-08731b64e0ba"
     },
     {
       "_rev": "0",
       "_id": "c72b9c00-1e2c-4139-9e7f-fb9fb822db96"
     }
   ]
 }
```

The following paging parameters are supported:

_pagedResultsCookie

Opaque cookie used by the server to keep track of the position in the search results. The format of the cookie is a string value.

The server provides the cookie value on the first request. You should then supply the cookie value in subsequent requests until the server returns a null cookie, meaning that the final page of results has been returned.

Paged results are enabled only if the `_pageSize` is a non-zero integer.

_pagedResultsOffset

Specifies the index within the result set of the number of records to be skipped before the first result is returned. The format of the `_pagedResultsOffset` is an integer value. When the value of `_pagedResultsOffset` is greater than or equal to 1, the server returns pages, starting after the specified index.

This request assumes that the `_pageSize` is set, and not equal to zero.

For example, if the result set includes 10 records, the `_pageSize` is 2, and the `_pagedResultsOffset` is 6, the server skips the first 6 records, then returns 2 records, 7 and 8. The `_pagedResultsCookie` value would then be 8 (the index of the last returned record) and the `_remainingPagedResults` value would be 2, the last two records (9 and 10) that have not yet been returned.

If the offset points to a page beyond the last of the search results, the result set returned is empty.

Note that the `_remainingPagedResults` parameter is not supported for all queries. Where it is not supported, the returned value is always `-1`.

_pageSize

An optional parameter indicating that query results should be returned in pages of the specified size. For all paged result requests other than the initial request, a cookie should be provided with the query request.

The default behavior is not to return paged query results. If set, this parameter should be an integer value, greater than zero.

7.3.6. Sorting Query Results

For common filter query expressions, you can sort the results of a query, using the `_sortKeys` parameter. This parameter takes a comma-separated list as a value and orders the way in which the JSON result is returned, based on this list.

The `_sortKeys` parameter is not supported for predefined queries.

The following query returns all users with the `givenName` `Dan`, and sorts the results alphabetically, according to surname (`sn`).

```
$
'https://localhost:8443/openidm/system/ldap/account?_queryFilter=givenName+eq+"Dan"&_fields=givenName
,sn&_sortKeys=sn'
```


```
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 3,
  "result": [
    {
      "sn": "Cope",
      "givenName": "Dan"
    },
    {
      "sn": "Langdon",
      "givenName": "Dan"
    },
    {
      "sn": "Lanoway",
      "givenName": "Dan"
    }
  ]
}
```

Chapter 8
Managing Users, Groups, and Roles

OpenIDM does not control the structure of objects that are stored in its repository. You can define any kind of managed object, but a definition for users, groups and roles is provided by default.

This chapter describes how to work with these default managed objects. More information about the OpenIDM object model is provided in Appendix C, "*Data Models and Objects Reference*".

8.1. Working with Managed Users

External users that are stored in OpenIDM's repository are referred to as *managed users*. For a JDBC repository, OpenIDM stores managed users in the `managedobjects` table. A second table, `managedobjectproperties`, serves as the index table. For an OrientDB repository, managed users are stored in the `managed_user` table.

OpenIDM provides RESTful access to managed users, at the context path `/openidm/managed/user`. For more information, see Section 1.3, "To Get Started With the OpenIDM REST Interface" in the *Installation Guide*.

8.2. Working With Managed Groups

OpenIDM provides support for a managed `"group"` object. For a JDBC repository, OpenIDM stores managed groups with all other managed objects, in the `managedobjects` table, and uses the `managedobjectproperties` for indexing. For an OrientDB repository, managed groups are stored in the `managed_group` table.

The managed group object is not provided by default. To use managed groups, add an object similar to the following to your `conf/managed.json` file:

```
{
    "name" : "group"
},
```

With this addition, OpenIDM provides RESTful access to managed groups, at the context path `/openidm/managed/group`.

For an example of a deployment that uses managed groups, see Section 3.6, "Sample 2d - Synchronizing LDAP Groups" in the *Installation Guide*.

8.3. Configuring Custom Roles

The default managed object model includes a managed `role` object that can be manipulated in the same way as any other managed object.

This section refers to two distinct types of roles - direct (static) and indirect (dynamic) roles. Direct roles refer to roles that are specifically added to the user's `"roles"` attribute by an administrator operation. Indirect roles might be added to the user entry as a result of a script or rule that assigns the role. For example, a user might acquire a `"sales-role"` as a result of being in the `"sales"` organization.

A managed user's `"roles"` attribute takes an array as a value. Currently, only flat strings are supported in this array.

The `"roles"` attribute includes any specifically assigned roles, and any roles assigned internally by OpenIDM. So, the `"roles"` attribute of a particular user entry might appear as follows:

```
"roles" : [
    "name" : "managed/role/sample-role",
    "name" : "openidm-authorized"
]
```

A role value that includes a `/` character is considered to be a URL that points to the role details on the router, for example, `managed/role/sample-role`.

The following sections describe basic role manipulation - how roles are defined, assigned to users, and deleted. The entitlements or assignments supplied by roles are described in the subsequent section.

8.3.1. Creating, Assigning, and Deleting Roles

Role definitions are stored in the repository and are accessible at the `/openidm/managed/role` context path. This section describes how to manipulate roles over the REST interface.

The examples in this section assume that OpenIDM has been started with the configuration of Sample 2b, and refers to the managed user objects created in that sample. For more information, see Section 3.4, "Sample 2b - LDAP Two Way" in the *Installation Guide*.

8.3.1.1. To Create a Role Definition

To create a managed role definition, use a PUT request on the `openidm/managed/role` context path, specifying the role ID in the URL. The following request creates a role definition named `newrole`. The role effectively assigns the value `"CN=employees,O=corp"` to the `ldapGroups` attribute on the `ldap` system.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
```

```
 --header "If-None-Match: *" \
 --request PUT \
 --data '{
  "properties": {
    "description": "an example role"
  },
  "assignments": {
    "ldap": {
      "attributes": [
        {
          "name": "ldapGroups",
          "assignmentOperation": "mergeWithTarget",
          "unassignmentOperation": "removeFromTarget",
          "value": [
            "CN=employees,O=corp"
          ]
        }
      ],
      "onAssignment": {
        "file": "roles\/onAssignment_ldap.js",
        "type": "text\/javascript"
      },
      "onUnassignment": {
        "file": "roles\/onUnassignment_ldap.js",
        "type": "text\/javascript"
      }
    }
  }
}' \
 "https://localhost:8443/openidm/managed/role/newrole"

 {
   "assignments": {
     "ldap": {
       "attributes": [
         {
           "name": "ldapGroups",
           "unassignmentOperation": "removeFromTarget",
           "assignmentOperation": "mergeWithTarget",
           "value": [
             "CN=employees,O=corp"
           ]
         }
       ],
       "onAssignment": {
         "file": "roles/onAssignment_ldap.js",
         "type": "text/javascript"
       },
       "onUnassignment": {
         "file": "roles/onUnassignment_ldap.js",
         "type": "text/javascript"
       }
     }
   },
   "_id": "newrole",
   "properties": {
     "description": "an example role"
   },
   "_rev": "1"
```

```
}
```

For information about each of the properties in the role definition, see Section 8.3.2.1, "A Sample Role Definition for Two Remote Systems".

Most of the examples in this guide use PUT to create client-assigned IDs for resources, as it makes the examples easier to read. Your deployment might require you to use server-assigned UUIDs, in which case you should use a POST request. For more information, see Should You Use PUT or POST to Create a Managed Object?.

8.3.1.2. To List the Defined Roles

To obtain a list of all defined managed roles, query the `/openidm/managed/role` context path, as follows.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/managed/role/?_queryId=query-all-ids"

{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 1,
  "result": [
    {
      "_rev": "0",
      "_id": "newrole"
    }
  ]
}
```

8.3.1.3. To Assign a Role to a User

To assign a direct role to a user, update the user's entry over REST, adding `managed/role/role ID` to the user's `"roles"` attribute. The following example adds the `ldap` role, created previously, to user `bjensen`, whose `_id` is `2e78fd22-a7cb-4585-9570-5f649e8abd25`.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --header "If-Match: *" \
 --request PATCH \
 --data '[
    {
        "operation": "add",
        "field": "/roles/-",
        "value": "managed/role/newrole"
```

```
    }
]' \
 "https://localhost:8443/openidm/managed/user/2e78fd22-a7cb-4585-9570-5f649e8abd25"
```


```
{
  "displayName": "Babara Jensen",
  "stateProvince": "",
  "userName": "bjensen",
  "postalAddress": "",
  "effectiveAssignments": {
    "ldap": {
      "attributes": [
        {
          "name": "ldapGroups",
          "unassignmentOperation": "removeFromTarget",
          "assignmentOperation": "mergeWithTarget",
          "assignedThrough": "managed/role/newrole",
          "value": [
            "CN=employees,O=corp"
          ]
        }
      ],
      "onAssignment": {
        "file": "roles/onAssignment_ldap.js",
        "type": "text/javascript"
      },
      "onUnassignment": {
        "file": "roles/onUnassignment_ldap.js",
        "type": "text/javascript"
      }
    }
  },
  "roles": [
    "openidm-authorized",
    "managed/role/newrole"
  ],
  "city": "",
  "effectiveRoles": [
    "openidm-authorized",
    "managed/role/newrole"
  ],
  "givenName": "Barbara",
  "lastPasswordAttempt": "Tue Oct 21 2014 16:01:22 GMT+0200 (SAST)",
  "address2": "",
  "passwordAttempts": "0",
  "sn": "Jensen",
  "mail": "bjensen@example.com",
  "country": "",
  "_rev": "2",
  "lastPasswordSet": "",
  "postalCode": "",
  "_id": "2e78fd22-a7cb-4585-9570-5f649e8abd25",
  "description": "Created for OpenIDM",
  "accountStatus": "active",
  "telephoneNumber": "1-360-229-7105"
}
```

Note the dash (`-`) character that is appended to the field name in the `data` that is being sent. This character specifies that the role should be added to the existing roles for that user. If you do not include the dash character, the request overwrites all current values of the user's `"roles"` attribute.

8.3.1.4. To Query Role Membership

To return a list of all users who have a specific directly assigned role, use the `get-users-of-direct-role` query, specifying the role ID. You cannot query role membership for indirect roles.

The following query returns all members of the `"newrole"` role created previously. Currently that role has only one member, `bjensen`, whose ID is `2e78fd22-a7cb-4585-9570-5f649e8abd25`. The query returns the complete user object.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/managed/user?_queryId=get-users-of-direct-role&role=managed/role/newrole"

{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 1,
  "result": [
    {
      "effectiveAssignments": {
        "ldap": {
          "attributes": [
            {
              "name": "ldapGroups"
,
...
      "_id": "2e78fd22-a7cb-4585-9570-5f649e8abd25",
      "_rev": "2",
      "description": "Created for OpenIDM",
      "accountStatus": "active"
    }
  ]
}
```

8.3.1.5. To Remove a Role Assignment

To remove a role assignment from a user, simply replace that user's `"roles"` attribute with the array of roles that the user should have. The following example removes the `newrole` role from user `bjensen` by replacing the current value of her `"roles"` attribute with its previous value (`"openidm-authorized"`).

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --header "If-Match: *" \
 --request PATCH \
 --data '[
    {
        "operation": "replace",
        "field": "/roles",
        "value": [
            "openidm-authorized"
        ]
    }
]' \
 "https://localhost:8443/openidm/managed/user/2e78fd22-a7cb-4585-9570-5f649e8abd25"
```

In the role definition, you can specify what should happen when an assignment of that role is removed. For more information, see Section 8.3.2, "Understanding Effective Roles and Effective Assignments".

8.3.1.6. To Delete a Managed Role Definition

To delete a role definition, send a DELETE request, specifying the role ID in the URL. The following sample command deletes the `newrole` role, created previously.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request DELETE \
 "https://localhost:8443/openidm/managed/role/newrole"
{
  "properties": {
    "description": "an example role"
  },
  "assignments": {
    "ldap": {
      "attributes": [
        {
          "name": "ldapGroups",
          "unassignmentOperation": "removeFromTarget",
          "assignmentOperation": "mergeWithTarget",
          "value": [
            "CN=employees,O=corp"
          ]
        }
      ],
      "onAssignment": {
        "file": "roles/onAssignment_ldap.js",
        "type": "text/javascript"
      },
      "onUnassignment": {
        "file": "roles/onUnassignment_ldap.js",
```

```
        "type": "text/javascript"
      }
    }
  },
  "_rev": "1",
  "_id": "newrole"
}
```

Note

You cannot delete a role definition if that role is currently assigned to a user. Attempting to delete an assigned role results in the following error:

```
{
  "message": "Cannot delete a role that is currently assigned",
  "reason": "Conflict",
  "code": 409
}
```

8.3.2. Understanding Effective Roles and Effective Assignments

The primary purpose of roles is the management of user access to system resources. User access is controlled by the *assignments* or entitlements provided by the role.

The previous section described how to create a basic role definition and to assign that role to a user. This section describes how the assignments that are specified for that role are applied.

8.3.2.1. A Sample Role Definition for Two Remote Systems

The following sample role definition shows how assignments are configured for two remote systems - an LDAP server (`ldap`), and an Active Directory Server (`ad`).

```
{
     "name": "samplerole",
     "_id": "samplerole",
     "assignments": {
         "ad": {
             "attributes": [
                 {
                     "name": "adSystems",
                     "value": [
                         "CN=fileshare,O=corp",
                         "CN=desktop,O=corp",
                         "CN=terminal,O=corp",
                         "CN=intranet,O=corp"
                     ],
                     "assignmentOperation": "mergeWithTarget",
                     "unassignmentOperation": "removeFromTarget"
                 }
             ]
         },
```

```
        "ldap": {
            "attributes": [
                {
                    "name": "ldapGroups",
                    "value": [
                        "CN=employees,O=corp"
                    ],
                    "assignmentOperation": "mergeWithTarget",
                    "unassignmentOperation": "removeFromTarget"
                },
                {
                    "name": "employeeType",
                    "value": "employee"
                }
            ],
            "onAssignment": {
                "file": "roles/onAssignment_ldap.js",
                "type": "text/javascript"
            },
            "onUnassignment": {
                "file": "roles/onUnassignment_ldap.js",
                "type": "text/javascript"
            }
        }
    }
}
```

The role definition includes the following properties:

- `"name"` is the name of the role, and should be unique. Avoid using special characters in the role name.

- `"_id"` is the object identifier of the role, by which it is accessed over REST.

- `"assignments"` specifies the list of assignments (or entitlements) that this role will create on the remote systems.

  Each assignment includes the name of the external system, such as `ad` and `ldap`, the attribute or attributes whose values will be generated, on the external system, and the value or values that will be applied to each attribute.

  OpenIDM uses the `"assignments"` property to keep assigned roles up to date.

- `"assignmentOperation"` and `"unassignmentOperation"`

  When you update a role definition by adding, updating, or removing an attribute, the update triggers an `"assignmentOperation"` or an `"unassignmentOperation"`.

  When you assign or unassign a role to a user, that action also triggers an `"assignmentOperation"` or an `"unassignmentOperation"`.

  - The `"assignmentOperation"` specifies the way in which the attribute value is applied, and can be one of `"replaceTarget"` (the default) or `"mergeWithTarget"`.

The `"replaceTarget"` operation replaces the entire target attribute value with whatever is specified in the role definition. When this operation is specified, the value from the role assignments becomes the only authoritative source for the attribute.

The `"mergeWithTarget"` operation first merges the source value with the existing target value, then adds the value or values from the role assignment. In the event that duplicate values are found (for attributes that take a list as a value), each value is included only once in the resulting target value.

- The `"unassignmentOperation"` specifies the way in which the attribute value is removed, and can only be set to `"removeFromTarget"`.

The `"mergeWithTarget"`, `"replaceTarget"` and `"removeFromTarget"` operations are aliases, and are defined in the file `openidm/bin/defaults/script/roles/defaultMapping.js`.

- `"onAssignment"` and `"onUnassignment"`

  These properties refer to customizable scripts, that are specific to each assignment.

  By default, OpenIDM addresses any change in role assignments with the assignment operations defined in the `defaultMapping.js` file. You can modify this behavior by writing custom `onAssignment` and `onUnassignment` scripts. If these custom scripts are specified, OpenIDM triggers the `"onAssignment"` or `"onUnassignment"` script whenever you create, assign, or delete a role from a user entry. In addition, every synchronization operation triggers the `"onAssignment"` script. The `"onUnassignment"` script is triggered when an assignment is removed from a role, or when a role is unassigned from a user.

  If you create a custom `"onAssignment"` or `"onUnassignment"` script, the script must return a `"targetObject"`, otherwise, the script operation might fail.

OpenIDM logs any changes to a managed role definition in the audit log.

8.3.2.2. Virtual Role Attributes

Based on the set of role definitions that are assigned to a specific user, the roles mechanism generates two virtual attributes on the user entry - `effectiveRoles` and `effectiveAssignments`.

The logic that calculates the `effectiveRoles` and `effectiveAssignments` attribute values is located in two scripts: `openidm/bin/defaults/script/roles/effectiveRoles.js` and `openidm/bin/defaults/script/roles/effectiveAssignments.js`. Do not alter these scripts. If you need to modify how roles and assignments are handled, create your own custom script and reference it in the `conf/managed.json` file. For information about using custom scripts, see Appendix F, "*Scripting Reference*".

The `effectiveRoles` attribute lists the specific role definitions that are applied to a user entry. By default, the effective roles script supports direct role assignments only. Dynamic role assignment is not provided out of the box, but can be added with a custom script that overrides the default `effectiveRoles.js` script. For more information, see Section 8.3.5, "Adding Support for Dynamic Assignments".

Based on the effective roles, the `effectiveAssignments` attribute provides the calculated resource assignments, that is the amalgamated set of entitlements for a specific user.

The value of the `effectiveAssignments` attribute provides the information required for the provisioner to apply the effective assignments, and provides a reference to the source of the assignment. In reading this attribute, it is therefore possible to find and change the root source of an assignment.

Effective assignments can merge attribute operations on the same system from multiple roles. For example, role A might add group A to a user's group membership list, and role B might add group B to the same group membership property on the same assigned system.

The effective roles and effective assignments attributes are configured in `openidm/conf/managed.json` as follows:

```
{
    "name" : "effectiveRoles",
    "type" : "virtual",
    "onRetrieve" : {
        "type" : "text/javascript",
        "file" : "roles/effectiveRoles.js",
        "rolesPropName" : "roles"
    }
},
{
    "name" : "effectiveAssignments",
    "type" : "virtual",
    "onRetrieve" : {
        "type" : "text/javascript",
        "file" : "roles/effectiveAssignments.js",
        "effectiveRolesPropName" : "effectiveRoles"
    }
}
```

By default, the `effectiveRoles.js` script uses the `"roles"` attribute of a user entry to determine the direct roles assigned to the user. The `effectiveAssignments.js` script uses the virtual `"effectiveRoles"` attribute of the user entry to calculate the user's effective assignments. If your deployment uses different attributes to store this information, change the `"rolesPropName"` and the `"effectiveRolesPropName"` properties of the virtual attribute definitions accordingly.

When a user entry is assigned a role, the `effectiveRoles` and `effectiveAssignments` of that entry are calculated according to the role definition. A managed user entry, whose roles have been generated based on the role definition illustrated previously, might appear as follows:

```
{
   "_id":"i",
   "_rev":"1",
   "roles":[
      "openidm-authorized",
      "managed/role/sample-role"
   ],
   "effectiveRoles":[
```

```
            "openidm-authorized",
            "managed/role/sample-role"
        ],
        "effectiveAssignments":{
            "ldap":{
                "attributes":[
                    {
                        "value":[
                            "CN=employees,O=corp"
                        ],
                        "operation":"replaceTarget",
                        "name":"ldapGroups",
                        "assignedThrough":"managed/role/sample-role"
                    },
                    {
                        "value":"employee",
                        "name":"employeeType",
                        "assignedThrough":"managed/role/sample-role"
                    }
                ]
            },
            "ad":{
                "attributes":[
                    {
                        "value":[
                            "CN=fileshare,O=corp",
                            "CN=desktop,O=corp",
                            "CN=terminal,O=corp",
                            "CN=intranet,O=corp"
                        ],
                        "operation":"replaceTarget",
                        "name":"adSystems",
                        "assignedThrough":"managed/role/sample-role"
                    }
                ]
            }
        }
    }
```

Note that the value of the `"assignedThrough"` property of the virtual `"effectiveAssignments"` attribute indicates how each assignment has been generated.

After you have defined a role, and assigned it to a user, verify that the expected effective roles and effective assignments have been generated for that user. To apply the effective assignments to the target resource, add a default mapping to your synchronization configuration, as described in the following section.

8.3.3. Setting up the Role Mapping

After the role has been defined, and the effective assignments checked, you must set up mapping for the role and, optionally, restrict provisioning based on the effective assignments.

This section describes these two steps.

8.3.3.1. Creating a Mapping For Effective Assignments

After the effective assignments have been calculated, OpenIDM applies these assignments to the target resources.

The following sample extract of a `sync.json` file applies the `ldap` assignment, illustrated in the previous section, on the target resource (`system/ldap/account`) for all entries that have `"effectiveAssignments" : "ldap"` in the source.

```
{
    "name" : "managedUser_systemLdapAccounts",
    "source" : "managed/user",
    "target" : "system/ldap/account",
    "links" : "systemLdapAccounts_managedUser",
    },
    "assignmentsToMap": [
        "ldap"
    ],
    ...
}
```

8.3.3.2. Using Roles For Conditional Mapping

The roles mechanism provides the ability to restrict provisioning based on a user's effective assignments. For example, you might want to prevent users from being provisioned to an Active Directory system, if they do not have specific access to that system.

Based on the `"effectiveAssignments"` virtual attribute, described in the previous section, you could configure a conditional mapping for this example, as follows:

1. Create a role definition that gives the user the Active Directory assignment, for example:

```
"_id": "ad-role",
    "assignments": {
        "ad": {
            "attributes": [
                {
                    "name": "adSystems",
                    "value": [
                        "CN=fileshare,O=corp",
                        "CN=desktop,O=corp",
                        "CN=terminal,O=corp",
                        "CN=intranet,O=corp"
                    ],
                    "assignmentOperation": "replaceTarget"
                }
            ]
        }
```

2. Add the role directly as a value of the user's `"roles"` attribute.

```
"roles" : [
    "name" : "managed/role/ad-role",
    "name" : "openidm-authorized"
]
```

3. Add a condition in the mapping that restricts provisioning to users who have the `"ad"` assignment as an effective assignment. The effective assignments are calculated from the values in the user's `"roles"` attribute.

```
{
    "mappings": [
        {
            "name": "managedUser_systemAdAccounts",
            "source": "managed/user",
            "sourceCondition": {
                "effectiveAssignments": "ad"
            },
            "target": "system/ad/account"
            ...
        }
    ]
}
```

8.3.4. Testing the Roles Mechanism

The following sample procedure creates a new role that includes an assignment, adds that role to the user entry `bjensen` and then shows how bjensen's effective assignments have been generated.

1. Create the role definition over REST.

   This example uses a PUT request to create the role definition, so that we can specify the role `_id`. The example adds a role definition with the ID `ldap-role`. The role ID is used to assign the role directly to the user entry.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --header "If-None-Match: *" \
 --request PUT \
 --data '{
  "assignments": {
    "ldap": {
      "attributes": [
        {
          "name": "ldapSystems",
          "value": [
            "cn=printers,ou=Groups,dc=example,dc=com",
            "cn=intranet,ou=Groups,dc=example,dc=com"
```

```
          ],
          "operation": "replaceTarget"
        }
      ]
    }
  }
}' \
 "https://localhost:8443/openidm/managed/role/ldap-role"
    {
  "assignments": {
    "ldap": {
      "attributes": [
        {
          "name": "ldapSystems",
          "operation": "replaceTarget",
          "value": [
            "cn=printers,ou=Groups,dc=example,dc=com",
            "cn=intranet,ou=Groups,dc=example,dc=com"
          ]
        }
      ]
    }
  },
  "_id": "ldap-role",
  "_rev": "0"
}
```

2. The `ldap-role` includes one assignment, named `ldap`. Add a mapping for the assignment, by adding the following lines to your `sync.json` file:

```
    "mappings":[
        "assignmentsToMap":[
            "ldap"
        ],
    ]
```

   By default, OpenIDM addresses any change in role assignments with the assignment operations defined in the `defaultMapping.js` file. You can modify this behavior by writing custom `onAssignment` and `onUnassignment` scripts.

3. Assign the role to user `bjensen`, whose ID is `2e78fd22-a7cb-4585-9570-5f649e8abd25`.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --header "If-Match: *" \
 --request PATCH \
 --data '[
    {
        "operation": "replace",
        "field": "/roles",
        "value": [
            "openidm-authorized",
            "managed/role/ldap-role"
```

```
        ]
    }
]' \
 "https://localhost:8443/openidm/managed/user/2e78fd22-a7cb-4585-9570-5f649e8abd25"
     {
    "mail": "bjensen@example.com",
    "sn": "Jensen",
    "passwordAttempts": "0",
    "address2": "",
    "lastPasswordAttempt": "Thu October 23 2014 12:49:32 GMT+0200 (SAST)",
    "givenName": "Barbara",
    "city": "",
    "country": "",
    "_rev": "2",
    "lastPasswordSet": "",
    "postalCode": "",
    "_id": "2e78fd22-a7cb-4585-9570-5f649e8abd25",
    "accountStatus": "active",
    "description": "Created for OpenIDM",
    "roles": [
        "openidm-authorized",
        "managed/role/ldap-role"
    ],
    "telephoneNumber": "1-360-229-7105",
    "postalAddress": "",
    "userName": "bjensen",
    "stateProvince": "",
    "displayName": "Babara Jensen"
}
```

4. Query `bjensen's` user entry to verify that her effective assignments have been updated.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/managed/user/2e78fd22-a7cb-4585-9570-5f649e8abd25"
      ...
{
  "effectiveAssignments": {
    "ldap": {
      "attributes": [
        {
          "assignedThrough": "managed/role/ldap-role",
          "name": "ldapSystems",
          "operation": "replaceTarget",
          "value": [
            "cn=printers,ou=Groups,dc=example,dc=com",
            "cn=intranet,ou=Groups,dc=example,dc=com"
          ]
        }
      ]
    }
  },
  ...
```

Note that bjensen's effective assignments have been updated to include the assignments provided by the `ldap-role` role.

8.3.5. Adding Support for Dynamic Assignments

Although support for dynamic role assignments is not provided by default, it can easily be added with a custom script, as follows.

1. Copy the default effective roles script to your project's `script/roles` directory.

   ```
   $ cp /path/to/openidm/bin/defaults/script/roles/effectiveRoles.js \
         project-dir/script/roles/
   ```

   The new script will override the default effective roles script.

2. Modify the effective roles script to include the dynamic role assignment logic.

   For example, to enable dynamic role assignment for the `example` organization, you might add the following extract after the section:

   ```
   // This is the location to expand to dynamic roles,
   // project role script return values can then be added via
   // effectiveRoles = effectiveRoles.concat(dynamicRolesArray);
   ```

   ```
   if (object.org === 'example') {
       effectiveRoles = effectiveRoles.concat(['dynamic-role1', 'dynamic-role2']);
   }
   ```

3. (Optional) To apply changes to the dynamic assignment rules to existing users, run a reconciliation operation on those users.

Note that changes to dynamic role assignments for existing users require a manual reconciliation of the affected group of users for those changes to take effect. So, if a new dynamic role definition is created, if an existing dynamic role definition is changed, or if changes are made to the dynamic assignment rule, the group of users affected by that assignment rule must be reconciled manually.

When a user entry is changed or synchronized, however, all dynamic role assignments are reassessed automatically.

8.3.6. Managed Role Object Script Hooks

In addition to the functionality provided by the assignments, a managed role object has script hooks that enable you to configure role behavior. The managed role object has the following structure in the managed objects configuration file (`managed.json`):

```
{
    "name" : "role",
    "postCreate" : {
        "type" : "text/javascript",
        "file" : "roles/update-users-of-role.js"
    },
    "postUpdate" : {
        "type" : "text/javascript",
        "file" : "roles/update-users-of-role.js"
    },
    "postDelete" : {
        "type" : "text/javascript",
        "file" : "roles/update-users-of-role.js"
    }
}
```

The `"postCreate"`, `"postUpdate"`, and `"postDelete"` properties enable you to specify what should happen when a role definition is created, updated, or deleted. By default, the `update-users-of-role.js` script runs in each of these cases.

The `update-users-of-role.js` script includes a `triggerSyncCheck` attribute, which reviews the `effectiveRoles` and `effectiveAssignments` virtual attributes, to determine whether OpenIDM should run a synchronization operation on these attributes.

This script iterates over all managed users, locates the users who have been assigned this role, and regenerates their effective assignments on the target resource. So, for example, if the role `"ldap"` gives a user an assignment on the resource "Active Directory", when that role definition is changed, a reconciliation operation runs to update the assignment for that user on the "Active Directory" resource.

Chapter 9
Using Policies to Validate Data

OpenIDM provides an extensible policy service that enables you to apply specific validation requirements to various components and properties. The policy service provides a REST interface for reading policy requirements and validating the properties of components against configured policies. Objects and properties are validated automatically when they are created, updated, or patched. Policies can be applied to user passwords, but also to any kind of managed object.

The policy service enables you to do the following:

- Read the configured policy requirements of a specific component.
- Read the configured policy requirements of all components.
- Validate a component object against the configured policies.
- Validate the properties of a component against the configured policies.

A default policy applies to all managed objects. You can configure the default policy to suit your requirements, or you can extend the policy service by supplying your own scripted policies.

9.1. Configuring the Default Policy

The default policy is configured in two files:

- A policy script file (`openidm/bin/defaults/script/policy.js`) which defines each policy and specifies how policy validation is performed.
- A policy configuration file (`openidm/conf/policy.json`) which specifies which policies are applicable to each resource.

9.1.1. Policy Script File

The policy script file defines policy configuration in two parts:

- A policy configuration object, which defines each element of the policy.
- A policy implementation function, which describes the requirements that are enforced by that policy.

Together, the configuration object and the implementation function determine whether an object is valid in terms of the policy. The following extract from the policy script file configures a policy that specifies that the value of a property must contain a certain number of capital letters.

```
...
{   "policyId" : "at-least-X-capitals",
    "policyExec" : "atLeastXCapitalLetters",
    "clientValidation": true,
    "validateOnlyIfPresent":true,
    "policyRequirements" : ["AT_LEAST_X_CAPITAL_LETTERS"]
},
...

policyFunctions.atLeastXCapitalLetters = function(fullObject, value, params, property) {
  var isRequired = _.find(this.failedPolicyRequirements, function (fpr) {
      return fpr.policyRequirement === "REQUIRED";
    }),
    isNonEmptyString = (typeof(value) === "string" && value.length),
    valuePassesRegexp = (function (v) {
      var test = isNonEmptyString ? v.match(/[(A-Z)]/g) : null;
      return test !== null && test.length >= params.numCaps;
    }(value));

  if ((isRequired || isNonEmptyString) && !valuePassesRegexp) {
    return [ { "policyRequirement" : "AT_LEAST_X_CAPITAL_LETTERS", "params" : {"numCaps":
 params.numCaps} } ];
  }

  return [];
}
...
```

To enforce user passwords that contain at least one capital letter, the previous policy ID is applied to the appropriate resource and the required number of capital letters is defined in the policy configuration file, as described in Section 9.1.2, "Policy Configuration File".

9.1.1.1. Policy Configuration Object

Each element of the policy is defined in a policy configuration object. The structure of a policy configuration object is as follows:

```
{   "policyId" : "minimum-length",
    "policyExec" : "propertyMinLength",
    "clientValidation": true,
    "validateOnlyIfPresent": true,
    "policyRequirements" : ["MIN_LENGTH"]
}
```

`"policyId"` - a unique ID that enables the policy to be referenced by component objects.
`"policyExec"` - the name of the function that contains the policy implementation. For more information, see Section 9.1.1.2, "Policy Implementation Function".

`"clientValidation"` - indicates whether the policy decision can be made on the client. When `"clientValidation": true`, the source code for the policy decision function is returned when the client requests the requirements for a property.
`"validateOnlyIfPresent"` - notes that the policy is to be validated only if it exists.
`"policyRequirements"` - an array containing the policy requirement ID of each requirement that is associated with the policy. Typically, a policy will validate only one requirement, but it can validate more than one.

9.1.1.2. Policy Implementation Function

Each policy ID has a corresponding policy implementation function that performs the validation. Functions take the following form:

```
function <name>(fullObject, value, params, propName) {
 <implementation_logic>
}
```

`fullObject` is the full resource object that is supplied with the request.
`value` is the value of the property that is being validated.
`params` refers to the `"params"` array that is specified in the property's policy configuration.
`propName` is the name of the property that is being validated.

The following example shows the implementation function for the `"required"` policy.

```
function required(fullObject, value, params, propName) {
    if (value === undefined) {
        return [ { "policyRequirement" : "REQUIRED" } ];
    }
    return [];
}
```

9.1.2. Policy Configuration File

The policy configuration file includes a pointer to the policy script, and the configured policies for each component resource. The following includes three sample extracts from the `policy.js` file, illustrating policies for passwords, roles, and mobile telephone numbers.

9.1.2.1. Sample Password Policy Extract

The following extract of the default policy configuration file shows how the `at-least-X-capitals` policy is applied to user passwords. In this case, the configuration file requires users to include at least one upper case (capital) letter in their passwords.

```
{
    "type" : "text/javascript",
    "file" : "bin/defaults/script/policy.js",
    "resources" : [
        {
            "resource" : "managed/user/*",
            "properties" : [
...
                {
                    "name" : "password",
                    "policies" : [
                        {
                            "policyId" : "required"
                        },
                        {
                            "policyId" : "not-empty"
                        },
                        {
                            "policyId" : "at-least-X-capitals",
                            "params" : {
                                "numCaps" : 1
                            }
                        },
                ...
            }
        ]
}
```

The configuration file includes the following properties:

- `"type"` - specifies the type of policy service. Supported types include `"text/javascript"` and `"groovy"`.
- `"file"` - provides the path to the policy script file, relative to the OpenIDM installation directory.
- `"resources"` provides an array of resource objects, in JSON format, that are subject to the policy service. Resource objects are identified by the `"resource"` parameter, which indicates the URI and supports wildcard syntax. For example, `"managed/user/*"` indicates that the policy applies to all objects under `/managed/user`. Each resource has the following properties:

  `"name"` - the name of the property to which the policy is applied.
  `"policyId"` - the ID of the policy that is applied to that property.
  `"params"` - any specific parameters that apply to that policy ID.

9.1.2.2. Sample Array Policy Extract

Some users may choose to include multiple cellular telephone numbers. In OpenIDM, multiple values for an object can be organized in an array. The following excerpt from a sample `policy.json` file requires an entry for `mobilePhones`, and includes two separate policies.

The first policy suggests that the `mobilePhones` policy must be present in the object, and there must be at least one element within that object (array).

The second policy suggests that for any given element of the `mobilePhones` object must not be an empty string.

```
...
    {
        "name" : "mobilePhones",
        "policies" : [
            {
                "policyId" : "required"
            },
            {
                "policyId" : "not-empty"
            }
        ]
    },
    {
        "name" : "mobilePhones[*]",
        "policies" : [
            {
                "policyId" : "not-empty"
            }
        ]
    }
...
```

9.2. Extending the Policy Service

You can extend the policy service by adding your own scripted policies in `openidm/script` and referencing them in the policy configuration file (`conf/policy.json`). Avoid manipulating the default policy script file (in `bin/defaults/script`) as doing so might result in interoperability issues in a future release. To reference additional policy scripts, set the `"additionalFiles"` property in `conf/policy.json`.

The following example creates a custom policy that rejects properties with null values. The policy is defined in a script named `mypolicy.js`.

```
var policy = {   "policyId" : "notNull",
       "policyExec" : "notNull",
       "policyRequirements" : ["NOT_NULL"]
}

addPolicy(policy);

function notNull(fullObject, value, params, property) {
   if (value == null) {
       return [ {"policyRequirement": "NOT_NULL"}];
   }
   return [];
}
```

The `mypolicy.js` policy is referenced in the `policy.json` configuration file as follows:

```
{
    "type" : "text/javascript",
    "file" : "bin/defaults/script/policy.js",
    "additionalFiles" : ["script/mypolicy.js"],
    "resources" : [
        {
...
```

You can also configure policies for managed object properties as part of the property definition in the `conf/managed.json` file. For example, the following extract of a managed.json file shows a policy configuration for the `password` property.

```
...
"properties" : [
    {
        "name" : "password",
        "encryption" : {
            "key" : "openidm-sym-default"
        },
        "scope" : "private"
        "policies" : [
            {
                "policyId" : "required"
            },
            {
                "policyId" : "not-empty"
            },
            {
                "policyId" : "at-least-X-capitals",
                "params" : {
                "numCaps" : 1
                }
            }
        ]
    },
...
```

9.3. Disabling Policy Enforcement

Policy enforcement refers to the automatic validation of data in the repository when it is created, updated, or patched. In certain situations you might want to disable policy enforcement temporarily. You might, for example, want to import existing data that does not meet the validation requirements with the intention of cleaning up this data at a later stage.

You can disable policy enforcement by setting `openidm.policy.enforcement.enabled` to `false` in the `conf/boot/boot.properties` file. This setting disables policy enforcement in the back-end only, and has no impact on direct policy validation calls to the Policy Service (which the user interface makes to validate input fields). So, with policy enforcement disabled, data added directly over REST is not subject to validation, but data added with the UI is still subject to validation.

Disabling policy enforcement permanently in a production system is not recommended.

9.4. Managing Policies Over REST

You can manage the policy service over the REST interface, by calling the REST endpoint `https://localhost:8443/openidm/policy`, as shown in the following examples.

9.4.1. Listing the Defined Policies

The following REST call displays a list of all the defined policies. The policy objects are returned in JSON format, with one object for each defined policy ID.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/policy"

{
  "resources": [
    {
      "properties": [
      {
        "name": "_id",
        "policies": [
          {
            "policyFunction":
...
```

To display the policies that apply to a specific component, include the component name in the URL. For example, the following REST call displays the policies that apply to managed users.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/policy/managed/user/*"

{
   "properties": [
     {
        "name": "_id",
        "policies": [
            {
            "policyFunction": "
               "\n  function (fullObject, value, params, property) {
               \n    var i, join = function (arr, d) {

...
}
```

9.4.2. Validating Objects and Properties Over REST

Use the `validateObject` action to verify that an object adheres to the requirements of a policy.

The following example verifies that a new managed user object is acceptable in terms of the policy requirements.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
  "sn":"Jones",
  "givenName":"Bob",
  "_id":"bjones",
  "telephoneNumber":"0827878921",
  "passPhrase":null,
  "mail":"bjones@example.com",
  "accountStatus":"active",
  "roles":"admin",
  "userName":"bjones@example.com",
  "password":"123"}' \
 "https://localhost:8443/openidm/policy/managed/user/bjones?_action=validateObject"


 {
   "failedPolicyRequirements": [
     {
       "property": "password",
       "policyRequirements": [
         {
           "params": {
```

```
            "numCaps": 1
          },
          "policyRequirement": "AT_LEAST_X_CAPITAL_LETTERS"
        }
      ]
    },
    {
      "property": "password",
      "policyRequirements": [
        {
          "params": {
            "minLength": 8
          },
          "policyRequirement": "MIN_LENGTH"
        }
      ]
    },
    {
      "property": "passPhrase",
      "policyRequirements": [
        {
          "params": {
            "minLength": 4
          },
          "policyRequirement": "MIN_LENGTH"
        }
      ]
    }
  ],
  "result": false
}
```

The result (`false`) indicates that the object is not valid. The unfulfilled policy requirements are provided as part of the response - in this case, the user password does not meet the validation requirements.

Use the `validateProperty` action to verify that a specific property adheres to the requirements of a policy.

The following example checks whether Barbara Jensen's new password (`12345`) is acceptable.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{ "password" : "12345" }' \
 "https://localhost:8443/openidm/policy/managed/user/bjensen?_action=validateProperty"

{
    "result": false,
    "failedPolicyRequirements": [
        {
            "policyRequirements": [
                {
                    "policyRequirement": "AT_LEAST_X_CAPITAL_LETTERS",
```

```
                    "params": {
                        "numCaps": 1
                    }
                },
                {
                    "policyRequirement": "MIN_LENGTH",
                    "params": {
                        "minLength": 8
                    }
                }
            ],
            "property": "password"
        }
    ]
}
```

The result (`false`) indicates that the password is not valid. The unfulfilled policy requirements are provided as part of the response - in this case, the minimum length and the minimum number of capital letters.

Validating a property that does fulfil the policy requirements returns a `true` result, for example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{ "password" : "1NewPassword" }' \
 "https://localhost:8443/openidm/policy/managed/user/bjensen?_action=validateProperty"


{
    "failedPolicyRequirements": []
    "result": true,
}
```

Chapter 10
Configuring Server Logs

This chapter briefly describes server logging. For audit information, see Chapter 18, "*Using Audit Logs*".

To configure logging, edit the `openidm/conf/logging.properties` file.

10.1. Log Message Files

The default configuration writes log messages in simple format to `openidm/logs/openidm*.log` files, rotating files when the size reaches 5 MB, and retaining up to 5 files. Also by default, OpenIDM writes all system and custom log messages to the files.

10.2. Logging Levels

You can update the configuration to attach loggers to individual packages, setting the log level to one of the following values.

```
SEVERE (highest value)
WARNING
INFO
CONFIG
FINE
FINER
FINEST (lowest value)
```

If you use `logger` functions in your JavaScript scripts, you can set the log level for the scripts as follows:

```
org.forgerock.script.javascript.JavaScript.level=level
```

You can override the log level settings per script by using

```
org.forgerock.script.javascript.JavaScript.script-name.level
```

10.3. Disabling Logs

You can also disable logs if desired. For example, before starting OpenIDM, you can disable `ConsoleHandler` logging in the same `openidm/conf/logging.properties` file.

Just set `java.util.logging.ConsoleHandler.level = OFF`, and comment out other references to `ConsoleHandler`, as shown in the following excerpt.

```
# ConsoleHandler: A simple handler for writing formatted records to System.err
#handlers=java.util.logging.FileHandler, java.util.logging.ConsoleHandler
handlers=java.util.logging.FileHandler
...
# --- ConsoleHandler ---
# Default: java.util.logging.ConsoleHandler.level = INFO
java.util.logging.ConsoleHandler.level = OFF
#java.util.logging.ConsoleHandler.formatter = ...
#java.util.logging.ConsoleHandler.filter=...
```

Chapter 11

Connecting to External Resources

This chapter describes how to connect to external resources such as LDAP, Active Directory, flat files, and others. Configurations shown here are simplified to show essential aspects. Not all resources support all OpenIDM operations, however the resources shown here support most of the CRUD operations, and also reconciliation and LiveSync.

In OpenIDM, *resources* are external systems, databases, directory servers, and other sources of identity data to be managed and audited by the identity management system. To connect to resources, OpenIDM loads the Identity Connector Framework, OpenICF. OpenICF aims to avoid the need to install agents to access resources, instead using the resources' native protocols. For example, OpenICF connects to database resources using the database's Java connection libraries or JDBC driver. It connects to directory servers over LDAP. It connects to UNIX systems by using **ssh**.

11.1. About OpenIDM and OpenICF

OpenICF provides a common interface to allow identity services access to the resources that contain user information. OpenIDM loads the OpenICF API as one of its OSGi modules. OpenICF uses *connectors* to separate the OpenIDM implementation from the dependencies of the resource to which OpenIDM is connecting. A specific connector is required for each remote resource. Connectors can run either locally or remotely.

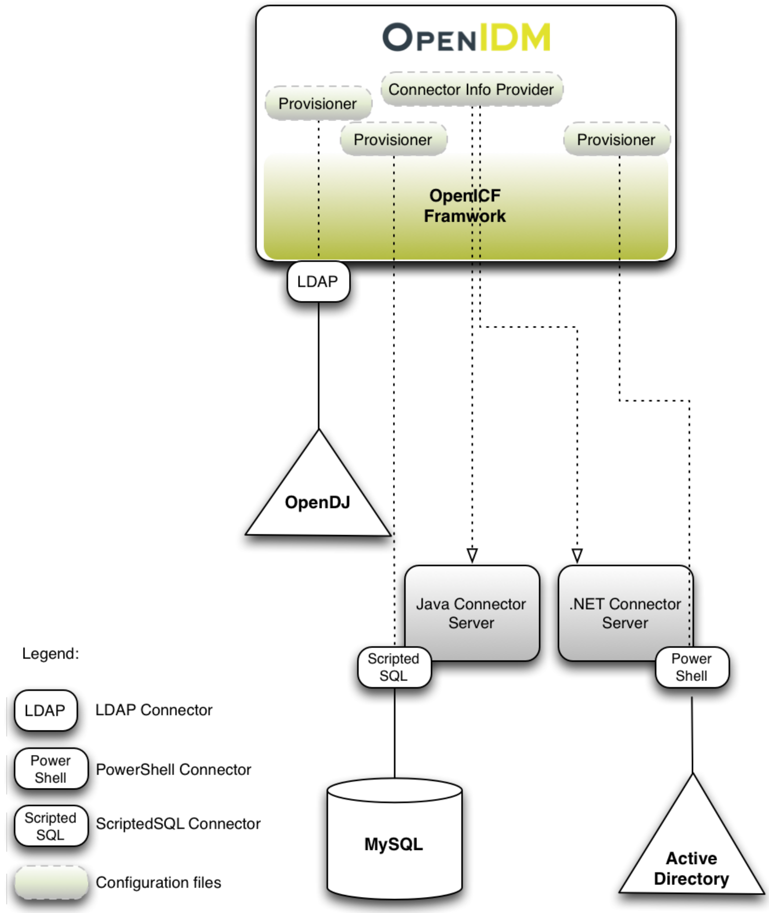
Local connectors are loaded by OpenICF as regular bundles in the OSGi container. Remote connectors must be executed on a remote *connector server*. Most connectors can be run locally. However, a remote connector server is required when access libraries that cannot be included as part of the OpenIDM process are needed. If a resource, such as Microsoft Active Directory, does not provide a connection library that can be included inside the Java Virtual Machine, OpenICF can use the native .dll with a remote .NET connector server. In other words, OpenICF connects to Active Directory through a remote connector server that is implemented as a .NET service.

Connections to remote connector servers are configured in a single *connector info provider* configuration file, located in `/path/to/openidm/conf`.

Connectors themselves are configured through *provisioner* files. One provisioner file must exist for each connector. Provisioner files are named `provisioner.openicf-name` where *name* corresponds to the name of the connector, and are also located in the `/path/to/openidm/conf` directory.

A number of sample connector configurations are available in the `openidm/samples/provisioners` directory. To use these connectors, edit the configuration files as required, and copy them to the `openidm/conf` directory.

The following figure shows how OpenIDM connects to resources by using connectors and remote connector servers. The figure shows one local connector (LDAP) and two remote connectors (Scripted SQL and PowerShell). In this example, the remote Scripted SQL connector uses a remote Java connector server. The remote PowerShell connector always requires a remote .NET connector server.



Tip

Connectors that use the .NET framework *must* run remotely. Java connectors can be run locally or remotely. Run them as remote services for scalability, or to have the service run in the cloud.

11.2. Accessing Remote Connectors

When you configure a remote connector, you use the *connector info provider service* to connect through a remote connector server. The connector info provider service configuration is stored in the file `openidm/conf/provisioner.openicf.connectorinfoprovider.json`. A sample configuration file is provided in the `openidm/samples/provisioners/` directory. To use this sample configuration, edit the file as required, and copy it to the `openidm/conf` directory.

The connector info provider service takes the following configuration:

```
{
  "connectorsLocation"     : string,
  "remoteConnectorServers" : [remoteConnectorServer objects]
}
```

Connector Info Provider Properties

connectorsLocation

string, optional

Specifies the directory in which the OpenICF connectors are located, relative to the OpenIDM installation directory. The default location is `openidm/connectors`.

remoteConnectorServers

array of RemoteConnectorServer objects, optional

An array of remote connector servers that are managed by this service.

Remote Connector Server Properties

The following example shows a `remoteConnectorServer` object configuration.

```
{
  "name"                  : "dotnet",
  "host"                  : "127.0.0.1",
  "port"                  : 8759,
  "heartbeatInterval"     : 60,
  "useSSL"                : false,
  "timeout"               : 0,
  "key"                   : "Passw0rd"
}
```

You can configure the following remote connector server object properties.

name

string, required

The name of the remote connector server object. This name is used to identify the remote connector server in the list of connector reference objects.

host

string, required

The remote host to connect to.

port

string, optional

The remote port to connect to. The default remote port is 8759.

heartbeatInterval

integer, optional

The interval, in seconds, at which heartbeat packets are transmitted. If the connector server is unreachable, based on this heartbeat interval, all services that use the connector server are made unavailable until the connector server can be reached again. The default interval is 60 seconds.

useSSL

boolean, optional

Specifies whether to connect to the connector server over SSL. The default value is `false`.

timeout

integer, optional

Specifies the timeout (in milliseconds) to use for the connection. The default value is `0`, which means that there is no timeout.

key

string, required

The secret key, or password, to use to authenticate to the remote connector server.

To run remotely, the connector .jar itself must be copied to the `openicf/bundles` directory, on the remote machine.

11.3. Configuring Connectors

Connectors are configured through the OpenICF provisioner service. Each connector configuration is stored in a file in the `openidm/conf/` folder, and accessible over REST at the `openidm/conf` endpoint. Configuration files are named `openidm/conf/provisioner.openicf-name` where *name* corresponds to the name of the connector. A number of sample connectors are available in the `openidm/samples/`

`provisioners` directory. To use these connectors, edit the configuration files as required, and copy them to the `openidm/conf` directory.

If you are creating your own connector configuration files, *do not include additional dash characters (* `-` *) in the connector name*, as this might cause problems with the OSGi parser. For example, the name `provisioner.openicf-hrdb.json` is fine. The name `provisioner.openicf-hr-db.json` is not.

The following example shows a connector configuration for an XML file resource.

```
{
 "name"                    : "xml",
 "connectorRef"            : connector-ref-object,
 "poolConfigOption"        : pool-config-option-object,
 "operationTimeout"        : operation-timeout-object,
 "configurationProperties" : configuration-properties-object,
 "objectTypes"             : object-types-object,
 "operationOptions"        : operation-options-object
}
```

The `"name"` property specifies the name of the system to which you are connecting. This name *must* be alphanumeric.

Connector Reference

The following example shows a connector reference object.

```
{
  "bundleName"       : "org.forgerock.openicf.connectors.xml-connector",
  "bundleVersion"    : "1.1.0.2",
  "connectorName"    : "org.forgerock.openicf.connectors.xml.XMLConnector",
  "connectorHostRef" : "host"
}
```

bundleName

string, required

The *ConnectorBundle-Name* of the OpenICF connector.

bundleVersion

string, required

The *ConnectorBundle-Version* of the OpenICF connector. The value can be a single version (such as `1.4.0.0`) or a range of versions, which enables you to support multiple connector versions in a single project.

You can specify a range of versions as follows:

- `[1.1.0.0,1.4.0.0]` indicates that all connector versions from 1.1 to 1.4, inclusive, are supported.
- `[1.1.0.0,1.4.0.0)` indicates that all connector versions from 1.1 to 1.4, including 1.1 but excluding 1.4, are supported.

- `(1.1.0.0,1.4.0.0]` indicates that all connector versions from 1.1 to 1.4, excluding 1.1 but including 1.4, are supported.
- `(1.1.0.0,1.4.0.0)` indicates that all connector versions from 1.1 to 1.4, exclusive, are supported.

When a range of versions is specified, OpenIDM uses the latest connector that is available within that range. If your project requires a specific connector version, you must explicitly state the version in your provisioner configuration file, or constrain the range to address only the version that you need.

connectorName

string, required

The Connector implementation class name.

connectorHostRef

string, optional

If the connector runs remotely, the value of this field must match the `name` field of the `RemoteConnectorServers` object in the connector server configuration file (`provisioner.openicf.connectorinfoprovider.json`). For example:

```
...
         "remoteConnectorServers" :
      [
         {
            "name" : "dotnet",
      ...
```

If the connector runs locally, the value of this field can be one of the following:

- If the connector .jar is installed in `openidm/connectors/`, the value must be `"#LOCAL"`. This is currently the default, and recommended location.
- If the connector .jar is installed in `openidm/bundle/` (not recommended), the value must be `"osgi:service/org.forgerock.openicf.framework.api.osgi.ConnectorManager"`.

Pool Configuration Option

The Pool Configuration Option (`"poolConfigOption"`) specifies the pool configuration for poolable connectors only. Non-poolable connectors ignore this parameter.

The following example shows a pool configuration option object for a poolable connector.

```
{
  "maxObjects"                 : 10,
  "maxIdle"                    : 10,
  "maxWait"                    : 150000,
  "minEvictableIdleTimeMillis" : 120000,
  "minIdle"                    : 1
}
```

maxObjects

The maximum number of idle and active instances of the connector.

maxIdle

The maximum number of idle instances of the connector.

maxWait

The maximum time, in milliseconds, that the pool waits for an object before timing out. A value of `0` means that there is no timeout.

minEvictableIdleTimeMillis

The maximum time, in milliseconds, that an object can be idle before it is removed. A value of `0` means that there is no idle timeout.

minIdle

The minimum number of idle instances of the connector.

Operation Timeout

The operation timeout enables you to configure timeout values per operation type. By default, there is no timeout configured for any operation type. A sample configuration follows:

```
{
  "CREATE"              : -1,
  "TEST"                : -1,
  "AUTHENTICATE"        : -1,
  "SEARCH"              : -1,
  "VALIDATE"            : -1,
  "GET"                 : -1,
  "UPDATE"              : -1,
  "DELETE"              : -1,
  "SCRIPT_ON_CONNECTOR" : -1,
  "SCRIPT_ON_RESOURCE"  : -1,
  "SYNC"                : -1,
  "SCHEMA"              : -1
}
```

operation-name

Timeout in milliseconds

A value of `-1` disables the timeout.

Configuration Properties

This object contains the configuration for the connection between the connector and the resource, and is therefore resource specific.

The following example shows a configuration properties object for the default XML sample resource connector.

```
"configurationProperties" : {
    "xsdIcfFilePath" : "&{launcher.project.location}/data/resource-schema-1.xsd",
    "xsdFilePath" : "&{launcher.project.location}/data/resource-schema-extension.xsd",
    "xmlFilePath" : "&{launcher.project.location}/data/xmlConnectorData.xml"
}
```

property

Individual properties depend on the type of connector.

Object Types

This configuration object specifies the object types (user, group, and so on) that are supported by the connector. The property name defines the `objectType`, used in the URI:

```
system/$systemName/$objectType
```

The configuration is based on the JSON Schema with the extensions described in the following section.

Attribute names that start or end with `__` are specific to the resource type and are used by OpenICF for particular purposes, such as `__NAME__`, used as the naming attribute for objects on a resource.

The following extract shows the configuration of an `account` object type.

```
{
  "account" :
  {
    "$schema" : "http://json-schema.org/draft-03/schema",
    "id" : "__ACCOUNT__",
    "type" : "object",
    "nativeType" : "__ACCOUNT__",
    "properties" :
    {
      "name" :
      {
        "type" : "string",
        "nativeName" : "__NAME__",
        "nativeType" : "JAVA_TYPE_PRIMITIVE_LONG",
        "flags" :
        [
          "NOT_CREATABLE",
          "NOT_UPDATEABLE",
          "NOT_READABLE",
          "NOT_RETURNED_BY_DEFAULT"
        ]
      },
      "groups" :
      {
        "type" : "array",
        "items" :
```

```
        {
          "type" : "string",
          "nativeType" : "string"
        },
        "nativeName" : "__GROUPS__",
        "nativeType" : "string",
        "flags" :
        [
          "NOT_RETURNED_BY_DEFAULT"
        ]
      },
      "givenName" : {
         "type" : "string",
         "nativeName" : "givenName",
         "nativeType" : "string"
         },
    }
  }
}
```

OpenICF 1.4 supports the `__ALL__` object type, which ensures that objects of every type are included in a synchronization operation. The primary purpose of this object type is to prevent synchronization errors when multiple changes affect more than one object type.

For example, imagine a deployment synchronizing two external systems. On system A, the administrator creates a user, `jdoe`, then adds the user to a group, `engineers`. When these changes are synchronized to system B, if the `__GROUPS__` object type is synchronized first, the synchronization will fail, because the group contains a user that does not yet exist on system B. Synchronizing the `__ALL__` object type ensures that user `jdoe` is created on the external system before he is added to the group `engineers`.

The `__ALL__` object type is assumed by default - you do not need to declare it in your provisioner configuration file. If it is not declared, the object type is named `__ALL__`. If you want to map a different name for this object type, declare it in your provisioner configuration. The following excerpt from a sample provisioner configuration uses the name `allobjects`:

```
"objectTypes": {
    "allobjects": {
        "$schema": "http://json-schema.org/draft-03/schema",
        "id": "__ALL__",
        "type": "object",
        "nativeType": "__ALL__"
    },
...
```

A LiveSync operation invoked with no object type assumes an object type of `__ALL__`. For example, the following call invokes a LiveSync operation on all defined object types in an LDAP system:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/system/ldap?_action=liveSync"
```

> **Note**
>
> The use of the `__ALL__` object type requires a mechanism to ensure the order in which synchronization changes are processed. Servers that use the `cn=changelog` mechanism to order sync changes (such as OpenDJ, Oracle DSEE and the legacy Sun Directory Server) cannot use the `__ALL__` object type by default, and must be forced to use time stamps to order their sync changes. For these LDAP server types, set `useTimestampsForSync` to `true` in the provisioner configuration.
>
> LDAP servers that use timestamps by default (such as Active Directory GCs and OpenLDAP) can use the `__ALL__` object type without any additional configuration. Active Directory and Active Directory LDS, which use Update Sequence Numbers, can also use the `__ALL__` object type without additional configuration.

Object Level Extensions

nativeType

string, optional

The native OpenICF object type.

The list of supported native object types is dependent on the resource, or on the connector. For example, an LDAP connector might have object types such as `__ACCOUNT__` and `__GROUP__`.

Property Level Extensions

nativeType

string, optional

The native OpenICF attribute type.

The following native types are supported:

```
JAVA_TYPE_BIGDECIMAL
JAVA_TYPE_BIGINTEGER
JAVA_TYPE_BYTE
JAVA_TYPE_BYTE_ARRAY
JAVA_TYPE_CHAR
JAVA_TYPE_CHARACTER
JAVA_TYPE_DATE
JAVA_TYPE_DOUBLE
JAVA_TYPE_FILE
JAVA_TYPE_FLOAT
JAVA_TYPE_GUARDEDBYTEARRAY
JAVA_TYPE_GUARDEDSTRING
JAVA_TYPE_INT
JAVA_TYPE_INTEGER
JAVA_TYPE_LONG
JAVA_TYPE_OBJECT
JAVA_TYPE_PRIMITIVE_BOOLEAN
JAVA_TYPE_PRIMITIVE_BYTE
JAVA_TYPE_PRIMITIVE_DOUBLE
JAVA_TYPE_PRIMITIVE_FLOAT
JAVA_TYPE_PRIMITIVE_LONG
JAVA_TYPE_STRING
```

nativeName

string, optional

The native OpenICF attribute name.

flags

string, optional

The native OpenICF attribute flags. The *required* and *multivalued* flags are defined by the JSON schema.

```
required = "required" : true
```

```
multivalued = "type" : "array"
```

If the type is `array`, an additional `"items"` field specifies the supported type for the objects in the array. For example:

```
"groups" :
    {
        "type" : "array",
        "items" :
        {
          "type" : "string",
          "nativeType" : "string"
        },
    ....
```

> **Note**
>
> Avoid using the dash character (`-`) in property names, like `last-name`, as dashes in names make JavaScript syntax more complex. If you cannot avoid the dash, then write `source['last-name']` instead of `source.last-name` in the JavaScripts.

Operation Options

Operation options (specified with the `"operationOptions"` property) define how to act on specified operations. You can, for example deny operations on specific resources to avoid OpenIDM accidentally updating a read-only resource during a synchronization operation.

The following example defines the options for the `"SYNC"` operation.

```
"operationOptions" : {
  {
    "SYNC" :
    {
      "denied" : true,
      "onDeny" : "DO_NOTHING",
      "objectFeatures" :
      {
        "__ACCOUNT__" :
```

```
        {
          "denied" : true,
          "onDeny" : "THROW_EXCEPTION",
          "operationOptionInfo" :
          {
            "$schema" : "http://json-schema.org/draft-03/schema",
            "id" : "FIX_ME",
            "type" : "object",
            "properties" :
            {
              "_OperationOption-float" :
              {
                 "type" : "number",
                 "nativeType" : "JAVA_TYPE_PRIMITIVE_FLOAT"
              }
            }
          }
        },
        "__GROUP__" :
        {
          "denied" : false,
          "onDeny" : "DO_NOTHING"
        }
      }
    }
  }
...
```

The OpenICF Framework supports the following operations:

- `AUTHENTICATE`: AuthenticationApiOp
- `CREATE`: CreateApiOp
- `DELETE`: DeleteApiOp
- `GET`: GetApiOp
- `RESOLVEUSERNAME`: ResolveUsernameApiOp
- `SCHEMA`: SchemaApiOp
- `SCRIPT_ON_CONNECTOR`: ScriptOnConnectorApiOp
- `SCRIPT_ON_RESOURCE`: ScriptOnResourceApiOp
- `SEARCH`: SearchApiOp
- `SYNC`: SyncApiOp
- `TEST`: TestApiOp
- `UPDATE`: UpdateApiOp
- `VALIDATE`: ValidateApiOp

denied

boolean, optional

This property prevents operation execution if the value is `true`.

onDeny

string, optional

If `denied` is `true`, then the service uses this value. Default value: `DO_NOTHING`.

- `DO_NOTHING`: On operation the service does nothing.
- `THROW_EXCEPTION`: On operation the service throws a `ForbiddenException` exception.

11.4. Installing and Configuring Remote Connector Servers

Connectors that use the .NET framework *must* run remotely. Java connectors can run locally or remotely. Connectors that run remotely require a connector server to enable OpenIDM to access the connector.

Note

OpenIDM 3.1 supports version 1.4.1.0 of the OpenICF Framework. Therefore, you must use version 1.4.1.0 of the .NET Connector Server, or the Java Connector Server. The 1.4.1.0 Java Connector Server is backward compatible with the version 1.1.x connectors. The 1.4.1.0 .NET Connector Server is compatible only with the 1.4.x connectors.

This section describes the steps to install a .NET connector server and a remote Java Connector Server.

11.4.1. Installing and Configuring a .NET Connector Server

A .NET connector server is useful when an application is written in Java, but a connector bundle is written using C#. Because a Java application (for example, a J2EE application) cannot load C# classes, you must deploy the C# bundles under a .NET connector server. The Java application can communicate with the C# connector server over the network, and the C# connector server acts as a proxy to provide access to the C# bundles that are deployed within the C# connector server, to any authenticated application.

The .NET connector server requires the .NET framework (version 4.0.30319 or later) and is supported on Windows Server 2008 and 2008 R2.

By default, the connector server outputs log messages to a file named `connectorserver.log`, in the `C:\path\to\openicf` directory. To change the location of the log file, set the `initializeData` parameter in the configuration file, before you install the connector server. For example, the following excerpt sets the log directory to `C:\openicf\logs\connectorserver.log`.

```
<add name="file"
    type="System.Diagnostics.TextWriterTraceListener"
    initializeData="C:\openicf\logs\connectorserver.log"
    traceOutputOptions="DateTime">
      <filter type="System.Diagnostics.EventTypeFilter" initializeData="Information"/>
  </add>
```

Procedure 11.1. Installing the .NET Connector Server

1. Download the OpenICF .NET Connector Server from ForgeRock's Backstage site.

   The .NET Connector Server is distributed in two formats. The `.msi` file is a wizard that installs the Connector Server as a Windows Service. The `.zip` file is simply a bundle of all the files required to run the Connector Server.

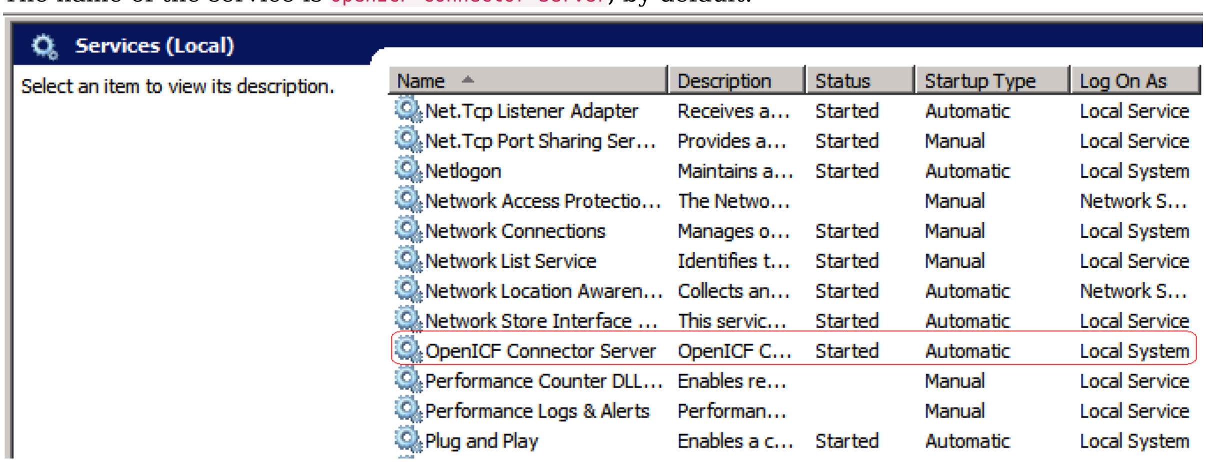
   If you do not want to run the Connector Server as a Windows service, download and extract the `.zip` file, and move on to Procedure 11.2, "Configuring the .NET Connector Server". Otherwise, follow the steps in this section.

2. Execute the `openicf-zip-${connectorServerVersion}-dotnet.msi` installation file and complete the wizard.

   When the wizard has completed, the Connector Server is installed as a Windows Service.

3. Open the Services console and make sure that the Connector Server is listed there.

   The name of the service is `OpenICF Connector Server`, by default.



Procedure 11.2. Configuring the .NET Connector Server

After you have installed the .NET Connector Server, as described in the previous section, follow these steps to configure the Connector Server.

1. Make sure that the Connector Server is not currently running. If it is running, use the Services console to stop it.

2. At the command prompt, change to the directory where the Connector Server was installed.

```
c:\> cd "c:\Program Files (x86)\Identity Connectors\Connector Server"
```

3. Run the **ConnectorServer /setkey** command to set a secret key for the Connector Server. The key can be any string value. This example sets the secret key to `Passw0rd`.

```
ConnectorServer /setkey Passw0rd
Key Updated.
```

   This key is used by clients connecting to the Connector Server. The key that you set here must also be set in the OpenIDM connector info provider configuration file (`conf/provisioner.openicf.connectorinfoprovider.json`). For more information, see Procedure 11.4, "Configuring OpenIDM to Connect to the .NET Connector Server".

4. Edit the Connector Server connection settings.

   The Connector Server configuration is saved in a file named `ConnectorServer.exe.Config` (in the directory in which the Connector Server is installed).

   Check and edit this file, as necessary, to reflect your installation. In particular, check the connection properties, under the `<appsettings>` item.

```
<add key="connectorserver.port" value="8759" />
<add key="connectorserver.usessl" value="false" />
<add key="connectorserver.certificatestorename" value="ConnectorServerSSLCertificate" />
<add key="connectorserver.ifaddress" value="0.0.0.0" />
<add key="connectorserver.key" value="xOS4IeeE6eb/AhMbhxZEC37PgtE=" />
```

   The following connection properties are set by default.

   `connectorserver.port`

   Specifies the port on which the Connector Server listens.

   > **Note**
   >
   > If Windows firewall is enabled, you must create an inbound port rule to open the TCP port for the connector server (8759 by default). If you do not open the TCP port, OpenIDM will be unable to contact the Connector Server. For more information, see the Microsoft documentation on creating an inbound port rule.

   `connectorserver.usessl`

   Indicates whether client connections to the Connector Server should be over SSL. This property is set to `false` by default.

To secure connections to the Connector Server, set this property to `true` and store the server certificate in your certificate store, using the following command:

```
ConnectorServer /storeCertificate /storeName <certificate-store-name> /certificateFile
 <certificate>
```

`connectorserver.certificatestorename`

Specifies the name of the certificate store, into which your server certificate has been installed.

`connectorserver.ifaddress`

Specifies a single IP address from which connections will be accepted.

If you set a value here (other than the default `0.0.0.0`) connections from all IP addresses other than the one specified are denied.

5. Check the trace settings, in the same configuration file, under the `<system.diagnostics>` item.

```
<system.diagnostics>
  <trace autoflush="true" indentsize="4">
    <listeners>
      <remove name="Default" />
      <add
          name="myListener"
          type="System.Diagnostics.TextWriterTraceListener"
          initializeData="c:\connectorserver.log"
          traceOutputOptions="DateTime">
          <filter
            type="System.Diagnostics.EventTypeFilter"
            initializeData="Information" />
      </add>
    </listeners>
  </trace>
</system.diagnostics>
```

The Connector Server uses the standard .NET trace mechanism. For more information about tracing options, see Microsoft's .NET documentation for `System.Diagnostics`.

The default trace settings are a good starting point. For less tracing, you can change the EventTypeFilter's initializeData to "Warning" or "Error". For very verbose logging you can set the value to "Verbose" or "All". The level of logging performed has a direct effect on the performance of the Connector Servers, so take care when setting this level.

Procedure 11.3. Starting the .NET Connector Server

Start the .NET Connector Server in one of the following ways.

1. Start the server as a Windows service, by using the Microsoft Services Console.

Locate the connector server service (`OpenICF Connector Server`), and click `Start the service` or `Restart the service`.

The service is executed with the credentials of the "run as" user (`System`, by default).

2. Start the server as a Windows service, by using the command line.

   In the Windows Command Prompt, run the following command:

   ```
   net start ConnectorServerService
   ```

   To stop the service in this manner, run the following command:

   ```
   net stop ConnectorServerService
   ```

3. Start the server without using Windows services.

   In the Windows Command Prompt, change directory to the location where the Connector Server was installed. The default location is `c:\Program Files (x86)\Identity Connectors\Connector Server`.

   Start the server with the following command:

   ```
   ConnectorServer.exe /run
   ```

   Note that this command starts the Connector Server with the credentials of the current user. It does not start the server as a Windows service.

Procedure 11.4. Configuring OpenIDM to Connect to the .NET Connector Server

The connector info provider service enables you to configure one or more remote connector servers to which OpenIDM can connect. The connector info provider configuration is stored in a file named `openidm/conf/provisioner.openicf.connectorinfoprovider.json`. A sample connector info provider configuration file is located in `openidm/samples/provisioners/`.

To configure OpenIDM to use the remote .NET connector server, follow these steps:

1. Start OpenIDM, if it is not already running.

2. Copy the sample connector info provider configuration file to the `path/to/openidm/conf` directory.

   ```
   $ cd /path/to/openidm
   $ cp samples/provisioners/provisioner.openicf.connectorinfoprovider.json conf/
   ```

3. Edit the connector info provider configuration, specifying the details of the remote connector server.

```
"remoteConnectorServers" : [
        {
            "name" : "dotnet",
            "host" : "192.0.2.0",
            "port" : 8759,
            "useSSL" : false,
            "timeout" : 0,
            "key" : "Passw0rd"
        }
    ]
```

Configurable properties are as follows:

`name`

Specifies the name of the connection to the .NET connector server. The name can be any string. This property is referenced in the connector configuration file (`provisioner.openicf-ad.json` with the `"connectorHostRef"` property.

`host`

Specifies the IP address of the host on which the Connector Server is installed.

`port`

Specifies the port on which the Connector Server listens. This property matches the `connectorserver.port` property in the `ConnectorServer.exe.config` file.

For more information, see Procedure 11.2, "Configuring the .NET Connector Server".

`useSSL`

Specifies whether the connection to the Connector Server should be secured. This property matches the `"connectorserver.usessl"` property in the `ConnectorServer.exe.config` file.

`timeout`

Specifies the length of time, in seconds, that OpenIDM should attempt to connect to the Connector Server before abandoning the attempt. To disable the timeout, set the value of this property to `0`.

`key`

Specifies the connector server key. This property matches the `key` property in the `ConnectorServer.exe.config` file. For more information, see Procedure 11.2, "Configuring the .NET Connector Server".

The string value that you enter here is encrypted as soon as the file is saved.

11.4.2. Installing and Configuring a Remote Java Connector Server

In certain situations, it might be necessary to set up a remote Java Connector Server. This section provides instructions for setting up a remote Java Connector Server on Unix/Linux and Windows.

Procedure 11.5. Installing a Remote Java Connector Server for Unix/Linux

1. Download the OpenICF Java Connector Server from ForgeRock's Backstage site.

2. Change to the appropriate directory and unpack the zip file. The following command unzips the file in the current folder.

   ```
   $ unzip openicf-zip-${connectorServerVersion}.zip
   ```

3. Change to the `openicf` directory:

   ```
   $ cd path/to/openicf
   ```

4. (Optional) The Java Connector Server uses a `key` property to authenticate the connection. The default key value is `changeit`. To change the value of the secret key, run a command similar to the following. This example sets the key value to `Passw0rd`:

   ```
   $ cd /path/to/openicf
   $ java \
    -cp "./lib/framework/*" \
    org.identityconnectors.framework.server.Main \
    -setKey
    -key Passw0rd
    -properties ./conf/ConnectorServer.properties
   ```

5. Review the `ConnectorServer.properties` file in the `/path/to/openicf/conf` directory, and make any required changes. By default, the configuration file has the following properties:

   ```
   connectorserver.port=8759
   connectorserver.libDir=lib
   connectorserver.usessl=false
   connectorserver.bundleDir=bundles
   connectorserver.loggerClass=org.forgerock.openicf.common.logging.slf4j.SLF4JLog
   connectorserver.key=xOS4IeeE6eb/AhMbhxZEC37PgtE\=
   ```

   Indicates whether client connections to the connector server should be over SSL. This property is set to `false` by default.

   To secure connections to the connector server, set this property to `true` and set the following properties before you start the connector server:

   ```
   java -Djavax.net.ssl.keyStore=mySrvKeystore -Djavax.net.ssl.keyStorePassword=Passw0rd
   ```

6. Start the Java Connector Server.

   ```
   $ java -cp "./lib/framework/*" \
    org.identityconnectors.framework.server.Main \
    -run \
    -properties ./conf/ConnectorServer.properties
   ```

The connector server is now running, and listening on port 8759, by default.

Log files are available in the `/path/to/openicf/logs` directory.

```
$ ls logs/
Connector.log  ConnectorServer.log  ConnectorServerTrace.log
```

7. If required, stop the Java Connector Server by pressing CTRL-C.

Procedure 11.6. Installing a Remote Java Connector Server for Windows

1. Download the OpenICF Java Connector Server from ForgeRock's Backstage site.

2. Change to the appropriate directory and unpack the zip file.

3. In a Command Prompt window, change to the `openicf` directory:

```
C:\>cd C:\path\to\openicf\bin
```

4. If required, secure the communication between OpenIDM and the Java Connector Server. The Java Connector Server uses a `key` property to authenticate the connection. The default key value is `changeit`.

   To change the value of the secret key, use the `bin\ConnectorServer.bat /setkey` command. The following example sets the key to `Passw0rd`:

```
c:\path\to\openicf>bin\ConnectorServer.bat /setkey Passw0rd
lib\framework\connector-framework.jar;lib\framework\connector-framework-
internal
.jar;lib\framework\groovy-all.jar;lib\framework\icfl-over-slf4j.jar;lib\framewor
k\slf4j-api.jar;lib\framework\logback-core.jar;lib\framework\logback-classic.jar
```

5. Review the `ConnectorServer.properties` file in the `path\to\openicf\conf` directory, and make any required changes. By default, the configuration file has the following properties:

```
connectorserver.port=8759
connectorserver.libDir=lib
connectorserver.usessl=false
connectorserver.bundleDir=bundles
connectorserver.loggerClass=org.forgerock.openicf.common.logging.slf4j.SLF4JLog
connectorserver.key=xOS4IeeE6eb/AhMbhxZEC37PgtE\=
```

6. You can either run the Java Connector Server as a Windows service, or just start and stop it from the command line.

   - To install the Java Connector Server as a Windows service, run the following command.

```
c:\path\to\openicf>bin\ConnectorServer.bat /install
```

     If you install the connector server as a Windows service you can use the Microsoft Service Console to start, stop and restart the service. The Java Connector Service is named `OpenICFConnectorServerJava`.

To uninstall the Java Connector Server as a Windows service, run the following command.

```
c:\path\to\openicf>bin\ConnectorServer.bat /uninstall
```

7. To start the Java Connector Server from the command line, enter the following command:

```
c:\path\to\openicf>bin\ConnectorServer.bat /run
lib\framework\connector-framework.jar;lib\framework\connector-framework-
internal
.jar;lib\framework\groovy-all.jar;lib\framework\icfl-over-slf4j.jar;lib\framework
\slf4j-api.jar;lib\framework\logback-core.jar;lib\framework\logback-classic.jar
```

   The connector server is now running, and listening on port 8759, by default.

   Log files are available in the `\path\to\openicf\logs` directory.

8. If required, stop the Java Connector Server by pressing `^C`.

11.5. Connectors Supported With OpenIDM 3.1

OpenIDM 3.1 provides several connectors by default, in the `path/to/openidm/connectors` directory. Additional connectors can be downloaded from ForgeRock's Backstage site.

This section describes the connectors that are supported for use with OpenIDM 3.1, and provides instructions for installing and configuring these connectors. For instructions on building connector configurations interactively, see Section 11.6, "Creating Default Connector Configurations".

11.5.1. XML File Connector

A sample XML connector configuration is provided in `path/to/openidm/samples/provisioners/provisioner.openicf-xml.json`. The following extract of the provisioner configuration shows the main configurable properties.

```
{
    "connectorRef": {
        "connectorHostRef": "#LOCAL",
        "bundleName": "org.forgerock.openicf.connectors.xml-connector",
        "bundleVersion": "1.1.0.2",
        "connectorName": "org.forgerock.openicf.connectors.xml.XMLConnector"
    }
}
```

The `connectorHostRef` is optional if the connector server is local.

The configuration properties for the XML file connector set the relative path to the file containing the identity data, and also the paths to the required XML schemas.

```
{
    "configurationProperties": {
        "xsdIcfFilePath" : "&{launcher.project.location}/data/resource-schema-1.xsd",
        "xsdFilePath" : "&{launcher.project.location}/data/resource-schema-extension.xsd",
        "xmlFilePath" : "&{launcher.project.location}/data/xmlConnectorData.xml"
    }
}
```

`&{launcher.project.location}` refers to the project directory of your OpenIDM instance. For more information, see Section 6.7, "Default and Custom Configuration Directories". Note that relative paths such as these work only if your connector server runs locally. For remote connector servers, you must specify the absolute path to the schema and data files.

xsdIcfFilePath

References the XSD file defining schema common to all XML file resources. Do not change the schema defined in this file.

xsdFilePath

References custom schema defining attributes specific to your project.

xmlFilePath

References the XML file containing account entries.

11.5.1.1. Example : Using the XML Connector to Reconcile Users in a Remote XML Data Store

This sample demonstrates reconciliation of users stored in an XML file on a remote machine. The remote Java Connector Server enables OpenIDM to synchronize the internal OpenIDM repository with the remote XML repository.

Before You Start

This sample assumes that a remote Java Connector Server is installed and running on a host named `remote-host`. For instructions on setting up the remote Java Connector Server, see Procedure 11.5, "Installing a Remote Java Connector Server for Unix/Linux" or Procedure 11.6, "Installing a Remote Java Connector Server for Windows".

The sample uses the XML data that is provided in the basic XML reconciliation sample (Sample 1). Before you start, copy the XML data from that sample to an accessible location on the machine that hosts the remote Java Connector Server. For example:

```
$ cd path/to/openidm
 $ scp -r samples/sample1/data testuser@remote-host:/home/testuser/xml-sample
 testuser@remote-host's password:
 resource-schema-1.xsd                    100% 4083     4.0KB/s   00:00
 resource-schema-extension.xsd            100% 1351     1.3KB/s   00:00
 xmlConnectorData.xml                     100% 1648     1.6KB/s   00:00
```

The XML connector runs as a *remote connector*, that is, on the remote host on which the Java Connector Server is installed. Copy the XML connector .jar from the OpenIDM installation to the `openicf/bundles` directory on the remote host.

```
$ cd path/to/openidm
 $ scp connectors/xml-connector-1.4.0.0.jar testuser@remote-host:/path/to/openicf/bundles
 testuser@172.16.203.97's password:
 xml-connector-1.4.0.0.jar                100% 4379KB   4.3MB/s   00:00
```

Procedure 11.7. Configuring OpenIDM for the XML Connector Example

This example uses the configuration of Sample 1, which is effectively your OpenIDM project location. Any configuration changes that you make must therefore be made in the `conf` directory of `sample1`.

1. Copy the remote connector configuration file (`provisioner.openicf.connectorinfoprovider.json`) from the provisioner samples directory to the configuration directory of your OpenIDM project (sample 1).

   ```
   $ cd path/to/openidm/samples/
    $ cp provisioners/provisioner.openicf.connectorinfoprovider.json sample1/conf
   ```

2. Edit the remote connector configuration file (`provisioner.openicf.connectorinfoprovider.json`) to match your network setup. Also, change the value of the `"connectorsLocation"` property to `"bundles"`, as this is where the connector will be installed on the remote host.

   The following example indicates that the remote Java Connector server is running on the host `remote-host`, listening on the default port, and configured with a secret key of `Passw0rd`.

   ```
   {
        "connectorsLocation" : "bundles",
        "remoteConnectorServers" : [
            {
                "name" : "xml",
                "host" : "remote-host",
                "port" : 8759,
                "useSSL" : false,
                "timeout" : 0,
                "key" : "Passw0rd"
            }
        ]
    }
   ```

3. Edit the XML connector configuration file (`provisioner.openicf-xml.json`) in the `sample1/conf` directory as follows.

```
{
     "name" : "xmlfile",
     "connectorRef" : {
         "connectorHostRef" : "xml",
         "bundleName" : "org.forgerock.openicf.connectors.file.openicf-xml-connector",
         "bundleVersion" : "1.1.0.2",
         "connectorName" : "org.forgerock.openicf.connectors.xml.XMLConnector"
     },
     "configurationProperties" : {
         "xsdIcfFilePath" : "/home/testuser/xml-sample/data/resource-schema-1.xsd",
         "xsdFilePath" : "/home/testuser/xml-sample/data/resource-schema-extension.xsd",
         "xmlFilePath" : "/home/testuser/xml-sample/data/xmlConnectorData.xml"
     },
 }
```

4. • The `"connectorHostRef"` property indicates which remote connector server to use, and refers to the `"name"` property defined in the `provisioner.openicf.connectorinfoprovider.json` file.

   • The `bundleVersion : 1.1.0.2` must be exactly the same as the version of the XML connector that you are using. If you specify a range here, the XML connector version must be included in this range.

   • The `"configurationProperties"` must specify the absolute path to the data files that you copied to the server on which the Java Connector Server is running.

5. Start OpenIDM with the configuration for Sample 1.

```
$ ./startup.sh -p samples/sample1/
```

6. In the Felix console, run the following command to show the state of the remote connector:

```
-> scr list
 ...
 [22] [active] org.forgerock.openidm.provisioner.openicf
 ...
```

   The connector module (`org.forgerock.openidm.provisioner.openicf`) should be `active`, indicating that the remote connector has been installed correctly. If the connector state is not `active`, check the configuration, following the preceding steps.

   The number of the connector module might differ. Make a note of the number returned.

7. View the configuration of the remote connector, by running the following command, substituting the number of the provisioner module returned in the previous step:

```
-> scr info 22
```

8. To test that the connector has been configured correctly, run a reconciliation operation as follows:

```
$ curl \
  --cacert self-signed.crt \
  --header "X-OpenIDM-Username: openidm-admin" \
  --header "X-OpenIDM-Password: openidm-admin" \
  --header "Content-Type: application/json" \
  --request POST \
  "https://localhost:8443/openidm/recon?_action=recon&mapping=systemXmlfileAccounts_managedUser"
```

If successful, the operation returns a reconciliation ID, similar to the following:

```
{"_id":"a5346543-db9a-4f8b-ba25-af2a1b576a54","state":"ACTIVE"}
```

9. To verify that the users from the remote XML files have been created in the OpenIDM repository, run the following command:

```
$ curl \
  --cacert self-signed.crt \
  --header "X-OpenIDM-Username: openidm-admin" \
  --header "X-OpenIDM-Password: openidm-admin" \
  --request GET \
  "https://localhost:8443/openidm/managed/user/?_queryId=query-all-ids"
 {
   "remainingPagedResults": -1,
   "pagedResultsCookie": null,
   "resultCount": 2,
   "result": [
     {
       "_rev": "0",
       "_id": "bjensen"
     },
     {
       "_rev": "0",
       "_id": "scarter"
     }
   ]
 }
```

11.5.2. Generic LDAP Connector

A sample LDAP connector configuration is provided in `path/to/openidm/samples/provisioners/provisioner.openicf-ldap.json`. The following extract of the provisioner configuration shows the main configurable properties.

The following excerpt shows the `connectorRef` configuration property for connection to an LDAP server. The `connectorHostRef` property is optional, if you use the connector .jar provided in `openidm/connectors`, and you use a local connector server.

```
{
    "connectorRef": {
        "connectorHostRef": "#LOCAL",
        "connectorName": "org.identityconnectors.ldap.LdapConnector",
        "bundleName": "org.forgerock.openicf.connectors.ldap-connector",
        "bundleVersion": "[1.4.0.0,2.0.0.0)"
    }
}
```

The following excerpt shows the settings for the connector configuration properties in the sample LDAP connector.

```
"configurationProperties" : {
    "host" : "localhost",
    "port" : 1389,
    "ssl" : false,
    "principal" : "cn=Directory Manager",
    "credentials" : "password",
    "baseContexts" : [
        "dc=example,dc=com"
    ],
    "baseContextsToSynchronize" : [
        "dc=example,dc=com"
    ],
    "accountSearchFilter" : null,
    "accountSynchronizationFilter" : null,
    "groupSearchFilter" : null,
    "groupSynchronizationFilter" : null,
    "passwordAttributeToSynchronize" : null,
    "synchronizePasswords" : false,
    "removeLogEntryObjectClassFromFilter" : true,
    "modifiersNamesToFilterOut" : [ ],
    "passwordDecryptionKey" : null,
    "changeLogBlockSize" : 100,
    "attributesToSynchronize" : [ ],
    "changeNumberAttribute" : "changeNumber",
    "passwordDecryptionInitializationVector" : null,
    "filterWithOrInsteadOfAnd" : false,
    "objectClassesToSynchronize" : [
        "inetOrgPerson"
    ],
    "vlvSortAttribute" : "uid",
    "passwordAttribute" : "userPassword",
    "useBlocks" : false,
    "maintainPosixGroupMembership" : false,
    "failover" : [ ],
    "readSchema" : true,
    "accountObjectClasses" : [
        "top",
        "person",
        "organizationalPerson",
        "inetOrgPerson"
    ],
    "accountUserNameAttributes" : [
        "uid"
    ],
```

```
    "groupMemberAttribute" : "uniqueMember",
    "passwordHashAlgorithm" : null,
    "usePagedResultControl" : false,
    "blockSize" : 100,
    "uidAttribute" : "dn",
    "maintainLdapGroupMembership" : false,
    "respectResourcePasswordPolicyChangeAfterReset" : false
},
```

host

The host name or IP address of the server on which the LDAP instance is running.

port

The port on which the LDAP server listens for LDAP requests. The sample configuration specifies a default port of 1389.

ssl

If `true`, the specified port listens for LDAPS connections.

principal

The bind DN that is used to connect to the LDAP server.

credentials

The password of the `principal` that is used to connect to the LDAP server.

baseContexts

One or more starting points in the LDAP tree that will be used when searching the tree. Searches are performed when discovering users from the LDAP server or when looking for the groups of which a user is a member.

baseContextsToSynchronize

One or more starting points in the LDAP tree that will be used to determine if a change should be synchronized. The base contexts attribute will be used to synchronize a change if this property is not set.

accountSynchronizationFilter

Used during synchronization actions to filter out LDAP accounts

accountObjectClasses

The object classes used when creating new LDAP user objects. When specifying more than one object class, add each object class as its own property. For object classes that inherit from parents other than `top`, such as `inetOrgPerson`, specify all object classes in the class hierarchy.

accountSearchFilter

Search filter that accounts must match

accountUserNameAttributes

Attributes holding the account's user name. Used during authentication to find the LDAP entry matching the user name.

attributesToSynchronize

List of attributes used during object synchronization. OpenIDM ignores change log updates that do not include any of the specified attributes. If empty, OpenIDM considers all changes.

blockSize

Block size for simple paged results and VLV index searches, reflecting the maximum number of accounts retrieved at any one time

changeLogBlockSize

Block size used when fetching change log entries

changeNumberAttribute

Change log attribute containing the last change number

failover

LDAP URLs specifying alternative LDAP servers to connect to if OpenIDM cannot connect to the primary LDAP server specified in the `host` and `port` properties

filterWithOrInsteadOfAnd

In most cases, the filter to fetch change log entries is AND-based. If this property is set, the filter ORs the required change numbers instead.

groupMemberAttribute

LDAP attribute holding members for non-POSIX static groups

maintainLdapGroupMembership

If `true`, OpenIDM modifies group membership when entries are renamed or deleted.

In the sample LDAP connector configuration file provided with OpenIDM, this property is set to `false`. This means that LDAP group membership is not modified when entries are renamed or deleted in OpenIDM. To ensure that entries are removed from LDAP groups when the entries are deleted, set this property to `true` or enable referential integrity on the LDAP server. For OpenDJ, see *Configuring Referential Integrity* for more information.

maintainPosixGroupMembership

If `true`, OpenIDM modifies POSIX group membership when entries are renamed or deleted.

modifiersNamesToFilterOut

Use to avoid loops caused by OpenIDM's own changes

objectClassesToSynchronize

OpenIDM synchronizes only entries having these object classes.

passwordAttribute

Attribute to which OpenIDM writes the predefined PASSWORD attribute

passwordAttributeToSynchronize

OpenIDM synchronizes password values on this attribute.

passwordDecryptionInitializationVector

Initialization vector used to decrypt passwords when performing password synchronization

passwordDecryptionKey

Key used to decrypt passwords when performing password synchronization

passwordHashAlgorithm

Hash password values with the specified algorithm, if the LDAP server stores them in clear text.

The hash algorithm can be one of the following:

- `NONE` - Clear text
- `WIN-AD` - Used for password changes to Active Directory
- `SHA` - Secure Hash Algorithm
- `SHA-1` - A 160-bit hash algorithm that resembles the MD5 algorithm
- `SSHA` - Salted SHA
- `MD5` - A 128-bit message-digest algorithm
- `SMD5` - Salted MD5

readSchema

If `true`, read LDAP schema from the LDAP server.

removeLogEntryObjectClassFromFilter

If `true`, the filter to fetch change log entries does not contain the `changeLogEntry` object class, and OpenIDM expects no entries with other object types in the change log. Default: `true`

respectResourcePasswordPolicyChangeAfterReset

If `true`, bind with the Password Expired and Password Policy controls, and throw `PasswordExpiredException` and other exceptions appropriately.

synchronizePasswords

If `true`, synchronize passwords.

uidAttribute

Specifies the LDAP attribute that should be used as the immutable ID (`_UID_`) for the entry. For an OpenDJ resource, you should use the `entryUUID`. You can use the `DN` as the UID attribute but note that this is *not* immutable.

useBlocks

If `true`, use block-based LDAP controls like simple paged results and virtual list view.

usePagedResultControl

If `true`, use simple paged results rather than virtual list view when both are available.

useTimestampsForSync

If `true`, use timestamps for LiveSync operations, instead of the change log.

By default, the LDAP connector has a change log strategy for LDAP servers that support a change log (such as OpenDJ and Oracle Directory Server Enterprise Edition). If the LDAP server does not support a change log, or if the change log is disabled, LiveSync for create and modify operations can still occur, based on the timestamps of modifications.

vlvSortAttribute

Attribute used as the sort key for virtual list view

If you use the LDAP connector over SSL, you must set the `ssl` property to `true` in the provisioner configuration file. You must also specify the path to a truststore in the `system.properties` file. A truststore is provided by default at `openidm/security/truststore`. Add the following line to the `system.properties` file, substituting the path to your own truststore if you do not want to use the default.

```
# Set the truststore
javax.net.ssl.trustStore=/path/to/openidm/security/truststore
```

11.5.3. Active Directory Connector

Unlike most other connectors, the Active Directory connector is written not in Java, but in C# for the .Net platform. OpenICF should connect to Active Directory over ADSI, the native connection protocol for Active Directory. The connector therefore requires a connector server that has access to the ADSI .dll files.

In general, the generic LDAP connector has better performance than the Active Directory connector. Unfortunately, Active Directory has some limitations when you use the LDAP connector, and the LDAP connector might therefore not be suitable in all Active Directory deployments. However, if your deployment can use the LDAP connector, it is preferable to do so.

Before you configure the Active Directory Connector, make sure that the .NET Connector Server is installed, configured and started, and that OpenIDM has been configured to use the Connector Server. For more information, see Section 11.4.1, "Installing and Configuring a .NET Connector Server".

Procedure 11.8. Setting Up the Active Directory Connector

1. Download the Active Directory Connector from ForgeRock's Backstage site.

2. Extract the contents of the AD Connector zip file into the directory in which you installed the Connector Server (by default `c:\Program Files (x86)\Identity Connectors\Connector Server>`).

   Note that the files, specifically the connector itself (`ActiveDirectory.Connector.dll`) must be directly under the `path\to\Identity Connectors\Connector Server` folder, and *not* in a subfolder.

   > **Note**
   >
   > If the account that is used to install the Active Directory connector is different from the account under which the Connector Server runs, you must give the Connector Server runtime account the rights to access the Active Directory connector log files.

3. A sample Active Directory Connector configuration file is provided in `path/to/opendim/samples/provisioners/provisioner.openicf-ad.json`. On the OpenIDM host, copy the sample Active Directory connector configuration file to the `openidm/conf` directory.

   ```
   $ cd /path/to/openidm
   $ cp samples/provisioners/provisioner.openicf-ad.json conf/
   ```

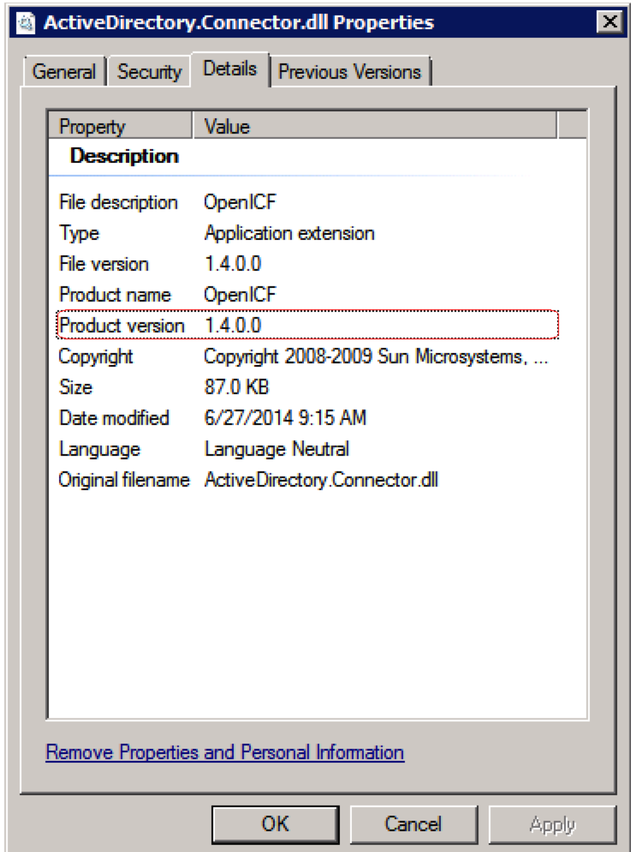
4. Edit the Active Directory connector configuration to match your Active Directory deployment.

   Specifically, check and edit the `"configurationProperties"` that define the connection details to the Active Directory server.

   Also, check that the `bundleVersion` of the connector matches the version of the `ActiveDirectory.Connector.dll` in the Connector Server directory. The bundle version can be a range that includes the version of the connector bundle. To check the .dll version:

   - Right click on the `ActiveDirectory.Connector.dll` file and select Properties.

   - Select the Details tab and note the Product Version.



The following configuration extract shows sample values for the `"connectorRef"` and `"configurationProperties"`:

```
...
"connectorRef" :
   {
      "connectorHostRef" : "dotnet",
      "connectorName" : "Org.IdentityConnectors.ActiveDirectory.ActiveDirectoryConnector",
      "bundleName" : "ActiveDirectory.Connector",
      "bundleVersion" : "[1.4.0.0,2.0.0.0)"
   },          ...
"configurationProperties" :
   {
      "DirectoryAdminName" : "EXAMPLE\\Administrator",
      "DirectoryAdminPassword" : "Passw0rd",
      "ObjectClass" : "User",
      "Container" : "dc=example,dc=com",
      "CreateHomeDirectory" : true,
      "LDAPHostName" : "192.0.2.0",
      "SearchChildDomains" : false,
      "DomainName" : "example",
      "SyncGlobalCatalogServer" : null,
      "SyncDomainController" : null,
      "SearchContext" : ""
   },
```

The main configurable properties are as follows:

`"connectorHostRef"`

Must point to an existing connector info provider configuration in `openidm/conf/provisioner.openicf.connectorinfoprovider.json`. The `"connectorHostRef"` property is required because the Active Directory connector must be installed on a .NET connector server, which is always "remote", relative to OpenIDM.

`"DirectoryAdminName"` and `"DirectoryAdminPassword"`

Specify the credentials of an administrator account in Active Directory, that the connector will use to bind to the server.

The `"DirectoryAdminName"` can be specified as a bindDN, or in the format *`DomainName\\samaccountname`*.

`"SearchChildDomains"` boolean, false by default

Specifies if a Global Catalog (GC) should be used. This parameter is used in search and query operations. A Global Catalog is a read-only, partial copy of the entire forest, and is never be used for create, update or delete operations.

`"LDAPHostName"`

Specifies a particular Domain Controller (DC) or Global Catalog (GC), using its hostname. This parameter is used for query, create, update, and delete operations.

If `"SearchChildDomains"` is set to `true`, this specific GC will be used for search and query operations. If the `"LDAPHostName"` is null (as it is by default), the connector will allow the ADSI libraries to pick up a valid DC or GC each time it needs to perform a query, create, update, or delete operation.

`"SyncGlobalCatalogServer"`

Specifies a Global Catalog server name for sync operations. This property is used in combination with the `"SearchChildDomains"` property.

If a value for `"SyncGlobalCatalogServer"` is set (that is, the value is not `null`) and `"SearchChildDomains"` is set to `true`, this GC server is used for sync operations. If no value for `"SyncGlobalCatalogServer"` is set and `"SearchChildDomains"` is set to `true`, the connector allows the ADSI libraries to pick up a valid GC.

`"SyncDomainController"`

Specifies a particular DC server for sync operations. If no DC is specified, the connector picks up the first available DC and retains this DC in future sync operations.

For a description of all configurable properties for this connector, see the OpenICF Connector Configuration Reference.

The updated configuration is applied immediately.

5. Check that the connector has been configured correctly by running the following command in the OSGi console:

```
scr list
```

This command returns all of the installed modules. The openicf provisioner module should be active, as follows:

```
[32] [active] org.forgerock.openidm.provisioner.openicf.connectorinfoprovider
```

The number of the module may differ. Make a note of the module number, as it is referenced in the commands that follow.

6. Review the contents of the connector by running the following command in the OSGi console (substituting the module number returned in the previous step):

```
scr info 32
ID: 32
Name: org.forgerock.openidm.provisioner.openicf.connectorinfoprovider
Bundle: org.forgerock.openidm.provisioner-openicf (82)
State: active
Default State: enabled
Activation: immediate
Configuration Policy: optional
Activate Method: activate (declared in the descriptor)
Deactivate Method: deactivate (declared in the descriptor)
Modified Method: -
```

```
Services: org.forgerock.openidm.provisioner.openicf.ConnectorInfoProvider
          org.forgerock.openidm.metadata.MetaDataProvider
          org.forgerock.openidm.provisioner.ConnectorConfigurationHelper
Service Type: service
Reference: osgiConnectorEventPublisher
    Satisfied: satisfied
    Service Name: org.identityconnectors.common.event.ConnectorEventPublisher
    Multiple: multiple
    Optional: optional
    Policy: dynamic
Reference: connectorInfoManager
    Satisfied: satisfied
    Service Name: org.identityconnectors.framework.api.ConnectorInfoManager
    Multiple: single
    Optional: optional
    Policy: static
Reference: connectorFacadeFactory
    Satisfied: satisfied
    Service Name: org.identityconnectors.framework.api.ConnectorFacadeFactory
    Multiple: single
    Optional: optional
    Policy: static
Properties:
    component.id = 32
    component.name = org.forgerock.openidm.provisioner.openicf.connectorinfoprovider
    felix.fileinstall.filename = file:/openidm/conf/provisioner.openicf.connectorinfoprovider.json
    jsonconfig = {
    "connectorsLocation" : "connectors",
    "remoteConnectorServers" : [
        {
            "name" : "dotnet",
            "host" : "192.0.2.0",
            "port" : 8759,
            "useSSL" : false,
            "timeout" : 0,
            "key" : {
                "$crypto" : {
                    "value" : {
                        "iv" : "3XpjsLV1YNP034Rt/6BZgg==",
                        "data" : "8JXxpoRJjYGFkRVHvTwGTA==",
                        "cipher" : "AES/CBC/PKCS5Padding",
                        "key" : "openidm-sym-default"
                    },
                    "type" : "x-simple-encryption"
                }
            }
        }
    ]
}
    service.description = OpenICF Connector Info Service
    service.pid = org.forgerock.openidm.provisioner.openicf.connectorinfoprovider
    service.vendor = ForgeRock AS.
```

7. The connector is now configured. To verify the configuration, perform a RESTful GET request on the remote system URL, for example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/system/ActiveDirectory/account?_queryId=query-all-ids"
```

This request should return the user accounts in the Active Directory server.

8. (Optional) To configure reconciliation or liveSync between OpenIDM and Active Directory, create a synchronization configuration file (`sync.json`) in the `openidm/conf` directory.

   The synchronization configuration file defines the attribute mappings and policies that are used during reconciliation.

   The following is a simple example of a `sync.json` file for Active Directory.

```
{
    "mappings" : [
        {
            "name" : "systemADAccounts_managedUser",
            "source" : "system/ActiveDirectory/account",
            "target" : "managed/user",
            "properties" : [
                { "source" : "cn", "target" : "displayName" },
                { "source" : "description", "target" : "description" },
                { "source" : "givenName", "target" : "givenName" },
                { "source" : "mail", "target" : "email" },
                { "source" : "sn", "target" : "familyName" },
                { "source" : "sAMAccountName", "target" : "userName" }
            ],
            "policies" : [
                { "situation" : "CONFIRMED", "action" : "UPDATE" },
                { "situation" : "FOUND", "action" : "UPDATE" },
                { "situation" : "ABSENT", "action" : "CREATE" },
                { "situation" : "AMBIGUOUS", "action" : "EXCEPTION" },
                { "situation" : "MISSING", "action" : "UNLINK" },
                { "situation" : "SOURCE_MISSING", "action" : "DELETE" },
                { "situation" : "UNQUALIFIED", "action" : "DELETE" },
                { "situation" : "UNASSIGNED", "action" : "DELETE" }
            ]
        }
    ]
}
```

9. To test the synchronization, run a reconciliation operation by running the following command.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/recon?_action=recon&mapping=systemADAccounts_managedUser"
```

If reconciliation is successful, the command returns a reconciliation run ID, similar to the following:

```
{"_id":"0629d920-e29f-4650-889f-4423632481ad","state":"ACTIVE"}
```

10. Query the internal repository, using either a **curl** command, or the OpenIDM UI, to make sure that the users in your Active Directory server were provisioned into the repository.

11.5.3.1. Using PowerShell Scripts With the Active Directory Connector

The Active Directory connector supports PowerShell scripting. The following example shows a simple PowerShell script that is referenced in the connector configuration and can be called over the REST interface.

This PowerShell script creates a new MS SQL user with a username that is specified when the script is called. The script sets the user's password to `Passw0rd` and, optionally, gives the user a role. Save this script as `openidm/script/createUser.ps1`.

Note

External script execution is disabled on system endpoints by default. For testing purposes, you can enable script execution over REST, on system endpoints by adding the `script` action to the system object, in the `access.js` file. For example:

```
$ more /path/to/openidm/script/access.js
       ...
{
    "pattern"   : "system/ActiveDirectory",
    "roles"     : "openidm-admin",
    "methods" : "action",
    "actions"   : "script"
},
```

Be aware that scripts passed to clients imply a security risk in production environments. If you need to expose a script for direct external invocation, it might be better to write a custom authorization function to constrain the script ID that is permitted. Alternatively, do not expose the script action for external invocation, and instead, expose a custom endpoint that can make only the desired script calls. For more information on using custom endpoints, see Section 6.6, "Adding Custom Endpoints".

```
    if ($loginName -ne $NULL) {
 [System.Reflection.Assembly]::LoadWithPartialName('Microsoft.SqlServer.SMO') | Out-Null
 $sqlSrv = New-Object ('Microsoft.SqlServer.Management.Smo.Server') ('WIN-C2MSQ8G1TCA')

 $login = New-Object -TypeName ('Microsoft.SqlServer.Management.Smo.Login') ($sqlSrv, $loginName)
 $login.LoginType = 'SqlLogin'
 $login.PasswordExpirationEnabled = $false
 $login.Create('Passw0rd')
 #  The next two lines are optional, and to give the new login a server role, optional
 $login.AddToRole('sysadmin')
 $login.Alter()
} else {
 $Error_Message = [string]"Required variables 'loginName' is missing!"
    Write-Error $Error_Message
    throw $Error_Message
}
```

Now edit the Active Directory connector configuration to reference the script. Add the following section to the connector configuration file (`opendim/conf/provisioner.openicf-ad.json`).

```
"systemActions" : [
    {
        "_scriptId" : "ConnectorScriptName",
        "actions" : [
            {
                "systemType" : ".*ActiveDirectoryConnector",
                "actionType" : "Shell",
                "actionSource" : "@echo off \r\n echo %loginName%\r\n"
            },
            {
                "systemType" : ".*ActiveDirectoryConnector",
                "actionType" : "PowerShell",
                "actionFile" : "script/createUser.ps1"
            }
        ]
    }
]
```

To call the PowerShell script over the REST interface, use the following request, specifying the userName as input:

```
$ curl \
  --cacert self-signed.crt \
  --header "X-OpenIDM-Username: openidm-admin" \
  --header "X-OpenIDM-Password: openidm-admin" \
  --header "Content-Type: application/json" \
  --request POST \
  "https://localhost:8443/openidm/system/ActiveDirectory/?
_action=script&scriptId=ConnectorScriptName&scriptExecuteMode=resource&loginName=myUser"
```

11.5.4. CSV File Connector

The CSV file connector is often useful when importing users, either for initial provisioning or for ongoing updates. When used continuously in production, a CSV file serves as a change log, often containing only user records that changed.

A sample CSV file connector configuration is provided in `openidm/samples/provisioners/provisioner.openicf-csv.json`.

The following example shows an excerpt of the provisioner configuration. The default location of the connector .jar is `openidm/connectors`. Therefore the value of the `connectorHostRef` property must be `"#LOCAL"`.

```
{
  "connectorRef": {
    "connectorHostRef": "#LOCAL",
    "connectorName": "org.forgerock.openicf.csvfile.CSVFileConnector",
    "bundleName": "org.forgerock.openicf.connectors.csvfile-connector",
    "bundleVersion": "1.1.0.2"
  }
}
```

The following excerpt shows required configuration properties.

```
{
    "configurationProperties": {
        "filePath": "data/hr.csv",
        "uniqueAttribute": "uid"
    }
}
```

The CSV file connector also supports a number of optional configuration properties, in addition to the required properties.

encoding (optional)

Default: `"utf-8"`

fieldDelimiter (optional)

Default: `","`

filePath (required)

References the CSV file containing account entries

multivalueDelimiter (optional)

Used with multi-valued attributes. Default: `";"`

passwordAttribute (optional)

Attribute containing the password. Use when password-based authentication is required.

uniqueAttribute (required)

Primary key used for the CSV file

usingMultivalue (optional)

Whether attributes can have multiple values. Default: `false`

11.5.5. Scripted SQL Connector

The Scripted SQL Connector uses customizable Groovy scripts to interact with the database.

The connector uses one script for each of the following actions on the external database.

- Create
- Delete
- Search
- Sync
- Test
- Update

Example groovy scripts are provided in the `openidm/samples/sample3/tools/` directory.

For a sample configuration that uses the scripted SQL connector, see Section 3.7.1, "Sample 3 - Using the Groovy Connector Toolkit to Connect to MySQL With ScriptedSQL" in the *Installation Guide*.

The scripted SQL connector runs with autocommit mode enabled by default. As soon as a statement is executed that modifies a table, the update is stored on disk and the change cannot be rolled back. This setting applies to all database actions (search, create, delete, test, synch, and update). You can disable autocommit in the connector configuration file (`conf/provisioner.openicf-scriptedsql.json`) by adding the `autocommit` property and setting it to `false`, for example:

```
"configurationProperties" : {
    "host" : "localhost",
    "port" : "3306",
    ...
    "database" : "HRDB",
    "autoCommit" : false,
    "reloadScriptOnExecution" : true,
    "createScriptFileName" : "&{launcher.project.location}/tools/CreateScript.groovy",
    ...
```

If you require a traditional transaction with a manual commit for a specific script, you can disable autocommit mode in the script or scripts for each action that requires a manual commit. For more information on disabling autocommit, see the corresponding MySQL documentation.

11.5.6. Database Table Connector

The Database Table connector enables provisioning to a single table in a JDBC database. A sample connector configuration for the Database Table connector is provided in `samples/provisioners/provisioner.openicf-contractordb.json`. The corresponding data definition language file is provided in `samples/provisioners/provisioner.openicf-contractordb.sql`.

The following excerpt shows the settings for the connector configuration properties in the sample Database Table connector:

```
"configurationProperties" :
    {
       "quoting" : "",
       "host" : "localhost",
       "port" : "3306",
       "user" : "root",
       "password" : "",
       "database" : "contractordb",
       "table" : "people",
       "keyColumn" : "UNIQUE_ID",
       "passwordColumn" : "",
       "jdbcDriver" : "com.mysql.jdbc.Driver",
       "jdbcUrlTemplate" : "jdbc:mysql://%h:%p/%d",
       "enableEmptyString" : false,
       "rethrowAllSQLExceptions" : true,
       "nativeTimestamps" : true,
       "allNative" : false,
       "validConnectionQuery" : null,
       "changeLogColumn" : "CHANGE_TIMESTEMP",
       "datasource" : "",
       "jndiProperties" : null
    },
```

The mandatory configurable properties are as follows:

database

The JDBC database that contains the table to which you are provisioning.

table

The name of the table in the JDBC database that contains the user accounts.

keyColumn

The column value that is used as the unique identifier for rows in the table.

For a description of all configurable properties for this connector, see the OpenICF Connector Configuration Reference.

11.5.7. Groovy Connector Toolkit

OpenICF 1.4 introduces a generic Groovy Connector Toolkit that enables you to run a Groovy script for any OpenICF operation, such as search, update, create, and so forth, on any external resource.

The Groovy Connector Toolkit is not a complete connector, in the traditional sense. Rather, it is a framework within which you must write your own Groovy scripts to address the requirements of your implementation. Specific scripts are provided within these samples, which demonstrate how the Groovy Connector Toolkit can be used. These scripts cannot be used "as is" in your deployment, but are a good starting point on which to base your customization.

The Groovy Connector Toolkit is bundled with OpenIDM 3.1, in the JAR `openidm/connectors/groovy-connector-1.4.1.0.jar`.

Sample implementations are provided in Section 3.7, "Using the Groovy Connector Toolkit to Create Scripted Connectors" in the *Installation Guide*.

11.5.8. PowerShell Connector Toolkit

The PowerShell Connector Toolkit is not a complete connector, in the traditional sense. Rather, it is a framework within which you must write your own PowerShell scripts to address the requirements of your Microsoft Windows ecosystem. You can use the PowerShell Connector Toolkit to create connectors that can provision any Microsoft system, including, but not limited to, Active Directory, MS SQL, MS Exchange, Sharepoint, Office365, and Azure. Essentially, any task that can be performed with PowerShell can be executed through connectors based on this toolkit.

Connectors created with the PowerShell Connector Toolkit run on the .NET platform and require the installation of a .NET connector server on the Windows system. To install the .NET connector, follow the instructions in Section 11.4.1, "Installing and Configuring a .NET Connector Server". These connectors also require PowerShell V2.

The PowerShell Connector Toolkit is not bundled with OpenIDM, but is available, with a subscription, from ForgeRock Backstage. To install the connector, download the archive (`mspowershell-connector-1.4.1.0.zip`) and extract the `MsPowerShell.Connector.dll` to the same folder in which the Connector Server(`connectorserver.exe`) is located. OpenIDM Enterprise includes sample connectors and scripts that will enable you to get started with this toolkit.

11.5.9. Salesforce Connector

OpenIDM Enterprise includes a Salesforce connector, along with a sample connector configuration. The Salesforce connector enables provisioning, reconciliation, and synchronization between Salesforce and the OpenIDM repository.

To use this connector, you need a Salesforce account, and a Connected App that has OAuth enabled, which will allow you to retrieve the required consumer key and consumer secret.

For additional instructions, and a sample Salesforce configuration, see Section 3.19, "Sample - Connecting to Salesforce With the Salesforce Connector" in the *Installation Guide*.

11.5.10. Google Apps Connector

OpenIDM Enterprise includes a Google Apps connector, along with a sample connector configuration. The Google Apps Connector enables you to interact with Google's web applications.

To use this connector, you need a Google Apps account.

If you have OpenIDM Enterprise, you can view a sample Google Apps connector configuration file in `samples/provisioners/provisioner.openicf-google.json`

The following is an excerpt of the provisioner configuration file. This example shows an excerpt of the provisioner configuration. The default location of the connector .jar is `openidm/connectors`. Therefore the value of the `connectorHostRef` property must be `"#LOCAL"`.

```
{
    "connectorHostRef": "#LOCAL",
    "connectorName": "org.forgerock.openicf.connectors.googleapps.GoogleAppsConnector",
    "bundleName": "org.forgerock.openicf.connectors.googleapps-connector",
    "bundleVersion": "[1.4.0.0,2.0.0.0)"
},
```

The following excerpt shows required configuration properties.

```
"configurationProperties": {
    "domain": "",
    "clientId": "",
    "clientSecret": null,
    "refreshToken": null
},
```

These configuration properties are fairly straightforward.

`domain`

Set to the domain name for OAuth 2-based authorization.

`clientId`

A client identifier, as issued by the OAuth 2 authorization server. For more information, see the following section of RFC 6749: *Client Identifier*.

`clientSecret`

Sometimes also known as the client password. OAuth 2 authorization servers can support the use of `clientId` and `clientSecret` credentials, as noted in the following section of RFC 6749: *Client Password*.

refreshToken

A client can use an OAuth 2 refresh token to continue accessing resources. For more information, see the following section of RFC 6749: *Refresh Tokens*.

Section 3.18, "Sample - Connecting to Google With the Google Apps Connector" in the *Installation Guide*, includes a Google Apps configuration, including example OAuth 2-based entries for `configurationProperties`.

For a description of all configurable properties for this connector, see the OpenICF Connector Configuration Reference.

11.6. Creating Default Connector Configurations

Rather than creating provisioner files by hand, use the service that OpenIDM exposes through the REST interface to create basic connector configuration files, or use the **cli.sh** or **cli.bat** scripts to generate a basic connector configuration.

This section describes how to create connector configurations over the REST interface.
For instructions on using the CLI to create connector configurations, see Section 3.3, "configureconnector".

You create a new connector configuration file in three stages:

1. List the available connectors.
2. Generate the core configuration.
3. Connect to the target system and generate the final configuration.

List the available connectors by using the following command.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/system?_action=availableConnectors"
```

Available connectors are installed in `openidm/connectors`. OpenIDM 3.1 bundles the following connectors:

- CSV File Connector
- Database Table Connector
- Scripted Groovy Connector Toolkit, which includes the following sample implementations:
  - Scripted SQL Connector
  - Scripted CREST Connector
  - Scripted REST Connector
- LDAP Connector

- XML Connector
- GoogleApps Connector (OpenIDM Enterprise only)
- Salesforce Connector (OpenIDM Enterprise only)

The preceding command therefore returns the following output:


```
{
  "connectorRef": [
    {
      "bundleVersion": "1.1.0.2",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.csvfile-connector",
      "displayName": "CSV File Connector",
      "connectorName": "org.forgerock.openicf.csvfile.CSVFileConnector"
    },
    {
      "bundleVersion": "1.1.0.1",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.databasetable-connector",
      "displayName": "Database Table Connector",
      "connectorName": "org.identityconnectors.databasetable.DatabaseTableConnector"
    },
    {
      "bundleVersion": "1.4.1.0",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.googleapps-connector",
      "displayName": "GoogleApps Connector",
      "connectorName": "org.forgerock.openicf.connectors.googleapps.GoogleAppsConnector"
    },
    {
      "bundleVersion": "1.4.1.0",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.groovy-connector",
      "displayName": "Scripted Poolable Groovy Connector",
      "connectorName": "org.forgerock.openicf.connectors.groovy.ScriptedPoolableConnector"
    },
    {
      "bundleVersion": "1.4.1.0",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.groovy-connector",
      "displayName": "Scripted Groovy Connector",
      "connectorName": "org.forgerock.openicf.connectors.groovy.ScriptedConnector"
    },
    {
      "bundleVersion": "1.4.1.0",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.groovy-connector",
      "displayName": "Scripted CREST Connector",
      "connectorName": "org.forgerock.openicf.connectors.scriptedcrest.ScriptedCRESTConnector"
    },
    {
      "bundleVersion": "1.4.1.0",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.groovy-connector",
      "displayName": "Scripted SQL Connector",
      "connectorName": "org.forgerock.openicf.connectors.scriptedsql.ScriptedSQLConnector"
```

```
    },
    {
      "bundleVersion": "1.4.1.0",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.groovy-connector",
      "displayName": "Scripted REST Connector",
      "connectorName": "org.forgerock.openicf.connectors.scriptedrest.ScriptedRESTConnector"
    },
    {
      "bundleVersion": "1.4.0.1",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.ldap-connector",
      "displayName": "LDAP Connector",
      "connectorName": "org.identityconnectors.ldap.LdapConnector"
    },
    {
      "bundleVersion": "1.1.0.2",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.xml-connector",
      "displayName": "XML Connector",
      "connectorName": "org.forgerock.openicf.connectors.xml.XMLConnector"
    },
    {
      "bundleVersion": "{provisioner.salesforcemodule.version}",
      "systemType": "provisioner.salesforce",
      "bundleName": "org.forgerock.openidm.salesforce",
      "displayName": "Salesforce Connector",
      "connectorName": "org.forgerock.openidm.salesforce.Salesforce"
    }
  ]
}
```

To generate the core configuration, choose one of the available connectors by copying one of the JSON objects from the generated list into the body of the REST command, as shown below for the XML connector.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{"connectorRef":
 {"connectorName": "org.forgerock.openicf.connectors.xml.XMLConnector",
 "displayName": "XML Connector",
 "bundleName": "org.forgerock.openicf.connectors.xml-connector",
 "bundleVersion": "1.1.0.2"}
 }' \
 "https://localhost:8443/openidm/system?_action=createCoreConfig"
```

This command returns a core connector configuration, similar to the following:

```
{
   "poolConfigOption": {
   "minIdle": 1,
   "minEvictableIdleTimeMillis": 120000,
   "maxWait": 150000,
   "maxIdle": 10,
```

```
    "maxObjects": 10
   },
    "resultsHandlerConfig": {
    "enableAttributesToGetSearchResultsHandler": true,
    "enableFilteredResultsHandler": true,
    "enableNormalizingResultsHandler": true
   },
   "operationTimeout": {
     "SCHEMA": -1,
     "SYNC": -1,
     "VALIDATE": -1,
     "SEARCH": -1,
     "AUTHENTICATE": -1,
     "CREATE": -1,
     "UPDATE": -1,
     "DELETE": -1,
     "TEST": -1,
     "SCRIPT_ON_CONNECTOR": -1,
     "SCRIPT_ON_RESOURCE": -1,
     "GET": -1,
     "RESOLVEUSERNAME": -1
   },
   "configurationProperties": {
    "xsdIcfFilePath": null,
    "xsdFilePath": null,
    "createFileIfNotExists": false,
    "xmlFilePath": null
   },
   "connectorRef": {
     "bundleVersion": "1.1.0.2",
     "bundleName": "org.forgerock.openicf.connectors.xml-connector",
     "displayName": "XML Connector",
     "connectorName": "org.forgerock.openicf.connectors.xml.XMLConnector"
   }
}
```

The configuration that is returned is not yet functional. Notice that it does not contain the required system-specific `"configurationProperties"`, such as the host name and port for web based connectors, or the "xmlFilePath" for the XML file-based connector. In addition, the configuration does not include the complete list of `"objectTypes"` and `"operationOptions"`.

To generate the final configuration, add values for the "configurationProperties" to the core configuration, and use the updated configuration as the body for the next command.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
  "configurationProperties":
    {
      "xsdIcfFilePath" : "samples/sample1/data/resource-schema-1.xsd",
      "xsdFilePath" : "samples/sample1/data/resource-schema-extension.xsd",
      "xmlFilePath" : "samples/sample1/data/xmlConnectorData.xml",
      "createFileIfNotExists": false
  },
```

```
  "operationTimeout": {
    "SCHEMA": -1,
    "SYNC": -1,
    "VALIDATE": -1,
    "SEARCH": -1,
    "AUTHENTICATE": -1,
    "CREATE": -1,
    "UPDATE": -1,
    "DELETE": -1,
    "TEST": -1,
    "SCRIPT_ON_CONNECTOR": -1,
    "SCRIPT_ON_RESOURCE": -1,
    "GET": -1,
    "RESOLVEUSERNAME": -1
  },
  "resultsHandlerConfig": {
    "enableAttributesToGetSearchResultsHandler": true,
    "enableFilteredResultsHandler": true,
    "enableNormalizingResultsHandler": true
  },
  "poolConfigOption": {
    "minIdle": 1,
    "minEvictableIdleTimeMillis": 120000,
    "maxWait": 150000,
    "maxIdle": 10,
    "maxObjects": 10
  },
  "connectorRef": {
    "bundleVersion": "1.1.0.2",
    "bundleName": "org.forgerock.openicf.connectors.xml-connector",
    "displayName": "XML Connector",
    "connectorName": "org.forgerock.openicf.connectors.xml.XMLConnector"
  }
}' \
 "https://localhost:8443/openidm/system?_action=createFullConfig"
```

Note

Notice the single quotes around the argument to the `--data` option in the preceding command. For most UNIX shells, single quotes around a string prevent the shell from executing the command when encountering a newline in the content. You can therefore pass the `--data '...'` option on a single line, or including line feeds.

OpenIDM attempts to read the schema, if available, from the external resource in order to generate output. OpenIDM then iterates through schema objects and attributes, creating JSON representations for "objectTypes" and "operationOptions" for supported objects and operations.

The output includes the basic `--data` input, along with `operationOptions` and `objectTypes`.

Because OpenIDM produces a full property set for all attributes and all object types in the schema from the external resource, the resulting configuration can be large. For an LDAP server, OpenIDM can generate a configuration containing several tens of thousands of lines, for example. You might therefore want to reduce the schema to a minimum on the external resource before you run the `createFullConfig` command.

11.7. Checking the Status of External Systems Over REST

After a connection has been configured, external systems are accessible over the REST interface at the URL `https://localhost:8443/openidm/system/connector-name`. Aside from accessing the data objects within the external systems, you can test the availability of the systems themselves.

To list the external systems that are connected to an OpenIDM instance, use the `test` action on the URL `https://localhost:8443/openidm/system/`. The following example shows the connector configuration for an external LDAP system.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/system?_action=test"
[
  {
    "ok": true,
    "connectorRef": {
      "bundleVersion": "[1.4.0.0,2.0.0.0)",
      "bundleName": "org.forgerock.openicf.connectors.ldap-connector",
      "connectorName": "org.identityconnectors.ldap.LdapConnector"
    },
    "objectTypes": [
      "group",
      "account"
    ],
    "config": "config/provisioner.openicf/ldap",
    "enabled": true,
    "name": "ldap"
  }
]
```

The status of the system is provided by the `ok` parameter. If the connection is available, the value of this parameter is `true`.

To obtain the status for a single system, include the name of the connector in the URL, for example:

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "https://localhost:8443/openidm/system/ldap?_action=test"
{
  "ok": true,
  "connectorRef": {
    "bundleVersion": "[1.4.0.0,2.0.0.0)",
    "bundleName": "org.forgerock.openicf.connectors.ldap-connector",
    "connectorName": "org.identityconnectors.ldap.LdapConnector"
  },
  "objectTypes": [
    "group",
    "account"
  ],
  "config": "config/provisioner.openicf/ldap",
  "enabled": true,
  "name": "ldap"
}
```

If there is a problem with the connection, the `"ok"` parameter returns `false`, with an indication of the error. In the following example, the LDAP server named `ldap`, running on `localhost:1389`, is down.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/system/ldap?_action=test"
{
  "ok": false,
  "error": "localhost:1389",
  "connectorRef": {
    "bundleVersion": "[1.4.0.0,2.0.0.0)",
    "bundleName": "org.forgerock.openicf.connectors.ldap-connector",
    "connectorName": "org.identityconnectors.ldap.LdapConnector"
  },
  "objectTypes": [
    "group",
    "account"
  ],
  "config": "config/provisioner.openicf/ldap",
  "enabled": true,
  "name": "ldap"
}
```

To test the validity of a connector configuration, use the `testConfig` action and include the configuration in the command. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
```

```
--data '{
   "name" : "xmlfile",
   "connectorRef" : {
       "bundleName" : "org.forgerock.openicf.connectors.xml-connector",
       "bundleVersion" : "1.1.0.2",
       "connectorName" : "org.forgerock.openicf.connectors.xml.XMLConnector"
   },
   "producerBufferSize" : 100,
   "connectorPoolingSupported" : true,
   "poolConfigOption" : {
       "maxObjects" : 10,
       "maxIdle" : 10,
       "maxWait" : 150000,
       "minEvictableIdleTimeMillis" : 120000,
       "minIdle" : 1
   },
   "operationTimeout" : {
       "CREATE" : -1,
       "TEST" : -1,
       "AUTHENTICATE" : -1,
       "SEARCH" : -1,
       "VALIDATE" : -1,
       "GET" : -1,
       "UPDATE" : -1,
       "DELETE" : -1,
       "SCRIPT_ON_CONNECTOR" : -1,
       "SCRIPT_ON_RESOURCE" : -1,
       "SYNC" : -1,
       "SCHEMA" : -1
   },
   "configurationProperties" : {
       "xsdIcfFilePath" : "samples/sample1/data/resource-schema-1.xsd",
       "xsdFilePath" : "samples/sample1/data/resource-schema-extension.xsd",
       "xmlFilePath" : "samples/sample1/data/xmlConnectorData.xml"
   },
   "syncFailureHandler" : {
       "maxRetries" : 5,
       "postRetryAction" : "logged-ignore"
   },
   "objectTypes" : {
       "account" : {
           "$schema" : "http://json-schema.org/draft-03/schema",
           "id" : "__ACCOUNT__",
           "type" : "object",
           "nativeType" : "__ACCOUNT__",
           "properties" : {
               "description" : {
                   "type" : "string",
                   "nativeName" : "__DESCRIPTION__",
                   "nativeType" : "string"
               },
               "firstname" : {
                   "type" : "string",
                   "nativeName" : "firstname",
                   "nativeType" : "string"
               },
               "email" : {
                   "type" : "string",
                   "nativeName" : "email",
```

```
                    "nativeType" : "string"
                },
                "_id" : {
                    "type" : "string",
                    "nativeName" : "__UID__"
                },
                "password" : {
                    "type" : "string",
                    "nativeName" : "password",
                    "nativeType" : "string"
                },
                "name" : {
                    "type" : "string",
                    "required" : true,
                    "nativeName" : "__NAME__",
                    "nativeType" : "string"
                },
                "lastname" : {
                    "type" : "string",
                    "required" : true,
                    "nativeName" : "lastname",
                    "nativeType" : "string"
                },
                "mobileTelephoneNumber" : {
                    "type" : "string",
                    "required" : true,
                    "nativeName" : "mobileTelephoneNumber",
                    "nativeType" : "string"
                },
                "securityQuestion" : {
                    "type" : "string",
                    "required" : true,
                    "nativeName" : "securityQuestion",
                    "nativeType" : "string"
                },
                "securityAnswer" : {
                    "type" : "string",
                    "required" : true,
                    "nativeName" : "securityAnswer",
                    "nativeType" : "string"
                },
                "roles" : {
                    "type" : "string",
                    "required" : false,
                    "nativeName" : "roles",
                    "nativeType" : "string"
                }
            }
        }
    },
    "operationOptions" : { }
}' \
 --request POST \
 "https://localhost:8443/openidm/system?_action=testConfig"
```

If the configuration is valid, the command returns `"ok": true`, for example:

```
{
   "ok": true,
   "name": "xmlfile"
}
```

If the configuration is not valid, the command returns an error, indicating the problem with the configuration. For example, the following result is returned when the LDAP connector configuration is missing a required property (in this case, the `baseContexts` to synchronize):

```
{
  "error": "org.identityconnectors.framework.common.exceptions.ConfigurationException:
           The list of base contexts cannot be empty",
  "name": "OpenDJ",
  "ok": false
}
```

The `testConfig` action requires a running OpenIDM instance, as it uses the REST API, but does not require an active connector instance for the connector whose configuration you want to test.

11.8. Adding Attributes to Connectors

You can add the attributes of your choice to a connector configuration file. Specifically, if you want to set up Property Level Extensions to one of the `objectTypes` such as `account`, use the format shown under Object Types.

You can configure connectors to enable provisioning of arbitrary property level extensions (such as image files) to system resources. For example, if you want to set up image files such as account avatars, open the appropriate provisioner file. Look for an `account` section similar to:

```
"account" : {
    "$schema" : "http://json-schema.org/draft-03/schema",
    "id" : "__ACCOUNT__",
    "type" : "object",
    "nativeType" : "__ACCOUNT__",
    "properties" : {
```

Under `"properties"`, add one of the following code blocks. The first block works for a single photo encoded as a base64 string. The second block would address multiple photos encoded in the same way.

```
"attributeByteArray" : {
    "type" : "string",
    "nativeName" : "attributeByteArray",
    "nativeType" : "JAVA_TYPE_BYTE_ARRAY"
},
```

```
"attributeByteArrayMultivalue": {
    "type": "array",
    "items": {
        "type": "string",
        "nativeType": "JAVA_TYPE_BYTE_ARRAY"
    },
    "nativeName": "attributeByteArrayMultivalue"
},
```

Chapter 12

Configuring Synchronization

One of the core services of OpenIDM is synchronizing identity data from different resources. This chapter explains what you must know to get started configuring OpenIDM's flexible synchronization mechanism, and illustrates the concepts with examples.

12.1. Types of Synchronization

Synchronization happens either when OpenIDM receives a change directly, or when OpenIDM discovers a change on an external resource.

For direct changes to OpenIDM, OpenIDM immediately pushes updates to all external resources configured to receive the updates. A direct change can originate not only as a write request through the REST interface, but also as an update resulting from reconciliation with another resource.

OpenIDM discovers and synchronizes changes from external resources through reconciliation and LiveSync.

In contrast, OpenIDM synchronizes changes from internal resources to external targets using automatic sync.

Reconciliation

In identity management, *reconciliation* is the process of bidirectional synchronization of objects between different data stores. Reconciliation applies mainly to user objects, although OpenIDM can reconcile any objects, including groups and roles.

To perform reconciliation, OpenIDM analyzes both source and target systems to uncover the differences that it must reconcile. Reconciliation can therefore be a heavyweight process. When working with large data sets, finding all changes can be more work than processing the changes.

Reconciliation is, however, thorough. It recognizes system error conditions and catches changes that might be missed by the more lightweight LiveSync mechanism. Reconciliation therefore serves as the basis for compliance and reporting functionality.

LiveSync

LiveSync captures the changes that occur on a remote system, then pushes those changes to OpenIDM. OpenIDM uses the defined mappings to replay the changes where they are required

- either in the OpenIDM repository, or on another remote system, or both. Unlike reconciliation, LiveSync uses a polling system, and is intended to react quickly to changes as they happen.

To perform this polling, LiveSync relies on a change detection mechanism on the external resource to determine which objects have changed. The change detection mechanism is specific to the external resource, and can be a time stamp, a sequence number, a change vector or other any method of recording changes that have occurred on the system. For example, OpenDJ implements a change log that provides OpenIDM with a list of objects that have changed since the last request. Active Directory implements a change sequence number, and certain databases might have a `lastChange` attribute.

Implicit synchronization

Implicit synchronization automatically pushes changes made in the OpenIDM internal repository to external systems.

Note that implicit synchronization only pushes changes out to the external data sources. To synchronize a complete data set, you should start with a reconciliation operation.

To disable implicit synchronization, see Section 12.11, "Disabling Automatic Synchronization Operations".

To determine what to synchronize, and how to carry out synchronization, OpenIDM relies on mappings configured in the `/path/to/conf/sync.json` file. LiveSync and implicit sync rely on the mappings configured once per OpenIDM server.

For reconciliation or LiveSync, you can schedule changes as described in Chapter 13, "*Scheduling Tasks and Events*".

12.2. Flexible Data Model

Identity management software tends to favor either a meta-directory data model, where all data are mirrored in a central repository, or a virtual data model, where only a minimum set of attributes are stored centrally, and most are loaded on demand from the external resources in which they are stored. The meta-directory model offers fast access at the risk of getting outdated data. The virtual model guarantees fresh data, but pays for that guarantee in terms of performance.

OpenIDM leaves the data model choice up to you. You determine the right trade offs for a particular deployment. OpenIDM does not hard code any particular schema or set of attributes stored in the repository. Instead, you define how external system objects map onto managed objects, and OpenIDM dynamically updates the repository to store the managed object attributes that you configure.

You can, for example, choose to follow the data model defined in the Simple Cloud Identity Management (SCIM) specification. The following object represents a SCIM user.

```
{
    "userName": "james1",
    "familyName": "Berg",
    "givenName": "James",
    "email": [
        "james1@example.com"
    ],
    "description": "Created by OpenIDM REST.",
    "password": "asdfkj23",
    "displayName": "James Berg",
    "phoneNumber": "12345",
    "employeeNumber": "12345",
    "userType": "Contractor",
    "title": "Vice President",
    "active": true
}
```

Note

Avoid using the dash character (`-`) in property names, like `last-name`, as dashes in names make JavaScript syntax more complex. If you cannot avoid the dash, then write `source['last-name']` instead of `source.last-name` in your JavaScript.

12.3. Basic Data Flow Configuration

Data flow for synchronization involves the following elements:

- Connector configuration files (`conf/provisioner-*.json`), with one file per external resource.
- Synchronization mappings file (`conf/sync.json`), with one file per OpenIDM instance.
- A links table that OpenIDM maintains in its repository.
- The scripts required to check objects and manipulate attributes.

12.3.1. Connector Configuration Files

Connector configuration files map external resource objects to OpenIDM objects, and are described in detail in Chapter 11, "*Connecting to External Resources*". Connector configuration files are named `openidm/conf/provisioner.`*`resource-name`*`.json`, where *resource-name* reflects the connector technology and external resource, such as `openicf-xml`.

An excerpt from an example connector configuration follows. The example shows the name for the connector and two attributes of an account object type. In the attribute mapping definitions, the attribute name is mapped from the `nativeName`, the attribute name used on the external resource, to the attribute name used in OpenIDM. Thus the example shows that the `sn` attribute in LDAP is mapped to `lastName` in OpenIDM. The `homePhone` attribute can have multiple values.

```
{
    "name": "MyLDAP",
    "objectTypes": {
        "account": {
            "lastName": {
                "type": "string",
                "required": true,
                "nativeName": "sn",
                "nativeType": "string"
            },
            "homePhone": {
                "type": "array",
                "items": {
                    "type": "string",
                    "nativeType": "string"
                },
                "nativeName": "homePhone",
                "nativeType": "string"
            }
        }
    }
}
```

In order for OpenIDM to access external resource objects and attributes, the object and its attributes must match the connector configuration. Note that the connector file only maps external resource objects to OpenIDM objects. To construct attributes and to manipulate their values, you use the synchronization mappings file.

12.3.2. Synchronization Mappings File

The synchronization mappings file (`openidm/conf/sync.json`) represents the core configuration for OpenIDM synchronization.

The `sync.json` file describes a set of mappings. Each mapping specifies how attributes from source objects correspond to attributes on target objects. The source and target indicate the direction for the data flow, so you must define a separate mapping for each data flow. For example, if you want data flows from an LDAP server to the repository and also from the repository to the LDAP server, you must define two separate mappings.

You identify external resource sources and targets as `system/name/object-type`, where *name* is the name used in the connector configuration file, and *object-type* is the object defined in the connector configuration file list of object types. For objects in OpenIDM's internal repository, you use `managed/object-type`, where *object-type* is defined in `openidm/conf/managed.json`. The name for the mapping by convention is set to a string of the form `source_target`, as shown in the following example.

```
{
    "mappings": [
        {
            "name": "systemLdapAccounts_managedUser",
            "source": "system/MyLDAP/account",
            "target": "managed/user",
            "properties": [
```

```
                {
                    "target": "sn",
                    "source": "lastName"
                },
                {
                    "target": "telephoneNumber",
                    "source": "homePhone"
                },
                {
                    "target": "phoneExtension",
                    "default": "0047"
                },
                {
                    "target": "mail",
                    "comment": "Set mail if non-empty.",
                    "source": "email",
                    "condition": {
                        "type": "text/javascript",
                        "source": "(object.email != null)"
                    }
                },
                {
                    "target": "displayName",
                    "source": "",
                    "transform": {
                        "type": "text/javascript",
                        "source": "source.lastName +', ' + source.firstName;"
                    }
                }
            ]
        }
    ]
}
```

In this example, the source is the external resource, `MyLDAP`, and the target is OpenIDM's repository, specifically the managed user objects. The `properties` reflect OpenIDM attribute names. For example, the mapping has the attribute `lastName` defined in the `MyLDAP` connector configuration file mapped to `sn` in the OpenIDM managed user object. Notice that the attribute names come from the connector configuration, rather than the external resource itself.

You can create attributes on the target as part of the mapping. In the preceding example, a `phoneExtension` attribute with a default value of `0047` is created on the target.

You can also use the `"default"` property to specify a value that should be assigned to the target property. When determining the value of the target property, any associated conditions are evaluated first, followed by the transform script, if present. The default value is applied (for update and create actions) if the `"source"` property and the `"transform"` script yield a null value. The default value overrides the target value, if one exists.

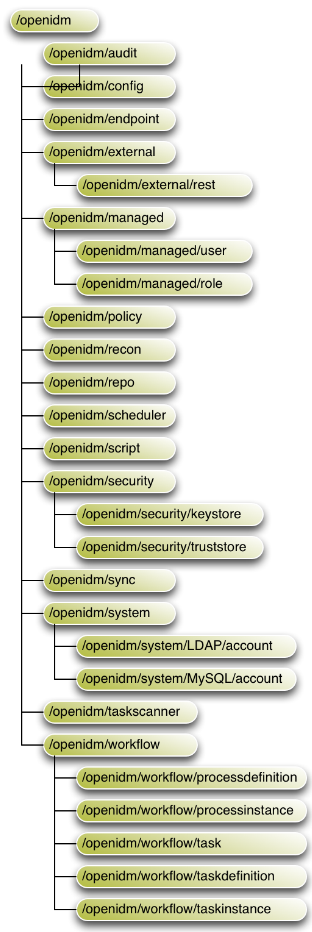
You can also set up conditions under which OpenIDM maps attributes as shown for the email attribute in the example. By default, OpenIDM synchronizes all attributes. In the example, the mail attribute is set only if the script for the condition returns `true`.

OpenIDM also enables you to transform attributes. In the example, the value of the `displayName` attribute is set using a combination of the `lastName` and `firstName` attribute values from the source.

For transformations, the `source` property is optional. However, the source object is only available when you specify the `source` property. Therefore, in order to use `source.lastName` and `source.firstName` to calculate the `displayName`, the example specifies `"source" : ""`.

To add a flow from the repository to `MyLDAP`, you would define a mapping with source `managed/user` and target `system/MyLDAP/account`, named for example `managedUser_systemLdapAccounts`.

The following image shows the paths to objects in the OpenIDM namespace.



OpenIDM stores managed objects in the repository, and exposes them under `/openidm/managed`. System objects on external resources are exposed under `/openidm/system`.

By default, OpenIDM synchronizes all objects that match those defined in the connector configuration for the resource. Many connectors allow you to limit the scope of objects that the connector accesses.

For example, the LDAP connector allows you to specify base DNs and LDAP filters so that you do not need to access every entry in the directory. OpenIDM also allows you to filter what is considered a valid source or valid target for synchronization by using scripts. To apply these filters, use the `validSource`, and `validTarget` properties in your mapping.

validSource

A script that determines if a source object is valid to be mapped. The script yields a boolean value: `true` indicates that the source object is valid; `false` can be used to defer mapping until some condition is met. In the root scope, the source object is provided in the `"source"` property. If the script is not specified, then all source objects are considered valid.

```
{
    "validSource": {
        "type": "text/javascript",
        "source": "source.ldapPassword != null"
    }
}
```

validTarget

A script, used during reconciliation's second phase, that determines if a target object is valid to be mapped. The script yields a boolean value: `true` indicates that the target object is valid; `false` indicates that the target object should not be included in reconciliation. In the root scope, the source object is provided in the `"target"` property. If the script is not specified, then all target objects are considered valid for mapping.

```
{
    "validTarget": {
        "type": "text/javascript",
        "source": "target.employeeType == 'internal'"
    }
}
```

During synchronization, your scripts always have access to a `source` object and a `target` object. Examples already shown in this section use `source.attributeName` to retrieve attributes from the source objects. Your scripts can also write to target attributes using `target.attributeName` syntax.

```
{
    "onUpdate": {
        "type": "text/javascript",
        "source": "if (source.email != null) {target.mail = source.email;}"
    }
}
```

For more information about scripting, see Appendix F, "*Scripting Reference*".

If a source resource is empty, the default behavior is for a reconciliation operation to exit, without failure, and to log a warning, similar to the following:

```
2014-03-20 10:41:18:918 WARN Cannot perform reconciliation with an empty source
    object set, unless explicitly configured to allow it.
```

The reconciliation summary is also logged in the reconciliation audit log.

This behavior prevents reconciliation operations from accidentally deleting everything in a target resource. For example, in the event that a source system is unavailable but erroneously reporting its status as "up", the absence of source objects should not result in objects being removed on the target resource.

There might be situations in which you do want reconciliations of an empty source resource to proceed. In this case, you can override the default behavior by setting the `"allowEmptySourceSet"` property to `true` in the mapping. For example:

```
{
    "mappings" : [
        {
        "name" : "systemXmlfileAccounts_managedUser",
        "source" : "system/xmlfile/account",
        "allowEmptySourceSet" : true,
        ...
```

Reconciliation of an empty source effectively wipes out the target.

You can update mappings in the synchronization configuration file (`sync.json`) while the server is running, provided you do not update a mapping that is currently in use by a reconciliation process.

12.3.3. Using Encrypted Values

OpenIDM supports reversible encryption of attribute values for managed objects. Attribute values to encrypt include passwords, authentication questions, credit card numbers, and social security numbers. If passwords are already encrypted on the external resource, they are generally excluded from the synchronization process. For more information, see Chapter 14, "*Managing Passwords*".

You configure encryption in the managed object configuration (in the `openidm/conf/managed.json` file). The following extract of that file shows a managed object configuration that encrypts and decrypts `securityAnswer`, `ssn`, and `password` attributes using the default symmetric key, and additional scripts for extra passwords.

```
{
    "objects": [
        {
            "name": "user",
            ...
            "properties": [
                {
                    "name": "securityAnswer",
                    "encryption": {
                        "key": "openidm-sym-default"
                    }
                },
                {
                    "name": "ssn",
                    "encryption": {
                        "key": "openidm-sym-default"
                    }
                },
                {
                    "name": "password",
                    "encryption": {
                        "key": "openidm-sym-default"
                    }
                }
            ],
            ...
        }
    ]
}
```

Do not use the default symmetric key, `openidm-sym-default`, in production. For instructions on adding your own symmetric key, see Chapter 16, "*Securing & Hardening OpenIDM*".

12.3.4. Restricting HTTP Access to Sensitive Data

You can protect specific sensitive data stored in the repository by marking the corresponding properties as "private". Private data, whether it is encrypted or not, is not accessible over the REST interface. Properties that are marked as private are removed from an object when that object is retrieved over REST.

To mark a property as private, set its `"scope"` to `"private"` in the `conf/managed.json` file.

The following extract of the `managed.json` file shows how HTTP access is prevented on the `password` and `securityAnswer` properties.

```
        "properties" : [
            {
                "name" : "securityAnswer",
                "encryption" : {
                    "key" : "openidm-sym-default"
                },
                "scope" : "private"
            },
            {
                "name" : "password",
                "encryption" : {
                    "key" : "openidm-sym-default"
                },
                "scope" : "private"
```

A potential caveat with using private properties is that such properties are *removed* if an object is updated by using an HTTP `PUT` request. A `PUT` request replaces the entire object in the repository. Because properties that are marked as private are ignored in HTTP requests, these properties are effectively removed from the object when the update is done. To work around this limitation, do not use `PUT` requests if you have configured private properties. Instead, use a `PATCH` request to update only those properties that need to be changed.

For example, to update the `givenName` of user jdoe, you could run the following command:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '[
    {
    "operation":"replace",
    "field":"/givenName",
    "value":"Jon"
    }
 ]' \
 "https://localhost:8443/openidm/managed/user?_action=patch&_queryId=for-userName&uid=jdoe"
```

Note

The filtering of private data applies only to direct HTTP read and query calls on managed objects. No automatic filtering is done for internal callers, and the data that these callers choose to expose.

12.3.5. Constructing and Manipulating Attributes

OpenIDM enables you to construct and manipulate attributes using scripts that are triggered when an object is created (onCreate), updated (onUpdate), retrieved (onRetrieve), or deleted (onDelete). Additional scripts are available when a managed object requires validation (onValidate), and when an object is about to be stored in the repository (onStore). Similar scripts are available for when a link is created (onLink) or removed (onUnlink).

The following example derives a DN for an LDAP entry when the entry is created in the internal repository.

```
{
    "onCreate": {
        "type": "text/javascript",
        "source":
            "target.dn = 'uid=' + source.uid + ',ou=people,dc=example,dc=com'"
    }
}
```

In addition, OpenIDM supports the use of post-action scripts, including after the creation of an object is complete (postCreate), after the update of an object is complete (postUpdate), and after the deletion of an object (postDelete).

12.3.6. Reusing Links

When two mappings exist to synchronize the same objects bidirectionally, you can use the `links` property in one mapping to have OpenIDM use the same internally managed link for both mappings. Otherwise, if no `links` property is specified, OpenIDM maintains a link for each mapping.

The following excerpt shows two mappings, one from MyLDAP accounts to managed users, and another from managed users to MyLDAP accounts. In the second mapping, the `link` property tells OpenIDM to reuse the links created in the first mapping, rather than create new links.

```
{
    "mappings": [
        {
            "name": "systemMyLDAPAccounts_managedUser",
            "source": "system/MyLDAP/account",
            "target": "managed/user"
        },
        {
            "name": "managedUser_systemMyLDAPAccounts",
            "source": "managed/user",
            "target": "system/MyLDAP/account",
            "links": "systemMyLDAPAccounts_managedUser"
        }
    ]
}
```

12.4. Managing Reconciliation Over REST

You can trigger, cancel, and monitor reconciliation operations over REST, using the REST endpoint `https://localhost:8443/openidm/recon`.

12.4.1. Triggering a Reconciliation Run

The following example triggers a reconciliation operation based on the `systemLdapAccounts_managedUser` mapping. The mapping is defined in the file `conf/sync.json`.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/recon?_action=recon&mapping=systemLdapAccounts_managedUser"
```

By default, an assigned reconciliation run ID is returned immediately when the reconciliation operation is initiated. Clients can make subsequent calls to the reconciliation service, using this reconciliation run ID to query its state and to call operations on it.

For example, the reconciliation run initiated previously would return something similar to the following:

```
{"_id":"0890ad62-4738-4a3f-8b8e-f3c83bbf212e","state":"ACTIVE"}
```

To have the entire reconciliation run complete before the reconciliation run ID is returned, set the `waitForCompletion` property to `true` when the reconciliation is initiated. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/recon?
_action=recon&mapping=systemLdapAccounts_managedUser&waitForCompletion=true"
```

12.4.2. Obtaining the Details of a Reconciliation Run

You can display the details of a particular reconciliation run over REST by specifying the reconciliation run ID in the URL. For example, the following call shows the details of the reconciliation run initiated in the previous section:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/recon/0890ad62-4738-4a3f-8b8e-f3c83bbf212e"
    {
  "ended": "2014-03-06T07:00:32.094Z",
  "_id": "7a07c100-4f11-4d7e-bf8e-fa4594f99d58",
  "mapping": "systemLdapAccounts_managedUser",
  "state": "SUCCESS",
  "stage": "COMPLETED_SUCCESS",
  "stageDescription": "reconciliation completed.",
  "progress": {
     "links": {
```

```
        "created": 0,
        "existing": {
          "total": "1",
          "processed": 1
        }
      },
      "target": {
        "created": 0,
        "existing": {
          "total": "3",
          "processed": 3
        }
      },
      "source": {
        "existing": {
          "total": "1",
          "processed": 1
        }
      }
   },
   "situationSummary": {
      "UNASSIGNED": 2,
      "TARGET_IGNORED": 0,
      "SOURCE_IGNORED": 0,
      "MISSING": 0,
      "FOUND": 0,
      "AMBIGUOUS": 0,
      "UNQUALIFIED": 0,
      "CONFIRMED": 1,
      "SOURCE_MISSING": 0,
      "ABSENT": 0
   },
   "started": "2014-03-06T07:00:31.907Z"
}
```

12.4.3. Canceling a Reconciliation Run

You can cancel a reconciliation run by sending a REST call with the `cancel` action, specifying the reconciliation run ID. For example, the following call cancels the reconciliation run initiated in the previous section:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/recon/0890ad62-4738-4a3f-8b8e-f3c83bbf212e?_action=cancel"
```

The output for a reconciliation cancellation request is similar to the following:

```
{
     "status":"SUCCESS",
     "action":"cancel",
     "_id":"0890ad62-4738-4a3f-8b8e-f3c83bbf212e"
}
```

If you specified that the call should wait for completion before the ID is returned, you can obtain the reconciliation run ID from the list of active reconciliations, as described in the following section.

12.4.4. Listing Reconciliation Runs

You can display a list of reconciliation processes that have completed, and those that are in progress, by running a RESTful GET on `"https://localhost:8443/openidm/recon"`. The following example displays all reconciliation runs.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/recon"
```

The output of such a request is similar to the following, with one item for each reconciliation run.


```
{
   "reconciliations": [
     {
       "ended": "2014-03-06T06:14:11.845Z",
       "_id": "4286510e-986a-4521-bfa4-8cd1e039a7f5",
       "mapping": "systemLdapAccounts_managedUser",
       "state": "SUCCESS",
       "stage": "COMPLETED_SUCCESS",
       "stageDescription": "reconciliation completed.",
       "progress": {
         "links": {
           "created": 1,
           "existing": {
           "total": "0",
           "processed": 0
         }
       },
       "target": {
         "created": 1,
         "existing": {
           "total": "2",
           "processed": 2
         }
       },
       "source": {
         "existing": {
           "total": "1",
           "processed": 1
         }
       }
     },
     "situationSummary": {
       "UNASSIGNED": 2,
       "TARGET_IGNORED": 0,
       "SOURCE_IGNORED": 0,
       "MISSING": 0,
       "FOUND": 0,
```

```
        "AMBIGUOUS": 0,
        "UNQUALIFIED": 0,
        "CONFIRMED": 0,
        "SOURCE_MISSING": 0,
        "ABSENT": 1
      },
      "started": "2014-03-06T06:14:04.722Z"
    },
  ]
}
```

Each reconciliation run has the following properties:

`_id`

The ID of the reconciliation run.

`mapping`

The name of the mapping, defined in the `conf/sync.json` file.

`state`

The high level state of the reconciliation run. Values can be as follows:

- `ACTIVE`

  The reconciliation run is in progress.

- `CANCELED`

  The reconciliation run was successfully canceled.

- `FAILED`

  The reconciliation run was terminated because of failure.

- `SUCCESS`

  The reconciliation run completed successfully.

`stage`

The current stage of the reconciliation run's progress. Values can be as follows:

- `ACTIVE_INITIALIZED`

  The initial stage, when a reconciliation run is first created.

- `ACTIVE_QUERY_ENTRIES`

Querying the source, target and possibly link sets to reconcile.

- `ACTIVE_RECONCILING_SOURCE`

  Reconciling the set of IDs retrieved from the mapping source.

- `ACTIVE_RECONCILING_TARGET`

  Reconciling any remaining entries from the set of IDs retrieved from the mapping target, that were not matched or processed during the source phase.

- `ACTIVE_LINK_CLEANUP`

  Checking whether any links are now unused and should be cleaned up.

- `ACTIVE_PROCESSING_RESULTS`

  Post-processing of reconciliation results.

- `ACTIVE_CANCELING`

  Attempting to abort a reconciliation run in progress.

- `COMPLETED_SUCCESS`

  Successfully completed processing the reconciliation run.

- `COMPLETED_CANCELED`

  Completed processing because the reconciliation run was aborted.

- `COMPLETED_FAILED`

  Completed processing because of a failure.

`stageDescription`

A description of the stages described previously.

`progress`

The progress object has the following structure (annotated here with comments):

```
"progress":{
  "source":{             // Progress on set of existing entries in the mapping source
    "existing":{
      "processed":1001,
        "total":"1001"   // Total number of entries in source set, if known, "?" otherwise
    }
  },
  "target":{             // Progress on set of existing entries in the mapping target
    "existing":{
      "processed":1001,
      "total":"1001"     // Total number of entries in target set, if known, "?" otherwise
    },
    "created":0          // New entries that were created
  },
  "links":{              // Progress on set of existing links between source and target
    "existing":{
      "processed":1001,
      "total":"1001"     // Total number of existing links, if known, "?" otherwise
    },
  "created":0            // Denotes new links that were created
  }
},
```

12.4.5. Triggering LiveSync Over REST

The ability to trigger LiveSync operations over REST, or by using the resource API, enables you to use an external scheduler to trigger a LiveSync operation, rather than using the OpenIDM scheduling mechanism.

There are two ways in which to trigger a LiveSync operation over REST.

- Use the `_action=liveSync` parameter directly on the resource. This is the recommended method. The following example calls a LiveSync operation on the user accounts in an external LDAP system.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/system/ldap/account?_action=liveSync"
```

- Target the `system` endpoint and supply a `source` parameter to identify the object that should be synchronized. This method matches the scheduler configuration and can therefore be used to test schedules before they are implemented.

  The following example calls the same LiveSync operation as the previous example.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/system?_action=liveSync&source=system/ldap/account"
```

A successful LiveSync operation returns the following response:

```
{
    "_rev": "4",
    "_id": "SYSTEMLDAPACCOUNT",
    "connectorData": {
        "nativeType": "integer",
        "syncToken": 1
    }
}
```

Do not run two identical LiveSync operations simultaneously - rather, ensure that the first operation has completed before a second similar operation is launched.

To troubleshoot a LiveSync operation that has not succeeded, you can include an optional parameter (`detailedFailure`) to return additional information. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/system/ldap/account?_action=liveSync&detailedFailure=true"
```

Note

The first time that a LiveSync operation is called, no synchronization token exists in the database to establish which changes have already been processed. The default LiveSync behavior is to locate the last existing entry in the change log, and to store that entry in the database as the current starting position from which changes should be applied. This behavior prevents LiveSync from processing changes that might already have been processed during an initial data load. Subsequent LiveSync operations will pick up and process any new changes.

Typically, in setting up LiveSync on a new system, you would load the data initially (by using reconciliation, for example) and then enable LiveSync, starting from that base point.

12.5. Restricting Reconciliation by Using Queries

Every reconciliation operation performs a query on the source, and on the target resource, to determine which records should be reconciled. The default source and target queries are `query-all-ids`, which means that all records in both the source and the target are considered candidates for that reconciliation operation.

You can restrict reconciliation to specific entries by defining explicit source or target queries in the mapping configuration.

For example, to restrict reconciliation to only those records whose `employeeType` on the source resource is `Permanent`, you might specify a source query as follows:

```
"mappings" : [
     {
         "name" : "managedUser_systemLdapAccounts",
         "source" : "managed/user",
         "target" : "system/ldap/account",
         "sourceQuery" : : {
                "queryFilter" : "employeeType eq \"Permanent\""
            },
...
```

The format of the query can be any query type that is supported by the resource, and can include additional parameters, if applicable. OpenIDM 3.1 supports the following query types.

For queries on managed objects:

- `_queryId` for arbitrary predefined, parameterized queries
- `_queryFilter` for arbitrary filters, in common filter notation
- `_queryExpression` for client-supplied queries, in native query format

For queries on system objects:

- `_queryId=query-all-ids` (the only supported predefined query)
- `_queryFilter` for arbitrary filters, in common filter notation

The source and target queries send the query to the resource that is defined for that source or target, by default. You can override the resource to which the query is sent by specifying a `resourceName` in the query. For example, to query a specific endpoint instead of the source resource, you might modify the preceding source query as follows:

```
"mappings" : [
    {
        "name" : "managedUser_systemLdapAccounts",
        "source" : "managed/user",
        "target" : "system/ldap/account",
        "sourceQuery" : {
            "resourceName" : "endpoint/scriptedQuery"
            "queryFilter" : "employeeType eq \"Permanent\""
        },
...
```

To override a source or target query that is defined in the mapping, you can specify the query when you call the reconciliation operation. For example, if you wanted to reconcile all employee entries, and not just the permanent employees, you would run the reconciliation operation as follows:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{"sourceQuery": {"_queryId" : "query-all-ids"}}' \
 "https://localhost:8443/openidm/recon?_action=recon&mapping=managedUser_systemLdapAccounts"
```

By default, a reconciliation operation runs both the source and target phase. To avoid queries on the target resource, set `runTargetPhase` to `false` in the mapping configuration (`conf/sync.json` file). For example, to prevent the target resource from being queried during the reconciliation operation configured in the previous example, amend the mapping configuration as follows:

```
{
    "mappings" : [
        {
            "name" : "systemLdapAccounts_managedUser",
            "source" : "system/ldap/account",
            "target" : "managed/user",
            "sourceQuery" : {
                "queryFilter" : "employeeType eq \"Permanent\""
            },
            "runTargetPhase" : false,
   ...
```

12.5.1. Improving Reconciliation Query Performance

In most reconciliation configurations, source and target queries make a read call to every record on the source and target systems, to determine candidates for reconciliation. On slow source or target systems, these frequent calls can incur a substantial performance cost.

To improve query performance in these situations, you can preload the entire result set into memory on the source or target system, or on both systems. Subsequent read queries on known IDs are made against the data in memory, rather than the data on the remote system. For this optimization to be effective, the entire result set must fit into the available memory on the system for which it is enabled.

The optimization works by defining a `sourceQuery` or `targetQuery` in the synchronization mapping that returns not just the ID, but the complete object.

The following example query loads the full result set into memory during the source phase of the reconciliation. The example uses a common filter expression, called with the `_queryFilter` keyword. The query returns the complete object for all entries that include a `uid` (`uid sw ""`).

```
"mappings" : [
    {
        "name" : "systemLdapAccounts_managedUser",
        "source" : "system/ldap/account",
        "target" : "managed/user",
        "sourceQuery" : {
            "_queryFilter" : "uid sw \"\""
        },
    ...
```

OpenIDM automatically attempts to detect what has been returned. The auto-detection mechanism assumes that a result set that includes three or more fields per object (apart from the `_id` and `rev` fields) contains the complete object.

You can explicitly state whether a query is configured to return complete objects by setting the value of `sourceQueryFullEntry` or `targetQueryFullEntry` in the mapping. The setting of these properties overrides the auto-detection mechanism.

Setting these properties to `false`, indicates that the returned object is not the complete object. This might be required if a query returns more than three fields of an object, but not the complete object. Without this setting, the auto-detect logic would assume that the complete object was being returned in this case. OpenIDM uses only the IDs from this query result. If the complete object is required, the object is queried on demand.

Setting these properties to `true` indicates that the complete object is returned. This setting is typically required only for very small objects, for which the number of returned fields does not reach the threshold required for the auto-detection mechanism to assume that it is a full object. In this case, the query result includes all the details required to pre-load the full object.

The following excerpt of the synchronization mapping file indicates that the full objects are returned and that OpenIDM should not autodetect the result set.

```
"mappings" : [
    {
        "name" : "systemLdapAccounts_managedUser",
        "source" : "system/ldap/account",
        "target" : "managed/user",
        "sourceQueryFullEntry" : true,
        "sourceQuery" : {
            "_queryFilter" : "uid sw \"\""
        },
    ...
```

12.6. Restricting Reconciliation to a Specific ID

In the same way that you can restrict reconciliation operations to specific records by using queries, you can specify an ID to restrict a reconciliation operation to a particular record.

To restrict reconciliation to a specific ID, use the `reconById` action, instead of the `recon` action when you call the reconciliation operation. Specify the ID with the `ids` parameter. Currently reconciling more than one ID with the `reconById` action is not supported.

The following example is based on the data from Sample 2b, which maps an LDAP server with the OpenIDM repository. The example reconciles only the user `bjensen`, using the `managedUser_systemLdapAccounts` mapping to update the user account in LDAP with the data from the OpenIDM repository. The `_id` for `bjensen` in this example is `b3c2f414-e7b3-46aa-8ce6-f4ab1e89288c`. The example assumes that implicit synchronization has been disabled and that a reconciliation operation is required to copy changes made in the repository to the LDAP system.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/recon?
_action=reconById&mapping=managedUser_systemLdapAccounts&ids=b3c2f414-e7b3-46aa-8ce6-f4ab1e89288c"
```

A reconciliation by ID takes the default reconciliation options that are specified in the mapping, so the source and target queries, and source and target phases described in the previous section apply equally to reconciliation by ID.

12.7. Querying the Reconciliation Audit Log

Reconciliation operations are logged in the file `/path/to/openidm/audit/recon.csv` and in the repository. You can read and query the reconciliation audit logs over the REST interface, as outlined in the following examples.

By default all `audit/recon` query responses are formatted based on the `entryType` of the entry. Fields that are not required for the specific entry type are stripped away from the response. For example, a `summary` entry would not need to include a null `targetObjectId` field, as this would not add information to a summary. You can specify that this auto-formatting be disabled and return the full entry for all entry types. To disable entry formatting, include `formatted=false` as a query parameter in the request.

To return all reconciliation operations logged in the audit log, run a RESTful GET on the `audit/recon` endpoint. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/audit/recon"
```

The following code sample shows an extract of the audit log after the first reconciliation operation in Sample 1.

```
{
  "entries": [
    {
      "mapping": "systemXmlfileAccounts_managedUser",
      "targetObjectId": "managed/user/scarter",
      "sourceObjectId": "system/xmlfile/account/scarter",
      "situation": "ABSENT",
      "reconciling": "source",
```

```
      "ambiguousTargetObjectIds": "",
      "action": "CREATE",
      "actionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "exception": "",
      "_id": "fe250514-d3e1-477a-bb90-88bd4525d70b",
      "entryType": "entry",
      "timestamp": "2014-09-08T08:57:47.575Z",
      "reconId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "rootActionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "status": "SUCCESS",
      "message": null,
      "messageDetail": null
    },
    {
      "mapping": "systemXmlfileAccounts_managedUser",
      "exception": "",
      "_id": "10e4195b-7b38-4b99-9916-a6d2de137c11",
      "entryType": "start",
      "timestamp": "2014-09-08T08:57:47.218Z",
      "reconId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "rootActionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "status": "SUCCESS",
      "message": "Reconciliation initiated by openidm-admin",
      "messageDetail": null
    },
    {
      "mapping": "systemXmlfileAccounts_managedUser",
      "exception": "",
      "_id": "d8634325-78f6-4504-b9f4-ba7b9103e391",
      "entryType": "summary",
      "timestamp": "2014-09-08T08:57:47.607Z",
      "reconId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "rootActionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "status": "SUCCESS",
      "message": "SOURCE_IGNORED: 0 MISSING: 0 FOUND: 0 AMBIGUOUS: 0 UNQUALIFIED: 0 CONFIRMED: 0
 SOURCE_MISSING: 0 ABSENT: 2 TARGET_IGNORED: 0 UNASSIGNED: 0 ",
      "messageDetail": {
        "stage": "COMPLETED_SUCCESS",
        "stageDescription": "reconciliation completed.",
        "progress": {
          "links": {
            "created": 2,
            "existing": {
              "processed": 0,
              "total": "0"
            }
          },
          "source": {
            "existing": {
              "processed": 2,
              "total": "2"
            }
          },
          "target": {
            "created": 2,
            "existing": {
              "processed": 0,
              "total": "0"
            }
```

```
          }
        },
        "duration": 388,
        "situationSummary": {
          "SOURCE_MISSING": 0,
          "FOUND": 0,
          "SOURCE_IGNORED": 0,
          "UNQUALIFIED": 0,
          "UNASSIGNED": 0,
          "TARGET_IGNORED": 0,
          "CONFIRMED": 0,
          "AMBIGUOUS": 0,
          "ABSENT": 2,
          "MISSING": 0
        },
        "statusSummary": {
          "FAILURE": 0,
          "SUCCESS": 2
        },
        "state": "SUCCESS",
        "mapping": "systemXmlfileAccounts_managedUser",
        "started": "2014-09-08T08:57:47.218Z",
        "ended": "2014-09-08T08:57:47.606Z"
      }
    },
    {
      "mapping": "systemXmlfileAccounts_managedUser",
      "targetObjectId": "managed/user/bjensen",
      "sourceObjectId": "system/xmlfile/account/bjensen",
      "situation": "ABSENT",
      "reconciling": "source",
      "ambiguousTargetObjectIds": "",
      "action": "CREATE",
      "actionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "exception": "",
      "_id": "939fd113-1158-4f5c-a7f7-6c4b005dce2f",
      "entryType": "entry",
      "timestamp": "2014-09-08T08:57:47.579Z",
      "reconId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "rootActionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "status": "SUCCESS",
      "message": null,
      "messageDetail": null
    }
  ]
}
```

Most of the fields in this audit log are self-explanatory. Each distinct reconciliation operation is identified by its `reconId`. Each entry in the log is identified by a unique `_id`. The first log entry indicates the status for the complete reconciliation operation. Successive entries indicate the status for each record affected by the reconciliation.

To obtain information on a specific audit log entry, include its entry `_id` in the URL. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/audit/recon/fe250514-d3e1-477a-bb90-88bd4525d70b"
```

The following sample output shows the results of a read operation on a specific reconciliation audit entry.


```
{
  "mapping": "systemXmlfileAccounts_managedUser",
  "targetObjectId": "managed/user/scarter",
  "sourceObjectId": "system/xmlfile/account/scarter",
  "situation": "ABSENT",
  "reconciling": "source",
  "ambiguousTargetObjectIds": "",
  "action": "CREATE",
  "actionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
  "exception": "",
  "_id": "fe250514-d3e1-477a-bb90-88bd4525d70b",
  "entryType": "entry",
  "timestamp": "2014-09-08T08:57:47.575Z",
  "reconId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
  "rootActionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
  "status": "SUCCESS",
  "message": null,
  "messageDetail": null
}
```


To query the audit log for a particular reconciliation operation, use the `audit-by-recon-id` keyword, specifying the reconciliation ID, as follows:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/audit/recon?_queryId=audit-by-recon-id&reconId=<reconID>"
```

Output similar to the following is returned, for the specified reconciliation operation:


```
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 4,
  "result": [
    {
      "mapping": "systemXmlfileAccounts_managedUser",
      "exception": "",
      "_id": "d8634325-78f6-4504-b9f4-ba7b9103e391",
      "entryType": "summary",
      "timestamp": "2014-09-08T08:57:47.607Z",
      "reconId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "rootActionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "status": "SUCCESS",
      "message": "SOURCE_IGNORED: 0 MISSING: 0 FOUND: 0 AMBIGUOUS: 0 UNQUALIFIED: 0
           CONFIRMED: 0 SOURCE_MISSING: 0 ABSENT: 2 TARGET_IGNORED: 0 UNASSIGNED: 0 ",
```

```
      "messageDetail": {
        "stage": "COMPLETED_SUCCESS",
        "stageDescription": "reconciliation completed.",
        "progress": {
          "links": {
            "created": 2,
            "existing": {
              "processed": 0,
              "total": "0"
            }
          },
          "source": {
            "existing": {
              "processed": 2,
              "total": "2"
            }
          },
          "target": {
            "created": 2,
            "existing": {
              "processed": 0,
              "total": "0"
            }
          }
        },
        "duration": 388,
        "situationSummary": {
          "SOURCE_MISSING": 0,
          "FOUND": 0,
          "SOURCE_IGNORED": 0,
          "UNQUALIFIED": 0,
          "UNASSIGNED": 0,
          "TARGET_IGNORED": 0,
          "CONFIRMED": 0,
          "AMBIGUOUS": 0,
          "ABSENT": 2,
          "MISSING": 0
        },
        "statusSummary": {
          "FAILURE": 0,
          "SUCCESS": 2
        },
        "state": "SUCCESS",
        "mapping": "systemXmlfileAccounts_managedUser",
        "started": "2014-09-08T08:57:47.218Z",
        "ended": "2014-09-08T08:57:47.606Z"
      }
    },
    {
      "mapping": "systemXmlfileAccounts_managedUser",
      "exception": "",
      "_id": "10e4195b-7b38-4b99-9916-a6d2de137c11",
      "entryType": "start",
      "timestamp": "2014-09-08T08:57:47.218Z",
      "reconId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "rootActionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "status": "SUCCESS",
      "message": "Reconciliation initiated by openidm-admin",
      "messageDetail": null
```

```
    },
    {
      "mapping": "systemXmlfileAccounts_managedUser",
      "targetObjectId": "managed/user/scarter",
      "sourceObjectId": "system/xmlfile/account/scarter",
      "situation": "ABSENT",
      "reconciling": "source",
      "ambiguousTargetObjectIds": "",
      "action": "CREATE",
      "actionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "exception": "",
      "_id": "fe250514-d3e1-477a-bb90-88bd4525d70b",
      "entryType": "entry",
      "timestamp": "2014-09-08T08:57:47.575Z",
      "reconId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "rootActionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "status": "SUCCESS",
      "message": null,
      "messageDetail": null
    },
    {
      "mapping": "systemXmlfileAccounts_managedUser",
      "targetObjectId": "managed/user/bjensen",
      "sourceObjectId": "system/xmlfile/account/bjensen",
      "situation": "ABSENT",
      "reconciling": "source",
      "ambiguousTargetObjectIds": "",
      "action": "CREATE",
      "actionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "exception": "",
      "_id": "939fd113-1158-4f5c-a7f7-6c4b005dce2f",
      "entryType": "entry",
      "timestamp": "2014-09-08T08:57:47.579Z",
      "reconId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "rootActionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "status": "SUCCESS",
      "message": null,
      "messageDetail": null
    }
  ]
}
```

To query the audit log for a specific reconciliation situation, use the `audit-by-recon-id-situation` keyword, specifying the reconciliation ID and the situation that you want to query. For example, the following query returns all ABSENT records found during the specified reconciliation operation:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/audit/recon?_queryId=audit-by-recon-id-
situation&situation=ABSENT&reconId=e5f3190d-41d9-4bea-907d-b287a9436a45"
```

Output similar to the following is returned, with one entry for each record that matches the situation queried:

```
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 2,
  "result": [
    {
      "mapping": "systemXmlfileAccounts_managedUser",
      "targetObjectId": "managed/user/scarter",
      "sourceObjectId": "system/xmlfile/account/scarter",
      "situation": "ABSENT",
      "reconciling": "source",
      "ambiguousTargetObjectIds": "",
      "action": "CREATE",
      "actionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "exception": "",
      "_id": "fe250514-d3e1-477a-bb90-88bd4525d70b",
      "entryType": "entry",
      "timestamp": "2014-09-08T08:57:47.575Z",
      "reconId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "rootActionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "status": "SUCCESS",
      "message": null,
      "messageDetail": null
    },
    {
      "mapping": "systemXmlfileAccounts_managedUser",
      "targetObjectId": "managed/user/bjensen",
      "sourceObjectId": "system/xmlfile/account/bjensen",
      "situation": "ABSENT",
      "reconciling": "source",
      "ambiguousTargetObjectIds": "",
      "action": "CREATE",
      "actionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "exception": "",
      "_id": "939fd113-1158-4f5c-a7f7-6c4b005dce2f",
      "entryType": "entry",
      "timestamp": "2014-09-08T08:57:47.579Z",
      "reconId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "rootActionId": "e5f3190d-41d9-4bea-907d-b287a9436a45",
      "status": "SUCCESS",
      "message": null,
      "messageDetail": null
    }
  ]
}
```


12.8. Querying the Activity Audit Log

The activity logs track all operations on internal (managed) and external (system) objects. Entries in the activity log contain identifiers for the reconciliation or synchronization action that triggered the activity, and for the original caller and the relationships between related actions.

You can access the activity logs over REST with the following call:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/audit/activity"
```

The following extract of the activity log shows the last entry in the log, which was a password change for user bjensen.


```
{
   "entries": [
   ...
   },
     "before": null,
     "requester": "openidm-admin",
     "parentActionId": "c2c102bc-7b32-4020-b5aa-9a7d63652cb6",
     "_id": "bbaff1e0-923b-48f0-b053-b1614cbb3647",
     "activityId": "c2c102bc-7b32-4020-b5aa-9a7d63652cb6",
     "timestamp": "2014-03-13T16:20:54.811Z",
     "action": "CREATE",
     "message": "create",
     "objectId": "managed/user/4f2f5eea-918a-4ef1-9244-be41dcf128a4",
     "rev": "1",
     "rootActionId": "c2c102bc-7b32-4020-b5aa-9a7d63652cb6"
   },
   {
     "passwordChanged": true,
     "changedFields": [
     "/password"
   ],
     "status": "SUCCESS",
     "after": {
       "securityAnswer": {
         "$crypto": {
           "value": {
             "key": "openidm-sym-default",
             "iv": "8CvlA6rWN03MAhLSKJmbvw==",
             "cipher": "AES/CBC/PKCS5Padding",
             "data": "oJBTrrX+wFAygFZkLuGPrhB/jAIICcdIBuCX1eEbpS0="
           },
           "type": "x-simple-encryption"
         }
       },
   ...
```


To return activity information for a specific action, include the `_id` of the action in the endpoint, for example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/audit/activity/22ef6d20-bd84-4267-9db8-745825a46ad1"
```

Results similar to the following are returned:

```
{
  "passwordChanged": true,
  "changedFields": [
    "/password"
  ],
  "status": "SUCCESS",
  "after": {
    "securityAnswer": {
      "$crypto": {
      "value": {
        "key": "openidm-sym-default",
        "iv": "HpsyTtTXc2pfNrXlYbro7Q==",
        "cipher": "AES/CBC/PKCS5Padding",
        "data": "0M6O7geNjalJ7e0EGSG9B90eaeF8zJuogdL74hcAIRg="
      },
      "type": "x-simple-encryption"
    }
  },
  "userName": "bjensen@example.com",
  "stateProvince": "",
  "postalAddress": "",
  "effectiveAssignments": {},
  "roles": "openidm-authorized",
  "telephoneNumber": "1234567",
  "accountStatus": "active",
  "password": {
    "$crypto": {
      "value": {
        "key": "openidm-sym-default",
        "iv": "dkRjURz761HaObBuLl+EkA==",
        "cipher": "AES/CBC/PKCS5Padding",
        "data": "9chNPUlXotHy195ERj6vlg=="
      },
      "type": "x-simple-encryption"
    }
  },
  "effectiveRoles": [
    "openidm-authorized"
  ],
  "givenName": "Barbara",
  "lastPasswordAttempt": "Thu Mar 13 2014 07:23:12 GMT-0800 (GMT-08:00)",
  "address2": "",
  "passwordAttempts": "0",
  "sn": "Jensen",
  "mail": "bjensen@example.com",
  "securityQuestion": "1",
  "city": "",
  "country": "",
  "_rev": "7",
  "lastPasswordSet": "",
  "postalCode": "",
  "_id": "bjensen",
  "description": "Created By XML1"
},
  "before": {
  "securityAnswer": "Some security answer",
  "userName": "bjensen@example.com",
  "stateProvince": "",
```

```
  "postalAddress": "",
  "roles": "openidm-authorized",
  "telephoneNumber": "1234567",
  "password": {
    "$crypto": {
      "value": {
        "key": "openidm-sym-default",
        "iv": "bqhRyLW1lI+KZROcpgyukg==",
        "cipher": "AES/CBC/PKCS5Padding",
        "data": "qO8A76GqNqftVVwOlasyPw=="
      },
      "type": "x-simple-encryption",
    "securityQuestion": "1",
  "givenName": "Barbara",
  "address2": "",
  "lastPasswordAttempt": "Thu Mar 13 2014 07:23:12 GMT-0800 (GMT-08:00)",
  "passwordAttempts": "0",
  "sn": "Jensen",
  "mail": "bjensen@example.com",
  "country": "",
  "city": "",
  "_rev": "7",
  "lastPasswordSet": "",
  "postalCode": "",
  "_id": "bjensen",
  "description": "Created By XML1",
  "accountStatus": "active"
},
"requester": "openidm-admin",
"parentActionId": "71ddeed8-9006-4578-b869-13e15a3ce6b5",
"_id": "ee88adb8-3329-4f81-a8f2-d9c8e0fbf72b",
"activityId": "71ddeed8-9006-4578-b869-13e15a3ce6b5",
"timestamp": "2014-03-13T16:21:27.086Z",
"action": "UPDATE",
"message": "update",
"objectId": "managed/user/bjensen",
"rev": "7",
"rootActionId": "71ddeed8-9006-4578-b869-13e15a3ce6b5"
}
```


Each action in the activity log has a `rootActionId` and a `parentActionId`. The `rootActionId` is the ID that was assigned to the incoming or initiating request. The `parentActionId` is the ID that is associated with the overall action. So, for example, if an HTTP request invokes a script that changes a user's password, the HTTP request is assigned the `rootActionId` and the action taken by the script is assigned the `parentActionId`. You can query the activity log for the details of a specific action by including the `parentActionId` in the query. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/audit/activity?_queryId=audit-by-activity-parent-
action&parentActionId=0aaba292-1dd3-4e98-a0e2-04bec9ae5209"
```

The following sample output shows the result of a query that requests details of the password change for bjensen.

```
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 2,
  "result": [
    {
      "rootActionId": "71ddeed8-9006-4578-b869-13e15a3ce6b5",
      "changedFields": [
        "/password"
    ],
      "action": "UPDATE",
      "objectId": "managed/user/bjensen",
      "before": {
        "securityAnswer": "Some security answer",
        "userName": "bjensen@example.com",
        "stateProvince": "",
        "postalAddress": "",
        "roles": "openidm-authorized",
        "telephoneNumber": "1234567",
        "password": "CAngetin1",
        "securityQuestion": "1",
        "givenName": "Barbara",
        "address2": "",
        "lastPasswordAttempt": "Thu Mar 13 2014 07:23:12 GMT-0800 (GMT-08:00)",
        "passwordAttempts": "0",
        "sn": "Jensen",
        "mail": "bjensen@example.com",
        "country": "",
        "city": "",
        "_rev": "7",
        "lastPasswordSet": "",
        "postalCode": "",
        "_id": "bjensen",
        "description": "Created By XML1",
        "accountStatus": "active"
      },
      "status": "SUCCESS",
      "_rev": "1",
      "_id": "ee88adb8-3329-4f81-a8f2-d9c8e0fbf72b",
      "parentActionId": "71ddeed8-9006-4578-b869-13e15a3ce6b5",
      "timestamp": "2014-03-13T16:21:27.086Z",
      "message": "update",
      "activityId": "71ddeed8-9006-4578-b869-13e15a3ce6b5",
      "after": {
        "securityAnswer": {
          "$crypto": {
            "value": {
              "key": "openidm-sym-default",
              "iv": "HpsyTtTXc2pfNrXlYbro7Q==",
              "cipher": "AES/CBC/PKCS5Padding",
              "data": "0M6O7geNjalJ7e0EGSG9B90eaeF8zJuogdL74hcAIRg="
            },
            "type": "x-simple-encryption"
          }
        },
        "userName": "bjensen@example.com",
        "stateProvince": "",
        "postalAddress": "",
```

```
        "effectiveAssignments": {},
        "roles": "openidm-authorized",
        "telephoneNumber": "1234567",
        "accountStatus": "active",
        "password": {
          "$crypto": {
            "value": {
              "key": "openidm-sym-default",
              "iv": "dkRjURz761HaObBuLl+EkA==",
              "cipher": "AES/CBC/PKCS5Padding",
              "data": "9chNPUlXotHy195ERj6vlg=="
          },
        "type": "x-simple-encryption"
      }
    },
    "effectiveRoles": [
       "openidm-authorized"
    ],
    "givenName": "Barbara",
    "lastPasswordAttempt": "Thu Mar 13 2014 07:23:12 GMT-0800 (GMT-08:00)",
    "address2": "",
    "passwordAttempts": "0",
    "sn": "Jensen",
    "mail": "bjensen@example.com",
    "securityQuestion": "1",
    "city": "",
    "country": "",
    "_rev": "7",
    "lastPasswordSet": "",
    "postalCode": "",
    "_id": "bjensen",
    "description": "Created By XML1"
  },
  "rev": "7",
  "requester": "openidm-admin",
  "passwordChanged": true
  }
 ]
}
```

Note

For audit logs in the repository, you can define custom queries using the parameterized query mechanism. For more information, see Section 7.3.2, "Parameterized Queries".

For more information about the entries in these logs, see Chapter 18, "*Using Audit Logs*".

12.9. Querying the Synchronization Audit Log

LiveSync and implicit sync operations are logged in the file `/path/to/openidm/audit/sync.csv` and in the repository. You can read the synchronization audit logs over the REST interface, as outlined in the following examples.

To return all synchronization operations logged in the audit log, run a RESTful GET on the `audit/sync` endpoint. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/audit/sync"
```

Most of the fields in the synchronization audit log are self-explanatory. Each distinct synchronization operation is identified by its `actionId`. The `rootActionId` is the ID that was assigned to the incoming or initiating request - so if a modification to a user entry triggers an implicit synchronization operation, the sync operation is assigned an `actionId` and `rootActionId` refers to the original change operation. Each entry in the log is identified by a unique `_id`.

To obtain information on a specific audit log entry, include its entry `_id` in the URL. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/audit/sync/a311b656-508c-4f56-9df4-f907364184f1"
```

The following sample output shows the results of a read operation on a specific synchronization audit entry.


```
{
  "entries": [
    {
      "mapping": "systemAdAccounts_managedUser",
      "targetObjectId": "7e5eb90b-f643-4858-803e-a01931f9c12e",
      "sourceObjectId": "system/ad/account/rheath",
      "situation": "CONFIRMED",
      "actionId": "ea6a81e0-a98a-4e72-8c77-50b5756be1f6",
      "_id": "b3e3190c-9e9d-4cd1-8fec-01705ad54109",
      "timestamp": "2014-10-30T14:48:58.415Z",
      "rootActionId": "ea6a81e0-a98a-4e72-8c77-50b5756be1f6",
      "status": "SUCCESS",
      "message": null,
      "messageDetail": null,
      "exception": "",
      "action": "UPDATE"
    },
    {
      "mapping": "managedUser_systemLdapAccounts",
      "targetObjectId": "uid=rheath,ou=People,dc=example,dc=com",
      "sourceObjectId": "managed/user/7e5eb90b-f643-4858-803e-a01931f9c12e",
      "situation": "CONFIRMED",
      "actionId": "ea6a81e0-a98a-4e72-8c77-50b5756be1f6",
      "_id": "105a39f7-f071-481a-ae82-e233e556cc5a",
      "timestamp": "2014-10-30T14:48:58.402Z",
      "rootActionId": "ea6a81e0-a98a-4e72-8c77-50b5756be1f6",
      "status": "SUCCESS",
      "message": null,
      "messageDetail": null,
```

```
      "exception": "",
      "action": "UPDATE"
    }
  ]
}
```

The output shows two records that originated from the same LiveSync action. The first record indicates a change on the `system/ad` entry, which triggered a LiveSync to update the corresponding `managed/user` entry. The second record indicates an implicit sync from `managed/user` to the corresponding entry in `system/ldap`. Note that the `rootActionId` is the same for both these records.

12.10. Configuring the LiveSync Retry Policy

OpenIDM enables you to specify what should happen if a LiveSync operation reports a failure for an operation. By configuring the LiveSync retry policy, you can specify how many times a failed modification should be reattempted and what should happen in the event that the modification is unsuccessful after the specified number of attempts. If no retry policy is configured, OpenIDM reattempts the change an infinite number of times, until the change is successful. This behavior can increase data consistency in the case of transient failures (for example, when the connection to the database is temporarily lost). However, in situations where the cause of the failure is permanent (for example, if the change does not meet certain policy requirements) the change will never succeed, regardless of the number of attempts. In this case, the infinite retry behavior can effectively block subsequent LiveSync operations from starting.

Generally, a scheduled reconciliation operation will eventually force consistency. However, to prevent repeated retries that block the LiveSync mechanism, you should restrict the number of times OpenIDM reattempts the same modification. You can then specify what OpenIDM does with failed LiveSync changes. The failed modification can be stored in a "dead letter queue", discarded, or reapplied. Alternatively, an administrator can be notified of the failure by email or by some other means. This behavior can be scripted. The default configuration, in the samples provided with OpenIDM, is to retry a failed modification five times, and then to log and ignore the failure.

The LiveSync retry policy is configured in the connector configuration file (`provisioner.openicf-*.json`). The sample connector configuration files have a retry policy defined as follows:

```
"syncFailureHandler" : {
  "maxRetries" : 5,
  "postRetryAction" : "logged-ignore"
},
```

The `maxRetries` field specifies the number of attempts that OpenIDM should make to process the failed modification. The value of this property must be a positive integer, or `-1`. A value of zero indicates that failed modifications should not be reattempted. In this case, the post retry action is executed immediately when a LiveSync operation fails. A value of `-1` (or omitting the `maxRetries` property, or the entire `syncFailureHandler` from the configuration) indicates that failed modifications should be retried an infinite number of times. In this case, no post retry action is executed.

The default retry policy relies on the scheduler, or whatever invokes the LiveSync operation. Therefore, if retries are enabled and a LiveSync modification fails, OpenIDM will retry the modification the next time that LiveSync is invoked.

The `postRetryAction` field indicates what action OpenIDM should take in the event that the maximum number of retries has been reached (or if `maxRetries` has been set to zero). The post retry action can be one of the following:

- `logged-ignore` indicates that OpenIDM should ignore the failed modification, and log its occurrence.
- `dead-letter-queue` indicates that OpenIDM should save the details of the failed modification in a table in the repository (accessible over REST at `repo/synchronisation/deadLetterQueue/provisioner-name`).
- `script` specifies a custom script that should be executed when the maximum number of retries has been reached. For information about using custom scripts in the configuration, see Appendix F, "*Scripting Reference*".

  In addition to the regular objects described in the Scripting Reference, the following objects are available in the script scope:

  - `syncFailure`

    Provides details about the failed record. The structure of the `syncFailure` object is as follows:

    ```
    "syncFailure" :
      {
        "token" : the ID of the token,
        "systemIdentifier" : a string identifier that matches the "name" property in
                             provisioner.openicf.json,
        "objectType" : the object type being synced, one of the keys in the
                       "objectTypes" property in provisioner.openicf.json,
        "uid" : the UID of the object (for example uid=joe,ou=People,dc=example,dc=com),
        "failedRecord", the record that failed to synchronize
      },
    ```

    To access these fields, include `syncFailure.fieldname` in your script.

  - `failureCause`

    Provides the exception that caused the original LiveSync failure.

  - `failureHandlers`

    OpenIDM currently provides two synchronization failure handlers "out of the box". `loggedIgnore` indicates that the failure should be logged, after which no further action should be taken. `deadLetterQueue` indicates that the failed record should be written to a specific table in the repository, where further action can be taken. To invoke one of the internal failure handlers from your script, use a call similar to the following (shown here for JavaScript):

    ```
    failureHandlers.deadLetterQueue.invoke(syncFailure, failureCause);
    ```

Two sample scripts are provided in `path/to/openidm/samples/syncfailure/script`, one that logs failures, and one that sends them to the dead letter queue in the repository.

The following sample provisioner configuration file extract shows a LiveSync retry policy that specifies a maximum of four retries before the failed modification is sent to the dead letter queue.

```
...
"connectorName" : "org.identityconnectors.ldap.LdapConnector"
    },
    "syncFailureHandler" : {
        "maxRetries" : 4,
        "postRetryAction" : dead-letter-queue
    },
    "poolConfigOption" : {
...
```

In the case of a failed modification, a message similar to the following is output to the log file:

```
INFO: sync retries = 1/4, retrying
```

OpenIDM reattempts the modification, the specified number of times. If the modification is still unsuccessful, a message similar to the following is logged:

```
INFO: sync retries = 4/4, retries exhausted
Jul 19, 2013 11:59:30 AM
    org.forgerock.openidm.provisioner.openicf.syncfailure.DeadLetterQueueHandler invoke
INFO: uid=jdoe,ou=people,dc=example,dc=com saved to dead letter queue
```

The log message indicates the entry for which the modification failed (`uid=jdoe`, in this example).

You can view the failed modification in the dead letter queue, over the REST interface, as follows:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/repo/synchronisation/deadLetterQueue/ldap?_queryId=query-all-ids"
     {
       "query-time-ms": 2,
       "result":
       [
           {
               "_id": "4",
               "_rev": "0"
           }
       ],
       "conversion-time-ms": 0
    }
```

To view the details of a specific failed modification, include its ID in the URL:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/repo/synchronisation/deadLetterQueue/ldap/4"
     {
  "objectType": "account",
  "systemIdentifier": "ldap",
  "failureCause": "org.forgerock.openidm.sync.SynchronizationException:
            org.forgerock.openidm.objset.ConflictException:
            org.forgerock.openidm.sync.SynchronizationException:
            org.forgerock.openidm.script.ScriptException:
            ReferenceError: \"bad\" is not defined.
            (PropertyMapping/mappings/0/properties/3/condition#1)",
  "token": 4,
  "failedRecord": "complete record, in xml format"
  "uid": "uid=jdoe,ou=people,dc=example,dc=com",
  "_rev": "0",
  "_id": "4"
}
```

12.11. Disabling Automatic Synchronization Operations

By default, all mappings participate in automatic synchronization operations, that is, a change to a managed object is automatically synchronized to all resources for which the managed object is configured as a source. Similarly, if LiveSync is enabled for a system, changes to an object on that system are automatically propagated to the managed object repository. You can prevent a specific mapping from participating in this automatic synchronization by setting the `"enableSync"` property of that mapping to false. In the following example, implicit synchronization is disabled. This means that changes to objects in the internal repository are not automatically propagated to the LDAP directory. To propagate changes to the LDAP directory, reconciliation must be launched manually.

```
{
    "mappings" : [
        {
            "name" : "managedUser_systemLdapAccounts",
            "source" : "managed/user",
            "target" : "system/ldap/account",
            "enableSync" : false,
             ....
}
```

If `enableSync` is set to `false` for a system to managed user mapping (for example `"systemLdapAccounts_managedUser"`), LiveSync is disabled for that mapping.

12.12. Configuring Synchronization Failure Compensation

When implicit synchronization is used to push a large number of changes from the managed object repository to several external repositories, the process can take some time. Problems such as lost connections might happen, resulting in the changes being only partially synchronized.

For example, if a Human Resources manager adds a group of new employees in one database, a partial synchronization might mean that some of those employees do not have access to their email or other systems.

You can configure implicit synchronization such that the system reverts an entire synchronization operation, in the event that it was not completely successful. An example of such a configuration is illustrated in Section 3.11, "Sample 5b - Failure Compensation With Multiple Resources" in the *Installation Guide*. That sample demonstrates how OpenIDM compensates when synchronization to an external resource fails.

Failure compensation works by using the optional `onSync` hook, which can be specified in the `conf/managed.json` file. The `onSync` hook can be used to provide failure compensation as follows:

```
...
"onDelete" : {
    "type" : "text/javascript",
    "file" : "ui/onDelete-user-cleanup.js"
    },
"onSync" : {
    "type" : "text/javascript",
    "file" : "compensate.js"
    },
"properties" : [
    ...
```

The `onSync` hook references a script (`compensate.js`), that is located in the `/path/to/openidm/bin/defaults/script` directory.

When a managed object is changed, an implicit synchronization operation attempts to synchronize the change (and any other pending changes) with any external data store(s) for which a mapping is configured.

The implicit synchronization process proceeds with each mapping, in the order in which the mappings are specified in `sync.json`.

The `compensate.js` script is designed to avoid partial synchronization. If synchronization is successful, for all configured mappings, OpenIDM exits from the script.

If an implicit synchronization operation fails for a particular resource, the `onSync` hook invokes the `compensate.js` script. This script attempts to revert the original change by performing another update to the managed object. This change, in turn, triggers another implicit synchronization operation to all external resources for which mappings are configured.

If the synchronization operation fails again, the `compensate.js` script is triggered again. This time, however, the script recognizes that the change was originally called as a result of a compensation and aborts. OpenIDM logs warning messages related to the sync action (`notifyCreate, notifyUpdate, notifyDelete`), along with the error that caused the sync failure.

If failure compensation is not configured, any issues with connections to an external resource can lead to data stores that are out of sync, such as the example cited earlier where some new employees do not have access to their corporate email accounts.

With the `compensate.js` script, any such errors will result in each data store using the information it had before the implicit synchronization operation started. OpenIDM stores that information, temporarily, in properties such as `oldObject` and `oldTarget`.

In this particular example, human resource managers should see that new employees are not shown in their database. Then, the administrators of the OpenIDM system can check log files for errors, address them, and then restart the implicit synchronization process with a new REST call.

12.13. Synchronization Situations and Actions

During synchronization, OpenIDM categorizes objects according to their *situation*. Situations are characterized by whether an object exists on a source or target system, whether OpenIDM has registered a link between the source object and the target object, and whether the object is considered *valid*, as assessed by the `validSource` and `validTarget` scripts. OpenIDM then takes a specific action, depending on the situation.

You can define actions for particular situations in the `policies` section of a synchronization mapping, as shown in the following excerpt.

```
{
    "policies": [
        {
            "situation": "CONFIRMED",
            "action": "UPDATE"
        },
        {
            "situation": "FOUND",
            "action": "UPDATE"
        },
        {
            "situation": "ABSENT",
            "action": "CREATE"
        },
        {
            "situation": "AMBIGUOUS",
            "action": "EXCEPTION"
        },
        {
            "situation": "MISSING",
            "action": "EXCEPTION"
        },
        {
```

```
            "situation": "UNQUALIFIED",
            "action": "DELETE"
        },
        {
            "situation": "UNASSIGNED",
            "action": "EXCEPTION"
        }
    ]
}
```

If you do not define a policy for a particular situation, OpenIDM takes the *default action* for the situation.

The following sections describe the possible situations and their default corresponding actions.

12.13.1. Synchronization Situations

OpenIDM performs a reconciliation operation in two phases:

1. *Source reconciliation*, where OpenIDM accounts for source objects and associated links, based on the configured mapping.
2. *Target reconciliation*, where OpenIDM iterates over the target objects that were not processed in the first phase.

During the source reconciliation phase, OpenIDM builds three lists, assigning values to the objects to reconcile.

1. All valid objects from the source

   OpenIDM assigns valid source objects `qualifies=1`. Invalid objects, including those that were not found in the source system, and those that were filtered out by the script specified in the `validSource` property, are assigned `qualifies=0`.

2. All records from the appropriate links table

   Objects that have a corresponding link in the links table of the repository are assigned `link=1`. Objects that do not have a corresponding link are assigned `link=0`.

3. All valid objects on the target system

   Objects that are found in the target system are assigned `target=1`. Objects that are not found in the target system are assigned `target=0`.

Based on the values assigned to objects during source reconciliation, OpenIDM assigns situations, listed here with default and appropriate alternative actions.

"CONFIRMED" (qualifies=1, link=1, target=1)

The source object qualifies for a target object, and a link to an existing target object was found. This situation is detected during change events and during reconciliation.

Default action: `UPDATE` the target object.

Other valid actions: `IGNORE, REPORT, NOREPORT, ASYNC`

"FOUND" (qualifies=1, link=0, target=1)

The source object qualifies for a target object and there is no link to an existing target object. There is a single target object, that correlates with this source object, according to the logic in the correlation query. This situation is detected during change events and reconciliation.

Default action: `UPDATE` the target object.

Other valid actions: `EXCEPTION, IGNORE, REPORT, NOREPORT, ASYNC`

"FOUND_ALREADY_LINKED" (qualifies=1, link=1, target=1)

The source object qualifies for a target object and there is no link from that source object to an existing target object. There is a single target object, that correlates with this source object, according to the logic in the correlation query, but that target object is already linked to a different source object. This situation is detected during change events and reconciliation.

Default action: log an `EXCEPTION`.

Other valid actions: `IGNORE, REPORT, NOREPORT, ASYNC`

"ABSENT" (qualifies=1, link=0, target=0)

The source object qualifies for a target object, there is no link to an existing target object, and there is no correlated target object found. This situation is detected during change events and reconciliation.

Default action: `CREATE` a target object.

Other valid actions: `EXCEPTION, IGNORE, REPORT, NOREPORT, ASYNC`

"AMBIGUOUS" (qualifies=1, link=0, target>1)

The source object qualifies for a target object, there is no link to an existing target object, but there is more than one correlated target object (that is, more than one possible match on the target system). This situation is detected during source object changes and reconciliation.

Default action: log an `EXCEPTION`.

Other valid actions: `IGNORE, REPORT, NOREPORT, ASYNC`

"MISSING" (qualifies=1, link=1, target=0)

The source object qualifies for a target object, and there is a link to a target object, but the target object is missing. This situation is detected during reconciliation operations and during source object changes.

Default action: log an `EXCEPTION`.

Other valid actions: `CREATE, UNLINK, IGNORE, REPORT, NOREPORT. ASYNC`

"UNQUALIFIED" (qualifies=0, link=0 or 1, target=1 or >1)

The source object is unqualified (by the "validSource" script). One or more target objects are found through the correlation logic. This situation is detected during change events and reconciliation.

Default action: `DELETE` the target object or objects.

Other valid actions: `EXCEPTION, IGNORE, REPORT, NOREPORT, ASYNC`

"TARGET_IGNORED" (qualifies=0, link=0 or 1, target=1)

The source object is unqualified (by the "validSource" script). One or more target objects are found through the correlation logic. This situation is detected only during source object changes.

It is different from "UNQUALIFIED", based on the status of the link and target. If there is a link, the target is not valid. If there is no link and exactly one target, that target is not valid.

Default action: `IGNORE` the target object until the next full reconciliation operation.

Other valid actions: `DELETE, UNLINK, EXCEPTION, REPORT, NOREPORT, ASYNC`

"SOURCE_IGNORED" (qualifies=0, link=0, target=0)

The source object is unqualified (by the "validSource" script), no link is found, and no correlated target exists. This situation is detected during source object changes and reconciliation.

Default action: `IGNORE` the source object.

Other valid actions: `EXCEPTION, REPORT, NOREPORT, ASYNC`

"LINK_ONLY" (qualifies=n/a, link=1, target=0)

The source may or may not be qualified, a link is found, but no target object is found. This situation is detected only during source object changes.

Default action: Log an `EXCEPTION`.

Other valid actions: `UNLINK, IGNORE, REPORT, NOREPORT, ASYNC`

"ALL_GONE" (qualifies=n/a, link=0, cannot-correlate)

The source object has been removed. No link is found. Correlation is not possible, for one of the following reasons:

- No previous source value can be found
- There is no correlation query

- A previous value was found, and a correlation query exists, but no corresponding target was found

  This situation is detected only during source object changes.

  Default action: "IGNORE" the source object.

  Other valid actions: `EXCEPTION, REPORT, NOREPORT, ASYNC`

During the target reconciliation phase, OpenIDM assigns the following values as it iterates through the target objects that were not accounted for during the source reconciliation.

1. Valid objects from the target

   OpenIDM assigns valid target objects `qualifies=1`. Invalid objects, including those that are filtered out by the script specified in the `validTarget` property, are assigned `qualifies=0`.

2. All records from the appropriate links table

   Objects that have a corresponding link in the links table of the repository are assigned `link=1`. Objects that do not have a corresponding link are assigned `link=0`.

3. All valid objects on the source system

   Objects that are found in the source system are assigned `source=1`. Objects that are not found in the source system are assigned `source=0`.

Based on the values that are assigned to objects during the target reconciliation phase, OpenIDM assigns situations, listed here with their default actions.

"TARGET_IGNORED" (qualifies=0)

During target reconciliation, the target becomes unqualified by the "validTarget" script. This situation is detected only during reconciliation operations.

Default action: `IGNORE` the target object.

Other valid actions: `DELETE, UNLINK, REPORT, NOREPORT, ASYNC`

"UNASSIGNED" (qualifies=1, link=0)

A valid target object exists, for which there is no link. This situation is detected only during reconciliation operations.

Default action: log an `EXCEPTION`.

Other valid actions: `IGNORE, REPORT, NOREPORT, ASYNC`

"CONFIRMED" (qualifies=1, link=1, source=1)

The target object qualifies, and a link to a source object exists. This situation is detected only during reconciliation operations.

Default action: `UPDATE` the target object.

Other valid actions: `IGNORE, REPORT, NOREPORT`

"UNQUALIFIED" (qualifies=0, link=1, source=1, but source does not qualify)

The target object is unqualified, (by the "validTarget" script), but there is a link to an existing source object, which is also unqualified. This situation is detected during change events and reconciliation.

Default action: `DELETE` the target object.

Other valid actions: `UNLINK, EXCEPTION, IGNORE, REPORT, NOREPORT, ASYNC`

SOURCE_MISSING (qualifies=1, link=1, source=0)

The target object qualifies and a link is found. But the source object is missing. This situation is detected during change events and reconciliation.

Default action: log an "EXCEPTION".

Other valid actions: `DELETE, UNLINK, IGNORE, REPORT, NOREPORT, ASYNC`

The following sections reiterate in detail how OpenIDM assigns situations during each of the two synchronization phases.

12.13.2. Source Reconciliation

OpenIDM starts reconciliation and LiveSync by reading a list of objects from the resource. For reconciliation, the list includes all objects that are available through the connector. For LiveSync, the list contains only changed objects. The connector can filter objects out of the list, too, by using the script specified in the `validSource` property.

OpenIDM then iterates over the list, checking each entry against the `validSource` filter, and classifying objects according to their situations as described in Section 12.13.1, "Synchronization Situations". OpenIDM uses the list of links for the current mapping to classify objects. Finally, OpenIDM executes the action that is configured for each situation.

The following table shows how OpenIDM assigns the appropriate situation during source reconciliation, depending on whether a valid source exists (Source Qualifies), whether a link exists in the repository (Link Exists), and how many target objects are found, based either on links or on the results of the correlation query.

Table 12.1. Resolving Source Reconciliation Situations

Source Qualifies?		**Link Exists?**		**Target Objects Found**[a]			**Situation**
Yes	**No**	**Yes**	**No**	**0**	**1**	**> 1**	
	X		X		X		SOURCE_MISSING

Source Qualifies?		Link Exists?		Target Objects Found[a]			Situation
Yes	No	Yes	No	0	1	> 1	
	X		X			X	UNQUALIFIED
	X	X		X			UNQUALIFIED
	X	X			X		TARGET_IGNORED
	X	X				X	UNQUALIFIED
X			X	X			ABSENT
X			X		X		FOUND
X			X[b]		X		FOUND_ALREADY_LINKED
X			X			X	AMBIGUOUS
X		X		X			MISSING
X		X			X		CONFIRMED

[a]If no link exists for the source object, then OpenIDM executes a correlation query. If no previous object is available, OpenIDM cannot correlate.
[b]A link does exist from the target object but it not for this specific source object.

12.13.3. Target Reconciliation

During source reconciliation, OpenIDM cannot detect situations where no source object exists, such as the UNASSIGNED situation. When no source object exists, OpenIDM detects the situation during the second reconciliation phase, target reconciliation. During target reconciliation, OpenIDM iterates over all target objects that do not have a representation on the source, checking each object against the `validTarget` filter, determining the appropriate situation, and executing the action configured for the situation.

The following table shows how OpenIDM assigns the appropriate situation during target reconciliation, depending on whether a valid target exists (Target Qualifies), whether a link with an appropriate type exists in the repository (Link Exists), whether a source object exists (Source Exists), and whether the source object qualifies (Source Qualifies). Not all situations assigned during source reconciliation are assigned during target reconciliation.

Table 12.2. Resolving Target Reconciliation Situations

Target Qualifies?		Link Exists?		Source Exists?		Source Qualifies?		Situation
Yes	No	Yes	No	Yes	No	Yes	No	
	X							TARGET_IGNORED
X			X		X			UNASSIGNED
X		X		X		X		CONFIRMED
X		X		X			X	UNQUALIFIED
X		X			X			SOURCE_MISSING

12.13.4. Situations Specific to Implicit Synchronization and LiveSync

Certain situations occur only during implicit synchronization (when OpenIDM pushes changes made in the repository out to external systems) and LiveSync (when OpenIDM polls external system change logs for changes and updates the repository).

The following table shows the situations that pertain only to implicit sync and LiveSync, when records are *deleted* from the source or target resource.

Table 12.3. Resolving Implicit Sync and LiveSync Delete Situations

Source Qualifies?		**Link Exists?**		**Target Objects Found** [a]			**Situation**
Yes	**No**	**Yes**	**No**	**0**	**1**	**> 1**	
N/A	N/A	X		X			LINK_ONLY
N/A	N/A		X	X			ALL_GONE
X			X			X	AMBIGUOUS
	X		X			X	UNQUALIFIED

[a] If no link exists for the source object, then OpenIDM executes a correlation query. If no previous object is available, OpenIDM cannot correlate.

12.13.5. Synchronization Actions

Once OpenIDM has assigned a situation to an object, OpenIDM takes the actions configured in the mapping. If no action is configured, then OpenIDM takes the default action for the situation. OpenIDM supports the following actions.

"CREATE"

Create and link a target object.

"UPDATE"

Link and update a target object.

"DELETE"

Delete and unlink the target object.

"LINK"

Link the correlated target object.

"UNLINK"

Unlink the linked target object.

"EXCEPTION"

Flag the link situation as an exception.

You should not use this action for LiveSync mappings.

"IGNORE"

Do not change the link or target object state.

"REPORT"

Do not perform any action but report on what would happen if the default action were performed.

"NOREPORT"

Do not perform any action or generate any report.

"ASYNC"

An asynchronous process has been started so do not perform any action or generate any report.

12.13.6. Providing a Script as an Action

In addition to the static synchronization actions described in the previous section, you can provide a script that is run in specific synchronization situations. The following extract of a sample `sync.json` file specifies that when a synchronization operation assesses an entry as `ABSENT`, the workflow named `managedUserApproval` is invoked. The parameters for the workflow are passed in as properties of the `action` parameter.

```
{
    "situation" : "ABSENT",
    "action" : {
        "workflowName" : "managedUserApproval",
        "type" : "text/javascript",
        "file" : "workflow/triggerWorkflowFromSync.js"
    }
}
```

The variables available to these scripts are described in Appendix F, "*Scripting Reference*".

12.14. Asynchronous Reconciliation

Reconciliation can work in tandem with workflows to provide additional business logic to the reconciliation process. You can define scripts to determine the action that should be taken for a particular reconciliation situation. A reconciliation process can launch a workflow after it has assessed a situation, and then perform the reconciliation, or some other action.

For example, you might want a reconciliation process to assess new user accounts that need to be created on a target resource. However, new user account creation might require some kind of approval from a manager before the accounts are actually created. The initial reconciliation process can assess the accounts that need to be created, launch a workflow to request management approval for those accounts, and then relaunch the reconciliation process to create the accounts, once the management approval has been received.

In this scenario, the defined script returns `IGNORE` for new accounts and the reconciliation engine does not continue processing the given object. The script then initiates an asynchronous process which calls back and completes the reconciliation process at a later stage.

A sample configuration for this scenario is available in `openidm/samples/sample9`, and described in Section 3.15, "Sample 9 - Asynchronous Reconciliation Using Workflows" in the *Installation Guide*.

Configuring asynchronous reconciliation involves the following steps:

1. Create the workflow definition file (`.xml or .bar` file) and place it in the `openidm/workflow` directory. For more information about creating workflows, see Chapter 17, "*Integrating Business Processes and Workflows*".

2. Modify the `conf/sync.json` file for the situation or situations that should call the workflow. Reference the workflow name in the configuration for that situation.

   For example, the following `sync.json` extract calls the `managedUserApproval` workflow if the situation is assessed as `ABSENT`:

```
{
    "situation" : "ABSENT",
    "action" : {
        "workflowName" : "managedUserApproval",
        "type" : "text/javascript",
        "file" : "workflow/triggerWorkflowFromSync.js"
    }
},
```

3. In the sample configuration, the workflow calls a second, explicit reconciliation process as a final step. This reconciliation process is called on the `sync` context path, with the `performAction` action (`openidm.action('sync', 'performAction', params)`).

   You can also use this kind of explicit reconciliation to perform a specific action on a source or target record, regardless of the assessed situation.

   You can call such an operation over the REST interface, specifying the source, and/or target IDs, the mapping, and the action to be taken. The action can be any one of the supported reconciliation actions, that is, `CREATE, UPDATE, DELETE, LINK, UNLINK, EXCEPTION, REPORT, NOREPORT, ASYNC, IGNORE`. In addition, if you specify a `reconId`, the action that is taken is logged in the `audit/recon` log, along with the the other audit data for that reconciliation run.

The following sample command calls the DELETE action on user `bjensen`, whose `_id` in the LDAP directory is `uid=bjensen,ou=People,dc=example,dc=com`. The user is deleted in the target resource, in this case, the OpenIDM repository.

Note that the `_id` must be URL-encoded in the REST call.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/sync?_action=performAction&sourceId=uid%3Dbjensen%2Cou%3DPeople%2Cdc
%3Dexample%2Cdc%3Dcom&mapping=
 systemLdapAccounts_ManagedUser&action=DELETE"
{}
```

12.15. Configuring Case Sensitivity for Data Stores

By default, OpenIDM is case-sensitive, which means that case is taken into account when comparing IDs during reconciliation. For data stores that are case-insensitive, such as OpenDJ, IDs and links that are created by a reconciliation process may be stored with a different case to the way in which they are stored in the OpenIDM repository. Such a situation can cause problems during a reconciliation operation, as the links for these IDs may not match.

For such data stores, you can configure OpenIDM to ignore case during reconciliation operations. With case sensitivity turned off in OpenIDM, for those specific mappings, comparisons are done without regard to case.

To specify that data stores are not case-sensitive, set the `"sourceIdsCaseSensitive"` or `"targetIdsCaseSensitive"` property to `false` in the mapping for those links. For example, if the LDAP data store is case-insensitive, set the mapping from the LDAP store to the managed user repository as follows:

```
"mappings" : [
{
"name" : "systemLdapAccounts_managedUser",
"source" : "system/ldap/account",
"sourceIdsCaseSensitive" : false,
"target" : "managed/user",
"properties" : [
...
```

If a mapping inherits links by using the `"links"` property, it is not necessary to set case sensitivity, because the mapping uses the setting of the referred links.

Note that configuring OpenIDM to be case-insensitive when comparing links does not make the OpenICF provisioner case-insensitive when it requests data. For example, if a user entry is stored with the ID `testuser` and you make a request for `https://localhost:8443/openidm/managed/TESTuser`, most provisioners will filter out the match because of the difference in case, and will indicate that the record is not found. To prevent the provisioner from performing this secondary filtering, set the `enableFilteredResultsHandler` property to `false` in the provisioner configuration. For example:

```
"resultsHandlerConfig" :
{
    "enableFilteredResultsHandler":false,
},
```

Caution

Do not disable the filtered results handler for the CSV file connector. The CSV file connector does not perform filtering so if you disable the filtered results handler for this connector, the full CSV file will be returned for every request.

12.16. Reconciliation Optimization

By default, reconciliation is configured to function in an optimized way. Some of these optimizations might, however, be unsuitable for your environment. The following sections describe the optimizations and how they can be configured.

12.16.1. Correlating Empty Target Sets

To optimize a reconciliation operation, the reconciliation process does not attempt to correlate source objects to target objects if the set of target objects is empty when the correlation is started. This considerably speeds up the process the first time the reconciliation is run. You can change this behavior for a specific mapping by adding the `correlateEmptyTargetSet` property to the mapping definition and setting it to `true`. For example:

```
{
    "mappings": [
        {
            "name"                     : "systemMyLDAPAccounts_managedUser",
            "source"                   : "system/MyLDAP/account",
            "target"                   : "managed/user",
            "correlateEmptyTargetSet"  : true
        },
    ]
}
```

Be aware that this setting will have a performance impact on the reconciliation process.

12.16.2. Prefetching Links

All links are queried at the start of a correlation and the results of that query are used. You can disable the prefetching of links, so that the correlation process looks up each link in the database as it processes each source or target object. You can disable the prefetching of links by adding the `prefetchLinks` property to the mapping, and setting it to `false`, for example:

```
{
    "mappings": [
        {
            "name": "systemMyLDAPAccounts_managedUser",
            "source": "system/MyLDAP/account",
            "target": "managed/user"
            "prefetchLinks" : false
        }
    ]
}
```

Be aware that this setting will have a performance impact on the reconciliation process.

12.16.3. Parallel Reconciliation Threads

By default, reconciliation is executed in a multi-threaded manner, that is, numerous threads are dedicated to the same reconciliation run. Multithreading generally improves reconciliation run performance. The default number of threads for a single reconciliation run is ten (plus the main reconciliation thread). Under normal circumstances, you should not need to change this number, however the default might not be appropriate in the following situations:

- The hardware has many cores and supports more concurrent threads. As a rule of thumb for performance tuning, start with setting the thread number to two times the number of cores.
- The source or target is an external system with high latency or slow response times. Threads may then spend considerable time waiting for a response from the external system. Increasing the available threads enables the system to prepare or continue with additional objects.

To change the number of threads, set the `taskThreads` property in the `conf/sync.json` file, for example:

```
    "mappings" : [
        {
            "name" : "systemXmlfileAccounts_managedUser",
            "source" : "system/xmlfile/account",
            "target" : "managed/user",
            "taskThreads" : 20
            ...
         }
    ]
}
```

A value of `0` specifies that reconciliation is run on the main reconciliation thread, that is, in a serial manner.

12.17. Correlation Queries

Every time OpenIDM creates an object through synchronization, it creates a *link* between the source and target objects. OpenIDM then uses the link to determine the object's situation during later synchronization operations.

Initial, full synchronization operations can involve correlating many objects that exist on both source and target systems. In this case, OpenIDM uses correlation queries to find target objects that already exist, and that correspond to source objects. For the target objects that match a correlation query, OpenIDM needs only to create a link, rather than a new target object.

Correlation queries are accomplished by using script to construct the actual query map. The content of the query is generated dynamically, using values from the source object. Each source object results in a new query being sent to the target system, using (possibly transformed) values from the source object for its execution.

Correlation queries are defined as part of the mapping (in `sync.json`) and run against *target resources*, either managed or system objects, depending on the mapping. Correlation queries on system objects access the connector, which executes the query on the external resource.

The preferred syntax for a correlation query is a filtered query, using the `_queryFilter` keyword, although predefined queries (using `_queryId`) and native queries (using `_queryExpression`) are also supported for correlation queries.

A correlation query must return a map that holds a generic query, with the following elements:

- A condition, such as "Equals", "Starts with", or "Greater than".

  For examples of query conditions, see Section 7.3.4, "Constructing Queries".

- The element that is being compared, on the target object, for example, `uid`.

  Note that this element on the target object is not necessarily a single attribute. Your query filter can be as simple, or as complex, as you need it to be, from a single operator to an entire boolean expression tree.

  When the target object is a system object, this attribute must be referred to by its OpenIDM name, rather than its native (OpenICF) name. For example, in the following provisioner configuration excerpt, the name to use would be `uid` and not `__NAME__`:

  ```
  "uid" : {
      "type" : "string",
      "nativeName" : "__NAME__",
      "required" : true,
      "nativeType" : "string"
  }
  ...
  ```

- The value to search for in the query.

  This value is generally based on one or more values from the source object, but is not necessarily the value of a single source object property. The way in which your script uses the values from the source object to find a matching record in the target system is up to you. It might be a transformation of a source object property (for example, `toUpperCase()`), concatenated with other strings or properties. You can also use this value to call an external REST endpoint, the response from which would be the final "value" portion of the query.

The following query finds objects on the target whose `uid` is the same as the `userName` of a source object.

```
"correlationQuery" : {
    "type" : "text/javascript",
    "source" : "var qry = {'_queryFilter': 'uid eq \"' + source.userName + '\"'}; qry"
},
```

The query can return zero or more objects. The situation that OpenIDM assigns to the source object depends on the number of target objects that are returned.

Correlation queries that do not use common query filter syntax must be defined in the configuration file for the repository, either `openidm/conf/repo.jdbc.json` or `openidm/conf/repo.orientdb.json`, and must be referenced in the mapping (`sync.json`) file.

The following example shows a query, defined in the OrientDB repository configuration (`openidm/conf/repo.orientdb.json`), that can be used as the basis for a correlation query.

```
"for-userName" : "SELECT * FROM ${unquoted:_resource} WHERE userName = ${uid}"
```

By default, a `${value}` token replacement is assumed to be a quoted string. If the value is not a quoted string, use the `unquoted:` prefix, as shown above.

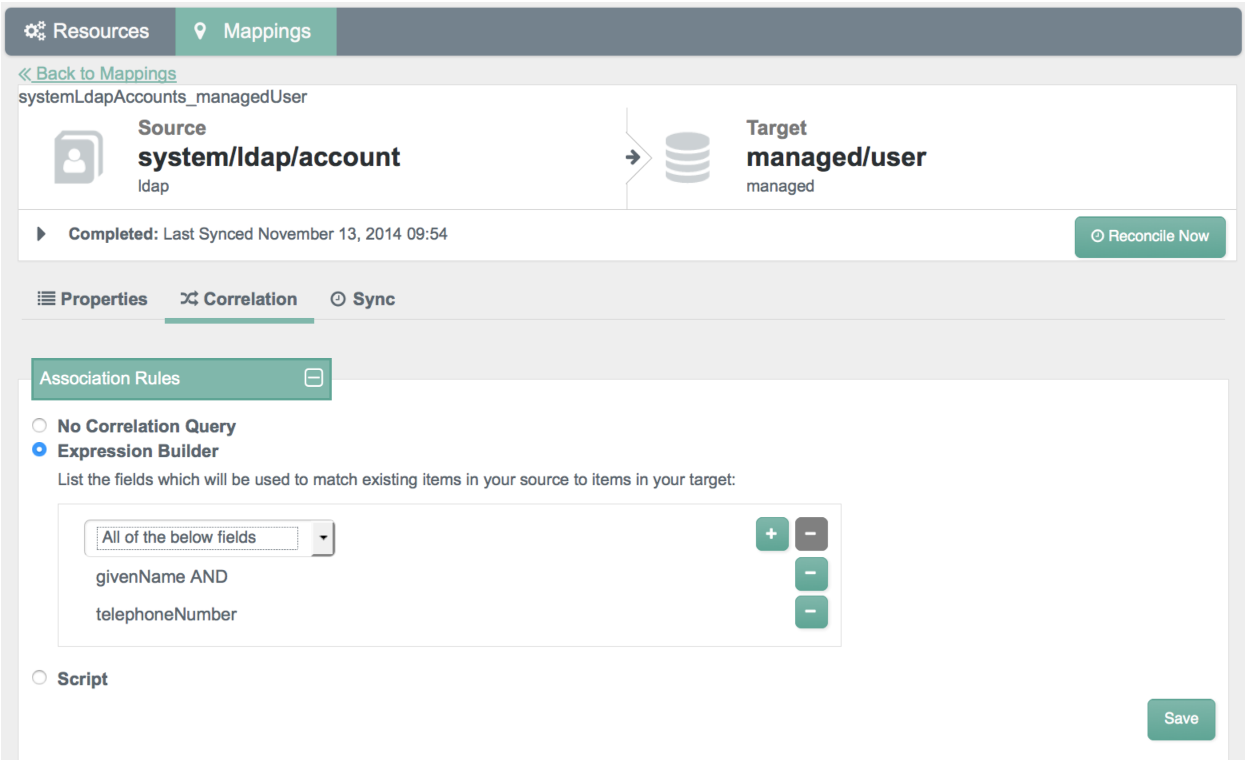
You would call this query in the mapping (`sync.json`) file as follows:

```
{
  "correlationQuery": {
    "type": "text/javascript",
    "source":
      "var qry = {'_queryId' : 'for-userName', 'uid' : source.name}; qry;"
  }
}
```

The `_queryId` property value (`for-userName`) matches the name of the query specified in `openidm/conf/repo.orientdb.json`. The `source.name` value replaces `${uid}` in the query. OpenIDM replaces `${unquoted:_resource}` in the query with the name of the table that holds managed objects.

OpenIDM 3.1 offers a new declarative correlation option, named the expression builder, that makes it easier to configure correlation queries. The easiest way to use the expression builder to build up a correlation query is by using the Admin UI. The following image shows how the expression builder is used to build up a correlation query for a mapping from `system/ldap/accounts` to `managed/user` objects.

The query essentially states that, in order for a match to exist between the source (LDAP) object and the target (managed) object, both the `userName` and `telephoneNumber` of those objects must match.



The resulting correlation query, in the mapping configuration (`sync.json`) is as follows:

```
"correlationQuery" : {
    "type" : "text/javascript",
    "expressionTree" : {
        "all" : [
            "givenName",
            "telephoneNumber"
        ]
    },
    "mapping" : "systemLdapAccounts_managedUser",
    "file" : "ui/correlateTreeToQueryFilter.js"
},
```

The logic in the expression builder is in the script `openidm/bin/defaults/script/ui/correlateTreeToQueryFilter.js` which converts the expression into the required query filter.

12.18. Advanced Data Flow Configuration

Section 12.3, "Basic Data Flow Configuration" shows how to trigger scripts when objects are created and updated. Other situations require you to trigger scripts in response to other synchronization actions. For example, you might not want OpenIDM to delete a managed user directly when an external account is deleted, but instead unlink the objects and deactivate the user in another resource. (Alternatively, you might delete the object in OpenIDM but nevertheless execute a script.) The following example shows a more advanced mapping configuration.

```
{
    "mappings": [
        {
            "name": "systemLdapAccount_managedUser",
            "source": "system/ldap/account",
            "target": "managed/user",
            "validSource": {
                "type": "text/javascript",
                "file": "script/isValid.js"
            },
            "correlationQuery" : {
                "type" : "text/javascript",
                "source" : "var map = {'_queryFilter': 'uid eq \"' +
                     source.userName + '\"'}; map;"
            },
            "properties": [
                {
                    "source": "uid",
                    "transform": {
                        "type": "text/javascript",
                        "source": "source.toLowerCase()"
                    },
                    "target": "userName"
                },
                {
                    "source": "",
                    "transform": {
                        "type": "text/javascript",
                        "source": "if (source.myGivenName)
                            {source.myGivenName;} else {source.givenName;}"
                    },
                    "target": "givenName"
                },
                {
                    "source": "",
                    "transform": {
                        "type": "text/javascript",
                        "source": "if (source.mySn)
                            {source.mySn;} else {source.sn;}"
                    },
                    "target": "familyName"
                },
                {
                    "source": "cn",
                    "target": "fullname"
                },
                {
                    "comment": "Multi-valued in LDAP, single-valued in AD.
                        Retrieve first non-empty value.",
                    "source": "title",
                    "transform": {
```

```
                        "type": "text/javascript",
                        "file": "script/getFirstNonEmpty.js"
                    },
                    "target": "title"
                },
                {
                    "condition": {
                        "type": "text/javascript",
                        "source": "var clearObj = openidm.decrypt(object);
                            ((clearObj.password != null) &&
                            (clearObj.ldapPassword != clearObj.password))"
                    },
                    "transform": {
                        "type": "text/javascript",
                        "source": "source.password"
                    },
                    "target": "__PASSWORD__"
                }
            ],
            "onCreate": {
                "type": "text/javascript",
                "source": "target.ldapPassword = null;
                    target.adPassword = null;
                    target.password = null;
                    target.ldapStatus = 'New Account'"
            },
            "onUpdate": {
                "type": "text/javascript",
                "source": "target.ldapStatus = 'OLD'"
            },
            "onUnlink": {
                "type": "text/javascript",
                "file": "script/triggerAdDisable.js"
            },
            "policies": [
                {
                    "situation": "CONFIRMED",
                    "action": "UPDATE"
                },
                {
                    "situation": "FOUND",
                    "action": "UPDATE"
                },
                {
                    "situation": "ABSENT",
                    "action": "CREATE"
                },
                {
                    "situation": "AMBIGUOUS",
                    "action": "EXCEPTION"
                },
                {
                    "situation": "MISSING",
                    "action": "EXCEPTION"
                },
                {
                    "situation": "UNQUALIFIED",
                    "action": "UNLINK"
                },
```

```
                    {
                        "situation": "UNASSIGNED",
                        "action": "EXCEPTION"
                    }
                ]
            }
        ]
}
```

The following list shows the properties that you can use as hooks in mapping configurations to call scripts.

Triggered by Situation

onCreate, onUpdate, onDelete, onLink, onUnlink

Object Filter

vaildSource, validTarget

Correlating Objects

correlationQuery

Triggered on Reconciliation

result

Scripts Inside Properties

condition, transform

Your scripts can get data from any connected system at any time by using the `openidm.read(id)` function, where `id` is the identifier of the object to read.

The following example reads a managed user object from the repository.

```
repoUser = openidm.read("managed/user/ddoe");
```

The following example reads an account from an external LDAP resource.

```
externalAccount = openidm.read("system/ldap/account/uid=ddoe,ou=People,dc=example,dc=com");
```

Note that the query targets a DN rather than a UID, as it did in the previous example. The attribute that is used for the `_id` is defined in the connector configuration file and, in this example, is set to `"uidAttribute" : "dn"`. Although it is possible to use a DN (or any unique attribute) for the `_id`, as a best practice, you should use an attribute that is both unique and immutable.

12.19. Scheduling Synchronization

You can schedule synchronization operations, such as LiveSync and reconciliation, using **cron**-like syntax.

This section describes scheduling for reconciliation and LiveSync, however, you can also use OpenIDM's scheduler service to schedule any other event by supplying a link to a script file, in which that event is defined. For information about scheduling other events, and for a deeper understanding of the OpenIDM scheduler service, see Chapter 13, "*Scheduling Tasks and Events*".

12.19.1. Configuring Scheduled Synchronization

Each scheduled reconciliation and LiveSync task requires a schedule configuration file in `openidm/conf`. By convention, files are named `openidm/conf/schedule-schedule-name .json`, where *schedule-name* is a logical name for the scheduled synchronization operation, such as `reconcile_systemXmlAccounts_managedUser`.

Schedule configuration files have the following format:

```
{
 "enabled"       : true,
 "persisted"     : false,
 "type"          : "cron",
 "startTime"     : "(optional) time",
 "endTime"       : "(optional) time",
 "schedule"      : "cron expression",
 "misfirePolicy" : "optional, string",
 "timeZone"      : "(optional) time zone",
 "invokeService" : "service identifier",
 "invokeContext" : "service specific context info"
}
```

For an explanation of each of these properties, see Chapter 13, "*Scheduling Tasks and Events*".

To schedule a reconciliation or LiveSync task, set the `invokeService` property to either `"sync"` (for reconciliation) or `"provisioner"` for LiveSync.

The value of the `invokeContext` property depends on the type of scheduled event. For reconciliation, the properties are set as follows:

```
{
    "invokeService": "sync",
    "invokeContext": {
        "action": "reconcile",
        "mapping": "systemLdapAccount_managedUser"
    }
}
```

The `"mapping"` is either referenced by its name in the `openidm/conf/sync.json` file, or defined inline by using the `"mapping"` property, as shown in the example in Section 12.19.2, "Alternative Mappings".

For LiveSync, the properties are set as follows:

```
{
    "invokeService": "provisioner",
    "invokeContext": {
        "action": "liveSync",
        "source": "system/OpenDJ/__ACCOUNT__"
    }
}
```

The `"source"` property follows OpenIDM's convention for a pointer to an external resource object and takes the form `system/resource-name/object-type`.

12.19.2. Alternative Mappings

Mappings for synchronization are usually stored in `openidm/conf/sync.json` for reconciliation, LiveSync, and for pushing changes made to managed objects to external resources. You can, however, provide alternative mappings for scheduled reconciliation by adding the mapping to the schedule configuration instead of referencing a mapping in `sync.json`.

```
{
    "enabled": true,
    "type": "cron",
    "schedule": "0 08 16 * * ?",
    "invokeService": "sync",
    "invokeContext": {
        "action": "reconcile",
        "mapping": {
            "name": "CSV_XML",
            "source": "system/Ldap/account",
            "target": "managed/user",
            "properties": [
                {
                    "source": "firstname",
                    "target": "firstname"
                },
                ...
            ],
            "policies": [...]
        }
    }
}
```

Chapter 13
Scheduling Tasks and Events

OpenIDM enables you to schedule reconciliation and synchronization tasks. You can also use scheduling to trigger scripts, collect and run reports, trigger workflows, perform custom logging, and so forth.

OpenIDM supports **cron**-like syntax to schedule events and tasks, based on expressions supported by the Quartz Scheduler (bundled with OpenIDM).

If you use configuration files to schedule tasks and events, you must place the schedule files in the `openidm/conf` directory. By convention, OpenIDM uses file names of the form `schedule-schedule-name.json`, where *schedule-name* is a logical name for the scheduled operation, for example, `schedule-reconcile_systemXmlAccounts_managedUser.json`. There are several example schedule configuration files in the `openidm/samples/schedules` directory.

You can configure OpenIDM to pick up changes to scheduled tasks and events dynamically, during initialization and also at runtime. For more information, see Section 6.2, "Changing the Default Configuration".

In addition to the fine-grained scheduling facility, you can perform a scheduled batch scan for a specified date in OpenIDM data, and then automatically execute a task when this date is reached. For more information, see Section 13.5, "Scanning Data to Trigger Tasks".

13.1. Scheduler Configuration

Schedules are configured through JSON objects. The schedule configuration involves three files:

- The `openidm/conf/boot/boot.properties` file, where you can enable the execution of persistent schedules
- The `openidm/conf/scheduler.json` file, that configures the overall scheduler service
- One `openidm/conf/schedule-schedule-name.json` file for each configured schedule

In the boot properties configuration file (`openidm/conf/boot/boot.properties`), the instance type is standalone and persistent schedules are enabled by default:

```
# valid instance types for node include standalone, clustered-first, and clustered-additional
openidm.instance.type=standalone

# enables the execution of persistent schedulers
openidm.scheduler.execute.persistent.schedules=true
```

The scheduler service configuration file (`openidm/conf/scheduler.json`) governs the configuration for a specific scheduler instance, and has the following format:

```
{
 "threadPool" : {
     "threadCount" : "10"
 },
 "scheduler" : {
     "executePersistentSchedules" : "&{openidm.scheduler.execute.persistent.schedules}"
 }
}
```

The properties in the `scheduler.json` file relate to the configuration of the Quartz Scheduler.

- `threadCount` specifies the maximum number of threads that are available for the concurrent execution of scheduled tasks.
- `executePersistentSchedules` allows you to disable persistent schedule execution for a specific node. If this parameter is set to `false`, the Scheduler Service will support the management of persistent schedules (CRUD operations) but it will not execute any persistent schedules. The value of this property can be a string or boolean and is `true` by default.

  Note that changing the value of the `openidm.scheduler.execute.persistent.schedules` property in the `boot.properties` file changes the scheduler that manages scheduled tasks on that node. Because the persistent and in-memory schedulers are managed separately, a situation can arise where two separate schedules have the same schedule name.
- `advancedProperties` (optional) enables you to configure additional properties for the Quartz Scheduler.

Note

In clustered environments, the scheduler service obtains an `instanceID` and checkin and timeout settings from the cluster management service (defined in the `openidm/conf/cluster.json` file). This behavior differs from OpenIDM 2.1.0 (in which the scheduler service specified the instance ID and checkin and timeout settings). Therefore, if you used the scheduler service in OpenIDM 2.1.0, you will need to migrate any reference to assigned instance IDs, allowing them to be provided by the cluster management service.

For details of all the configurable properties for the Quartz Scheduler, see the *Quartz Scheduler Configuration Reference*.

Each schedule configuration file, `openidm/conf/schedule-`*`schedule-name`*`.json`, has the following format:

```
{
 "enabled"              : true,
 "persisted"            : false,
 "concurrentExecution" : false,
 "type"                 : "cron",
 "startTime"            : "(optional) time",
 "endTime"              : "(optional) time",
 "schedule"             : "cron expression",
 "misfirePolicy"        : "optional, string",
 "timeZone"             : "(optional) time zone",
 "invokeService"        : "service identifier",
 "invokeContext"        : "service specific context info",
 "invokeLogLevel"       : "(optional) level"
}
```

The schedule configuration properties are defined as follows:

enabled

Set to `true` to enable the schedule. When this property is set to `false`, OpenIDM considers the schedule configuration dormant, and does not allow it to be triggered or executed.

If you want to retain a schedule configuration, but do not want it used, set `enabled` to `false` for task and event schedulers, instead of changing the configuration or **cron** expressions.

persisted (optional)

Specifies whether the schedule state should be persisted or stored in RAM. Boolean (`true` or `false`), `false` by default.

In a clustered environment, this property must be set to `true` to have the schedule fire only once across the cluster. For more information, see Section 13.2, "Configuring Persistent Schedules".

concurrentExecution

Specifies whether multiple instances of the same schedule can run concurrently. Boolean (`true` or `false`), `false` by default. Multiple instances of the same schedule cannot run concurrently by default. This setting prevents a new scheduled task from being launched before the same previously launched task has completed. For example, under normal circumstances you would want a liveSync operation to complete its execution before the same operation was launched again. To enable concurrent execution of multiple schedules, set this parameter to `true`. The behavior of "missed" scheduled tasks is governed by the misfirePolicy.

type

Currently OpenIDM supports only `cron`.

startTime (optional)

Used to start the schedule at some time in the future. If this parameter is omitted, empty, or set to a time in the past, the task or event is scheduled to start immediately.

Use ISO 8601 format to specify times and dates (`YYYY-MM-DD Thh:mm :ss`).

endTime (optional)

Used to plan the end of scheduling.

schedule

Takes **cron** expression syntax. For more information, see the *CronTrigger Tutorial* and *Lesson 6: CronTrigger*.

misfirePolicy

For persistent schedules, this optional parameter specifies the behavior if the scheduled task is missed, for some reason. Possible values are as follows:

- `fireAndProceed`. The first execution of a missed schedule is immediately executed when the server is back online. Subsequent executions are discarded. After this, the normal schedule is resumed.
- `doNothing`, all missed schedules are discarded and the normal schedule is resumed when the server is back online.

timeZone (optional)

If not set, OpenIDM uses the system time zone.

invokeService

Defines the type of scheduled event or action. The value of this parameter can be one of the following:

- `"sync"` for reconciliation
- `"provisioner"` for LiveSync
- `"script"` to call some other scheduled operation defined in a script

invokeContext

Specifies contextual information, depending on the type of scheduled event (the value of the `invokeService` parameter).

The following example invokes reconciliation.

```
{
    "invokeService": "sync",
    "invokeContext": {
        "action": "reconcile",
        "mapping": "systemLdapAccount_managedUser"
    }
}
```

For a scheduled reconciliation task, you can define the mapping in one of two ways:

- Reference a mapping by its name in `sync.json`, as shown in the previous example. The mapping must exist in the `openidm/conf/sync.json` file.
- Add the mapping definition inline by using the `"mapping"` property, as shown in the example in Section 12.19.2, "Alternative Mappings".

The following example invokes a LiveSync action.

```
{
    "invokeService": "provisioner",
    "invokeContext": {
        "action": "liveSync",
        "source": "system/OpenDJ/__ACCOUNT__"
    }
}
```

For scheduled LiveSync tasks, the `"source"` property follows OpenIDM's convention for a pointer to an external resource object and takes the form `system/resource-name /object-type`.

The following example invokes a script, which prints the string `Hello World` to the OpenIDM log (`/openidm/logs/openidm0.log.X`).

```
{
    "invokeService": "script",
    "invokeContext": {
        "script": {
            "type": "text/javascript",
            "source": "console.log('Hello World');"
        }
    }
}
```

Note that these are sample configurations only. Your own schedule configuration will differ according to your specific requirements.

invokeLogLevel (optional)

Specifies the level at which the invocation will be logged. Particularly for schedules that run very frequently, such as LiveSync, the scheduled task can generate significant output to the log file, and the log level should be adjusted accordingly. The default schedule log level is `info`. The value can be set to any one of the SLF4J log levels:

- `"trace"`
- `"debug"`
- `"info"`

- `"warn"`
- `"error"`
- `"fatal"`

13.2. Configuring Persistent Schedules

By default, scheduling information, such as schedule state and details of the schedule execution, is stored in RAM. This means that such information is lost when OpenIDM is rebooted. The schedule configuration itself (defined in the `openidm/conf/schedule- schedule-name.json` file) is not lost when OpenIDM is shut down, and normal scheduling continues when the server is restarted. However, there are no details of missed schedule executions that should have occurred during the period the server was unavailable.

You can configure schedules to be persistent, which means that the scheduling information is stored in the internal repository rather than in RAM. With persistent schedules, scheduling information is retained when OpenIDM is shut down. Any previously scheduled jobs can be rescheduled automatically when OpenIDM is restarted.

Persistent schedules also enable you to manage scheduling across a cluster (multiple OpenIDM instances). When scheduling is persistent, a particular schedule will be executed only once across the cluster, rather than once on every OpenIDM instance. For example, if your deployment includes a cluster of OpenIDM nodes for high availability, you can use persistent scheduling to start a reconciliation action on only one node in the cluster, instead of starting several competing reconciliation actions on each node.

You can use persistent schedules with the default OrientDB repository, or with the MySQL repository (see Chapter 4, "*Installing a Repository For Production*" in the *Installation Guide*).

To configure persistent schedules, set the `"persisted"` property to `true` in the schedule configuration file (`schedule-schedule-name.json`).

If OpenIDM is down when a scheduled task was set to occur, one or more executions of that schedule might be missed. To specify what action should be taken if schedules are missed, set the `misfirePolicy` in the schedule configuration file. The `misfirePolicy` determines what OpenIDM should do if scheduled tasks are missed. Possible values are as follows:

- `fireAndProceed`. The first execution of a missed schedule is immediately executed when the server is back online. Subsequent executions are discarded. After this, the normal schedule is resumed.
- `doNothing`. All missed schedules are discarded and the normal schedule is resumed when the server is back online.

13.3. Schedule Examples

The following example shows a schedule for reconciliation that is not enabled. When enabled (`"enabled" : true,`), reconciliation runs every 30 minutes, starting on the hour.

```
{
    "enabled": false,
    "persisted": false,
    "type": "cron",
    "schedule": "0 0/30 * * * ?",
    "invokeService": "sync",
    "invokeContext": {
        "action": "reconcile",
        "mapping": "systemLdapAccounts_managedUser"
    }
}
```

The following example shows a schedule for LiveSync enabled to run every 15 seconds, starting at the beginning of the minute. The schedule is persisted, that is, stored in the internal repository rather than in memory. If one or more LiveSync executions are missed, as a result of OpenIDM being unavailable, the first execution of the LiveSync action is executed when the server is back online. Subsequent executions are discarded. After this, the normal schedule is resumed.

```
{
    "enabled": false,
    "persisted": true,
    "misfirePolicy" : "fireAndProceed",
    "type": "cron",
    "schedule": "0/15 * * * * ?",
    "invokeService": "provisioner",
    "invokeContext": {
        "action": "liveSync",
        "source": "system/ldap/account"
    }
}
```

13.4. Managing Schedules Over REST

OpenIDM exposes the scheduler service under the `/openidm/scheduler` context path. The following examples show how schedules can be created, read, updated, and deleted, over REST, like any other object.

13.4.1. Creating a Schedule

You can create a schedule with a PUT request, which allows you to specify the ID of the schedule, or with a POST request, in which case the server assigns an ID automatically.

The following example uses a PUT request to create a schedule that fires a script (`script/testlog.js`) every second. The schedule configuration is as described in Section 13.1, "Scheduler Configuration".

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
```

```
 --header "Content-Type: application/json" \
 --request PUT \
 --data '{
    "enabled":true,
    "type":"cron",
    "schedule":"0/1 * * * * ?",
    "persisted":true,
    "misfirePolicy":"fireAndProceed",
    "invokeService":"script",
    "invokeContext": {
        "script": {
            "type":"text/javascript",
            "file":"script/testlog.js"
        }
    }
 }' \
 "https://localhost:8443/openidm/scheduler/testlog-schedule"
{
  "type": "cron",
  "invokeService": "script",
  "persisted": true,
  "_id": "testlog-schedule",
  "schedule": "0/1 * * * * ?",
  "misfirePolicy": "fireAndProceed",
  "enabled": true,
  "invokeContext": {
    "script": {
      "file": "script/testlog.js",
      "type": "text/javascript"
    }
  }
}
```

The following example uses a POST request to create an identical schedule to the one created in the previous example, but with a server-assigned ID.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
    "enabled":true,
    "type":"cron",
    "schedule":"0/1 * * * * ?",
    "persisted":true,
    "misfirePolicy":"fireAndProceed",
    "invokeService":"script",
    "invokeContext": {
        "script": {
            "type":"text/javascript",
            "file":"script/testlog.js"
        }
    }
 }' \
 "https://localhost:8443/openidm/scheduler?_action=create"
{
  "type": "cron",
```

```
  "invokeService": "script",
  "persisted": true,
  "_id": "d6d1b256-7e46-486e-af88-169b4b1ad57a",
  "schedule": "0/1 * * * * ?",
  "misfirePolicy": "fireAndProceed",
  "enabled": true,
  "invokeContext": {
    "script": {
      "file": "script/testlog.js",
      "type": "text/javascript"
    }
  }
}
```

The output includes the `_id` of the schedule, in this case `"_id": "d6d1b256-7e46-486e-af88-169b4b1ad57a"`.

13.4.2. Obtaining the Details of a Schedule

The following example displays the details of the schedule created in the previous section. Specify the schedule ID in the URL.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/scheduler/d6d1b256-7e46-486e-af88-169b4b1ad57a"
{
  "_id": "d6d1b256-7e46-486e-af88-169b4b1ad57a",
  "schedule": "0/1 * * * * ?",
  "misfirePolicy": "fireAndProceed",
  "startTime": null,
  "invokeContext": {
    "script": {
      "file": "script/testlog.js",
      "type": "text/javascript"
    }
  },
  "enabled": true,
  "concurrentExecution": false,
  "persisted": true,
  "timeZone": null,
  "type": "cron",
  "invokeService": "org.forgerock.openidm.script",
  "endTime": null,
  "invokeLogLevel": "info"
}
```

13.4.3. Updating a Schedule

To update a schedule definition, use a PUT request and update all properties of the object. Note that PATCH requests are currently supported only for managed objects. The following example disables the schedule created in the previous section.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PUT \
 --data '{
    "enabled":false,
    "type":"cron",
    "schedule":"0/1 * * * * ?",
    "persisted":true,
    "misfirePolicy":"fireAndProceed",
    "invokeService":"script",
    "invokeContext": {
        "script": {
            "type":"text/javascript",
            "file":"script/testlog.js"
        }
    }
 }' \
 "https://localhost:8443/openidm/scheduler/d6d1b256-7e46-486e-af88-169b4b1ad57a"
   null
```

13.4.4. Listing Configured Schedules

To display a list of all configured schedules, query the `openidm/scheduler` context path as shown in the following example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/scheduler?_queryId=query-all-ids"
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 2,
  "result": [
    {
      "_id": "d6d1b256-7e46-486e-af88-169b4b1ad57a"
    },
    {
      "_id": "recon"
    }
  ]
}
```

13.4.5. Deleting a Schedule

To deleted a configured schedule, call a DELETE request on the schedule ID. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request DELETE \
 "https://localhost:8443/openidm/scheduler/d6d1b256-7e46-486e-af88-169b4b1ad57a"
null
```

13.5. Scanning Data to Trigger Tasks

In addition to the fine-grained scheduling facility described previously, OpenIDM provides a task scanning mechanism. The task scanner enables you to perform a batch scan on a specified property in OpenIDM, at a scheduled interval, and then to execute a task when the value of that property matches a specified value.

When the task scanner identifies a condition that should trigger the task, it can invoke a script created specifically to handle the task.

For example, the task scanner can scan all `managed/user` objects for a "sunset date" and can invoke a script that executes a "sunset task" on the user object when this date is reached.

13.5.1. Configuring the Task Scanner

The task scanner is essentially a scheduled task that queries a set of managed users. The task scanner is configured in the same way as a regular scheduled task, in a schedule configuration file named (`schedule-task-name.json`), with the `"invokeService"` parameter set to `"taskscanner"`. The `"invokeContext"` parameter defines the details of the scan, and the task that should be executed when the specified condition is triggered.

The following example defines a scheduled scanning task that triggers a sunset script. The schedule configuration file is provided in `openidm/samples/taskscanner/conf/schedule-taskscan_sunset.json`. To use this sample file, copy it to the `openidm/conf` directory.

```
{
    "enabled" : true,
    "type" : "cron",
    "schedule" : "0 0 * * * ?",
    "concurrentExecution" : false,
    "invokeService" : "taskscanner",
    "invokeContext" : {
        "waitForCompletion" : false,
        "maxRecords" : 2000,
        "numberOfThreads" : 5,
        "scan" : {
            "_queryId" : "scan-tasks",
            "object" : "managed/user",
            "property" : "sunset/date",
            "condition" : {
                "before" : "${Time.now}"
            },
```

```
            "taskState" : {
                "started" : "sunset/task-started",
                "completed" : "sunset/task-completed"
            },
            "recovery" : {
                "timeout" : "10m"
            }
        },
        "task" : {
            "script" : {
                "type" : "text/javascript",
                "file" : "script/sunset.js"
            }
        }
    }
}
```

The schedule configuration calls a script (`script/sunset.js`). To test the sample, copy this script file from `openidm/samples/taskscanner/script/sunset.js` to the `openidm/script` directory. The remaining properties in the schedule configuration are as follows:

The `"invokeContext"` parameter takes the following properties:

`"waitForCompletion"` (optional)

This property specifies whether the task should be performed synchronously. Tasks are performed asynchronously by default (with `waitForCompletion` set to false). A task ID (such as `{"_id":"354ec41f-c781-4b61-85ac-93c28c180e46"}`) is returned immediately. If this property is set to true, tasks are performed synchronously and the ID is not returned until all tasks have completed.

`"maxRecords"` (optional)

The maximum number of records that can be processed. This property is not set by default so the number of records is unlimited. If a maximum number of records is specified, that number will be spread evenly over the number of threads.

`"numberOfThreads"` (optional)

By default, the task scanner runs in a multi-threaded manner, that is, numerous threads are dedicated to the same scanning task run. Multi-threading generally improves the performance of the task scanner. The default number of threads for a single scanning task is ten. To change this default, set the `"numberOfThreads"` property.

`"scan"`

Defines the details of the scan. The following properties are defined:

`"_queryId"`

Specifies the predefined query that is performed to identify the entries for which this task should be run.

The query that is referenced here must be defined in the database configuration file (`conf/repo.orientdb.json` or `conf/repo.jdbc.json`). A sample query for a scanned task (`"scan-tasks"`) is defined in the JDBC repository configuration file as follows:

```
"scan-tasks" : "SELECT fullobject FROM ${_dbSchema}.${_mainTable}
 obj INNER JOIN ${_dbSchema}.${_propTable}
 prop ON obj.id = prop.${_mainTable}_id
 LEFT OUTER JOIN ${_dbSchema}.${_propTable}
 complete ON obj.id = complete.${_mainTable}_id
 AND complete.propkey=${taskState.completed}
 INNER JOIN ${_dbSchema}.objecttypes objtype
 ON objtype.id = obj.objecttypes_id
 WHERE ( prop.propkey=${property} AND prop.propvalue < ${condition.before}
 AND objtype.objecttype = ${_resource} )
 AND ( complete.propvalue is NULL )",
```

Note that this query identifies records for which the value of the specified `property` is smaller than the condition. The sample query supports only time-based conditions, with the time specified in ISO 8601 format (Zulu time). You can write any query to target the records that you require.

`"object"`

Defines the managed object type against which the query should be performed, as defined in the `managed.json` file.

`"property"`

Defines the property of the managed object, against which the query is performed. In the previous example, the `"property" : "sunset/date"` indicates a JSON pointer that maps to the object attribute, and can be understood as `sunset: {"date" : "date"}`. For more information about JSON pointer syntax, see RFC 6901.

If you are using a JDBC repository, with a generic mapping, you must explicitly set this property as searchable so that it can be queried by the task scanner. For more information, see Section 5.2.1, "Using Generic Mappings".

`"condition"` (optional)

Indicates the conditions that must be matched for the defined property.

In the previous example, the scanner scans for users for whom the property `sunset/date` is prior to the current timestamp (at the time the script is executed).

You can use these fields to define any condition. For example, if you wanted to limit the scanned objects to a specified location, say, London, you could formulate a query to compare against object locations and then set the condition to be:

```
            "condition" : {
                "location" : "London"
            },
```

For time-based conditions, the `"condition"` property supports macro syntax, based on the `Time.now` object (which fetches the current time). You can specify any date/time in relation to the current time, using the `+` or `-` operator, and a duration modifier. For example: `"${Time.now + 1d}"` would return all user objects whose `sunset/date` is the following day (current time plus one day). You must include space characters around the operator (`+` or `-`). The duration modifier supports the following unit specifiers:

`s` - second
`m` - minute
`h` - hour
`d` - day
`M` - month
`y` - year

`"taskState"`

Indicates the names of the fields in which the start message and the completed message are stored. These fields are used to track the status of the task.

`"started"` specifies the field that stores the timestamp for when the task begins.
`"completed"` specifies the field that stores the timestamp for when the task completes its operation. The `"completed"` field is present as soon as the task has started, but its value is `null` until the task has completed.

`"recovery"` (optional)

Specifies a configurable timeout, after which the task scanner process ends. In a scenario with clustered OpenIDM instances, there might be more than one task scanner running at a time. A task cannot be executed by two task scanners at the same time. When one task scanner "claims" a task, it indicates that the task has been started. That task is then unavailable to be claimed by another task scanner and remains unavailable until the end of the task is indicated. In the event that the first task scanner does not complete the task by the specified timeout, for whatever reason, a second task scanner can pick up the task.

`"task"`

Provides details of the task that is performed. Usually, the task is invoked by a script, whose details are defined in the `"script"` property:

`"type"` - the type of script. Currently, only JavaScript is supported.
`"file"` - the path to the script file. The script file takes at least two objects (in addition to the default objects that are provided to all OpenIDM scripts): `"input"` which is the individual object that is retrieved from the query (in the example, this is the individual user object) and `"objectID"` which is a string that contains the full identifier of the object. The objectID is useful for performing updates with the script as it allows you to target the object directly, for example: `openidm.update(objectID, input['_rev'], input);`. A sample script file is provided in `openidm/samples/taskscanner/script/sunset.js`. To use this sample file, you must copy it to the `openidm/script` directory. The sample script marks all user objects that match the specified conditions as "inactive". You can use this sample script to trigger a specific workflow, or any other task

associated with the sunset process. For more information about using scripts in OpenIDM, see Appendix F, "*Scripting Reference*".

13.5.2. Managing Scanning Tasks Over REST

You can trigger, cancel, and monitor scanning tasks over the REST interface, using the REST endpoint `https://localhost:8443/openidm/taskscanner`.

13.5.2.1. Triggering a Scanning Task

The following REST command executes a task named "taskscan_sunrise". The task itself is defined in a file named `openidm/conf/schedule-taskscan_sunset.json`.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/taskscanner?_action=execute&name=schedule/taskscan_sunset"
```

By default, a scanning task ID is returned immediately when the task is initiated. Clients can make subsequent calls to the task scanner service, using this task ID to query its state and to call operations on it.

For example, the scanning task initiated previously would return something similar to the following, as soon as it was initiated:

```
{"_id":"edfaf59c-aad1-442a-adf6-3620b24f8385"}
```

To have the scanning task complete before the ID is returned, set the `waitForCompletion` property to `true` in the task definition file (`schedule-taskscan_sunset.json`). You can also set the property directly over the REST interface when the task is initiated. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/taskscanner?_action=execute&name=schedule/
taskscan_sunset&waitForCompletion=true"
```

13.5.2.2. Canceling a Scanning Task

You can cancel a scanning task by sending a REST call with the `cancel` action, specifying the task ID. For example, the following call cancels the scanning task initiated in the previous section.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/taskscanner/edfaf59c-aad1-442a-adf6-3620b24f8385?_action=cancel"
```

The output for a scanning task cancellation request is similar to the following:

```
    {"_id":"edfaf59c-aad1-442a-adf6-3620b24f8385",
     "action":"cancel",
     "status":"SUCCESS"}
```

13.5.2.3. Listing Scanning Tasks

You can display a list of scanning tasks that have completed, and those that are in progress, by running a RESTful GET on the `openidm/taskscanner"` context. The following example displays all scanning tasks.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/taskscanner"
```

The output of such a request is similar to the following, with one item for each scanning task.

```
{
 "tasks": [
    {
      "ended": 1352455546182
      "started": 1352455546149,
      "progress": {
        "failures": 0
        "successes": 2400,
        "total": 2400,
        "processed": 2400,
        "state": "COMPLETED",
      },
      "_id": "edfaf59c-aad1-442a-adf6-3620b24f8385",
    }
  ]
}
```

Each scanning task has the following properties:

`ended`

The time at which the scanning task ended.

`started`

The time at which the scanning task started.

`progress`

The progress of the scanning task, summarised in the following fields:

`failures` - the number of records not able to be processed
`successes` - the number of records processed successfully
`total` - the total number of records
`processed` - the number of processed records
`state` - the overall state of the task, `INITIALIZED`, `ACTIVE`, `COMPLETED`, `CANCELLED`, or `ERROR`

`_id`

The ID of the scanning task.

The number of processed tasks whose details are retained is governed by the `"openidm.taskscanner.maxcompletedruns"` property in the `conf/system.properties` file. By default, the last one hundred completed tasks are retained.

Chapter 14
Managing Passwords

OpenIDM provides password management features that help you enforce password policies, limit the number of passwords users must remember, and let users reset and change their passwords.

14.1. Enforcing Password Policy

A password policy is a set of rules defining what sequence of characters constitutes an acceptable password. Acceptable passwords generally are too complex for users or automated programs to generate or guess.

Password policies set requirements for password length, character sets that passwords must contain, dictionary words and other values that passwords must not contain. Password policies also require that users not reuse old passwords, and that users change their passwords on a regular basis.

OpenIDM enforces password policy rules as part of the general policy service. For more information about the policy service, see Chapter 9, "*Using Policies to Validate Data*". The default password policy applies the following rules to passwords when they are created and updated:

- A password property is required for any user object.
- The value of a password cannot be empty.
- The password must include at least one capital letter.
- The password must include at least one number.
- The minimum length of a password is 8 characters.
- The password cannot contain the user name, given name, or family name.

You can remove these validation requirements, or include additional requirements, by configuring the policy for passwords. For more information, see Section 9.1, "Configuring the Default Policy".

The password validation mechanism can apply in many situations.

Password change and password reset

Password change involves changing a user or account password in accordance with password policy. Password reset involves setting a new user or account password on behalf of a user.

By default, OpenIDM controls password values as they are provisioned.

For instructions on changing the default administrative user password, `openidm-admin`, see Procedure 16.2, "To Replace the Default User & Password".

Password recovery

Password recovery involves recovering a password or setting a new password when the password has been forgotten.

OpenIDM provides a self-service end user interface for password changes, password recovery, and password reset. For more information, see Section 4.3.1, "Enabling Self-Registration".

Password comparisons with dictionary words

You can add dictionary lookups to prevent use of password values that match dictionary words.

Password history

You can add checks to prevent reuse of previous password values. For more information, see Section 14.1.1, "Creating a Password History Policy".

Password expiration

You can configure OpenIDM to call a workflow that ensures users are able to change expiring or to reset expired passwords.

14.1.1. Creating a Password History Policy

To minimize password reuse, you can set up a password history policy. One way to do so is with a custom javascript file for the `onCreate` trigger. You can then add a reference to that javascript file in the `conf/managed.json` file.

You would then add a scripted policy in a custom javascript file, ready to be called out in appropriate JSON configuration files.

The following procedure retains a record of the last four passwords for each user. Any attempt to reuse one of those passwords is rejected.

This procedure takes advantage of the directories configured in the `conf/script.json` file. If you started OpenIDM with files in some `customconfig` subdirectory, you would need to make sure such files exist in that directory tree. For more information, see Section 6.7, "Default and Custom Configuration Directories".

Procedure 14.1. Configuring Limits on Password History

1. Create a custom `onCreate` javascript file. One way to do so is with a copy of the `onCreate-user-set-default-files.js` file in the `bin/defaults/script/ui` directory. You can save the custom file in the

`script` directory. For example, the following commands create an `onCreate-user-custom.js` file in the default script directory defined in `conf/script.json`:

```
$ cd /path/to/openidm/bin/defaults/script/ui
$ cp onCreate-user-set-default-fields.js /path/to/openidm/script/onCreate-user-custom.js
```

2. In the newly created custom Javascript file, include the cipher for password encryption:

```
var cipher = "AES/CBC/PKCS5Padding",
     alias = identityServer.getProperty("openidm.config.crypto.alias", "true", true);
```

3. Next, declare a new `lastPass` attribute. For example, to prevent reuse of the last four passwords, you would add the following line:

```
object.lastPass = new Array(4);
```

4. After the new array is declared, the following lines would increment the previous password:

```
if (object.password) {
    object.lastPass.shift();
    object.lastPass.push(object.password);
}
```

5. Now create a new file with a script that increments passwords in the array with each new password. This procedure uses the following file name: `onUpdate-user-pwpolicy.js`, written to the same directory as the `onCreate-user-custom.js` file, in this case, `script`.

6. Add the following content to the newly created `onUpdate-user-pwpolicy.js` file:

```
/*global newObject, oldObject */
var cipher = "AES/CBC/PKCS5Padding",
  alias = identityServer.getProperty("openidm.config.crypto.alias", "true", true);

if (openidm.isEncrypted(newObject.lastPass)) {
  newObject.lastPass = openidm.decrypt(newObject.lastPass);
}

if (typeof newObject.lastPass === "undefined") {
  newObject.lastPass = new Array(4);
}

if (newObject.password !== oldObject.password) {
  newObject.lastPass.shift();
  newObject.lastPass.push(newObject.password);
}

newObject.lastPass = openidm.encrypt(newObject.lastPass, cipher, alias);
}
```

7. In the existing `conf/managed.json` file, add appropriate lines that point to the files just created in the `script` directory. Given the default directories previously described in the `conf/script.json` file, you do not need to add a directory path to the newly created files. The following is an excerpt of the modified `conf/managed.json` file:

```
{
      "objects" : [
           "name" : "user"
           "onCreate" : {
                "type" : "text/javascript",
                "file" : "onCreate-user-custom.js"
           },
           "onUpdate" : {
                "type" : "text/javascript",
                "file" : "onUpdate-user-pwpolicy.js"
           },
           "onDelete" : {
                "type" : "text/javascript",
                "file" : "ui/onDelete-user-cleanup.js"
           },
```

8. Now extend the policy service to all users by adding a scripted policy. One way to do so is by adding the following information to a custom javascript file. For this procedure, call that file `pwpolicy.js`, also in the `script` subdirectory.

   As you can see from the comments to the file, it is designed to ignore new users, users without a password history, and users for whom passwords have not changed.

   The last part of the file decrypts encrypted passwords prior to making the comparison, and makes sure the password has a non-zero length.

```
/*global addPolicy, request, openidm */

addPolicy({
  "policyId" : "is-new",
  "policyExec" : "isNew",
  "policyRequirements" : ["IS_NEW"]
});

function isNew(fullObject, value, params, property) {
  var currentObject, lastPass, i;

  // don't do a read if the resource ends with "/*", which indicates that
  // this is a create with a server-supplied id
  if (!request.resourceName || request.resourceName.match('/\\*$')) {
    return [];
  }

  currentObject = openidm.read(request.resourceName);

  // don't try this policy if the resource being evaluated wasn't found. Happens in the
  // case of a create with a client-supplied id.
  if (currentObject === null) {
    return [];
  }

  // don't try this policy is there is no history object available
  if (currentObject.lastPass === null || currentObject.lastPass === undefined) {
     return [];
  }
```

```
  if (currentObject[property] !== null && currentObject[property] !== undefined &&
     openidm.isEncrypted(currentObject[property])) {
     currentObject[property] = openidm.decrypt(currentObject[property]);
  }

  // if the password hasn't changed, then we aren't interested in checking the history
  if (currentObject[property] === value) {
     return [];
  }

  if (openidm.isEncrypted(currentObject.lastPass)) {
     lastPass = openidm.decrypt(currentObject.lastPass);
  } else {
     lastPass = currentObject.lastPass;
  }

  for(i=0; i < lastPass.length; i++) {
    if (lastPass[i] === value) {
      return [{"policyRequirement": "IS_NEW"}];
    }
  }
  return [];

}
```

9. Now open the `conf/policy.json` file. Add the following lines to call the newly created `pwpolicy.js` script, right after the existing line that calls the `policy.js` script:

```
...
      "file" : "policy.js",
      "additionalFiles" :  [
          "script/pwpolicy.js"],
...
```

10. Later in the same `conf/policy.json` file, in the `password` configuration block, add the newly created `is-new` `policyId`:

```
...
     {
          "name" : "password",
          "policies" : [
              {
                  "policyId" : "not-empty"
              },
              {
                  "policyId" : "is-new"
              },
...
```

11. Reopen the `conf/managed.json` file. Add the following code to the `properties` section to encrypt the new `lastPass` attribute, and to prevent REST retrievals of such passwords:

```
...
     "properties" : [
         {
             "name" : "lastPass",
             "encryption" : {
                 "key" : "openidm-sym-default"
             },
             "scope" : "private"
         }
     ...
```

14.2. Password Synchronization

Password synchronization intercepts user password changes, and ensures uniform password changes across resources that store the password. Following password synchronization, the user authenticates using the same password on each resource. No centralized directory or authentication server is required for performing authentication. Password synchronization reduces the number of passwords users need to remember, so they can use fewer, stronger passwords.

OpenIDM can propagate passwords to the resources that store a user's password, and can intercept and synchronize passwords that are changed natively in OpenDJ and Active Directory.

When you use password synchronization, set up password policy enforcement on OpenDJ or Active Directory rather than on OpenIDM. Alternatively, ensure that all password policies that are enforced are identical to prevent password updates on one resource from being rejected by OpenIDM or by another resource.

The password synchronization plugins intercept password changes on the resource before the passwords are stored in encrypted form. The plugins then send intercepted password values to OpenIDM over an encrypted channel.

In the event that the OpenIDM instance is unavailable when a password is changed, the plugin intercepts the change, encrypts the password, and stores the encrypted password in a JSON file. The plugin then checks whether the OpenIDM instance is available, at a predefined interval. When OpenIDM becomes available, the plugin performs a PATCH on the user record, to replace the password with the encrypted password stored in the JSON file.

To be able to synchronize the passwords, the plugin requires that the `managed/user` object exist in the OpenIDM repository. Users have typically been created by a reconciliation or liveSync process.

The OpenDJ password sync plugin is supported for OpenDJ versions 2.4.6, 2.5, and 2.6. The Active Directory password sync plugin is supported on Windows 2003, Windows 2008 R2, and Windows 2012 R2.

The procedures in this section assume that you have set up OpenDJ to communicate over the secure LDAP protocol (LDAPS), as described in the OpenDJ documentation. The procedures use the standard ports for regular and LDAP communictions, 389 and 636, or possibly corresponding alternative ports, 1389 and 1636.

The procedures in this section also assume that you have a working instance of Active Directory.

Procedure 14.2. Prepare OpenIDM for Password Synchronization

The following instructions describe the steps you should take to prepare OpenIDM to synchronize passwords between an instance of OpenDJ and an instance of Active Directory.

1. Include the attributes shown in `/path/to/openidm/samples/misc/managed.json` to enable password synchronization between OpenIDM, OpenDJ, and Active Directory.

   To do so, include the contents of that `managed.json` file in the one you use when starting OpenIDM.

   For reference, the password attributes for the three systems are as follows:

   `ldapPassword` for OpenDJ
   `adPassword` for Active Directory
   `password` for the internal OpenIDM password

2. If you want to incorporate the OpenDJ self-signed certificate into the OpenIDM keystore, add that information to the appropriate `authentication.json` file. For example, if you use the version of this file in the `/path/to/openidm/conf` directory, you might add `"CN=localhost, O=OpenDJ Self-Signed Certificate"`, as shown in the following excerpt:

   ```
   ...
   {
        "name" : "CLIENT_CERT",
        "properties" : {
            "queryOnResource" : "security/truststore",
            "defaultUserRoles" : [
                "openidm-cert"
            ],
            "allowedAuthenticationIdPatterns" : [
                "CN=localhost, O=OpenDJ Self-Signed Certificate"
            ]
        },
        "enabled" : true
   }
        ...
   ```

   In production, you should use a certificate that has been issued by a Certificate Authority.

Procedure 14.3. To Install the OpenDJ Password Synchronization Plugin

Before you start:

- Make sure that OpenDJ is configured to communicate over LDAPS as described in the OpenDJ documentation.
- OpenIDM must be running.

The following steps install the plugin on an OpenDJ directory server that is running on the same host as OpenIDM. If you run OpenDJ on a different host, use the fully qualified domain name rather than `localhost`, and use your certificates rather than the generated OpenIDM certificate.

1. OpenIDM generates a self-signed certificate the first time it starts up. You must import this self-signed certificate into OpenDJ's truststore so that the OpenDJ agent can make SSL requests to the OpenIDM endpoints.

    a. Export OpenIDM's generated self-signed certificate to a file, as follows (UNIX):

    ```
    $ cd /path/to/openidm/security
    $ keytool \
     -export \
     -alias openidm-localhost \
     -file openidm-localhost.crt \
     -keystore keystore.jceks \
     -storetype jceks
    Enter keystore password: <changeit>
    Certificate stored in file <openidm-localhost.crt>
    ```

    b. Import the self-signed certificate into the trust store for OpenDJ (UNIX).

    ```
    $ cd /path/to/OpenDJ/config
    $ keytool \
     -importcert \
     -alias openidm-localhost \
     -keystore truststore \
     -storepass `cat keystore.pin` \
     -file /path/to/openidm/security/openidm-localhost.crt
    Owner: CN=localhost, O=OpenIDM Self-Signed Certificate, OU=None, L=None, ST=None, C=None
    Issuer: CN=localhost, O=OpenIDM Self-Signed Certificate, OU=None, L=None, ST=None, C=None
    Serial number: 149168335c9
    Valid from: Mon Sep 15 18:12:18 PDT 2014 until: Tue Oct 15 18:12:18 PDT 2024
    Certificate fingerprints:
      MD5:  0C:BF:08:06:F0:69:E8:E6:6F:39:38:B8:CC:9A:C1:60
      SHA1: B0:40:17:0A:6E:3A:3B:BB:82:39:A1:97:04:00:BC:7C:94:63:76:E7
      Signature algorithm name: SHA512withRSA
      Version: 3
    Trust this certificate? [no]:  yes
    Certificate was added to keystore
    ```

2. Download the OpenDJ password synchronization plugin from ForgeRock's Backstage site. OpenIDM 3.1 supports version 1.0 of the plugin.

3. Unzip the module delivery.

    ```
    $ unzip ~/Downloads/opendj-accountchange-handler-1.0.0.zip
       creating: opendj/
    ...
    ```

4. Copy the files to the directory where OpenDJ is installed.

    ```
    $ cd opendj
    $ cp -r * /path/to/OpenDJ/
    ```

5. Restart OpenDJ to load the additional schema from the module.

```
$ cd /path/to/OpenDJ/bin
$ ./stop-ds --restart
```

6. Add the plugin configuration to OpenDJ's configuration (UNIX).

```
$ ./ldapmodify \
 --port 1389 \
 --hostname `hostname` \
 --bindDN "cn=Directory Manager" \
 --bindPassword "password" \
 --defaultAdd \
 --filename ../config/openidm-pwsync-plugin-config.ldif
Processing ADD request for cn=OpenIDM Notification Handler,
        cn=Account Status Notification Handlers,cn=config
ADD operation successful for DN cn=OpenIDM Notification Handler,
        cn=Account Status Notification Handlers,cn=config
```

7. Restart OpenDJ.

```
$ ./stop-ds --restart
...
[20/Nov/2013:08:55:47 +0100] category=EXTENSIONS severity=INFORMATION
 msgID=1049147 msg=Loaded extension from file '/path/to/OpenDJ/lib/extensions
 /opendj-accountchange-handler-1.0.0.jar' (build <unknown>,
 revision <unknown>)
...
[20/Nov/2013:08:55:51 +0100] category=CORE severity=NOTICE msgID=458891
 msg=The Directory Server has sent an alert notification generated by class
 org.opends.server.core.DirectoryServer (alert type
 org.opends.server.DirectoryServerStarted, alert ID 458887):
 The Directory Server has started successfully
```

8. Enable the plugin for the appropriate password policy.

   The following command enables the plugin for the default password policy (UNIX).

```
$ ./dsconfig \
 set-password-policy-prop \
 --port 4444 \
 --hostname `hostname` \
 --bindDN "cn=Directory Manager" \
 --bindPassword password \
 --policy-name "Default Password Policy" \
 --set account-status-notification-handler:"OpenIDM Notification Handler" \
 --trustStorePath ../config/admin-truststore \
 --no-prompt
```

9. If the `password` attribute does not exist in the `managed/user` object on OpenIDM, the password sync service will return an error when the password is updated in OpenDJ. To prevent this, add the following `onCreate` script to the OpenDJ > Managed Users mapping in the `sync.json` file:

```
"mappings" : [
 {
   "name" : "systemLdapAccounts_managedUser",
   "source" : "system/ldap/account",
   "target" : "managed/user",
   "properties" : [
     {
       "source" : "uid",
       "target" : "userName"
     }
   ],
   "onCreate" : {
     "type" : "text/javascript",
     "source" : "target.password=''"
   },
...
```

The onCreate script creates an empty password in the `managed/user` object, so that the attribute exists and can be patched.

Procedure 14.4. To Install the Active Directory Password Synchronization Plugin

Use the Active Directory password synchronization plugin to synchronize passwords between OpenIDM and Active Directory (on systems running at least Microsoft Windows Server 2003).

Install the plugin on Active Directory domain controllers (DCs) to intercept password changes, and send the password values to OpenIDM over an encrypted channel. You must have Administrator privileges to install the plugin. In a clustered Active Directory environment, you must install the plugin on all DCs.

1. Download the Active Directory password synchronization plugin from Forgerock's Backstage site.
2. - Double-click the setup file to launch the installation wizard.
   - Alternatively, from a command line, start the installation wizard with the `setup.exe` command. If you want to save the settings in a configuration file, you can use the /saveinf switch as follows.

     ```
     C:\Path\To > setup.exe /saveinf=C:\temp\adsync.inf
     ```

   - If you have a configuration file with installation parameters, you can install the password plugin in silent mode as follows:

     ```
     C:\Path\To > setup.exe  /verysilent /loadinf=C:\temp\adsync.inf
     ```
3. Provide the following information during the installation. You must accept the license agreement shown to proceed with the installation.

OpenIDM Connection information

- *OpenIDM URL.* Enter the URL where OpenIDM is deployed, including the query that targets each user account. For example:

  ```
  https://localhost:8443/openidm/managed/user?_action=patch&_queryId=for-userName&uid=
  ${samaccountname}
  ```

  For mutual authentication, the default URL is

  ```
  https://localhost:8444/openidm/managed/user?_action=patch&_queryId=for-userName&uid=
  ${samaccountname}
  ```

  For this query to work, you must set a mapping from `sAMAccountname` to `userName` in the `/path/to/openidm/conf/sync.json` file, for example:

  ```
  {
      "mappings" : [
          {
              "name" : "systemAdAccounts_managedUser",
              "source" : "system/ad/account",
              "target" : "managed/user",
              "properties" : [
                  ...
                  {
                      "source" : "sAMAccountName",
                      "target" : "userName"
                  },
                  ...
          }
      ]
  }
  ```

- *OpenIDM User Password attribute.* The password attribute for the `managed/user` object, such as `Password`.

  If the `password` attribute does not exist in the `managed/user` object, the password sync service will return an error when the password is updated in Active Directory. To prevent this, add the following script to the Active Directory > Managed Users mapping in the `sync.json` file:

  ```
  "onCreate" : {
      "type" : "text/javascript",
      "source" : "target.password=''; target.adPassword='';"
  },
  ```

  The onCreate script creates an empty password in the `managed/user` object, so that the attribute exists and can be patched.

OpenIDM Authentication Parameters

Provide the following information:

- *User name.* Enter the user name that is used to authenticate to OpenIDM, for example, `openidm-admin`.
- *Password.* Enter the password of the user that authenticates to OpenIDM, for example, `openidm-admin`.
- *Select authentication type.* Select the type of authentication that Active Directory will use to authenticate to OpenIDM.

  For plain HTTP authentication, select `OpenIDM Header`. For mutual authentication, select `Certificate`.

Certificate authentication settings

If you selected `Certificate` as the authentication type on the previous screen, specify the details of the certificate that will be used for authentication.

- *Select Certificate file.* Browse to select the certificate file that Active Directory will use to authenticate to OpenIDM. The certificate file must be configured with an appropriate encoding, cryptographic hash function, and digital signature. The plugin can read a public or a private key from a PKCS12 archive file.

  For production purposes, you should use a certificate that has been issued by a Certificate Authority. For testing purposes, you can generate a self-signed certificate. Whichever certificate you use, the certificate must be imported into OpenIDM's trust store.

  To generate a self-signed certificate for Active Directory, follow these steps:

  1. On the Active Directory host, generate a private key, which is then used to generate a self-signed certificate with the alias `ad-pwd-plugin-localhost` (Windows).

     ```
     > keytool.exe ^
      -genkey ^
      -alias ad-pwd-plugin-localhost ^
      -keyalg rsa ^
      -dname "CN=localhost, O=AD-pwd-plugin Self-Signed Certificate" ^
      -keystore keystore.jceks ^
      -storetype JCEKS
     Enter keystore password: changeit
     Re-enter new password: changeit
     Enter key password for <ad-pwd-plugin-localhost>
           <RETURN if same as keystore password>
     ```

  2. Now use the private key, stored in the `keystore.jceks` file, to generate the self-signed certificate (Windows).

```
> keytool.exe ^
 -selfcert ^
 -alias ad-pwd-plugin-localhost ^
 -validity 365 ^
 -keystore keystore.jceks ^
 -storetype JCEKS ^
 -storepass changeit
```

3. Export the certificate. In this case, the **keytool** command exports the certificate in a PKCS12 archive file format, used to store a private key with a certificate (Windows).

```
> keytool.exe ^
 -importkeystore ^
 -srckeystore keystore.jceks ^
 -srcstoretype jceks ^
 -srcstorepass changeit ^
 -srckeypass changeit ^
 -srcalias ad-pwd-plugin-localhost ^
 -destkeystore ad-pwd-plugin-localhost.p12 ^
 -deststoretype PKCS12 ^
 -deststorepass changeit ^
 -destkeypass changeit ^
 -destalias ad-pwd-plugin-localhost ^
 -noprompt
```

4. The PKCS12 archive file is named `ad-pwd-plugin-localhost.p12`. Import the contents of the keystore contained in this file to the system that hosts OpenIDM. To do so, import the PKCS12 file into the OpenIDM keystore file, named `truststore`, in the `/path/to/openidm/security` directory (UNIX).

```
$ keytool \
 -importkeystore \
 -srckeystore /path/to/ad-pwd-plugin-localhost.p12
 -srcstoretype PKCS12
 -destkeystore truststore
 -deststoretype JKS
```

- *Password to open the archive file with the private key and certificate.* Specify the keystore password (`changeit`, in the previous example).

Password Encryption settings

Provide the details of the certificate that will be used to encrypt password values.

- *Archive file with certificate.* Browse to select the archive file that will be used for password encryption. That file is normally set up in PKCS12 format.

  For evaluation purposes, you can use a self-signed certificate, as described earlier. For production purposes, you should use a certificate that has been issued by a Certificate Authority.

Whichever certificate you use, the certificate must be imported into OpenIDM's keystore, so that OpenIDM can locate the key with which to decrypt the data. To import the certificate into OpenIDM's keystore, `keystore.jceks`, run the following command on the OpenIDM host (UNIX):

```
$ keytool \
 -importkeystore \
 -srckeystore /path/to/ad-pwd-plugin-localhost.p12 \
 -srcstoretype PKCS12 \
 -destkeystore /path/to/openidm/security/keystore.jceks \
 -deststoretype jceks
```

- *Private key alias.* Specify the alias for the certificate, such as `ad-pwd-plugin-localhost`.
- *Password to open certificate file.* Specify the password to access the PFX keystore file, such as `changeit`, from the previous example.
- *Select encryption standard.* Specify the encryption standard that will be used when encrypting the password value (AES-128, AES-192, or AES-256).

Data storage

Provide the details for the storage of encrypted passwords in the event that OpenIDM is not available when a password modification is made.

- Select a secure directory in which the JSON files that contain encrypted passwords are queued. The server should prevent access to this folder, except access by the `Password Sync service`. The path name cannot include spaces.
- *Directory poll interval (seconds).* Enter the number of seconds between calls to check whether OpenIDM is available, for example, `60`, to poll OpenIDM every minute.

Log storage

Provide the details of the messages that should be logged by the plugin.

- Select the location to which messages should be logged. The path name cannot include spaces.
- *Select logging level.* Select the severity of messages that should be logged, either `error`, `info`, `warning`, `fatal`, or `debug`.

Select Destination Location

Setup installs the plugin in the location you select, by default `C:\Program Files\OpenIDM Password Sync`.

4. After running the installation wizard, restart the computer.

5. If you need to change any settings after installation, access the settings using the Registry Editor under HKEY_LOCAL_MACHINE > SOFTWARE > ForgeRock > OpenIDM > PasswordSync.

   If you have configured SSL access, make sure `authType` is set to `idm`.

6. If you selected to authenticate over plain HTTP in the previous step, your setup is now complete.

   If you selected to authenticate with mutual authentication, complete this step.

   - The Password Sync Service uses Windows certificate stores to verify OpenIDM's identity. The certificate that OpenIDM uses must therefore be added to the list of trusted certificates on the Windows machine.

     For production purposes, you should use a certificate that has been issued by a certificate authority. For test purposes, you can use the self-signed certificate that is generated by OpenIDM on first startup.

     To add the OpenIDM certificate to the list of trusted certificates, use the Microsoft Management Console.

     1. Select Start and type `mmc` in the Search field.

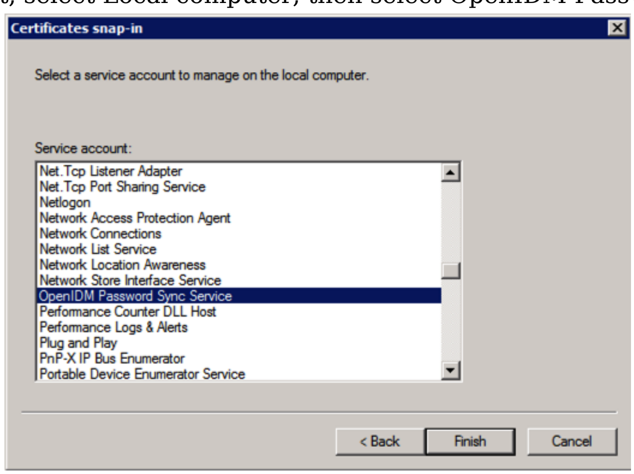
     2. In the Console window, select File > Add/Remove Snap-in.

     3. From the left hand column, select Certificates and click Add.

     4. Select My user account, and click Finish.

     5. Repeat the previous two steps for Service account and Computer account.

        For Service account, select Local computer, then select OpenIDM Password Sync Service.



        For Computer account, select Local computer.

6. Click Finish when you have added the three certificate snap-ins.
7. Still in the mmc Console, expand Certificates - Current User > Personal and select Certificates.
8. Select Action > All Tasks > Import to open the Certificate Import Wizard.
9. Browse for the OpenIDM certificate (`openidm-localhost.crt` by default, if you use OpenIDM's self-signed certificate).
10. Enter the Password for the certificate (`changeit` by default, if you use OpenIDM's self-signed certificate).
11. Accept the default for the Certificate Store.
12. Click Finish to complete the import.
13. Repeat the previous six steps to import the certificate for:

    `Certificates - Current User > Trusted Root Certification Authorities`
    `Certificates - Service > OpenIDM Password Sync\Personal`
    `Certificates - Service > OpenIDM Password Sync\Trusted Root Certification Authorities`
    `Certificates > Local Computer > Personal`
    `Certificates > Local Computer > Trusted Root Certification Authorities`

Procedure 14.5. To Set Up OpenIDM to Handle Password Changes

Follow these steps to configure OpenIDM to access password changes from OpenDJ and Active Directory.

1. You must add the OpenDJ/Active Directory server certificates that you have used to OpenIDM's trust store so that OpenIDM knows to trust OpenDJ/Active Directory during mutual authentication.

   Use the Java **keytool** command to import the certificate into the OpenIDM trust store. You may have already done so in previous procedures.

2. Add the configuration to managed objects to handle password synchronization.

   An example for synchronization with both OpenDJ and Active Directory is provided in the `samples/misc/managed.json` file, JavaScript lines folded for readability:

```
{
    "objects": [
        {
            "name": "user",
            "properties": [
                {
                    "name": "ldapPassword",
```

```
                    "encryption": {
                        "key": "openidm-sym-default"
                    }
                },
                {
                    "name": "adPassword",
                    "encryption": {
                        "key": "openidm-sym-default"
                    }
                },
                {
                    "name": "password",
                    "encryption": {
                        "key": "openidm-sym-default"
                    }
                }
            ],
            "onUpdate": {
                "type": "text/javascript",
                "source":
                 "if (newObject.ldapPassword != oldObject.ldapPassword) {
                     newObject.password = newObject.ldapPassword
                  } else if (newObject.adPassword != oldObject.adPassword) {
                      newObject.password = newObject.adPassword
                  }"
            }
        }
    ]
}
```

This sample assumes you define the password as `ldapPassword` for OpenDJ, and `adPassword` for Active Directory.

3. Update the connector configuration files to add the password property to the `account` object type.

   For OpenDJ, update `provisioner.openicf-ldap.json`, as follows:

```
"objectTypes" :
   {
      "account" :
         {
            "$schema" : "http://json-schema.org/draft-03/schema",
            "id" : "__ACCOUNT__",
            "type" : "object",
            "nativeType" : "__ACCOUNT__",
            "properties" :
               {
                  "cn" :
                     {
                        "type" : "string",
                        "nativeName" : "cn",
                        "nativeType" : "string"
                     },
                   ...
                  "ldapPassword" :
                     {
                        "type" : "string",
                        "nativeName" : "userPassword",
                        "nativeType" : "string"
                     },
  ...
```

For Active Directory, update `provisioner.openicf-ad.json`, as follows:

```
"objectTypes" :
   {
      "account" :
         {
            "$schema" : "http://json-schema.org/draft-03/schema",
            "id" : "__ACCOUNT__",
            "type" : "object",
            "nativeType" : "__ACCOUNT__",
            "properties" :
               {
                  "cn" :
                     {
                        "type" : "string",
                        "nativeName" : "cn",
                        "nativeType" : "string"
                     },
                   ...
                  "adPassword" :
                     {
                        "type" : "string",
                        "nativeName" : "_PASSWORD_",
                        "nativeType" : "JAVA_TYPE_GUARDEDSTRING"
                     },
  ...
```

4. When you change a password in OpenDJ, you will notice that the value changes in OpenIDM.

```
$ tail -f openidm/audit/activity.csv | grep bjensen
...userName=bjensen, ... password={$crypto={...data=tEsy7ZXo6nZtEqzW/uVE/A==...
...userName=bjensen, ... password={$crypto={...data=BReT79lnQEPcvfQG3ibLpg==...
```

Be aware that the plugin is patching the password value of the managed user in OpenIDM. The target `password` property must exist for the patch to work.

To configure implicit synchronization, that is the password is updated in Active Directory automatically when it is changed in OpenIDM, you must complete the following three steps:

- Define a mapping from `managed/user` to `system/ad/account` in your `/path/to/openidm/conf/sync.json` file.
- Specify the `{"source" : "password", "target" : "adPassword"}` property as part of this mapping.
- Make sure that implicit synchronization is enabled for that mapping. By default, all mappings participate in implicit synchronization operations so you should not have to enable this operation manually unless you have specifically set the `"enableSync"` property of the mapping to `false`.

Chapter 15

Managing Authentication, Authorization and Role-Based Access Control

OpenIDM provides a flexible authentication and authorization mechanism, based on REST interface URLs and on roles which may be stored in the repository.

15.1. OpenIDM Users

While OpenIDM authenticates internal and managed users with the `DELEGATED` module, there are differences between these two types of users.

15.1.1. Internal Users

OpenIDM creates two internal users by default: `anonymous` and `openidm-admin`. These accounts are separated from other user accounts to protect them from any reconciliation or synchronization processes.

OpenIDM stores internal users and their role membership in a table in the repository. For the way internal users are mapped, see the discussion on the `explicitMapping` property to `"internal/user` described in Section 5.2.3, "Using Explicit Mappings".

For more information on storage mechanisms for managed users in OrientDB and JDBC, see Section 8.1, "Working with Managed Users".

anonymous

This user enables anonymous access to OpenIDM, for users who do not have their own accounts. The anonymous user, configured by default with the `openidm-reg` role, has limited rights within OpenIDM. It can be used to allow self-registration. For more information on the process, see Section 4.3.1, "Enabling Self-Registration".

openidm-admin

This user serves as the top-level administrator. After installation, the `openidm-admin` user has full access, and provides a fallback mechanism in case other users are locked out. Do not use `openidm-admin` for regular tasks. Under normal circumstances, the `openidm-admin` account does not represent a regular user, so any audit log records for this account do not represent the actions of any real person.

OpenIDM encrypts the default administrative password, `openidm-admin`. Change the password immediately after installation. For instructions, see Procedure 16.2, "To Replace the Default User & Password".

15.1.1.1. Managing Internal Users Over REST

To list the internal users over REST, query the `repo` endpoint as follows:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET  \
 "https://localhost:8443/openidm/repo/internal/user?_queryId=query-all-ids"
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 2,
  "result": [
    {
      "_rev": "0",
      "_id": "openidm-admin"
    },
    {
      "_rev": "0",
      "_id": "anonymous"
    }
  ]
}
```

To query the details of an internal user, include the user's ID in the request, for example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET  \
 "https://localhost:8443/openidm/repo/internal/user/openidm-admin"
{
  "password": "openidm-admin",
  "userName": "openidm-admin",
  "roles": "openidm-admin,openidm-authorized",
  "_rev": "1",
  "_id": "openidm-admin"
}
```

To change the username or password of the default administrative user, send a PUT request to the user object. The following example changes the password of the `openidm-admin` user to `Passw0rd`:

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request PUT \
 --data '{
    "password": "Passw0rd",
    "userName": "openidm-admin",
    "roles": "openidm-admin,openidm-authorized",
    "_id": "openidm-admin"
 }' \
 "https://localhost:8443/openidm/repo/internal/user/openidm-admin"
{
  "roles": "openidm-admin,openidm-authorized",
  "password": {
    "$crypto": {
      "value": {
        "key": "openidm-sym-default",
        "iv": "USfN9kARk4QjoyjGa/r8WA==",
        "cipher": "AES/CBC/PKCS5Padding",
        "data": "27tDQg49z8nWqvIOEh7VAg=="
      },
      "type": "x-simple-encryption"
    }
  },
  "_id": "openidm-admin",
  "userName": "openidm-admin",
  "_rev": "2"
}
```

15.1.2. Managed Users

External users managed by OpenIDM are known as managed users.

The location of managed users depends on the type of repository. For JDBC repositories, OpenIDM stores managed users in the managed objects table, named `managedobjects`. OpenIDM may access an index table `managedobjectproperties` as well.

For the OrientDB repository, managed objects are stored in the table `managed_user`.

By default, the attribute names for managed user login and password are `userName` and `password`, respectively.

15.2. Authentication

OpenIDM does not allow access to the REST interface without authentication.

User self-registration requires anonymous access. For that purpose, OpenIDM includes an `anonymous` user, with the following password: `anonymous`. For more information, see Section 15.1.1, "Internal Users".

In production, only applications are expected to access the REST interface.

OpenIDM supports an improved authentication mechanism on the REST interface. Unlike basic authentication or form-based authentication, the OpenIDM authentication mechanism is compatible with the AJAX framework. You can configure authentication with standard or OpenIDM-specific header fields, as follows:

OpenIDM authentication with standard header fields

```
$ curl --user userName:password
```

This method uses standard basic authentication. However, it does not prompt for missing credentials.

OpenIDM authentication with OpenIDM header fields

```
$ curl
 --header "X-OpenIDM-Username: openidm-admin"
 --header "X-OpenIDM-Password: openidm-admin"
```

> **Note**
>
> This document uses the OpenIDM authentication options for all REST calls. Where no OpenIDM-specific options exist, the "long-form" option such as **--data** is used. In contrast, the README files that accompany OpenIDM generally use "short-form" options such as **-X** (instead of **--request**) and **-H** (instead of **--header**).

For more information about the OpenIDM authentication mechanism, see Section 16.2.4, "Use Message Level Security".

You can change the attributes used by OpenIDM to store user login and password values. Attribute names are shown in a database query listed in `openidm/conf/repo.repo-type.json`.

Two queries are defined by default.

`credential-internaluser-query`

Uses the `_openidm_id` attribute for login

`credential-query`

Uses the `userName` attribute for login

The `openidm/conf/authentication.json` file defines the active query with the `queryId` property. In the following example, `credential-query` is the `queryId` identifier used in a `queryRequest` to validate credentials.

```
{
    "queryId" : "credential-query",
    "queryOnResource" : "managed/user",
...
}
```

You can explicitly define the properties that constitute passwords or roles with the `propertyMapping` object in the `conf/authentication.json` file. The default property mapping is shown here:

```
...
   "propertyMapping" : {
       "authenticationId" : "username",
       "userCredential" : "password",
       "userRoles" : "roles"
   },
...
```

15.3. Supported Authentication Modules

OpenIDM supports a variety of modules, including those available from the Common Authentication Framework (CAF). The CAF modules available to OpenIDM include `JWT_SESSION`, `OPENAM_SESSION`, and `IWA`. OpenIDM also provides two additional authentication modules: `DELEGATED` and `CLIENT_CERT`.

OpenIDM evaluates authentication modules in the order in which they are placed in the `authentication.json` file.

JWT_SESSION

The JSON Web Token authentication module includes session information. For details on this common authentication module, see the following Javadoc page: *Class JwtSessionModule*.

CLIENT_CERT

The client certificate module accommodates users who authenticate with a client certificate.

DELEGATED

The DELEGATED module validates client requests with the help of one of the following entities:

- `MANAGED_USER`, a managed user object
- `INTERNAL_USER`, an internal user object
- `PASSTHROUGH`, an OpenICF connector.

OPENAM_SESSION

The OPENAM_SESSION module allows you to protect a deployment of OpenIDM with ForgeRock's OpenAM Access Management product. For an example of how you might use the OPENAM_SESSION module, see Section 3.16, "Sample - Configuring Authentication Management With OpenAM" in the *Installation Guide*.

IWA

The IWA module supports Integrated Windows Authentication. In other words, the IWA module supports the use of an LDAP connector for an Active Directory server. For an example of how you can set that up with a Kerberos server, see Section 15.5, "Kerberos Configuration Example".

15.4. Using Delegated Authentication

In addition to the internal and managed user authentication modules, OpenIDM 3.1 supports a delegated authentication mechanism. With delegated authentication, the username and password included with the REST request are validated against those stored in a remote system, such as an LDAP server.

The samples listed in Chapter 3, "*More OpenIDM Samples*" in the *Installation Guide* include multiple options for authentication mechanisms.

You can add the delegated authentication module to the `conf/authentication.json` file. For example, the following excerpt illustrates one way to implement the `DELEGATED` configuration object. For descriptive purposes, you can substitute the `PASSTHROUGH` alias for `DELEGATED`.

```
"authModules" : [
   {
      "name" : "DELEGATED",
      "properties" : {
         "augmentSecurityContext": {
            "type" : "text/javascript",
            "file" : "auth/populateAsManagedUser.js"
         },
         "queryOnResource" : "system/ldap/account",
         "propertyMapping" : {
            "authenticationId" : "uid",
            "groupMembership" : "memberOf"
         },
         "groupRoleMapping" : {
            "openidm-admin" : ["cn=admins"]
         },
         "managedUserLink" : "systemLdapAccounts_managedUser",
         "defaultUserRoles" : [
            "openidm-authorized"
         ]
      },
      "enabled" : true
   },
   ...
]
```

The properties shown from this excerpt are defined in Section 15.7.3, "Properties for Authentication and Roles"

The content of the delegated authentication object varies. Samples 2/2b/2c/2d, 3, 5, and 6 include slightly different versions of the `conf/authentication.json` file.

Samples 2, 2b, 2c, 2d (LDAP)

Samples 2, 2b, 2c, and 2d relate to connections from an LDAP server. Samples 5 and 5b are quite similar, as they uses XML information to masquerade as an LDAP server. The `authentication.json` file is identical in each of these samples.

In the common `authentication.json` file, the `queryOnResource` endpoint is `system/ldap/account`. The `managedUserLink` is `systemLdapAccounts_managedUser`.

Sample 3 (Scripted SQL)

Sample 3 relates to a connection to a scripted SQL database. As such, the `queryOnResource` endpoint is `system/scriptedsql/account`. The `managedUserLink` is `systemHrdb_managedUser`.

Sample 5, 5b (Synchronization of two resources)

The XML files used in samples 5 and 5b simulate a connection between LDAP servers. For that reason, the `conf/authentication.json` file used in these samples are identical to that for sample 2/2b/2c/2d.

Sample 6 (LiveSync)

The `queryOnResource` endpoint is `system/ad/account`. The `autheticationId` matches the AD attribute used for account names. The associated `managedUserLink` is `systemAdAccounts_managedUser`.

15.5. Kerberos Configuration Example

This section assumes that you have an active Kerberos server acting as a Key Distribution Center (KDC). If you're running Active Directory in your deployment, that service includes a Kerberos KDC by default.

To take advantage of a Kerberos KDC, you need to do two things: first include at least the `IWA` and possibly the `PASSTHROUGH` modules in the `authentication.json` file. Second, modify the `system.properties` file to take advantage of the noted modules.

For `IWA`, based on Integrated Windows Authentication, this section assumes you have configured an LDAP connector for an Active Directory server. To confirm, identify the following mapping source in the `sync.json` configuration file:

```
system/ad/account
```

You could then include the following code block in the `authentication.json` file. Include appropriate values for the `kerberosRealm` and `kerberosServerName`. For a list of definitions, see Section 15.5.1, "Kerberos Definitions".

```
"authModules" : [
   ...
   {
   "name" : "IWA",
   "properties": {
   "servicePrincipal" : "",
   "keytabFileName" : "security/name.HTTP.keytab",
   "kerberosRealm" : "",
   "kerberosServerName" : "",
   "queryOnResource" : "system/ad/account",
   "propertyMapping" : {
   "authenticationId" : "sAMAccountName",
   "groupMembership" : "memberOf"
   },
   "groupRoleMapping" : { "openidm-admin": [ ] },
   "groupComparisonMethod": "ldap",
   "defaultUserRoles" : [
   "openidm-authorized"
   ]
   },
   "enabled" : true
   }
```

To grant different roles to users who are authenticated through the `IWA` module, list them with their `groupRoleMapping`.

You could pair the `IWA` module with the `PASSTHROUGH` module. When paired, a failure in the `IWA` module allows users to revert to forms-based authentication.

You could add the `PASSTHROUGH` module as follows, in the `authentication.json` file:

```
 ...
   {
   "name" : "PASSTHROUGH",
   "properties": {
   "queryOnResource" : "system/AD/account",
   "propertyMapping" : {
   "authenticationId" : "sAMAccountName",
   "groupMembership" : "memberOf" },
   "groupRoleMapping" : { "openidm-admin": [ ] },
   "groupComparisonMethod": "ldap",
   "defaultUserRoles" : [
   "openidm-authorized"
   ]
   },
   "enabled" : true
   }
   ...
```

Once you have included at least the `IWA` module, edit the `system.properties` file. Include the following entry to point to a JAAS configuration file. Substitute if desired for `gssapi_jaas.conf`

```
java.security.auth.login.config=/path/to/openidm/conf/gssapi_jaas.conf
```

In the `gssapi_jaas.conf` file, include the following information related to the LDAP connector:

```
org.identityconnectors.ldap.LdapConnector {
com.sun.security.auth.module.Krb5LoginModule required client=TRUE
principal="bjensen@EXAMPLE.COM" useKeyTab=true keyTab="/path/to/bjensen.keytab";
};
```

15.5.1. Kerberos Definitions

The Windows Desktop authentication module uses Kerberos. The user presents a Kerberos token to the ForgeRock product, through the Simple and Protected GSS-API Negotiation Mechanism (SPNEGO) protocol. The Windows Desktop authentication module enables desktop single sign on such that a user who has already authenticated with a Kerberos Key Distribution Center can authenticate without having to provide the login information again. Users might need to set up Integrated Windows Authentication in Internet Explorer to benefit from single sign on when logged on to a Windows desktop.

The Kerberos attributes shown may correspond to a **ssoadm** attribute for OpenAM or a JSON attribute for OpenIDM.

Service Principal

Specify the Kerberos principal for authentication in the following format.

```
HTTP/host.domain@dc-domain-name
```

Here, *host* and *domain* correspond to the host and domain names of the installed ForgeRock product, and *dc-domain-name* is the domain name of the Windows Kerberos domain controller server. The *dc-domain-name* can differ from the domain name for the installed ForgeRock product.

You set up the account on the Windows domain controller, creating a computer account for the installed ForgeRock product and associating the new account with a service provider name.

ssoadm attribute: `iplanet-am-auth-windowsdesktopsso-principal-name`

JSON attribute: `servicePrincipal`

Keytab File Name

Specify the full path of the keytab file for the Service Principal. You generate the keytab file using the Windows **ktpass** utility.

ssoadm attribute: `iplanet-am-auth-windowsdesktopsso-keytab-file`

JSON attribute: `keytabFileName`

Kerberos Realm

Specify the Kerberos Key Distribution Center realm. For the Windows Kerberos service this is the domain controller server domain name.

ssoadm attribute: `iplanet-am-auth-windowsdesktopsso-kerberos-realm`

JSON attribute: `kerberosRealm`

Kerberos Server Name

Specify the fully qualified domain name of the Kerberos Key Distribution Center server, such as that of the domain controller server.

ssoadm attribute: `iplanet-am-auth-windowsdesktopsso-kdc`

JSON attribute: `kerberosServerName`

Return Principal with Domain Name

When enabled, OpenAM automatically returns the Kerberos principal with the domain controller's domain name during authentication.

ssoadm attribute: `iplanet-am-auth-windowsdesktopsso-returnRealm`

JSON attribute: `returnRealm`

Authentication Level

Sets the authentication level used to indicate the level of security associated with the module. The value can range from 0 to any positive integer.

ssoadm attribute: `iplanet-am-auth-windowsdesktopsso-auth-level`

JSON attribute: `authLevel`

Search for the user in the realm

Validates the user against the configured data stores. If the user from the Kerberos token is not found, authentication will fail. If an authentication chain is set, the user will be able to authenticate through another module.

ssoadm attribute: `iplanet-am-auth-windowsdesktopsso-lookupUserInRealm`

JSON attribute: `lookupUserInRealm`

> **Note**
>
> Note: For Windows 7 and later, you will need to disable the "Enable Integrated Windows Authentication" option in Internet Explorer. In addition, you will need to add and activate the DisableNTMLPreAuth key to the

Windows Registry. For detailed instructions, see the Microsoft KB article on when *You cannot post data to a non-NTLM-authenticated Web site*

15.6. Roles and Authentication

OpenIDM includes a number of default roles, and supports the configuration of managed roles, enabling you to customize the roles mechanism as needed.

The following roles are configured by default:

openidm-reg

Role assigned to users who access OpenIDM with the default anonymous account.

The `openidm-reg` role is excluded from the reauthorization required policy definition by default.

openidm-admin

OpenIDM administrator role, excluded from the reauthorization required policy definition by default.

openidm-authorized

Default role for any user who has authenticated with a user name and password.

openidm-cert

Default role for any user authenticated with mutual SSL authentication.

This role applies only for mutual authentication. Furthermore, the shared secret (certificate) must be adequately protected. The `openidm-cert` role is excluded from the reauthorization required policy definition by default.

OpenIDM begins the process of assigning the roles of a user with the `roles` property. OpenIDM then proceeds in the following sequence to define user roles:

- If the `defaultRoles` property is set, OpenIDM assigns those roles to the given user. The `defaultRoles` property must be configured in an array.
- The `userRoles` property is a string that defines the attribute. The value of the attribute may be either a comma-delimited string or a list of strings. You can identify the list with a REST call to a `queryOnResource` endpoint such as `system/ldap/account`
- If the `groupRoleMapping` and `groupMembership` properties are defined, OpenIDM assigns additional roles to users depending on any existing group membership.

The roles calculated in sequence are cumulative. In other words, if all of the above properties are defined, OpenIDM would assign roles from `defaultRoles` and `userRoles`. It would also use a `MappingRoleCalculator` to define roles from the `groupRoleMapping` and `groupMembership` properties.

For users who have authenticated with mutual SSL authentication, the module is `CLIENT_CERT` and the default role for such users is `openidm-cert`.

```
{   "name" : "CLIENT_CERT",
    "properties" : {
        "queryOnResource": "managed/user",
        "defaultUserRoles": [  "openidm-cert" ],
        "allowedAuthenticationPatterns" : [ ]
    },
    "enabled" : "true"
}
```

Access control for such users is configured in the `access.js` file. For more information, see Section 15.7, "Authorization".

15.7. Authorization

OpenIDM provides role-based authorization that restricts direct HTTP access to REST interface URLs. The default authorization configuration grants different access rights to users that are assigned the roles `"openidm-admin"`, `"openidm-cert"`, `"openidm-authorized"`, and `"openidm-reg"`.

Note that this access control applies to direct HTTP calls only. Access for internal calls (for example, calls from scripts) is not affected by this mechanism.

Authorization is configured in two script files:

- `openidm/bin/defaults/script/router-authz.js`
- `openidm/script/access.js`

OpenIDM calls these scripts for each request, via the `onRequest` hook that is defined in the default `router.json` file. The scripts either throw the string `Access denied`, or nothing. If `Access denied` is thrown, OpenIDM denies the request.

15.7.1. `router-authz.js`

This file provides the functions that enforce access rules. For example, the following function controls whether users with a certain role can start a specified process.

```
...
function isAllowedToStartProcess() {
var processDefinitionId = request.content._processDefinitionId;
return isProcessOnUsersList(processDefinitionId);
}
...
```

There are certain authorization-related functions in `router-authz.js` that should *not* be altered, as described in a comment in the file.

15.7.2. `access.js`

This file defines the access configuration for HTTP requests and references the methods defined in `router-authz.js`. Each entry in the configuration contains a pattern to match against the incoming request ID, and the associated roles, methods, and actions that are allowed for requests on that pattern.

The options shown in the default version of the file do not include all of the actions available at each endpoint.

The following sample configuration entry indicates the configurable parameters and their purpose.

```
{
    "pattern"   : "*",
    "roles"     : "openidm-admin",
    "methods"   : "*", // default to all methods allowed
    "actions"   : "*", // default to all actions allowed
    "customAuthz" : "disallowQueryExpression()",
    "excludePatterns": "system/*"
},
```

As shown, this entry affects users with the `openidm-admin` role. Such users have HTTP access to all but `system` endpoints. The parameters are as follows:

- `"pattern"` - the REST endpoint to which access is being controlled. `"*"` indicates access to all endpoints. `"managed/user/*"` would indicate access to all managed user objects.
- `"roles"` - a list of the roles to which this access configuration applies.
- `"methods"` - a comma separated list of the methods to which access is being granted. The method can be one or more of `create, read, update, delete, patch, action, query`. A value of `"*"` indicates that all methods are allowed. A value of `""` indicates that no methods are allowed.
- `"actions"` - a comma separated list of the allowed actions. The possible values depend on the service (URL) that is being exposed. The following list indicates the possible actions for each service.

  `openidm/info/*` - `(no action parameter applies)`
  `openidm/authentication` - `reauthenticate`
  `openidm/config/ui/*` - `(no action parameter applies)`
  `openidm/endpoint/securityQA` - `securityQuestionForUserName, checkSecurityAnswerForUserName, setNewPasswordForUserName`
  `openidm/endpoint/getprocessforuser` - `create, complete`
  `openidm/endpoint/gettaskview` - `create, complete`
  `openidm/external/email` - `send`
  `openidm/external/rest` - `(no action parameter applies)`
  `openidm/managed` - `patch, triggerSyncCheck`
  `openidm/managed/user` - `validateObject, validateProperty`
  `openidm/policy` - `validateObject, validateProperty`
  `openidm/recon` - `recon, reconByQuery, reconById, cancel`

`openidm/repo` - `updateDbCredentials`
`openidm/script/*` - `eval`
`openidm/security/keystore` - `generateCert, generateCSR`
`openidm/security/truststore` - `generateCert, generateCSR`
`openidm/sync` - `notifyCreate, notifyUpdate, notifyDelete, recon, performAction`
`openidm/system` - `test, testConfig, availableConnectors, createCoreConfig, createFullConfig, liveSync, authenticate`
`openidm/system/<name>` - `script, test, liveSync`
`openidm/system/<name>/{id}` - `authenticate, liveSync`
`openidm/taskscanner` - `execute, cancel`
`openidm/workflow/processdefinition` - `create, complete`
`openidm/workflow/processinstance` - `create, complete`
`openidm/workflow/taskinstance` - `claim, create, complete`

A value of `"*"` indicates that all actions exposed for that service are allowed. A value of `""` indicates that no actions are allowed.

- `"customAuthz"` - an optional parameter that enables you to specify a custom function for additional authorization checks. These functions are defined in `router-authz.js`.

  The `allowedPropertiesForManagedUser` variable, declared at the beginning of the file, enables you to create a white list of attributes that users are able to modify on their own accounts.

- `"excludePatterns"` - an optional parameter that enables you to specify particular endpoints to which access should not be given.

15.7.3. Properties for Authentication and Roles

The properties in this section define how users and groups may be associated with roles and certain authentication mechanisms. Some of these properties are included in the excerpt of the `authentication.json` file shown in Section 15.4, "Using Delegated Authentication".

Different authentication modules may apply. In files such as `authentication.json`, you may assign an authentication module to the `name` property. Just be sure to include `enabled=true` or `enabled=false` for the configured module(s). For a list of available modules, see Section 15.3, "Supported Authentication Modules".

`queryOnResource`

The system endpoint against which the user authenticates, such as `system/ldap/account`, `system/scriptedsql/account`, `system/ad/account`, `managed/user`, and `repo/internal/user`.

`augmentSecurityContext` (optional)

This parameter points to a script, executed only after a successful authentication request to provide additional information, based on the security context.

For delegated (pass-through authentication), OpenIDM uses the `populateAsManagedUser.js` script. This script uses authentication details returned from the pass-through authentication module.

Those details can point to a linked managed user record. If a linked record is found, the script adjusts the details of the security context to match that managed user object. The adjusted security context enables additional operations for the authenticated user, such as the ability to access the default user interface.

The script must be either JavaScript (`"type":"text/javascript"`) or Groovy (`"type":"groovy"`), and can be provided inline (`"source":"script source"`) or in a file (`"file":"filename"`).

`propertyMapping` (optional)

A list that enables you to map the following OpenIDM properties to fields in the system resource used for the authentication.

`authenticationId`

Specifies the authentication property, such as `"uid"`, `"sAMAccountName"`, and `"username"`

`groupMembership`

Specifies the name of the property in the remote system that contains the list of groups of which the authenticated user is a member, such as `memberOf`, or `ldapGroups`.

`groupRoleMapping` (optional)

Enables you to assign roles to users, based on their group membership in the system resource. In this example, users who are members of the `"cn=admins"` group in the LDAP directory automatically acquire the `"openidm-admin"` role. Group membership is determined, based on the `groupMembership` property, described previously.

`managedUserLink` (optional)

Used by the script specified in `"augmentSecurityContext"` to switch the context of an authenticated user from their original security context to a context that is based on the related `managed/user` account. The value is based on the `name` of the mapping in the associated `sync.json` file.

The value of this property is the `"links"` entry (usually the mapping name defined in `sync.json`) that was used to relate the remote system users with the managed users.

`defaultUserRoles` (optional)

Can be defined for any authentication module. OpenIDM assigns such roles (or an empty set) to the security context of a user.

`enabled`

Specifies whether the given authentication module is enabled (`true`) or disabled (`false`).

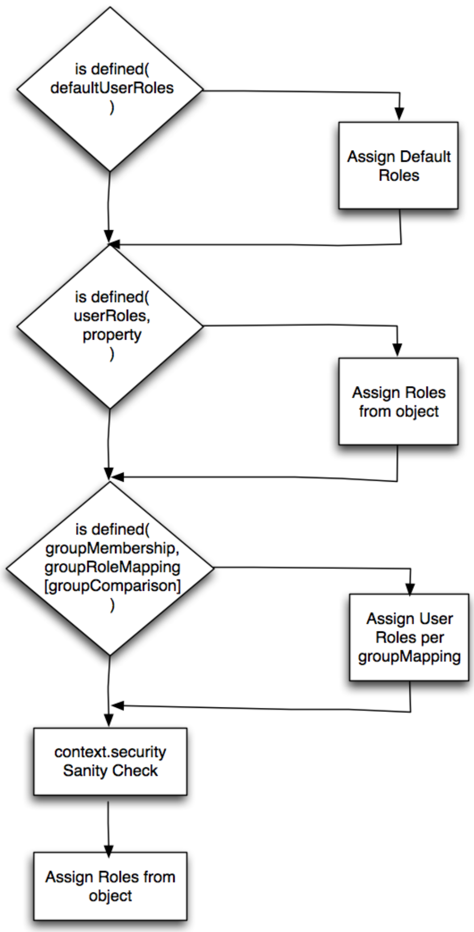
15.7.4. Extending the Authorization Mechanism

You can extend the default authorization mechanism by defining additional functions in `router-authz.js` and by creating new access control configuration definitions in `access.js`.

15.8. Building Role-Based Access Control (RBAC)

In OpenIDM, role assignments can be configured with different authentication options. Roles can be assigned in a number of ways. The roles assigned to specific users are cumulative.

The roles for each user are calculated based on the process depicted here:



In OpenIDM, RBAC incorporates authentication and authorization options from roles configured for clients, for managed / internal users, as well as for group memberships.

For information on the properties listed in this section, see Section 15.7.3, "Properties for Authentication and Roles".

Roles and authentication options can be configured for users in three stages:

Client Controlled

The `defaultUserRoles` may be added to authentication modules configured in the applicable `authentication.json` file. Default roles are listed in Section 15.6, "Roles and Authentication".

If you see the following entry in `authentication.json`, the cited authentication property applies to all authenticated users:

```
"defaultUserRoles" : [ ]
```

Managed / Internal

Accumulated roles for users are collected in the `userRoles` property.

For a definition of managed and internal users, see Section 15.1, "OpenIDM Users".

Group roles

OpenIDM also uses group roles as input. Options include `groupMembership`, `groupRoleMapping`, and `groupComparison`

context.security

Once OpenIDM assigns roles and authentication modules to a user, OpenIDM then evaluates the result based on the `context.security` map, based on the scripts in the `policy.js` file. Details require an extended discussion in the next section.

15.8.1. Roles, Authentication, and the Security Context

The Security Context, written into the code as `context.security`, consists of a principal defined by the `authenticationId`, along with access control defined through the `authorizationId`.

If authentication is successful, Common Authentication Framework (CAF) modules set a principal. OpenIDM stores that principal as the `authenticationId`. For more information, see the authentication components defined in Section 15.3, "Supported Authentication Modules".

The `authorizationId` includes two roles-related components, generated by OpenIDM:

roles

Discussed in Section 15.6, "Roles and Authentication"

component

Resources defined through properties defined in Section 15.7.3, "Properties for Authentication and Roles". The `authorizationId` component is set to the value references in the `queryOnResource` property.

Chapter 16

Securing & Hardening OpenIDM

OpenIDM provides a security management service, that manages keystore and truststore files. The security service is accessible over the REST interface, enabling you to read and import SSL certificates, and to generate certificate signing requests.

This chapter describes the security management service and its REST interface.

In addition, the chapter outlines the specific security procedures that you should follow before deploying OpenIDM in a production environment.

Note

In a production environment, we recommend that you avoid the use of: communications over insecure HTTP, self-signed certificates, and certificates associated with insecure ciphers.

16.1. Accessing the Security Management Service

OpenIDM stores keystore and truststore files in a folder named `/path/to/openidm/security`. These files can be managed by using the **keytool** command, or over the REST interface, at the URL `https://localhost:8443/openidm/security`. For information about using the **keytool** command, see http://docs.oracle.com/javase/6/docs/technotes/tools/solaris/keytool.html.

The following sections describe how to manage certificates and keys over REST.

16.1.1. Displaying the Contents of the Keystore

OpenIDM generates a symmetric key and a private key the first time the server is started. After startup, display the contents of the keystore over REST, as follows:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/security/keystore"

{
  "type" : "JCEKS",
  "provider" : {
     "Cipher.Blowfish SupportedKeyFormats" : "RAW",
     "AlgorithmParameters.DESede" : "com.sun.crypto.provider.DESedeParameters",
     "AlgorithmParameters.DES" : "com.sun.crypto.provider.DESParameters",
  ...
  },
  "aliases" : [ "openidm-sym-default", "openidm-localhost" ]
}
```

By default, OpenIDM includes the following aliases:

- `openidm-sym-default` - the default symmetric key that is used, for example, to encrypt the configuration.
- `openidm-localhost` - the default alias that is used by the Jetty web server to service SSL requests. This alias references a private key and a self-signed certificate. You can use the self-signed certificate for testing purposes. When you deploy OpenIDM in a production environment, you should replace the self-signed certificate with a certificate that has been signed by a certificate authority.

16.1.2. Generating a Certificate Signing Request Over REST

To request a signed certificate, generate a certificate signing request (CSR) over REST, as described in this section. The details of the CSR are specified in JSON format, for example:

```
{
    "DN" : "www.example.com",
    "OU" : "HR",
    "L"  : "Cupertino",
    "C"  : "US"
}
```

For information about the complete contents of a CSR, see http://www.sslshopper.com/what-is-a-csr-certificate-signing-request.html.

To generate a CSR over the REST interface, include the private key alias in the URL. The following example, uses the default alias (`openidm-localhost`). If you have created your own private key for this request, specify its alias instead of `openidm-localhost`. Set `"returnPrivateKey" : true` to return the private key along with the request.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
```

```
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{"CN" : "www.example.com",
 "OU" : "HR",
 "L"  : "Cupertino",
 "C"  : "US",
 "returnPrivateKey" : true,
 "alias" : "openidm-localhost"}' \
 "https://localhost:8443/openidm/security/keystore?_action=generateCSR"

{
  "_id": "openidm-localhost",
  "csr": "-----BEGIN CERTIFICATE REQUEST-----\n
MIICmzCCAYMCAQAwWDEZMBcGA1UEAwwQd3d3MS5
leGFtcGxlLmNvbTELMAkGA1UE\nCwwCSFIxDTALBgNVBAoMBE5vbmUxEjAQBgNVBAcMCUN1cGVyd
GlubzELMAkGA1UE\nBhMCVVMwggEiMA0GCSqGSIb3DQEBAQUAA4IBDwAwggEKAoIBAQDAjCjTt1b
o0WKH\nP/4PR/Td3A1ElTo4/J/7o7eWflOqs8vW5d76SMcJFKOQ6FhoOcOHRNewch+a0DBK\njKF
aRCE1c0PuXiIlrO7wsF4dFTtTZKAhrpFdM+0hU4LeyCDxQQ5UDga3rmyVIvC8\nL1PvW+sZEcZ9r
T67XOV03cwUpjvG4W58FCUKd6UAI0szfIrFdvJp4q4LkkBNkk9J\nUf+MXsSVuHzZrqvqhX900Is
a19mXD6/P9Cql8KmwEzzbglGFf6uYAK33F71Kx409\nTeS85sjmBbyJwUVwhgQ0R35H3HC6jex4P
jx1rSfPmsi61JBx9kyGu6rnSv5FOQGy\nBQpgQFnJAgMBAAEwDQYJKoZIhvcNAQENBQADggEBAKc
yInfo2d7/12jUrOjL4Bqt\nStuQS/HkO2KAsc/zUnlpJyd3RPI7Gs1C6FxIRVCzi4Via5QzE06n2
F8HHkinqc6m\nBWhIcf5Omk6fSqG0aw7fqn20XWDkRm+I4vtm8P8CuWftUj5qv5kmyUtrcQ3+YPD
O\nL+cK4cfuCkjLQ3h4GIgBJP+gfWX8fTmCHyaHEFjLTMj1hZYEx+3f8awOVFoNmr3/\nB8LIJNH
UiFHO6EED7LDOwa/z32mTRET0nK5DVO60H80JSWxzdWYZQV/IzHzm8ST4\n6j6vuheBZiG5gZR2V
F0x5XoudQrSg7lpVslXBHNeiM85+H08RMQh8Am2bp+Xstw=\n",
     -----END CERTIFICATE REQUEST-----\n",
  "publicKey": {
     "format": "X.509",
     "encoded": "-----BEGIN PUBLIC KEY-----\n
MIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEAr
ALtYU662bNbQZG7JZ3M\noOUmVP9cPP3+DhQ5H0V0qB+9YjE4XUtuwUGqaUmuT+mrXHwGpLAqvUm
NsVyXJj9s\nJhX6PCyXzO3RdKBVC8pphMfKXodjBC57ef0OkWjO5ZRAqCRwS3BXkoCfu6/ZXRpk\
ncc/A1RmLZdPmcuKmN5vQl4E3Z6F4YyG7M0g7TE54dhqPvGNS9cO4r0Vom9373MDh\n+8QSfmLCC
94Ro+VUAF9Q6nk2j0PgTi+QZ0i93jbKAWWX57w6S5i7CpEptKyeP9iG\ncFnJddSICPHkbQJ73gu
lyZYkbcBblNUxIhODZV5bJ0oxn9qgYvzlxJupldYsYkBo\ncwIDAQAB\n
     -----END PUBLIC KEY-----\n",
     "algorithm": "RSA"
  },
  "privateKey": {
     "format": "PKCS#8",
     "encoded": "-----BEGIN RSA PRIVATE KEY-----\n
MIIEpAIBAAKCAQEArALtYU662bNbQZG7JZ3MoOU
VP9cPP3+DhQ5H0V0qB+9YjE4\nXUtuwUGqaUmuT+mrXHwGpLAqvUmNsVyXJj9sJhX6PCyXzO3RdK
BVC8pphMfKXodj\nBC57ef0OkWjO5ZRAqCRwS3BXkoCfu6/ZXRpkcc/A1RmLZdPmcuKmN5vQl4E3
Z0i93jbKAWWX57w6S5i7CpEptKyeP9iGcFnJddSICPHkbQJ73gulyZYkbcBb\nlNUxIhODZV5bJ0
Z6F4\nYyG7M0g7TE54dhqPvGNS9cO4r0Vom9373MDh+8QSfmLCC94Ro+VUAF9Q6nk2j0Pg\nTi+Q
oxn9qgYvzlxJupldYsYkBocwIDAQABAoIBAGmfpopRIPWbaBb8\nWNIBcuz9qSsaX1ZolP+qNWVZ
bgfq7Y0FMlo/frQXEYBzqSETGJHC6wVn0+bF6scV\nVw86dLtyVWVr8I77HdoitfZ2hZLuZ/rh4d
BohpPi63YoyJs7DPTy4y2/v1aLuwoy\nMiQ0l6c3bm6sr+eIVgMH4A9Xk5/jzAHVTCBrvfTYZnh6
qD4Qmiuj8pQn79HQV8NK\nLt/5kmV1+uGj78jg7NR06NjNsa4L3mNZSiqsn2haPXZAnBjKfWApxe
GugURgNBCO\ncmYqCDZLvpMy4S/qoRBu+6qdYGprb+tHshBYNywuDkrgszhwgr5yRm8VQ60T9tM/
\nceKM+TECgYEA2Az2DkpC9TjJHPJG7x4boRRVqV5YRgPf5MrU+7PxDMb+EauXXUXg\nsch9Eeon
30yINqSv6FwATLVlkzQpZLkkJ6GJqAxUmPjRslAuosiSJqKaWamDUDbz\nSu/7iANJWvRGayqZsa
GQqFwM0Xpfp/EiBGe757k0D02u8sAv94A75bsCgYEAy9FQ\nMwDU3CaDzgv0qgR1ojXkSW0dCbv0
QPEkKZ2Ik7JbXzwVGzfdv2VUVrzRKBGReYzn\nGg/s4HbZkYy4O+SJo44n/5iO2pgKG5MEDFHSpw
X54Rm+qabT2fQ2lFJ/myWKsPgJ\n4gZ9bUvcemCcLLzsiAphueulQp49eOLnkzPlQKkCgYEAy7A0
jrZuuDjoStUUET5G\neC/urvZWrPPcMx0TfZZhTVWSlWA8HWDS/WnymGA1ZS4HQdU0TxHl6mwerp
```

```
C/8ckn\nEAIZAQlW/L2hHcbAoRIN0ET+1kedmJOl/mGQt+O5Vfn1JfYM3s5ezouyPhBsfK43\nDw
Ypvsb6EO+BYDXXQzVvwx8CgYB9o67LcfTFLNzNFCOi9pLJBm2OMbvXt0wPCFch\nbCG34hdfMntU
RvDjvgPqYASSrZm+kvQW5cBAciMWDOe4y91ovAW+En3lFBoO+2Zg\nbcPr/8wUTblxfQxU660Fa4
GL0u2Wv5/f+94vlLb5nTpIfcFU7wllAXTjBwaf0Uet\nPy1P2QKBgQDPoyJqPi2TdN7ZQYcoXAM4
Gl5Yv9oO16RC917XH6SLvj0ePmdLgBXo\nrR6aAmOjLzFp9jiytWZqVR9DbAWd2YNpvQav4Gude3
lteew02UT+GNv/gC71bXCw\ncFTxnmKjP8YYIBBqZXzuk9wEaHN7OdGybUW0dsBCGxTXwDKe8XiA
6w==\n-----END RSA PRIVATE KEY-----\n",
     "algorithm": "RSA"
}
```


This sample request returns the CSR, the private key associated with the request, and the public key. The security management service stores the private key in the repository. When the signed certificate is returned by the certificate authority and you import the certificate into the keystore, you do not need to supply the private key. The security management service locates the private key in the repository, adds the certificate chain, and loads it into the keystore.

If you will be importing the signed certificate into the keystore of an OpenIDM instance that is not connected to the repository in which this private key was stored, you must include the private key when you import the signed certificate. Setting `"returnPrivateKey" : true` in the CSR enables you to maintain a copy of the private key for this purpose.

Send the output from

```
"csr": "-----BEGIN CERTIFICATE REQUEST-----
     ...
     -----END CERTIFICATE REQUEST-----
```

to your certificate authority for signature.

16.1.3. To Import a Signed Certificate into the Keystore

When a signed certificate is returned by the certificate authority, import it into the keystore by running a RESTful `PUT` command on the keystore alias. Include the CA root certificate in the command. If you are not importing the certificate into the same keystore as the one from which the CSR was generated, include the private key in the PUT request.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PUT \
 --data '{
    "alias": "openidm-localhost",
    "fromCSR": true,
    "certs": [
        "-----BEGIN CERTIFICATE-----\n
MIIGcDCCBVigAwIBAgIDC23tMA0GCSqGSIb3DQEBBQUAMIGMMQswCQYDVQQGEwJJ\n
TDEWMBQGA1UEChMNU3RhcnRDb20gTHRkLjErMCkGA1UECxMiU2VjdXJlIERpZ2l0\n
YWwgQ2VydGlmaWNhdGUgU2lnbmluZzE4MDYGA1UEAxMvU3RhcnRDb20gQ2xhc3Mg\n
MSBQcmltYXJ5IEludGVybWVkaWF0ZSBTZXJ2ZXIgQ0EwHhcNMTMwODA3MTMyODAz\n
WhcNMTQwODA4MDY0NTM5WjB2MRkwFwYDVQQNExBwZ3BDaGU4cEJPZnptVE9KMQsw\n
CQYDVQQGEwJHQjEjMCEGA1UEAxMadGVzdC1jb25uZWN0LmZvcmdlcm9jay5jb20x\n
JzAlBgkqhkiG9w0BCQEWGHBvc3RtYXN0ZXJAZm9yZ2Vyb2NrLmNvbTCCASIwDQYJ\n
```

```
KoZIhvcNAQEBBQADggEPADCCAQoCggEBAJRWGbnMGs+uGKU6ZrlTaaFdPczLqZnv\n
D37T0FOc/X3XXHxSVH94FDk7N4ansP2o6BsDWttIkM2AXkX3efMRaNpgxg7l4+DL\n
opV6H1RkrRba2Lom6Hp2pgkqvOBfd1ZMOmLbjUHt0jhypnIzu7TVwtTH7Ywsrx9F\n
uR9d4veYdW70IeQ64EhUG3RJBGG++AYJZCOjgEfbCwAYe/NoX/YVu+aMreHMR/+0\n
CV0YXKvHZgytcwZIc5WkQYaSWQA9lDWZzt5XjCErCATfiGEQ0k02QgpEfNTXxwQs\n
kfxh//O/qbfOWmloGwVU/2NY+5z3ZW8/eCksmiL1gGAYQAd+9+WI7BsCAwEAAaOC\n
Au4wggLqMAkGA1UdEwQCMAAwCwYDVR0PBAQDAgOoMBMGA1UdJQQMMAoGCCsGAQUF\n
BwMBMB0GA1UdDgQWBBR2zHzb71ZOHSwDZk28L9It3PvOtzAfBgNVHSMEGDAWgBTr\n
QjTQmLCrn/Qbawj3zGQu7w4sRTA0BgNVHREELTArghp0ZXN0LWNvbm5lY3QuZm9y\n
Z2Vyb2NrLmNvbYINZm9yZ2Vyb2NrLmNvbTCCAVYGA1UdIASCAU0wggFJMAgGBmeB\n
DAECATCCATsGCysGAQQBgbU3AQIDMIIBKjAuBggrBgEFBQcCARYiaHR0cDovL3d3\n
dy5zdGFydHNzbC5jb20vcG9saWN5LnBkZjCB9wYIKwYBBQUHAgIwgeowJxYgU3Rh\n
cnRDb20gQ2VydGlmaWNhdGlvbiBBdXRob3JpdHkwAwIBARqBvlRoaXMgY2VydGlm\n
aWNhdGUgd2FzIGlzc3VlZCBhY2NvcmRpbmcgdG8gdGhlIENsYXNzIDEgVmFsaWRh\n
dGlvbiByZXF1aXJlbWVudHMgb2YgdGhlIFN0YXJ0Q29tIENBIHBvbGljeSwgcmVs\n
aWFuY2Ugb25seSBmb3IgdGhlIGludGVuZGVkIHB1cnBvc2UgaW4gY29tcGxpYW5j\n
ZSBvZiB0aGUgcmVseWluZyBwYXJ0eSBvYmxpZ2F0aW9ucy4wNQYDVR0fBC4wLDAq\n
oCigJoYkaHR0cDovL2NybC5zdGFydHNzbC5jb20vY3J0MS1jcmwuY3JsMIGOBggr\n
BgEFBQcBAQSBgTB/MDkGCCsGAQUFBzABhi1odHRwOi8vb2NzcC5zdGFydHNzbC5j\n
b20vc3ViL2NsYXNzMS9zZXJ2ZXIvY2EwQgYIKwYBBQUHMAKGNmh0dHA6Ly9haWEu\n
c3RhcnRzc2wuY29tL2NlcnRzL3N1Yi5jbGFzczEuc2VydmVyLmNhLmNydDAjBgNV\n
HRIEHDAahhhodHRwOi8vd3d3LnN0YXJ0c3NsLmNvbS8wDQYJKoZIhvcNAQEFBQAD\n
ggEBAKVOAHtXTrgISj7XvE4/lLxAfIP56nlhpoLu8CqVlLK6eK4zCQRyTiFYx3xq\n
VQMSNVgQIdimjEsMz8o5/fDrCrozsT6sqxIPFsdgdskPyz9YyC9Y/AVBuECxabQr\n
B//0STicfdPg8PuDYtI64/INA47d/gtb57RaTFYxKs6bU8vtObinDJCwT33x4tvt\n
ob18DwB3/PeTbWyVUIxB0nvfm89dys0SF2alaA/bLuy0B7rdlppd4dOMpmiD0tnI\n
DORtr5HOD1xGiixZWzA1V2pTmF/hJZbhmEgBUSIyPK5Z9pZPephMf+/KrovbQqKr\n
6SEjgs7dGwpo6fA2mfCH5cCrid0=\n
-----END CERTIFICATE-----",
        "-----BEGIN CERTIFICATE-----\n
MIIDdTCCAl2gAwIBAgILBAAAAAABFUtaw5QwDQYJKoZIhvcNAQEFBQAwVzELMAkG\n
A1UEBhMCQkUxGTAXBgNVBAoTEEdsb2JhbFNpZ24gbnYtc2ExEDAOBgNVBAsTB1Jv\n
b3QgQ0ExGzAZBgNVBAMTEkdsb2JhbFNpZ24gUm9vdCBDQTAeFw05ODA5MDExMjAw\n
MDBaFw0yODAxMjgxMjAwMDBaMFcxCzAJBgNVBAYTAkJFMRkwFwYDVQQKExBHbG9i\n
YWxTaWduIG52LXNhMRAwDgYDVQQLEwdSb290IENBMRswGQYDVQQDExJHbG9iYWxT\n
aWduIFJvb3QgQ0EwggEiMA0GCSqGSIb3DQEBAQUAA4IBDwAwggEKAoIBAQDaDuaZ\n
jc6j40+Kfvvxi4Mla+pIH/EqsLmVEQS98GPR4mdmzxzdzxtIK+6NiY6arymAZavp\n
xy0Sy6scTHAHoT0KMM0VjU/43dSMUBUc71DuxC73/OlS8pF94G3VNTCOXkNz8kHp\n
1Wrjsok6Vjk4bwY8iGlbKk3Fp1S4bInMm/k8yuX9ifUSPJJ4ltbcdG6TRGHRjcdG\n
snUOhugZitVtbNV4FpWi6cgKOOvyJBNPc1STE4U6G7weNLWLBYy5d4ux2x8gkasJ\n
U26Qzns3dLlwR5EiUWMWea6xrkEmCMgZK9FGqkjWZCrXgzT/LCrBbBlDSgeF59N8\n
9iFo7+ryUp9/k5DPAgMBAAGjQjBAMA4GA1UdDwEB/wQEAwIBBjAPBgNVHRMBAf8E\n
BTADAQH/MB0GA1UdDgQWBBRge2YaRQ2XyolQL30EzTSo//z9SzANBgkqhkiG9w0B\n
AQUFAAOCAQEA1nPnfE920I2/7LqivjTFKDK1fPxsnCwrvQmeU79rXqoRSLblCKOz\n
yj1hTdNGCbM+w6DjY1Ub8rrvrTnhQ7k4o+YviiY776BQVvnGCv04zcQLcFGUl5gE\n
38NflNUVyRRBnMRddWQVDf9VMOyGj/8N7yy5Y0b2qvzfvGn9LhJIZJrglfCm7ymP\n
AbEVtQwdpf5pLGkkeB6zpxxxYu7KyJesF12KwvhHhm4qxFYxldBniYUr+WymXUad\n
DKqC5JlR3XC321Y9YeRq4VzW9v493kHMB65jUr9TU/Qr6cf9tveCX4XSQRjbgbME\n
HMUfpIBvFSDJ3gyICh3WZlXi/EjJKSZp4A==
\n
-----END CERTIFICATE-----"
    ],
    "privateKey": "-----BEGIN RSA PRIVATE KEY-----\n
zDot5q3vP9YjCihMZMkSa0zT2Zt+8S+mC0EVuYuTVhVpqrVNtkP1mlt+CYqmDffY\n
sGuD6SMrT6+SeAzX2uYFgY4+s8yaRWBcr0C5Z7yihilM6BK+IJ4is9kaW5VFr1Ph\n
wRKvSeFHBGh2wLNpjVSNPzLMDZBtkVi9Ny/xD5C3M1Gah0PGmnrPGCP8tr1Lshv4\n
PxYJwzHzouTdQDkLYlCjMN++NmIYfx7zrbEYV4VzXMxgNq7d3+d5dlVfE8xpAjSR\n
Lqlamib+doe1oWOQ2WiS6baBAH+Gw5rgqfwhJbCY/UlbCpuJ6kl7TLvTrFp8YpvB\n
Iv1GD0yuwSued3a+AxMFuIzTBYd2rC6rHq+eF4eHd/Q/Sbm9+9VuW/h8dW3LGvbE\n
```

```
5SUUhNw6uSkOZmZ0z/+FLbwoLPCASukY9biSd+12KJf4N42WZxID+9mJTp1j/Bv7\n
n29oGfZ3vav8PqG+F987hSyWEIdGTMfIxwaUrdYe1fmbUCxv0suMcYTRbAs9g3cm\n
eCNxbZBYC/fL+Nlj5NjZ+gxA/tEXV7wWynPZW3mZny6fQpDTDMslqsoFZR+rAUzH\n
ViePuLbCdxIC5heUyqvDBbeOzgQWOu6SZjX+mAQpo0DPKt1KDP4DKv9EW92sIwW3\n
AnFg98sje0DZ+zfsnevGioQMJrG0JSnqTYADxHaauu7NWndkfMZisfNIKA0u+ajU\n
AbP8xFXIP5JU8O4tWmlbxAbMOYfrZHabFNZx4DH1OVOJqdJIVx0KER0GSZd50D6W\n
QBzCfEbwMlJ17OB0AgWzNrbaak3MCmW1mh7OecjQwge1ajy7ho+JtQ==\n
-----END RSA PRIVATE KEY-----"
 }' \
 "https://localhost:8443/openidm/security/keystore/cert"


{
    "_id": "openidm-localhost"
}
```

If the import is successful, the command returns the alias of the keystore to which the signed certificate was added.

16.1.4. Generating a Self-Signed Certificate Over REST

To generate a self-signed X.509 certificate, use the `generateCert` action on the `keystore` endpoint. This action must be performed as an authenticated administrative user. The generated certificate is returned in the response to the request, and stored in the OpenIDM keystore.

Specify the details of the certificate in the JSON payload. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
   "algorithm" : "RSA",
   "signatureAlgorithm" : "SHA512WithRSAEncryption",
   "keySize"  : 2048,
   "domainName"  : "www.example.com",
   "validFrom" : "2014-08-13T07:59:44.497+02:00",
   "validTo" : "2015-08-13T07:59:44.497+02:00",
   "returnPrivateKey" : true,
   "alias" : "new-alias"
 }' \
 "https://localhost:8443/openidm/security/keystore?_action=generateCert"

   {
  "publicKey": {
    "algorithm": "RSA",
    "encoded": "-----BEGIN PUBLIC KEY-----\nMIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8AMIIB
    ...
    \n-----END PUBLIC KEY-----\n",
    "format": "X.509"
  },
  "cert": "-----BEGIN CERTIFICATE-----\nMIIDSDCCAjCgAwIBAgIGAUfOo3GvMA0GCSqGSIb3
    ...
    \n-----END CERTIFICATE-----\n",
```

```
  "type": "X.509",
  "_id": "new-alias"
}
```

The following certificate details can be specified:

- `"algorithm"` (optional) - the public key algorithm, for example, `RSA`. If no algorithm is specified, a default of `RSA` is used.
- `"signatureAlgorithm"` (optional) - the signature type, for example, `SHA512WithRSAEncryption`. If no algorithm is specified, a default of `SHA512WithRSAEncryption` is used.
- `"keySize"` (optional) - the size of the key (in bits) used in the cryptographic algorithm, for example `2048`. If no key size is specified, a default of `2048` is used.
- `"domainName"` - the fully qualified domain name (FQDN) of your server, for example `www.example.com`.
- `"validFrom"` and `"validTo"` (optional) - the validity period of the certificate, in UTC time format, for example `2014-08-13T07:59:44.497+02:00`. If no values are specified, the certificate is valid for one year, from the current date.
- `"returnPrivateKey"` (optional) - set this to `true` to return the private key along with the request.
- `"alias"` - the keystore alias or string that identifies the certificate, for example `openidm-localhost`.

16.1.5. Security Management Service Endpoints

The OpenIDM security management service includes the following endpoints:

- `openidm/security/keystore`
- `openidm/security/truststore`

You can use these endpoints to READ the contents on the keystore and truststore.

In addition, you can use these endpoints to perform related actions such as `generateCert` and `generateCSR`.

When you set up an `_action` request on either endpoint, you need to include all properties, including `alias`, in the request data.

The alias is not provided in the URL; it is available in the data object. For example, you might include `"alias" : "openidm-localhost"` within a `--data '{ "alias" : "openidm-localhost" }'` option.

Certificates and private keys are associated with the following endpoints: `openidm/security/keystore/cert`, `openidm/security/keystore/privatekey`, and `openidm/security/truststore/cert`.

All CRUD requests on such certificates and private/public keys use these endpoints.

16.2. Security Precautions for a Production Environment

Out of the box, OpenIDM is set up for ease of development and deployment. When you deploy OpenIDM in production, there are specific precautions you should take to minimize security breaches. After following the guidance in this section, make sure that you test your installation to verify that it behaves as expected before putting it into production.

16.2.1. Use SSL and HTTPS

You should disable plain HTTP access, as described in Section 16.2.6, "Secure Jetty".

Use TLS/SSL to access OpenIDM, ideally with mutual authentication so that only trusted systems can invoke each other. TLS/SSL protects data on the network. Mutual authentication with strong certificates, imported into the trust and keystores of each application, provides a level of confidence for trusting application access.

Augment this protection with message level security where appropriate.

16.2.2. Restrict REST Access to the HTTPS Port

When possible, use a certificate to secure REST access, over HTTPS. For production, that certificate should be signed by a certificate authority.

OpenIDM generates a self-signed certificate when it first starts up. You can use this certificate to test secure REST access.

While not recommended for production, you can test secure REST access using the default self-signed certificate. To do so, you can create a self-signed certificate file, `self-signed.crt`, using the following procedure:

1. Extract the certificate that is generated when OpenIDM starts up.

   ```
   $ openssl s_client -showcerts -connect localhost:8443 </dev/null
   ```

   This command outputs the entire certificate to the terminal.

2. Using any text editor, create a file named `self-signed.crt`. Copy the portion of the certificate from `-----BEGIN CERTIFICATE-----` to `----END CERTIFICATE-----` and paste it into the `self-signed.crt` file, which should appear similar to the following:

```
$ more self-signed.crt
-----BEGIN CERTIFICATE-----
MIIB8zCCAVygAwIBAgIETkvDjjANBgkqhkiG9w0BAQUFADA+MSgwJgYDVQQKEx9P
cGVuSURNIFNlbGYtU2lnbmVkIENlcnRpZmljYXRlMRIwEAYDVQQDEwlsb2NhbGhv
c3QwHhcNMTEwODE3MTMzNTEwWhcNMjEwODE3MTMzNTEwWjA+MSgwJgYDVQQKEx9P
cGVuSURNIFNlbGYtU2lnbmVkIENlcnRpZmljYXRlMRIwEAYDVQQDEwlsb2NhbGhv
c3QwgZ8wDQYJKoZIhvcNAQEBBQADgY0AMIGJAoGBAKwMkyvHS5yHAnI7+tXUIbfI
nQfhcTChpWNPTHc/cli/+Ta1InTpN8vRScPoBG0BjCaIKnVVl2zZ5ya74UKgwAVe
oJQ0xDZvIyeC9PlvGoqsdtH/Ihi+T+zzZ14oVxn74qWoxZcvkG6rWEOd42QzpVhg
wMBzX98slxkOZhG9IdRxAgMBAAEwDQYJKoZIhvcNAQEFBQADgYEASo4qMI0axEKZ
m0jU4yJejLBHydWoZVZ8fKcHVlD/rTirtVgWsVgvdr3yUr0Idk1rH1nEF47Tzn+V
UCq7qJZ75HnIIeVrZqmfTx8169paAKAaNF/KRhTE6ZII8+awst02L86shSSWqWz3
s5xPB2YTaZHWWdzrPVv90gL8JL/N7/
Q=
-----END CERTIFICATE-----
```

3. Test REST access on the HTTPS port, referencing the self-signed certificate in the command. For example:

```
$ curl \
 --header "X-OpenIDM-Username:openidm-admin" \
 --header "X-OpenIDM-Password:openidm-admin" \
 --cacert self-signed.crt \
 --request GET \
 "https://localhost:8443/openidm/managed/user/?_queryId=query-all-ids"
     {
    "result": [],
    "resultCount": 0,
    "pagedResultsCooke": null,
    "remainingPagedResuts": -1
}
```

16.2.3. Encrypt Data Internally and Externally

Beyond relying on end-to-end availability of TLS/SSL to protect data, OpenIDM also supports explicit encryption of data that goes on the network. This can be important if the TLS/SSL termination happens prior to the final endpoint.

OpenIDM also supports encryption of data stored in the repository, using a symmetric key. This protects against some attacks on the data store. Explicit table mapping is supported for encrypted string values.

OpenIDM automatically encrypts sensitive data in configuration files, such as passwords. OpenIDM replaces clear text values when the system first reads the configuration file. Take care with configuration files having clear text values that OpenIDM has not yet read and updated.

16.2.4. Use Message Level Security

OpenIDM supports message level security, forcing authentication before granting access. Authentication works by means of a filter-based mechanism that lets you use either an HTTP Basic like mechanism or OpenIDM-specific headers, setting a cookie in the response that you can use for subsequent authentication. If you attempt to access OpenIDM URLs without the appropriate headers or session cookie, OpenIDM returns HTTP 401 Unauthorized, or HTTP 403 Forbidden, depending on the situation. If you use a session cookie, you must include an additional header that indicates the origin of the request.

16.2.4.1. Message Level Security with Logins

The following examples show successful authentications.

```
$ curl \
 --cacert self-signed.crt \
 --dump-header /dev/stdout \
 --user openidm-admin:openidm-admin \
 "https://localhost:8443/openidm/managed/user?_queryId=query-all-ids"

HTTP/1.1 200 OK
Content-Type: application/json; charset=UTF-8
Cache-Control: no-cache
Set-Cookie: session-jwt=2l0zobpuk6st1b2m7gvhg5zas ...;Path=/
Expires: Thu, 01 Jan 1970 00:00:00 GMT
Vary: Accept-Encoding, User-Agent
Content-Length: 82
Server: Jetty(8.y.z-SNAPSHOT)

{"result":[],"resultCount":"0","pagedResultsCookie":null,"remainingPagedResults":-1}


$ curl \
 --cacert self-signed.crt \
 --dump-header /dev/stdout \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 "https://localhost:8443/openidm/managed/user?_queryId=query-all-ids"

HTTP/1.1 200 OK
Content-Type: application/json; charset=UTF-8
Cache-Control: no-cache
Set-Cookie: session-jwt=2l0zobpuk6st1b2m7gvhg5zas ...;Path=/
Expires: Thu, 01 Jan 1970 00:00:00 GMT
Vary: Accept-Encoding, User-Agent
Content-Length: 82
Server: Jetty(8.y.z-SNAPSHOT)

{"result":[],"resultCount":"0","pagedResultsCookie":null,"remainingPagedResults":-1}


$ curl \
 --dump-header /dev/stdout \
 --cacert self-signed.crt \
 --header "Cookie: session-jwt=2l0zobpuk6st1b2m7gvhg5zas ..." \
 --header "X-Requested-With: OpenIDM Plugin" \
 "https://localhost:8443/openidm/managed/user?_queryId=query-all-ids"

Expires: Thu, 01 Jan 1970 00:00:00 GMT
Content-Type: application/json; charset=UTF-8
```

```
Cache-Control: no-cache
Vary: Accept-Encoding, User-Agent
Content-Length: 82
Server: Jetty(8.y.z-SNAPSHOT)
```

Notice that the last example uses the cookie OpenIDM set in the response to the previous request, and includes the `X-Requested-With` header to indicate the origin of the request. The value of the header can be any string, but should be informative for logging purposes. If you do not include the `X-Requested-With` header, OpenIDM returns HTTP 403 Forbidden.

> **Note**
>
> The careful readers among you may notice that the expiration date of the JWT cookie, January 1, 1970, corresponds to the start of UNIX time. Since that time is in the past, browsers will not store that cookie after the browser is closed.

You can also request one-time authentication without a session.

```
$ curl \
 --dump-header /dev/stdout \
 --cacert self-signed.crt \
 --header "X-OpenIDM-NoSession: true" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 "https://localhost:8443/openidm/managed/user?_queryId=query-all-ids"

HTTP/1.1 200 OK
Content-Type: application/json; charset=UTF-8
Cache-Control: no-cache
Vary: Accept-Encoding, User-Agent
Content-Length: 82
Server: Jetty(8.y.z-SNAPSHOT)

{"result":[],"resultCount":"0","pagedResultsCookie":null,"remainingPagedResults":-1}
```

16.2.4.2. Logout By Removing the JWT Cookie

OpenIDM maintains sessions with a JWT session cookie, stored in a client browser. To log out and destroy the session, you would access and remove that cookie from the client browser.

The JWT session cookie is based on the `JWT_SESSION` module documented in *Supported Authentication Modules*.

16.2.5. Replace Default Security Settings

The default security settings are adequate for evaluation purposes. For production, change the default encryption key, and then replace the default user password.

Procedure 16.1. To Change Default Encryption Keys

By default, OpenIDM uses a symmetric encryption key with alias `openidm-sym-default`. Change this default key before deploying OpenIDM in production.

As noted in the section on the *keytool* command, the default keystore password is `changeit`.

1. Add the new key to the keystore.

```
$ cd /path/to/openidm/
$ keytool \
 -genseckey \
 -alias new-sym-key \
 -keyalg AES \
 -keysize 128 \
 -keystore security/keystore.jceks \
 -storetype JCEKS
    Enter keystore password:
Enter key password for <new-sym-key>
  (RETURN if same as keystore password):
Re-enter new password:
```

   Additional options associated with the **keytool** command in OpenIDM are shown in the following file: `openidm/samples/security/keystore_readme.txt`.

2. Change the alias used in `openidm/conf/boot/boot.properties`.

Procedure 16.2. To Replace the Default User & Password

After changing the default encryption key, change at least the default user password.

1. Use the **encrypt** command to obtain the encrypted version of the new password.

```
$ cd /path/to/openidm/
$ cli.sh encrypt newpwd

..
.
-----BEGIN ENCRYPTED VALUE-----
{
  "$crypto" : {
    "value" : {
      "iv" : "TCoC/YrmiRmINw6jCPB5LQ==",
      "data" : "nCFvBIApIQ7C6k+UPzosaA==",
      "cipher" : "AES/CBC/PKCS5Padding",
      "key" : "openidm-sym-default"
    },
    "type" : "x-simple-encryption"
  }
}
------END ENCRYPTED VALUE------
```

2. Replace the user object in the `openidm/db/database/scripts/openidm.sql` script before setting up your JDBC repository for OpenIDM.

   Alternatively, replace the user in the internal user table.

16.2.6. Secure Jetty

If you do not want to use regular HTTP on a production OpenIDM system, you need to make two changes.

First, edit the `openidm/conf/jetty.xml` configuration file. Comment out the line that enables regular HTTP.

The following excerpt includes the Java comment code that you would add around the `openidm.port.http` argument. The value of this argument (8080 by default) is taken from the `conf/boot/boot.properties` file.

```
<Call name="addConnector">
  <Arg>
    <New class="org.eclipse.jetty.server.nio.SelectChannelConnector">
      <Set name="host"><Property name="jetty.host" /></Set>
<!-- <Set name="port"><Call class="org.forgerock.openidm.jetty.Param"
          name="getProperty"<Arg>openidm.port.http</Arg></Call></Set>  -->
        <Set name="maxIdleTime">300000</Set>
        <Set name="Acceptors">2</Set>
        <Set name="statsOn">false</Set>
        <Set name="confidentialPort">
          <Call class="org.forgerock.openidm.jetty.Param" name="getProperty">
            <Arg>openidm.port.https</Arg>
          </Call>
        </Set>
      </New>
   </Arg>
</Call>
```

Second, edit the `openidm/conf/config.properties` configuration file. Set the `org.osgi.service.http.enabled` property to false, as shown in the following excerpt:

```
# Enable pax web http/https services to enable jetty
org.osgi.service.http.enabled=false
org.osgi.service.http.secure.enabled=true
```

16.2.7. Protect Sensitive REST Interface URLs

Anything attached to the router is accessible with the default policy, including the repository. If you do not need such access, deny it in the authorization policy to reduce the attack surface.

In addition, you can deny direct HTTP access to system objects in production, particularly access to `action`. As a rule of thumb, do not expose anything that is not used in production. The main public interfaces over HTTP are `/openidm/managed/` and `/openidm/config/`. Other URIs are triggered indirectly, or are used for internal consumption.

OpenIDM supports native query expressions on the repository, and it is possible to enable these over HTTP, for example, the following query should identify managed users in an OrientDB repository:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 "https://localhost:8443/openidm/managed/user?_queryExpression=select+*+from+managed_user"
```

By default, direct HTTP access to native queries is disallowed, and should remain so in production systems.

For testing or development purposes, it can be helpful to enable native queries on the repository over HTTP. To do so, edit the access control configuration file (`access.js`). In that file, remove any instances of `"disallowQueryExpression()"` such as the following:

```
{
    "pattern"   : "*",
    "roles"     : "openidm-admin",
    "methods"   : "*", // default to all methods allowed
    "actions"   : "*", // default to all actions allowed
 // "customAuthz" : "disallowQueryExpression()",
    "excludePatterns": "system/*"
},
...
{
    "pattern"   : "system/*",
    "roles"     : "openidm-admin",
    "methods"   : "create,read,update,delete,patch,query", // restrictions on 'action'
    "actions"   : ""
 // "customAuthz" : "disallowQueryExpression()"
},
...
 "customAuthz" : "ownDataOnly() &&
    managedUserRestrictedToAllowedProperties('"+allowedPropertiesForManagedUser+"')",
    // && disallowQueryExpression()"
```

See the chapter on *Managing Authentication, Authorization & RBAC* for an example showing how to protect sensitive URLs.

16.2.8. Protect Sensitive Files & Directories

Protect OpenIDM files from access by unauthorized users.

In particular, prevent other users from reading files in at least the `openidm/conf/boot/` and `openidm/security/` directories.

The objective is to limit access to the user that is running the service. Depending on the operating system and configuration, that user might be `root`, `Administrator`, `openidm`, or something similar.

Procedure 16.3. Protecting key files in Unix

1. For the target directory, and the files therein, make sure user and group ownership is limited to the user that is running the OpenIDM service.
2. Disable access of any sort for `other` users. One simple command for that purpose, from the `/path/to/openidm` directory, is:

   ```
   # chmod -R o-rwx .
   ```

Procedure 16.4. Protecting key files in Windows

1. The OpenIDM process in Windows is normally run by the `Administrator` user.
2. If you are concerned about the security of the administrative account, you can `Deny` permissions on the noted directories to existing users, or alternatively the `Users` group.

16.2.9. Obfuscate Bootstrap Information

OpenIDM uses the information in `conf/boot/boot.properties`, including the keystore password, to start up. The keystore password is `changeit` by default, and is stored in clear text in the `boot.properties` file. To set an obfuscated version of the keystore password in the `boot.properties` file, follow these steps.

1. Generate an obfuscated version of the password, by using the crypto bundle provided with OpenIDM:

   ```
   $ $ java -jar /path/to/openidm/bundle/openidm-crypto-3.1.0-6.jar


   This utility helps obfuscate passwords to prevent casual observation.
   It is not securely encrypted and needs further measures to prevent disclosure.
   Please enter the password:
   OBF:1vn21ugu1saj1v9i1v941sar1ugw1vo0
   CRYPT:a8b5a01ba48a306f300b62a1541734c7
   ```

2. Paste either the obfuscated password (`OBF:xxxxxxx`) or the encrypted password (`CRYPT:xxxxxxx`) into the `conf/boot/boot.properties` file. Comment out the regular keystore password and remove the comment tag, either from the line that contains the obfuscated password or from the line that contains the encrypted password:

```
$ more conf/boot/boot.properties

...
# Keystore password, adjust to match your keystore and protect this file
# openidm.keystore.password=changeit
openidm.truststore.password=changeit

# Optionally use the crypto bundle to obfuscate the password and set one of these:
openidm.keystore.password=OBF:1vn21ugu1saj1v9i1v941sar1ugw1vo0
# openidm.keystore
.password=CRYPT:a8b5a01ba48a306f300b62a1541734c7
...
```

3. Restart OpenIDM.

```
$ ./startup.sh
```

16.2.10. Remove or Protect Development & Debug Tools

Before deploying OpenIDM in production, remove or protect development and debug tools, including the OSGi console exposed under `/system/console`. Authentication for this console is not integrated with authentication for OpenIDM.

To remove the OSGi console, remove the web console bundle, `org.apache.felix.webconsole-version.jar`.

If you cannot remove the OSGi console, then protect it by overriding the default `admin:admin` credentials. Create a file called `openidm/conf/org.apache.felix.webconsole.internal.servlet.OsgiManager.cfg` containing the user name and password to access the console in Java properties file format.

```
username=user-name
password=password
```

16.2.11. Protect the OpenIDM Repository

Use the JDBC or MSSQL repositories. OrientDB is not yet supported for production use.

Use a strong password for the JDBC connection. Do not rely on default passwords.

Use a case sensitive database, particularly if you work with systems with different identifiers that match except for case. Otherwise correlation queries can pick up identifiers that should not be considered the same.

16.2.12. Adjust Log Levels

Leave log levels at `INFO` in production to ensure that you capture enough information to help diagnose issues. See the chapter on *Configuring Server Logs* for more information.

At start up and shut down, `INFO` can produce many messages. Yet, during stable operation, `INFO` generally results in log messages only when coarse-grain operations such as scheduled reconciliation start or stop.

16.2.13. Set Up Restart At System Boot

You can run OpenIDM in the background as a service (daemon), and add startup and shutdown scripts to manage the service at system boot and shutdown. For more information, see *Starting and Stopping OpenIDM*.

See your operating system documentation for details on adding a service such as OpenIDM to be started at boot and shut down at system shutdown.

Chapter 17
Integrating Business Processes and Workflows

Key to any identity management solution is the ability to provide workflow-driven provisioning activities, whether for self-service actions such as requests for entitlements, roles or resources, running sunrise or sunset processes, handling approvals with escalations, or performing maintenance.

OpenIDM provides an embedded workflow and business process engine based on Activiti and the Business Process Model and Notation (BPMN) 2.0 standard.

More information about Activiti and the Activiti project can be found at http://www.activiti.org.

17.1. BPMN 2.0 and the Activiti Tools

Business Process Model and Notation 2.0 is the result of consensus among Business Process Management (BPM) system vendors. The Object Management Group (OMG) has developed and maintained the BPMN standard since 2004.

The first version of the BPMN specification focused only on graphical notation, and quickly became popular with the business analyst audience. BPMN 1.x defines how constructs such as human tasks, executable scripts, and automated decisions are visualized in a vendor-neutral, standard way. The second version of BPMN extends that focus to include execution semantics, and a common exchange format. Thus, BPMN 2.0 process definition models can be exchanged not only between different graphical editors, but can also be executed as is on any BPMN 2.0-compliant engine, such as the engine embedded in OpenIDM.

Using BPMN 2.0, you can add artifacts describing workflow and business process behavior to OpenIDM for provisioning and other purposes. For example, you can craft the actual artifacts defining business processes and workflow in a text editor, or using the Activiti Eclipse Designer plugin. Eclipse Designer provides visual design capabilities, simplifying packaging and deployment of the artifact to OpenIDM. For instructions on installing Eclipse Designer, see the Activiti documentation.

Also, read the documentation covering BPMN 2.0 Constructs, which describes in detail the graphical notations and XML representations for events, flows, gateways, tasks, and process constructs.

With the latest version of Activiti, JavaScript tasks can be added to workflow definitions. However, OpenIDM functions cannot be called from a JavaScript task in a workflow. Therefore, you can use JavaScript for non-OpenIDM workflow tasks, but you must use the `activiti:expression` construct to call OpenIDM functions.

17.2. Setting Up Activiti Integration With OpenIDM

OpenIDM embeds an Activiti Process Engine that is started in the OpenIDM OSGi container.

After you have installed OpenIDM, as described in Chapter 1, "*Installing OpenIDM Services*" in the *Installation Guide*, start OpenIDM, and run the **scr list** command at the console to check that the workflow bundle is active.

```
-> OpenIDM ready
scr list
   Id   State          Name
...
[  39] [active       ] org.forgerock.openidm.workflow
...
```

OpenIDM reads workflow definitions from the `/path/to/openidm/workflow` directory. To test workflow integration, at least one workflow definition must exist in this directory.

A sample workflow (`example.bpmn20.xml`) is provided in the `/path/to/openidm/samples/misc` directory. Copy this workflow to the `/path/to/openidm/workflow` directory to test the workflow integration.

```
$ cd /path/to/openidm
$ cp samples/misc/example.bpmn20.xml workflow/
```

Verify the workflow integration by using the REST API. The following REST call lists the defined workflows:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/processdefinition?_queryId=query-all-ids"
```

The sample workflow definition that you copied in the previous step is named `osgiProcess`. The result of the preceding REST call therefore includes output similar to the following:

```
{
...
  "result":[
     {
        ...
        "key": "osgiProcess",
        ...
        "name":"Osgi process",
        ...
        "_id":"osgiProcess:1:3",
        ...
     }
        ]
}
```

The `osgiProcess` workflow calls OpenIDM, queries the available workflow definitions from Activiti, then prints the list of workflow definitions to the OpenIDM logs. Invoke the `osgiProcess` workflow with the following REST call:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{"_key":"osgiProcess"}' \
 "https://localhost:8443/openidm/workflow/processinstance?_action=create"
```

The workflow prints the list of workflow definitions to the OpenIDM console. With the default sample, you should see something like this on the console:

```

script task using resolver: [
  pagedResultsCookie:null,
  remainingPagedResults:-1,
  result:[
    [
   tenantId:,
   candidateStarterGroupIdExpressions:[],
   candidateStarterUserIdExpressions:[],
   participantProcess:null,
   processDiagramResourceName:null,
   historyLevel:null,
   hasStartFormKey:false,
   laneSets:[],
   version:1, _id:osgiProcess:1:3,
   description:null,
   name:Osgi process,
   executionListeners:[:],
   key:osgiProcess,
   resourceName:OSGI-INF/activiti/example.bpmn20.xml,
   ioSpecification:null,
   taskDefinitions:null,
   suspensionState:1,
   deploymentId:1,
   properties:[:],
   startFormHandler:null,
   suspended:false,
   variables:null,
   _rev:1,
   revisionNext:2,
   category:Examples,
   eventSupport:[:],
   graphicalNotationDefined:false
 ]
  ]
]
script task using expression resolver: [
  pagedResultsCookie:null,
  remainingPagedResults:-1,
  result:[
    [
   tenantId:,
   candidateStarterGroupIdExpressions:[],
      ...
]
```

17.2.1. Configuring the Activiti Engine

The OpenIDM Activiti module is configured in a file named `conf/workflow.json`. If this file is absent from the configuration, the workflow module is unavailable for use. In the default OpenIDM installation, the `workflow.json` file has the following basic configuration:

```
{
   "enabled"  : true
}
```

You can disable the workflow module by setting the `"enabled"` property to `false`.

There are several additional configuration properties for the Activiti module. A sample `workflow.json` file that includes all configurable properties, is provided in `samples/misc`. To configure an Activiti engine beyond the default configuration, edit this sample file and copy it to the `/path/to/openidm/conf` directory.

The sample `workflow.json` file contains the following configuration:

```
  {
    "enabled"  : true,
    "location" : "remote",
    "engine" : {
        "url" : "http://localhost:9090/openidm-workflow-remote-3.1",
        "username" : "youractivitiuser",
        "password" : "youractivitipassword"
    },
    "mail" : {
        "host" : "yourserver.smtp.com",
        "port" : 587,
        "username" : "yourusername",
        "password" : "yourpassword",
        "starttls" : true
    },
    "history" : "audit"
}
```

These fields have the following meaning:

- `enabled`. Indicates whether the Activiti module is enabled for use. Possible values are `true` or `false`. The default value is `true`.
- `mail`. Specifies the details of the mail server that Activiti will use to send email notifications. By default, Activiti uses the mail server `localhost:25`. To specify a different mail server, enter the details of the mail server here.
  - `host`. The host of the mail server.
  - `port`. The port number of the mail server.
  - `username`. The user name of the account that connects to the mail server.

  - `password`. The password for the user specified above.
  - `startTLS`. Whether startTLS should be used to secure the connection.
- `history`. Determines the history level that should be used for the Activiti engine. For more information, see Section 17.2.1.1, "Configuring the Activiti History Level".

17.2.1.1. Configuring the Activiti History Level

The Activiti history level determines how much historical information is retained when workflows are executed. You can configure the history level by setting the `history` property in the `workflow.json` file, for example:

```
"history" : "audit"
```

The following history levels can be configured:

- `none`. No history archiving is done. This level results in the best performance for workflow execution, but no historical information is available.
- `activity`. Archives all process instances and activity instances. No details are archived.
- `audit`. This is the default level. All process instances, activity instances and submitted form properties are archived so that all user interaction through forms is traceable and can be audited.
- `full`. This is the highest level of history archiving and has the greatest performance impact. This history level stores all the information that is stored for the `audit` level, as well as any process variable updates.

17.2.2. Defining Activiti Workflows

The following section outlines the process to follow when you create an Activiti workflow for OpenIDM. Before you start creating workflows, you must configure the Activiti engine, as described in Section 17.2.1, "Configuring the Activiti Engine".

1. Define your workflow in a text file, either using an editor, such as Activiti Eclipse BPMN 2.0 Designer, or a simple text editor.
2. Package the workflow definition file as a `.bar` file (Business Archive File). If you are using Eclipse to define the workflow, a `.bar` file is created when you select "Create deployment artifacts". A `.bar` file is essentially the same as a `.zip` file, but with the `.bar` extension.
3. Copy the `.bar` file to the `openidm/workflow` directory.
4. Invoke the workflow using a script (in `openidm/script/`) or directly using the REST interface. For more information, see Section 17.2.3, "Invoking Activiti Workflows".

   You can also schedule the workflow to be invoked repeatedly, or at a future time. For more information, see Chapter 13, "*Scheduling Tasks and Events*".

17.2.3. Invoking Activiti Workflows

You can invoke workflows and business processes from any trigger point within OpenIDM, including reacting to situations discovered during reconciliation. Workflows can be invoked from script files, using the `openidm.create()` function, or directly from the REST interface.

The following sample script extract shows how to invoke a workflow from a script file:

```
/*
 * Calling 'myWorkflow' workflow
 */

var params = {
 "_key": "myWorkflow"
};

openidm.create('workflow/processinstance', null, params);
```

The `null` in this example indicates that you do not want to specify an ID as part of the create call. For more information, see Section F.3.1, "openidm.create(container, id, value)".

You can invoke the same workflow from the REST interface by sending the following REST call to OpenIDM:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{"_key":"myWorkflow"}' \
 "https://localhost:8443/openidm/workflow/processinstance?_action=create"
```

There are two ways in which you can specify the workflow definition that is used when a new workflow instance is started.

- `_key` specifies the `id` attribute of the workflow process definition, for example:

  ```
  <process id="sendNotificationProcess" name="Send Notification Process">
  ```

  If there is more than one workflow definition with the same `_key` parameter, the latest deployed version of the workflow definition is invoked.

- `_processDefinitionId` specifies the ID that is generated by the Activiti Process Engine when a workflow definition is deployed, for example:

  ```
  "sendNotificationProcess:1:104";
  ```

  You can obtain the `processDefinitionId` by querying the available workflows, for example:

```
{
 "result": [
   {
     "name": "Process Start Auto Generated Task Auto Generated",
     "_id": "ProcessSAGTAG:1:728"
   },
   {
     "name": "Process Start Auto Generated Task Empty",
     "_id": "ProcessSAGTE:1:725"
   },
   ...
```

If you specify a `_key` and a `_processDefinitionId`, the `_processDefinitionId` is used because it is more precise.

You can use the optional `_businessKey` parameter to add specific business logic information to the workflow when it is invoked. For example, the following workflow invocation assigns the workflow a business key of `"newOrder"`. This business key can later be used to query "newOrder" processes.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '{"_key":"myWorkflow", "_businessKey":"newOrder"}' \
 "https://localhost:8443/openidm/workflow/processinstance?_action=create"
```

17.2.4. Querying Activiti Workflows

The Activiti implementation supports filtered queries that enable you to query the running process instances and tasks, based on specific query parameters. To perform a filtered query send a GET request to the `workflow/processinstance` context path, including the query in the URL.

For example, the following query returns all process instances with the business key `"newOrder"`, as invoked in the previous example.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/processinstance?_queryId=filtered-
query&processInstanceBusinessKey=newOrder"
```

Any Activiti properties can be queried using the same notation, for example, `processDefinitionId=managedUserApproval:1:6405`. The query syntax applies to all queries with `_queryId=filtered-query`. The following query returns all process instances that were started by the user `openidm-admin`:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/processinstance?_queryId=filtered-query&startUserId=openidm-
admin"
```

You can also query process instances based on the value of any process instance variable, by prefixing the variable name with `var-`. For example:

```
var-processvariablename=processvariablevalue
```

17.3. Using Custom Templates for Activiti Workflows

The embedded Activiti engine is integrated with the default user interface. For simple workflows, you can use the standard Activiti form properties, and have the UI render the corresponding generic forms automatically. If you require a more complex form template, (including input validation, rich input field types, complex CSS, and so forth) you must define a custom form template.

There are two ways in which you can define custom form templates for your workflows:

- Create an HTML template, and refer to that template in the workflow definition.

  This is the recommended method of creating custom form templates. To refer to the HTML template in the workflow definition, use the `activiti:formKey` attribute, for example `activiti:formKey="nUCStartForm.xhtml"`.

  The HTML file must be deployed as part of the workflow definition. Create a .zip file that contains the HTML template and the workflow definition file. Rename the .zip file with a .bar extension.

  For a sample workflow that uses external, referenced form templates, see `samples/usecase/workflow/newUserCreate.bpmn20.xml`. The HTML templates, and the corresponding .bar file are included in that directory.

- Use an embedded template within the workflow definition.

  This method is not ideal, because the HTML code must be escaped, and is difficult to read, edit, or maintain, as a result. Also, sections of HTML code will most likely need to be duplicated if your workflow includes multiple task stages. However, you might want to use this method if your form is small, not too complex and you do not want to bother with creating a separate HTML file and .bar deployment.

17.4. Managing Workflows Over the REST Interface

In addition to the queries described previously, the following examples show the context paths that are exposed for managing workflows over the REST interface. The example output is based on the sample workflow that is provided in `openidm/samples/sample9`.

openidm/workflow/processdefinition

- List the available workflow definitions:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/processdefinition?_queryId=query-all-ids"

{
  "result" : [ {
    "tenantId" : "",
    "candidateStarterGroupIdExpressions" : [ ],
    "candidateStarterUserIdExpressions" : [ ],
    "participantProcess" : null,
    "processDiagramResourceName" : null,
    "historyLevel" : null,
    "hasStartFormKey" : false,
    "laneSets" : [ ],
    "version" : 1,
    "_id" : "managedUserApproval:1:3",
    "description" : null,
    "name" : "Managed User Approval Workflow",
    "executionListeners" : { },
    "key" : "managedUserApproval",
    "resourceName" : "OSGI-INF/activiti/managedUserApproval.bpmn20.xml",
    "ioSpecification" : null,
    "taskDefinitions" : null,
    "suspensionState" : 1,
    "deploymentId" : "1",
    "properties" : { },
    "startFormHandler" : null,
    "suspended" : false,
    "variables" : null,
    "_rev" : 1,
    "revisionNext" : 2,
    "category" : "Examples",
    "eventSupport" : { },
    "graphicalNotationDefined" : false
  } ],
  "resultCount" : 1,
  "pagedResultsCookie" : null,
  "remainingPagedResults" : -1
}
```

- List the workflow definitions, based on certain filter criteria:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/processdefinition?_queryId=filtered-query&category=Examples"


{
  "result": [
    {
      ...
      "name": "Managed User Approval Workflow",
      "_id": "managedUserApproval:1:3",
      ...
      "category" : "Examples",
      ...
    }
  ]
}
```

openidm/workflow/processdefinition/{id}

- Obtain detailed information for a process definition, based on the ID. You can determine the ID by querying all the available process definitions, as described in the first example in this section.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/processdefinition/managedUserApproval:1:3"


{
  "tenantId" : "",
  "candidateStarterGroupIdExpressions" : [ ],
  "candidateStarterUserIdExpressions" : [ ],
  "participantProcess" : null,
  "processDiagramResourceName" : null,
  "historyLevel" : null,
  "hasStartFormKey" : false,
  "laneSets" : [ ],
  "version" : 1,
  "formProperties" : [ ],
  "_id" : "managedUserApproval:1:3",
  "description" : null,
  "name" : "Managed User Approval Workflow",
  "executionListeners" : {
    "end" : [ { } ]
  },
  "key" : "managedUserApproval",
  "resourceName" : "OSGI-INF/activiti/managedUserApproval.bpmn20.xml",
  "ioSpecification" : null,
  "taskDefinitions" : {
```

```
    "evaluateRequest" : {
      "assigneeExpression" : {
        "expressionText" : "openidm-admin"
      },
      "candidateGroupIdExpressions" : [ ],
      "candidateUserIdExpressions" : [ ],
      "categoryExpression" : null,
      "descriptionExpression" : null,
      "dueDateExpression" : null,
      "key" : "evaluateRequest",
      "nameExpression" : {
        "expressionText" : "Evaluate request"
      },
      "ownerExpression" : null,
      "priorityExpression" : null,
      "taskFormHandler" : {
        "deploymentId" : "1",
        "formKey" : null,
        "formPropertyHandlers" : [ {
          "defaultExpression" : null,
          "id" : "requesterName",
          "name" : "Requester's name",
          "readable" : true,
          "required" : false,
          "type" : null,
          "variableExpression" : {
            "expressionText" : "${sourceId}"
          },
          "variableName" : null,
          "writable" : false
        }, {
          "defaultExpression" : null,
          "id" : "requestApproved",
          "name" : "Do you approve the request?",
          "readable" : true,
          "required" : true,
          "type" : {
            "name" : "enum",
            "values" : {
              "true" : "Yes",
              "false" : "No"
            }
          },
          "variableExpression" : null,
          "variableName" : null,
          "writable" : true
        } ]
      },
      "taskListeners" : {
        "assignment" : [ { } ],
        "create" : [ { } ]
      }
    }
  },
  "suspensionState" : 1,
  "deploymentId" : "1",
  "properties" : {
    "documentation" : null
  },
```

```
  "startFormHandler" : {
    "deploymentId" : "1",
    "formKey" : null,
    "formPropertyHandlers" : [ ]
  },
  "suspended" : false,
  "variables" : { },
  "_rev" : 2,
  "revisionNext" : 3,
  "category" : "Examples",
  "eventSupport" : { },
  "graphicalNotationDefined" : false
}
```


- Delete a workflow process definition, based on its ID. Note that you cannot delete a process definition if there are currently running instances of that process definition.

  OpenIDM picks up workflow definitions from the files located in the `/path/to/openidm/workflow` directory. If you delete the workflow definition (`.xml` file) from this directory, the OSGI bundle is deleted. However, deleting this file does not remove the workflow definition from the Activiti engine. You must therefore delete the definition over REST, as shown in the following example.

  Note that, although there is only one representation of a workflow definition in the file system, there might be several versions of the same definition in Activiti. If you want to delete redundant process definitions, delete the definition over REST, *making sure that you do not delete the latest version*.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "If-Match: *" \
 --request DELETE \
 "https://localhost:8443/openidm/workflow/processdefinition/managedUserApproval:1:3"
```

  The delete request returns the contents of the deleted workflow definition.

openidm/workflow/processinstance

- Start a workflow process instance. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --data '{"_key":"managedUserApproval"}' \
 --request POST \
 "https://localhost:8443/openidm/workflow/processinstance?_action=create"

{
  "_id" : "4",
  "processInstanceId" : "4",
  "status" : "suspended",
  "businessKey" : null,
  "processDefinitionId" : "managedUserApproval:1:3"
}
```

- Obtain the list of running workflows (process instances). The query returns a list of IDs. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/processinstance?_queryId=query-all-ids"


{
  "result" : [ {
    "tenantId" : "",
    "businessKey" : null,
    "queryVariables" : null,
    "durationInMillis" : null,
    "processVariables" : { },
    "endTime" : null,
    "superProcessInstanceId" : null,
    "startActivityId" : "start",
    "startTime" : "2014-04-25T09:54:30.035+02:00",
    "startUserId" : "openidm-admin",
    "_id" : "4",
    "endActivityId" : null,
    "processInstanceId" : "4",
    "processDefinitionId" : "managedUserApproval:1:3",
    "deleteReason" : null
  } ],
  "resultCount" : 1,
  "pagedResultsCookie" : null,
  "remainingPagedResults" : -1
}
```

- Obtain the list of running workflows based on specific filter criteria.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/processinstance?_queryId=filtered-
query&businessKey=myBusinessKey"
```

openidm/workflow/processinstance/{id}

- Obtain the details of the specified process instance. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/processinstance/4"

     {
  "tenantId" : "",
  "businessKey" : null,
  "queryVariables" : null,
  "durationInMillis" : null,
  "processVariables" : { },
  "endTime" : null,
  "superProcessInstanceId" : null,
  "startActivityId" : "start",
  "startTime" : "2014-05-12T20:56:25.415+02:00",
  "startUserId" : "openidm-admin",
  "_id" : "4",
  "endActivityId" : null,
  "processInstanceId" : "4",
  "processDefinitionId" : "managedUserApproval:1:3",
  "deleteReason" : null
}
```

- Stop the specified process instance. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request DELETE \
 "https://localhost:8443/openidm/workflow/processinstance/4"
    {
  "deleteReason": null,
  "processDefinitionId": "managedUserApproval:1:3",
  "processInstanceId": "4",
  "endActivityId": null,
  "_id": "4",
  "startUserId": "openidm-admin",
  "startTime": "2014-06-18T10:33:40.955+02:00",
  "tenantId": "",
  "businessKey": null,
  "queryVariables": null,
  "durationInMillis": null,
  "processVariables": {},
  "endTime": null,
  "superProcessInstanceId": null,
  "startActivityId": "start"
}
```

The delete request returns the contents of the deleted process instance.

openidm/workflow/processdefinition/{id}/taskdefinition

- Query the list of tasks defined for a specific process definition. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/processdefinition/managedUserApproval:1:3/taskdefinition?
_queryId=query-all-ids"

{
  "result" : [ {
    "taskCandidateGroup" : [ ],
    "ownerExpression" : null,
    "assignee" : {
      "expressionText" : "openidm-admin"
    },
    "categoryExpression" : null,
    "taskListeners" : {
      "assignment" : [ { } ],
      "create" : [ { } ]
    },
    "formProperties" : {
      "deploymentId" : "1",
      "formKey" : null,
      "formPropertyHandlers" : [ {
        "_id" : "requesterName",
        "defaultExpression" : null,
```

```
        "name" : "Requester's name",
        "readable" : true,
        "required" : false,
        "type" : null,
        "variableExpression" : {
          "expressionText" : "${sourceId}"
        },
        "variableName" : null,
        "writable" : false
      }, {
        "_id" : "requestApproved",
        "defaultExpression" : null,
        "name" : "Do you approve the request?",
        "readable" : true,
        "required" : true,
        "type" : {
          "name" : "enum",
          "values" : {
            "true" : "Yes",
            "false" : "No"
          }
        },
        "variableExpression" : null,
        "variableName" : null,
        "writable" : true
      } ]
    },
    "taskCandidateUser" : [ ],
    "formResourceKey" : null,
    "_id" : "evaluateRequest",
    "priority" : null,
    "descriptionExpression" : null,
    "name" : {
      "expressionText" : "Evaluate request"
    },
    "dueDate" : null
  } ],
  "resultCount" : 1,
  "pagedResultsCookie" : null,
  "remainingPagedResults" : -1
}
```

- Query a task definition based on the process definition ID and the task name (`taskDefinitionKey`). For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/processdefinition/managedUserApproval:1:3/taskdefinition/evaluateRequest"

      {
  "taskCandidateGroup" : [ ],
  "ownerExpression" : null,
  "formProperties" : {
    "deploymentId" : "1",
```

```
    "formKey" : null,
    "formPropertyHandlers" : [ {
      "_id" : "requesterName",
      "defaultExpression" : null,
      "name" : "Requester's name",
      "readable" : true,
      "required" : false,
      "type" : null,
      "variableExpression" : {
        "expressionText" : "${sourceId}"
      },
      "variableName" : null,
      "writable" : false
    }, {
      "_id" : "requestApproved",
      "defaultExpression" : null,
      "name" : "Do you approve the request?",
      "readable" : true,
      "required" : true,
      "type" : {
        "name" : "enum",
        "values" : {
          "true" : "Yes",
          "false" : "No"
        }
      },
      "variableExpression" : null,
      "variableName" : null,
      "writable" : true
    } ]
  },
  "taskCandidateUser" : [ ],
  "_id" : "evaluateRequest",
  "priority" : null,
  "name" : {
    "expressionText" : "Evaluate request"
  },
  "descriptionExpression" : null,
  "categoryExpression" : null,
  "assignee" : {
    "expressionText" : "openidm-admin"
  },
  "taskListeners" : {
    "assignment" : [ { } ],
    "create" : [ { } ]
  },
  "dueDate" : null
}
```


openidm/workflow/taskinstance

- Query all running task instances. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
```

```
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/taskinstance?_queryId=query-all-ids"

      {
  "result" : [ {
    "tenantId" : "",
    "createTime" : "2014-05-12T21:17:10.054+02:00",
    "executionId" : "10",
    "delegationStateString" : null,
    "processVariables" : { },
    "_id" : "15",
    "processInstanceId" : "10",
    "description" : null,
    "priority" : 50,
    "name" : "Evaluate request",
    "dueDate" : null,
    "parentTaskId" : null,
    "processDefinitionId" : "managedUserApproval:1:3",
    "taskLocalVariables" : { },
    "suspensionState" : 1,
    "assignee" : "openidm-admin",
    "cachedElContext" : null,
    "queryVariables" : null,
    "activityInstanceVariables" : { },
    "deleted" : false,
    "suspended" : false,
    "_rev" : 1,
    "revisionNext" : 2,
    "category" : null,
    "taskDefinitionKey" : "evaluateRequest",
    "owner" : null,
    "eventName" : null,
    "delegationState" : null
  } ],
  "resultCount" : 1,
  "pagedResultsCookie" : null,
  "remainingPagedResults" : -1
}
```

- Query task instances based on candidate users or candidate groups. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/taskinstance?_queryId=filtered-
query&taskCandidateUser=manager1"
```

or

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/taskinstance?_queryId=filtered-
query&taskCandidateGroup=management"
```

Note that you can include both users and groups in the same query.

openidm/workflow/taskinstance/{id}

- Obtain detailed information for a running task, based on the task ID. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/taskinstance/15"

     {
  "dueDate": null,
  "processDefinitionId": "managedUserApproval:1:3",
  "owner": null,
  "taskDefinitionKey": "evaluateRequest",
  "name": "Evaluate request"
,
...
```

- Update task-related data stored in the Activiti workflow engine. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "If-Match : *" \
 --request PUT \
 --data '{"description":"Evaluate the new managed user request"}' \
 "https://localhost:8443/openidm/workflow/taskinstance/15"
```

- Complete the specified task. The variables required by the task are provided in the request body. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '{"requestApproved":"true"}' \
 "https://localhost:8443/openidm/workflow/taskinstance/15?_action=complete"
```

- Claim the specified task. A user who claims a task has that task inserted into his list of pending tasks. The ID of the user who claims the task is provided in the request body. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '{"userId":"manager1"}' \
 "https://localhost:8443/openidm/workflow/taskinstance/15?_action=claim"
```

17.5. Example Activiti Workflows With OpenIDM

This section describes two example workflows - an email notification workflow, and a workflow that demonstrates provisioning, using the browser-based user interface.

17.5.1. Example Email Notification Workflow

This example uses the Activiti Eclipse BPMN 2.0 Designer to set up an email notification business process. The example relies on an SMTP server listening on `localhost`, port 25.

The example sets up a workflow that can accept parameters used to specify the sender and recipient of the mail.

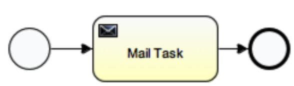
`${fromSender}`

Specifies the sender

`${toEmail}`

Specifies the recipient

Create a new BPMN2 diagram in Eclipse, then drag and drop components to create the workflow. This simple example uses a `StartEvent`, `MailTask`, and `EndEvent`.



When you have created the workflow definition, edit the generated XML source code, adding the `<extensionElements>` to the `<serviceTask>` tag, as follows.

```
<?xml version="1.0" encoding="UTF-8"?>
<definitions
 xmlns="http://www.omg.org/spec/BPMN/20100524/MODEL"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xmlns:activiti="http://activiti.org/bpmn"
 xmlns:bpmndi="http://www.omg.org/spec/BPMN/20100524/DI"
 xmlns:omgdc="http://www.omg.org/spec/DD/20100524/DC"
 xmlns:omgdi="http://www.omg.org/spec/DD/20100524/DI"
 typeLanguage="http://www.w3.org/2001/XMLSchema"
 expressionLanguage="http://www.w3.org/1999/XPath"
 targetNamespace="http://www.activiti.org/test">
 <process id="EmailNotification" name="emailNotification">
   <documentation>Simple Email Notification Task</documentation>
   <startEvent id="startevent1" name="Start"></startEvent>
   <sequenceFlow id="flow1" name="" sourceRef="startevent1"
     targetRef="mailtask1"></sequenceFlow>
   <endEvent id="endevent1" name="End"></endEvent>
   <sequenceFlow id="flow2" name="" sourceRef="mailtask1"
     targetRef="endevent1"></sequenceFlow>
   <serviceTask id="mailtask1" name="Email Notification"
     activiti:type="mail">
     <extensionElements>
       <activiti:field name="to" expression="${toEmail}"
       ></activiti:field>
       <activiti:field name="from" expression="${fromSender}"
       ></activiti:field>
       <activiti:field name="subject" expression="Simple Email Notification"
       ></activiti:field>
       <activiti:field name="text">
         <activiti:expression><![CDATA[Here is a simple Email Notification
         from ${fromSender}.]]></activiti:expression>
       </activiti:field>
     </extensionElements>
   </serviceTask>
 </process>
 <bpmndi:BPMNDiagram id="BPMNDiagram_EmailNotification">
   <bpmndi:BPMNPlane bpmnElement="EmailNotification"
     id="BPMNPlane_EmailNotification">
     <bpmndi:BPMNShape bpmnElement="startevent1" id="BPMNShape_startevent1">
       <omgdc:Bounds height="35" width="35" x="170" y="250"></omgdc:Bounds>
     </bpmndi:BPMNShape>
     <bpmndi:BPMNShape bpmnElement="endevent1" id="BPMNShape_endevent1">
       <omgdc:Bounds height="35" width="35" x="410" y="250"></omgdc:Bounds>
     </bpmndi:BPMNShape>
     <bpmndi:BPMNShape bpmnElement="mailtask1" id="BPMNShape_mailtask1">
       <omgdc:Bounds height="55" width="105" x="250" y="240"></omgdc:Bounds>
     </bpmndi:BPMNShape>
     <bpmndi:BPMNEdge bpmnElement="flow1" id="BPMNEdge_flow1">
       <omgdi:waypoint x="205" y="267"></omgdi:waypoint>
       <omgdi:waypoint x="250" y="267"></omgdi:waypoint>
     </bpmndi:BPMNEdge>
     <bpmndi:BPMNEdge bpmnElement="flow2" id="BPMNEdge_flow2">
       <omgdi:waypoint x="355" y="267"></omgdi:waypoint>
       <omgdi:waypoint x="410" y="267"></omgdi:waypoint>
     </bpmndi:BPMNEdge>
```

```
  </bpmndi:BPMNPlane>
 </bpmndi:BPMNDiagram>
</definitions>
```

Save the workflow definition as a `bpmn20.xml` file (`email-notification.bpmn20.xml`) in the `openidm/workflow` directory.

After you have deployed the workflow, create a script named `openidm/script/triggerEmailNotification.js`. The script invokes the workflow.

```
/*
 * Calling 'EmailNotification' workflow
 */

var params = {
 "_key" : "EmailNotification",
 "fromSender" : "noreply@openidm",
 "toEmail" : "jdoe@example.com"
};

openidm.action('workflow/processinstance', {"_action" : "createProcessInstance"}, params);
```

You can also invoke the workflow over the REST interface with the following REST command:

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --data '{
    "_key":"EmailNotification",
    "fromSender":"noreply@openidm",
    "toEmail":"jdoe@example.com"
 }' \
 --request POST \
 "https://localhost:8443/openidm/workflow/processinstance?_action=create"
```

To schedule the workflow to be invoked regularly, create a schedule configuration object named `openidm/conf/schedule-EmailNotification.json`. The following schedule invokes the workflow once per minute.

```
{
   "enabled" : true,
   "type" : "cron",
   "schedule" : "0 0/1 * * * ?",
   "invokeService" : "script",
   "invokeContext" : {
       "script" : {
           "type" : "text/javascript",
           "file" : "script/triggerEmailNotification.js"
       },
   }
}
```

17.5.2. Sample Workflow - Provisioning User Accounts

This example, provided in `openidm/samples/workflow`, uses workflows to provision user accounts. The example demonstrates the use of the browser-based user interface to manage workflows.

17.5.2.1. Overview of the Sample

The sample starts with a reconciliation process that loads user accounts from an XML file into the managed users repository. The reconciliation creates two users, with UIDs `user1` and `manager1`. Both users have the same password (`Welcome1`).

The sample adds two new business roles to the configuration - `employee` (assigned to `user1`) and `manager` (assigned to `manager1`).

As part of the provisioning, employees are required to initiate a "Contract Onboarding" process. This process is a request to add a contractor to the managed users repository, with an option to include the contractor in the original data source (the XML file).

When the employee has completed the required form, the request is sent to the manager for approval. Any user with the role `"manager"` can claim the approval task. If the request is approved, the user is created in the managed users repository. If a request was made to add the user to the original data source (the XML file) this is done in a subsequent step.

The workflow uses embedded templates to build a more sophisticated input form. The form is validated with the server-side policy rules, described in Chapter 9, "*Using Policies to Validate Data*".

17.5.2.2. Running the Sample

1. Start OpenIDM with the configuration for the workflow sample.

```
$ cd /path/to/openidm
$ ./startup.sh -p samples/workflow
```

2. Run reconciliation over the REST interface.

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "https://localhost:8443/openidm/recon?_action=recon&mapping=systemXmlfileAccounts_managedUser"
```

Successful reconciliation returns an "_id" object, such as the following:

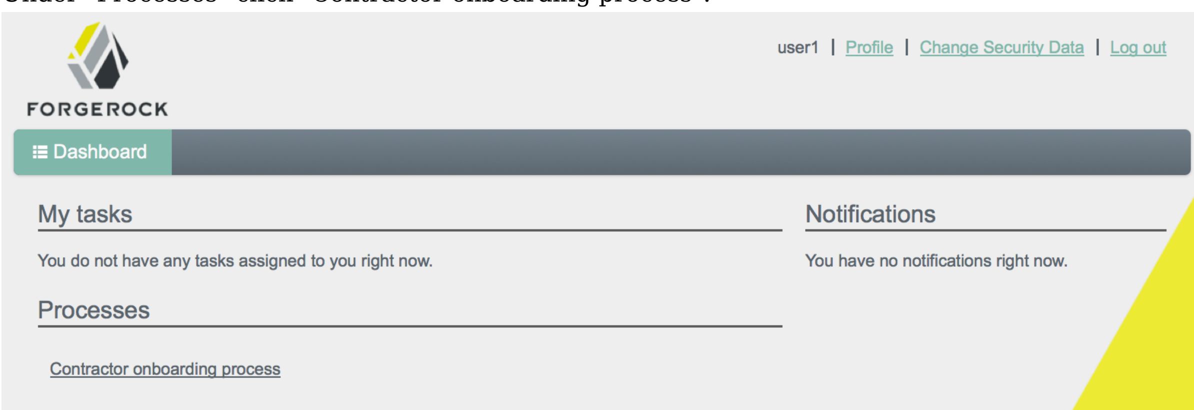
```
{"_id":"aea493f5-29ee-423d-b4b1-10449c60886c","state":"ACTIVE"}
```

The two users are added to the repository. You can test this with the following REST query, which shows the two users, `manager1` and `user1`.

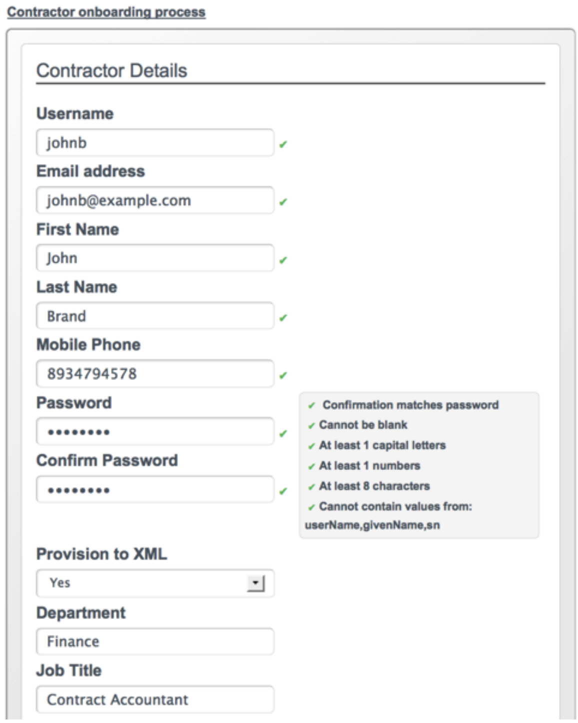
```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/managed/user/?_queryId=query-all-ids"

      {
  "result" : [ {
    "_id" : "manager1",
    "_rev" : "0"
  }, {
    "_id" : "user1",
    "_rev" : "0"
  } ],
  "resultCount" : 2,
  "pagedResultsCookie" : null,
  "remainingPagedResults" : -1
}
```

3. Log into the user interface as `user1`, with password `Welcome1`. For information about logging in to the user interface, see Section 4.2, "Overview of the User View UI".

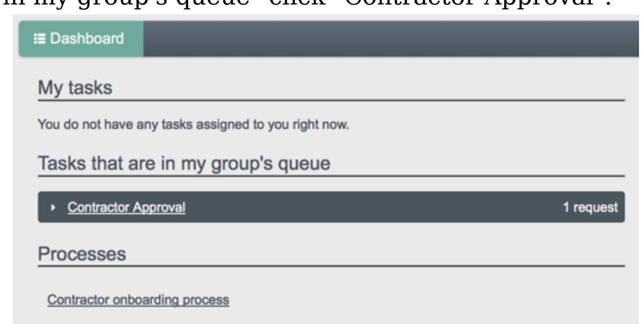
4. Under "Processes" click "Contractor onboarding process".



5. Complete the details of the new user, then click Start.

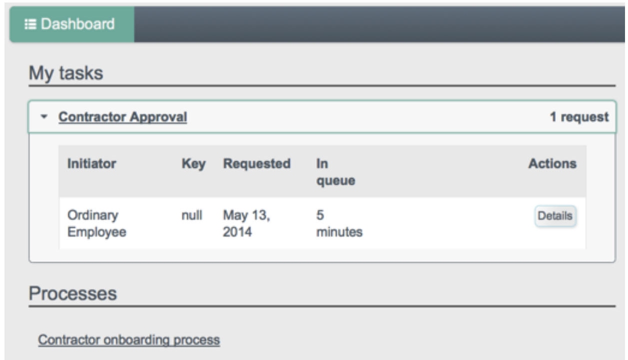


6. Log out of the UI.
7. Log into the UI as `manager1`, with password `Welcome1`.
8. Under "Tasks that are in my group's queue" click "Contractor Approval".



9. From the drop-down list, select "Assign to me".

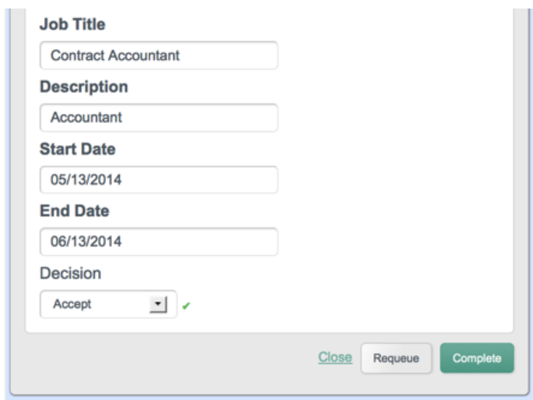
   Note that the "Contractor Approval" task has now moved under "My tasks".
10. Under "My tasks" click "Contractor Approval".



11. Under Actions, click Details.

    The form containing the details of the contractor is displayed.

12. At the bottom of the form, select a decision from the drop-down list (either "Accept" or "Reject"), then click Complete.



    When you Accept the new contractor details, the user account is created in the repository. You can check the new account by running the following REST command:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/managed/user/?_queryId=query-all-ids"


{
  "result" : [ {
    "_id" : "manager1",
    "_rev" : "0"
  }, {
    "_id" : "user1",
    "_rev" : "0"
  }, {
    "_id" : "96a9513b-7896-4d22-83cc-6b35a709f0a8",
    "_rev" : "0"
  } ],
  "resultCount" : 3,
  "pagedResultsCookie" : null,
  "remainingPagedResults" : -1
}
```

Display the details of the new user, by running a REST query on the user ID, as follows:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/managed/user/96a9513b-7896-4d22-83cc-6b35a709f0a8"


{
  "_id" : "96a9513b-7896-4d22-83cc-6b35a709f0a8",
  "_rev" : "1",
  "startDate" : "05/13/2014",
  "manager" : "user1",
  "passwordAttempts" : "0",
  "department" : "Finance",
  "address2" : "",
  "endDate" : "06/13/2014",
  "givenName" : "John",
  "effectiveRoles" : [ "openidm-authorized" ],
  "city" : "",
  "lastPasswordSet" : "",
  "postalCode" : "",
  "description" : "Accountant",
  "accountStatus" : "active",
  "userName" : "johnb",
  "stateProvince" : "",
  "jobTitle" : "Contract Accountant",
  "mail" : "johnb@example.com",
  "sn" : "Brand",
  "provisionToXML" : "1",
  "lastPasswordAttempt" : "Tue May 13 2014 09:56:49 GMT+0200 (SAST)",
  "country" : "",
```

```
  "telephoneNumber" : "8934794578",
  "roles" : [ "openidm-authorized" ],
  "effectiveAssignments" : { },
  "postalAddress" : ""
}
```

You can now log into the UI as the new user (with the details that you specified in Step 5). Under "Notifications" you will see a welcome message indicating the working dates of the new user. If you log in as `user1` you are notified of the result of the manager's decision.

If you specified that the new user should be added to the original data source, you will see that the account was added to the XML file:

```
$ cd /path/to/openidm
$ cat samples/workflow/data/xmlConnectorData.xml
      ...
   <ri:__ACCOUNT__>
      <icf:__DESCRIPTION__>Accountant</icf:__DESCRIPTION__>
      <ri:roles>openidm-authorized</ri:roles>
      <ri:mobileTelephoneNumber>8934794578</ri:mobileTelephoneNumber>
      <ri:firstname>John</ri:firstname>
      <ri:manager>user1</ri:manager>
      <ri:startDate>05/13/2014</ri:startDate>
      <ri:jobTitle>Contract Accountant</ri:jobTitle>
      <icf:__UID__>67b6bb5f-5457-4ac6-bb49-5d98f2b1f3f8</icf:__UID__>
      <icf:__NAME__>johnb</icf:__NAME__>
      <ri:email>johnb@example.com</ri:email>
      <icf:__PASSWORD__>Welcome1</icf:__PASSWORD__>
      <ri:department>Finance</ri:department>
      <ri:endDate>06/13/2014</ri:endDate>
      <ri:lastname>Brand</ri:lastname>
   </
ri:__ACCOUNT__>
...
```

If you declined the approval request, the user will not be created in either data source.

You can see the details of the workflow definition in `samples/workflow/workflow/contractorOnboarding.bpmn20.xml`.

17.6. Workflow Use Cases

This section describes a number of sample workflows, that demonstrate typical use cases for OpenIDM. The use cases, provided in `/path/to/openidm/samples/usecase`, work together to provide a complete business story, with the same set of sample data. Each of the use cases is integrated with the default UI.

These use cases use OrientDB as a repository by default. Alternative repository configuration files are provided in `/path/to/openidm/samples/usecase/db`. If you want to use one of these alternative repositories, remove the `repo.orientdb.json` file from the `conf/` directory of the use case you are testing (for example, `samples/usecase/usecase1/conf/repo.orientdb.json`) and copy the appropriate JDBC repository configuration file (`repo.jdbc.json`) into that `conf/` directory. For more information on using an alternative repository, see Chapter 4, "*Installing a Repository For Production*" in the *Installation Guide*.

The use cases can be run independently, but rely on the data set that is imported during use case 1 - so you *must* run use case 1 before running any of the other use cases.

The use cases assume an initial data set of twenty "ordinary" managed users in OpenIDM (user.0 - user.19). The users are divided as follows:

Users	Department	Manager	Employees	Contractors
user.0-user.4	Human Resources	user.0	user.0-user.3	user.4
user.5-user.9	Production Planning	user.5	user.5-user.8	user.9
user.10-user.14	Sales & Distribution	user.10	user.10-user.13	user.14
user.15-user.19	Treasury & Payments	user.15	user.15-user.18	user.19

In addition, the following "special" users are defined:

- `hradmin` - represents the human interaction of the HR department
- `systemadmin` - represents the human interaction of the populated systems (Business and Project)
- `superadmin` - represents the manager of the managers

Note that the **curl** commands in this section use the secure port for OpenIDM (8443) and assume a self-signed certificate named `self-signed.crt`, located in the directory from which the command is launched. For instructions on using the self-signed certificate that is generated when OpenIDM first starts up, see Section 16.2.2, "Restrict REST Access to the HTTPS Port".

17.6.1. Use Case 1 - Initial Reconciliation

This use case assumes an OpenDJ server and populates the managed user repository with users from OpenDJ.

To prepare the sample:

- Download and install OpenDJ, as described in the OpenDJ Install Guide.

  This sample assumes that OpenDJ is listening on port 1389, the standard LDAP port for users who cannot use privileged ports.

- During the install, import the user data from the LDIF file `/path/to/openidm/samples/usecase/data/hr_data.ldif`.
- The use case assumes a user with DN `cn=Directory Manager` and password `password` who will bind to the directory server.

The OpenDJ server now contains the users required for all the workflow use cases.

1. Start OpenIDM with the configuration for use case 1.

```
$ cd /path/to/openidm
$ ./startup.sh -p samples/usecase/usecase1
```

2. Run reconciliation to populate the managed user repository with the users from the OpenDJ server.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/recon?_action=recon&mapping=systemHRAccounts_managedUser"
```

3. Query the managed users that were created by the reconciliation process.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/managed/user?_queryId=query-all-ids"

      {
  "result" : [ {
    "_id" : "user.5",
    "_rev" : "0"
  }, {
    "_id" : "user.10",
    "_rev" : "0"
  }, {
    "_id" : "user.1",
    "_rev" : "0"
  },
 ...
 {
    "_id" : "hradmin",
    "_rev" : "0"
  }, {
    "_id" : "systemadmin",
    "_rev" : "0"
  }, {
    "_id" : "superadmin",
    "_rev" : "0"
  } ],
  "resultCount" : 23,
  "pagedResultsCookie" : null,
  "remainingPagedResults" : -1
}
```

23 users will have been created by the reconciliation process. The default password of all the newly created users is `Passw0rd`.

4. Shut down OpenIDM before you proceed with the next use case.

```
$ cd /path/to/openidm
$ ./shutdown.sh
```

17.6.2. Use Case 2 - New User Onboarding

This use case demonstrates a new user onboarding process. The process can be initiated by any of the users created in the previous reconciliation process. In this example, we use `user.1` to initiate the process. `user.1` captures the details of a new user, and then submits the new user entry for approval by the prospective manager of that new user.

The use case includes three separate workflows - onboarding (creation of the new user), sunrise (commencement of the new user work period) and sunset (termination of the user contract).

The use case also demonstrates email notification with the optional configuration of an external email service. If you want to use email notification, you must configure the external email service, as described in Procedure 17.2, "Configuring Email Notification", before you start the workflow.

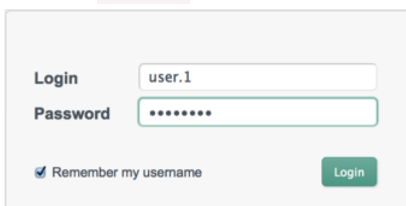
The use case works with the OpenIDM UI, accessible at the following URL by default: `https://localhost:8443/openidmui/`.

Procedure 17.1. Initiating the Onboarding Workflow

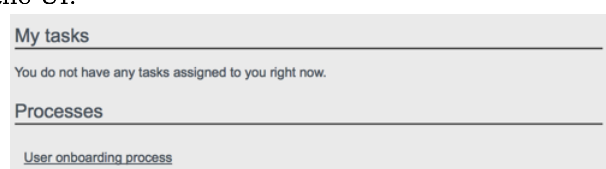
1. Start OpenIDM with the configuration for use case 2.

```
$ cd /path/to/openidm
$ ./startup.sh -p samples/usecase/usecase2
```

2. Log into the UI as `user.1` with password `Passw0rd`.



3. In this use case, the processes associated with the new user onboarding workflow are visible to any user who logs into the UI.



Click on the User Onboarding Process and complete the fields for a sample new user. Complete at least all mandatory fields.

Department. Specifies one of four departments to which the new user will belong (Human Resources, Production Planning, Sales & Distribution, or Treasury & Payments). The value you select here determines the "manager" of the new user, to which the request will be sent for approval. (See the previous table of users for a list of the managers of the various departments.)

User Type. Governs user access to specific accounts. If the User Type is "Employee", the new user will have access to an account named "Business". This access is represented as an attribute of the managed user entry in the OpenIDM repository, as follows: `accounts : ["Business"]`. If the User Type is "Contractor", the new user will have no accounts associated with its managed user representation in OpenIDM.

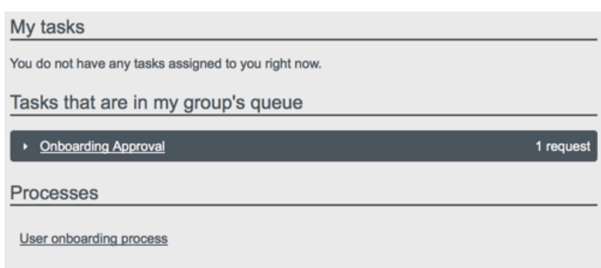
Send Email Notification. Indicates whether an email should be sent to alert the manager of the new required approval. The email details used here are defined when you configure email notification, as described in Procedure 17.2, "Configuring Email Notification". If you select not to send an email notification, the notification is simply added to the OpenIDM repository, and appears when the manager logs into the UI.

4. Click Start to initiate the onboarding workflow.

   This action sends the new user request to the corresponding "management" users (the department manager, as well as the `superadmin` user, who is an overall manager).

5. Log out of the UI, and log back in as the management user of the department that you selected when you completed the new user form. For example, if you selected "Human Resources", log in as `user.0`, which simulates the management user for the HR department. All users have the password `Passw0rd`.

   Notice that this user now has an Onboarding Approval task in the queue of tasks assigned to his group.



6. Click on the Onboarding Approval task and select "Assign to Me".

   This action "claims" the task for `user.0`, removes it from the group queue, and places it in the list of pending tasks for `user.0`.

7. Click on the Onboarding Approval task under the My Tasks list and click Details.

The complete new user request is displayed for the manager's approval. As the manager, you can add any information that was missing from the original request.

In addition, you can specify the following information for the new user.

- *Start Date*. Completing this field results in the user being created, with a `"startDate"` added to that user's managed user entry. The status of the user is `inactive`. This field is optional, and is used by the task scanner to trigger the Sunrise workflow.
- *End Date*. Completing this field results in the user being created, with an `"endDate"` added to that user's managed user entry. The field is optional, and is used by the task scanner to trigger the Sunset workflow.
- *Manager*. Selecting "Yes" here adds a `"title"` property, with a value of `"manager"`, to the new managed user entry.
- *Decision*. Selecting "Reject" here terminates the workflow and sends a notification to the user who initiated the workflow. Selecting "Accept" creates the managed user entry in OpenIDM. The password of the new user is `Passw0rd`.

  Two notifications are created when the request is accepted - one for the user who initiated the workflow, and one for the newly created user. The notifications are visible in the UI after login. If you selected email notification, one email is sent to the user defined when you configured email notification, as described in Procedure 17.2, "Configuring Email Notification".

8. At the bottom of the form, there is an option either to Requeue the request or to Complete it. Click Complete.

   If you click Requeue here, the task is removed from the list of My Tasks for that user, and returned to the list of tasks pending for that group. The task can then be claimed by any member of that group.

   When the new user request has been approved, the user is created in the OpenIDM repository. If you did not include a Start Date in the manager approval, you should now be able to log into the UI with the details of the new user. If you included a Start Date, you need to complete the sunrise workflow before the user account is active (which will enable you to log in as this user).

Procedure 17.2. Configuring Email Notification

This step is optional, and required only if you want to use email notification with this workflow.

1. Edit the settings in the file `/path/to/openidm/samples/usecase/usecase2/conf/external.email.json` to match the settings of your mail server. For example:

```
$ cd /path/to/openidm
$ more samples/usecase/usecase2/conf/external.email.json

    {
      "host" : "smtp.gmail.com",
      "port" : "587",
      "username" : "my-username"
      "password" : "my-password",
      "mail.smtp.auth" : "true",
      "mail.smtp.starttls.enable" : "true"
}
```

2. Change the notification email parameters in the workflow definition file. To edit the workflow definition file:

    1. Copy the workflow archive (`.bar`) file (`samples/usecase/usecase2/workflow/newUserCreate.bar`) to a temporary location.

    2. Unzip the temporary workflow `.bar` file. This step extracts the workflow definition file (`newUserCreate.bpmn20.xml`) and two xhtml templates required by the workflow.

    ```
    $ unzip newUserCreate.bar
    Archive:  newUserCreate.bar
      inflating: nUCDecideApprovalForm.xhtml
      inflating: nUCStartForm.xhtml
      inflating: newUserCreate.bpmn20.xml
    ```

    3. Edit the extracted workflow definition file (`newUserCreate.bpmn20.xml`). The email parameters are towards the end of this file:

    ```
    $ cd /path/to/openidm/samples/usecase/usecase2/workflow
    $ grep emailParams newUserCreate.bpmn20.xml
    emailParams = [from : 'usecasetest@forgerock.com', to : 'notification@example.com'
    ,
    ...
    ```

    Change the `from` and `to` parameters to reflect valid email addresses.

    4. Zip up the amended workflow definition file, and the xhtml templates into a workflow `.bar` file.

    ```
    $ zip newUserCreate.bar newUserCreate.bpmn20.xml nUCDecideApprovalForm.xhtml nUCStartForm.xhtml
    updating: nUCDecideApprovalForm.xhtml (deflated 82%)
    updating: nUCStartForm.xhtml (deflated 82%)
    updating: newUserCreate.bpmn20.xml (deflated 85%)
    ```

    5. Copy the new `.bar` file to the workflow directory, overwriting the existing `.bar` file.

    ```
    $ cp /tmp/newUserCreate.bar /path/to/openidm/samples/usecase/usecase2/workflow
    ```

Procedure 17.3. Initiating the Sunrise Workflow

If a sunrise date is specified for the new user, the user is created in the repository, with an `inactive` account status.

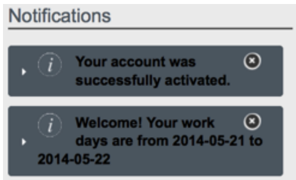
- To trigger the sunrise workflow (which activates the account), enable the sunrise task scanning schedule. The schedule is disabled by default.

  Modify the schedule configuration file (`samples/usecase/usecase2/conf/schedule-taskscan_sunrise.json`), setting the `"enabled"` property to `true`.

  ```
  $ cd /path/to/openidm
  $ grep "enabled" samples/usecase/usecase2/conf/schedule-taskscan_sunrise.json
  "enabled" : true,
  ```

  The scan runs every minute, and checks the repository for users that have a sunrise date that is anything up to one day after the current date. When the scan is triggered, it locates the newly created user and starts the sunrise workflow on this user. The workflow takes the following actions:

  - Changes the account status of the user to `active`.
  - Generates a notification for the new user, which is visible when the user logs into the UI.



Procedure 17.4. Initiating the Sunset Workflow

If a sunset date is set for the new user, you can trigger the sunset workflow to deactivate the user account when the end of his work period is reached.

1. To trigger the sunset workflow, enable the sunset task scanning schedule. The schedule is disabled by default.

   Modify the schedule configuration file (`samples/usecase/usecase2/conf/schedule-taskscan_sunset.json`), setting the `"enabled"` property to `true`.

   ```
   $ cd /path/to/openidm
   $ grep "enabled" samples/usecase/usecase2/conf/schedule-taskscan_sunset.json

   "enabled" : true,
   ```

   The scan runs every minute, and checks the repository for users that have a sunset date that is anything up to one day after the current date. When the scan is triggered, it locates users whose contracts are about to end, and starts the sunset workflow on these users. When the workflow is initiated, it assigns a task to the manager of the affected user. In this example, the task is assigned to `user.0`.

2. When the sunset schedule has been enabled, log into OpenIDM UI as `user.0` (with password `Passw0rd`). If the user's sunset date is within one day of the current date, a "Contract Termination" task becomes available under the 'My tasks' section for the manager of that user.

   Select the contract termination task and click Details.

3. In the Decision field, select either "Accept termination" or "Modify date", then click Complete.

   When you accept the termination, the user's account status is set to `inactive` and the HR administrative user receives a notification to that effect, next time that user logs into the UI. The deactivated user is no longer able to log into the UI.

   If you select to modify the date, the sunset date of that user is changed to the value that you specify in the End Date field on that form. The management user receives a UI notification that the employee's contract has been extended.

4. Shut down OpenIDM before you proceed with the next use case.

```
$ cd /path/to/openidm
$ ./shutdown.sh
```

17.6.3. Use Case 3 - User Access Request

This use case simulates a user access request, with two levels of approval for the request.

If you want to use email notification with this workflow, follow the instructions in Procedure 17.2, "Configuring Email Notification" before you start the workflow, substituting `usecase3/conf/external.email.json` and `usecase3/workflow/accessRequest.bpmn20.xml` for the files described in that procedure.

1. Start OpenIDM with the configuration for use case 3.

```
$ cd /path/to/openidm
$ ./startup.sh -p samples/usecase/usecase3
```

2. Log into the UI as `user.1` with password `Passw0rd`.

   `user.1` belongs to the HR department and, in this workflow, is requesting access to a Project system.

3. Click on the Access Request Process in the list of available processes and click Start to start the workflow.

   A User Access Request appears in the list of tasks for `user.1`.

4. Select the User Access Request task and click Details.

   The resulting form indicates the various systems to which the user may request access.

Access to Business system. This field reflects the current value of the "accounts" property for that user in the repository. If the value includes "Business" this field is True.

Access to Project system. Set this field to True to request Project access for user.1.

Send Email Notification. Indicates whether an email should be sent to alert the manager of the new access request. The email details used here are defined when you configure email notification, as described in Procedure 17.2, "Configuring Email Notification". If you select not to send an email notification, the notification is simply added to the OpenIDM repository, and appears when the manager logs into the UI.

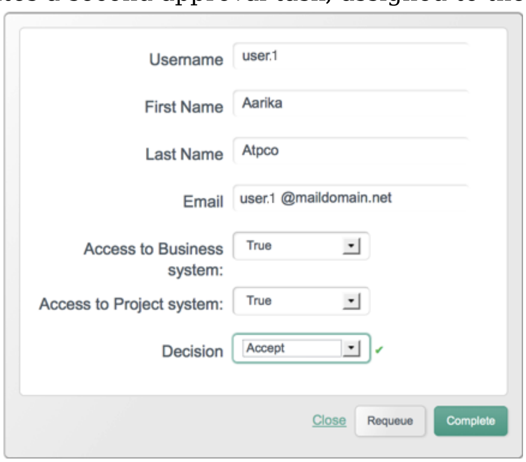
Select either Cancel, to terminate the process, or Request, to start a user task, assigned to the manager of the user requesting access (user.0 in this example).

5. Log out of the UI and log back in as the manager (user.0 with password Passw0rd).
6. Under "Tasks that are in my group's queue" click "User Access Request Approval" and select "Assign to me".

   Note that the "User Access Request Approval" task has now moved under "My tasks".
7. Under "My tasks" click "User Access Request Approval" and click Details.
8. The details of the access request are displayed. The manager is able to modify the access rights. Select Accept or Reject to approve or deny the request.

   Rejecting the request results in a notification being sent to the user who made the request. If you have enabled email notification, a single email is sent to the account defined when you configure email notification, as described in Procedure 17.2, "Configuring Email Notification".

   Accepting the request initiates a second approval task, assigned to the systemadmin user.



   Click Complete to complete the task.

9. Log out of the UI and log in as the `systemadmin` user (with password `Passw0rd`).

   This user now has one User Access Request Approval task in his queue.

10. Select the task and click Details.

    This task interface is similar to that of the task that was assigned to the manager.

    Rejecting the request results in a notification being sent to the user who made the request.

    Accepting the request updates the managed/user record in OpenIDM, to reflect the approved access changes.

    If you have enabled email notification, a single email is sent to the account defined when you configured the external email service (Procedure 17.2, "Configuring Email Notification"), indicating whether the request has been accepted or rejected.

Note that this sample includes an *escalation* step that is attached to the manager approval task. If the manager does not complete assessment of the user task within ten minutes of its initiation, a new user task is created and assigned to the `superadmin` user. This task has the same interface and functionality as the task assigned to the manager. Accordingly, when the `superadmin` user completes the task, the execution is passed to the `systemadmin` user for approval.

Shut down OpenIDM before you proceed with the next use case.

```
$ cd /path/to/openidm
$ ./shutdown.sh
```

17.6.4. Use Case 4 - Orphan Account Detection

This use case demonstrates two asynchronous tasks, started from a reconciliation process:

- Detecting orphan accounts on a target object set
- Handling ambiguous results during correlation

This use case relies on a customized synchronization configuration (mapping) file, named `syncManagedBusiness.json`, in the `/path/to/openidm/samples/usecase/usecase4/conf` directory.

This file defines a mapping (`recon_managedUser_systemBusiness`) between a source (managed users) and a target object set. The target object set is defined in the file `samples/usecase/usecase4/data/business.csv`. The `business.csv` file includes all users from the initial reconciliation (described in Section 17.6.1, "Use Case 1 - Initial Reconciliation"). These users are categorized as `employees`, and therefore include the property `"accounts" : ["Business"]` in their managed user entry (see Section 17.6.2, "Use Case 2 - New User Onboarding" for an explanation of the User Type).

The mapping includes the following `"validSource"` field:

```
"validSource" : {
    "type" : "text/javascript",
    "file" : "script/isSourceValidBusiness.js"
},
```

This field references a script which specifies that only those users who are employees are taken into account during the reconciliation.

In addition, the `business.csv` file includes the following users:

- `user.50`. This user is defined *only* in the .csv file, and not in the managed/user repository. When a reconciliation operation is run, this user is detected as an *orphan account*. The orphan account workflow is triggered when an "UNQUALIFIED" or "UNASSIGNED" situation is encountered, as indicated in this section of the mapping:

```
{
    "situation" : "UNQUALIFIED",
    "action" : {
        "workflowName" : "orphanAccountReport",
        "type" : "text/javascript",
        "file" : "workflow/triggerWorkflowFromSync.js"
    }
},
{
    "situation" : "UNASSIGNED",
    "action" : {
        "workflowName" : "orphanAccountReport",
        "type" : "text/javascript",
        "file" : "workflow/triggerWorkflowFromSync.js"
    }
}
```

- `user.33`. This user has a `"userName"` attribute of `"user.3"` (which is the same as the `"userName"` attribute of the user, `user.3`). The correlation query of the reconciliation operation is based on the `"userName"` attribute. During the correlation query, two candidate users are therefore correlated with the same managed user (`user.3`), and the result is ambiguous. The manual match workflow is triggered when an "AMBIGUOUS" situation is encountered, as indicated in this section of the mapping:

```
{
    "situation" : "AMBIGUOUS",
    "action" : {
        "workflowName" : "manualMatch",
        "type" : "text/javascript",
        "file" : "workflow/triggerWorkflowFromSync.js"
    }
}
```

1. Before you start with this use case, rename the mapping file to `sync.json`.

```
$ cd /path/to/openidm/samples/usecase/usecase4/conf
$ mv syncManagedBusiness.json sync.json
```

2. Start OpenIDM with the configuration for use case 4.

```
$ cd /path/to/openidm
$ ./startup.sh -p samples/usecase/usecase4
```

   You will see a warning in the Felix console about a password not being defined in the CSV file (`WARN Password attribute is not defined. [CSVFileConfiguration]`). You can ignore this warning.

3. Run a reconciliation operation, according to the mapping defined in `sync.json`.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "https://localhost:8443/openidm/recon?_action=recon&mapping=recon_managedUser_systemBusiness"
```

   When the reconciliation operation finds the ambiguous entry (`user.3`) and the orphan entry (`user.50`) in the CSV file, two asynchronous workflows are launched (`manualMatch` and `orphanAccountReport`), as indicated in the mapping file, described previously.

4. Log into the UI as the `systemadmin` user, with password `Passw0rd`.

5. Select the Manual Linking task from the My tasks list and click Details.

   The *Possible targets* field presents a list of target entries to which the ambiguous record can be linked. In this example, `user.3 - Atrc, Aaron` and `user.33 - Atrc, Aaron` are the two candidate users found in the target object set by the correlation query. When you select one of these values, the workflow manually links the managed user (`user.3`) to the selected user.

   If you select Ignore, here, no action is taken (no link is created), and the workflow terminates.

6. Select the Orphan Account task from the My tasks list and click Details.

   The *Link to* field enables you to enter an existing managed user ID to which this orphan account should be linked. For the purposes of this example, enter `user.5`.

   The *Delete* option deletes the user from the target object set (the CSV file in this case) and terminates the workflow.

7. Shut down OpenIDM before you proceed with the next use case.

```
$ cd /path/to/openidm
$ ./shutdown.sh
```

17.6.5. Use Case 5 - Certification

This use case includes two scheduled tasks that demonstrate a certification workflow.

The first scheduled task fetches all the managed users and begins a certification workflow for each user. The workflow shows the roles that are assigned to each user and allows you to accept (certify) or change those role assignments. The second scheduled task fetches all the defined managed roles and begins a certification workflow for the roles. The workflow demonstrates managed role assignment.

In this use case, four managed roles are defined, based on the departments to which the managed users belong. The managed roles are `Human Resources`, `Production Planning`, `Sales and Distribution`, and

`Treasury and Payments`. Every user is assigned a dynamic role by default, which corresponds to that user's department.

Note

By default the scheduled tasks used in this workflow run every minute, so you will need to wait a minute before logging into the UI, after enabling the schedules. You can change the frequency by editing the `"schedule"` property in the schedule configuration files (`schedule-certification.json` and `schedule-certificationEntitlements.json`). This property takes standard cron syntax. Every minute, a new task is created for each user or role, so you will see several tasks in the group queue if you log in to the UI after some time. In a live deployment, this kind of workflow would probably only run once every few months.

1. Start OpenIDM with the configuration for use case 5.

```
$ cd /path/to/openidm
$ ./startup.sh -p samples/usecase/usecase5
```

2. Define the four managed roles over the REST interface, by sending the following PUT requests to the `managed/role` endpoint.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --header "If-None-Match: *" \
 --request PUT \
 --data '{
  "properties": {
    "description": "Role for Human Resources department"
  },
  "assignments": {
    "ad1": {
      "attributes": [
        {
          "value": [
            "CN=cisco_vpn,DC=example,DC=com"
          ],
          "assignmentOperation": "mergeWithTarget",
          "unassignmentOperation": "removeFromTarget",
          "name": "memberOf"
        }
      ]
    }
  },
  "name": "Human Resources"
}' \
 "https://localhost:8443/openidm/managed/role/human-resources"
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --header "If-None-Match: *" \
 --request PUT \
 --data '{
```

```
  "properties": {
    "description": "Role for Production Planning department"
  },
  "assignments": {
    "ad1": {
      "attributes": [
        {
          "value": [
            "CN=intranet,DC=example,DC=com",
            "CN=email,DC=example,DC=com",
            "CN=radius_dialin,DC=example,DC=com"
          ],
          "assignmentOperation": "mergeWithTarget",
          "unassignmentOperation": "removeFromTarget",
          "name": "memberOf"
        }
      ]
    }
  },
  "name": "Production Planning"
}' \
 "https://localhost:8443/openidm/managed/role/production-planning"
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --header "If-None-Match: *" \
 --request PUT \
 --data '{
  "properties": {
    "description": "Role for Sales and Distribution department"
  },
  "assignments": {
    "ad1": {
      "attributes": [
        {
          "value": [
            "CN=intranet,DC=example,DC=com",
            "CN=email,DC=example,DC=com"
          ],
          "assignmentOperation": "mergeWithTarget",
          "unassignmentOperation": "removeFromTarget",
          "name": "memberOf"
        }
      ]
    }
  },
  "name": "Sales and Distribution"
}' \
 "https://localhost:8443/openidm/managed/role/sales-distribution"
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --header "If-None-Match: *" \
 --request PUT \
 --data '{
```

```
  "properties": {
    "description": "Role for Treasury and Payments department"
  },
  "assignments": {
    "ad1": {
      "attributes": [
        {
          "value": [
            "CN=intranet,DC=example,DC=com"
          ],
          "assignmentOperation": "mergeWithTarget",
          "unassignmentOperation": "removeFromTarget",
          "name": "memberOf"
        }
      ]
    }
  },
  "name": "Treasury and Payments"
}' \
 "https://localhost:8443/openidm/managed/role/treasury-payments"
```

3. To trigger the user certification scheduled task, enable the schedule in the schedule configuration file (`schedule-certification.json`).

```
$ cd /path/to/openidm/samples/usecase/usecase5/conf/
$ more schedule-certification.json
{
    "enabled" : true,
    "type" : "cron"
,
...
}
```

4. Log into the UI as `user.0` with password `Passw0rd`.

   `user.0` represents the manager of the users who are being certified.

5. Under "Tasks that are in my group's queue" click "Role Status Check". A scheduled task has been started for each managed user. Choose one of the users, for example, user.1, and select "Assign to me" under the Actions column.

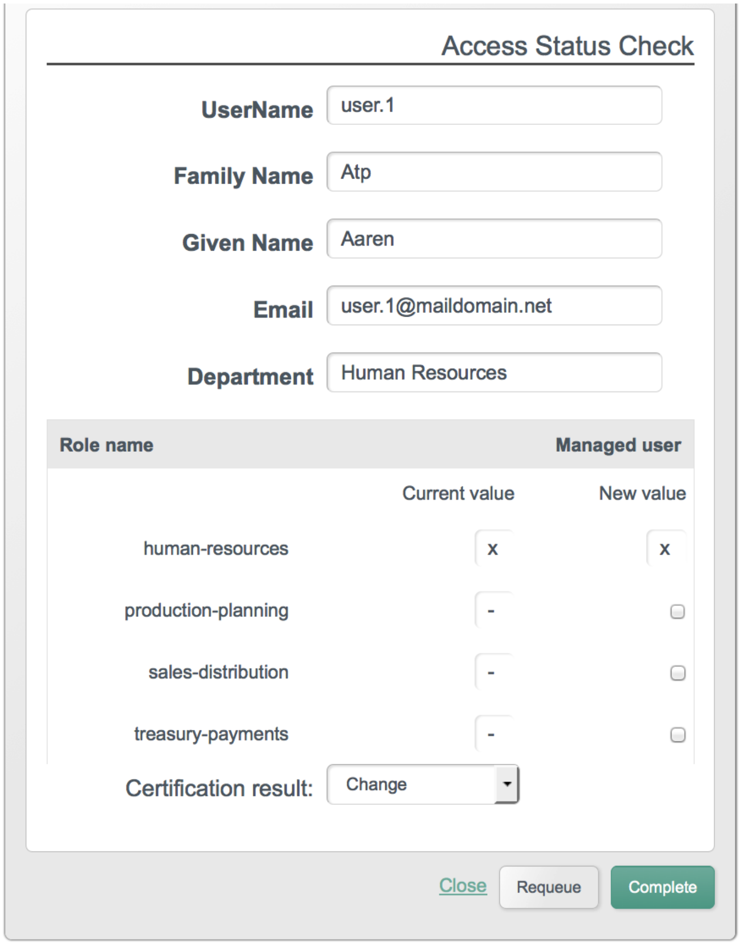
   The "Role Status Check" task for that user moves under "My tasks".

6. Under "My tasks" click "Role Status Check" and click Details.

7. The *Access Status Check* window shows the details of the user for whom the certification is being processed, and a list of roles that can be assigned.

   An `x` in the first column indicates that the role is currently assigned to the user. A value in the second column indicates the roles that will be assigned to the user when the certification process is complete.

If the role is dynamic, that is, assigned to the user based on the department to which the user belongs, the value is read-only. user.1 has the `human-resources` role assigned dynamically, as a function of the department to which this user belongs.



8. Select the appropriate roles that should be assigned to this user, then select one of the following options from the "Certification result" list:

   - **Change.** The user's role assignments are updated, based on the values specified in the second column.

   - **Certify.** The user's role assignments are not updated. In other words, the user's current role assignments are certified.

- **Escalate.** The task is reassigned to the superadmin user. To test this, log out, and log in again as the `superadmin`. The superadmin can select whether to change or certify the role assignments.

  When you have completed the role selection, and the action to be taken, click Complete.

  Clicking *Requeue* here simply returns the task to the list of pending tasks in that group's queue.

9. Log out of the UI.

   This is the end of the first scheduled task.

10. Trigger the managed role certification by enabling the scheduled task in the schedule configuration file (`schedule-certificationEntitlements.json`).

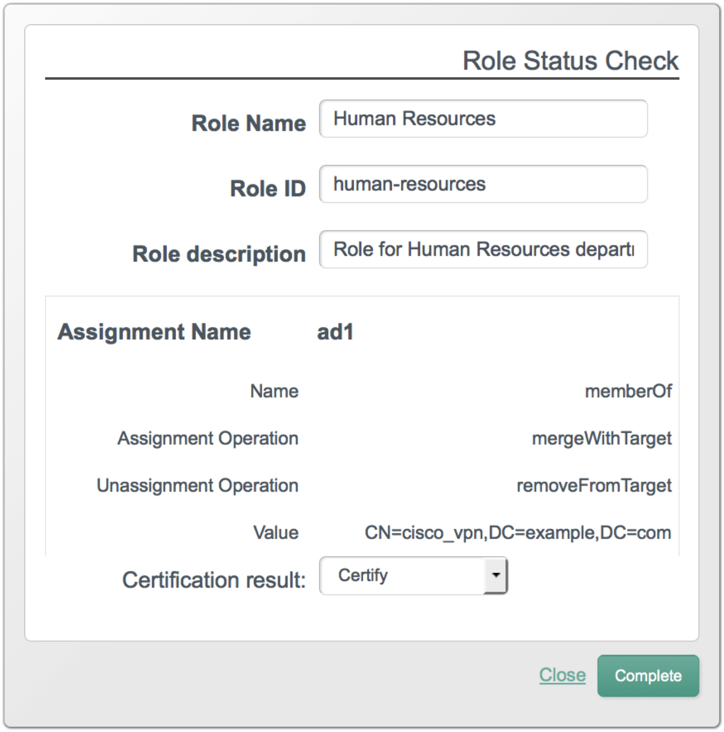
```
$ cd /path/to/openidm/samples/usecase/usecase5/conf/
$ more schedule-certificationEntitlements.json
{
    "enabled" : true,
    "type" : "cron"
,
...
}
```

11. Log into the UI as `systemadmin` with password `Passw0rd`.

12. Under "My tasks" select "Entitlement Status Check".

13. Under the "Key" column, you will see the names of the various managed roles whose entitlements are being certified in this workflow.

    Select one of the entitlement check tasks (for example, for the `human-resources` role) and click Details.



14. The Role Status Check panel shows the name, ID and description of the role whose assignments or entitlements you are certifying. For each assignment, the name of the attribute whose value is assigned, and the assignment and unassignment operations are indicated.

    The only field that can be edited on this panel is the "Value" field, which specifies the value that should be used for the named attribute when this role is assigned to a user. To edit the value, click in the field and either replace the existing value or press Enter at the end of the existing value to add a new value. Because this attribute is multivalued, multiple values are indicated by typing them on separate lines.

    For more information about managed roles and assignment and unassignment operations, see Section 8.3, "Configuring Custom Roles".

15. Enter the values that should be used for this attribute, then select one of the following options from the "Certification result" list:

    - **Update.** The role definition is updated to use the attribute value or values that you specified in the "Value" field.

    - **Certify.** The role definition is not updated and the current assignment value is certified.

When you have completed the role selection, and the action to be taken, click Complete.

This is the end of the role entitlement workflow.

16. Shut down OpenIDM before you proceed with the next use case.

```
$ cd /path/to/openidm
$ ./shutdown.sh
```

17.6.6. Use Case 6 - Password Change Reminder

This use case demonstrates using the task scanner to trigger a password change reminder workflow for managed users.

In this example, each managed user entry in OpenIDM has a dedicated attribute, `lastPasswordSet`, that stores the date on which the password was last changed. The value of this attribute is updated by an `onStore` script, defined in the managed user configuration file (`conf/managed.json`), as follows:

```
"onStore" : {
    "type" : "text/javascript",
    "file" : "script/onStoreManagedUser.js"
},
```

When a new password is stored for a user, the script sets the date on which this change was made. The task scanner periodically scans the `lastPasswordSet` attribute, and starts the workflow if the password was changed more than an hour ago. This condition is configured in the schedule configuration file (`schedule-taskscan_passwordchange.json`):

```
$ cd /path/to/openidm
$ more samples/usecase/usecase6/conf/schedule-taskscan_passwordchange.json

...
"condition" : {
    "before" : "${Time.now - 1h}"
}
,
....
```

Obviously, in a real deployment, the period between required password changes would be longer, and this value would need to be set accordingly. For the purposes of testing this use case, you might want to set the value to a shorter period, such as `"${Time.now - 1m}"`, which will send the notification one minute after a password change.

By default, the workflow sends notifications to the user entry, visible when the user logs into the UI. If you want notifications sent by email, configure the external email service, as follows:

1. Edit the settings in the file `/path/to/openidm/samples/usecase/usecase6/conf/external.email.json` to match the settings of your mail server. For example:

```
$ cd /path/to/openidm
$ more samples/usecase/usecase6/conf/external.email.json

{
        "host" : "smtp.gmail.com",
        "port" : "587",
        "username" : "my-username"
        "password" : "my-password",
        "mail.smtp.auth" : "true",
        "mail.smtp.starttls.enable" : "true"
}
```

2. Enable email notification in the script file that starts the workflow (`samples/usecase/usecase6/script/passwordchange.js`). For example:

```
$ cd /path/to/openidm
$ more samples/usecase/usecase6/script/passwordchange.js

/*global  objectID*/

(function () {
    var params = {
 "userId" : objectID,
 "emailEnabled" : "true",
 "_key": "passwordChangeReminder"
};
```

3. Make sure that all users have a valid email address as the value of their `mail` attribute, in the OpenIDM repository.

The task scanning schedule is disabled by default. To test this use case, follow these steps:

1. Enable the task scanning schedule by setting `enabled` to `true` in the schedule configuration file (`schedule-taskscan_passwordchange.json`).

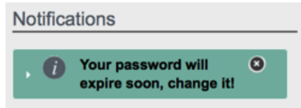
```
$ cd /path/to/openidm
$ more samples/usecase/usecase6/conf/schedule-taskscan_passwordchange.json

{
    "enabled" : true
,
...
```

2. Start OpenIDM with the configuration for use case 6.

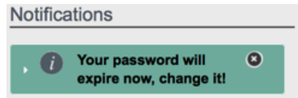
```
$ cd /path/to/openidm
$ ./startup.sh -p samples/usecase/usecase6
```

3. Log into the UI as any of the users listed in the introduction to this section (for example, `user.4`, with password `Passw0rd`).

   The user sees the following notification upon login:



If the password has not been changed after five minutes, a second notification is sent to the user.



If the password has not been changed two minutes after this second notification, the user's account is deactivated and that user is no longer able to log into the UI.

4. (Optional) To avoid the second notification, or the account deactivation, you can change the user password through the UI, as follows:

   a. Log into the UI as the user whose password you want to change and click Change Security Data at the top right of the page.

   b. Enter the existing password (in this case `Passw0rd`).

   c. Enter a new password that conforms to the requirements of the password policy.

Chapter 18
Using Audit Logs

OpenIDM auditing can publish and log all relevant system activity to the targets you specify. Auditing can include data from reconciliation as a basis for reporting, access details, and activity logs that capture operations on internal (managed) objects and external (system) objects. Auditing provides the data for all the relevant reports, including orphan account reports.

The auditing interface allows you to push auditing data to local files, to the OpenIDM repository, and to a remote system.

18.1. Audit Log Types

This section describes the types of audit log OpenIDM provides.

Access Log

OpenIDM writes messages concerning access to the REST API in this log.

Default file: `openidm/audit/access.csv`

Activity Log

OpenIDM logs operations on internal (managed) and external (system) objects to this log type.

Entries in the activity log contain identifiers, both for the action that triggered the activity, and also for the original caller and the relationships between related actions.

Default file: `openidm/audit/activity.csv`

Reconciliation Log

OpenIDM logs the results of a reconciliation run, including situations and the resulting actions taken to this log type. The activity log contains details about the actions, where log entries display parent activity identifiers, `recon/`*`reconID`*.

Default file: `openidm/audit/recon.csv`

Where an action happens related to a higher level business function, the log entry points to a parent activity for that function. The relationships are hierarchical. For example, a synchronization operation could result from scheduled reconciliation for an object type. OpenIDM also logs the top level root activity with each entry, making it possible to query related activities.

18.2. Audit Log Formats

This section describes the audit log formats to help you map these to the reports you generate.

Access Log Fields

The access log includes the following information:

`"_id"`

UUID for the message object, such as `"0419d364-1b3d-4e4f-b769-555c3ca098b0"`

`"action"`

Action requested, such as `"authenticate"`

`"ip"`

IP address of the client. For access from the local host, this can appear for example as `"0:0:0:0:0:0:0:1%0"`.

`"principal"`

Principal (username) requesting the operation, such as `"openidm-admin"`

`"roles"`

Roles associated with the principal, such as `"[openidm-admin, openidm-authorized]"`

`"status"`

Result of the operation, such as `"SUCCESS"`

`"timestamp"`

The time that OpenIDM logged the message, in UTC format, for example `"2012-11-18T08:48:00.160Z"`

`"userid"`

The ID (`_id`) of the user requesting the operation, such as `openidm-admin`, `jdoe` or a UUID that has been generated by the server, such as `"0d7532e2-2b45-420e-b10e-c35684c633fd"`.

Activity Log Fields

The activity log includes the following information for each entry:

`"_id"`

UUID for the message object, such as `"0419d364-1b3d-4e4f-b769-555c3ca098b0"`

`"action"`

Action performed on that entry, such as `"create"`.

`"activityId"`

UUID for the activity corresponding to the UUID of the resource context

`"after"`

JSON representation of the object resulting from the activity

`"before"`

JSON representation of the object prior to the activity

`"changedFields"`

List of the fields that were changed as a result of the activity. This list takes into consideration only those fields that have been configured as `"watchedFields"` in the `conf/audit.json` file.

`"message"`

Human readable text about the activity

`"objectId"`

Object identifier, such as `"managed/user/jdoe"` or `"managed/user/38e29216-4b0e-4701-8a6f-ed8bf69692c7"`.

`"parentActionId"`

UUID of the action leading to the activity

`"passwordChanged"`

Boolean (`true` or `false`) indicating whether the action resulted in a password change.

`"requester"`

Principal requesting the operation

`"rev"`

Object revision number

`"rootActionId"`

UUID of the root cause for the activity. This matches a corresponding `"rootActionId"` in a reconciliation message.

`"status"`

Result of the operation, such as `"SUCCESS"`

`"timestamp"`

Time when OpenIDM logged the message, in UTC format, for example `"2012-11-18T08:48:00.160Z"`

Reconciliation Log Fields

Reconciliation messages include the following information:

`"_id"`

UUID for the message object, such as `"0419d364-1b3d-4e4f-b769-555c3ca098b0"`

`"action"`

Synchronization action, such as `"CREATE"`. For a list of possible actions, see Section 12.13.5, "Synchronization Actions".

`"actionID"`

The unique ID assigned to the action.

`"ambiguousTargetObjectIds"`

When the situation is AMBIGUOUS or UNQUALIFIED and OpenIDM cannot distinguish between more than one target object, OpenIDM logs the identifiers of the objects in this field in comma-separated format. This makes it possible to figure out what was ambiguous afterwards.

`"entryType"`

The type of reconciliation log entry, such as `"start"`, or `"summary"`.

`"exception"`

The stack trace of the exception, if any.

`"mapping"`

The name of the mapping used for the reconciliation (defined in `conf/sync.json`, for example `"systemLdapAccounts_managedUser"`.

`"message"`

Human readable text about the reconciliation action that was taken.

"messageDetail"

For the "summary" entry type, this field contains details about that specific stage of the reconciliation run, such as the stage name and description, start and end time, and so forth.

When script exceptions are encountered during a reconciliation run, the error details can also be stored in this property.

For script exception details to be pulled in, the script exception must take the following format:

```
"throw {
    'openidmCode' : HTTP error code,
    'message' : error message,
    'detail' : {
        details
    }
};"
```

"reconId"

UUID for the reconciliation operation, which is the same for all entries pertaining to the reconciliation run.

"reconciling"

What OpenIDM is reconciling, "source" for the first phase, "target" for the second phase

"rootActionId"

UUID of the root cause for the activity. This matches a corresponding "rootActionId" in an activity message.

"situation"

The situation encountered. For a list of possible situations, see Section 12.13.1, "Synchronization Situations".

"sourceObjectId"

The object identifier on the source system, such as "system/xmlfile/account/bjensen" or "managed/user/bjensen" (depending on the resource configured as the source in the mapping).

"status"

Result of the operation, such as "SUCCESS"

"targetObjectId"

The object identifier on the target system, such as "system/xmlfile/account/bjensen" or "managed/user/bjensen" (depending on the resource configured as the target in the mapping).

`"timestamp"`

Time when OpenIDM logged the message, in UTC format, for example `"2012-11-18T08:48:00.160Z"`

18.3. Audit Configuration

OpenIDM exposes the audit logging configuration under `https://localhost:8443/openidm/config/audit` for the REST API, and in the file `conf/audit.json` where you installed OpenIDM. A sample `conf/audit.json` configuration file follows:

```
{
    "eventTypes" : {
        "activity" : {
            "filter" : {
                "actions" : [
                    "create",
                    "update",
                    "delete",
                    "patch",
                    "action"
                ]
            },
            "watchedFields" : [ ],
            "passwordFields" : [ "password" ]
        },
        "recon" : { }
    },
    "logTo" : [
        {
            "logType" : "csv",
            "location" : "audit",
            "recordDelimiter" : ";",
            "ignoreLoggingFailures" : true
        },
        {
            "logType" : "repository",
            "useForQueries" : true,
            "ignoreLoggingFailures" : true
        }
    ],
    "exceptionFormatter" : {
        "type" : "text/javascript",
        "file" : "bin/defaults/script/audit/stacktraceFormatter.js"
    }
}
```

18.3.1. Event Types

The `eventTypes` configuration specifies what events OpenIDM writes to audit logs. OpenIDM supports the following event types: access, activity, synchronization, and reconciliation. The filter for actions under activity logging shows the actions on managed or system objects for which OpenIDM writes to the activity log.

The `filter actions` list enables you to configure the conditions that result in actions being written to the activity log.

`read`

When an object is read by using its identifier. By default, read actions are not logged. Add the `"read"` action to the list of actions to log all read actions.

Note that, due to the potential result size in the case of read operations on `system/` endpoints, only the read is logged, and not the resource detail. If you really need to log the complete resource detail, add the following line to your `conf/boot/boot.properties` file:

```
openidm.audit.logFullObjects=true
```

`create`

When an object is created.

`update`

When an object is updated.

`delete`

When an object is deleted.

`patch`

When an object is partially modified.

`query`

When a query is performed on an object. By default, query actions are not logged. Add the `"query"` action to the list of actions to log all query actions.

Note that, due to the potential result size in the case of query operations on `system/` endpoints, only the query is logged, and not the resource detail. If you really need to log the complete resource detail, add the following line to your `conf/boot/boot.properties` file:

```
openidm.audit.logFullObjects=true
```

`action`

When an action is performed on an object.

You can optionally add a `filter triggers` list that specifies the actions that are logged for a particular trigger. For example, the following addition to the `audit.json` file specifies that only `create` and `update` actions are logged for an activity that was triggered by a `recon`.

```
...
        "filter" : {
            "actions" : [
                "create",
                "update",
                "delete",
                "patch",
                "action"
            ],
            "triggers" : {
                "recon" : [
                    "create",
                    "update"
                ]
            }
        },
        "watchedFields" : [ ],
...
```

If a trigger is provided, but no actions are specified, nothing is logged for that trigger. If a trigger is omitted, all actions are logged for that trigger. In the current OpenIDM release, only the `recon` trigger is implemented. For a list of reconciliation actions that can be logged, see Section 12.13.5, "Synchronization Actions".

The `watchedFields` parameter enables you to specify a list of fields that should be "watched" for changes. When the value of one of the fields in this list changes, the change is logged in the audit log, under the column `"changedFields"`. Fields are listed in comma-separated format, for example:

```
"watchedFields" : [ "email", "address" ]
```

The `passwordFields` parameter enables you to specify a list of fields that are considered passwords. This parameter functions much like the `watchedFields` parameter in that changes to these field values are logged in the audit log, under the column `"changedFields"`. In addition, when a password field is changed, the boolean `"passwordChanged"` flag is set to `true` in the audit log. Fields are listed in comma-separated format, for example:

```
"passwordFields" : [ "password", "username" ]
```

18.3.2. Log To List

The `logTo` list enables you to specify the format of the log, where it is written, and various parameters for each log type.

`logType`

The format of the audit log. The log type can be one of the following:

- `csv` - write to a comma-separated variable format file.

  The `"location"` property indicates the name of the directory in which the file should be written, relative to the directory in which you installed OpenIDM.

Audit file names are fixed, `access.csv`, `activity.csv`, and `recon.csv`.

The `"recordDelimiter"` property enables you to specify the separator between each record.

- `repository` - write to the OpenIDM repository.

  OpenIDM stores entries under the `/openidm/repo/audit/` context. Such entries appear as `audit/access/_id`, `audit/activity/_id`, and `audit/recon/_id`, where the *_id* is the UUID of the entry, such as `0419d364-1b3d-4e4f-b769-555c3ca098b0`.

  In the OrientDB repository, OpenIDM stores log records in the `audit_access`, `audit_activity`, and `audit_recon` tables.

  In a JDBC repository, OpenIDM stores records in the `auditaccess`, `auditactivity`, and `auditrecon` tables.

  The `"useForQueries"` boolean property indicates whether the repository logger should be used to service reads and query requests. The value is `true` by default. If `"useForQueries"` is set to `false`, the CSV file is used to service read and query requests.

- `router` - enables log events to be directed to any endpoint in the system, such as `system/scriptedsql` or `endpoint/myhandler`.

  As noted with previous instances of `logType`, the `location` specifies the relative directory, and `useForQueries` defines whether the logger is used to service read and query requests.

`ignoreLoggingFailures`

In certain situations, you might want to tolerate the inability to write to an audit log and prevent an exception from being thrown if the logging fails. For example, a request for configuration data might succeed, but fail to write to the activity log. Reasons for logging failures might include full disk (for a CSV logger) or repository unavailable (for a repository logger).

For each log type, you can specify that failure to write to the log should be ignored, and should not prevent the successful execution of the underlying request. To ignore logging failures for a specific log type, add the `"ignoreLoggingFailures"` property to the log type configuration, and set its value to `true`. This parameter is not included in the default `audit.json` file, and its value is considered to be `false` by default for all log types.

You can specify a `logTo` location to the directory of your choice. The example shown in Example 6.2, "Custom Audit Log Location" shows how you can configure `logTo` to direct audit logs to a user home directory.

To review the audit log, see Section 12.7, "Querying the Reconciliation Audit Log". You can review several different ways to run a RESTful GET on audit endpoints in that section.

18.3.2.1. Logging to a Remote System

You can configure logging to a remote system. OpenIDM exposes a useful logging configuration in the openidm/samples/audit-sample directory, in the conf/audit.json configuration file. The logTo location stanza differs slightly from other versions of that file, in that it includes the following excerpt:

```
...
        "logTo" : [
    ...
            },
            {
                "logType" : "router",
                "location" : "system/auditdb",
                "useForQueries" : true
            }
     ...
```

To connect to an external JDBC database, you can use the location property, which is configured with the auditdb system.

You can then set up that connection in the conf/provisioner.openicf-scriptedsql.json file. In this particular example, that file starts with:

```
{
     "name" : "auditdb",
```

You can configure remote access in that file, in the configurationProperties stanza, in the host and jdbcConnectionUrl properties. Substitute the URL or IP address of the running remote MySQL server for localhost:

```
...
 },
     "configurationProperties" : {
     "host" : "localhost",
     "port" : "3306",
     "user" : "root",
     "password" : "password",
     "database" : "audit",
     "autoCommit" : false,
     "reloadScriptOnExecution" : false,
     "jdbcDriver" : "com.mysql.jdbc.Driver",
     "jdbcConnectionUrl" : "jdbc:mysql://localhost:3306/audit",
     "jdbcUrlTemplate" : "jdbc:mysql://%h:%p/%d",
     "createScriptFileName" : "&{launcher.project.location}/tools/CreateScript.groovy",
     "testScriptFileName" : "&{launcher.project.location}/tools/TestScript.groovy",
     "searchScriptFileName" : "&{launcher.project.location}/tools/SearchScript.groovy"
 },
    ...
```

After you change the localhost entries, start OpenIDM with the configuration associated with your audit configuration. The following command is based on the openidm/samples/audit-sample that comes with OpenIDM.

```
$ ./setup.sh -p samples/audit-sample
```

18.3.3. Exception Formatter

The `exceptionFormatter` property specifies the name and type of file that handles the formatting and display of exceptions thrown by the audit logger. Supported types include `"text/javascript"` and `"groovy"`.

The `"file"` property provides the path to the script file that performs the formatting. The default exception formatter is `"bin/defaults/script/audit/stacktraceFormatter.js"`.

18.4. Generating Reports

When generating reports from audit logs, you can correlate information from activity and reconciliation logs by matching the `"rootActionId"` on entries in both logs.

The following MySQL query shows a join of the audit activity and audit reconciliation tables using root action ID values.

```
mysql> select distinct auditrecon.activity,auditrecon.sourceobjectid,
 auditrecon.targetobjectid,auditactivity.activitydate,auditrecon.status
 from auditactivity inner join auditrecon
 auditactivity.rootactionid=auditrecon.rootactionid
 where auditrecon.activity is not null group by auditrecon.sourceobjectid;
+----------+--------------------------+---------------------+---------------------+---------+
| activity | sourceobjectid           | targetobjectid      | activitydate        | status  |
+----------+--------------------------+---------------------+---------------------+---------+
| CREATE   | system/xmlfile/account/1 | managed/user/juser   | 2012-01-17T07:59:12 | SUCCESS |
| CREATE   | system/xmlfile/account/2 | managed/user/ajensen | 2012-01-17T07:59:12 | SUCCESS |
| CREATE   | system/xmlfile/account/3 | managed/user/bjensen | 2012-01-17T07:59:12 | SUCCESS |
+----------+--------------------------+---------------------+---------------------+---------+
3 rows in set (0.00 sec)
```

18.5. Filtering Data for Audits

With OpenIDM, you can collect large amounts of data on each transaction, subdivided in several different `eventTypes`: access, activity, reconciliation, and synchronization.

In some cases, you may want to minimize the amount of data collected with one or more filters. As with other Section 18.3, "Audit Configuration" options, you can do so in the `conf/audit.json` file, based on the event type.

For example, the following entry under `eventTypes` refers to the `auditfilter.js` file to script limits to reconciliation information:

```
{
   "eventTypes" : {
       ...
       "recon" : {
           "filter" : {
               "script" : {
                   "type" : "text/javascript",
                   "file" : "auditfilter.js"
               }
           }
       }
   },
   ...
}
```

You can create a script for filtering. As it does for other scripts, OpenIDM makes the create request and the context objects available to the script. Before the audit record is written, it can be accessed as a `request.content` object. For guidance, see Section F.1, "Scripting Configuration".

For example, if you want to set up a script to log just the summary records for mapping managed users in an LDAP data store, you could include the following entry in the `auditfilter.js` script:

```
return request.content.entryType == 'summary' &&
   request.content.mapping == 'systemLdapAccounts_managedUser'
```

The script must return `true` to include the log entry; `false` to exclude it.

18.6. Purging Obsolete Audit Information

If audit records grow "excessively" large, any subsequent reconciliations and queries to audit tables may become "sluggish". In a deployment with limited resources, a lack of disk space may affect system performance.

You may have already run through the process of Section 18.5, "Filtering Data for Audits". If desired, you can also purge audit records with specific queries. Alternatively, you can also purge audit records older than a specific date, using timestamps.

OpenIDM includes a preconfigured purge script, `autoPurgeRecon.js` in the `bin/defaults/script/audit` directory. This script purges audit log entries from the repositoyr only, not from the corresponding CSV files.

You will also want to set up a schedule. For that purpose, you can find a pre-configured `schedule-autoPurgeAuditRecon.json` file in the `samples/schedules` subdirectory. You can configure that file as desired and then copy it to the `conf/` subdirectory for your deployment.

Examine the contents of the `schedule-autoPurgeAuditRecon.json` file:

```
{
   "enabled" : false,
   "type" : "cron",
   "schedule" : "0 0 */12 * * ?",
   "persisted" : true,
   "misfirePolicy" : "doNothing",
   "invokeService" : "script",
   "invokeContext" : {
      "script" : {
         "type" : "text/javascript",
         "file" : "audit/autoPurgeAuditRecon.js",
         "input" : {
            "mappings" : [ "%" ],
            "purgeType" : "purgeByNumOfReconsToKeep",
            "numOfRecons" : 1,
            "intervalUnit" : "minutes",
            "intervalValue" : 1
         }
      }
   }
}
```

For more information on the schedule-related properties in this file, see Section 12.19, "Scheduling Synchronization".

Beyond scheduling, you may also be interested in the following parameters:

input

Input information; the parameters below specify different kinds of input.

mappings

An array of mappings to prune. Each element in the array can be either a string or an object.

Strings must contain the mapping(s) name and can use "%" as a wild card value that will be used in a LIKE condition.

Objects provide the ability to specify mapping(s) to include/exclude and must be of the form:

```
{
      "include" : "mapping1",
      "exclude" : "mapping2"
```

purgeType

The type of purge to perform, Can be set to one of two values:

purgeByNumOfReconsToKeep

Uses the `deleteFromAuditReconByNumOf` function and the `numOfRecons` config variable.

purgeByExpired

Uses the `deleteFromAuditReconByExpired` function and the config variables `intervalUnit` and `intervalValue`.

num-of-recons

The number of recon summary records to keep for a given mapping, including all child records.

intervalUnit

The type of time interval when using `purgeByExpired`. Acceptable values include: `minutes`, `hours`, or `days`.

intervalValue

The value of the time interval when using `purgeByExpired`. Set to an integer value.

Once you have filtered and purged unneeded log information from the database, you can use log rotation services to limit the size of individual log files, and archive them as needed. Some log rotation services also support archiving to remote log servers. Details vary by the service and the operating system.

Chapter 19
Configuring OpenIDM to Work in a Cluster

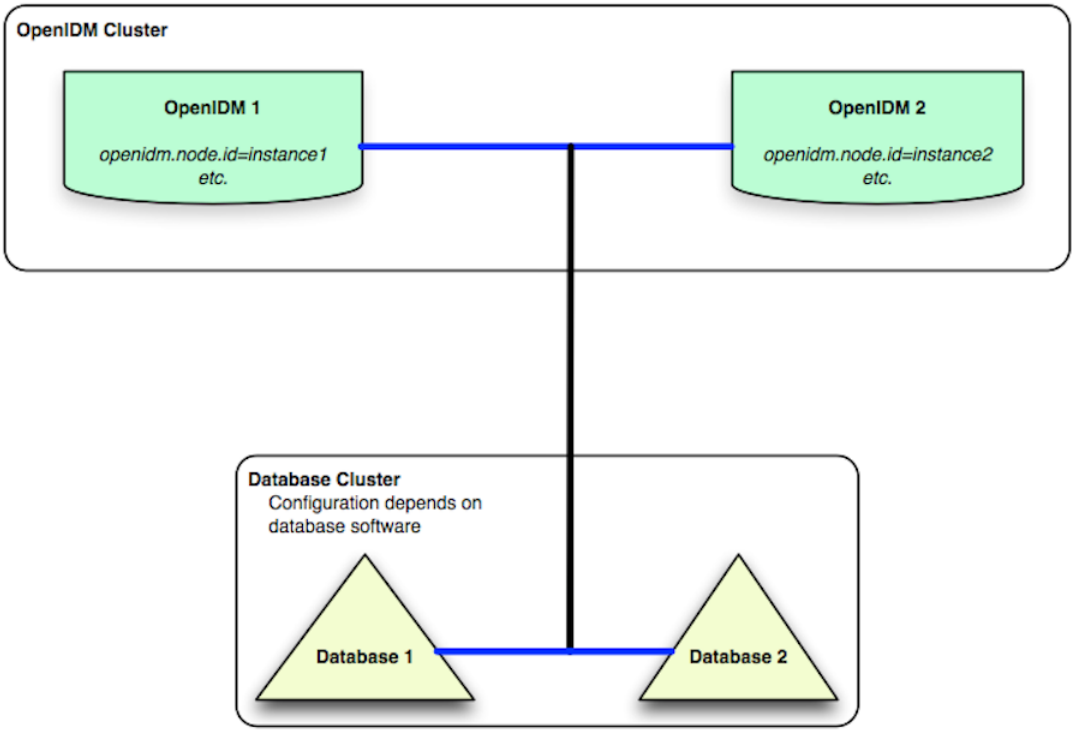
To ensure availability of the identity management service, you can deploy multiple OpenIDM instances in a cluster. In a clustered environment, all instances point to the same external database. The database itself might or might not be clustered, depending on your particular availability strategy.

In a clustered environment, if one instance of OpenIDM becomes unavailable or does not check in with the cluster management service, another instance of OpenIDM detects this situation. If the unavailable instance did not complete one or more tasks, the available instance attempts to recover and rerun those tasks.

For example, if `instance1` goes down while executing a scheduled task, the cluster manager notifies the scheduler service that `instance1` is not available. The scheduler service then attempts to clean up any jobs that `instance1` was running when it went down.

This chapter describes what changes you need to make to OpenIDM to configure multiple instances that point to a database.

The following diagram depicts a relatively simple cluster configuration. You do need to do more than just set a unique value for `openidm.node.id`



The default installation of OpenIDM is pre-configured to enable the cluster service. The `conf/cluster.json` file includes the `"enabled" : true` directive. All you need to do with multiple instances of OpenIDM on the same subnet is modify each `boot.properties` file. Pay attention to the `openidm.node.id` and `openidm.instance.type` properties in that file.

When you configure a cluster, check the configuration files for each instance of OpenIDM. Except for `boot.properties`, the configuration files should be identical.

19.1. Configuring an OpenIDM Instance as Part of a Cluster

Before you configure an instance of OpenIDM to work in a cluster, make sure that OpenIDM is stopped. If someone had previously run that instance of OpenIDM, delete the `/path/to/openidm/felix-cache` directory.

All OpenIDM instances that form part of a single cluster must be configured to use the same repository type. Note that OrientDB is not supported in production environments.

To configure an individual OpenIDM instance as a part of a clustered deployment, follow these steps.

1. Configure OpenIDM for a MySQL repository, as described in Chapter 4, "*Installing a Repository For Production*" in the *Installation Guide*.

   You need only import the data definition language script for OpenIDM into MySQL once, not repeatedly for each OpenIDM instance.

2. Section 19.1.1, "Edit the Boot Configuration"

3. Section 19.1.2, "Edit the Cluster Configuration"

4. If you are using scheduled tasks, do configure persistent schedules to ensure that they fire only once across the cluster. For more information, see Section 13.2, "Configuring Persistent Schedules".

19.1.1. Edit the Boot Configuration

Each participating instance in a cluster must have its own unique node or instance ID, and must be attributed a role in the cluster. Specify these parameters in the `conf/boot/boot.properties` file of each instance.

- Specify a unique identifier for the instance, such as:

  ```
  openidm.node.id=instance1
  ```

  On subsequent instances, the `openidm.node.id` can be set to `instance2`, `instance3`, and so forth. You can choose any value, as long as it is unique within the cluster.

  In the cluster manager configuration file, `cluster.json`, the clustering service is enabled by default with the following setting:

  ```
  "enabled": true
  ```

  The cluster manager specifies the OpenIDM instance ID from the `boot.properties` file as follows:

  ```
  "instanceId" : "&{openidm.node.id}",
  ```

  The scheduler uses the instance ID to claim and execute pending jobs. If multiple nodes have the same instance ID, problems will arise with multiple nodes attempting to execute the same scheduled jobs.

  The cluster manager requires nodes to have unique IDs to ensure that it is able to detect when a node becomes unavailable.

- Specify the instance type in the cluster.

On the primary instance, revise the following line in the `boot.properties` file as follows:

```
openidm.instance.type=clustered-first
```

On subsequent instances, revise the following line in the `boot.properties` file as follows:

```
openidm.instance.type=clustered-additional
```

The instance type is used during the setup process. When the primary node has been configured, additional nodes are bootstrapped with the security settings (keystore and truststore) of the primary node. After all nodes have been configured, they are all considered equal in the cluster, that is, there is no concept of a "master" node.

If no instance type is specified, the default value for this property is `openidm.instance.type=standalone`, which indicates that the instance will not be part of a cluster.

19.1.2. Edit the Cluster Configuration

The cluster configuration file is `/path/to/openidm/conf/cluster.json`. To enable a cluster, you should not have to make changes to this file:

```
{
 "instanceId" : "&{openidm.node.id}",
 "instanceTimeout" : "30000",
 "instanceRecoveryTimeout" : "30000",
 "instanceCheckInInterval" : "5000",
 "instanceCheckInOffset" : "0",
 "enabled" : true
 }
```

- The `instanceId` is set to the value of `openidm.node.id`, as configured in the `conf/boot/boot.properties` file.
- `instanceTimeout` specifies the length of time (in milliseconds) that an instance can be "down" before the instance is considered to be in recovery mode.

  Recovery mode implies that the `instanceTimeout` of an instance has expired, and that another instance of OpenIDM in the cluster has detected that event. That second instance of OpenIDM is now attempting to *recover* the instance. The logic behind the recovery mechanism differs, depending on the component within OpenIDM. The scheduler component has well-defined recovery logic, and attempts to move any jobs that had been acquired by the unavailable instance back into the pool of waiting jobs.
- `instanceRecoveryTimeout` specifies the length of time (in milliseconds) that an instance can be in recovery mode before that instance is considered to be offline.

  The purpose of the recovery timeout is to prevent an instance from attempting to recover an unavailable instance indefinitely.

- `instanceCheckInInterval` specifies the frequency (in milliseconds) that this instance checks in with the cluster manager to indicate that it is still online.
- `instanceCheckInOffset` specifies an offset (in milliseconds) for the checkin timing, per instance, when a number of instances in a cluster are started simultaneously.

  Specifying a checkin offset prevents a situation in which all the instances in a cluster check in at the same time, and place a strain on the cluster manager resource.
- `enabled` notes whether or not the clustering service should be enabled when you start OpenIDM.

If the default cluster configuration is not suitable for your deployment, edit the `cluster.json` file for each instance.

19.2. Managing Scheduled Tasks Across a Cluster

In a clustered environment, the scheduler service looks for pending jobs and handles them as follows:

- Non-persistent (in-memory) jobs will fire on each node in the cluster.
- Persistent scheduled jobs are picked up and executed by a single node in the cluster.
- Jobs that are configured as persistent but *not concurrent* will fire only once across the cluster and will not fire again at the scheduled time, on the same node, or on a different node, until the current job has completed.

  For example, a reconciliation operation that runs for longer than the time between scheduled intervals will not trigger a duplicate job while it is still running.

The order in which nodes in a cluster claim jobs is random. If a node goes down, the cluster manager will automatically fail over jobs that have been claimed by that node, but not yet started. For example, if node A claims a job but does not start it, and then goes down, node B can reclaim that job. If node A claims and job, starts it, and then goes down, the job cannot be reclaimed by another node in the cluster. That specific job will never be completed. Instance B can claim the next iteration (or scheduled occurrence) of the job.

Note that this failover behavior is different to the behavior in OpenIDM 2.1.0, in which an unavailable node would need to come up again to free a job that it had already claimed.

If a number of changes are made as a result of a LiveSync action, a single instance will claim the action, and will process all the changes related to that action.

To prevent a specific instance from claiming pending jobs, `"executePersistentSchedules"` should be set to `false` in the scheduler configuration for that instance. Because all nodes in a cluster read their configuration from a single repository you must use token substitution, via the `boot.properties` file, to define a specific scheduler configuration for each node.

So, if you want certain nodes to participate in processing clustered schedules (such as LiveSync) and other nodes not to participate, you can specify this information in the `conf/boot/boot.properties` file of each node. For example, to prevent a node from participating, add the following line to the `boot.properties` file of that node:

```
execute.clustered.schedules=false
```

The initial scheduler configuration that is loaded into the repository must point to the relevant property in `boot.properties`. So, the initial `scheduler.json` file would include a token such as the following:

```
{
    "executePersistentSchedules" : "&{execute.clustered.schedules}",
}
```

You do not want to allow changes to a configuration file to overwrite the global configuration in the repository. To prevent this, start each instance of OpenIDM and then disable the file-based configuration view in a clustered deployment. For more information, see Section 6.3.2, "Disabling Automatic Configuration Updates".

19.3. Managing Nodes Over REST

You can manage clusters and individual nodes over the REST interface, at the URL `https://localhost:8443/openidm/cluster/`. The following sample REST commands demonstrate the cluster information that is available over REST.

Example 19.1. Displaying the Nodes in the Cluster

The following REST request displays the nodes configured in the cluster, and their status.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/cluster"

{
  "results": [
    {
      "shutdown": "",
      "startup": "2013-10-28T11:48:29.026+02:00",
      "instanceId": "instance1",
      "state": "running"
    },
    {
      "shutdown": "",
      "startup": "2013-10-28T11:51:31.639+02:00",
      "instanceId": "instance2",
      "state": "running"
    }
  ]
}
```

Example 19.2. Checking the State of an Individual Node

To check the status of a specific node, include its instance ID in the URL, for example:

```
$  curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/cluster/instance1"

{
  "results": {
    "shutdown": "",
    "startup": "2013-10-28T11:48:29.026+02:00",
    "instanceId": "instance1",
    "state": "running"
  }
}
```

Chapter 20
Sending Email

This chapter shows you how to configure the outbound email service, so that you can send email through OpenIDM either by script or through the REST API.

Procedure 20.1. To Set Up Outbound Email

The outbound email service relies on a configuration object to identify the email account used to send messages. A sample configuration is provided in `/path/to/openidm/samples/misc/external.email.json`. To set up the external email service, follow these steps.

1. Shut down OpenIDM.

2. Copy the sample configuration to the `conf` directory.

```
$ cd /path/to/openidm/
$ cp samples/misc/external.email.json conf/
```

3. Edit `external.email.json` to reflect the account that is used to send messages.

```
{
        "host" : "smtp.example.com",
        "port" : "25",
        "username" : "openidm",
        "password" : "secret12",
        "mail.smtp.auth" : "true",
        "mail.smtp.starttls.enable" : "true"
}
```

OpenIDM encrypts the password you provide.

Follow these hints when editing the configuration.

`"host"`

SMTP server host name or IP address. This can be `"localhost"` if the server is on the same system as OpenIDM.

`"port"`

SMTP server port number such as 25, or 587 `"username"`

Mail account user name needed when `"mail.smtp.auth" : "true"`

`"password"`

Mail account user password needed when `"mail.smtp.auth" : "true"`

`"mail.smtp.auth"`

If `"true"`, use SMTP authentication

`"mail.smtp.starttls.enable"`

If `"true"`, use TLS

`"from"`

Optional default `From:` address

4. Start up OpenIDM.
5. Check that the email service is active.

```
-> scr list
...
[   6] [active       ] org.forgerock.openidm.external.email
...
```

Note

The REST call described in the section that follows may use the local SMTP server. For a "quick and dirty" test, you could use the default port, disable authentication, and TLS:

```
"host" : "localhost",
"port" : "25,
"username" : "xxxxxx",
"password" : "xxxxxx",
"mail.smtp.auth" : "false",
"mail.smtp.starttls.enable" : "false"
```

20.1. Sending Mail Over REST

Although you are more likely to send mail from a script in production, you can send email using the REST API by sending an HTTP POST to `/openidm/external/email` in order to test that your configuration works. You pass the message parameters as POST parameters, URL encoding the content as necessary.

The following example sends a test email using the REST API.

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '{"from":"openidm@example.com",
   "to":"admin@example.com",
   "subject":"Test",
   "body":"Test"}' \
 "https://localhost:8443/openidm/external/email?_action=send"
```

20.2. Sending Mail From a Script

You can send email by using the resource API functions with the `external/email` context, as in the following example, where `params` is an object that contains the POST parameters. For more information on the resource API functions, see Section F.3, "Function Reference".

```
var params =  new Object();
params.from = "openidm@example.com";
params.to = "admin@example.com";
params.cc = "wally@example.com,dilbert@example.com";
params.subject = "OpenIDM recon report";
params.type = "text/html";
params.body = "<html><body><p>Recon report follows...</p></body></html>";

openidm.action("external/email", "send", params);
```

OpenIDM supports the following POST parameters.

`from`

Sender mail address

`to`

Comma-separated list of recipient mail addresses

`cc`

Optional comma-separated list of copy recipient mail addresses

`bcc`

Optional comma-separated list of blind copy recipient mail addresses

`subject`

Email subject

`body`

Email body text

`type`

Optional MIME type. One of `"text/plain"`, `"text/html"`, or `"text/xml"`.

Chapter 21
Accessing External REST Services

You can access remote REST services by using the `openidm/external/rest` endpoint, or by specifying the `external/rest` resource in your scripts. Note that this service is not intended as a full connector to synchronize or reconcile identity data, but as a way to make dynamic HTTP calls as part of the OpenIDM logic. For more declarative and encapsulated interaction with remote REST services, and for synchronization or reconciliation operations, you should rather use the scripted REST connector.

An external REST call via a script might look something like the following:

```
openidm.action("external/rest", "call", params);
```

The `"call"` parameter specifies the action name to be used for this invocation, and is the standard method signature for the `openidm.action` method in OpenIDM 3.1.

An external REST call over REST might look something like the following:

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '{
  "url": "http://www.december.com/html/demo/hello.html",
  "method": "GET",
  "detectResultFormat": false,
  "headers": { "custom-header": "custom-header-value" }
  }' \
 "https://localhost:8443/openidm/external/rest?_action=call"
{
  "body": "<!DOCTYPE html PUBLIC \"-//IETF//DTD HTML 2.0//EN\">\r\n
           <html>\r\n
           <head>\r\n
           <title>\r\n   Hello World Demonstration Document\r\n  </title>\r\n
           </head>\r\n
           <body>\r\n
           <h1>\r\n   Hello, World!\r\n  </h1>
           …
           </html>\r\n",
  "headers": {
    "Server": "Apache",
    "ETag": "\"299-4175ff09d1140\"",
    "Date": "Mon, 28 Jul 2014 08:21:25 GMT",
    "Content-Length": "665",
    "Last-Modified": "Thu, 29 Jun 2006 17:05:33 GMT",
    "Keep-Alive": "timeout=15, max=100",
```

```
    "Content-Type": "text/html",
    "Connection": "Keep-Alive",
    "Accept-Ranges": "bytes"
  }
}
```

Note that attributes in the POST body *do not* have underscore prefixes. This is different to the OpenIDM 2.1 implementation, in which underscores were required.

HTTP 2xx responses are represented as regular, successful responses to the invocation. All other responses, including redirections, are returned as exceptions, with the HTTP status code in the exception `"code"`, and the response body in the exception `"detail"`, within the "content" element.

21.1. Invocation Parameters

The following parameters are passed in the resource API parameters map. These parameters can override the static configuration (if present) on a per-invocation basis.

- `url`. The target URL to invoke, in string format.
- `method`. The HTTP action to invoke, in string format.

  Possible actions include `"POST"`, `"GET"`, `"PUT"`, `"DELETE"`, `"HEAD"` and `"OPTIONS"`.
- `authenticate`. The authentication type, and the details with which to authenticate.

  OpenIDM 3.1 supports the following authentication types:

  - `basic` authentication, with a username and password, for example:

    ```
    "authenticate" : {"type": "basic", "user" : "john", "password" : "Passw0rd"}
    ```
  - `bearer` authentication, which takes an OAuth `token`, instead of a username and password, for example:

    ```
    "authenticate" : {"type": "bearer", "token" : "ya29.iQDWKpn8AHy09p....."}
    ```

  If no `authenticate` parameter is specified, no authentication is used.
- `headers`. The HTTP headers to set, in a map format from string (*header-name*) to string (*header-value*). For example, `Accept-Language: en-US`.
- `content-type`. The media type of the data that is sent, for example `Content-Type: application/json` or `Content-Type: application/xml`.
- `body`. The body/resource representation to send (for PUT and POST operations), in string format.
- `detectResultFormat`. Specifies whether JSON or non-JSON results are expected. Boolean, defaults to `true`.

For all responses other than 2xx, the result is returned as an exception, with the HTTP code in the exception `"code"`. Any details are returned in the exception `"detail"` under the `"content"` element. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '{
     "url":"http://december.com/non_existing_page",
     "method":"GET",
     "content-type":"application/xml"
   }' \
 "https://localhost:8443/openidm/external/rest?_action=call"
{
    "detail": {
        "content": "<html><head><title>December Communications, Inc. Missing Page</title> (...) </html>
\n"
    },
    "message": "Error while processing GET request: Not Found",
    "reason": "Not Found",
    "code": 404
}
```

For more information about non-JSON results, see Section 21.2, "Support for Non-JSON Responses".

21.2. Support for Non-JSON Responses

The external REST service supports any arbitrary payload (currently in stringified format). The `"detectResultFormat"` parameter specifies whether the server should attempt to detect the response format and, if the format is known, parse that format.

Currently, the only known response format is JSON. So, if the service that is requested returns results in JSON format, and `"detectResultFormat"` is set to `true` (the default), the response from the call to external/rest will be the identical JSON data that was returned from the remote system. This enables JSON clients to interact with the external REST service with minimal changes to account for in the response.

If the service returns results in JSON format and `"detectResultFormat"` is set to `false`, results are represented as a stringified entry.

If `"detectResultFormat"` is set to `true` and the mime type is not recognized (currently any type other than JSON) the result is the same as if `"detectResultFormat"` were set to `false`. Set `"detectResultFormat"` to `false` if the remote system returns non-JSON data, or if you require details in addition to the literal JSON response body (for example, if you need to access a specific response header, such as a cookie).

The representation as parsed JSON differs from the stringified format as follows:

- The parsed JSON representation returns the message payload directly in the body, with no wrapper. Currently, for parsed JSON responses, additional meta-data is not returned in the body. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '{
     "url": "http://localhost:8080/openidm/info/ping",
     "method": "GET",
     "detectResultFormat": true,
     "headers": { "X-OpenIDM-Username": "anonymous", "X-OpenIDM-Password": "anonymous" }
   }' \
 "https://localhost:8443/openidm/external/rest?_action=call"
{
  "shortDesc": "OpenIDM ready",
  "state": "ACTIVE_READY"
}
```

- The stringified format includes a wrapper that represents other meta-data, such as returned headers. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '{
     "url": "http://localhost:8080/openidm/info/ping",
     "method": "GET",
     "detectResultFormat": false,
     "headers": { "X-OpenIDM-Username": "anonymous", "X-OpenIDM-Password": "anonymous" }
   }' \
 "https://localhost:8443/openidm/external/rest?_action=call"
{
  "body": "{\"state\":\"ACTIVE_READY\",\"shortDesc\":\"OpenIDM ready\"}",
  "headers": {
    "Cache-Control": "no-cache",
    "Server": "Jetty(8.y.z-SNAPSHOT)",
    "Content-Type": "application/json;charset=UTF-8",
    "Set-Cookie": "session-jwt=eyAiYWxn...-cQ.3QT4zT4ZZTj8LH8Oo_zx3w;Path=/",
    "Expires": "Thu, 01 Jan 1970 00:00:00 GMT",
    "Content-Length": "52",
    "Vary": "Accept-Encoding, User-Agent"
  }
}
```

A sample non-JSON response would be similar:

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
```

```
 --request POST \
 --data '{
     "url":"http://december.com",
     "method":"GET",
     "content-type":"application/xml",
     "detectResultFormat":false
   }' \
 "https://localhost:8443/openidm/external/rest?_action=call"
{
  "body": "<!DOCTYPE HTML PUBLIC \"-//W3C//DTD HTML 4.01 Transitional//EN\"
          \"http://www.w3.org/TR/html4/loose.dtd\"> \n
          <html><head><title>December Communications, Inc.
          december.com</title>\n
          <meta http-equiv=\"Content-Type\" content=\"text/html;
          charset=iso-8859-1\">
          ..."
  "headers": {
  "Server": "Apache",
  "ETag": "\"4c3c-4f06c64da3980\"",
  "Date": "Mon, 28 Jul 2014 19:16:33 GMT",
  "Content-Length": "19516",
  "Last-Modified": "Mon, 20 Jan 2014 20:04:06 GMT",
  "Keep-Alive": "timeout=15, max=100",
  "Content-Type": "text/html",
  "Connection": "Keep-Alive",
  "Accept-Ranges": "bytes"
  }
}
```

Chapter 22
OpenIDM Project Best Practices

This chapter lists points to check when implementing an identity management solution with OpenIDM.

22.1. Implementation Phases

Any identity management project should follow a set of well defined phases, where each phase defines discrete deliverables. The phases take the project from initiation to finally going live with a tested solution.

22.1.1. Initiation

The project's initiation phase involves identifying and gathering project background, requirements, and goals at a high level. The deliverable for this phase is a statement of work or a mission statement.

22.1.2. Definition

In the definition phase, you gather more detailed information on existing systems, determine how to integrate, describe account schemas, procedures, and other information relevant to the OpenIDM deployment. The deliverable for this phase is one or more documents that define detailed requirements for the project, and that cover project definition, the business case, use cases to solve, and functional specifications.

The definition phase should capture at least the following.

User Administration and Management

Procedures for managing users and accounts, who manages users, what processes look like for joiners, movers and leavers, and what is required of OpenIDM to manage users

Password Management and Password Synchronization

Procedures for managing account passwords, password policies, who manages passwords, and what is required of OpenIDM to manage passwords

Security Policy

What security policies defines for users, accounts, passwords, and access control

Target Systems

Target systems and resources with which OpenIDM must integrate. Information such as schema, attribute mappings and attribute transformation flow, credentials and other integration specific information.

Entitlement Management

Procedures to manage user access to resources, individual entitlements, grouping provisioning activities into encapsulated concepts such as roles and groups

Synchronization and Data Flow

Detailed outlines showing how identity information flows from authoritative sources to target systems, attribute transformations required

Interfaces

How to secure the REST, user and file-based interfaces, and to secure the communication protocols involved

Auditing and Reporting

Procedures for auditing and reporting, including who takes responsibility for auditing and reporting, and what information is aggregated and reported. Characteristics of reporting engines provided, or definition of the reporting engine to be integrated.

Technical Requirements

Other technical requirements for the solution such as how to maintain the solution in terms of monitoring, patch management, availability, backup, restore and recovery process. This includes any other components leveraged such as a ConnectorServer and plug-ins for password synchronization on Active Directory, or OpenDJ.

22.1.3. Design

This phase focuses on solution design including on OpenIDM and other components. The deliverables for this phase are the architecture and design documents, and also success criteria with detailed descriptions and test cases to verify when project goals have been met.

22.1.4. Build

This phase builds and tests the solution prior to moving the solution into production.

22.1.5. Production

This phase deploys the solution into production until an application steady state is reached and maintenance routines and procedures can be applied.

Chapter 23
Troubleshooting

When things are not working check this chapter for tips and answers.

23.1. OpenIDM Stopped in Background

When you start OpenIDM in the background without having disabled the text console, the job can stop immediately after startup.

```
$ ./startup.sh &
[2] 346
$ ./startup.sh
Using OPENIDM_HOME:   /path/to/openidm
Using OPENIDM_OPTS:   -Xmx1024m -Xms1024m
Using LOGGING_CONFIG:
 -Djava.util.logging.config.file=/path/to/openidm/conf/logging.properties
Using boot properties at /path/to/openidm/conf/boot/boot.properties
->

[2]+  Stopped                 ./startup.sh
```

To resolve this problem, make sure you remove `openidm/bundle/org.apache.felix.shell.tui-1.4.1.jar` before starting OpenIDM, and also remove Felix cache files in `openidm/felix-cache/`.

23.2. Internal Server Error During Reconciliation or Synchronization

You might see an error message such as the following returned from reconciliation or synchronization.

```
{
    "error": "Conflict",
    "description": "Internal Server Error:
        org.forgerock.openidm.sync.SynchronizationException:
        Cowardly refusing to perform reconciliation with an
        empty source object set: Cowardly refusing to perform
        reconciliation with an empty source object set"
}
```

This error can be misleading. This usually means the connector is not able to communicate with the target source.

Check the settings for your connector. For example, with the XML connector you get this error if the filename for the source is invalid. With the LDAP connector, you can get this error if your connector cannot contact the target LDAP server.

23.3. The scr list Command Shows Sync Service As Unsatisfied

You might encounter this message in the logs.

```
WARNING: Loading configuration file /path/to/openidm/conf/sync.json failed
org.forgerock.openidm.config.InvalidException:
 Configuration for org.forgerock.openidm.sync could not be parsed and may not
     be valid JSON : Unexpected character ('}' (code 125)): expected a value
     at [Source: java.io.StringReader@3951f910; line: 24, column: 6]
 at org.forgerock.openidm.config.crypto.ConfigCrypto.parse...
 at org.forgerock.openidm.config.crypto.ConfigCrypto.encrypt...
 at org.forgerock.openidm.config.installer.JSONConfigInstaller.setConfig...
```

This indicates a syntax error in `openidm/conf/sync.json`. After fixing your configuration, change to the `/path/to/openidm/` directory, and use the **cli.sh validate** command to check that your configuration files are valid.

```
$ cd /path/to/openidm ; ./cli.sh validate
Using boot properties at /path/to/openidm/conf/boot/boot.properties
...................................................................
[Validating] Load JSON configuration files from:
[Validating]  /path/to/openidm/conf
[Validating] audit.json .................................. SUCCESS
[Validating] authentication.json ......................... SUCCESS
[Validating] managed.json ................................ SUCCESS
[Validating] provisioner.openicf-xml.json ................ SUCCESS
[Validating] repo.orientdb.json .......................... SUCCESS
[Validating] router.json ................................. SUCCESS
[Validating] scheduler-reconcile_systemXmlAccounts_managedUser.json  SUCCESS
[Validating] sync.json ................................... SUCCESS
```

23.4. JSON Parsing Error

You might encounter this error message in the logs.

```
"Configuration for org.forgerock.openidm.provisioner.openicf could not be
 parsed and may not be valid JSON : Unexpected character ('}' (code 125)):
 was expecting double-quote to start field name"
```

The error message usually indicates the precise point where the JSON file has the syntax problem. The error above was caused by an extra comma in the JSON file, `{"attributeName":{},{},}`. The second comma is redundant.

The situation usually results in the service that the specific JSON file configures being left in the `unsatisfied` state.

After fixing your configuration, change to the `/path/to/openidm/` directory, and use the **cli.sh validate** command to check that your configuration files are valid.

23.5. System Not Available

OpenIDM throws the following error as a result of a reconciliation where the source systems configuration can not be found.

```
{
    "error": "Conflict",
    "description": "Internal Server Error:
        org.forgerock.openidm.sync.SynchronizationException:
        org.forgerock.openidm.objset.ObjectSetException:
        System: system/HR/account is not available.:
        org.forgerock.openidm.objset.ObjectSetException:
        System: system/HR/account is not available.:
        System: system/HR/account is not available."
}
```

This error occurs when the `"name"` property value in `provisioner.resource.json` is changed from `HR` to something else.

The same error occurs when a provisioner configuration fails to load due to misconfiguration, or when the path to the data file for a CSV or XML connector is incorrectly set.

23.6. Bad Connector Host Reference in Provisioner Configuration

You might see the following error when a provisioner configuration loads.

```
Wait for meta data for config org.forgerock.openidm.provisioner.openicf-scriptedsql
```

In this case the configuration fails to load because information is missing. One possible cause is an incorrect value for `connectorHostRef` in the provisioner configuration file.

For local Java connector servers, the following rules apply.

- If the connector .jar is installed as a bundle under `openidm/bundle`, then the value must be `"connectorHostRef" : "osgi:service/org.forgerock.openicf.framework.api.osgi.ConnectorManager",`.

- If the connector .jar is installed as a connector under `openidm/connectors`, then the value must be `"connectorHostRef" : "#LOCAL",`.

23.7. Missing Name Attribute

In this case, the situation in the audit recon log shows "NULL".

A missing name attribute error, followed by an `IllegalArgumentException`, points to misconfiguration of the correlation rule, with the correlation query pointing to the external system. Such queries usually reference the "name" field which, if empty, leads to the error below.

```
Jan 20, 2012 1:59:58 PM
 org.forgerock.openidm.provisioner.openicf.commons.AttributeInfoHelper build
SEVERE: Failed to build name attribute out of [null]
Jan 20, 2012 1:59:58 PM
 org.forgerock.openidm.provisioner.openicf.impl.OpenICFProvisionerService query
SEVERE: Operation [query, system/ad/account] failed with Exception on system
 object: java.lang.IllegalArgumentException: Attribute value must be an
 instance of String.
Jan 20, 2012 1:59:58 PM org.forgerock.openidm.router.JsonResourceRouterService
 handle
WARNING: JSON resource exception
org.forgerock.json.resource.JsonResourceException: IllegalArgumentException
 at org.forgerock.openidm.provisioner....OpenICFProvisionerService.query...
 at org.forgerock.openidm.provisioner.....OpenICFProvisionerService.handle...
 at org.forgerock.openidm.provisioner.impl.SystemObjectSetService.handle...
 at org.forgerock.json.resource.JsonResourceRouter.handle...
```

Check your `correlationQuery`. Another symptom of a broken correlation query is that the audit recon log shows a situation of "NULL", and no onCreate, onUpdate or similar scripts are executed.

Chapter 24
Advanced Configuration

OpenIDM is a highly customizable, extensible identity management system. For the most part, the customization and configuration required for a "typical" deployment is described earlier in this book. This chapter describes advanced configuration methods that would usually not be required in a deployment, but that might assist in situations that require a high level of customization.

24.1. Advanced Startup Configuration

A customizable startup configuration file (named `launcher.json`) enables you to specify how the OSGi Framework is started. You specify the startup configuration file with the `-c` option of the **startup** command.

Unless you are working with a highly customized deployment, you should not modify the default framework configuration.

If no configuration file is specified, the default configuration (defined in `/path/to/openidm/bin/launcher.json`) is used. The following command starts OpenIDM with an alternative startup configuration file:

```
$ ./startup.sh -c /Users/admin/openidm/bin/launcher.json
```

You can modify the default startup configuration file to specify a different startup configuration.

The customizable properties of the default startup configuration file are as follows:

- `"location" : "bundle"` - resolves to the install location. You can also load OpenIDM from a specified zip file (`"location" : "openidm.zip"`) or you can install a single jar file (`"location" : "openidm-system-2.2.jar"`).
- `"includes" : "**/openidm-system-*.jar"` - the specified folder is scanned for jar files relating to the system startup. If the value of `"includes"` is `*.jar`, you must specifically exclude any jars in the bundle that you do not want to install, by setting the `"excludes"` property.
- `"start-level" : 1` - specifies a start level for the jar files identified previously.
- `"action" : "install.start"` - a period-separated list of actions to be taken on the jar files. Values can be one or more of `"install.start.update.uninstall"`.
- `"config.properties"` - takes either a path to a configuration file (relative to the project location) or a list of configuration properties and their values. The list must be in the format `"string":"string"`, for example:

```
"config.properties" :
  {
      "property" : "value"
  },
```

- `"system.properties"` - takes either a path to a `system.properties` file (relative to the project location) or a list of system properties and their values. The list must be in the format `"string":"string"`, for example:

```
"system.properties" :
  {
      "property" : "value"
  },
```

- `"boot.properties"` - takes either a path to a `boot.properties` file (relative to the project location) or a list of boot properties and their values.The list must be in the format `"string":object`, for example:

```
"boot.properties" :
  {
      "property" : true
  },
```

Appendix A. File Layout

When you unpack and start OpenIDM 3.1, you create the following files and directories. Note that the precise paths will depend on the install, project, and working directories that you have selected during startup. For more information, see Section 2.2, "Specifying the OpenIDM Startup Configuration".

`openidm/audit/`

OpenIDM audit log directory default location, created at run time, as configured in `openidm/conf/audit.json`

`openidm/audit/access.csv`

Default OpenIDM access audit log

`openidm/audit/activity.csv`

Default OpenIDM activity audit log

`openidm/audit/recon.csv`

Default OpenIDM reconciliation audit log

`openidm/audit/sync.csv`

Default OpenIDM synchronization audit log

`openidm/bin/`

OpenIDM core libraries and scripts

`openidm/bin/create-openidm-logrotate.sh`

Script to create an `openidmlog` log rotation scheduler for inclusion under `/etc/logrotate.d/`

`openidm/bin/create-openidm-rc.sh`

Script to create an `openidm` resource definition file for inclusion under `/etc/init.d/`

`openidm/bin/defaults/script`

Default scripts required to run specific services. In general, you should not modify these scripts. Instead, add customized scripts to the `openidm/script` folder.

`openidm/bin/defaults/script/audit/*.js`

Scripts related to the audit logging service.

`openidm/bin/defaults/script/auth/*.js`

Scripts related to the authentication mechanism, described in the Section 15.2, "Authentication".

`openidm/bin/defaults/script/compensate.js`

Script that provides the compensation functionality to assure or roll back reconciliation operations. For more information, see Section 12.12, "Configuring Synchronization Failure Compensation".

`openidm/bin/defaults/script/info/crypto.js`

A wrapper script for the `openidm.encrypt` function.

`openidm/bin/defaults/script/info/login.js`

Provides information about the current OpenIDM session.

`openidm/bin/defaults/script/info/ping.js`

Provides basic information about the health of an OpenIDM system

`openidm/bin/defaults/script/lib/*`

Internal libraries required by certain OpenIDM javascripts.

`openidm/bin/defaults/script/linkedView.js`

A script that returns all the records linked to a specific resource, used in reconciliation.

`openidm/bin/defaults/script/policy.js`

Defines each policy and specifies how policy validation is performed

`openidm/bin/defaults/script/policyFilter.js`

Enforces policy validation

`openidm/bin/defaults/script/roles/*.js`

Scripts to provide the default roles functionality. For more information, see Section 8.3, "Configuring Custom Roles".

`openidm/bin/defaults/script/router-authz.js`

Provides the functions that enforce access rules

`openidm/bin/defaults/script/ui/*`

Scripts required by the UI

`openidm/bin/defaults/script/workflow/*`

Default workflow scripts

`openidm/bin/felix.jar`
`openidm/bin/openidm.jar`
`openidm/bin/org.apache.felix.gogo.runtime-0.10.0.jar`
`openidm/bin/org.apache.felix.gogo.shell-0.10.0.jar`

Files relating to the Apache Felix OSGi framework

`openidm/bin/launcher.bat`
`openidm/bin/launcher.jar`
`openidm/bin/launcher.json`

Files relating to the startup configuration

`openidm/bin/LICENSE.TXT`
`openidm/bin/NOTICE.TXT`

Files relating to the Apache Software License

`openidm/bin/install-service.bat`
`openidm/bin/MonitorService.bat`
`openidm/bin/prunmgr.exe`
`openidm/bin/amd64/prunsrv.exe`
`openidm/bin/i386/prunsrv.exe`
`openidm/bin/ia64/prunsrv.exe`

Files required by the user interface to monitor and configure installed services

`openidm/bin/startup/`
`openidm/bin/startup/OS X - Run OpenIDM In Background.command`
`openidm/bin/startup/OS X - Run OpenIDM In Terminal Window.command`
`openidm/bin/startup/OS X - Stop OpenIDM.command`

Clickable commands for Mac OS X

`openidm/bin/workflow/`

Files related to the Activiti workflow engine

`openidm/bundle/`

OSGi bundles and modules required by OpenIDM. Upgrade can install new and upgraded bundles here.

`openidm/cli.bat`
`openidm/cli.sh`

Management commands for operations such as validating configuration files

`openidm/conf/`

OpenIDM configuration files, including .properties files and JSON files. You can also access JSON views through the REST interface.

`openidm/conf/audit.json`

Audit event publisher configuration file

`openidm/conf/authentication.json`

Authentication configuration file for access to the REST API

`openidm/conf/boot/boot.properties`

OpenIDM bootstrap properties

`openidm/conf/cluster.json`

Configuration file to enable use of this OpenIDM instance in a cluster

`openidm/conf/config.properties`

Felix and OSGi bundle configuration properties

`openidm/conf/endpoint-*.json`

Endpoint configuration files required by the UI for the default workflows

`openidm/conf/info-*.json`

Configuration files for the info service, described in Section 2.3, "Obtaining Information About an OpenIDM Instance".

`openidm/conf/jetty.xml`

Jetty configuration controlling access to the REST interface `openidm/conf/logging.properties`

OpenIDM log configuration properties

`openidm/conf/managed.json`

Managed object configuration file

`openidm/conf/policy.json`

Default policy configuration

`openidm/conf/process-access.json`

Workflow access configuration

`openidm/conf/repo.orientdb.json`

OrientDB internal repository configuration file

`openidm/conf/router.json`

Router service configuration file

`openidm/conf/scheduler.json`

Scheduler service configuration

`openidm/conf/script.json`

Script configuration file with default script directories.

`openidm/conf/servletfilter-*.json`

Sample servlet filter configuration, described in Section H.3, "Registering Additional Servlet Filters".

`openidm/conf/system.properties`

System configuration properties used when starting OpenIDM services

`openidm/conf/ui-configuration.json`

Main configuration file for the browser-based user interface

`openidm/conf/ui-countries.json`

Configurable list of countries available when registering users in the user interface

`openidm/conf/ui-secquestions.json`

Configurable list of security questions available when registering users in the user interface

openidm/conf/ui-themeconfig.json

Customizable UI theme configuration file

openidm/conf/ui.context-enduser.json

Configuration file that specifies the context root of the UI, `/openidmui` by default

openidm/conf/workflow.json

Configuration of the Activiti workflow engine

openidm/connectors/

OpenICF connector libraries. OSGi enabled connector libraries can also be stored in `openidm/bundle/`.

openidm/db/

Internal repository files, including OrientDB files and sample repository configurations for JDBC-based repositories.

openidm/db/db2

Sample repository configuration and data definition language script for DB2 database.

openidm/db/h2

Sample repository configuration and data definition language script for H2 database, supported for Activiti engine.

openidm/db/mssql

Sample repository configuration, data definition language script, and `bnd` file (for creating OSGi bundle) for configuring an MS SQL repository. For more information, see Section 4.2, "To Set Up OpenIDM With MS SQL" in the *Installation Guide*.

openidm/db/mysql

Sample repository configuration and data definition language scripts for configuring a MySQL repository. For more information, see Section 4.1, "To Set Up OpenIDM With MySQL" in the *Installation Guide*.

openidm/db/oracle

Sample repository configuration and data definition language script for configuring an OracleDB repository. For more information, see Section 4.3, "To Set Up OpenIDM With Oracle Database" in the *Installation Guide*.

`openidm/db/postgresql`

Sample repository configuration, data definition language script, and schema optimization scripts for configuring a PostgreSQL repository. For more information, see Section 4.4, "To Set Up OpenIDM With PostgreSQL" in the *Installation Guide*.

`openidm/db/util`

Files required for support of OrientDB Studio.

`openidm/felix-cache/`

Bundle cache directory created when the Felix framework is started

`openidm/lib`

Location in which third-party libraries (required, for example, by custom connectors) should be placed.

`openidm/logs/`

OpenIDM service log directory

`openidm/logs/openidm0.log.*`

OpenIDM service log files as configured in `openidm/conf/logging.properties`

`openidm/samples/`

OpenIDM sample configurations

`openidm/samples/audit-sample/`

Sample demonstrates configuring a MySQL database to receive the audit logs for access, activity, and recon.

`openidm/samples/customendpoint/`

Sample custom endpoint configuration. For more information, see Section 6.6, "Adding Custom Endpoints".

`openidm/samples/infoservice/`

Sample that shows how to use the configurable information service. For more information, see Section 2.3, "Obtaining Information About an OpenIDM Instance".

`openidm/samples/misc/`

Sample configuration files

`openidm/samples/provisioners/`

Sample connector configuration files

`openidm/samples/sample1/`

XML file connector sample

`openidm/samples/sample2/`

One-way reconciliation sample using OpenDJ and LDAP connector

`openidm/samples/sample2b/`

Bi-directional reconciliation sample using OpenDJ and LDAP connector

`openidm/samples/sample2c/`

Sample using LDAP connector to synchronize LDAP group membership

`openidm/samples/sample2d/`

>Sample using LDAP connector to synchronize LDAP groups

`openidm/samples/sample3/`

Scripted SQL connector sample for MySQL

`openidm/samples/sample4/`

Sample demonstrating synchronization between two external resources (CSV and XML) without using the OpenIDM internal repository

`openidm/samples/sample5/`

LDAP to OpenIDM to Active Directory attribute flow sample using XML resources rather than actual directories

`openidm/samples/sample5b/`

Similar to sample 5 but also configures a compensation script that attempts to ensure either all the synchronization or none of the synchronization is performed

`openidm/samples/sample6/`

LiveSync and reconciliation sample for use with two LDAP servers, using Active Directory and OpenDJ

`openidm/samples/sample7/`

Sample exposing identities with a SCIM-line schema

`openidm/samples/sample8/`

Sample demonstrating logging in scripts

`openidm/samples/sample9/`

Sample demonstrating how to perform an asynchronous action from a reconciliation

`openidm/samples/schedules/`

Sample schedule configuration files

`openidm/samples/security/`

Sample keystore, truststore, and certificates

`openidm/samples/syncfailure/`

Sample showing the sync failure handler for liveSync

`openidm/samples/taskscanner/`

Sample sunset scanning task. For more information, see Section 13.5, "Scanning Data to Trigger Tasks".

`openidm/samples/workflow/`

Typical use case of a workflow for provisioning

`openidm/samples/usecase/*`

Several workflow samples to demonstrate common use cases

`openidm/script/`

OpenIDM location for script files referenced in the configuration

`openidm/script/access.js`

Default authorization policy script

`openidm/security/`

OpenIDM security configuration, keystore, and truststore

`openidm/shutdown.sh`

Script to shutdown OpenIDM services based on the process identifier

`openidm/startup.bat`

Script to start OpenIDM services on Windows

`openidm/startup.sh`

Script to start OpenIDM services on UNIX `openidm/ui/default/*`

Default OpenIDM graphical UI files

`openidm/ui/extension/*`

Location for any UI customizations

`openidm/workflow/`

OpenIDM location for BPMN 2.0 workflows and .bar files

Appendix B. Ports Used

By default, OpenIDM 3.1 listens on the following ports (specified in the file `/path/to/openidm/conf/boot/boot.properties`):

`8080`

HTTP access to the REST API, requiring OpenIDM authentication. This port is not secure, exposing clear text passwords and all data that is not encrypted. This port is therefore not suitable for production use.

`8443`

HTTPS access to the REST API, requiring OpenIDM authentication

`8444`

HTTPS access to the REST API, requiring SSL mutual authentication. Clients that present certificates found in the truststore under `openidm/security/` are granted access to the system.

The Jetty configuration (in `openidm/conf/jetty.xml`) references the ports that are specified in the `boot.properties` file.

Appendix C. Data Models and Objects Reference

OpenIDM allows you to customize a variety of objects that can be addressed via a URL or URI, and that have a common set of functions that OpenIDM can perform on them such as CRUD, query, and action.

Depending on how you intend to use them, different objects are appropriate.

Table C.1. OpenIDM Objects

Object Type	Intended Use	Special Functionality
Managed objects	Serve as targets and sources for synchronization, and to build virtual identities.	Provide appropriate auditing, script hooks, declarative mappings and so forth in addition to the REST interface.
Configuration objects	Ideal for look-up tables or other custom configuration, which can be configured externally like any other system configuration.	Adds file view, REST interface, and so forth
Repository objects	The equivalent of arbitrary database table access. Appropriate for managing data purely through the underlying data store or repository API.	Persistence and API access
System objects	Representation of target resource objects, such as accounts, but also resource objects such as groups.	

Object Type	Intended Use	Special Functionality
Audit objects	Houses audit data in the OpenIDM internal repository.	
Links	Defines a relation between two objects.	

C.1. Managed Objects

A *managed object* in OpenIDM is an object which represents the identity-related data managed by OpenIDM. Managed objects are stored by OpenIDM in its data store. All managed objects are JSON-based data structures.

C.1.1. Managed Object Schema

Managed objects have an associated schema to enforce a specific data structure. Schema is specified using the JSON Schema specification. This is currently an Internet-Draft, with implementations in multiple programming languages.

C.1.1.1. Managed Object Reserved Properties

Top-level properties in a managed object that begin with an underscore (`_`) are reserved by OpenIDM for internal use, and are not explicitly part of its schema. Internal properties are read-only, and are ignored when provided by the REST API client.

The following properties exist for all managed objects in OpenIDM.

_id

string

The unique identifier for the object. This value forms a part of the managed object's URI.

_rev

string

The revision of the object. This is the same value that is exposed as the object's ETag through the REST API. The content of this attribute is not defined. No consumer should make any assumptions of its content beyond equivalence comparison. This attribute may be provided by the underlying data store.

_schema_id

string

The a reference to the schema object that the managed object is associated with.

_schema_rev

string

The revision of the schema that was used for validation when the object was last stored.

C.1.1.2. Managed Object Schema Validation

Schema validation is performed unequivocally whenever an object is stored, and conditionally whenever an object is retrieved from the data store and exhibits a `_schema_rev` value that differs from the `_rev` of the schema that the OpenIDM instance currently has for that managed object type. Whenever schema validation is performed, the `_schema_rev` of the object is updated to contain the `_rev` value of the current schema.

C.1.1.3. Managed Object Derived Properties

Properties can be defined to be strictly derived from other properties within the object. This allows computed and composite values to be created in the object. Whenever an object undergoes a change, all derived properties are recomputed. The values of derived properties are stored in the data store, and are not recomputed upon retrieval.

C.1.2. Data Consistency

Single-object operations shall be consistent within the scope of the operation performed, limited by capabilities of the underlying data store. Bulk operations shall not have any consistency guarantees. OpenIDM does not expose any transactional semantics in the managed object access API.

All access through the REST API uses the ETag and associated conditional headers: `If-Match`, `If-None-Match`. In operations that modify model objects, conditional headers are mandatory.

C.1.3. Managed Object Triggers

Triggers are user-definable functions that validate or modify object or property state.

C.1.3.1. State Triggers

Managed objects are resource-oriented. A set of triggers is defined to intercept the supported request methods on managed objects. Such triggers are intended to perform authorization, redact, or modify objects before the action is performed. The object being operated on is in scope for each trigger, meaning that the object is retrieved by the data store before the trigger is fired.

If retrieval of the object fails, the failure occurs before any trigger is called. Triggers are executed before any optimistic concurrency mechanisms are invoked. The reason for this is to prevent a potential attacker from getting information about an object (including its presence in the data store) before authorization is applied.

onCreate

Called upon a request to create a new object. Throwing an exception causes the create to fail.

postCreate

Called after the creation of a new object is complete.

onRead

Called upon a request to retrieve a whole object or portion of an object. Throwing an exception causes the object to not be included in the result. This method is also called when lists of objects are retrieved via requests to its container object; in this case, only the requested properties are included in the object. Allows for uniform access control for retrieval of objects, regardless of the method in which they were requested.

onUpdate

Called upon a request to store an object. The "old" and "new" objects are in-scope for the trigger. The "old" object represents a complete object as retrieved from the data store. The trigger can elect to change "new" object properties. If as a result of the trigger the object's "old" and "new" values are identical (that is, update is reverted), the update ends prematurely, though successfully. Throwing an exception causes the update to fail.

postUpdate

Called after an update request is complete.

onDelete

Called upon a request to delete an object. Throwing an exception causes the deletion to fail.

postDelete

Called after an object is deleted.

C.1.3.2. Object Storage Triggers

An object-scoped trigger applies to an entire object. Unless otherwise specified, the object itself is in scope for the trigger.

onValidate

Validates an object prior to its storage in the data store. Throws an exception in the event of a validation failure.

onStore

Called just prior to when an object is stored in the data store. Typically used to transform an object just prior to its storage (for example, encryption).

C.1.3.3. Property Storage Triggers

A property-scoped trigger applies to a specific property within an object. Only the property itself is in scope for the trigger. No other properties in the object should be accessed during execution of the trigger. Unless otherwise specified, the order of execution of property-scoped triggers is intentionally left undefined.

onValidate

Validates a given property value after its retrieval from and prior to its storage in the data store. Throws an exception in the event of a validation failure.

onRetrieve

Called in the result of a query request. Executed only when the `executeOnRetrieve` condition shows a full managed object.

onStore

Called prior to when an object is stored in the data store. Typically used to transform a given property prior to its object's storage.

C.1.3.4. Storage Trigger Sequences

Triggers are executed in the following order:

Object Retrieval Sequence

1. Retrieve the raw object from the data store
2. The `executeOnRetrieve` boolean is used to see if a full managed object is returned. The sequence continues if the boolean is set to `true`.
3. Call object `onRetrieve` trigger
4. Per-property within the object:
   - Call property `onRetrieve` trigger
   - Perform schema validation if `_schema_rev` does not match (see Section C.1.1.2, "Managed Object Schema Validation".

Object Storage Sequence

1. Per-property within the object:
   - Call property `onValidate` trigger
   - Call object `onValidate` trigger

2. Per-property trigger within the object:
   - Call property `onStore` trigger
   - Call object `onStore` trigger
   - Store the object with any resulting changes to the data store

C.1.4. Managed Object Encryption

Sensitive object properties can be encrypted prior to storage, typically through the property `onStore` trigger. The trigger has access to configuration data, which can include arbitrary attributes that you define, such as a symmetric encryption key. Such attributes can be decrypted during retrieval from the data store through the property `onRetrieve` trigger.

C.1.5. Managed Object Configuration

Configuration of managed objects is provided through an array of managed object configuration objects.

```
{
  "objects": [ managed-object-config object, ... ]
}
```

objects

array of managed-object-config objects, required

Specifies the objects that the managed object service manages.

Managed-Object-Config Object Properties

Specifies the configuration of each managed object.

```
{
  "name"      : string,
  "schema"    : json-schema object,
  "onCreate"  : script object,
  "postCreate": script object,
  "onRead"    : script object,
  "onUpdate"  : script object,
  "postUpdate": script object,
  "onDelete"  : script object,
  "postDelete": script object,
  "onValidate": script object,
  "onRetrieve": script object,
  "onStore"   : script object,
  "properties": [ property-configuration object, ... ]
}
```

name

string, required

The name of the managed object. Used to identify the managed object in URIs and identifiers.

schema

json-schema object, optional

The schema to use to validate the structure and content of the managed object. The schema-object format is specified by the JSON Schema specification.

onCreate

script object, optional

A script object to trigger when the creation of an object is being requested. The object to be created is provided in the root scope as an object property. The script may change the object. If an exception is thrown, the create aborts with an exception.

postCreate

script object, optional

A script object to trigger after an object is created, but before any targets are synchronized.

onRead

script object, optional

A script object to trigger when the read of an object is being requested. The object being read is provided in the root scope as an object property. The script may change the object. If an exception is thrown, the read aborts with an exception.

onUpdate

script object, optional

A script object to trigger when an update to an object is requested. The old value of the object being updated is provided in the root scope as an `oldObject` property. The new value of the object being updated is provided in the root scope as a `newObject` property. The script may change the `newObject`. If an exception is thrown, the update aborts with an exception.

postUpdate

script object, optional

A script object to trigger after an update to an object is complete, but before any targets are synchronized.

onDelete

script object, optional

A script object to trigger when the deletion of an object is being requested. The object being deleted is provided in the root scope as an object property. If an exception is thrown, the deletion aborts with an exception.

postDelete

script object, optional

A script object to trigger after a delete of an object is complete, but before any further synchronization.

onValidate

script object, optional

A script object to trigger when the object requires validation. The object to be validated is provided in the root scope as an object property. If an exception is thrown, the validation fails.

onRetrieve

script object, optional

A script object to trigger once an object is retrieved from the repository. The object that was retrieved is provided in the root scope as an object property. The script may change the object. If an exception is thrown, then object retrieval fails.

onStore

script object, optional

A script object to trigger when an object is about to be stored in the repository. The object to be stored is provided in the root scope as an object property. The script may change the object. If an exception is thrown, then object storage fails.

properties

array of property-config objects, optional

A list of property specifications.

Script Object Properties

```
{
  "type"  : "text/javascript",
  "source": string
 }
```

type

string, required

Specifies the type of script to be executed. Supported types include `"text/javascript"` and `"groovy"`.

source, file

string, required (only one, source or file is required)

Specifies the source code of the script to be executed (if the keyword is "source"), or a pointer to the file that contains the script (if the keyword is "file").

Property Config Properties

```
{
  "name"      : string,
  "onValidate": script object,
  "onRetrieve": script object,
  "onStore"   : script object,
  "encryption": property-encryption object,
  "scope"     : string
}
```

name

string, required

The name of the property being configured.

onValidate

script object, optional

A script object to trigger when the property requires validation. The property to be validated is provided in the root scope as the `property` property. If an exception is thrown, the validation fails.

onRetrieve

script object, optional

A script object to trigger once a property is retrieved from the repository. The property that was retrieved is provided in the root scope as the `property` property. The script may change the property value. If an exception is thrown, then object retrieval fails.

onStore

script object, optional

A script object to trigger when a property is about to be stored in the repository. The property to be stored is provided in the root scope as the `property` property. The script may change the property value. If an exception is thrown, then object storage fails.

encryption

property-encryption object, optional

Specifies the configuration for encryption of the property in the repository. If omitted or null, the property is not encrypted.

scope

string, optional

Specifies whether the property should be filtered from HTTP/external calls. The value can be either `"public"` or `"private"`. `"private"` indicates that the property should be filtered, `"public"` indicates no filtering. If no value is set, the property is assumed to be public and thus not filtered.

Property Encryption Object

```
{
  "cipher": string,
  "key"   : string
}
```

cipher

string, optional

The cipher transformation used to encrypt the property. If omitted or null, the default cipher of `"AES/CBC/PKCS5Padding"` is used.

key

string, required

The alias of the key in the OpenIDM cryptography service keystore used to encrypt the property.

C.1.6. Custom Managed Objects

Managed objects in OpenIDM are inherently fully user definable and customizable. Like all OpenIDM objects, managed objects can maintain relationships to each other in the form of links. Managed objects are intended for use as targets and sources for synchronization operations to represent domain objects, and to build up virtual identities. The name comes from the intention that OpenIDM stores and manages these objects, as opposed to system objects that are present in external systems.

OpenIDM can synchronize and map directly between external systems (system objects), without storing intermediate managed objects. Managed objects are appropriate, however, as a way to cache the data—for example, when mapping to multiple target systems, or when decoupling the availability of systems—to more fully report and audit on all object changes during reconciliation, and to build up views that are different from the original source, such as transformed and combined or virtual views. Managed objects can also be allowed to act as an authoritative source if no other appropriate source is available.

Other object types exist for other settings that should be available to a script, such as configuration or look-up tables that do not need audit logging.

C.1.6.1. Setting Up a Managed Object Type

To set up a managed object, you declare the object in the `conf/managed.json` file where OpenIDM is installed. The following example adds a simple `foobar` object declaration after the user object type.

```
{
    "objects": [
        {
            "name": "user"
        },
        {
            "name": "foobar"
        }
    ]
}
```

C.1.6.2. Manipulating Managed Objects Declaratively

By mapping an object to another object, either an external system object or another internal managed object, you automatically tie the object life cycle and property settings to the other object. For more information, see Chapter 12, "*Configuring Synchronization*".

C.1.6.3. Manipulating Managed Objects Programmatically

You can address managed objects as resources using URLs or URIs with the `managed/` prefix. This works whether you address the managed object internally as a script running in OpenIDM or externally through the REST interface.

You can use all resource API functions in script objects for create, read, update, delete operations, and also for arbitrary queries on the object set, but not currently for arbitrary actions. For more information, see Appendix F, "*Scripting Reference*".

OpenIDM supports concurrency through a multi version concurrency control (MVCC) mechanism. In other words, each time an object changes, OpenIDM assigns it a new revision.

Objects can be arbitrarily complex as long as they use supported types, such as maps, lists, numbers, strings, and booleans as defined in JSON.

C.1.6.3.1. Creating Objects

The following script example creates an object type.

```
openidm.create("managed/foobar", "myidentifier", mymap)
```

C.1.6.3.2. Updating Objects

The following script example updates an object type.

```
var expectedRev = origMap._rev
openidm.update("managed/foobar/myidentifier", expectedRev, mymap)
```

The MVCC mechanism requires that `expectedRev` be set to the expected revision of the object to update. You obtain the revision from the object's `_rev` property. If something else changes the object concurrently, OpenIDM rejects the update, and you must either retry or inspect the concurrent modification.

C.1.6.3.3. Patching Objects

You can partially update a managed object using the patch method, which changes only the specified properties of the object. OpenIDM implements the JSON patch media type version 02, described at http://tools.ietf.org/html/rfc6902.

The following script example updates an object type.

```

openidm.patch("managed/foobar/myidentifier", rev, value)
```

The patch method supports a revision of `"null"`, which effectively disables the MVCC mechanism, that is, changes are applied, regardless of revision. In the REST interface, this matches the `If-Match: "*"` condition supported by patch.

The API supports patch by query, so the caller does not need to know the identifier of the object to change.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '[{
  "operation":"replace",
  "field":"/password",
  "value":"Passw0rd"
  }]' \
 "https://localhost:8443/openidm/managed/user?_action=patch&_queryId=for-userName&uid=DDOE"
```

For the syntax on how to formulate the query `_queryId=for-userName&uid=DDOE` see Section C.1.6.3.6, "Querying Object Sets".

C.1.6.3.4. Deleting Objects

The following script example deletes an object type.

```
var expectedRev = origMap._rev
openidm.delete("managed/foobar/myidentifier", expectedRev)
```

The MVCC mechanism requires that `expectedRev` be set to the expected revision of the object to update. You obtain the revision from the object's `_rev` property. If something else changes the object concurrently, OpenIDM rejects deletion, and you must either retry or inspect the concurrent modification.

C.1.6.3.5. Reading Objects

The following script example reads an object type.

```
val = openidm.read("managed/foobar/myidentifier")
```

C.1.6.3.6. Querying Object Sets

You can query managed objects using common query filter syntax, or by configuring predefined queries in your repository configuration. The following script example queries managed user objects whose userName is Smith.

```
var qry = {
    "_queryFilter" : "/userName eq \"smith\""
};
val = openidm.query("managed/user", qry);
```

For more information, see Section 7.3, "Defining and Calling Queries".

C.1.7. Accessing Managed Objects Through the REST API

OpenIDM exposes all managed object functionality through the REST API unless you configure a policy to prevent such access. In addition to the common REST functionality of create, read, update, delete, patch, and query, the REST API also supports patch by query. For more information, see Appendix E, "*REST API Reference*".

OpenIDM requires authentication to access the REST API. Authentication configuration is shown in `openidm/conf/authentication.json`. The default authorization filter script is `openidm/script/router-authz.js`.

C.2. Configuration Objects

OpenIDM provides an extensible configuration to allow you to leverage regular configuration mechanisms.

Unlike native OpenIDM configuration, which OpenIDM interprets automatically and can start new services, OpenIDM stores custom configuration objects and makes them available to your code through the API.

For an introduction to standard configuration objects, see Chapter 6, "*Configuring OpenIDM*".

C.2.1. When To Use Custom Configuration Objects

Configuration objects are ideal for metadata and settings that need not be included in the data to reconcile. In other words, use configuration objects for data that does not require audit log, and does not serve directly as a target or source for mappings.

Although you can set and manipulate configuration objects both programmatically and manually, configuration objects are expected to change slowly, perhaps through a mix of both manual file updates and programmatic updates. To store temporary values that can change frequently and that you do not expect to be updated by configuration file changes, custom repository objects might be more appropriate.

C.2.2. Custom Configuration Object Naming Conventions

By convention custom configuration objects are added under the reserved context, `config/custom`.

You can choose any name under `config/context`. Be sure, however, to choose a value for *context* that does not clash with future OpenIDM configuration names.

C.2.3. Mapping Configuration Objects To Configuration Files

If you have not disabled the file based view for configuration, you can view and edit all configuration including custom configuration in `openidm/conf/*.json` files. The configuration maps to a file named `context-config-name.json`, where *context* for custom configuration objects is `custom` by convention, and *config-name* is the configuration object name. A configuration object named `escalation` thus maps to a file named `conf/custom-escalation.json`.

OpenIDM detects and automatically picks up changes to the file.

OpenIDM also applies changes made through APIs to the file.

By default, OpenIDM stores configuration objects in the repository. The file view is an added convenience aimed to help you in the development phase of your project.

C.2.4. Configuration Objects File & REST Payload Formats

By default, OpenIDM maps configuration objects to JSON representations.

OpenIDM represents objects internally in plain, native types like maps, lists, strings, numbers, booleans, null. OpenIDM constrains the object model to simple types so that mapping objects to external representations is trivial.

The following example shows a representation of a configuration object with a look-up map.

```
{
    "CODE123" : "ALERT",
    "CODE889" : "IGNORE"
}
```

In the JSON representation, maps are represented with braces (`{ }`), and lists are represented with brackets (`[ ]`). Objects can be arbitrarily complex, as in the following example.

```
{
    "CODE123" : {
        "email" : ["sample@sample.com", "john.doe@somedomain.com"],
        "sms" : ["555666777"]
    }
    "CODE889" : "IGNORE"
}
```

C.2.5. Accessing Configuration Objects Through the REST API

You can list all available configuration objects, including system and custom configurations, using an HTTP GET on `/openidm/config`.

The `_id` property in the configuration object provides the link to the configuration details with an HTTP GET on `/openidm/config/id-value`. By convention, the *id-value* for a custom configuration object called `escalation` is `custom/escalation`.

OpenIDM supports REST mappings for create, read, update, query, and delete of configuration objects. Currently OpenIDM does not support patch operations for configuration objects.

C.2.6. Accessing Configuration Objects Programmatically

You can address configuration objects as resources using the URL or URI `config/` prefix both internally and also through the REST interface. The resource API provides script object functions for create, read, update, query, and delete operations.

OpenIDM supports concurrency through a multi version concurrency control mechanism. In other words, each time an object changes, OpenIDM assigns it a new revision.

Objects can be arbitrarily complex as long as they use supported types, such as maps, lists, numbers, strings, and booleans.

C.2.7. Creating Objects

The following script example creates an object type.

```
openidm.create("config/custom", "myconfig", mymap)
```

C.2.8. Updating Objects

The following script example updates a custom configuration object type.

```
openidm.update("config/custom/myconfig", mymap)
```

C.2.9. Deleting Objects

The following script example deletes a custom configuration object type.

```
openidm.delete("config/custom/myconfig")
```

C.2.10. Reading Objects

The following script example reads an object type.

```

val = openidm.read("config/custom/myconfig")
```

C.3. System Objects

System objects are pluggable representations of objects on external systems. They follow the same RESTful resource based design principles as managed objects. There is a default implementation for the OpenICF framework, which allows any connector object to be represented as a system object.

C.4. Audit Objects

Audit objects house audit data selected for local storage in the OpenIDM repository. For details, see Chapter 18, "*Using Audit Logs*".

C.5. Links

Link objects define relations between source objects and target objects, usually relations between managed objects and system objects. The link relationship is established by provisioning activity that either results in a new account on a target system, or a reconciliation or synchronization scenario that takes a `LINK` action.

Appendix D. Synchronization Reference

The synchronization engine is one of the core services of OpenIDM. You configure the synchronization service through a `mappings` property that specifies mappings between objects that are managed by the synchronization engine.

```
{
  "mappings": [ object-mapping object, ... ]
}
```

D.1. Object-Mapping Objects

An object-mapping object specifies the configuration for a mapping of source objects to target objects.

```
 {
  "name"             : string,
  "source"           : string,
  "target"           : string,
  "links"            : string,
  "validSource"      : script object,
  "validTarget"      : script object,
  "correlationQuery": script object,
  "properties"       : [ property object, ... ],
  "policies"         : [ policy object, ... ],
  "onCreate"         : script object,
  "onUpdate"         : script object,
  "onLink"           : script object,
  "onUnlink"         : script object,
  "result"           : script object
}
```

Mapping Object Properties

name

string, required

Uniquely names the object mapping. Used in the link object identifier.

source

string, required

Specifies the path of the source object set. Example: `"managed/user"`.

target

string, required

Specifies the path of the target object set. Example: `"system/ldap/account"`.

links

string, optional

Enables reuse of the links created in another mapping. Example: `"systemLdapAccounts_managedUser"` reuses the links created by a previous mapping whose `name` is `"systemLdapAccounts_managedUser"`.

validSource

script object, optional

A script that determines if a source object is valid to be mapped. The script yields a boolean value: `true` indicates the source object is valid; `false` can be used to defer mapping until some condition is met. In the root scope, the source object is provided in the `"source"` property. If the script is not specified, then all source objects are considered valid.

validTarget

script object, optional

A script used during the target phase of reconciliation that determines if a target object is valid to be mapped. The script yields a boolean value: `true` indicates that the target object is valid; `false` indicates that the target object should not be included in reconciliation. In the root scope, the target object is provided in the `"target"` property. If the script is not specified, then all target objects are considered valid for mapping.

correlationQuery

script object, optional

A script that yields a query object to query the target object set when a source object has no linked target. The syntax for writing the query depends on the target system of the correlation.

For examples of some common targets, see Section 12.17, "Correlation Queries". The source object is provided in the `"source"` property in the script scope.

properties

array of property-mapping objects, optional

Specifies mappings between source object properties and target object properties, with optional transformation scripts.

policies

array of policy objects, optional

Specifies a set of link conditions and associated actions to take in response.

onCreate

script object, optional

A script to execute when a target object is to be created, after property mappings have been applied. In the root scope, the source object is provided in the `"source"` property, projected target object in the `"target"` property and the link situation that led to the create operation in `"situation"`. The `_id` property in the target object can be modified, allowing the mapping to select an identifier; if not set then the identifier is expected to be set by the target object set. If the script throws an exception, then target object creation is aborted.

onUpdate

script object, optional

A script to execute when a target object is to be updated, after property mappings have been applied. In the root scope, the source object is provided in the `"source"` property, projected target object in the `"target"` property, link situation that led to the update operation in `"situation"`. If the script throws an exception, then target object update is aborted.

onLink

script object, optional

A script to execute when a source object is to be linked to a target object, after property mappings have been applied. In the root scope, the source object is provided in the `"source"` property, projected target object in the `"target"` property. If the script throws an exception, then target object linking is aborted.

onUnlink

script object, optional

A script to execute when a source and a target object are to be unlinked, after property mappings have been applied. In the root scope, the source object is provided in the `"source"` property, projected target object in the `"target"` property. If the script throws an exception, then target object unlinking is aborted.

result

script object, optional

A script to execute on each mapping event, independent of the nature of the operation. In the root scope, the source object is provided in the `"source"` property, projected target object in the `"target"` property. If the script throws an exception, then target object unlinking is aborted.

The "result" script is executed only during reconciliation operations!

D.1.1. Property Objects

A property object specifies how the value of a target property is determined.

```
{
 "target" : string,
 "source" : string,
 "transform" : script object,
 "condition" : script object,
 "default": value
}
```

Property Object Properties

target

string, required

Specifies the path of the property in the target object to map to.

source

string, optional

Specifies the path of the property in the source object to map from. If not specified, then the target property value is derived from the script or default value.

transform

script object, optional

A script to determine the target property value. The root scope contains the value of the source in the `"source"` property, if specified. If the `"source"` property has a value of `""`, then the entire source object of the mapping is contained in the root scope. The resulting value yielded by the script is stored in the target property.

condition

script object, optional

A script to determine whether the mapping should be executed or not. The condition has an `"object"` property available in root scope, which (if specified) contains the full source object. For example `"source": "(object.email != null)"`. The script is considered to return a boolean value.

default

any value, optional

Specifies the value to assign to the target property if a non-null value is not established by `"source"` or `"transform"`. If not specified, the default value is `null`.

D.1.2. Policy Objects

A policy object specifies a link condition and the associated actions to take in response.

```
{
  "situation"  : string,
  "action"     : string or script object
  "postAction" : optional, script object
}
```

Policy Object Properties

situation

string, required

Specifies the situation for which an associated action is to be defined.

action

string or script object, required

Specifies the action to perform. If a script is specified, the script is executed and is expected to yield a string containing the action to perform.

postAction

script object, optional

Specifies the action to perform after the previously specified action has completed.

> **Note**
>
> No `postAction` script is triggered if the `action` is either `IGNORE` or `ASYNC`.

D.1.2.1. Script Object

Script objects take the following form.

```
{
  "type"  : "text/javascript",
  "source": string
}
```

type

string, required

Specifies the type of script to be executed. Supported types include `"text/javascript"` and `"groovy"`.

source

string, required

Specifies the source code of the script to be executed.

D.2. Links

To maintain links between source and target objects in mappings, OpenIDM stores an object set in the repository. The object set identifier follows this scheme.

```
links/mapping
```

Here, *mapping* represents the name of the mapping for which links are managed.

Link entries have the following structure.

```
{
   "_id":string,
   "_rev":string,
   "linkType":string,
   "firstId":string
   "secondId":string,
}
```

_id

string

The identifier of the link object.

_rev

string, required

The value of link object's revision.

linkType

string, required

The type of the link. Usually then name of the mapping which created the link.

firstId

string, required

The identifier of the first of the two linked objects.

secondId

string

The identifier of the second of the two linked objects.

D.3. Queries

OpenIDM performs the following queries on a link object set.

1. Find link(s) for a given firstId object identifier.

   ```
   SELECT * FROM links WHERE linkType
        = value AND firstId = value
   ```

   Although a single result makes sense, this query is intended to allow multiple results so that this scenario can be handled as an exception.

2. Select link(s) for a given second object identifier.

   ```
   SELECT * FROM links  WHERE linkType
       = value AND secondId = value
   ```

   Although a single result makes sense, this query is intended to allow multiple results so that this scenario can be handled as an exception.

D.4. Reconciliation

OpenIDM performs reconciliation on a per-mapping basis. The process of reconciliation for a given mapping includes these stages.

1. Iterate through all objects for the object set specified as `"source"`. For each source object, carry out the following steps.

   a. Look for a link to a target object in the link object set, and perform a correlation query (if defined).

   b. Determine the link condition, as well as whether a target object can be found.

   c. Determine the action to perform based on the policy defined for the condition.

   d. Perform the action.

   e. Keep track of the target objects for which a condition and action has already been determined.

   f. Write the results.

2. Iterate through all object identifiers for the object set specified as `"target"`. For each identifier, carry out the following steps.

   a. Find the target in the link object set.

      Determine if the target object was handled in the first phase.

   b. Determine the action to perform based on the policy defined for the condition.

   c. Perform the action.

   d. Write the results.

3. Iterate through all link objects, carrying out the following steps.

   a. If the `reconId` is `"my"`, then skip the object.

      If the `reconId` is not recognized, then the source or the target is missing.

   b. Determine the action to perform based on the policy.

   c. Perform the action.

   d. Store the `reconId` identifer in the mapping to indicate that it was processed in this run.

> **Note**
>
> To optimize a reconciliation operation, the reconciliation process does not attempt to correlate source objects to target objects if the set of target objects is empty when the correlation is started. For information on changing this default behaviour, see Section 12.16, "Reconciliation Optimization".

D.5. REST API

External synchronized objects expose an API to request immediate synchronization. This API includes the following requests and responses.

Request

Example:

```
POST /openidm/system/xml/account/jsmith?_action=liveSync HTTP/1.1
```

Response (success)

Example:

```
HTTP/1.1 204 No Content
...
```

Response (synchronization failure)

Example:

```
HTTP/1.1 409 Conflict
...
[JSON representation of error]
```

Appendix E. REST API Reference

Representational State Transfer (REST) is a software architecture style for exposing resources, using the technologies and protocols of the World Wide Web. REST describes how distributed data objects, or resources, can be defined and addressed. OpenIDM provides a RESTful API for accessing managed objects, system objects, workflows, and some elements of the system configuration.

The ForgeRock implementation of REST, known as commons REST (CREST), defines an API intended for common use across all ForgeRock products. CREST is a framework used to access various web resources, and for writing to RESTful resource providers (servers).

CREST is intended to support the following types of operations, described in detail in Section E.4, "Supported Operations": `Create`, `Read`, `Update`, `Delete`, `Action`, and `Query`.

ForgeRock defines a JSON Resource core library, as a common framework to implement RESTful APIs. That core library includes two components:

`json-resource`

A Maven module that provides core interfaces such as `Connections`, `Requests`, and `Request Handlers`.

`json-resource-servlet`

Provides J2EE servlet integration. Defines a common HTTP-based REST API for interacting with JSON resources.

Note

You can examine the libraries associated with ForgeRock REST at http://commons.forgerock.org/forgerock-rest.

E.1. URI Scheme

The URI scheme for accessing a managed object follows this convention, assuming the OpenIDM web application was deployed at `/openidm`.

```
/openidm/managed/type/id
```

Similar schemes exist for URIs associated with all but system objects. For more information, see Section 15.7.2, "`access.js`".

The URI scheme for accessing a system object follows this convention:

```
/openidm/system/resource-name/type/id
```

An example of a system object in an LDAP repository might be:

```
/openidm/system/ldap/account/07b46858-56eb-457c-b935-cfe6ddf769c7
```

Note that for LDAP resources, you should not map the LDAP `dn` to the OpenIDM `uidAttribute` (`_id`). The attribute that is used for the `_id` should be immutable. You should therefore map the LDAP `entryUUID` operational attribute to the OpenIDM `_id`, as shown in the following excerpt of the provisioner configuration file:

```
...
"uidAttribute" : "entryUUID",
...
```

E.2. Object Identifiers

Every managed and system object has an identifier (expressed as *id* in the URI scheme) that is used to address the object through the REST API. The REST API allows for client-generated and server-generated identifiers, through PUT and POST methods. The default server-generated identifier type is a UUID. If you create an object by using `POST`, a server-assigned ID is generated in the form of a UUID. If you create an object by using PUT, the client assigns the ID in whatever format you specify.

Most of the examples in this guide use client-assigned IDs, as it makes the examples easier to read.

For more information on whether to use PUT or POST to create managed objects, see Should You Use PUT or POST to Create a Managed Object?.

E.3. Content Negotiation

The REST API fully supports negotiation of content representation through the `Accept` HTTP header. Currently, the supported content type is JSON. In most cases, you should include the following header:

```
Accept: application/json
```

In a REST call (using the **curl** command, for example), you would include the following option to specify the noted header:

```
--header "Content-Type: application/json"
```

You can also specify the default UTF-8 character set as follows:

```
--header "Content-Type: application/json;charset=utf-8"
```

The `application/json` content type is not needed when a REST call is made with the GET and DELETE methods.

E.4. Supported Operations

CREST supports several types of operations for communication with web servers.

The following request parameters can be used in conjunction with the supported operations.

`_debug=[true,false]`

If `_debug=true`, the `HttpServlet` dumps the `HttpServletRequest` to the embedded Jetty Servlet log file.

`_prettyPrint=[true,false]`

If `_prettyPrint=true`, the `HttpServlet` formats the response, in a fashion similar to the JSON parser known as jq.

For example, adding `_prettyPrint=true` to the end of a `query-all-ids` request formats the output in the following manner:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/managed/user?_queryId=query-all-ids&_prettyPrint=true"
{
 "result" : [ {
   "_id" : "bjensen",
   "_rev" : "0"
 }, {
   "_id" : "scarter",
   "_rev" : "0"
 }, {
   "_id" : "jberg",
   "_rev" : "0"
 } ],
 "resultCount" : 3,
 "pagedResultsCookie" : null,
 "remainingPagedResults" : -1
}
```

Note that most command-line examples in this guide do not show this parameter, although the output in the examples is formatted for readability.

_fields

The `_fields` parameter can be used to return multiple common attributes.

For example, you can use `GET` to read specific attributes for a user as follows:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET
 "https://localhost:8443/openidm/managed/user/james?_fields=userName,mail"
{
  "mail": "james@example.com",
  "userName": "james"
}
```

E.4.1. Creating an Object

Objects can be created with two different HTTP operations: `POST` and `PUT`.

To create an object with a server-assigned ID, use the `POST` operation with the `create` action. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
    "userName":"mike",
    "sn":"Smith",
    "givenName":"Mike",
    "mail": "mike@example.com",
    "telephoneNumber": "082082082",
    "password":"Passw0rd"
 }'
 "https://localhost:8443/openidm/managed/user?_action=create"
{
  "userName": "mike",
  ...
  "_rev": "1",
  "_id": "a5bed4d7-99d4-41c4-8d64-49493b48a920",
  ...
}
```

To create an object with a client-assigned ID, use the `PUT` operation, with either of the following headers:

`If-None-Match: *`
`If-None-Match: "*"`

Specify the ID as part of the URL, for example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --header "If-None-Match: *"
 --request PUT \
 --data '{
    "userName":"james",
    "sn":"Berg",
    "givenName":"James",
    "mail": "james@example.com",
    "telephoneNumber": "082082082",
    "password":"Passw0rd"
    }' \
 "https://localhost:8443/openidm/managed/user/james"
{
  "userName": "james",
  ...
  "_rev": "1",
  ...
  "_id": "james",
  ...
}
```

E.4.2. Reading an Object

To read the contents of an object, use the `GET` operation, specifying the object ID. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/system/ldap/account/fc252fd9-b982-3ed6-b42a-c76d2546312c"
{
    "givenName": "Barbara",
    "telephoneNumber": "1-360-229-7105",
    "dn": "uid=bjensen,ou=People,dc=example,dc=com",
    "description": "Created for OpenIDM",
    "mail": "bjensen@example.com",
    "ldapGroups": [
        "cn=openidm2,ou=Groups,dc=example,dc=com"
    ],
    "cn": "Babara Jensen",
    "uid": "bjensen",
    "sn": "Jensen",
    "_id": "fc252fd9-b982-3ed6-b42a-c76d2546312c"
}
```

E.4.3. Updating an Object

An update replaces some or all of the contents of an existing object. Any object can be updated over REST with a PUT request. *Managed objects* can also be updated with a POST request, using the `patch` action, or with a PATCH request.

To update an object with a `PUT` request, use the `If-Match` header, for example:

```
$  curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --header "If-Match : *" \
 --request PUT \
 --data '{"description":"The new description for Babs Jensen"}'
 "https://localhost:8443/openidm/system/ldap/account/fc252fd9-b982-3ed6-b42a-c76d2546312c"
{
    "givenName": "Barbara",
    "telephoneNumber": "1-360-229-7105",
    "dn": "uid=bjensen,ou=People,dc=example,dc=com",
    "description": "The new description for Babs Jensen",
    "mail": "bjensen@example.com",
    "ldapGroups": [
        "cn=openidm2,ou=Groups,dc=example,dc=com"
    ],
    "cn": "Babara Jensen",
    "uid": "bjensen",
    "sn": "Jensen",
    "_id": "fc252fd9-b982-3ed6-b42a-c76d2546312c"
}
```

To update a managed object with a POST request, use the `patch` action and specify the updated fields as an array in the `data` option. For example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '[
   {
   "operation":"replace",
   "field":"/description",
   "value":"The new description for James"
   }
 ]'
 "https://localhost:8443/openidm/managed/user/james?_action=patch"
{
   ...
   "userName": "james",
   ...
   "_id": "james",
  "description": "The new description for James",
   ...
}
```

To update a managed object with a PATCH request, use the `If-Match` header. A PATCH request can add, remove, replace, or increment an attribute value. A `replace` operation replaces an existing value, or adds a value if no value exists.

The following example shows a patch request that updates a multi-valued attribute by adding a new value. Note the dash `-` character appended to the field name, which specifies that the value provided should be added to the existing values. If the dash character is omitted, the provided value replaces the existing values of that field.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --header "If-Match: *" \
 --request PATCH \
 --data '[
    {
        "operation": "add",
        "field": "/roles/-",
        "value": "managed/role/ldap"

    }
]' \
 "https://localhost:8443/openidm/managed/user/bjensen"
```

E.4.4. Deleting an Object

A delete request is similar to an update request, and can optionally include the HTTP `If-Match` header. To delete an object, specify its ID in the request, for example:

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request DELETE \
 "https://localhost:8443/openidm/system/ldap/account/e81c7f15-2e6d-4c3c-8005-890101070dd9"
{
    "_id": "e81c7f15-2e6d-4c3c-8005-890101070dd9"
}
```

E.4.5. Querying Resources

Resources can be queried using the `GET` method, with one of the following query parameters:

For queries on managed objects:

- `_queryId` for arbitrary predefined, parameterized queries
- `_queryFilter` for arbitrary filters, in common filter notation
- `_queryExpression` for client-supplied queries, in native query format

For queries on system objects:

- `_queryId=query-all-ids` (the only supported predefined query)
- `_queryFilter` for arbitrary filters, in common filter notation

For additional information on queries, see Section 7.3.4, "Constructing Queries".

E.5. Conditional Operations

The REST API fully supports conditional operations through the use of the `ETag`, `If-Match` and `If-None-Match` HTTP headers. The use of HTTP conditional operations is the basis of OpenIDM's optimistic concurrency control system. Clients should make requests conditional in order to prevent inadvertent modification of the wrong version of an object.

E.6. Supported Methods

The managed object API uses standard HTTP methods to access managed objects.

GET

Retrieves a managed object in OpenIDM.

Example Request

```
GET /openidm/managed/user/bdd793f8
...
```

Example Response

```
HTTP/1.1 200 OK
Content-Type: application/json;charset=UTF-8
Cache-Control: no-cache
Vary: Accept-Encoding, User-Agent
Set-Cookie: session-jwt=2sadf... afd5;Path=/
Expires: Thu, 01 Jan 2015 00:00:00 GMT
Content-Length: 1230
Server: Jetty(8.y.z-SNAPSHOT)
...

[JSON representation of the managed object]
```

HEAD

Returns metainformation about a managed object in OpenIDM.

Example Request

```
HEAD /openidm/managed/user/bdd793f8
...
```

Example Response

```
HTTP/1.1 200 OK
Content-Type: application/json
Content-Length: 123
ETag: "0"
```

PUT

Creates or updates a managed object.

Example Request: Creating a new object

```
PUT /openidm/managed/user/5752c0fd9509
Content-Type: application/json
Content-Length: 123
If-None-Match: *
...

[JSON representation of the managed object to create]
```

Example Response: Creating a new object (success)

```
HTTP/1.1 201 Created
Content-Type: application/json
Content-Length: 45
ETag: "0"
...

[JSON representation containing metadata (underscore-prefixed) properties]
```

Example Response: Creating a new object without the `If-None-Match` header

```
HTTP/1.1 404 Not Found
Content-Type: application/json
Content-Length: 83
...

[JSON representation of error]
```

Example Request: Updating an existing object

```
PUT /openidm/managed/user/5752c0fd9509
Content-Type: application/json
Content-Length: 123
If-Match: "1"
...

[JSON representation of managed object to update]
```

Example Response: Updating an existing object (success)

```
HTTP/1.1 200 OK
Content-Type: application/json
Content-Length: 45
ETag: "2"
...

[JSON representation of updated object]
```

Example Response: Updating an existing object when no version is supplied

```
HTTP/1.1 200 OK
Content-Type: application/json
Content-Length: 89
ETag: "3"
...

[JSON representation of updated object]
```

Example Response: Updating an existing object when an invalid version is supplied

```
HTTP/1.1 412 Precondition Required
Content-Type: application/json
Content-Length: 89
...

[JSON representation of error]
```

Example Response: Updating an existing object with `If-Match: *`

```
HTTP/1.1 200 OK
Content-Type: application/json
Content-Length: 45
ETag: "0"
...
[JSON representation of updated object]
```

Should You Use PUT or POST to Create a Managed Object?

You can use PUT and POST to create managed objects. To create a managed object with a PUT, you would include the `_id` in the request. If you create a managed object with a POST, the server assigns the `_id` in the form of a UUID.

In some cases, you may want to use PUT, as POST is not idempotent. If you can specify the `_id` to assign to the object, use PUT.

Alternatively, POST generates a server-assigned ID in the form of a UUID. In some cases, you may prefer to use UUIDs in production, as a POST can generate them easily in clustered environments.

POST

The POST method allows arbitrary actions to be performed on managed objects. The `_action` query parameter defines the action to be performed.

The `create` action is used to create a managed object. Because POST is neither safe nor idempotent, PUT is the preferred method of creating managed objects, and should be used if the client knows what identifier it wants to assign the object. The response contains the server-generated `_id` of the newly created managed object.

The POST method create optionally accepts an `_id` query parameter to specify the identifier to give the newly created object. If an `_id` is not provided, the server selects its own identifier.

The `patch` action is used to update one or more attributes of a managed object, without replacing the entire object.

Example Create Request

```
POST /openidm/managed/user?_action=create
Content-Type: application/json;charset=UTF-8
Content-Length: 123
...

[JSON representation of the managed object to create]
```

Example Response

```
HTTP/1.1 201 Created
Content-Type: application/json;charset=UTF-8
Cache-Control: no-cache
Location: https://Some_URI
...

[JSON representation containing metadata (underscore-prefixed) properties]
```

Example Patch Request

```
POST /openidm/managed/user?_action=patch
Content-Type: application/json;charset=UTF-8
Content-Length: 123
...

[JSON representation of the managed object to create]
```

Example Response (success)

```
HTTP/1.1 200 OK
Content-Type: application/json;charset=UTF-8
Cache-Control: no-cache
Set-Cookie: session-jwt=yAiYWxnIjogI;Path=/
...
```

DELETE

Deletes a managed object.

Example Request

```
DELETE /openidm/managed/user/c3471805b60f
If-Match: "0"
...
```

Example Response (success)

```
HTTP/1.1 200 OK
Content-Length: 405
Content-Type: application/json;charset=UTF-8
Etag: "4"
...

[JSON representation of the managed object that was deleted]
```

Example Response: Deleting an existing object when no version is supplied

```
HTTP/1.1 200 OK
Content-Length: 405
Content-Type: application/json;charset=UTF-8
Etag: "4"
...

[JSON representation of the managed object that was deleted]
```

Example Response: Deleting an existing object when an invalid version is supplied

```
HTTP/1.1 412 Precondition Required
Content-Type: application/json;charset=UTF-8
Content-Length: 89
...

[JSON representation of error]
```

PATCH

Performs a partial modification of a managed object.

See the JSON Patch Internet-Draft for details.

Example Request

```
PATCH /openidm/managed/user/5752c0fd9509
Content-Type: application/patch+json
Content-Length: 456
If-Match: "0"
...

[JSON representation of patch document to apply]
```

Example Response (success)

```
HTTP/1.1 200 OK
Set-Cookie: JSESSIONID=1kke440cyv1vivbrid6ljso7b;Path=/
Expires: Thu, 01 Jan 1970 00:00:00 GMT
Content-Type: application/json; charset=UTF-8
ETag: "1"
...
{"_id":"5752c0fd9509","_rev":"2"}
```

Updating an existing object when no version is supplied (version conflict)

```
HTTP/1.1 409 Conflict
Content-Type: application/json;charset=UTF-8
Content-Length: 89
...

[JSON representation of error]
```

Example Response: Updating an existing object when an invalid version is supplied (version conflict)

```
HTTP/1.1 412 Precondition Required
Content-Type: application/json;charset=UTF-8
Content-Length: 89
...

[JSON representation of error]
```

E.7. REST Endpoints and Sample Commands

This section describes the OpenIDM REST endpoints and provides a number of sample commands that show the interaction with the REST interface.

E.7.1. Managing the Server Configuration Over REST

OpenIDM stores configuration objects in the repository, and exposes them under the context path `/openidm/config`. Single instance configuration objects are exposed under `/openidm/config/object-name`.

Multiple instance configuration objects are exposed under `/openidm/config/object-name/instance-name`. The following table outlines these configuration objects and how they can be accessed through the REST interface.

URI	HTTP Operation	Description
/openidm/config	GET	Returns a list of configuration objects
/openidm/config/audit	GET	Returns the current logging configuration
/openidm/config/provisioner.openicf/*provisioner-name*	GET	Returns the configuration of the specified connector
/openidm/config/router	PUT	Changes the router configuration. Modifications are provided with the `-data` option, in JSON format.
/openidm/config/*object*	DELETE	Deletes the specified configuration object.

OpenIDM supports REST mappings for create, read, update, query, and delete of configuration objects. Currently OpenIDM does not support patch operations for configuration objects.

For an example that displays the current configuration, the current logging configuration, the configuration with an XML connector provisioner, and how the configuration can be modified over the router, see Section 6.4, "Configuring OpenIDM Over REST".

One entry is returned for each configuration object. To obtain additional information on the configuration object, include its `pid` or `_id` in the URL. The following example displays configuration information on the `sync` object, based on OpenIDM using Sample 1.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/config/sync"
{
  "mappings": [ {
    "target" : "managed/user",
    "correlationQuery" : {
      "type" : "text/javascript",
      "source" : "var query = {'_queryId' : 'for-userName', 'uid' : source.name};query;"
    },
    "properties" : [ {
      "target" : "_id",
      "source" : "_id"
    }, {
      "target" : "description",
      "source" : "description"
    }, {
      "target" : "givenName",
      "source" : "firstname"
    }, {
      "target" : "mail",
      "source" : "email"
    },
 {
...
```

E.7.2. Managing Users Over REST

User objects are stored in the repository and are exposed under the context path `/managed/user`. Many examples of REST calls related to this context path exist throughout this document. The following table lists available functionality associated with the `/managed/user` context path.

URI	HTTP Operation	Description
/openidm/managed/user?_queryId=query-all-ids	GET	List all the managed users in the repository
/openidm/managed/user?_queryFilter=*filter*	GET	Query the managed user object with the defined filter. The value of the query filter must be URL encoded.
/openidm/managed/user/*id*	GET	Retrieve the JSON representation of a specific user
/openidm/managed/user/*userName*	PUT	Create a new user
/openidm/managed/user/*userName*	PUT	Update a user entry (replaces the entire entry)
/openidm/managed/user?_action=create	POST	Create a new user

URI	HTTP Operation	Description
/openidm/managed/user?_action=patch&_queryId=for-userName&uid=*userName*	POST	Update a user (can be used to replace the value of one or more existing attributes)
/openidm/managed/user/*userName*	PATCH	Update specified fields of a user entry
/openidm/managed/user/*userName*	DELETE	Delete a user entry

The following example retrieves the JSON representation of all users stored in the internal repository.

```
$ curl \
--cacert self-signed.crt
 \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"https://localhost:8443/openidm/managed/user?_queryId=query-all-ids"
```

The following example queries the repository for managed users whose user name is Smith.

```
$ curl \
--cacert self-signed.crt
 \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
 "https://localhost:8443/openidm/managed/user?_queryFilter=userName%20eq%20%22smith%22"
```

The following example retrieves the JSON representation of a specified user.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/managed/user/user_id"
```

To add a user without a specified ID, see Section 2.8, "Adding Users Over REST" in the *Installation Guide*.

The following example adds a user with a specific user ID.

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request PUT \
 --data '{
    "userName":"james",
    "sn":"Berg",
    "givenName":"James",
    "mail": "james@example.com",
    "telephoneNumber": "082082082",
    "password":"password"
  }' \
"https://localhost:8443/openidm/managed/user/james"
```

The following example checks whether a user exists, then updates the user entry. The command replaces the telephone number with the new data provided in the request body.

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '[{
  "operation":"replace",
  "field":"/telephoneNumber",
  "value":"1234567"
  }]' \
  "https://localhost:8443/openidm/managed/user?_action=patch&_queryId=for-userName&uid=id"
```

E.7.3. Managing System Objects Over REST

System objects, that is, objects that are stored in remote systems, are exposed under the `/openidm/system` context. OpenIDM provides access to system objects over REST, as listed in the following table.

URI	HTTP Operation	Description
/openidm/system?_action=*action-name*	POST	`_action=availableConnectors` returns a list of the connectors that are available in `openidm/connectors` or in `openidm/bundle`. `_action=createCoreConfig` takes the supplied connector reference (`connectorRef`) and adds the configuration properties required for that connector. This generates a core connector configuration that you can use to create a full configuration with the `createFullConfig` action.

URI	HTTP Operation	Description
		`_action=createFullConfig` generates a complete connector configuration, using the configuration properties from the `createCoreConfig` action, and retrieving the object types and operation options from the resource, to complete the configuration. `_action=test` returns a list of all remote systems, with their status, and supported object types. `_action=testConfig` validates the connector configuration provided in the POST body. `_action=liveSync` triggers a liveSync operation on the specified source object. `_action=authenticate` authenticates to the specified system with the credentials provided.
/openidm/system/*system-name*?_action=*action-name*	POST	`_action=test` tests the status of the specified system.
/openidm/system/*system-name*/*system-object*?_action=*action-name*	POST	`_action=liveSync` triggers a liveSync operation on the specified system object. `_action=script` runs the specified script on the system object. `_action=authenticate` authenticates to the specified system object, with the provided credentials. `_action=create` creates a new system object.
/openidm/system/*system-name*/*system-object*?_queryId=query-all-ids	GET	Lists all IDs related to the specified system object, such as users, and groups.
/openidm/system/*system-name*/*system-object*?_queryFilter=*filter*	GET	Lists the item(s) associated with the query filter.
/openidm/system/*system-name*/*system-object*/*id*	PUT	Creates a system object, or updates the system object, if it exists (replaces the entire object).
/openidm/system/*system-name*/*system-object*/*id*	DELETE	Deletes a system object.

Note

When you create a system object with a PUT request (that is, specifying a client-assigned ID), you should specify the ID in the URL only and not in the JSON payload. If you specify a different ID in the URL and in the JSON payload, the request will fail, with an error similar to the following:

```
{
    "code":500,
    "reason":"Internal Server Error",
    "message":"The uid attribute is not single value attribute."}
```

The `patch` action is not supported on system objects.

Example E.1. Returning a list of the available connector configurations

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "https://localhost:8443/openidm/system?_action=availableConnectors"
```

Example E.2. Returning a list of remote systems, and their status

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "https://localhost:8443/openidm/system?_action=test"
[
  {
    "ok": true,
    "connectorRef": {
      "bundleVersion": "[1.4.0.0,2.0.0.0)",
      "bundleName": "org.forgerock.openicf.connectors.ldap-connector",
      "connectorName": "org.identityconnectors.ldap.LdapConnector"
    },
    "objectTypes": [
      "group",
      "account"
    ],
    "config": "config/provisioner.openicf/ldap",
    "enabled": true,
    "name": "ldap"
  }
]
```

Example E.3. Two options for running a liveSync operation on a specified system object

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "https://localhost:8443/openidm/system?_action=liveSync&source=system/ldap/account"
{
  "_rev": "1",
  "_id": "SYSTEMLDAPACCOUNT",
  "connectorData": {
    "nativeType": "integer",
    "syncToken": 0
  }
}
```

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "https://localhost:8443/openidm/system/ldap/account?_action=liveSync"

{
  "_rev": "2",
  "_id": "SYSTEMLDAPACCOUNT",
  "connectorData": {
    "nativeType": "integer",
    "syncToken": 0
  }
}
```

Example E.4. Running a script on a system object

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "https://localhost:8443/openidm/system/ldap/account?_action=script&_scriptId=addUser"
```

Example E.5. Authenticating to a system object

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "https://localhost:8443/openidm/system/ldap/account?
_action=authenticate&username=bjensen&password=Passw0rd"
{
  "_id": "fc252fd9-b982-3ed6-b42a-c76d2546312c"
}
```

Example E.6. Creating a new system object

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --data '{
    "cn":"James Smith",
    "dn":"uid=jsmith,ou=people,dc=example,dc=com",
    "uid":"jsmith",
    "sn":"Smith",
    "givenName":"James",
    "mail": "jsmith@example.com",
    "description":"Created by OpenIDM REST"}' \
 --request POST \
 "https://localhost:8443/openidm/system/ldap/account?_action=create"
{
    "telephoneNumber":null,
    "description":"Created by OpenIDM REST",
    "mail":"jsmith@example.com",
    "givenName":"James",
    "cn":"James Smith",
    "dn":"uid=jsmith,ou=people,dc=example,dc=com",
    "uid":"jsmith",
    "ldapGroups":[],
    "sn":"Smith",
    "_id":"07b46858-56eb-457c-b935-cfe6ddf769c7"
}
```

Example E.7. Renaming a system object

You can rename a system object simply by supplying a new naming attribute value in a PUT request. The PUT request replaces the entire object. The naming attribute depends on the external resource.

The following example renames an object on an LDAP server, by changing the DN of the LDAP object (effectively performing a modDN operation on that object).

The example renames the user created in the previous example.

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "If-Match: *" \
 --data '{
    "cn":"James Smith",
    "dn":"uid=jimmysmith,ou=people,dc=example,dc=com",
    "uid":"jimmysmith",
    "sn":"Smith",
    "givenName":"James",
    "mail": "jsmith@example.com"}' \
 --request PUT \
 "https://localhost:8443/openidm/system/ldap/account/07b46858-56eb-457c-b935-cfe6ddf769c7"
{
  "mail":"jsmith@example.com",
  "cn":"James Smith",
  "sn":"Smith",
  "dn":"uid=jimmysmith,ou=people,dc=example,dc=com",
  "ldapGroups":[],
  "telephoneNumber":null,
  "description":"Created by OpenIDM REST",
  "givenName":"James",
  "uid":"jimmysmith",
  "_id":"07b46858-56eb-457c-b935-cfe6ddf769c7"
}
```

Example E.8. List the IDs associated with a specific system object

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/system/ldap/account?_queryId=query-all-ids"
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 3,
  "result": [
        {
           "dn": "uid=jdoe,ou=People,dc=example,dc=com",
           "_id": "1ff2e78f-4c4c-300c-b8f7-c2ab160061e0"
       },
       {
           "dn": "uid=bjensen,ou=People,dc=example,dc=com",
           "_id": "fc252fd9-b982-3ed6-b42a-c76d2546312c"
       },
       {
           "dn": "uid=jimmysmith,ou=people,dc=example,dc=com",
           "_id": "07b46858-56eb-457c-b935-cfe6ddf769c7"
       }
  ]
}
```

E.7.4. Managing Workflows Over REST

Workflow objects are exposed under the `/openidm/workflow` context. OpenIDM provides access to the workflow module over REST, as listed in the following table.

URI	HTTP Operation	Description
/openidm/workflow/processdefinition?_queryId=*id*	GET	Lists workflow definitions based on filtering criteria
/openidm/workflow/processdefinition/*id*	GET	Returns detailed information about the specified process definition
/openidm/workflow/processinstance?_queryId=query-all-ids	GET	Lists the available running workflows, by IDs
/openidm/workflow/processinstance/*id*	GET	Provides detailed information of a running process instance
/openidm/workflow/processdefinition/*id*/taskdefinition	GET	Returns detailed information about the task definition, when you include an *id* or a query for all IDs, `?_queryId=query-all-ids`
/openidm/workflow/taskinstance?_queryId=query-all-ids	GET	Lists all active tasks
/openidm/workflow/taskinstance?_queryId=filteredQuery&*filter*	GET	Lists the tasks according to the specified filter
/openidm/workflow/processinstance?_action=create	POST	Start a new workflow. Parameters are included in the request body.
/openidm/workflow/taskinstance/*id*	PUT	Update task data
/openidm/workflow/processinstance/*id*	DELETE	Stops a process instance
/openidm/workflow/taskinstance/*id*?_action=claim	POST	Claim or complete a task. Parameters are included in the request body. Specifically for user tasks, a user can *claim* a specific task, which will then be assigned to that user.

The following examples list the defined workflows. For a workflow to appear in this list, the corresponding workflow definition must be in the `openidm/workflow` directory.

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "https://localhost:8443/openidm/workflow/processdefinition?_queryId=query-all-ids"
```

Depending on the defined workflows, the output will be something like the following:

```
{
"result":[ {
     "tenantId" : "",
     "candidateStarterGroupIdExpressions" : [ ],
     "candidateStarterUserIdExpressions" : [ ],
     "participantProcess" : null,
...
 } ],
     "resultCount" : 1,
     "pagedResultsCookie" : null,
     "remainingPagedResults" : -1
}
```


The following example invokes a workflow named "myWorkflow". The `foo` parameter is given the value `bar` in the workflow invocation.

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '{
      "key":"contractorOnboarding",
      "foo":"bar"
  }' \
 "https://localhost:8443/openidm/workflow/processinstance?_action=create"
```

E.7.5. Managing Scanned Tasks Over REST

OpenIDM provides a task scanning mechanism that enables you to perform a batch scan for a specified date in OpenIDM data, on a scheduled interval, and then to execute a task when this date is reached. For more information about scanned tasks, see Section 13.5, "Scanning Data to Trigger Tasks".

OpenIDM provides REST access to the task scanner, as listed in the following table.

URI	HTTP Operation	Description
/openidm/taskscanner	GET	Lists the all scanning tasks, past and present.
/openidm/taskscanner/*id*	GET	Lists details of the given task.
/openidm/taskscanner?_action=execute&name=*name*	POST	Triggers the specified task scan run.
/openidm/taskscanner/*id*?_action=cancel	POST	Cancels the specified task scan run.

E.7.6. Accessing Log Entries Over REST

You can interact with the audit and activity logs over REST, as shown in the following table.

URI	HTTP Operation	Description
/openidm/audit/recon	GET	Displays the reconciliation audit log
/openidm/audit/recon/*id*	GET	Reads a specific reconciliation audit log entry
/openidm/audit/recon?_queryId=audit-by-recon-id&reconId=*id*	GET	Queries the audit log for a particular reconciliation operation
/openidm/audit/recon?_queryId=audit-by-recon-id-situation&situation= *situation*&reconId=*id*	GET	Queries the reconciliation audit log for a specific reconciliation situation
/openidm/audit/activity	GET	Displays the activity log
/openidm/audit/activity/*id*	GET	Returns activity information for a specific action
/openidm/audit/activity?_queryId=audit-by-activity-parent-action&parentActionId=*id*	GET	Queries the activity log for the details of an action
/openidm/audit/access	GET	Displays the full list of auditable actions.
/openidm/audit/access/*id*	GET	Displays information on the specific audit item.

E.7.7. Managing Reconciliation Operations Over REST

You can interact with the reconciliation engine over REST, as shown in the following table.

URI	HTTP Operation	Description
/openidm/recon	GET	Lists all completed reconciliation runs
/openidm/recon?_action=recon&mapping=*mapping-name*	POST	Launches a reconciliation run with the specified mapping
/openidm/recon/*id*?_action=cancel	POST	Cancels the specified reconciliation run
/openidm/system/*datastore* account?_action=liveSync	POST	Calls a LiveSync operation.

The following example runs a reconciliation action, with the mapping `systemHrdb_managedUser`, defined in the `sync.json` file.

```
$ curl \
 --cacert self-signed.crt \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "https://localhost:8443/openidm/recon?_action=recon&mapping=systemHrdb_managedUser"
```

E.7.8. Managing the Repository over REST

You can interact with the repository engine over REST, as shown in the following table.

URI	HTTP Operation	Description
/openidm/repo/synchronisation/deadLetterQueue/*resource*?_queryId=query-all-ids"	GET	Lists any failed synchronisation records for that resource, that have been placed in the dead letter queue.
/openidm/repo/link?_queryId=query-all-ids"	GET	Lists entries in the links table
/openidm/repo/internal/user?_queryId=query-all-ids"	GET	Lists the internal users
/openidm/repo/internal/user/*username*"	PUT	Enables you to change the username or password of an internal user
/openidm/repo?_action=updateDbCredentials	POST	Enables you to change the database username and password, in the case of an OrientDB repository

For examples of queries on the `repo/` endpoint, see Section 5.4, "Interacting With the Repository Over REST".

E.8. HTTP Status Codes

The OpenIDM REST API returns the standard HTTP response codes, as described in the following table.

HTTP Status	Description
200 OK	The request was successfully completed. If this request created a new resource that is addressable with a URI, and a response body is returned containing a representation of the new resource, a 200 status will be returned with a Location header containing the canonical URI for the newly created resource.
201 Created	A request that created a new resource was completed. A representation of the new resource is returned. A Location header containing the canonical URI for the newly created resource should also be returned.
202 Accepted	The request has been accepted for processing, but the processing has not been completed.
204 No Content	The server fulfilled the request, but does not need to return a response message body.
400 Bad Request	The request could not be processed because it contains missing or invalid information.
401 Unauthorized	The authentication credentials included with this request are missing or invalid.
403 Forbidden	The server recognized your credentials, but you do not possess authorization to perform this request.
404 Not Found	The request specified a URI of a resource that does not exist.

HTTP Status	Description
405 Method Not Allowed	The HTTP verb specified in the request (DELETE, GET, HEAD, POST, PUT) is not supported for this request URI.
406 Not Acceptable	The resource identified by this request is not capable of generating a representation corresponding to one of the media types in the Accept header of the request.
409 Conflict	A creation or update request could not be completed, because it would cause a conflict in the current state of the resources supported by the server (for example, an attempt to create a new resource with a unique identifier already assigned to some existing resource).
500 Internal Server Error	The server encountered an unexpected condition which prevented it from fulfilling the request.
501 Not Implemented	The server does not (currently) support the functionality required to fulfill the request.
503 Service Unavailable	The server is currently unable to handle the request due to temporary overloading or maintenance of the server.

Appendix F. Scripting Reference

Scripting allows you to customize various aspects of OpenIDM functionality, for example, by providing custom logic between source and target mappings, defining correlation rules, filters, and triggers, and so on.

OpenIDM 3.1 supports scripts written in JavaScript and Groovy. Script options are configured in the `conf/script.json` file, described in Section F.1.1, "Script Configuration File" .

F.1. Scripting Configuration

OpenIDM includes several default scripts in the following directory: `path/to/openidm/bin/defaults/script/`. Do not modify or remove any of the scripts in this directory, as OpenIDM needs these scripts to run specific services. Scripts in this folder are not guaranteed to remain constant between product releases.

If you develop custom scripts, copy them to the `script/` directory for your project, such as `path/to/openidm/script/`.

F.1.1. Script Configuration File

OpenIDM 3.1 includes a script configuration file (`/path/to/openidm/conf/script.json`) that enables you to modify the parameters used by your Groovy and Java Scripts. You can also use this file to change the default project and script directories. For more information, see Section 6.7, "Default and Custom Configuration Directories".

The properties shown in the default version of the `script.json` file are described here:

properties

Additional custom properties.

ECMAScript

JavaScript is an ECMAScript language.

javascript.debug

See Section F.6, "Debugging OpenIDM JavaScripts"

javascript.recompile.minimumInterval

Minimum time after which a script can be recompiled.

groovy.warnings

Specifies a log level for Groovy scripts.

groovy.source.encoding

Defines the encoding format for Groovy scripts.

groovy.target.directory

Specifies the output directory.

groovy.target.bytecode

Specifies the output bytecode.

groovy.classpath

Defines directories with Groovy class files.

groovy.output.verbose

Specifies the verbosity of stack traces.

groovy.output.debug

Sets debugging status.

groovy.errors.tolerance

Sets number of non-fatal errors before aborting a compilation.

groovy.script.extension

Defines the file extension for a Groovy script.

groovy.script.base

Defines the base class for the script.

groovy.recompile

Allows a script to be recompiled.

groovy.recompile.minimumInterval

Minimum time between when Groovy scripts can be compiled.

groovy.target.indy

Defines whether a Groovy indy test can be used.

groovy.disabled.global.ast.transformations

Notes whether Groovy Abstract Syntax Transformations (AST)s are disabled.

The remaining options in the `script.json` file are discussed in Section 6.7, "Default and Custom Configuration Directories".

F.1.2. Calling A Script From Another Configuration File

```
{
  "type" : "text/javascript",
  "source": string
}
```

or

```
{
  "type" : "text/javascript",
  "file" : file location
}
```

type

string, required

Specifies the type of script to be executed. Supported types include `"text/javascript"` and `"groovy"`.

source

string, required if file is not specified

Specifies the source code of the script to be executed.

file

string, required if source is not specified

Specifies the file containing the source code of the script to execute.

F.2. Examples

The following example (included in the `sync.json` file) returns `true` if the `employeeType` is equal to `external`, otherwise returns `false`. This script can be useful during reconciliation to establish whether the source object should be a part of the reconciliation, or ignored.

```
"validTarget": {
   "type" : "text/javascript",
   "source": "target.employeeType == 'external'"
}
```

The following example (included in the `sync.json` file) sets the `__PASSWORD__` attribute to `defaultpwd` when OpenIDM creates a target object.

```
"onCreate" : {
  "type" : "text/javascript",
  "source": "target.__PASSWORD__ = 'defaultpwd'"
}
```

The following example (included in the `router.json` file) shows a trigger to create Solaris home directories using a script. The script is located in a file, `/path/to/openidm/script/createUnixHomeDir.js`.

```
{
  "filters" : [ {
    "pattern" : "^system/solaris/account$",
    "methods" : [ "create" ],
    "onResponse" : {
      "type" : "text/javascript",
      "file" : "script/createUnixHomeDir.js"
    }
  } ]
}
```

F.3. Function Reference

Functions (access to managed objects, system objects, and configuration objects) within OpenIDM are accessible to scripts via the `openidm` object, which is included in the top-level scope provided to each script.

OpenIDM also provides a `logger` object to access SLF4J facilities. The following code shows an example:

```
logger.info("Parameters passed in: {} {} {}", param1, param2, param3);
```

To set the log level, use `org.forgerock.openidm.script.javascript.JavaScript.level` in `openidm/conf/logging.properties`.

F.3.1. openidm.create(container, id, value)

This function creates a new resource object.

Parameters

container

string

The resource container in which the object will be created, for example, `managed/user`.

id

string

The identifier of the object to be created, if the client is supplying the ID. If the server should generate an ID, pass null here.

value

object

The value of the object to be created.

Returns

- The created OpenIDM resource object.

Throws

- An exception is thrown if the object could not be created.

F.3.2. openidm.patch(id, rev, value)

This function performs a partial modification of a managed object. Unlike the `update` function, only the modified attributes are provided, not the entire object.

Parameters

id

string

The identifier of the object to be updated.

rev

string

The revision of the object to be updated, or `null` if the object is not subject to revision control.

value

object

The value of the modifications to be applied to the object.

Returns

- The modified OpenIDM resource object.

Throws

- An exception is thrown if the object could not be updated.

F.3.3. openidm.read(id)

This function reads and returns an OpenIDM resource object.

Parameters

id

string

The identifier of the object to be read.

Returns

- The read OpenIDM resource object, or `null` if not found.

F.3.4. openidm.update(id, rev, value)

This function updates a resource object.

Parameters

id

string

The identifier of the resource object to be updated.

rev

string

The revision of the object to be updated, or `null` if the object is not subject to revision control.

value

object

The value of the object to be updated.

Returns

- The modified OpenIDM resource object.

Throws

- An exception is thrown if the object could not be updated.

F.3.5. openidm.delete(id, rev)

This function deletes a resource object.

Parameters

id

string

The identifier of the object to be deleted.

rev

string

The revision of the object to be deleted, or `null` if the object is not subject to revision control.

Returns

- A `null` value if successful.

Throws

- An exception is thrown if the object could not be deleted.

Note that `delete` is a reserved word in JavaScript and this function can therefore not be called in the usual manner. To call delete from a JavaScript, you must specify the call as shown in the following example:

```
openidm['delete']('managed/user/'+ user._id, user._rev)
```

Calling `openidm.delete()` directly from a JavaScript results in an error similar to the following:

```
org.forgerock.openidm.script.ScriptException: missing name after . operator
```

F.3.6. openidm.query(id, params)

This function performs a query on the specified OpenIDM resource object.

Parameters

id

string

The identifier of the object to perform the query on.

params

object

An object containing the query ID and its parameters.

Returns

- The result of the query. A query result includes the following parameters:

  "query-time-ms"

  The time, in milliseconds, that OpenIDM took to process the query.

  "conversion-time-ms"

  (For an OrientDB repository only) the time, in milliseconds, taken to convert the data to a JSON object.

  "result"

  The list of entries retrieved by the query. The result includes the revision (`"_rev"`) of the entry and any other properties that were requested in the query.

The following example shows the result of a custom query that requests the ID, user name, and email address of managed users in the repository. For an OrientDB repository, the query would be something like `select _openidm_id, userName, email from managed_user,`.

```
{
  "conversion-time-ms": 0,
  "result": [
    {
      "email": "bjensen@example.com",
      "userName": "bjensen",
      "_rev": "0",
      "_id": "36bbb745-517f-4695-93d0-998e1e7065cf"
    },
    {
      "email": "scarter@example.com",
      "userName": "scarter",
      "_rev": "0",
      "_id": "cc3bf6f0-949e-4699-9b8e-8c78ce04a287"
    }
  ],
  "query-time-ms": 1
}
```

Throws

- An exception is thrown if the given query could not be processed.

F.3.7. openidm.action(id, params, value)

This function performs an action on the specified OpenIDM resource object.

Parameters

id

string

The identifier of the object on which the action should be performed.

params

object

An object containing the parameters to pass to the action.

value

object

A value that can be provided to the action for processing.

Returns

- The result of the action. May be `null` if no result is provided.

Throws

- An exception is thrown if the given action could not be executed for any reason.

F.3.8. openidm.encrypt(value, cipher, alias)

This function encrypts a value.

Parameters

value

any

The value to be encrypted.

cipher

string

The cipher with which to encrypt the value, using the form "algorithm/mode/padding" or just "algorithm". Example: `AES/ECB/PKCS5Padding`.

alias

string

The key alias in the keystore with which to encrypt the node.

Returns

- The value, encrypted with the specified cipher and key.

Throws

- An exception is thrown if the object could not be encrypted for any reason.

F.3.9. openidm.decrypt(value)

This function decrypts a value.

Parameters

value

any

The value to be decrypted.

Returns

- A deep copy of the value, with any encrypted value decrypted.

Throws

- An exception is thrown if the object could not be decrypted for any reason.

F.3.10. logger.debug(string message, object... params)

Logs a message at DEBUG level.

Parameters

message

string

The message format to log. Params replace `{}` in your message.

params

object

Arguments to include in the message.

Returns

- A `null` value if successful.

Throws

- An exception is thrown if the message could not be logged.

F.3.11. logger.error(string message, object... params)

Logs a message at ERROR level.

Parameters

message

string

The message format to log. Params replace `{}` in your message.

params

object

Arguments to include in the message.

Returns

- A `null` value if successful.

Throws

- An exception is thrown if the message could not be logged.

F.3.12. logger.info(string message, object... params)

Logs a message at INFO level.

Parameters

message

string

The message format to log. Params replace `{}` in your message.

params

object

Arguments to include in the message.

Returns

- A `null` value if successful.

Throws

- An exception is thrown if the message could not be logged.

F.3.13. logger.trace(string message, object... params)

Logs a message at TRACE level.

Parameters

message

string

The message format to log. Params replace `{}` in your message.

params

object

Arguments to include in the message.

Returns

- A `null` value if successful.

Throws

- An exception is thrown if the message could not be logged.

F.3.14. logger.warn(string message, object... params)

Logs a message at WARN level.

Parameters

message

string

The message format to log. Params replace `{}` in your message.

params

object

Arguments to include in the message.

Returns

- A `null` value if successful.

Throws

- An exception is thrown if the message could not be logged.

F.4. Places to Trigger Scripts

Scripts can be triggered at different places, by different events.

In `openidm/conf/sync.json`

Triggered by situation

onCreate, onUpdate, onDelete, onLink, onUnlink

Object filter

vaildSource, validTarget

Correlating objects

correlationQuery

Triggered on any reconciliation

result

Scripts inside properties

condition, transform

`sync.json` supports only one script per hook. If multiple scripts are defined for the same hook, only the last one is kept.

In `openidm/conf/managed.json`

onCreate, onRead, onUpdate, onDelete, onValidate, onRetrieve, onStore, postCreate, postUpdate, and postDelete

`managed.json` supports only one script per hook. If multiple scripts are defined for the same hook, only the last one is kept.

In `openidm/conf/router.json`

onRequest, onResponse, onFailure

`router.json` supports multiple scripts per hook.

F.5. Variables Available in Scripts

The variables that are available to scripts depend on the triggers that launch the script. The following section outlines the available variables, per trigger.

condition

object

correlationQuery

source

Custom endpoint scripts

request

onCreate, postCreate

object, source, target

onLink

source, target

onRead, onDelete

object

onRetrieve

object (when called from either an object or a property storage trigger); property (only when called from a property storage trigger)

As a property, returns the modified property values from the script.

onStore

object, property

As a property, returns the modified property values from the script.

onUnlink

source, target

onUpdate, postUpdate

oldObject, newObject

onValidate

object, property

postDelete

oldObject

propertyName

Name of the property that is changed.

result

source, target

synchronization situation scripts

`recon.actionParam` - the details of the synchronization operation in progress. This variable can be used for asynchronous callbacks to execute the action at a later stage.

`sourceAction` - a boolean that indicates whether the situation was assessed during the source phase

`source` (if found)

`target` (if found)

The properties from the configured script object.

taskScanner

input, objectID

transform

source

validSource

source

validTarget

target

F.6. Debugging OpenIDM JavaScripts

OpenIDM includes Eclipse JSDT libraries so you can use Eclipse to debug your OpenIDM JavaScripts during development.

Procedure F.1. To Enable Debugging

Follow these steps to enable debugging using Eclipse.

1. Install the environment to support JavaScript development in either of the following ways.

- Download and install Eclipse IDE for JavaScript Web Developers from the Eclipse download page.
- Add the JavaScript Development Tools to your existing Eclipse installation.

2. Create an empty JavaScript project called `External JavaScript Source` in Eclipse.

   Eclipse then uses the `External JavaScript Source` directory in the default workspace location to store sources that it downloads from OpenIDM.

3. Stop OpenIDM.

4. Edit `openidm/conf/boot/boot.properties` to enable debugging.

   a. Uncomment and edit the following line.

   ```
   #openidm.script.javascript.debug=transport=socket,suspend=y,address=9888,trace=true
   ```

   Here `suspend=y` prevents OpenIDM from starting until the remote JavaScript debugger has connected. You might therefore choose to set this to `suspend=n`.

   b. Uncomment and edit the following line.

   ```
   #openidm.script.javascript.sources=/Eclipse/workspace/External JavaScript Source/
   ```

   Adjust `/Eclipse/workspace/External JavaScript Source/` to match the absolute path to this folder including the trailing `/` character. On Windows, also use forward slashes, such as`C:/Eclipse/workspace/External JavaScript Source/`.

   Each time OpenIDM loads a new script, it then creates or overwrites the file in the `External JavaScript Source` directory. Before toggling breakpoints, be sure to refresh the source manually in Eclipse so you have the latest version.

5. Edit the `openidm/conf/script.json` file to enable debugging. Specifically, uncomment and edit the following line:

   ```
   "#javascript.debug": "transport=socket,suspend=y,address=9888,trace=true",
   ```

6. Prepare the Eclipse debugger to allow you to set breakpoints.

   In the Eclipse Debug perspective, select the Breakpoints tab, and then click the Add Script Load Breakpoint icon to open the list of scripts.

   In the Add Script Load Breakpoint window, select your scripts, and then click OK.

7. Start OpenIDM, and connect the debugger.

To create a new debug, configuration click Run > Debug Configurations... > Remote JavaScript > New button, and then set the port to 9888 as shown above.

F.7. Validating Scripts Over REST

OpenIDM exposes a `script` endpoint over which scripts can be validated, by specifying the script parameters as part of the JSON payload. This functionality enables you to test how a script will operate in your deployment, with complete control over the inputs and outputs. Testing scripts in this way can be useful in debugging.

In addition, the script service enables you to call out to other scripts (even scripts written in a different language, such as from JavaScript to Groovy). For example, you might have logic written in Javascript, but also some code available in Groovy. Ordinarily, it would be challenging to interoperate between these two environments, but this script service enables you to call one from the other on the OpenIDM router.

Scripts called over the `script` endpoint have access to the `"openidm"` and `"context"` objects. The only supported action on the `script` endpoint is `eval`, so scripts can not be launched from this endpoint, but merely evaluated. The last statement that is executed is the value produced by the script, and the expected result of the REST call.

The following REST call attempts to evaluate the `autoPurgeAuditRecon.js` script (provided in `openidm/bin/defaults/script/audit`), but provides an incorrect purge type (`"purgeByNumOfRecordsToKeep"` instead of `"purgeByNumOfReconsToKeep"`). The error is picked up in the evaluation. The example assumes that the script exists in the directory reserved for custom scripts (`openidm/script`).

```
$ curl \
 --cacert self-signed.crt \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
   "type": "text/javascript",
   "file": "script/autoPurgeAuditRecon.js",
   "globals": {
     "input": {
       "mappings": ["%"],
       "purgeType": "purgeByNumOfRecordsToKeep",
       "numOfRecons": 1
     }
   }
 }' \
 "https://localhost:8443/openidm/script?_action=eval"

"Must choose to either purge by expired or number of recons to keep"
```

Note that the variables passed into this script are namespaced with the `"globals"` map. It is preferable to namespace variables passed into scripts in this way, to avoid collisions with the top-level reserved words for script maps, such as `file`, `source`, and `type`.

Appendix G. Router Service Reference

The OpenIDM router service provides the uniform interface to all objects in OpenIDM: managed objects, system objects, configuration objects, and so on.

G.1. Configuration

The router object as shown in `conf/router.json` defines an array of filter objects.

```
{
  "filters": [ filter object, ... ]
}
```

The required filters array defines a list of filters to be processed on each router request. Filters are processed in the order in which they are specified in this array.

G.1.1. Filter Objects

Filter objects are defined as follows.

```
{
  "pattern": string,
  "methods": [ string, ... ],
  "condition": script object,
  "onRequest": script object,
  "onResponse": script object,
  "onFailure": script object
}
```

"pattern"

string, optional

Specifies a regular expression pattern matching the JSON pointer of the object to trigger scripts. If not specified, all identifiers (including `null`) match. Pattern matching is done on the resource name, rather than on individual objects.

"methods"

array of strings, optional

One or more methods for which the script(s) should be triggered. Supported methods are: `"create"`, `"read"`, `"update"`, `"delete"`, `"patch"`, `"query"`, `"action"`. If not specified, all methods are matched.

"condition"

script object, optional

Specifies a script that is called first to determine if the script should be triggered. If the condition yields `"true"`, the other script(s) are executed. If no condition is specified, the script(s) are called unconditionally.

"onRequest"

script object, optional

Specifies a script to execute before the request is dispatched to the resource. If the script throws an exception, the method is not performed, and a client error response is provided.

"onResponse"

script object, optional

Specifies a script to execute after the request is successfully dispatched to the resource and a response is returned. Throwing an exception from this script does not undo the method already performed.

"onFailure"

script object, optional

Specifies a script to execute if the request resulted in an exception being thrown. Throwing an exception from this script does not undo the method already performed.

G.1.2. Script Execution Sequence

All "onRequest" and "onResponse" scripts are executed in sequence. First, the "onRequest" scripts are executed from the top down, then the "onResponse" scripts are executed from the bottom up.

```
client -> filter 1 onRequest -> filter 2 onRequest -> resource
client <- filter 1 onResponse <- filter 2 onResponse <- resource
```

The following sample `router.json` file shows the order in which the scripts would be executed:

```
{
    "filters" : [
        {
            "onRequest" : {
                "type" : "text/javascript",
                "file" : "script/router-authz.js"
            }
        },
        {
            "pattern" : "^managed/user",
            "methods" : [
                "read"
            ],
            "onRequest" : {
                "type" : "text/javascript",
                "source" : "console.log('requestFilter 1');"
            }
        },
        {
            "pattern" : "^managed/user",
            "methods" : [
                "read"
            ],
            "onResponse" : {
                "type" : "text/javascript",
                "source" : "console.log('responseFilter 1');"
            }
        },
        {
            "pattern" : "^managed/user",
            "methods" : [
                "read"
            ],
            "onRequest" : {
                "type" : "text/javascript",
                "source" : "console.log('requestFilter 2');"
            }
        },
        {
            "pattern" : "^managed/user",
            "methods" : [
                "read"
            ],
            "onResponse" : {
                "type" : "text/javascript",
                "source" : "console.log('responseFilter 2');"
            }
        }
    ]
}
```

Will produce a log like:

```
requestFilter 1
requestFilter 2
responseFilter 2
responseFilter 1
```

G.1.3. Script Scope

Scripts are provided with the following scope.

```
{
  "openidm": openidm-functions object,
  "request": resource-request object,
  "response": resource-response object,
  "exception": exception object
}
```

"openidm"

`openidm-functions` object (see Section F.3, "Function Reference").

Provides access to OpenIDM resources.

"request"

resource-request object

The resource-request context, which has one or more parent contexts. Provided in the scope of `"condition"`, `"onRequest"`, `"onResponse"` and `"onFailure"` scripts.

"response"

`openidm-functions` object (see Section F.3, "Function Reference").

The response to the resource-request. Only provided in the scope of the `"onResponse"` script.

"exception"

exception object

The exception value that was thrown as a result of processing the request. Only provided in the scope of the `"onFailure"` script.

An exception object is defined as follows.

```
{
  "code": integer,
  "reason": string,
  "message": string,
  "detail": string
}
```

"code"

integer

The numeric HTTP code of the exception.

"reason"

string

The short reason phrase of the exception.

"message"

string

A brief message describing the exception.

"detail"

(optional), string

A detailed description of the exception, in structured JSON format, suitable for programmatic evaluation.

G.2. Example

The following example executes a script after a managed user object is created or updated.

```
{
    "filters": [
        {
            "pattern": "^managed/user",
            "methods": [
                "create",
                "update"
            ],
            "onResponse": {
                "type": "text/javascript",
                "file": "scripts/afterUpdateUser.js"
            }
        }
    ]
}
```

Appendix H. Embedded Jetty Configuration

OpenIDM 3.1 includes an embedded Jetty web server.

To configure the embedded Jetty server, edit `openidm/conf/jetty.xml`. OpenIDM delegates most of the connector configuration to `jetty.xml`. OSGi and PAX web specific settings for connector configuration therefore do not have an effect. This lets you take advantage of all Jetty capabilities, as the web server is not configured through an abstraction that might limit some of the options.

The Jetty configuration can reference configuration properties (such as port numbers and keystore details) from OpenIDM's `boot.properties` configuration file.

H.1. Using OpenIDM Configuration Properties in the Jetty Configuration

OpenIDM exposes a `Param` class that you can use in `jetty.xml` to include OpenIDM configuration. The `Param` class exposes Bean properties for common Jetty settings and generic property access for other, arbitrary settings.

H.1.1. Accessing Explicit Bean Properties

To retrieve an explicit Bean property, use the following syntax in `jetty.xml`.

```
<Get class="org.forgerock.openidm.jetty.Param" name="<bean property name>"/>
```

For example, to set a Jetty property for keystore password:

```
<Set name="password">
    <Get class="org.forgerock.openidm.jetty.Param" name="keystorePassword"/>
</Set>
```

Also see the bundled `jetty.xml` for further examples.

The following explicit Bean properties are available.

port

Maps to `openidm.port.http`

port

Maps to `openidm.port.https`

port

Maps to `openidm.port.mutualauth`

keystoreType

Maps to `openidm.keystore.type`

keystoreProvider

Maps to `openidm.keystore.provider`

keystoreLocation

Maps to `openidm.keystore.location`

keystorePassword

Maps to `openidm.keystore.password`

keystoreKeyPassword

Maps to `openidm.keystore.key.password`, or the keystore password, if not set

truststoreLocation

Maps to `openidm.truststore.location`, or the keystore location, if not set

truststorePassword

Maps to `openidm.truststore.password`, or the keystore password, if not set

H.1.2. Accessing Generic Properties

```
<Call class="org.forgerock.openidm.jetty.Param" name="getProperty">
  <Arg>org.forgerock.openidm.some.sample.property</Arg>
</Call>
```

H.2. Jetty Default Settings

By default the embedded Jetty server uses the following settings.

- The HTTP, SSL, and Mutual Authentication ports defined in OpenIDM
- The same keystore and truststore settings as OpenIDM
- Trivial sample realm, `openidm/security/realm.properties` to add users

The default settings are intended for evaluation only. Adjust them according to your production requirements.

H.3. Registering Additional Servlet Filters

You can register generic servlet filters in the embedded Jetty server to perform additional filtering tasks on requests to or responses from OpenIDM. For example, you might want to use a servlet filter to protect access to OpenIDM with an access management product. Servlet filters are configured in files named `openidm/conf/servletfilter-name.json`. These servlet filter configuration files define the filter class, required libraries, and other settings.

A sample servlet filter configuration is provided in the `servletfilter-cors.json` file in the `/path/to/openidm/conf` directory.

The sample servlet filter configuration file is shown below:

```
{
    "classPathURLs" : [ ],
    "systemProperties" : { },
    "requestAttributes" : { },
    "scriptExtensions" : { }.
    "initParams" : {
       "allowedOrigins" : "https://localhost:8443",
       "allowedMethods" : "GET,POST,PUT,DELETE,PATCH",
       "allowedHeaders" : "accept,x-openidm-password,x-openidm-nosession,
                           x-openidm-username,content-type,origin,
                           x-requested-with",
       "allowCredentials" : "true",
       "chainPreflight" : "false"
    },
    "urlPatterns" : [
       "/*"
    ],
    "filterClass" : "org.eclipse.jetty.servlets.CrossOriginFilter"
}
```

The sample configuration includes the following properties:

`"classPathURLs"`

The URLs to any required classes or libraries that should be added to the classpath used by the servlet filter class

`"systemProperties"`

Any additional Java system properties required by the filter

`"requestAttributes"`

The HTTP Servlet request attributes that will be set by OpenIDM when the filter is invoked. OpenIDM expects certain request attributes to be set by any module that protects access to it, so this helps in setting these expected settings.

`"scriptExtensions"`

Optional script extensions to OpenIDM. Currently only `"augmentSecurityContext"` is supported. A script that is defined in `augmentSecurityContext` is executed by OpenIDM after a successful authentication request. The script helps to populate the expected security context in OpenIDM. For example, the login module (servlet filter) might select to supply only the authenticated user name, while the associated roles and user ID can be augmented by the script.

Supported script types include `"text/javascript"` and `"groovy"`. The script can be provided inline (`"source":`*`script source`*) or in a file (`"file":`*`filename`*). The sample filter extends the filter interface with the functionality in the script `script/security/populateContext.js`.

`"filterClass"`

The servlet filter that is being registered

The following additional properties can be configured for the filter:

`"httpContextId"`

The HTTP context under which the filter should be registered. The default is `"openidm"`.

`"servletNames"`

A list of servlet names to which the filter should apply. The default is `"OpenIDM REST"`.

`"urlPatterns"`

A list of URL patterns to which the filter applies. The default is `["/openidm/*", "/openidmui/*"]`.

`"initParams"`

Filter configuration initialization parameters that are passed to the servlet filter `init` method. For more information, see http://docs.oracle.com/javaee/5/api/javax/servlet/FilterConfig.html.

H.4. Disabling and Enabling Secure Protocols

Secure communications are important. To that end, the embedded Jetty web server enables a number of different protocols. To review the list of enabled protocols, run the following commands:

```
$ cd /path/to/openidm/logs
$ grep Enabled openidm0.log.0
   openidm0.log.0:INFO: Enabled Protocols [SSLv2Hello, TLSv1, TLSv1.1, TLSv1.2] of
[SSLv2Hello, SSLv3, TLSv1, TLSv1.1, TLSv1.2]
```

Note the difference between enabled and available protocols. Based on this particular output, `SSLv3` is missing from the list of enabled protocols. To see how this was done, open the `jetty.xml` file in the /path/to/openidm/conf directory. Note the `"ExcludeProtocols"` code block shown here:

```
...
    <Set name="ExcludeProtocols">
        <Array type="java.lang.String">
            <Item>SSLv3</Item>
        </Array>
    </Set>
...
```

> **Note**
>
> As noted in the following *Security Advisory*, "SSL 3.0 [RFC6101] is an obsolete and insecure protocol."

To exclude another protocol from the `Enabled` list, just add it to the `"ExcludeProtocols"` XML block. For example, if you included the following line in that XML block, your instance of Jetty would also exclude TLSv1:

```
<Item>TLSv1</Item>
```

You can reverse the process by removing the protocol from the `"ExcludeProtocols"` block.

To see if certain protocols should be included in the `"ExcludeProtocols"` block, review the current list of *ForgeRock Security Advisories*

For more information on Jetty configuration see the following document from the developers of *Jetty: The Definitive Reference*

Appendix I. Release Levels & Interface Stability

This appendix includes ForgeRock definitions for product release levels and interface stability.

I.1. ForgeRock Product Release Levels

ForgeRock defines Major, Minor, and Maintenance product release levels. The release level is reflected in the version number. The release level tells you what sort of compatibility changes to expect.

Table I.1. Release Level Definitions

Release Label	Version Numbers	Characteristics
Major	Version: x[.0.0] (trailing 0s are optional)	• Bring major new features, minor features, and bug fixes • Can include changes even to Stable interfaces • Can remove previously Deprecated functionality, and in rare cases remove Evolving functionality that has not been explicitly Deprecated • Include changes present in previous Minor and Maintenance releases
Minor	Version: x.y[.0] (trailing 0s are optional)	• Bring minor features, and bug fixes

Release Label	Version Numbers	Characteristics
		• Can include backwards-compatible changes to Stable interfaces in the same Major release, and incompatible changes to Evolving interfaces • Can remove previously Deprecated functionality • Include changes present in previous Minor and Maintenance releases
Maintenance	Version: x.y.z	• Bring bug fixes • Are intended to be fully compatible with previous versions from the same Minor release

I.2. ForgeRock Product Interface Stability

ForgeRock products support many protocols, APIs, GUIs, and command-line interfaces. Some of these interfaces are standard and very stable. Others offer new functionality that is continuing to evolve.

ForgeRock acknowledges that you invest in these interfaces, and therefore must know when and how ForgeRock expects them to change. For that reason, ForgeRock defines interface stability labels and uses these definitions in ForgeRock products.

Table I.2. Interface Stability Definitions

Stability Label	Definition
Stable	This documented interface is expected to undergo backwards-compatible changes only for major releases. Changes may be announced at least one minor release before they take effect.
Evolving	This documented interface is continuing to evolve and so is expected to change, potentially in backwards-incompatible ways even in a minor release. Changes are documented at the time of product release. While new protocols and APIs are still in the process of standardization, they are Evolving. This applies for example to recent Internet-Draft implementations, and also to newly developed functionality.
Deprecated	This interface is deprecated and likely to be removed in a future release. For previously stable interfaces, the change was likely announced in a previous release. Deprecated interfaces will be removed from ForgeRock products.
Removed	This interface was deprecated in a previous release and has now been removed from the product.
Technology Preview	Technology previews provide access to new features that are evolving new technology that are not yet supported. Technology preview features may be functionally incomplete and the function as implemented is subject to change without notice. DO NOT DEPLOY A TECHNOLOGY PREVIEW INTO A PRODUCTION ENVIRONMENT.

Stability Label	Definition
	Customers are encouraged to test drive the technology preview features in a non-production environment and are welcome to make comments and suggestions about the features in the associated forums. ForgeRock does not guarantee that a technology preview feature will be present in future releases, the final complete version of the feature is liable to change between preview and the final version. Once a technology preview moves into the completed version, said feature will become part of the ForgeRock platform. Technology previews are provided on an “AS-IS” basis for evaluation purposes only and ForgeRock accepts no liability or obligations for the use thereof.
Internal/Undocumented	Internal and undocumented interfaces can change without notice. If you depend on one of these interfaces, contact ForgeRock support or email info@forgerock.com to discuss your needs.

OpenIDM Glossary

JSON	JavaScript Object Notation, a lightweight data interchange format based on a subset of JavaScript syntax. For more information, see the JSON site.
JWT	JSON Web Token. As noted in the *JSON Web Token draft IETF Memo*, "JSON Web Token (JWT) is a compact URL-safe means of representing claims to be transferred between two parties." For OpenIDM, the JWT is associated with the `JWT_SESSION` authentication module.
managed object	An object that represents the identity-related data managed by OpenIDM. Managed objects are configurable, JSON-based data structures that OpenIDM stores in its pluggable repository. The default configuration of a managed object is that of a user, but you can define any kind of managed object, for example, groups or roles.
mapping	A policy that is defined between a source object and a target object during reconciliation or synchronization. A mapping can also define a trigger for validation, customization, filtering, and transformation of source and target objects.
OSGi	A module system and service platform for the Java programming language that implements a complete and dynamic component model. For a good introduction, see the OSGi site. OpenIDM services are designed to run in any OSGi container, but OpenIDM currently runs in Apache Felix.
reconciliation	During reconciliation, comparisons are made between managed objects and objects on source or target systems. Reconciliation can result in one or more specified actions, including, but not limited to, synchronization.

resource	An external system, database, directory server, or other source of identity data to be managed and audited by the identity management system.
REST	Representational State Transfer. A software architecture style for exposing resources, using the technologies and protocols of the World Wide Web. REST describes how distributed data objects, or resources, can be defined and addressed.
source object	In the context of reconciliation, a source object is a data object on the source system, that OpenIDM scans before attempting to find a corresponding object on the target system. Depending on the defined mapping, OpenIDM then adjusts the object on the target system (target object).
synchronization	The synchronization process creates, updates, or deletes objects on a target system, based on the defined mappings from the source system. Synchronization can be scheduled or on demand.
system object	A pluggable representation of an object on an external system. For example, a user entry that is stored in an external LDAP directory is represented as a system object in OpenIDM for the period during which OpenIDM requires access to that entry.System objects follow the same RESTful resource-based design principles as managed objects.
target object	In the context of reconciliation, a target object is a data object on the target system, that OpenIDM scans after locating its corresponding object on the source system. Depending on the defined mapping, OpenIDM then adjusts the target object to match the corresponding source object.

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