Integrator's Guide

/ ForgeRock Identity Management 6.5

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Anders Askåsen
Paul Bryan
Mark Craig
Andi Egloff
Laszlo Hordos
Matthias Tristl
Lana Frost
Mike Jang
Daly Chikhaoui
Nabil Maynard

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

Abstract

Guide to configuring and integrating ForgeRock® Identity Management software into identity management solutions. This software offers flexible services for automating management of the identity life cycle.

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Preface

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

1. About This Guide

In this guide you will learn how to integrate ForgeRock Identity Management (IDM) software as part of a complete identity management solution.

This guide is written for systems integrators building solutions based on ForgeRock Identity Management services. This guide describes the product functionality, and shows you how to set up and configure IDM software as part of your overall identity management solution.

2. 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.

3. 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

This chapter introduces the IDM architecture, and describes component modules and services.

In this chapter you will learn:

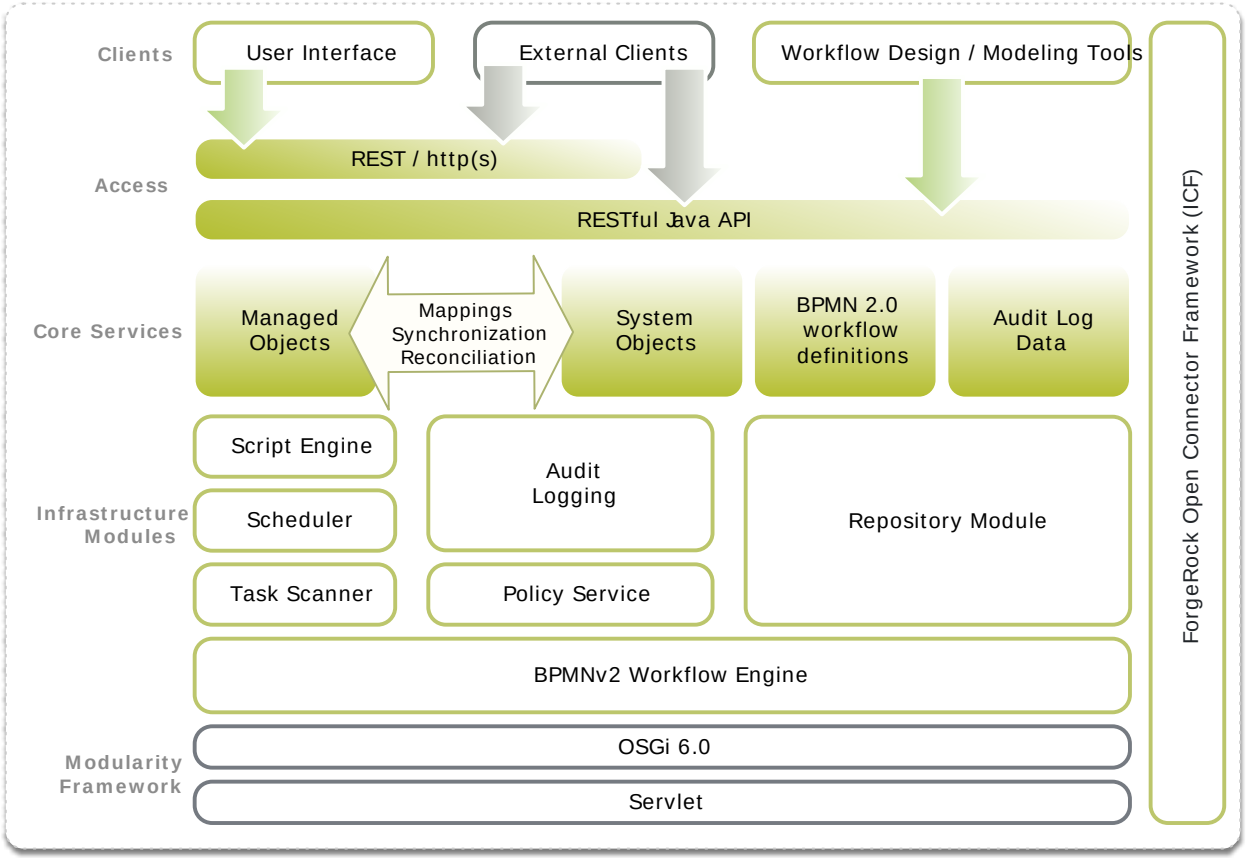
- How IDM uses the OSGi framework as a basis for its modular architecture
- How the infrastructure modules provide the features required for IDM's core services
- What those core services are and how they fit in to the overall architecture
- How IDM provides access to the resources it manages

1.1. Modular Framework

IDM implements infrastructure modules that run in an OSGi framework. It exposes core services through RESTful APIs to client applications.

The following figure provides an overview of the architecture. Specific components are described in more detail in subsequent sections of this chapter.

Modular Architecture



The IDM 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 more information, see What is OSGi? IDM runs in Apache Felix, an implementation of the OSGi Framework and Service Platform.

Servlet

The Servlet layer provides RESTful HTTP access to the managed objects and services. IDM embeds the Jetty Servlet Container, which can be configured for either HTTP or HTTPS access.

1.2. Infrastructure Modules

The infrastructure modules provide the underlying features needed for core services:

BPMN 2.0 Workflow Engine

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

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

Task Scanner

The task-scanning mechanism performs a batch scan for a specified property, on a scheduled interval. The task scanner executes a task when the value of that property matches a specified value.

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

Scheduler

The scheduler supports Quartz cron triggers and simple triggers. Use the scheduler to trigger regular reconciliations, liveSync, and scripts, to collect and run reports, to trigger workflows, and to perform custom logging.

For more information, see "*Scheduling Tasks and Events*".

Script Engine

The script engine is a pluggable module that provides the triggers and plugin points for IDM. JavaScript and Groovy are supported.

Policy Service

An extensible policy service applies validation requirements to objects and properties, when they are created or updated.

For more information, see "*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 more information, see "*Setting Up Audit Logging*".

Repository

The repository provides a common abstraction for a pluggable persistence layer. IDM supports reconciliation and synchronization with several major external data stores in production, including relational databases, LDAP servers, and even flat CSV and XML files.

The repository API uses a JSON-based object model with RESTful principles consistent with the other IDM services. To facilitate testing, IDM includes an embedded instance of ForgeRock Directory Services (DS). In production, you must use a supported repository, as described in "*Selecting a Repository*" in the *Installation Guide*.

1.3. Core Services

The core services are the heart of the resource-oriented unified object model and architecture:

Object Model

Artifacts handled by IDM 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.

IDM can serialize and deserialize these structures to and from JSON as required. IDM also exposes a set of triggers and functions that you can define, in either JavaScript or Groovy, which can natively read and modify these JSON-based object model structures.

Managed Objects

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

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

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/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 IDM.

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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/system/..."
```

There is a default implementation for the ICF 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 more information, see "*Synchronizing Data Between Resources*".

Synchronization and Reconciliation

Reconciliation enables on-demand and scheduled resource comparisons between the managed object repository and the 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 more information, see "*Synchronizing Data Between Resources*".

1.4. Secure Commons REST Commands

Representational State Transfer (REST) is a software architecture style for exposing resources, using the technologies and protocols of the World Wide Web. For more information on the ForgeRock REST API, see "*REST API Reference*".

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 "Restricting REST Access to the HTTPS Port". You can use those instructions with the self-signed certificate generated when IDM starts, or with a `*.crt` file provided by a certificate authority.

1.5. Access Layer

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

RESTful Interfaces

IDM provides REST APIs for CRUD operations, for invoking synchronization and reconciliation, and to access several other services.

For more information, see "*REST API Reference*".

User Interfaces

User interfaces provide access to most of the functionality available over the REST API.

Chapter 2

Starting, Stopping, and Running the Server

This chapter covers the scripts provided for starting and stopping IDM, 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 the Server

By default, you start and stop IDM in interactive mode.

To start the server 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 the server, and opens an OSGi console with a `->` prompt where you can issue console commands.

The default hostname and ports for IDM are set in the `resolver/boot.properties` file found in the `openidm/` directory. IDM is initially configured to run on `http` on port `8080`, `https` on port `8443`, with a hostname of `localhost`. For more information about changing ports and hostnames, see "*Host and Port Information*".

To stop the server interactively in the OSGi console, run the **shutdown** command:

```
-> shutdown
```

You can also start IDM as a background process on UNIX and Linux systems. Follow these steps, preferable before you start IDM for the first time:

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

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

2. Start the server in the background. The **nohup** survives a logout and the **2>&1&** redirects standard output and standard error to the noted `console.out` file:

```
$ nohup ./startup.sh > logs/console.out 2>&1&
[1] 2343
```

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

```
$ ./shutdown.sh
./shutdown.sh
Stopping OpenIDM (2343)
```

Note

Although installations on OS X systems are not supported in production, you might want to run IDM on OS X in a demo or test environment. To run IDM in the background on an OS X system, take the following additional steps:

- Remove the `org.apache.felix.shell.tui-*.jar` bundle from the `openidm/bundle` directory.
- Disable `ConsoleHandler` logging, as described in "Disable Logs".

2.2. Specifying the Startup Configuration

By default, IDM starts with the configuration, script, and binary files in the `openidm/conf`, `openidm/script`, and `openidm/bin` directories. You can launch IDM with a different set of configuration, script, and binary files for test purposes, to manage different projects, or to run one of the included samples.

The **startup.sh** script specifies the following elements of a running instance:

`-p | --project-location {/path/to/project/directory}`

The project location specifies the directory that contains the configuration and script files that IDM will use.

All configuration objects and any artifacts that are not in the bundled defaults (such as custom scripts) *must* be included in the project location. These objects include all files otherwise included in the `openidm/conf` and `openidm/script` directories.

For example, the following command starts the server with the configuration of the `sync-with-csv` sample (located in `/path/to/openidm/samples/sync-with-csv`):

```
$ ./startup.sh -p /path/to/openidm/samples/sync-with-csv
```

If you do not provide an absolute path, the project location path is relative to the system property, `user.dir`. IDM sets `idm.instance.dir` to that relative directory path. Alternatively, if you start the server without the **-p** option, IDM sets `idm.instance.dir` to `/path/to/openidm`.

> **Note**
>
> In this documentation, "your project" refers to the value of `idm.instance.dir`.

`-w |--working-location {/path/to/working/directory}`

The working location specifies the directory in which the embedded DS instance is installed, and the directory to which IDM writes its database cache, audit logs, and felix cache. The working location includes everything that is in the default `db/`, `audit/`, and `felix-cache/` subdirectories.

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

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

If you do not provide an absolute path, the path is relative to the system property, `user.dir`. IDM sets `idm.data.dir` to that relative directory path. If you do not specify a working location, IDM sets `idm.data.dir` to `/path/to/openidm`. This means the default working location data is located in the `openidm/db`, `openidm/felix-cache` and `openidm/audit` directories.

Note that this property does not affect the location of the IDM system logs. To change the location of these logs, edit the `conf/logging.properties` file.

You can also change the location of the Felix cache, by editing the `conf/config.properties` file, or by starting the server with the `-s` option, described later in this section.

`-c | --config {/path/to/config/file}`

A customizable startup configuration file (named `launcher.json`) lets you 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 "*Advanced Configuration*".

`-P {property=value}`

Any properties passed to the startup script with the `-P` option are used when the server loads the `launcher.json` startup configuration file.

Options specified here have the lowest order of precedence when the configuration is loaded. If the same property is defined in any other configuration source, the value specified here is ignored.

`-s | --storage {/path/to/storage/directory}`

Specifies the OSGi storage location of the cached configuration files.

You can use this option to redirect output if you are installing on a read-only filesystem volume. For more information, see "*Installing on a Read-Only Volume*" in the *Installation Guide*. This

option is also useful when you are testing different configurations. Sometimes when you start the server with two different sample configurations, one after the other, the cached configurations are merged and cause problems. Specifying a storage location creates a separate `felix-cache` directory in that location, and the cached configuration files remain completely separate.

Additionally, IDM sets the system property `idm.install.dir` to the location IDM is installed in. For example, if IDM was installed in `/Users/admin/openidm/`, that is what `idm.install.dir` will be set to.

For information about changing the startup configuration by substituting property values, see "Using Property Value Substitution".

2.3. Monitoring Server Health

Because IDM is highly modular and configurable, 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.

The health check service allows you to monitor the status of internal resources.

To monitor the status of external resources such as LDAP servers and external databases, use the commands described in "Checking the Status of External Systems Over REST".

2.3.1. Basic Health Checks

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

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

To verify the current server state, use the following REST call:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/info/ping"
{
  "_id": "",
  "_rev": "",
  "shortDesc": "OpenIDM ready",
  "state": "ACTIVE_READY"
}
```

2.3.2. Obtaining Session Information

To obtain information about the current IDM session, beyond basic health checks, use the following REST call:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/info/login"
{
  "_id": "login",
  "authenticationId": "openidm-admin",
  "authorization": {
    "component": "internal/user",
    "authLogin": false,
    "roles": [
      "internal/role/openidm-admin",
      "internal/role/openidm-authorized"
    ],
    "ipAddress": "0:0:0:0:0:0:0:1",
    "id": "openidm-admin",
    "moduleId": "INTERNAL_USER"
  }
}
```

Note

You can also increment the `loginCount` with a related endpoint described in "Authenticating Internal and Managed Users".

2.3.3. Monitoring Tuning and Health Parameters

The `openidm/health` endpoint provides more detailed monitoring information on the following areas:

- `Operating System` on the `openidm/health/os` endpoint
- `Memory` on the `openidm/health/memory` endpoint
- `Reconciliation`, on the `openidm/health/recon` endpoint.

For information on controlling access to these endpoints, see "Understanding the Access Configuration Script (`access.js`)".

2.3.3.1. Operating System Health Check

With the following REST call, you can get basic information about the host operating system:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/health/os"
{
    "_id" : "",
    "_rev" : "",
    "availableProcessors" : 1,
    "systemLoadAverage" : 0.06,
    "operatingSystemArchitecture" : "amd64",
    "operatingSystemName" : "Linux",
    "operatingSystemVersion" : "2.6.32-504.30.3.el6.x86_64"
}
```

From the output, you can see that this particular system has one 64-bit CPU, with a load average of 6 percent, on a Linux system with the noted kernel `operatingSystemVersion` number.

2.3.3.2. Memory Health Check

With the following REST call, you can get basic information about overall JVM memory use:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/health/memory"
{
    "_id" : "",
    "_rev" : "",
    "objectPendingFinalization" : 0,
    "heapMemoryUsage" : {
        "init" : 1073741824,
        "used" : 88538392,
        "committed" : 1037959168,
        "max" : 1037959168
    },
    "nonHeapMemoryUsage" : {
        "init" : 24313856,
        "used" : 69255024,
        "committed" : 69664768,
        "max" : 224395264
    }
}
```

The output includes information on JVM Heap and Non-Heap memory, in bytes. Briefly:

- JVM Heap memory is used to store Java objects.
- JVM Non-Heap Memory is used by Java to store loaded classes and related meta-data.

2.3.3.3. Reconciliation Health Check

With the following REST call, you can get basic information about the system demands related to reconciliation:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/health/recon"
{
    "_id" : "",
    "_rev" : "",
    "activeThreads" : 1,
    "corePoolSize" : 10,
    "largestPoolSize" : 1,
    "maximumPoolSize" : 10,
    "currentPoolSize" : 1
}
```

From the output, you can review the number of active threads used by the reconciliation, as well as the available thread pool.

2.3.4. Verifying the State of Health Check Service Modules

The configurable health check service verifies the status of the modules and services required for an operational system. During system startup, IDM checks that these modules and services are available and reports on any requirements that have not been met. If dynamic configuration changes are made, IDM rechecks that the required modules and services are functioning, to allow ongoing monitoring of system operation.

Examples of Required Modules

IDM checks all required modules. Examples of those modules are shown here:

```
    "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.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-ds"
    "org.forgerock.openidm.config"
    "org.forgerock.openidm.crypto"
```

Examples of Required Services

IDM checks all required services. Examples of those services are shown here:

```
    "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 the list of required modules and services, or add to it, by adding the following lines to your `resolver/boot.properties` file. Bundles and services are specified as a list of symbolic names, separated by commas:

- `openidm.healthservice.reqbundles` - overrides the default required bundles.
- `openidm.healthservice.reqservices` - overrides the default required services.
- `openidm.healthservice.additionalreqbundles` - specifies required bundles (in addition to the default list).

- `openidm.healthservice.additionalreqservices` - specifies required services (in addition to the default list).

By default, the server is given 15 seconds to start up all the required bundles and services before 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 milliseconds) in your `resolver/boot.properties` file. This example sets the startup time to five seconds:

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

2.4. Displaying Information About Installed Modules

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

```
-> scr list

 BundleId Component Name Default State
    Component Id State      PIDs (Factory PID)
 [   5]   org.forgerock.openidm.config.enhanced.starter  enabled
    [   1] [active      ] org.forgerock.openidm.config.enhanced.starter
 [   5]   org.forgerock.openidm.config.manage  enabled
    [   0] [active      ] org.forgerock.openidm.config.manage
 [  10]   org.forgerock.openidm.datasource.jdbc  enabled
 [  10]   org.forgerock.openidm.repo.jdbc  enabled
 [  11]   org.forgerock.openidm.repo.ds  enabled
    [  35] [active      ] org.forgerock.openidm.repo.ds
 [  16]   org.forgerock.openidm.cluster  enabled
    [  18] [active      ] org.forgerock.openidm.cluster
 [  17]   org.forgerock.openidm.http.context  enabled
    [   2] [active      ] org.forgerock.openidm.http.context
 [ 123]   org.forgerock.openidm.api-servlet  enabled
    [   5] [active      ] org.forgerock.openidm.api-servlet
 [ 123]   org.forgerock.openidm.error-servlet  enabled
    [   3] [active      ] org.forgerock.openidm.error-servlet
 [ 123]   org.forgerock.openidm.router.servlet  enabled
    [   4] [active      ] org.forgerock.openidm.router.servlet
 [ 124]   org.forgerock.openidm.audit  enabled
    [  24] [active      ] org.forgerock.openidm.audit
 [ 124]   org.forgerock.openidm.audit.filter  enabled
    [   6] [active      ] org.forgerock.openidm.audit.filter
->
```

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

```
-> scr info Id
```

The following example displays additional information about the router service:

```
-> scr info 4
*** Bundle: org.forgerock.openidm.api-servlet (123)
Component Description:
  Name: org.forgerock.openidm.router.servlet
  Implementation Class: org.forgerock.openidm.servlet.internal.ServletConnectionFactory
  Default State: enabled
  Activation: immediate
  Configuration Policy: ignore
  Activate Method: activate
  Deactivate Method: deactivate
  Modified Method: -
  Configuration Pid: [org.forgerock.openidm.router.servlet]
  Services:
    org.forgerock.json.resource.ConnectionFactory
    org.forgerock.openidm.router.RouterFilterRegistration
  Service Scope: singleton
  Reference: requestHandler
    Interface Name: org.forgerock.json.resource.RequestHandler
    Target Filter: (org.forgerock.openidm.router=*)
    Cardinality: 1..1
    Policy: static
    Policy option: reluctant
    Reference Scope: bundle
...
->
```

2.5. Querying Enabled Features

"Displaying Information About Installed Modules" showed how to list installed modules and their states on a running IDM instance. An alternative method of assessing the state of a server configuration is to query the enabled features over REST.

The feature availability service determines the set of possible features from the active bundles, and provides the following information:

- The name and `_id` of the feature
- Whether the feature is enabled
- If the feature is enabled, the REST endpoint on which that feature can be accessed

You can query the available features on the `info/features` endpoint, for example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/info/features?_queryFilter=true"
{
  "result": [
    {
      "_id": "retrieveUsername",
      "name": "retrieveUsername",
```

```
      "enabled": false,
      "endpoints": []
    },
    {
      "_id": "identityProviders",
      "name": "identityProviders",
      "enabled": true,
      "endpoints": [
        "identityProviders"
      ]
    },
    {
      "_id": "workflow",
      "name": "workflow",
      "enabled": true,
      "endpoints": [
        "workflow*"
      ]
    },
    {
      "_id": "passwordReset",
      "name": "passwordReset",
      "enabled": false,
      "endpoints": []
    },
    {
      "_id": "registration",
      "name": "registration",
      "enabled": true,
      "endpoints": [
        "selfservice/registration"
      ]
    },
    {
      "_id": "email",
      "name": "email",
      "enabled": false,
      "endpoints": []
    }
  ],
  ...
}
```

2.6. Starting in Debug Mode

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

- Start IDM 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 -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/resolver/boot
.properties
-> OpenIDM version "6.5.2.0" (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. Troubleshooting a Server Instance

For information about troubleshooting various issues in IDM, including collecting useful troubleshooting information such as logs, heap dumps and stack traces, see the corresponding Knowledge Base article.

Chapter 3
Command-Line Interface

This chapter describes the basic command-line interface (CLI). The CLI includes a number of utilities for managing an IDM 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/resolver/boot.properties
openidm# encrypt ....
```

or

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

By default, the command-line utilities run with the properties defined in your `resolver/boot.properties` file.

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

```
openidm#
```

The startup and shutdown scripts are not discussed in this chapter. For information about these scripts, see "*Starting, Stopping, and Running the Server*".

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:secureHash   Hash the input string.
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:update               Update the system with the provided update file.
remote:configimport         Imports the configuration set from local file/directory.
```

The following options are common to the **configexport**, **configimport**, and **configureconnector** subcommands:

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

-P or --port PORT

The port number associated with the 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.

3.1. Using the **configexport** Subcommand

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 lets you inspect the active configuration of an IDM instance.

OpenIDM must be running when you execute this command.

Usage is as follows:

```
$ ./cli.sh configexport --user username:password 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 table configuration (`repo.ds.json` or `repo.jdbc.json`) and the datasource connection configuration, for JDBC repositories (`datasource.jdbc-default.json`)
- The script configuration (`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`)
- Standard security questions (`selfservice.kba.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. Using the **configimport** Subcommand

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 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.

The subcommand takes the following options:

`-r`, `--replaceall`, `--replaceAll`

Replaces the entire list of configuration files with the files in the specified import location.

Note that this option 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.

`--retries` **(integer)**

This option specifies the number of times the command should attempt to update the configuration if the server is not ready.

Default value : 10

`--retryDelay` **(integer)**

This option specifies the delay (in milliseconds) between configuration update retries if the server is not ready.

Default value : 500

Usage is as follows:

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

For example:

```
$ ./cli.sh configimport --user openidm-admin:openidm-admin --retries 5 --retryDelay 250 --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 the same as those for the **export** command, described in the previous section.

3.3. Using the **configureconnector** Subcommand

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

Usage is as follows:

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

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

```
$ ./cli.sh configureconnector --user openidm-admin:openidm-admin --name myCsvConnector
 Executing ./cli.sh...
Starting shell in /path/to/openidm
Mar 22, 2018 09:50:01 AM org.forgerock.openidm.core.FilePropertyAccessor loadProps
0. Workday Connector version 1.5.20.8
1. SSH Connector version 1.5.20.8
2. ServiceNow Connector version 1.5.20.8
3. Scripted SQL Connector version 1.5.20.8
4. Scripted REST Connector version 1.5.20.8
5. Scim Connector version 1.5.20.8
6. Salesforce Connector version 1.5.20.8
7. MongoDB Connector version 1.5.20.8
8. Marketo Connector version 1.5.20.8
9. LDAP Connector version 1.5.20.8
10. Kerberos Connector version 1.5.20.8
11. Scripted Poolable Groovy Connector version 1.5.20.8
12. Scripted Groovy Connector version 1.5.20.8
13. GoogleApps Connector version 1.5.20.8
14. Database Table Connector version 1.5.20.8
15. CSV File Connector version 1.5.20.8
16. Adobe Marketing Cloud Connector version 1.5.20.8
17. Exit
Select [0..17]: 15
Edit the configuration file and run the command again. The configuration was saved
 to
/path/to/openidm/temp/provisioner.openicf-myCsvConnector.json
```

The basic configuration is saved in a file named `/openidm/temp/provisioner.openicf-connector-name.json`. Edit at least the `configurationProperties` parameter in this file to complete the connector configuration. For example, for a CSV connector:

```
"configurationProperties" : {
    "headerPassword" : "password",
    "csvFile" : "&{idm.instance.dir}/data/csvConnectorData.csv",
    "newlineString" : "\n",
    "headerUid" : "uid",
    "quoteCharacter" : "\"",
    "fieldDelimiter" : ",",
    "syncFileRetentionCount" : 3
},
```

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

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

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

You can now copy the new `provisioner.openicf-myCsvConnector.json` file to your project's `conf/` subdirectory.

You can also configure connectors over the REST interface, or through the Admin UI. For more information, see "Configuring Connectors".

3.4. Using the **encrypt** Subcommand

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 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
```

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 `-j` option indicates that the string to be encrypted is a JSON object, and validates the object. If the object is malformed JSON and you use the `-j` option, the command throws an error. It is easier to input JSON objects in interactive mode. If you input the JSON object on the command-line, the object must be surrounded by quotes and any special characters, including curly braces, must be escaped. The rules for escaping these characters are fairly complex. For more information, see the OSGi specification. For example:

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

The following example encrypts a normal string value:

```
$ ./cli.sh encrypt mypassword
Executing ./cli.sh...x
Starting shell in /path/to/
openidm
-----BEGIN ENCRYPTED VALUE-----
{
  "$crypto" : {
    "type" : "x-simple-encryption",
    "value" : {
      "cipher" : "AES/CBC/PKCS5Padding",
      "stableId" : "openidm-sym-default",
      "salt" : "vdz6bUztiT6QsExNrZQAEA==",
      "data" : "RgMLRbX0guxF80nwrtaZkkoFFGqSQdNWF7Ve0zS+N1I=",
      "keySize" : 16,
      "purpose" : "idm.config.encryption",
      "iv" : "R9w1TcWfbd9FPmOjfvMhZQ==",
      "mac" : "9pXtSKAt9+dO3Mu0NlrJsQ=="
    }
  }
}
------END ENCRYPTED VALUE------
```

The following example prompts for a JSON object to be encrypted:

```
$ ./cli.sh encrypt -j
Using boot properties at /path/to/openidm/resolver/boot.properties
Enter the Json value

> Press ctrl-D to finish input
Start data input:
{"password":"myPassw0rd"}
^D
-----BEGIN ENCRYPTED VALUE-----
{
  "$crypto" : {
    "type" : "x-simple-encryption",
    "value" : {
      "cipher" : "AES/CBC/PKCS5Padding",
      "stableId" : "openidm-sym-default",
      "salt" : "vdz6bUztiT6QsExNrZQAEA==",
      "data" : "RgMLRbX0guxF80nwrtaZkkoFFGqSQdNWF7Ve0zS+N1I=",
      "keySize" : 16,
      "purpose" : "idm.config.encryption",
      "iv" : "R9w1TcWfbd9FPmOjfvMhZQ==",
      "mac" : "9pXtSKAt9+dO3Mu0NlrJsQ=="
    }
  }
}
------END ENCRYPTED VALUE------
```

3.5. Using the **secureHash** Subcommand

The **secureHash** subcommand hashes an input string, or JSON object, using the specified hash algorithm. This subcommand can be used to hash password values, or other sensitive data, to be stored in the repository. The hashed value is output to standard output and provides details of the algorithm that was used to hash the data.

Usage is as follows:

```
$ ./cli.sh secureHash --algorithm [-j] string
```

The `-a` or `--algorithm` option specifies the hash algorithm to use. For a list of supported hash algorithms, see "Encoding Attribute Values by Using Salted Hash Algorithms".

If you do not enter the string as part of the command, the command prompts for the string to be hashed. If you enter the string as part of the command, any special characters, for example quotation marks, must be escaped.

The `-j` option indicates that the string to be hashed is a JSON object, and validates the object. If the object is malformed JSON and you use the `-j` option, the command throws an error. It is easier to input JSON objects in interactive mode. If you input the JSON object on the command-line, the object must be surrounded by quotes and any special characters, including curly braces, must be escaped. The rules for escaping these characters are fairly complex. For more information, see the OSGi specification. For example:

```
$ ./cli.sh secureHash --algorithm SHA-384 '\{\"password\":\"myPassw0rd\"\}'
```

The following example hashes a password value (`mypassword`) using the `SHA-384` algorithm:

```
$ ./cli.sh secureHash --algorithm SHA-384 mypassword
Executing ./cli.sh...
Starting shell in /path/to/openidm
Nov 14, 2017 1:19:49 PM org.forgerock.openidm.core.FilePropertyAccessor loadProps
INFO: Using properties at /path/to/openidm/resolver/boot
.properties
-----BEGIN HASHED VALUE-----
{
  "$crypto" : {
    "value" : {
      "algorithm" : "SHA-384",
      "data" : "1bgOyADyXRFt4lNA80NOM0MeqWyBmAITFnB4742QdSTaLZkCw0kITPOCUhnSaeM8vKMG/W3jRN7slpcrc9jjqg=="
    },
    "type" : "salted-hash"
  }
}
------END HASHED VALUE------
```

The following example prompts for a JSON object to be hashed:

```
$ ./cli.sh secureHash --algorithm SHA-384 -j
Executing ./cli.sh...
Executing ./cli.sh...
Starting shell in /path/to/openidm
Nov 14, 2017 1:24:26 PM org.forgerock.openidm.core.FilePropertyAccessor loadProps
INFO: Using properties at /path/to/openidm/resolver/boot.properties
Enter the Json value

> Press ctrl-D to finish input
Start data input:
{"password":"myPassw0rd"}
^D
-----BEGIN HASHED VALUE-----
{
  "$crypto" : {
    "value" : {
      "algorithm" : "SHA-384",
      "data" : "7Caabx7d+vOZ7d3VMwdQObQJdTQ3uGOItsX5AwR4ViygUfARR/XuxRIBQt1LRq58ZOQXFwuw+3rvzK7Kld8pSg=="
    },
    "type" : "salted-hash"
  }
}
------END HASHED VALUE------
```

3.6. Using the **keytool** Subcommand

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

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

Usage is as follows:

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

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

```
$ ./cli.sh keytool --export openidm-sym-default
   Executing ./cli.sh...
Starting shell in /home/idm/openidm
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`. For security reasons, you *must* change this password in a production environment. For information about changing the keystore password, see "To Change the Default Keystore Password".

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

If a secret key with that name already exists, IDM returns the following error:

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

3.7. Using the **validate** Subcommand

The **validate** subcommand validates all .json configuration files in your project's `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/resolver/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] workflow.json ............................. SUCCESS
```

3.8. Using the **update** Subcommand

The **update** subcommand supports updates for patches and migrations. For an example of this process, see "*Updating Servers*" in the *Installation Guide*.

Chapter 4

Using the Browser-Based UI

IDM provides a customizable, browser-based user interface. The functionality is subdivided into Administrative and Self-Service User Interfaces.

If you are configuring or administering IDM, navigate to the Administrative User Interface (Admin UI). If IDM is installed on the local system, you can get to the Admin UI at the following URL: `https://localhost:8443/admin`. In the Admin UI, you can configure connectors, customize managed objects, set up attribute mappings, manage accounts, and more.

The End User UI 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 IDM starts, you can access the End User UI at `https://localhost:8443/`. For more information, see "*Configuring User Self-Service*".

All users, including `openidm-admin`, can change their password through the End User UI.

Warning

The default password for the administrative user, `openidm-admin`, is `openidm-admin`. To protect your deployment in production, change the default administrative password, as described in "To Change the Default Administrator Password".

4.1. Configuring the Server from the Admin UI

The Admin UI provides a graphical interface for most aspects of the IDM configuration.

Use the Quick Start cards and the Configure and Manage drop-down menus to configure the server.

In the following sections, you will examine the default Admin UI dashboard, and learn how to set up custom Admin UI dashboards.

Caution

If your browser uses an AdBlock extension, it might inadvertently block some UI functionality, particularly if your configuration includes strings such as `ad`. For example, a connection to an Active Directory server might

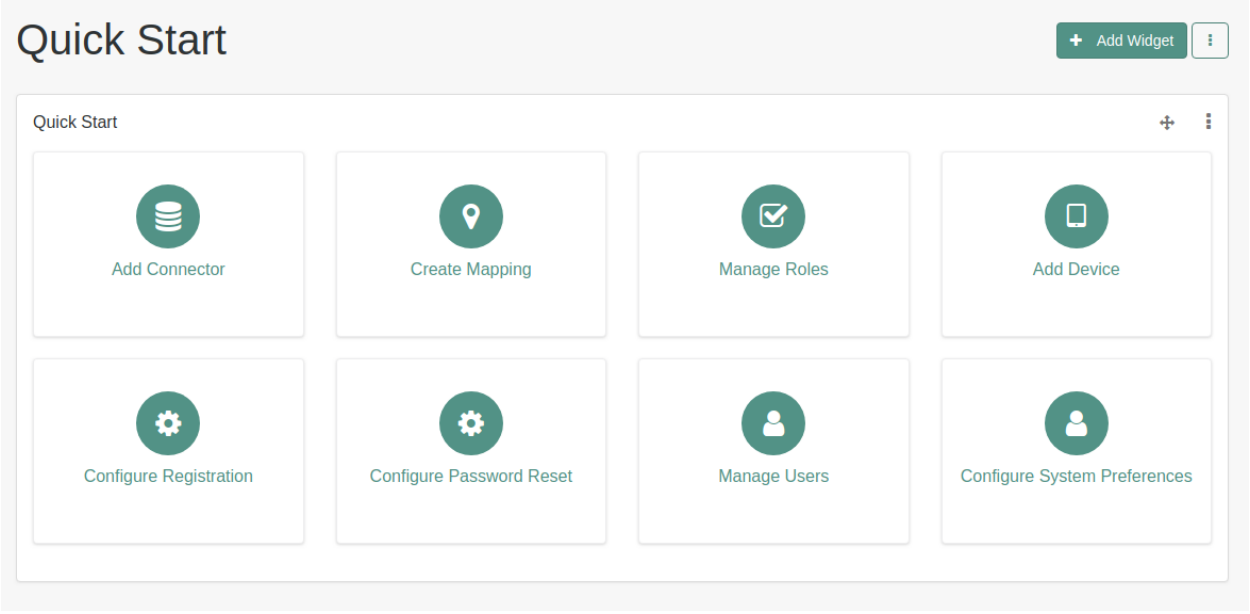
be configured at the endpoint `system/ad`. To avoid problems related to blocked UI functionality, either remove the AdBlock extension, or set up a suitable white list to ensure that none of the targeted endpoints are blocked.

4.1.1. Default Admin UI Dashboards

The Admin UI includes multiple default dashboards. You can create additional dashboards, or add and remove widgets from the existing dashboards. For more information, see "Managing Dashboards".

When you log into the Admin UI the Quick Start dashboard loads by default.

Quick Start Dashboard



The Admin UI includes a fixed top menu bar. As you navigate around the Admin UI, you should see the same menu bar throughout.

To display all configured dashboards, select Dashboards > Manage Dashboards. In addition to the Quick Start dashboard, three dashboards are provided by default: System Monitoring, Resource Report and Business Report. The default dashboards cover the following functionality:

Quick Start Dashboard

- Quick Start cards support one-click access to common administrative tasks. For more information, see "Quick Start Cards".

System Monitoring Dashboard

- Audit Events include information on audit data, segregated by date. For more information on these events, see "*Setting Up Audit Logging*".
- System Health includes data on current CPU and memory usage.
- Last Reconciliation includes data from the most recent reconciliation between data stores.

Resource Report

- The Resources Report includes widgets that show the number of active users, configured roles, and active connectors.
- The Resources widget shows all configured connectors, mappings, and managed object types.

Business Report

The Business Report includes widgets related to login and registration activity.

4.1.1.1. Quick Start Cards

The `Quick Start` cards allow quick access to the following configuration options:

- `Add Connector`

  Use the Admin UI to connect to external resources. For more information, see "Creating Connector Configurations With the Admin UI".

- `Create Mapping`

  Configure synchronization mappings to map objects between resources. For more information, see "Mapping Source Objects to Target Objects".

- `Manage Roles`

  Set up managed provisioning or authorization roles. For more information, see "*Working With Managed Roles*".

- `Add Device`

  Use the Admin UI to set up managed objects, including users, groups, roles, or even Internet of Things (IoT) devices. For more information, see "Managing Accounts".

- `Configure Registration`

  Configure user Self-Registration. You can set up the End User UI login screen, with a link that allows new users to start a verified account registration process. For more information, see "*Configuring User Self-Service*".

- `Configure Password Reset`

Configure user self-service Password Reset. You can configure the ability for users to reset forgotten passwords. For more information, see "*Configuring User Self-Service*".

- `Manage Users`

  Allows management of users in the repository. For more information, see "Working with Managed Users".

- `Configure System Preferences`

  Configure the following aspects of the server:

  - Audit, as described in "*Setting Up Audit Logging*".
  - End User UI, as described in "Changing the UI Path".
  - Privacy & Consent, as described in "Configuring Privacy & Consent".
  - Workflows, as described in "*Integrating Business Processes and Workflows*".

4.1.2. Managing Dashboards

You can set up additional dashboards for customized views of the Admin UI, and you can embed external dashboards such as Kibana or Grafana, or other monitoring boards.

To create a new dashboard, select Dashboards > New Dashboard. Enter a dashboard name and select whether this dashboard should be the default board that is displayed when you load the Admin UI.

- For a customized view of the Admin UI, select Widgets as the Dashboard Type, then select Create Dashboard and add the widgets that you want exposed in that view.

  You can also customize the view by starting with an existing dashboard. In the upper-right corner of the UI, next to the Add Widget button, click the vertical ellipses (⋮) then select Rename or Duplicate.

- To embed an external dashboard, select Embedded URL as the Dashboard Type, then enter the URL of the dashboard that you want to embed and select Create Dashboard.

To add a widget to a dashboard, click Add Widget and select the widget type. Widgets are grouped in logical categories, so scroll down to the category that fits the widget you want to add.

- To modify the position of a widget in a dashboard, click and drag the move icon for the widget (✣).

If you add a new Quick Start widget, select the vertical ellipsis (⋮) icon in the upper right corner of the widget, and click Settings.

- You can configure an Admin UI sub-widget to embed in the Quick Start widget.
- If you are linking to a specific page in the Admin UI, the destination URL can be the part of the address after the main page for the Admin UI, such as `https://localhost:8443/<someURI>`

For example, to create a quick start link to the Audit configuration tab, at `https://localhost:8443/admin/#settings/audit/`, enter `#settings/audit` in the destination URL text box.

IDM writes the changes you make to the `ui-dashboard.json` file for your project.

For example, if you add two widgets (Last Reconciliation and System Health) to a new dashboard named Test, you'll see the following excerpt in your `ui-dashboard.json` file:

```
{
    "name" : "test",
    "isDefault" : false,
    "widgets" : [
        {
            "type" : "lastRecon",
            "size" : "large",
            "barchart" : "false"
        },
        {
            "type" : "systemHealthFull",
            "size" : "large"
        }
    ],
    "embeddedDashboard" : false
}
```

For more information on each property, see the following table:

Admin UI Widget Properties in `ui-dashboard.json`

Property	Options	Description
`name`	User entry	Dashboard name
`isDefault`	`true` or `false`	Default dashboard; can set one default
`widgets`	Different options for `type`	Code blocks that define a widget
`type`	`lifeCycleMemoryHeap`, `lifeCycleMemoryNonHeap`, `systemHealthFull`, `cpuUsage`, `lastRecon`, `resourceList`, `quickStart`, `frame`, `userRelationship`	Widget name
`size`	`x-small`, `small`, `medium`, or `large`	Width of widget, based on a 12-column grid system, where x-small=4, small=6, medium=8, and large=12; for more information, see Bootstrap CSS
`height`	Height, in units such as `cm`, `mm`, `px`, and `in`	Height; applies only to Embed Web Page widget
`frameUrl`	URL	Web page to embed; applies only to Embed Web Page widget

Property	Options	Description
`title`	User entry	Label shown in the UI; applies only to Embed Web Page widget
`barchart`	`true` or `false`	Reconciliation bar chart; applies only to Last Reconciliation widget

When complete, you can select the name of the new dashboard under the Dashboards menu or from the Manage Dashboards panel.

You can modify the options for each dashboard and widget. Select the vertical ellipsis in the upper right corner of the object, and make desired choices from the pop-up menu.

The following tables display an alphabetical list of the available widgets, by category:

Admin UI Reporting Widgets

Name	Description
Audit Events	Graphical display of audit events; also see "Viewing Audit Events in the Admin UI".
Count Widget	A reporting widget that provides an instant display of the number of specific objects, for example active managed users, enabled social providers, and so on. For more information, see "*Reporting, Monitoring, and Notifications*".
Dropwizard Table With Graph	Does not appear in the list of widgets unless metrics are active, per "Metrics and Monitoring".
Graph Widget	Provides a graphical view of a specific managed resource, for example managed users, based on some metric.
Last Reconciliation	Shows statistics from the most recent reconciliation, shown in System Monitoring dashboard; also see "Obtaining the Details of a Reconciliation"
New Registrations	The number of users that have self-registered that week. To display data using this widget, user self-registration must be enabled (see "User Self-Registration").
Password Resets	The number of password resets that week. To display data using this widget, password reset must be enabled (see "User Password Reset").
Resources	Connectors, mappings, managed objects; shown in Administration dashboard
Sign-Ins	The number of managed users that have signed in to the service that week.

Social Widgets

Name	Description
Daily Social Logins	Graphical display of logins via social identity providers; for related information see "*Configuring Social Identity Providers*"
Social Registration (year)	Graphical display of registrations over the past year; for related information, see "*Configuring Social Identity Providers*"

System Status Widgets

Name	Description
Cluster Node Status	Lists the instances in a cluster, with their status. For more information, see "Managing Nodes Through the Admin UI".
CPU Usage	Also part of System Health widget
Memory Usage (JVM Heap)	Graphs available JVM Heap memory (ref "Memory Health Check"
Memory Usage (JVM NonHeap)	Graphs available JVM Non-Heap memory (ref "Memory Health Check"
System Health	Shown in System Monitoring dashboard; includes CPU Usage, Memory Usage (JVM Heap), and Memory Usage (JVM NonHeap)

Utility Widgets

Name	Description
Embed Web Page	Supports embedding of external content; for more information, see Embed Web Page Widget Requirements
Identity Relationships	Graphical display of relationships between identities; also see "Viewing Relationships in Graph Form"
Managed Objects Relationship Diagram	Graphical diagram with connections between managed object properties; also see "Viewing the Relationship Configuration in the UI"
Quick Start	Links to common tasks; shown in Administration dashboard

Embed Web Page Widget Requirements

To use the Embed Web Page applet, you'll need a web site that supports appropriate `x-frame-options`. For example, Google has a *Maps Embed API* for that purpose.

4.2. Managing Accounts

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

4.2.1. Account Configuration

In the Admin UI, you can manage most details associated with an account. Create a user if needed, and then select Manage > User > *Username*. In the screen that appears, you can configure the following elements of a user account:

Details

The Details tab includes basic identifying data for each user, based on attributes configured in your project's `managed.json` file.

Password

As an administrator, you can create new passwords for users in the managed user repository.

Provisioning Roles

Used to specify how objects are provisioned to an external system. For more information, see "*Working With Managed Roles*".

Authorization Roles

Used to specify the authorization rights of a managed user within IDM. For more information, see "*Working With Managed Roles*".

Direct Reports

Users who are listed as managers of others have graphical entries linked to those users under the Direct Reports tab.

Linked Systems

Used to display account information reconciled from external systems.

4.2.2. Procedures for Managing Accounts

With the following procedures, you can use the Admin UI to add, update, and delete accounts for managed objects such as users. To make these changes using REST, see "Working with Managed Users".

The managed object does not have to be a user. It can be a role, a group, or even a physical item such as an IoT device. The basic process for adding, modifying, deactivating, and deleting other objects is the same as it is with accounts. However, the details may vary; for example, many IoT devices do not have telephone numbers.

To Add a User Account

1. Log in to the Admin UI at `https://localhost:8443/admin`.
2. Click Manage > User.
3. Click New User.
4. Complete the fields on the New User page.

By default, the New User page displays only the `password` and the fields that are configured as `required` in the schema, as shown in this excerpt from `managed.json`

```
"required" : [
    "userName",
    "givenName",
    "sn",
    "mail"
]
```

To display additional properties on the New User page, add the desired property to this list of required attributes.

The fields on this page are subject to policy validation, as described in "*Using Policies to Validate Data*". So, for example, the email address must be a valid email address, and the password must comply with the configured password policy.

In a similar way, you can create accounts for other managed objects.

You can review new managed object settings in the `managed.json` file of your *`project-dir`*`/conf` directory.

In the following procedures, you learn how:

- "To Update a User Account"
- "To Delete a User Account"
- "To View an Account in External Resources"

To Update a User Account

1. Log in to the Admin UI at `https://localhost:8443/admin` as an administrative user.
2. Click Manage > User.
3. Click the Username of the user that you want to update.
4. On the profile page for the user, modify the fields you want to change and click Update.

   The user account is updated in the repository.

To Delete a User Account

1. Log in to the Admin UI at `https://localhost:8443/admin` as an administrative user.
2. Click Manage > User.
3. Select the checkbox next to the desired Username.

4. Click the Delete Selected button.
5. Click OK to confirm the deletion.

   The user is deleted from the internal repository.

To View an Account in External Resources

The Admin UI displays the details of the account in the repository (managed/user). When a mapping has been configured between the repository and one or more external resources, you can view details of that account in any external system to which it is linked. As this view is read-only, you cannot update a user record in a linked system from within the Self-Service 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 in to the Admin UI at `https://localhost:8443/admin`.
2. Click Manage User > *Username* > Linked Systems.
3. The Linked Systems panel indicates the external mapped resource or resources.
4. 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.

4.3. Customizing the Admin UI

You can customize the Admin UI for your specific deployment. When you install IDM, you will find the default Admin UI configuration files in the following directory: `openidm/ui/admin/default`.

In most cases, we recommend that you copy this directory to `openidm/ui/admin/extension` with commands such as:

```
$ cd /path/to/openidm/ui/admin
$ cp -r default/. extension
```

You can then set up custom files in the `extension/` subdirectory.

The Admin UI templates in the `openidm/ui/admin/default/templates` directory might help you get started.

If you want to customize workflows in the UI, see "Managing User Access to Workflows".

4.3.1. Customizing the Admin UI, by Functionality

You may want to customize parts of the Admin UI. You've set up an `openidm/ui/admin/extension` directory as described in "Customizing the Admin UI". In that directory, you can find a series of subdirectories. The following table is intended to help you search for the right file(s) to customize:

File Functionality by Admin UI Directory

Subdirectory	Description
`config`	Top-level configuration directory of JavaScript files. Customizable subdirectories include `errorhandlers/` with HTTP error messages and `messages/` with info and error messages. For actual messages, see the `translation.json` file in the `locales/en/` subdirectory.
`css/` and `libs/`	If you use a different bootstrap theme, you can replace the files in this and related subdirectories. For more information, see "UI Themes and Bootstrap".
`fonts/`	The font files in this directory are based on the Font Awesome CSS toolkit described in "Changing the UI Theme".
`images/` and `img/`	IDM uses the image files in these directories, which you can choose to replace with your own.
`locales/`	Includes the associated `translation.json` file, by default in the `en/` subdirectory.
`org/`	Source files for the End User UI
`partials/`	Includes partial components of HTML pages in the End User UI, for assignments, authentication, connectors, dashboards, email, basic forms, login buttons, etc.
`templates/`	The files in the `templates/` subdirectory are in actual use. For an example of how you can customize such files in the Admin UI, see "Customizing the End User UI".

To see an example of how this works, review "Customizing the End User UI". It includes examples of how you can customize parts of the End User UI. You can use the same technique to customize parts of the Admin UI.

Tip

The above table is not a complete list. To see a visual representation of customizable Admin UI files, from the Linux command line, run the following commands:

```
$ cd /path/to/openidm/ui/admin/extension
$ tree
```

4.4. Changing the UI Theme

You can customize the theme of the user interface. The default UI uses the *Bootstrap* framework and the *Font Awesome* CSS toolkit. You can download and customize the UI with the Bootstrap themes of your choice.

Note

If you use *Brand Icons from the Font Awesome CSS Toolkit*, be aware of the following statement:

All brand icons are trademarks of their respective owners. The use of these trademarks does not indicate endorsement of the trademark holder by ForgeRock, nor vice versa.

4.4.1. UI Themes and Bootstrap

You can configure a few features of the UI in the `ui-themeconfig.json` file in your project's `conf/` subdirectory. However, to change most theme-related features of the UI, you must copy target files to the appropriate `extension` subdirectory, and then modify them as discussed in "Customizing the Admin UI".

By default the UI reads the stylesheets and images from the respective `openidm/ui/function/default` directories. Do not modify the files in this directory. Your changes may be overwritten the next time you update or even patch your system.

The default Admin UI configuration files are located in `openidm/ui/admin/default`. To customize the UI, copy this directory to `openidm/ui/admin/extension`:

You may also need to update the `"stylesheets"` listing in the `ui-themeconfig.json` file for your project, in the *`project-dir`*`/conf` directory.

```
"stylesheets" : [
    "css/bootstrap-3.4.1-custom.css",
    "css/structure.css",
    "css/theme.css"
],
```

You can find these `stylesheets` in the `/css` subdirectory.

- `bootstrap-3.4.1-custom.css`: Includes custom settings that you can get from various Bootstrap configuration sites, such as the Bootstrap *Customize and Download* website.

  You may find the ForgeRock version of this in the `config.json` file in the `ui/admin/default/css/common/structure/` directory.

- `structure.css`: Supports configuration of structural elements of the UI.

- `theme.css`: Includes customizable options for UI themes such as colors, buttons, and navigation bars.

If you want to set up custom versions of these files, copy them to the `extension/css` subdirectories.

4.4.2. Changing the Default Logo

The default UI logo is in `openidm/ui/admin/default/images`. To change the logo, place your custom image in the `openidm/ui/admin/extension/images` directory. You should see the changes after refreshing your browser.

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

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

```
...
"loginLogo" : {
     "src" : "images/example-logo.png",
     "title" : "Example.com",
     "alt" : "Example.com",
     "height" : "104px",
     "width" : "210px"
},
...
```

Refresh your browser window for the new logo to appear.

You can configure a few features of the UI in the `ui-themeconfig.json` file in your project's `conf` directory. However, to change most theme-related features of the UI, you must copy target files to the appropriate `extension` subdirectory, and then modify them as discussed in "Customizing the Admin UI".

By default the UI reads the stylesheets and images from the `openidm/ui/admin/default` directory. Do not modify the files in this directory. Your changes may be overwritten the next time you update or even patch your system.

To customize your UI, first set up matching subdirectories in (`openidm/ui/admin/extension`). For example, `openidm/ui/admin/extension/libs` and `openidm/ui/admin/extension/css`.

You might also need to update the `"stylesheets"` listing in the `ui-themeconfig.json` file for your project, in the *`project-dir`*`/conf` directory.

```
"stylesheets" : [
    "css/bootstrap-3.4.1-custom.css",
    "css/structure.css",
    "css/theme.css"
],
```

The default stylesheets have the following function:

- `bootstrap-3.4.1-custom.css`: Includes custom settings that you can get from various Bootstrap configuration sites, such as the Bootstrap Customize and Download site. This site lets you upload a `config.json` file that makes it easier to create a customized Bootstrap file. The ForgeRock version of this file is in `ui/admin/default/css/common/structure/`. You can use this file as a starting point for your customization.
- `structure.css`: For configuring structural elements of the UI.
- `theme.css`: Includes customizable options for UI themes such as colors, buttons, and navigation bars.

To set up custom versions of these files, copy them to the `extension/css` subdirectories.

4.4.4. Custom Response Headers

You can specify custom response headers for your UI by using the `responseHeaders` property in UI context configuration files such as `conf/ui.context-selfservice.json`. For example, the `X-Frame-Options` header is a security measure used to prevent a web page from being embedded within the frame of another page. For more information about response headers, see the MDN page on HTTP Headers.

Since the `responseHeaders` property is specified in the configuration file for each UI context, you can set different custom headers depending on the needs of that part of IDM. For example, you may want different security headers included for the Admin and End User UIs.

4.5. Resetting User Passwords

When working with end users, administrators frequently have to reset their passwords. You can do so directly, through the Admin UI. Alternatively, you can configure an external system for that purpose, or set up password reset, as described in "User Password Reset".

4.5.1. Changing a User Password Through the Admin UI

From the Admin UI, you can change the passwords of accounts in the internal Managed User data store; to do so, take the following steps in the Admin UI:

1. Select Manage > User. Choose a specific user from the list that appears.

2. Select the Password tab for that user; you should be able to change that user's password there.

4.5.2. Using an External System for Password Reset

By default, the Password Reset mechanism is handled within IDM. You can reroute Password Reset in the event that a user has forgotten their 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.

4.6. 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/#logout/`.

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

4.7. Changing the UI Path

By default, the End User UI is registered at the root context and is accessible at the URL `https://localhost:8443`. To specify a different URL, edit the *`project-dir`*`/conf/ui.context-selfservice.json` file, setting the `urlContextRoot` property to the new URL.

For example, to change the URL of the End User UI to `https://localhost:8443/exampleui`, edit the file as follows:

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

Alternatively, to change the End User UI URL in the Admin UI, follow these steps:

1. Log in to the Admin UI.
2. Select Configure > System Preferences, and select the Self-Service UI tab.
3. Specify the new context route in the Relative URL field.

4.8. API Explorer

IDM includes an API Explorer, an implementation of the *OpenAPI Initiative Specification*, also known popularly as Swagger.

To access the API Explorer, log into the Admin UI, select the question mark in the upper right corner, and choose API Explorer from the drop-down menu.

Note

If the API Explorer does not appear, you may need to enable it in your `resolver/boot.properties` file, specifically with the `openidm.apidescriptor.enabled` property. For more information see, "Disabling the API Explorer".

The API Explorer covers most of the endpoints provided with a default IDM installation.

Each endpoint lists supported HTTP methods such as POST and GET. When custom actions are available, the API Explorer lists them as *HTTP Method* `/path/to/endpoint?_action=something`.

To see how this works, navigate to the `User` endpoint, select List Operations, and choose the GET option associated with the `/managed/user#_query_id_query-all` endpoint.

In this case, the defaults are set, and all you need to do is select the `Try it out!` button. The output you see includes:

- The REST call, in the form of the **curl** command.
- The request URL, which specifies the endpoint and associated parameters.
- The response body, which contains the data that you requested.
- The HTTP response code; if everything works, this should be `200`.
- Response headers.

Tip

If you see a `401 Access Denied` code in the response body, your session may have timed out, and you'll have to log into the Admin UI again.

For details on common ForgeRock REST parameters, see "About ForgeRock Common REST".

You'll see examples of REST calls throughout this documentation set. You can try these calls with the API Explorer.

You can also generate an OpenAPI-compliant descriptor of the REST API to provide API reference documentation specific to your deployment. The following command saves the API descriptor of the managed/user endpoint to a file named `my-openidm-api.json`:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 --output "my-openidm-api.json" \
 "http://localhost:8080/openidm/managed/user?_api"
```

For information about publishing reference documentation using the API descriptor, see "To Publish OpenAPI Documentation".

4.9. 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 *project-dir*/conf/ui.context-selfservice.json file, setting the enabled property to false:

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

Chapter 5

Configuring User Self-Service

ForgeRock Identity Management (IDM) allows you to configure a number of features of user self-service, including user self-registration, password reset, username retrieval, custom email notifications, Privacy & Consent, progressive profile completion, Terms & Conditions, and more, as described in the following sections:

- "User Self-Registration"
- "User Password Reset"
- "Forgotten Username"
- "Configuring Notification Emails"
- "Configuring Privacy & Consent"
- "Customizing the End User UI"
- "Setting Up User-Managed Access (UMA), Trusted Devices, and Privacy"
- "Progressive Profile Completion"
- "Adding Terms & Conditions"
- "Localizing the End User UI"

Each of these sections are designed to help you as an IDM deployer, customize the End User UI. To that end, these sections discuss:

- Required and supplementary configuration files, along with available functionality for each file.
- REST endpoints, sometimes including REST calls to identify and change the configuration of each End User UI function.

When appropriate, this chapter includes the steps that you'd take to verify functionality from an end user point of view.

Note

Some of the options described in this chapter can be used to help support compliance with the General Data Protection Regulation (GDPR).

5.1. User Self-Registration

IDM supports user self-registration. When enabled, users can log into the IDM End User UI, and create their own accounts on your system, with customizable criteria. Once enabled, administrators no longer need to create user accounts manually.

In the following sections, you'll examine:

- "Basic Setup: User Self-Registration Configuration Files"
- "Managing User Self-Registration Over REST"
- "Configuring the User Self-Registration Form"
- "User Self-Registration: Social"
- "Configuring User Self-Registration From the Admin UI"
- "Configuring Multiple User Self-Registration Flows"

5.1.1. Basic Setup: User Self-Registration Configuration Files

To set up basic user self-registration, you'll need at least the following configuration files:

- `selfservice-registration.json`

  You can find a template version of this file in the following directory: `openidm/samples/example-configurations/self-service`.

- `ui-configuration.json`

  You can find this file in the default IDM project configuration directory, `openidm/conf`.

Note

Depending on how you configure User Self-Registration, you may need to set up additional configuration files, as discussed in "Configuring the User Self-Registration Form".

To enable self-service registration in the UI, enable the following boolean in `ui-configuration.json`:

```
"selfRegistration" : true,
```

You can include several features with user self-registration, as shown in the following excerpts of the `selfservice-registration.json` file:

- The `allInOneRegistration` property determines whether IDM collects all user registration information in one or multiple pages. By default, it's set to true:

```
"allInOneRegistration" : true,
```

- The `idmUserDetails` code block includes the IDM property for email addresses (`mail`), whether or not registration with social identity providers is enabled, along with data required from new users, as described in "Configuring the User Self-Registration Form".

- The `registrationPreferences` code block includes preferences as defined in the `managed.json` file. For more information, see "Configuring End User Preferences".

- If you've set up Terms & Conditions, users who self-register will have to accept them, based on criteria you create, as discussed in "Adding Terms & Conditions". If you've included Terms & Conditions with user self-registration, you'll see the following code block:

```
{
     "name" : "termsAndConditions"
},
```

- If you've configured Privacy & Consent, you'll see a code block with the `consent` name. The following code block includes template Privacy & Consent terms in English (`en`) and French (`fr`):

```
{
     "name" : "consent",
     "consentTranslations" : {
         "en" : "Please consent to sharing your data with whomever we like.",
         "fr" : "Veuillez accepter le partage de vos données avec les services de notre choix."
     }
},
```

Note

Substitute Privacy & Consent content that meet the requirements of your legal authorities.

New users will have to manually accept these conditions before they complete the self-registration process. For more information, see "Configuring Privacy & Consent".

- If you've activated Google reCAPTCHA for user self-service registration, you'll see the following code block:

```
{
     "name" : "captcha",
     "recaptchaSiteKey" : "<siteKey>",
     "recaptchaSecretKey" : "<secretKey>",
     "recaptchaUri" : "https://www.google.com/recaptcha/api/siteverify"
},
```

As suggested by the code, you'd substitute the actual `siteKey` and `secretKey` assigned by Google for your domain. For more information, see "Configuring Google reCAPTCHA".

- If you've included email verification, be sure to configure an outgoing email server per "*Configuring Outbound Email*". For a discussion of the code block to add to `selfservice-registration.json`, see "Configuring Emails for Self-Service Registration".
- If you've configured security questions, users who self-register will have to create them during registration, and as needed, answer them during the password reset process. If so configured, users who've been reconciled from external data stores will also be prompted to add security questions. The relevant code block is shown here, which includes security questions as a stage in the user self-registration process. For related configuration options, see "Configuring Security Questions".

```
{
     "name" : "kbaSecurityAnswerDefinitionStage",
     "kbaConfig" : null
},
```

For audit activity data related to user self-registration, see "Querying the Activity Audit Log".

5.1.2. Managing User Self-Registration Over REST

You can review the current user self-registration configuration over REST:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/config/selfservice/registration"
```

Unless you've disabled file writes per "Disabling Automatic Configuration Updates", the output will match the contents of your project's `selfservice-registration.json` file.

If needed, you can update this configuration by including the desired contents of the file:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request PUT
 \
--data '{ <Insert file contents here> }' \
"http://localhost:8080/openidm/config/selfservice/registration"
```

5.1.3. Configuring the User Self-Registration Form

During user self-registration, IDM lists the attributes that users see in the user registration form, as defined in the `selfservice-registration.json` file. You can modify the properties shown to users in the `registrationProperties` code block:

```
"registrationProperties" : [
    "userName",
    "givenName",
    "sn",
    "mail"
],
```

If you add a managed user property to the `registrationProperties` code block, IDM includes it in the user self-registration screen.

Alternatively, you can add a managed user property in the Admin UI. Select Configure > User Registration, and add a property under the Registration Form tab. This action also adds a managed user property to the noted code block.

In either case, you can change the order of properties; IDM shows the order you configure in the user self-registration screen.

You can also set up user self-registration via configuration files, as described in the following table:

User Self-Registration Configuration Files

File Name	Description
`external.email.json`	If you want to enable email validation, you'll need to configure this file, as discussed in "*Configuring Outbound Email*".
`managed.json`	You can customize user self-registration based on entries in this file. To change the labels seen by end users, change the associated `title`.
`policy.json`	For more information, see "Adding Custom Policies for Self-Registration and Password Reset".
`selfservice.kba.json`	See "Configuring Security Questions".
`selfservice-registration.json`	See "User Self-Registration".
`ui-configuration.json`	See "User Self-Registration".
`consent.json`	Specifies whether Privacy & Consent is enabled; however, you'll need to set up additional configuration files, as described in "Configuring Privacy & Consent".

5.1.4. User Self-Registration: Social

Before you can activate Social Registration under the User Registration, Social tab, you'll need to configure registration with social identity providers. To review the process, see "*Configuring Social Identity Providers*".

When you've configured one or more social identity providers, you can activate the Social Registration option. This action adds:

- The following setting to the `selfservice-registration.json` configuration file:

```
"socialRegistrationEnabled" : true,
```

- The following configuration file: `selfservice-socialUserClaim.json`, discussed in "Account Claiming: Links Between Accounts and Social Identity Providers".

Under the Social tab, you'll see a list of property mappings as defined in the `selfservice.propertymap.json` file.

One or more `source` properties in this file takes information from a social identity provider. When a user registers with their social identity account, that information is reconciled to the matching `target` property for IDM. For example, the `email` property from a social identity provider is normally reconciled to the IDM managed user `mail` property.

You can also find property mappings in the `sync.json` for your project. For details of these synchronization mappings, see "Mapping Source Objects to Target Objects".

5.1.5. Configuring User Self-Registration From the Admin UI

To configure user self-registration from the Admin UI, select Configure > User Registration and select Enable User Registration in the page that appears.

You'll see a pop-up window that specifies User Registration Settings, including the following:

- Identity Resource, typically `managed/user`
- Identity Email Field, typically `mail` or `email`
- Success URL for the End User UI; users who successfully log in are redirected to that URL. By default, the success URL is `http://localhost:8080/#dashboard/`.
- Preferences, which set up default marketing preferences for new users. New users can change these preferences during registration, or from the End User UI.
- Advanced Options, Snapshot Token, typically a JSON Web Token (JWT)
- Advanced Options, Token Lifetime, with a default of 300 seconds

You can also add these settings to the following configuration file: `selfservice-registration.json`. When you modify these settings in the Admin UI, IDM creates the file for you.

Once active, you'll see three tabs under User Registration in the Admin UI:

- *Registration Form*, as described in "Configuring the User Self-Registration Form"
- *Social*, as described in "User Self-Registration: Social"
- *Options*, as described in "Common Steps: User Self-Registration, Password Reset, Forgotten Username"

5.1.6. Verifying Self-Registration in the End User UI

After configuring user self-registration, test the result from the end user's point of view. Navigate to the End User UI at `http://localhost:8080`, and select `Create an account`. You'll see a single-page Sign Up screen with configured text boxes and required security questions. If included in your configuration files, you'll also see marketing preferences such as "Send me news and updates".

If you've configured Terms & Conditions, you'll see a link to those terms:

```
By clicking "Sign Up" you agree to our Terms & Conditions.
```

Tip

To modify the Terms & Conditions, use the Admin UI or edit the `selfservice.terms.json` file, as described in "Adding Terms & Conditions".

If you've activated the reCAPTCHA option as described in "Configuring Google reCAPTCHA", you'll need to satisfy the requirements before you can select the `SAVE` button to create your new user account.

If you've activated the Privacy & Consent option, you'll see a Privacy Notice pop-up. By default, users who try to register aren't allowed to select the `Give Consent` button, until they actually consent to sharing their information.

Tip

To activate and configure the wording for Privacy & Consent, use the Admin UI or edit the `selfservice-registration.json` file, as described in "Configuring Privacy & Consent".

Once the new user is created, you should be able to verify the account in the following ways:

- Log into the End User UI as the new user.
- Find the `userName` of the new user over REST; one method is shown in "Working with Managed Users".
- Log into the Admin UI, and select Manage > User. You should see that new user in the list.

5.1.7. Configuring Multiple User Self-Registration Flows

You can set up multiple self-registration flows, with features limited only by the capabilities listed in "User Self-Registration".

Note

Multiple self-registration flows, and customization of the End User UI beyond what is described in this document (and the noted public Git repository), are *not* supported.

For additional information on customizing the End User UI, see the following ForgeRock Git repository: *ForgeRock/end-user-ui: Identity Management (End User)*.

For example, you may want to set up different portals for regular employees and contractors. You'd configure each portal with different self-registration flows, managed by the same IDM backend. Each portal would use the appropriate registration API.

To prepare for this section, you'll need a `selfservice-registration.json` file. You can find a copy in the following directory: `/path/to/openidm/samples/example-configurations/self-service`.

To avoid errors when using this file, you should either:

- Copy the following files from the same directory:

  `selfservice.terms.json`
  `selfservice-termsAndConditions.json`

- Delete the `termsAndConditions` code block from the respective `selfservice-registration*.json` files.

User self-registration is normally coded in the `selfservice-registration.json` file. In preparation, copy this file to the `selfservice-registration*.json` to the names shown in the following list:

- Employee Portal
  - Configuration file: `selfservice-registrationEmployee.json`
  - URL: `https://localhost:8443/openidm/selfservice/registrationEmployee`
  - `verificationLink`: `https://localhost:8443/#/registrationEmployee`
- Contractor Portal
  - Configuration file: `selfservice-registrationContractor.json`
  - URL: `https://localhost:8443/openidm/selfservice/registrationContractor`
  - `verificationLink`: `https://localhost:8443/#/registrationContractor`

Edit the configuration file for each portal.

1. Modify the `verificationLink` URL associated with each portal as described.
2. Edit the `access.js` file. You can find it in the `script/` subdirectory for your project.

   Add endpoint information for each new self-service registration file to the `access.js`, after the `selfservice/registration` code block. For example, the following code excerpt would apply to the `registrationEmployee` and `registrationContractor` endpoints.

```
{
    "pattern"    : "selfservice/registrationEmployee",
    "roles"      : "*",
    "methods"    : "read,action",
    "actions"    : "submitRequirements"
},
{
    "pattern"    : "selfservice/registrationContractor",
    "roles"      : "*",
    "methods"    : "read,action",
    "actions"    : "submitRequirements"
},
```

3. Modify the functionality of each selfservice-registration*.json file as desired. For guidance, see the sections noted in the following table:

Configuring `selfservice-registration*.json` Files for Different Portals

Feature	Code Block	Link
Social Registration	`"socialRegistrationEnabled" : true,`	"User Self-Registration: Social"
Properties requested during self-registration	`"registrationProperties" : [ "userName", "givenName", "sn", "mail" ],`	"Configuring the User Self-Registration Form"
Terms & Conditions	`{ "name" : "termsAndConditions" }`	"Adding Terms & Conditions"
Privacy & Consent	`{ "name" : "consent", "consentTranslations" : { "en" : "substitute appropriate Privacy & Consent wording", "fr" : "substitute appropriate Privacy & Consent wording, in French" } },`	
reCAPTCHA	`{ "name" : "captcha", "recaptchaSiteKey" : "<siteKey>", "recaptchaSecretKey" : "<secretKey>", "recaptchaUri" : "https://www.google.com/recaptcha/api/siteverify" }`	"Configuring Google reCAPTCHA"

Feature	Code Block	Link
Email Validation		"Configuring Emails for Self-Service Registration"
Security Questions	`{ "name" : "kbaSecurityAnswerDefinitionStage", "kbaConfig" : null },`	"Configuring Security Questions"

If you leave out the code blocks associated with the feature, you won't see that feature in the self-service registration flow. In that way, you can set up different self-service registration flows for the Employee and Contractor portals.

Once you've configured both portals, you can make REST calls to both URLs:

`https://localhost:8443/openidm/selfservice/registrationEmployee`
`https://localhost:8443/openidm/selfservice/registrationContractor`

For more advice on how you can create custom registration flows, see the following public ForgeRock Git repository: *Identity Management (End User) - UI*.

Note

The changes described in this section require changes to the End User UI source code as described in the noted public Git repository. Pay particular attention to the instructions associated with the `Registration.vue` file.

5.2. User Password Reset

IDM supports self-service user password reset. When enabled, users who forget their passwords can log into the IDM End User UI, and can verify their identities with options such as email validation and security questions.

In the following sections, you'll examine:

- "Basic Setup: User Password Reset Configuration Files"
- "Managing User Password Reset Over REST"
- "Configuring User Self-Registration From the Admin UI"

IDM includes the ability to set up random passwords, as described in "Generating Random Passwords".

5.2.1. Basic Setup: User Password Reset Configuration Files

To set up basic user password reset features, you'll need at least the following configuration files:

- `selfservice-reset.json`

  You can find a template version of this file in the following directory: `openidm/samples/example-configurations/self-service`.

- `ui-configuration.json`

  You can find this file in the default IDM project configuration directory, `openidm/conf`.

To set up self-service user password reset registration, enable the following boolean in `ui-configuration.json`:

```
"passwordReset" : true,
```

You can include several features with user password reset, as shown in the following excerpts of the `selfservice-reset.json` file:

- If you've activated Google reCAPTCHA for user self-service registration, you'll see the following code block:

  ```
  {
       "name" : "captcha",
       "recaptchaSiteKey" : "<siteKey>",
       "recaptchaSecretKey" : "<secretKey>",
       "recaptchaUri" : "https://www.google.com/recaptcha/api/siteverify"
  },
  ```

  As suggested by the code, you'd substitute the actual `siteKey` and `secretKey` assigned by Google for your domain. For more information, see "Configuring Google reCAPTCHA".

- For password reset, IDM needs to verify user identities. To ensure that password reset links are sent to the right user, include the following code block:

  ```
  {
      "name" : "userQuery",
      "validQueryFields" : [
          "userName",
          "mail",
          "givenName",
          "sn"
      ],
      "identityIdField" : "_id",
      "identityEmailField" : "mail",
      "identityUsernameField" : "userName",
      "identityServiceUrl" : "managed/user"
  },
  ```

  This code allows IDM to verify user identities by their username, email address, first name (`givenName`), or last name (`sn`, short for surname).

- If you've included email verification, be sure to configure an outgoing email server per "*Configuring Outbound Email*". For a discussion of the code block to add to `selfservice-registration.json`, see "Configuring Emails for Password Reset".

- If you've configured security questions, users who self-register will have to create questions and answers during the self-registration process.

  If the feature is enabled, users who've been reconciled from external data stores will also be prompted, once, upon their next login, to add security questions and answers. The relevant code block is shown here, which points IDM to other configuration files as discussed in links from this section.

```
{
     "name" : "kbaSecurityAnswerDefinitionStage",
     "kbaConfig" : null
},
```

5.2.2. Managing User Password Reset Over REST

You can review the current user password reset configuration over REST:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/config/selfservice/reset"
```

Unless you've disabled file writes per "Disabling Automatic Configuration Updates", the output should match the contents of your project's `selfservice-reset.json` file.

If needed, you can update this configuration by including the desired contents of the file:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request PUT
 \
--data '{ <Insert file contents here> }' \
"http://localhost:8080/openidm/config/selfservice/reset"
```

5.2.3. Configuring Password Reset From the Admin UI

To configure Password Reset from the Admin UI, select Configure > Password Reset. When you select Enable Password Reset, you'll see a `Configure Password Reset Form` that allows you to specify the:

- Identity Resource, typically `managed/user`
- Advanced Options, Snapshot Token, typically a JSON Web Token (JWT)
- Advanced Options, Token Lifetime, with a default of 300 seconds

You can also add these settings to the following configuration file: `selfservice-reset.json`. When you modify these settings in the Admin UI, IDM creates the file for you.

5.2.4. Verifying Password Reset in the End User UI

After configuring password reset in "User Password Reset", you can test the result from the end user's point of view. Navigate to the End User UI at `http://localhost:8080`, select the Profile icon ( ) > Account Security > Password > `Reset your password`.

You should see a Reset Your Password page with pre-configured queries. After providing an answer, IDM should send a password reset link to the email associated with the target user account.

5.3. Forgotten Username

You can set up IDM to allow users to recover forgotten usernames. You can require that users enter email addresses, or first and last names. Depending on your choices, IDM then will either display that username on the screen, and/or email such information to that user.

In the following sections, you'll examine:

- "Basic Setup: Forgotten Username Configuration Files"
- "Managing Forgotten Username Retrieval Over REST"
- "Configuring Forgotten Username Retrieval From the Admin UI"

5.3.1. Basic Setup: Forgotten Username Configuration Files

To set up basic forgotten username configuration, you'll need at least the following configuration files:

- `selfservice-username.json`

  You can find a template version of this file in the following directory: `openidm/samples/example-configurations/self-service`.

- `ui-configuration.json`

  You can find this file in the default IDM project configuration directory, `openidm/conf`.

To set up forgotten username retrieval, enable the following boolean in `ui-configuration.json`:

```
"forgotUsername" : true,
```

You can include several features with forgotten username retrieval, as shown in the following excerpts of the `selfservice-reset.json` file:

- If you've activated Google reCAPTCHA for forgotten username retrieval, you'll see the following code block:

```
{
    "name" : "captcha",
    "recaptchaSiteKey" : "<siteKey>",
    "recaptchaSecretKey" : "<secretKey>",
    "recaptchaUri" : "https://www.google.com/recaptcha/api/siteverify"
},
```

As suggested by the code, you'd substitute actual `siteKey` and `secretKey` assigned by Google for your domain. For more information, see "Configuring Google reCAPTCHA".

- For forgotten username retrieval, IDM needs to verify user identities. To ensure that usernames are sent to the right user, include the following code block:

```
{
    "name" : "userQuery",
    "validQueryFields" : [
        "mail",
        "givenName",
        "sn"
    ],
    "identityIdField" : "_id",
    "identityEmailField" : "mail",
    "identityUsernameField" : "userName",
    "identityServiceUrl" : "managed/user"
},
```

This code allows IDM to verify user identities by their username, email address, first name (`givenName`), or last name (`sn`, short for surname).

- If you've included email verification, you must also configure an outgoing email server per "*Configuring Outbound Email*". For a discussion of the code block to add to `selfservice-username.json`, see "Configuring Emails for Forgotten Username".

- The following code block, after confirming user identity, allows IDM to display the username:

```
{
     "name" : "retrieveUsername"
}
```

5.3.2. Managing Forgotten Username Retrieval Over REST

You can review the current forgotten username configuration over REST:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/config/selfservice/username"
```

Unless you've disabled file writes per "Disabling Automatic Configuration Updates", the output will match the contents of your project's `selfservice-username.json` file.

If needed, you can update this configuration by including the desired contents of the file:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request PUT
 \
--data '{ <Insert file contents here> }' \
"http://localhost:8080/openidm/config/selfservice/username"
```

5.3.3. Configuring Forgotten Username Retrieval From the Admin UI

To configure forgotten username retrieval from the Admin UI, select Configure > Forgotten Username. When you select Enable Forgotten Username Retrieval, you'll see a *Configure Forgotten Username Form* that allows you to specify the:

- Identity Resource, typically `managed/user`
- Advanced Options, Snapshot Token, typically a JSON Web Token (JWT).
- Advanced Options, Token Lifetime, with a default of 300 seconds

You can also add these settings to the following configuration file: `selfservice-username.json`. When you modify these settings in the Admin UI, IDM creates the file for you.

5.3.4. Verifying Access to a Forgotten Username in the End User UI

After configuring forgotten username retrieval, you can test the result from the end user's point of view. Navigate to the End User UI at `http://localhost:8080`, and select `Forgot Username?`.

You should see a Retrieve Your Username page with pre-configured queries. After providing an answer, IDM should either display your username in the local browser, or send that username to the associated email address.

5.4. Common Steps: User Self-Registration, Password Reset, Forgotten Username

For each of the titled Self-Service features, you can configure several steps in the main configuration file for each feature: `selfservice-registration.json`, `selfservice-reset.json`, and `selfservice-username.json`. For more information, see the following sections:

- "Configuring Google reCAPTCHA"

- "Configuring Self-Service Email Validation / Username"
- "Configuring Security Questions"
- "Adding Custom Policies for Self-Registration and Password Reset"

5.4.1. Configuring Google reCAPTCHA

Google reCAPTCHA helps prevent bots from registering users or resetting passwords on your system. For Google documentation on this feature, see *Google reCAPTCHA*. IDM works with Google reCAPTCHA v2.

To use Google reCAPTCHA, you will need a Google account and your domain name (RFC 2606-compliant URLs such as `localhost` and `example.com` are acceptable for test purposes). Google then provides a Site key and a Secret key that you can include in the self-service function configuration.

For example, you can set up reCAPTCHA by adding the following code block to the configuration file for user self-registration `selfservice-registration.json`, password reset, `selfservice-reset.json` and forgotten username `selfservice-username.json` functionality.

```
{
    "name" : "captcha",
    "recaptchaSiteKey" : "< Insert Site Key Here >",
    "recaptchaSecretKey" : "< Insert Secret Key Here >",
    "recaptchaUri" : "https://www.google.com/recaptcha/api/siteverify"
},
```

You may also add the reCAPTCHA keys through the UI for each of these self-service features.

5.4.2. Configuring Self-Service Email Validation / Username

When a user requests a new account, a password reset, or a reminder of their username, you can configure IDM to confirm the request by sending an email message to that user.

Before you can configure email validation, you must first configure an outgoing email service. To do so, select Configure > Email Settings. For more information, read "*Configuring Outbound Email*".

To activate Email Validation, you'll need to include an appropriate code block, depending on whether you're setting up self-registration, password reset, or forgotten username functionality, in the corresponding configuration file.

Alternatively, in the Admin UI, select Configure > User Registration or Password Reset or Forgotten Username. Enable the feature. Under the Options tab, enable the Email option.

To configure the email message that informs the user of the new account, see "Configuring Notification Emails".

The following sections include the code blocks that are added to each configuration file:

5.4.2.1. Configuring Emails for Self-Service Registration

To configure emails for self-service registration, you can add the following code block to the `selfservice-registration.json` file:

```
{
    "name" : "emailValidation",
    "identityEmailField" : "mail",
    "emailServiceUrl" : "external/email",
    "emailServiceParameters" : {
        "waitForCompletion" : false
    },
    "from" : "info@example.com",
    "subject" : "Register new account",
    "mimeType" : "text/html",
    "subjectTranslations" : {
        "en" : "Register new account",
        "fr" : "Créer un nouveau compte"
    },
    "messageTranslations" : {
        "en" : "<h3>This is your registration email.</h3><h4><a href=\"%link%\">Email verification link</
a></h4>",
        "fr" : "<h3>Ceci est votre mail d'inscription.</h3><h4><a href=\"%link%\">Lien de vérification
 email</a></h4>"
    },
    "verificationLinkToken" : "%link%",
    "verificationLink" : "https://localhost:8443/#/registration/"
},
```

As suggested by the code block, it includes default registration email messages in English (`en`) and French (`fr`). The `verificationLink` sent with the email takes users to the IDM self-registration URL.

As noted in "Managing User Self-Registration Over REST", you can make these changes over the following endpoint URI: `/openidm/config/selfservice/registration`

If desired, you can also configure self-service registration emails through the Admin UI. Select Configure > User Registration. If needed, activate the Enable User Registration Option. Under the Options tab, in the Email Validation box, select the ✎ icon. The Configure Validation Email pop-up should appear.

When you use the Admin UI to customize self-registration emails, you can review the changes in the `selfservice-registration.json` file.

5.4.2.2. Configuring Emails for Password Reset

To configure emails for password reset, you can add the following code block to the `selfservice-reset.json` file:

```
{
    "name" : "emailValidation",
    "identityEmailField" : "mail",
    "emailServiceUrl" : "external/email",
    "emailServiceParameters" : {
        "waitForCompletion" : false
    },
    "from" : "info@example.com",
    "subject" : "Reset password email",
    "mimeType" : "text/html",
    "subjectTranslations" : {
        "en" : "Reset your password",
        "fr" : "Réinitialisez votre mot de passe"
    },
    "messageTranslations" : {
        "en" : "<h3>Click to reset your password</h3><h4><a href=\"%link%\">Password reset link</a></h4>",
        "fr" : "<h3>Cliquez pour réinitialiser votre mot de passe</h3><h4><a href=\"%link%\">Mot de passe
 lien de réinitialisation</a></h4>"
    },
    "verificationLinkToken" : "%link%",
    "verificationLink" : "https://localhost:8443/#/passwordreset/"
},
```

As suggested by the code block, it includes default password reset email messages in English (`en`) and French (`fr`). The `verificationLink` sent with the email takes users to the IDM password reset URL.

As noted in "Managing User Password Reset Over REST", you can make these changes over the following endpoint URI: `/openidm/config/selfservice/reset`

If desired, you can also configure self-service password reset emails through the Admin UI. Select Configure > Password Reset. If needed, activate the Enable Password Reset option, and in the Email Validation box, select the icon. The Configure Validation Email pop-up should appear.

When you use the Admin UI to customize password reset emails, you can review the changes in the `selfservice-reset.json` file.

5.4.2.3. Configuring Emails for Forgotten Username

To configure emails for forgotten username functionality, you can add the following code block to the `selfservice-username.json` file:

```
{
    "name" : "emailUsername",
    "emailServiceUrl" : "external/email",
    "emailServiceParameters" : {
        "waitForCompletion" : false
    },
    "from" : "info@example.com",
    "mimeType" : "text/html",
    "subjectTranslations" : {
        "en" : "Account Information - username"
    },
    "messageTranslations" : {
        "en" : "<h3>Username is:</h3><br />%username%"
    },
    "usernameToken" : "%username%"
},
```

As suggested by the code block, it includes default email messages in English (`en`), with a `usernameToken` that includes the actual username in the message.

As noted in "Managing Forgotten Username Retrieval Over REST", you can make these changes over the following endpoint URI: `/openidm/config/selfservice/username`

If desired, you can also configure forgotten username retrieval emails through the Admin UI. Select Configure > Forgotten Username. If needed, activate the Enable Forgotten Username Retrieval option, and in the Email Username box, select the icon. The Configure Email Username pop-up should appear.

When you use the Admin UI to customize forgotten username retrieval emails, you can review the changes in the `selfservice-username.json` file.

5.4.3. Configuring Security Questions

IDM uses security questions to enable users to verify their identities. Security questions are sometimes referred to as Knowledge-Based Authentication (KBA). When an administrator has configured security questions, self-service users can choose from the questions set in the `selfservice.kba.json` file, as described in "Security Questions and Self-Registration".

You can prompt users to update their security questions. As these questions may be subject to risks, you can set up IDM to prompt the user to update and/or add security questions, courtesy of the `selfservice-kbaUpdate.json` file. For more information, see "Prompting to Update Security Questions".

5.4.3.1. Security Questions and Self-Registration

The user is prompted to enter answers to pre-configured or custom security questions, during the self-registration process. These questions are used to help verify an identity when a user requests a password reset. These questions do not apply for users who need username retrieval.

The template version of the `selfservice.kba.json` file is straightforward; it includes `minimumAnswersToDefine`, which requires a user to define at least that many security questions and

answers, along with `minimumAnswersToVerify`, which requires a user to answer (in this case) at least one of those questions when asking for a password reset.

```
{
      "kbaPropertyName" : "kbaInfo",
      "minimumAnswersToDefine": 2,
      "minimumAnswersToVerify": 1,
      "questions" : {
          "1" : {
              "en" : "What's your favorite color?",
              "en_GB" : "What is your favourite colour?",
              "fr" : "Quelle est votre couleur préférée?"
          },
          "2" : {
              "en" : "Who was your first employer?"
          }
      }
}
```

To configure account lockout based on the security questions, add the following lines to your `selfservice.kba.json` file:

```
"numberOfAttemptsAllowed" : 2,
"kbaAttemptsPropertyName" : "lockoutproperty"
```

With this configuration, users who make more than two mistakes in answering security questions are prevented from using the password reset facility until the `kbaAttemptsPropertyName` field is removed or the number is set to a value lower than the `numberOfAttemptsAllowed`. The number of mistakes is recorded in whatever property you assign to `kbaAttemptsPropertyName` (`lockoutproperty` in this example).

If you are using an explicit mapping for managed user objects, you must add this *lockoutproperty* to your database schema *and* to the `objectToColumn` mapping in your repository configuration file.

For example, the previous configuration would require the following addition to your `conf/repo.jdbc.json` file:

```
"explicitMapping" : {
     "managed/user": {
     "table" : "managed_user",
     "objectToColumn": {
         ...
         "lockoutproperty" : "lockoutproperty",
         ...
}
```

You would also need to create a `lockoutproperty` column in the `openidm.managed_user` table, with datatype `VARCHAR`. For example:

```
mysql> show columns from managed_user;

+---------------------+-------------+------+-----+---------+-------+
| Field               | Type        | Null | Key | Default | Extra |
+---------------------+-------------+------+-----+---------+-------+
| objectid            | varchar(38)  | NO   | PRI | NULL    |       |
| rev                 | varchar(38)  | NO   |     | NULL    |       |
| username            | varchar(255) | YES  | UNI | NULL    |       |
| password            | varchar(511) | YES  |     | NULL    |       |
| accountstatus       | varchar(255) | YES  | MUL | NULL    |       |
| postalcode          | varchar(255) | YES  |     | NULL    |       |
| lockoutproperty     | varchar(255) | YES  |     | NULL    |       |
...
```

Warning

Once you deploy these IDM self-service features, you should never remove or change existing security questions, as users may have included those questions during the user self-registration process.

You may change or add the questions of your choice, in JSON format. If you're configuring user self-registration, you can also edit these questions through the Admin UI. In fact, the Admin UI allows you to localize these questions in different languages.

In the Admin UI, select Configure > User Registration. Enable User Registration, select Options > Security Questions and select the edit icon to add, edit, or delete these questions.

Any change you make to the security questions under User Registration also applies to Password Reset. To confirm, select Configure > Password Reset. Enable Password Reset, and edit the Security Questions. You'll see the same questions there.

In addition, individual users can configure their own questions and answers, in two ways:

- During the user self-registration process
- From the End User UI, in the user's Profile section (), under Account Security > Security Questions

Important

A managed user's security questions can only be changed through the `selfservice/userupdate` endpoint, or when the user is created through `selfservice/registration` and provides their own questions. You cannot manipulate a user's `kbaInfo` property directly through the `managed/user` endpoint.

When the answers to security questions are hashed, they are converted to lowercase. If you intend to pre-populate answers with a mapping, the `openidm.hash` function or the `secureHash` mechanism, you must provide the string in lowercase to match the value of the answer.

5.4.3.2. Prompting to Update Security Questions

IDM supports a requirement for users to update their security questions, in the `selfservice-kbaUpdate.json` file. You can find this file in the following directory: `/path/to/openidm/samples/example-configurations/self-service`.

Alternatively, if you set up security questions from the Admin UI, you can navigate to Configure > Security Questions > Update Form, and select Enable Update. This action adds a `selfservice-kbaUpdate.json` file to your project's `conf/` subdirectory.

For more information on this configuration file, see "Conditional User Stage" in the *Self-Service REST API Reference*.

5.4.4. Adding Custom Policies for Self-Registration and Password Reset

IDM has specific policies for usernames and passwords, in the `policy.js` file in the `openidm/bin/defaults/script` directory. To enforce these policies for user self-registration and password reset, add the following objects to your `conf/policy.json` file, under `resources`:

```
{
    "resource" : "selfservice/registration",
    "calculatedProperties" : {
        "type" : "text/javascript",
        "source" : "require('selfServicePolicies').getRegistrationProperties()"
    }
},
{
    "resource" : "selfservice/reset",
    "calculatedProperties" : {
        "type" : "text/javascript",
        "source" : "require('selfServicePolicies').getResetProperties()"
    }
},
```

For more information on IDM policies, see "*Using Policies to Validate Data*".

5.5. Configuring Notification Emails

When you configure the outbound email service as described in "*Configuring Outbound Email*", IDM may use that service to notify users of significant events, primarily related to user self-service. For specifics, see the following table for related notification emails:

Configuring Notification Emails

Situation	Configuration File	Details
When a user is successfully registered	`emailTemplate-welcome.json`	See "User Self-Registration Email Template"
When a user asks for their forgotten username	`selfservice-username.json`	See "Configuring Emails for Forgotten Username"
When a user registers using self-service and needs to verify their email address	`selfservice-registration.json`	See "Configuring Emails for Self-Service Registration"
When a user asks for a password reset	`selfservice-reset.json`	See "Configuring Emails for Password Reset"

Each email template can specify an email address to use in the `From` field. If this field is left blank, IDM will default to the address specified in Email Settings.

Note

Email templates utilize Handlebar expressions to reference object data dynamically. For example, to reference the `userName` of an object:

```
{{object.userName}}
```

Note

Some email providers, such as Google, will override the `From` address you specify in the templates, and instead use the address used to authenticate with the SMTP server. The email address specified in the template may still be present, but in an email header hidden from most users, such as `X-Google-Original-From`.

5.5.1. User Self-Registration Email Template

When a new user registers through the IDM self-registration interface, and if you've configured email per "*Configuring Outbound Email*", that user will get a welcome email as configured in the `emailTemplate-welcome.json` file:

```
{
    "enabled" : true,
    "from" : "",
    "subject" : {
        "en" : "Your account has been created"
    },
    "message" : {
        "en" : "<html><body><p>Welcome to OpenIDM. Your username is '{{object.userName}}'.</p></body></
html>"
    },
    "defaultLocale" : "en"
}
```

You may want to make the following changes:

- Add an email address to the `from` property, perhaps an email address for your organization's systems administrator.
- Set up appropriate locale(s).
- Modify the subject line as needed.
- Include a welcome `message` appropriate to your organization.

5.5.2. Managing Email Templates from the Admin UI

The Admin UI includes tools that can help you customize email messages related to two administrative tasks: creating users and resetting passwords.

To configure these messages from the Admin UI, select Configure > Email Settings > Templates, where you'll see the following option:

- Welcome: To configure emails that notify a user of a newly created account, as defined in `emailTemplate-welcome.json`.

> **Note**
>
> IDM sends the same welcome email to users created with a REST call. For an example of user creation over REST, see "Working with Managed Users".

5.6. Configuring Privacy & Consent

IDM supports Privacy & Consent for users who register via IDM directly or via a social identity provider. For more information on the registration process, see "User Self-Registration" and "*Configuring Social Identity Providers*".

As configured for IDM, if you set up Privacy & Consent, users have to accept sharing their data before they get registered accounts.

To set up Privacy & Consent, edit the following configuration files:

- In `selfservice-registration.json`, you'll need to specify privacy notices in the `consentTranslations` code block:

```
{
    "name" : "consent",
    "consentTranslations" : {
     "en" : "<Substitute appropriate Privacy & Consent wording>",
     "fr" : "<Substitute appropriate Privacy & Consent wording, in French>"
    }
},
```

You can also set this up on the following endpoint: `/openidm/config/selfservice/registration`

- In `consent.json`, make sure it's `enabled`:

```
{
    "enabled" : true
}
```

You can also set this up on the following endpoint: `/openidm/config/consent`

- In the `sync.json` file, for the required mapping, include:

```
"consentRequired" : true,
```

You can also set this up on the following endpoint: `/openidm/config/sync`

Alternatively, you can set up Privacy & Consent in the Admin UI by enabling the following:

- In the Admin UI, select Configure > System Preferences. In the Privacy & Consent tab, activate the Enable toggle, and select Save.
- Configure Privacy & Consent in the desired mapping. To review available mappings, select Configure > Mappings.

Note

IDM activates Privacy & Consent *only* for mappings *from* a Managed Object source. In other words, end users give their consent for transferring some or all of their data only to external systems, such as DS. Then, IDM includes a Privacy & Consent option in the End User UI for regular users.

Conversely, in a mapping *to* a Managed Object target, the IDM Admin UI seems to allow you to activate Privacy & Consent mappings. As users in your Managed Object store presumably have given their consent to share their information, IDM does not implement those changes in the End User UI.

- Select Configure > User Registration. Select Enable User Registration if it isn't already enabled, and then enable Privacy & Consent.

To see how this works for a newly registered user, see "Verifying Self-Registration in the End User UI".

5.7. Account Claiming: Links Between Accounts and Social Identity Providers

If your users have one or more social identity providers, they can link them to the same IDM user account. This section assumes that you have configured one or more of the social identity providers described in "*Configuring Social Identity Providers*".

Conversely, you should not be able to link more than one IDM account with a single social identity provider account.

When social accounts are associated with an IDM account, IDM creates a managed record, which uses the name of the social identity provider name as the managed object type, and the subject is used as the `_id`. This combination has a unique constraint; if you try to associate a second IDM account with the same social account, IDM detects a conflict, which prevents the association.

The default process uses the email address associated with the account. Once you've configured social identity providers, you can see this filter in the `selfservice-socialUserClaim.json` file:

```
{
    "name" : "socialUserClaim",
    "identityServiceUrl" : "managed/user",
    "claimQueryFilter" : "/mail eq \"{{mail}}\""
},
```

You can modify the `claimQueryFilter` to a different property such as `telephoneNumber`. Make sure that property is:

- Set to "required" in the `managed.json` file; the default list for managed users is shown here:

```
"required" : [
    "userName",
    "givenName",
    "sn",
    "mail"
]
```

- Unique; for example, if multiple users have the same telephone number, IDM responds with error messages shown in "When Multiple Users have the Same Email Address".

Based on the `claimQueryFilter`, what IDM does depends on the following scenarios:

- "When the Email Address is New"
- "When One User has the Same Email Address"
- "When Multiple Users have the Same Email Address"

5.7.1. When the Email Address is New

When you register with a social identity provider, IDM checks the email address of that account against the managed user data store.

If that email address doesn't exist for any IDM managed user, IDM takes available identifying information, and pre-populates the self-registration screen. If all required information is included, IDM proceeds to other screens, depending on what you've activated in this section: "Common Steps: User Self-Registration, Password Reset, Forgotten Username".

5.7.2. When One User has the Same Email Address

When you register with a social identity provider, IDM checks the email address of that account against the managed user data store.

If that email address exists for *one* IDM managed user, IDM gives you a chance to link to that account, with the following message:

```
We found an existing account with the same email address
<substitute email address>. To continue, please enter your password to
link accounts.
```

In the text box, users are expected to enter their IDM account password.

5.7.3. When Multiple Users have the Same Email Address

When you register with a social identity provider, IDM checks the email address of that account against the managed user data store.

If that email address exists for *multiple* IDM managed users, IDM denies the login attempt, with the following error message:

```
Unable to authenticate using login provider
```

IDM denies further attempts to login with that account with the following message:

```
Forbidden request error
```

5.7.4. The Process for End Users

When your users register with a social identity provider, as defined in "*Configuring Social Identity Providers*", they create an account in the IDM managed user data store. As an end user, you can link additional social identity providers to that data store, from the End User UI, using the following steps:

1. Navigate to the End User UI, at an URL such as `http://IDM.example.com:8080`.
2. Log into the account, either as an IDM user, or with a social identity provider.
3. Navigate to Profile ( ) > Social Sign-in. You should see a list of configured social identity providers.
4. Connect to the social identity providers of your choice. Unless you've already signed in with that social provider, you should be prompted to log into that provider.
5. To test the result, log out and log back in, using the link for the newly linked social identity provider.

5.7.5. Reviewing Linked Accounts as an Administrator

You can review social identity accounts linked to an IDM account, from the Admin UI and from the command line. You can disable or delete social identity provider information for a specific user from the command line, as described in "Reviewing Linked Accounts Over REST".

When you activate a social identity provider, IDM creates a new managed object for that provider. You can review that managed object in the `managed.json` file, as well as in the Admin UI, by selecting Configure > Managed Objects.

The information shown is reflected in the schema in the `identityProvider-providername.json` file for the selected provider.

Note

Do not edit social identity provider profile information through IDM. Any changes that you make won't be synchronized with that provider.

5.7.5.1. Reviewing Linked Accounts Over REST

To identify linked social identity provider accounts for a user, you must specifically add the `idps` field to your user query. For example, the following query shows bjensen's linked social identity information:

```
$ curl \
--header "X-OpenIDM-Username:openidm-admin"
 \
--header "X-OpenIDM-Password:openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/managed/user?_queryFilter=userName+eq+'bjensen'&_fields=idps"
{
  "result": [
    {
      "_id": "bjensen",
      "_rev": "000000003062291c",
      "idps": [
        {
          "_ref": "managed/google/108246554379618660085",
          "_refResourceCollection": "managed/google",
          "_refResourceId": "108246554379618660085",
          "_refProperties": {
            "_id": "ba01a4c3-8a7f-468b-8b09-95f5d34f05ea",
            "_rev": "0000000098619792"
          }
        }
      ]
    }
  ]
,
...
}
```

For more information about a specific social identity provider, query the identity *relationship* using the referred resource ID. The following example shows the information collected from the Google provider for bjensen:

```
$ curl \
--header "X-OpenIDM-Username:openidm-admin"
 \
--header "X-OpenIDM-Password:openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/managed/google/108246554379618660085"
    {
  "_id": "108246554379618660085",
  "_rev": "00000000e5cace4d",
  "sub": "108246554379618660085",
  "name": "Barbara Jensen",
  "given_name": "Barbara",
  "family_name": "Jensen",
  "picture": "https://lh3.googleusercontent.com/-XdUIqdMkCWA/AAAAAAAAAAI/AAAAAAAAAAA/4252rscbv5M/photo
.jpg",
  "email": "babs.jensen@gmail.com",
  "email_verified": true,
  "locale": "en",
  "_meta": {
    "subject": "108246554379618660085",
    "scope": [
      "openid",
      "profile",
      "email"
    ],
    "dateCollected": "2018-03-08T02:07:27.882"
  }
}
```

When a user disables logins through one specific social identity provider in the End User UI, that sets `"enabled" : false` in the data for that provider. However, that user's social identity information is preserved.

Alternatively, you can use a REST call to disable logins to a specific social identity provider. The following REST call removes a user's ability to log in through Google:

```
$ curl  \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-type: application/json"
 \
--request POST \
"http://localhost:8080/openidm/managed/user/9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb?
_action=unbind&provider=google"
```

In this case, the REST call deletes all Google social identity provider information for that user.

5.7.5.2. Reviewing Linked Accounts From the Admin UI

When you configure a social identity provider, IDM includes two features in the Admin UI.

- The ability to review the social identity accounts linked to specific users. To see how this works, log into the Admin UI, and select Manage > User, and select a user. Under the Identity Providers tab, you can review the social identity providers associated with a specific account.
- A managed object for each provider. For example, if you've enabled Google as a social identity provider, select Manage > Google. In the screen that appears, you can select the ID for any Google social identity account that has been used or linked to an existing IDM account, and review the profile information shared from that provider.

5.8. Customizing the End User UI

For information on customizing the IDM End User UI, see the following ForgeRock Git repository: *ForgeRock/end-user-ui: Identity Management (End User)*.

5.9. Setting Up User-Managed Access (UMA), Trusted Devices, and Privacy

In the following sections, you'll refer to AM documentation to set up User-Managed Access (UMA), Trusted Devices, and Privacy for your end users. These options require IDM working with AM. For a working implementation of both products, see "*Integrating IDM With the ForgeRock Identity Platform*" in the *Samples Guide*.

Tip

If you want to configure both UMA and Trusted Devices in AM, configure these features in the following order, as described in the sections that follow:

1. Set up UMA
2. Use AM to configure UMA-based resources
3. Configure Trusted Devices

If you have to reconfigure UMA at a later date, you'll have to first disable Trusted Devices. You can enable Trusted Devices, once again, afterwards.

5.9.1. User Managed Access in IDM

When you integrate IDM with ForgeRock Access Management (AM) you can take advantage of AM's abilities to work with User-Managed Access (UMA) workflows. AM and IDM use a common installation of ForgeRock Directory Services (DS) to store user data.

For instructions on how to set up this integration, see "*Integrating IDM With the ForgeRock Identity Platform*" in the *Samples Guide*. Be sure to set up DS as the AM user data store. Once you've set up integration through that sample, you can configure AM to work with UMA. For more information, see the AM *User-Managed Access (UMA) Guide*. From that guide, you need to know how to:

- Set up AM as an authorization server.
- Register resource sets and client agents in AM.
- Help users manage access to their protected resources through AM.

Pay close attention to the AM documentation on configuring an OAuth 2.0 UMA Client and UMA Server. You may need to add specific grant types to each OAuth 2.0 application.

If you follow AM documentation to set up UMA, you'll see instructions on setting up users as resource owners and requesting parties. If you set up users in AM, be sure to include the following information for each user:

- First Name
- Last Name
- Email Address

AM writes this information to the common DS user data store. You can then synchronize these users to the IDM Managed User data store, with a command such as:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request POST \
"http://localhost:8080/openidm/recon?_action=recon&mapping=systemLdapAccounts_managedUser"
```

After your users have shared UMA resources from the AM Self-Service UI, they can view what they've done and shared in the IDM End User UI, by selecting the Sharing icon (↷).

5.9.2. Configuring Trusted Devices on IDM

You can configure Trusted Devices through AM, using the following sections of the AM Authentication and Single Sign-On Guide: *Configuring Authentication Chains* and *Device ID (Match) Authentication Module*. You can use the techniques described in these sections to set up different authentication chains for administrators and regular users.

You can create an AM authentication chain with the following modules and criteria:

AM Authentication Chain Modules

Module	Criteria
Data Store	Requisite

Module	Criteria
Device Id (Match)	Sufficient
Device Id (Save)	Required

This is different from the authentication chain described in the following section of the *AM Authentication and Single Sign-On Guide*: *Device ID (Match) Authentication Module*, as it does not include the *HOTP Authentication Module*

When trusted devices are enabled, users are presented with a prompt on a screen with the following question "Add to Trusted Devices?". If the user selects `Yes`, that user is prompted for the name of the Trusted Device.

Note

In default configurations, trusted devices are not saved for the AM `amadmin` account. However, you can set up different AM administrative users as described in the following section of the AM *Setup and Maintenance Guide*: *Delegating Realm Administration Privileges*.

You can set up different authentication chains for regular and administrative users, as described in the AM *Authentication and Single Sign-On Guide*.

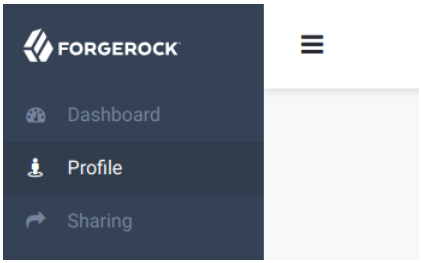
5.10. Privacy: My Account Information in the End User UI

While end users can find their information in the End User UI, you can use REST calls and audit logs to find the same information. However, some of the information in this section, such as Trusted Devices and UMA-based sharing, may require integration with ForgeRock Directory Services (DS) or ForgeRock Access Management (AM), as described in "*Integrating IDM With the ForgeRock Identity Platform*" in the *Samples Guide*.

What the enduser sees upon log into the End User UI depends on which features are configured.

- When you log into the End User UI, you'll be taken to the IDM Profile page (), with at least the following information under settings:
  - Account Security
  - Preferences
  - Account Controls
- You'll see at least a Dashboard () and a Profile icon () in the left hand pane. If you've configured UMA as described in "Setting Up User-Managed Access (UMA), Trusted Devices, and Privacy", you'll also see a Sharing icon (). To see descriptions with each icon, select the Menu icon ():

Icons in the End User UI



- When you add features described earlier in this chapter, you'll see additional options in the profile page, as described in the following table:

Information in the End User Profile Page

Title	Description	Section
Account Security	Password and Security Questions, default	"Configuring Security Questions"
Social Sign-in	Links to Social Identity Provider Accounts	"*Configuring Social Identity Providers*"
Authorized Applications	Applications that can access an account	"Authorized Applications"
Trusted Devices	Based on system and browser	"Configuring Trusted Devices on IDM"
Preferences	Default	"Configuring End User Preferences"
Personal Data Sharing	Provides control	"Personal Data Sharing"
Account Controls	Includes collected account data (Default)	"Account Controls"

5.10.1. Personal Information

End users can find their account details in the End User UI, by selecting the Profile icon ( ) > Edit Personal Info. By default, user information includes at least the following properties: Username, First Name, Last Name, and Email Address.

Each user can modify this information as needed, as long as `"userEditable" : true` for the property in your project's `managed.json` file. For more information, see "Creating and Modifying Managed Object Types".

5.10.2. Sign-In & Security

Under this tab, end users can change their passwords. They can also add, delete, or modify security questions, and link or unlink supported social identity accounts. For more information, see "Configuring Security Questions" and "*Configuring Social Identity Providers*".

5.10.3. Preferences

The preferences tab allows end users to modify marketing preferences, as defined in the `managed.json` file, and the Managed Object User property Preferences tab. For more information, see "Configuring End User Preferences".

End users can toggle marketing preferences. When IDM includes a mapping to a marketing database, these preferences are sent to that database. This can help administrators use IDM to target marketing campaigns and identify potential leads.

5.10.4. Trusted Devices

A *trusted device* uses AM's Device ID (Match) and Device ID (Save) authentication modules, as described in the AM Authentication and Single Sign-On Guide. When such modules are configured (see "Configuring Trusted Devices on IDM"), end users can add such devices the first time they log in from a new location.

During the login process, when an end user selects *Log In*, that user is prompted for a *Trusted Device Name*. Users see their added devices under the Trusted Devices tab.

A trusted device entry is paired with a specific browser on a specific system. The next time the same end user logs in from the same browser and system, in the same location, that user should not be prompted to enter a trusted device again.

End users can remove their trusted devices from the tab.

5.10.5. Authorized Applications

The Authorized Applications section is specific to end users as OAuth 2 clients. and reflects the corresponding section of the AM Self-Service dashboard, as described in the following section of the AM *OAuth 2.0 Guide on*: *User Consent Management*.

Note

The one exception is when IDM is configured to work with AM as described in "*Integrating IDM With the ForgeRock Identity Platform*" in the *Samples Guide*. You'll see an "Authorized Application" in this case, with a name such as `openidm`. While end users can select `Remove`, to try to delete something like `openidm` as an

"Authorized Application", `openidm` will reappear the next time the user logs into the End User UI, in the "full stack" configuration.

5.10.6. Personal Data Sharing

This section assumes that as an administrator, you've followed the instructions in "Configuring Privacy & Consent" to enable Privacy & Consent.

End users who see a Personal Data Sharing section have control of whether personal data is shared with an external database, such as one that might contain marketing leads.

The managed object record for end users who consent to sharing such data is shown in REST output and the audit activity log as one `consentedMappings` object:

```
"consentedMappings" : [ {
   "mapping" : "managedUser_systemLdapAccounts",
   "consentDate" : "2017-08-25T18:13:08.358Z"
}
```

If enabled, end users will see a Personal Data Sharing section in their profiles. If they select the Allow link, they can see the data properties that would be shared with the external database.

This option supports the right to restrict processing of user personal data.

5.10.7. Account Controls

The Account Controls section allows end users to download their account data (in JSON format), and to delete their accounts from IDM.

Important

When end users delete their accounts, the change is propagated to external systems by implicit sync. However, it is then up to the administrator of the external system to make sure that any additional user information is purged from that system.

To modify the message associated with the `Delete Your Account` option, refer to the following section of the public ForgeRock Identity Management (End User) Git repository on *Translations*. You'll find content GitHub "Customizing the End User UI", find the `translation.json` file, search for the `deleteAccount` code block, and edit text information as desired.

The options shown in this section can help meet requirements related to data portability, as well as the right to be forgotten.

5.11. Progressive Profile Completion

Progressive profile completion can help you build relationships with end users. Once users have established a history in their accounts, you can collect more information based on customizable

criteria. Ideally, you should be able to use that information to create better experiences for those end users.

After activating "User Self-Registration", users need only the following information to register:

- User name
- First name
- Last name
- Email address

Progressive profile completion allows you to collect additional information, limited by the attributes defined in the `managed.json` file for your project.

In the following sections, you'll examine how you use progressive profile completion to ask or require more information from users. You're limited only by the properties defined in your project's `managed.json` file.

For more information, see "Setting Up a Progressive Profile Completion Form With `selfservice-profile.json`".

5.11.1. Setting Up a Progressive Profile Completion Form With `selfservice-profile.json`

If you're testing progressive profile completion, you can start from the `selfservice-profile.json` file in the following directory: `openidm/samples/example-configurations/self-service/`

Copy this file to your project's `conf/` subdirectory and start IDM. After the conditions shown in this configuration file are met, end users will see a form prompting them to add a telephone number.

```
{
    "stageConfigs" : [
        {
            "name" : "conditionaluser",
            "identityServiceUrl" : "managed/user",
            "condition" : {
                "type" : "loginCount",
                "interval" : "at",
                "amount" : 25
            },
            "evaluateConditionOnField" : "user",
            "onConditionTrue" : {
                "name" : "attributecollection",
                "identityServiceUrl" : "managed/user",
                "uiConfig" : {
                    "displayName" : "Add your telephone number",
                    "purpose" : "Help us verify your identity",
                    "buttonText" : "Save"
                },
                "attributes" : [
                    {
                        "name" : "telephoneNumber",
                        "isRequired" : true
                    }
                ]
            }
        }
    ]
}
```

The following table includes a detailed list of each property shown in this file:

The `selfservice-profile.json` File

Property	Description
`stageConfigs`	Progressive profile completion is a stage user self-service
`name`	`conditionaluser` sets up conditions for end users
`identityServiceUrl`	`managed/user` specifies IDM Managed Users
`condition`	Condition when to display the form
`type`	Type of `condition`; for a list of conditions, see "Standard Progressive Profile Completion Conditions"
`evaluateConditionOnField`	IDM evaluates the condition, per `user`
`onConditionTrue`	Present the form with the following properties
`name`	Data that you collect with the form is an `attributeCollection`
`uiConfig`	Labels to include the in the form seen by the end user
`displayName`	Form title
`purpose`	Form explanation
`buttonText`	Customizable

Property	Description
attributes	Attribute name from managed.json
isRequired	If an end user has to enter data to complete a connection to IDM

5.11.1.1. Standard Progressive Profile Completion Conditions

You can set up a number of different conditions for when users are prompted to add information to their profiles. IDM includes the following pre-defined criteria:

loginCount

May specify at or every number of logins, as defined by the following value: amount.

> **Note**
>
> End users can bypass progressive profile completion screens, when configured with a loginCount. Every time they see such a request, they can open a new browser window to bypass that request, and log into the End User UI. They won't have to provide the information requested, even if you've set the attribute as Required under the Attributes tab.

timeSince

May specify a time since the user was created, the createDate, in years, months, weeks, days, hours, and minutes.

profileCompleteness

Based on the number of items completed by the user from managed.json, in percent, as defined by percentLessThan; for more information, see "Defining Overall Profile Completion".

propertyValue

Based on the value of a specific user entry, such as postalAddress, which can be defined by "Presence Expressions".

5.11.1.2. Custom Progressive Profile Conditions

You can also set up custom conditions with query filters and scripts. These criteria may deviate from standard query filters described in "Constructing Queries" and standard scripted conditions described in "Adding Conditional Policy Definitions".

- A query filter (queryFilter), as defined in "Defining and Calling Queries". For example, the following query filter checks user information for users who live in the city of Portland:

```
"condition" : {
   "type" : "queryFilter",
   "filter" : "/city eq \"Portland\""
},
```

In addition, you can also reference metadata, as described in "Tracking Metadata For Managed Objects". For example, the following query filter searches for users with:

- A `loginCount` greater than or equal to five
- Does not have a telephone number

```
"filter" : "(/_meta/loginCount ge 5 and !(/telephoneNumber pr))"
```

Warning

If you include `_meta` in query filters, the Admin UI will not work for the subject progressive profiling form.

While it's technically possible to include a number like `5` in the Admin UI with the query filter, IDM would write the number as a string to the `selfservice-profile.json` file. You'd still have to change that number directly in the noted file.

- An inline script (`scripted`), or a reference to a script file; IDM works with scripts written in either JavaScript or Groovy. For example, you could set up a script here:

```
"condition" : {
   "type" : "scripted",
   "script" : {
       "type" : "text/javascript",
       "globals" : { },
       "source" : "<some script code>"
},
```

Alternatively, you could point to some JavaScript or Groovy file:

```
"condition" : {
   "type" : "scripted",
   "script" : {
       "type" : "text/javascript",
       "globals" : { },
       "file" : "path/to/someScript.js"
},
```

For the script code, you'll need to reference fields directly, and not by `object.field`. For example, the following code would test for the presence of a telephone number:

```
typeof telephoneNumber === 'undefined' || telephoneNumber === ''
```

While you can also reference metadata for scripts, you can't check for all available fields, as there is no outer `object` field. However, you can refer to fields that are part of the user object.

5.11.1.3. Defining Overall Profile Completion

A user profile is based on every item in `managed.json` where both `viewable` and `userEditable` are set to `true`. Every qualifying item has equal weight.

So if there are 20 qualifying items in `managed.json`, a user who has entries for 10 items has a *Profile completion percentage* of 50.

5.11.2. The `auth.profile.json` File

In some circumstances, you may wish to create a temporary role for users who are in the middle of progressive profile completion, such as if you wish to enable access to an endpoint, while prohibiting access to other parts of the End User UI (as well as the rest of IDM).

To do this, you may optionally define an `authenticationRole` in `auth.profile.json`, which you can use as a role assignment in `access.js` or elsewhere.

For example, if you wished to assign access to a custom endpoint for users who have incomplete profiles, you could modify `auth.profile.json` to include a custom `authenticationRole` called `incomplete-profile`:

```
{
  "profileEnhancementProcesses": [
    "selfservice/termsAndConditions",
    "selfservice/kbaUpdate",
    "selfservice/profile"
  ],
  "authenticationRole": "incomplete-profile",
  "authorizationRole": "internal/role/openidm-authorized"
}
```

You could then give access to this role to your custom endpoint in `access.js`:

```
{
    "pattern"    : "endpoint/extra-steps",
    "roles"      : "incomplete-profile",
    "methods"    : "read",
    ...
},
```

Access for these and other roles is governed by the `access.js` script. For more information, see "Understanding the Access Configuration Script (`access.js`)".

The role specified in `authenticationRole` can be an existing role, or it can be a placeholder string. If it is a placeholder, it will not function as a real role, but can still be used for access in `access.js`, and will appear in access and authentication log files in the `openidm/audit` directory.

5.11.3. Progressive Profile Completion and Metadata

Progressive profile completion requires that you track object metadata, as described in "Tracking Metadata For Managed Objects". Read that section to configure tracking of the following data:

- `createDate`: The date the user was created; used in the `onCreateUser.js` script in the `openidm/bin/defaults/script` directory.
- `loginCount`: The number of logins, by user.
- `stagesCompleted`: Used to track progressive profile forms, and whether they've been completed, by user.

User acceptance of Terms & Conditions is tracked by default (see "Adding Terms & Conditions").

5.11.4. Configuring Progressive Profile Completion over REST

You can manage the progressive profile completion configuration through the following endpoint: `openidm/config/selfservice/profile`. To review your current configuration, run the following command:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/config/selfservice/profile"
```

Unless you've disabled file writes per "Disabling Automatic Configuration Updates", the output will match the contents of your project's `selfservice-profile.json` file.

In a similar fashion, you can update this configuration by including the desired contents of the file:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request PUT
 \
--data '{
    "stageConfigs" : [
        {
            "name" : "conditionaluser",
            "identityServiceUrl" : "managed/user",
            "condition" : {
                "type" : "loginCount",
                "interval" : "at",
                "amount" : 25
            },
            "evaluateConditionOnField" : "user",
            "onConditionTrue" : {
                "name" : "attributecollection",
                "identityServiceUrl" : "managed/user",
                "uiConfig" : {
                    "displayName" : "Add your telephone number",
                    "purpose" : "Help us verify your identity",
                    "buttonText" : "Save"
```

```
                },
                "attributes" : [
                    {
                        "name" : "telephoneNumber",
                        "isRequired" : true
                    }
                ]
            }
        }
    ]
}' \
"http://localhost:8080/openidm/config/selfservice/profile"
```

5.11.5. Configuring Progressive Profile Completion Through the Admin UI

The UI is straightforward; in the Admin UI, when you select Configure > Progressive Profile, you'll add a *New Form*, with:

- Attributes defined in `managed.json`
- Conditions that may be based on a query filter, a script, or pre-defined criteria such as number of logins.

What you configure in the Admin UI is written to the `selfservice-profile.json` file. The information under the following Admin UI Progressive Profile Completion page tabs is written to the following code blocks in that file:

- Details: `uiConfig`
- Display Condition: `condition`
- Attributes: `attributes`

Warning

When you use the UI, you *must* specify a property under the Attributes tab. Otherwise, IDM won't display a Progressive Profile form. To specify a property, select Configure > Progressive Profile. Select a Progressive Profile form > Attributes tab > Add a Property. Be sure to select an Attribute Name based on user properties configured in the `managed.json` file.

5.12. Adding Terms & Conditions

Many organizations require their users to accept Terms & Conditions. When you activate this option for user self-registration, IDM includes a link to Terms & Conditions as part of the self-registration process.

You can also force existing IDM users to accept new Terms & Conditions when they log into the End User UI through the `selfservice-termsAndConditions.json` file described in "Terms & Conditions Configuration Files".

5.12.1. Terms & Conditions Configuration Files

If you want to try the IDM implementation of Terms & Conditions, look at these files from the `openidm/samples/example-configurations/self-service` directory:

- `selfservice.terms.json`
- `selfservice-termsAndConditions.json`

Copy these files to your project directory and start IDM. To see how these Terms & Conditions appear to end users, create a regular user. Log into the End User UI as that user. You will be prompted to accept default Terms & Conditions.

The Terms & Conditions that you see in the End User UI come from the `selfservice.terms.json` file:

```
{
  "versions": [
    {
      "version": "2.0",
      "termsTranslations": {
        "en": "Some 2.0 fake terms",
        "fr": "More 2.0 fake terms"
      },
      "createDate": "2017-12-19T03:54:16.865Z"
    },
    {
      "version": "1.5",
      "termsTranslations": {
        "en": "Some 1.5 fake terms",
        "fr": "More 1.5 fake terms"
      },
      "createDate": "2017-11-20T04:20:11.320Z"
    }
  ],
  "active": "1.5",
  "uiConfig" : {
    "displayName" : "We've updated our terms",
    "purpose" : "You must accept the updated terms in order to proceed.",
    "buttonText" : "Accept"
  }
}
```

Note

IDM does not support <form> elements or <script> tags in Terms & Conditions text.

Substitute Terms & Conditions content that meet the requirements of your legal authorities.

As suggested by this file, you can set up different versions of Terms & Conditions in multiple languages. What is seen by end users is driven by the `active` version.

For details, see the following table:

The `selfservice.terms.json` File

Property	Description
`version`	Specifies a version number
`termsTranslations`	Supports Terms & Conditions in different languages
`createDate`	Creation date
`active`	Specifies the version of Terms & Conditions shown to users; must match an existing `version`
`displayName`	The title of the Terms & Conditions page, as seen by end users
`purpose`	Help text shown below the `displayName`
`buttonText`	Button text shown to the end user for acceptance

The other Terms & Conditions configuration file is `selfservice-termsAndConditions.json`. If it exists, end users must accept the specified Terms & Conditions before logging into IDM. As shown here, this applies Terms & Conditions to the `managed/user` store.

```
{
    "stageConfigs" : [
        {
            "name" : "conditionaluser",
            "identityServiceUrl" : "managed/user",
            "condition" : {
                "type" : "terms"
            },
            "evaluateConditionOnField" : "user",
            "onConditionTrue" : {
                "name" : "termsAndConditions"
            }
        },
        {
            "name" : "patchObject",
            "identityServiceUrl" : "managed/user"
        }
    ]
}
```

When a user accepts Terms & Conditions, IDM records relevant information in the `_meta` data for that user, as described in "Identifying When a User Accepts Terms & Conditions".

You can set up user self-registration to require acceptance of Terms & Conditions as described in "User Self-Registration".

Note

If you've set up Terms & Conditions in multiple languages, what your end users see depends on the default language set in the browser, based on ISO-639 language codes:

First, IDM looks for the active version, as defined in the `selfservice.terms.json` file.

- If the default language in the browser matches one of the Terms & Conditions languages that you've configured, that's what the end user will see.
- If the default language in the browser does not match any Terms & Conditions locales, IDM looks for:
  - The `en` locale.
  - If there is no `en` locale, IDM uses the first locale shown for the active version.

5.12.2. Updating Terms & Conditions over REST

You can manage the configuration for Terms & Conditions over the following endpoints:

- `openidm/config/selfservice.terms`
- `openidm/config/selfservice/termsAndConditions`

For example, the following command would replace the value of `buttonText`:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request PATCH
 \
--data '[ {
   "operation" : "replace",
   "field" : "uiConfig/buttonText",
   "value" : "OK"
} ]' \
"http://localhost:8080/openidm/config/selfservice.terms"
```

5.12.3. Identifying When a User Accepts Terms & Conditions

You can identify when a user accepts Terms & Conditions, as well as the associated version. To do so, take the following steps:

- If needed, find identifying information for all managed users:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/managed/user?_queryId=query-all"
```

- Pick a desired user, and use REST to get that user's information. This example illustrates how a user with a `userName` of `kvaughan` has already accepted a specific version of Terms & Conditions:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/managed/user?_queryFilter=userName+eq+'kvaughan'&_fields=*,/_meta/*"
{
  "result": [
    {
      ...
      "userName": "kvaughan",
      ...
        "termsAccepted": {
          "acceptDate": "2018-04-12T22:55:33.370Z",
          "termsVersion": "2.0"
        },
        "createDate": "2018-04-12T22:55:33.395Z",
        "lastChanged": {
          "date": "2018-04-12T22:55:33.395Z"
        },
        "loginCount": 1,
        "_rev": "00000000776f8be1",
        "_id": "69124007-05ec-46e1-a8a8-ecc3d94db124"
      }
    }
  ],
  ...
}
```

5.12.4. Configuring Terms & Conditions in the Admin UI

From the Admin UI, select Configure > Terms & Conditions. You can then create a new version, which prompts you to configure the following:

- Version number (must be unique).
- If there are existing Terms & Conditions, you'll see a *Make active* switch for the new Terms & Conditions.
- Locale, in ISO-639 format.
- Terms & Conditions, in the specified language locales. You can set up Terms & Conditions in text and/or basic HTML.

Once you've added Terms & Conditions in all desired locales, select Save to save them in the `selfservice.terms.json` file.

Note

The Admin UI does not allow you to delete existing Terms & Conditions.

Once you have at least one set of Terms & Conditions, you should see a Settings tab, where you can:

- Require acceptance; the next time any end user logs into IDM, that user will see a copy of your Terms & Conditions, with the Header, Description, and Button Text.
- To make sure new users have to accept these Terms & Conditions, select Configure > User Registration in the Admin UI. Enable Terms & Conditions under the Options tab. For more information, see "User Self-Registration". Users who self-register will see the following message, with a link to those Terms & Conditions:

```
By creating an account, you agree to the Terms & Conditions
```

These changes are recorded in `_meta` data for each user and can be retrieved through REST calls described in "Identifying When a User Accepts Terms & Conditions".

5.13. Localizing the End User UI

The End User UI is configured in US English. For more information on how to localize and modify the messages in the End User UI, see the following section of the ForgeRock Identity Management (End User) repository on *Translations and Text*.

5.14. Tokens and User Self-Service

Many processes within user self-service involve multiple stages, such as user self-registration, password reset, and forgotten username. As the user transitions from one stage to another, IDM uses JWT tokens to represent the current state of the process. As each stage is completed, IDM returns a new token. Each request that follows includes that latest token.

For example, users who use these features to recover their usernames and passwords get two tokens in the following scenario:

- The user goes through the forgotten username process, gets a JWT Token with a lifetime (default = 300 seconds) that allows that user to get to the next step in the process.
- With username in hand, that user may then start the password reset process. That user gets a second JWT token, with the token lifetime configured for that process.

Note

The default IDM JWT token is encrypted and stateless. However, if you need a token that can be included in a link that works in all email clients, change the `snapshotToken` `type` in the appropriate configuration file to `uuid`.

5.15. End User UI Notifications

Whenever there are changes related to individual users, IDM sends notifications to the affected user. When such users log into the End User UI, they can find their notifications by selecting the bell (🔔) icon.

Notifications are configured in `notification-*.json` files, as described in "Notification Configuration Files".

IDM includes a `notifications` endpoint, which can help you identify all notifications:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/internal/notification?_queryFilter=true"
```

You can isolate notifications by user. As noted elsewhere, you can identify user IDs with the following command:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/managed/user?_queryId=query-all-ids"
```

You can then isolate the notifications by user ID, with the `_notifications` field.

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/managed/user/e3a9385b-733f-4a1c-891b-c89292b30d70?_fields=_notifications/*"
```

For other `_queryFilter` options, see "Defining and Calling Queries".

You can filter notifications with any of the properties shown in the following table:

End User Notification Properties

Property	Description
`createDate`	Creation date
`notificationType`	Message type: limited to info, warning, or error
`message`	Message seen by the end user

You can get additional information from the activity audit log, in the `audit/activity.audit.json` file. including the following:

- The `userId` who made the change.
- The `runAs` name of the user who made the change.
- If configured in "Specifying Fields to Monitor", any watched fields that have changed.
- If the password was changed, as indicated by the `passwordChanged` property.

Chapter 6

Managing the Repository

IDM stores managed objects, internal users, and configuration objects in a repository. By default, the server uses an embedded ForgeRock Directory Services (DS) instance as its repository. In production, you must replace this embedded instance with an external DS instance, or with a JDBC repository, as described in "*Selecting a Repository*" in the *Installation Guide*.

This chapter describes the 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 repository over the REST interface.

6.1. Understanding the Repository Configuration Files

IDM provides configuration files for all supported repositories. These configuration files are located in the `/path/to/openidm/db/database/conf` directory. For JDBC repositories, the configuration is defined in two files:

- `datasource.jdbc-default.json`, which specifies the connection details to the repository.
- `repo.jdbc.json`, which specifies the mapping between IDM resources and the tables in the repository, and includes a number of predefined queries.
- `repo.init.json`, which specifies IDM's initial internal roles and users. The file is used when first launching IDM, and can be used to create additional roles and users, but ignores roles and users that have already been created. For more information about internal roles, see "Authorization".

For a DS repository, the `repo.ds.json` file specifies the resource mapping and, in the case of an external repository, the connection details to the LDAP server.

Copy the configuration files for your specific database type to your project's `conf/` directory.

6.1.1. Understanding the JDBC Connection Configuration File

The default database connection configuration file for a MySQL database follows:

```
{
    "driverClass" : "com.mysql.jdbc.Driver",
    "jdbcUrl" : "jdbc:mysql://&{openidm.repo.host}:&{openidm.repo.port}/openidm?
allowMultiQueries=true&characterEncoding=utf8",
    "databaseName" : "openidm",
    "username" : "openidm",
    "password" : "openidm",
    "connectionTimeout" : 30000,
    "connectionPool" : {
        "type" : "hikari",
        "minimumIdle" : 20,
        "maximumPoolSize" : 50
    }
}
```

The configuration file includes the following properties:

`driverClass`

`"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"`

`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'`.

Specify the values for `openidm.repo.host` and `openidm.repo.port` in one of the following ways:

- Set the values in `resolver/boot.properties` or your project's `conf/system.properties` file, for example:

  ```
  openidm.repo.host = localhost
  openidm.repo.port = 3306
  ```

- Set the properties in the `OPENIDM_OPTS` environment variable and export that variable before startup. You must include the JVM memory options when you set this variable. For example:

```
$ export OPENIDM_OPTS="-Xmx1024m -Xms1024m -Dopenidm.repo.host=localhost -Dopenidm.repo.port=3306"
$ ./startup.sh
Executing ./startup.sh...
Using OPENIDM_HOME:   /path/to/openidm
Using PROJECT_HOME:   /path/to/openidm
Using OPENIDM_OPTS:   -Xmx1024m -Xms1024m -Dopenidm.repo.host=localhost -Dopenidm.repo.port=3306
Using LOGGING_CONFIG: -Djava.util.logging.config.file=/path/to/openidm/conf/logging.properties
Using boot properties at /path/to/openidm/resolver/boot
.properties
-> OpenIDM version "6.5.2.0"
OpenIDM ready
```

`databaseName`

The name of the database to which IDM connects. By default, this is `openidm`.

`username`

The username with which to access the JDBC database.

`password`

The password with which to access the JDBC database. IDM 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.

`connectionTimeout`

The period of time, in milliseconds, after which IDM should consider an attempted connection to the database to have failed. The default period is 30000 milliseconds (30 seconds).

`connectionPool`

Database connection pooling configuration. The default connection pool library is HikariCP:

```
"connectionPool" : {
    "type" : "hikari"
}
```

IDM uses the default HikariCP configuration, except for the following parameters. You might need to adjust these parameters, according to your database workload:

- `minimumIdle`

  This property controls the minimum number of idle connections that HikariCP maintains in the connection pool. If the number of idle connections drops below this value, HikariCP attempts to add additional connections.

  By default, HikariCP runs as a fixed-sized connection pool, that is, this property is not set. The connection configuration files provided with IDM set the minimum number of idle connections to `20`.

- `maximumPoolSize`

This property controls the maximum number of connections to the database, including idle connections and connections that are being used.

By default, HikariCP sets the maximum number of connections to `10`. The connection configuration files provided with IDM set the maximum number of connections to `50`.

For information about the HikariCP configuration parameters, see the HikariCPCP Project Page.

6.1.2. Understanding the JDBC Database Table Configuration

An excerpt of a MySQL database table configuration file follows:

```
{
     "dbType" : "MYSQL",
     "useDataSource" : "default",
     "maxBatchSize" : 100,
     "maxTxRetry" : 5,
     "queries" : {...},
     "commands" : {...},
     "resourceMapping" : {...}
 }
```

The configuration file includes the following properties:

`dbType` : string, optional

The type of database. The database type might affect the queries used and other optimizations. Supported database types include the following:

`DB2`
`SQLSERVER` (for Microsoft SQL Server)
`MYSQL`
`ORACLE`
`POSTGRESQL`

`useDataSource` : string, optional

This option refers to the connection details that are defined in the configuration file, described previously. The default configuration file is named `datasource.jdbc-default.json`. This is the file that is used by default (and the value of the `"useDataSource"` is therefore `"default"`). You might want to specify a different connection configuration file, instead of overwriting the details in the default file. In this case, set your connection configuration file `datasource.jdbc-`*`name`*`.json` and set the value of `"useDataSource"` to whatever *name* you have used.

`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.

`maxTxRetry`

The maximum number of times that a specific transaction should be attempted before that transaction is aborted.

`queries`

Predefined queries that can be referenced from the configuration. For more information about predefined queries, see "Parameterized Queries". 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 obj.objectid, obj.rev, obj.fullobject FROM ${_dbSchema}.
${_mainTable} obj
         INNER JOIN ${_dbSchema}.objecttypes objtype ON objtype.id = obj.objecttypes_id
         AND objtype.objecttype = ${_resource} INNER JOIN ${_dbSchema}.${_propTable} usernameprop
         ON obj.id = usernameprop.${_mainTable}_id AND usernameprop.propkey='/userName'
         INNER JOIN ${_dbSchema}.${_propTable} statusprop ON obj.id = statusprop.${_mainTable}_id
         AND statusprop.propkey='/accountStatus' WHERE usernameprop.propvalue = ${username}
         AND statusprop.propvalue = 'active'",
         ...
     "explicitTables" : {
         "credential-query" : "SELECT * FROM ${_dbSchema}.${_table}
           WHERE username = ${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" });
  ```

  For more information about the query function, see "openidm.query(resourceName, params, fields)".

- 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 to query non-string values in the database. This is particularly useful with explicit tables.

`commands`

Specific commands configured to manage the database over the REST interface. Currently, the following default commands are included in the configuration:

- `purge-by-recon-expired`
- `purge-by-recon-number-of`
- `delete-mapping-links`
- `delete-target-ids-for-recon`

These commands assist with removing stale reconciliation audit information from the repository, and preventing the repository from growing too large. The commands work by executing a query filter, then performing the specified operation on each result set. Currently the only supported operation is `DELETE`, which removes all entries that match the filter. For more information about repository commands, see "Running Queries and Commands on the Repository".

`resourceMapping`

Defines the mapping between IDM 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.

6.1.3. Understanding the DS Repository Configuration

An excerpt of a DS repository configuration file follows:

```
{
     "embedded" : false,
     "maxConnectionAttempts" : 5,
     "security" : {...},
     "ldapConnectionFactories" : {...},
     "queries" : {...},
     "commands" : {...},
     "rest2LdapOptions": {...},
     "indices": {...},
     "schemaProviders": {...},
     "resourceMapping" : {...}
 }
```

The configuration file includes the following properties:

`embedded` : boolean

Specifies an embedded or external DS instance.

IDM uses an embedded DS instance by default. The embedded instance is not supported in production.

`maxConnectionAttempts` : integer

Specifies the number of times IDM should attempt to connect to the DS instance. On startup, IDM will attempt to connect to DS indefinitely. The `maxConnectionAttempts` parameter controls the number of reconnection attempts in the event of a failure during normal operation, for example, if an attempt to access the DS repository times out.

By default, IDM will attempt to reconnect to the DS instance `5` times.

`security`

Specifies the DS key manager and trust manager provider types, both `jvm` by default. For example:

```
"security": {
    "trustManager": "jvm",
    "keyManager": "jvm"
}
```

`ldapConnectionFactories`

For an external DS repository, configures the connection to the DS instance. For example:

```
"ldapConnectionFactories": {
    "bind": {
        "connectionSecurity": "none",
        "sslCertAlias": "client-cert",
        "heartBeatIntervalSeconds": 60,
        "heartBeatTimeoutMilliSeconds": 10000,
        "primaryLdapServers": [{ "hostname": "localhost", "port": 31389 }],
        "secondaryLdapServers": []
    },
    "root": {
        "inheritFrom": "bind",
        "authentication": {
            "simple": { "bindDn": "cn=Directory Manager", "bindPassword": "password" }
        }
    }
}
```

queries

Predefined queries that can be referenced from the configuration. For a DS repository, all predefined queries are really filtered queries (using the `_queryFilter` parameter), for example:

```
"query-all-ids": {
    "_queryFilter": "true",
    "_fields": "_id,_rev"
},
```

The queries are divided between those for `generic` mappings and those for `explicit` mappings, but the queries themselves are the same for both mapping types.

commands

Specific commands configured to manage the repository over the REST interface. Currently, only two commands are included by default:

- `delete-mapping-links`
- `delete-target-ids-for-recon`

Both of these commands assist with removing stale reconciliation audit information from the repository, and preventing the repository from growing too large. For more information about repository commands, see "Running Queries and Commands on the Repository".

rest2LdapOptions

Specifies the configuration for accessing the LDAP data stored in DS. For more information, see Gateway REST2LDAP Configuration File in the *DS Reference*.

indices

For generic mappings, sets up LDAP indices on custom object properties. For more information, see "Improving Generic Mapping Search Performance (DS)".

`schemaProviders`

For generic mappings, lets you list custom objects whose properties should be indexed. For more information, see "Improving Generic Mapping Search Performance (DS)".

`resourceMapping`

Defines the mapping between IDM resource URIs (for example, `managed/user`) and the DS directory tree. The structure of the resource mapping object is as follows:

```
{
    "resourceMapping" : {
        "defaultMapping": {
            "dnTemplate": "ou=generic,dc=openidm,dc=forgerock,dc=com"
        },
        "explicitMapping" : {...},
        "genericMapping" : {...}
}
```

The default mapping object represents a default generic organizational unit (`ou`) in which any resource that does not have a more specific mapping is stored.

The generic and explicit mapping objects are described in "Using Generic and Explicit Object Mappings" .

6.2. Using Generic and Explicit Object Mappings

There are two ways to map IDM objects to the tables in a JDBC database or to organizational units in DS:

- *Generic mapping*, which allows you to store arbitrary objects without special configuration or administration.
- *Explicit mapping*, which maps specific objects and properties to tables and columns in the JDBC database or to organizational units in DS.

These two mapping strategies are discussed in the following sections, for JDBC repositories and for DS repositories:

6.2.1. Generic and Explicit Mappings With a JDBC Repository

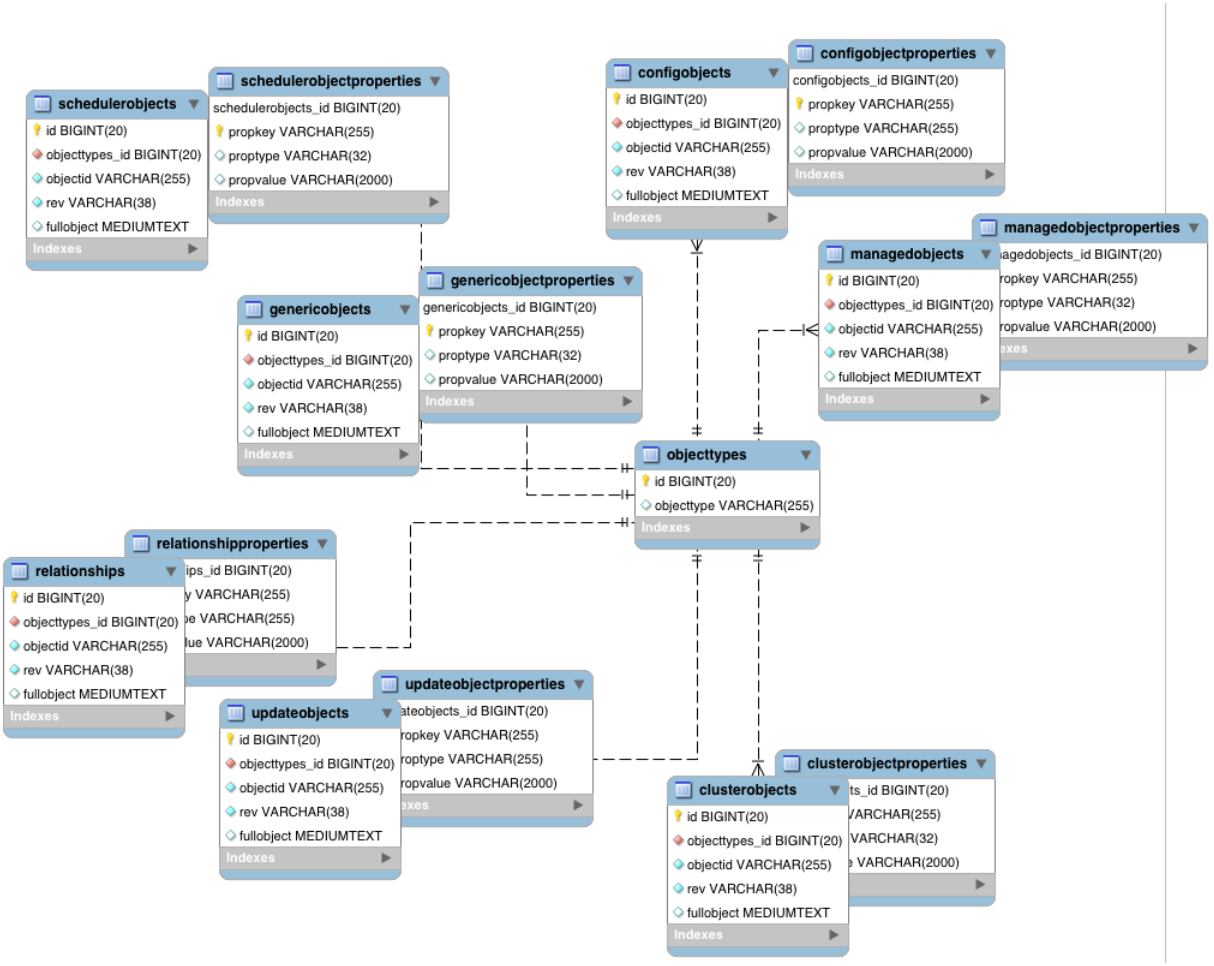
6.2.1.1. Using Generic Mappings With a JDBC Repository

Generic mapping speeds up development, and can make system maintenance more flexible by providing a 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, when using a MySQL repository. The diagram indicates the relationship between the main table and the corresponding properties table for each object.

Generic Tables Entity Relationship Diagram



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 obj.objectid, obj.rev, obj.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:

1. Select the full object, the object ID, and the object revision from the main table:

   ```
   SELECT obj.objectid, obj.rev, obj.fullobject FROM ${_dbSchema}.${_mainTable} obj
   ```

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

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

3. 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
   ```

4. 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 `objecttypes` 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 multiversion concurrency control (MVCC). For more information, see "Manipulating Managed Objects Programmatically".

`propertiesTable` (string, mandatory)

Indicates the properties table, used for searches.

> **Note**
>
> PostgreSQL repositories do not use these properties tables to access specific properties. Instead, the PostgreSQL `json_extract_path_text()` function achieves this functionality.

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`).
- `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.

> **Note**
>
> PostgreSQL repositories do not use the `searchableDefault` property.

`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.

6.2.1.2. Improving Generic Mapping Search Performance (JDBC)

All properties in a generic mapping are searchable by default. In other words, the value of the `searchableDefault` property is `true` unless you explicitly set it to false. 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.

The sample JDBC repository configuration files (`db/database/conf/repo.jdbc.json`) restrict searches to specific properties by setting the `searchableDefault` to `false` for `managed/user` mappings. You must 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, IDM 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.

6.2.1.3. Using Explicit Mappings With a JDBC Repository

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, because 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.

You can have a generic mapping configuration for most managed objects, *and* an explicit mapping that overrides the default generic mapping in certain cases.

IDM provides a sample configuration, for each JDBC repository, that sets up an explicit mapping for the managed *user* object and a generic mapping for all other managed objects. This configuration is defined in the files named `/path/to/openidm/db/repository/conf/repo.jdbc-repository-explicit-managed-user.json`. To use this configuration, copy the file that corresponds to your repository to your project's `conf/` directory and rename it `repo.jdbc.json`. Run the `sample-explicit-managed-user.sql` data definition script (in the `path/to/openidm/db/repository/scripts` directory) to set up the corresponding tables when you configure your JDBC repository.

IDM 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" }
```

Available column data types you can specify are `STRING` (the default), `NUMBER`, `JSON_MAP`, `JSON_LIST`, and `FULLOBJECT`.

Caution

Pay particular attention to the following caveats when you map properties to explicit columns in your database:

- Support for data types in columns is restricted to numeric values (`NUMBER`) and strings (`STRING`). Although you can specify other data types, IDM handles all other data types as strings. Your database will need to convert these types from a string to the alternative data type. This conversion is *not guaranteed to work*.

  If the conversion does work, the format might not be the same when the data is read from the database as it was when it was saved. For example, your database might parse a date in the format `12/12/2012` and return the date in the format `2012-12-12` when the property is read.

- Passwords are encrypted before they are stored in the repository. The length of the password column must be long enough to store the encrypted password value, which can vary depending on how it is encrypted and whether it is also hashed.

  The `sample-explicit-managed-user.sql` file referenced in this section sets the password column to a length of 511 characters (`VARCHAR(511)`) to account for the additional space an encrypted password requires. For more information about IDM encryption and an example encrypted password value, see "Using the **encrypt** Subcommand" and "Encoding Attribute Values".

- If your data objects include *virtual properties*, you must include columns in which to store these properties. If you don't explicitly map the virtual properties, you will see errors similar to the following when you attempt to create the corresponding object"

```
{
    "code":400,
    "reason":"Bad Request",
    "message":"Unmapped fields [/property-name/0]
    for type managed/user and table openidm.managed_user"
}
```

When virtual properties are returned in the result of a query, the query previously persisted values of the requested virtual properties. To recalculate virtual property values in a query, you must set `executeOnRetrieve` to `true` in the query request parameters. For more information, see "Property Storage Triggers".

6.2.2. Generic and Explicit Mappings With a DS Repository

For both generic and explicit mappings, IDM maps object types using a `dnTemplate` property. The `dnTemplate` is effectively a pointer to where the object is stored in DS. For example, the following excerpt of the default `repo.ds.json` file shows how configuration objects are stored under the DN `ou=config,dc=openidm,dc=forgerock,dc=com`:

```
"config": {
    "dnTemplate": "ou=config,dc=openidm,dc=forgerock,dc=com"
},
```

6.2.2.1. Using Generic Mappings With a DS Repository

By default, IDM uses a generic mapping for all objects *except* the following:

- Internal users, roles, and privileges
- Links
- Clustered reconciliation target IDs

  Note that clustered reconciliation is not currently supported with a DS repository.
- Locks
- Objects related to queued synchronization

With a generic mapping, all the properties of an object are stored as a single JSON blob in the `fr-idm-json` attribute. To create a new generic mapping, you need only specify the `dnTemplate`, that is, where the object will be stored in the directory tree.

You can specify a wildcard mapping, that stores all nested URIs under a particular branch of the directory tree, for example:

```
"managed/*": {
    "dnTemplate": "ou=managed,dc=openidm,dc=forgerock,dc=com"
},
```

With this mapping, all objects under `managed/`, such as `managed/user` and `managed/device`, will be stored in the branch `ou=managed,dc=openidm,dc=forgerock,dc=com`. You do not have to specify separate mappings for each of these objects. The mapping creates a new `ou` for each object. So, for example, `managed/user` objects will be stored under the DN `ou=user,ou=managed,dc=openidm,dc=forgerock,dc=com` and `managed/device` objects will be stored under the DN `ou=device,ou=managed,dc=openidm,dc=forgerock,dc=com`.

6.2.2.1.1. Improving Generic Mapping Search Performance (DS)

By default, all generic objects are instances of the `fr-idm-generic-obj` object class and their properties are stored as a single JSON blob in the `fr-idm-json` attribute. The `fr-idm-json` attribute is indexed by default, which results in *all* attributes of a generic object being indexed. JDBC repositories behave in a similar way, with all generic objects being searchable by default.

To optimize search performance on specific generic resources, you can set up your own schema providers and indices as described in this section. For a detailed explanation of how indexes improve LDAP search performance, see Indexing Attribute Values in the *DS Administration Guide*.

For the embedded DS repository, or an external DS repository installed as described in "Using an External DS Repository" in the *Installation Guide*, the following managed user properties are indexed by default:

- `userName` (cn)
- `givenName`
- `sn`
- `mail`
- `telephoneNumber`

You can configure managed user indexes in the repository configuration (`repo.ds.json`) by adding `indices` and `schemaProviders` objects, as follows:

```
"indices" : {
    ...
    "fr-idm-managed-user-json" : {
      "type" : [ "EQUALITY" ]
    },
    ...
  },
  "schemaProviders" : {
    "Managed User Json" : {
      "matchingRuleName" : "caseIgnoreJsonQueryMatchManagedUser",
      "matchingRuleOid" : "1.3.6.1.4.1.36733.2.....",
      "caseSensitiveStrings" : false,
      "fields" : [ "userName", "givenName", "sn", "mail", "telephoneNumber" ]
    },
    ...
  },
```

The indexed properties are listed in the array of `fields` for that managed object. To index additional managed user properties, add the property names to this array of `fields`.

To set up indexes on generic objects other than the managed user object, you must do the following:

- Add the object to the DS schema.

  The schema for an embedded DS repository is stored in the `/path/to/openidm/db/openidm/opendj/db/schema/60-repo-schema.ldif` file.

You can use the managed user object as an example of the schema syntax:

```
###
# Managed User
###
attributeTypes: ( 1.3.6.1.4.1.36733.2.3.1.13
  NAME 'fr-idm-managed-user-json'
  SYNTAX 1.3.6.1.4.1.36733.2.1.3.1
  EQUALITY caseIgnoreJsonQueryMatchManagedUser
  ORDERING caseIgnoreOrderingMatch
  SINGLE-VALUE
  X-ORIGIN 'OpenIDM DSRepoService')
objectClasses: ( 1.3.6.1.4.1.36733.2.3.2.6
  NAME 'fr-idm-managed-user'
  SUP top
  STRUCTURAL
  MUST ( fr-idm-managed-user-json )
  X-ORIGIN 'OpenIDM DSRepoService' )
```

For information about adding JSON objects to the DS schema, see Working With JSON in the *DS Administration Guide*.

Warning

If you delete the `db/openidm` directory, any additions you have made to the schema will be lost. If you have customized the schema, be sure to back up the `60-repo-schema.ldif` file.

- Add the object to the `indices` property in the `conf/repo.ds.json` file.

  The following example sets up an equality index for a managed devices object:

```
"indices" : {
    ...
    "fr-idm-managed-devices-json" : {
      "type" : [ "EQUALITY" ]
    },
    ...
       },
```

- Add the object to the `schemaProviders` property in the `conf/repo.ds.json` file and list the properties that should be indexed.

  The following example sets up indexes for the `deviceName`, `brand`, and `assetNumber` properties of the managed device object:

```
"schemaProviders" : {
    "Managed Device Json" : {
      "matchingRuleName" : "caseIgnoreJsonQueryMatchManagedDevice",
      "matchingRuleOid" : "1.3.6.1.4.1.36733.2.....",
      "caseSensitiveStrings" : false,
      "fields" : [ "deviceName", "brand", "assetNumber" ]
    },
```

For more information about indexing JSON attributes, see Configuring an Index for a JSON Attribute in the *DS Administration Guide*.

Note

The OIDs shown in this section are reserved for ForgeRock internal use. If you set up additional objects and attributes, or if you change the default schema, you must specify your own OIDs here.

6.2.2.2. Using Explicit Mappings With a DS Repository

The default configuration uses generic mappings for all objects *except* internal users and roles, links, and clustered reconciliation target IDs. To use an explicit mapping for managed user objects, follow these steps:

1. Stop IDM if it is running.
2. Copy the `repo.ds-explicit-managed-user.json` file to your project's `conf` directory, and rename that file `repo.ds.json`:

```
$ cd /path/to/openidm
$ cp db/ds/conf/repo.ds-explicit-managed-user.json project-dir/conf/repo.ds.json
```

Important

This file is configured for an embedded DS repository by default. To set up an explicit mapping for an external DS repository, change the value of the `"embedded"` property to `false` and add the following properties:

```
"security": {
    "trustManager": "jvm",
    "keyManager": "jvm"
},
"ldapConnectionFactories": {
    "bind": {
        "connectionSecurity": "none",
        "sslCertAlias": "client-cert",
        "heartBeatIntervalSeconds": 60,
        "heartBeatTimeoutMilliSeconds": 10000,
        "primaryLdapServers": [{ "hostname": "localhost", "port": 31389 }],
        "secondaryLdapServers": []
    },
    "root": {
        "inheritFrom": "bind",
        "authentication": {
            "simple": { "bindDn": "cn=Directory Manager", "bindPassword": "password" }
        }
    }
},
```

For more information on these properties, see "Understanding the DS Repository Configuration".

3. Restart IDM.

IDM uses the DS REST to LDAP gateway to map JSON objects to LDAP objects stored in the directory. To create additional explicit mappings, you must specify the LDAP `objectClasses` to which the object is mapped, and how each property maps to its corresponding LDAP attributes. Specify at least the property `type` and the corresponding `ldapAttribute`.

The following excerpt of the explicit managed user object mapping provides an example:

```
"managed/user" : {
    "dnTemplate": "ou=user,ou=managed,dc=openidm,dc=forgerock,dc=com",
    "objectClasses": [ "person", "organizationalPerson", "inetOrgPerson", "fr-idm-managed-user-
explicit" ],
    "properties": {
        "_id": {
            "type": "simple", "ldapAttribute": "uid", "isRequired": true, "writability": "createOnly"
        },
        "userName": {
            "type": "simple", "ldapAttribute": "cn"
        },
        "password": {
            "type": "json", "ldapAttribute": "fr-idm-password"
        },
        "accountStatus": {
            "type": "simple", "ldapAttribute": "fr-idm-accountStatus"
        },
        "roles": {
            "type": "json", "ldapAttribute": "fr-idm-role", "isMultiValued": true
        },
        "effectiveRoles": {
            "type": "json", "ldapAttribute": "fr-idm-effectiveRole", "isMultiValued": true
        },
        "effectiveAssignments": {
            "type": "json", "ldapAttribute": "fr-idm-effectiveAssignment", "isMultiValued": true
        },
        ...
    }
},
```

You do not need to map the `_rev` (revision) property of an object as this property is implicit in all objects and maps to the DS `etag` operational attribute.

If your data objects include *virtual properties*, you must include property mappings for these properties. If you don't explicitly map the virtual properties, you will see errors similar to the following when you attempt to create the corresponding object:

```
{"code":400,"reason":"Bad Request","message":"Unmapped fields...}
```

For more information about the REST to LDAP property mappings, see Mapping Configuration File in the *DS Reference*.

For performance reasons, the DS repository does not apply unique constraints to links. This behavior is different to the JDBC repositories, where uniqueness on link objects is enforced.

Important

DS currently has a default index entry limit of 4000. Therefore, you cannot query more than 4000 records unless you create a Virtual List View (VLV) index. A VLV index is designed to help DS respond to client applications that need to browse through a long list of objects.

You cannot create a VLV index on a JSON attribute. For generic mappings, IDM avoids this restriction by using client-side sorting and searching. However, for explicit mappings you *must* create a VLV index for any filtered or sorted results, such as results displayed in a UI grid. To configure a VLV index, use the **dsconfig** command described in Configuring a Virtual List View Index in the *DS Administration Guide*.

6.2.2.2.1. Specifying How IDM IDs Map to LDAP Entry Names

The DS REST2LDAP configuration lets you specify a `namingStrategy` that determines how LDAP entry names are mapped to JSON resources. When IDM stores its objects in a DS repository, this `namingStrategy` determines how the IDM `_id` value maps to the Relative Distinguished Name (RDN) of the corresponding DS object.

The `namingStrategy` is specified as part of the `explicitMapping` of an object in the `repo.ds.json` file. The following example shows a naming strategy configuration for an explicit managed user mapping:

```
"resourceMapping": {
    "defaultMapping": {
        "dnTemplate": "ou=generic,dc=openidm,dc=forgerock,dc=com"
    },
    ...
    "explicitMapping": {
        "managed/user" : {
            "dnTemplate": "ou=user,ou=managed,dc=openidm,dc=forgerock,dc=com",
            "objectClasses": [
                "person",
                "organizationalPerson",
                "inetOrgPerson",
                "fr-idm-managed-user-explicit"
            ],
            "namingStrategy" : {
                "type" : "clientDnNaming",
                "dnAttribute" : "uid"
            },
         ...
}
```

The `namingStrategy` can be one of the following:

- `clientDnNaming` - IDM provides an `_id` to DS and that `_id` is used to generate the DS RDN. In the following example, the IDM `_id` maps to the LDAP `uid` attribute:

```
{
     "namingStrategy": {
         "type": "clientDnNaming",
         "dnAttribute": "uid"
     }
 }
```

With this *default* configuration, entries are stored in DS with a DN similar to the following:

```
"uid=idm-uuid,ou=user,ou=managed,dc=openidm,dc=forgerock,dc=com"
```

Note

If these default DNs are suitable in your deployment, you do not have to change anything with regard to the naming strategy.

- `clientNaming` - IDM provides an `_id` to DS but the DS RDN is derived from a different user attribute in the LDAP entry. In the following example, the RDN is the `cn` attribute. The `_id` that IDM provides for the object maps to the LDAP `uid` attribute:

```
{
     "namingStrategy": {
         "type": "clientNaming",
         "dnAttribute": "cn",
         "idAttribute": "uid"
     }
 }
```

With this configuration, entries are stored in DS with a DN similar to the following:

```
"cn=username,ou=user,ou=managed,dc=openidm,dc=forgerock,dc=com"
```

Specifying a `namingStrategy` is optional. If you do not specify a strategy, the default is `clientDnNaming` with the following configuration:

```
{
     "namingStrategy" : {
         "type" : "clientDnNaming",
         "dnAttribute" : "uid"
     },
     "properties: : {
         "_id": {
             "type": "simple",
             "ldapAttribute": "uid",
             "isRequired": true,
             "writability": "createOnly"
         },
     ...
     }
 }
```

Note

If you do not set a `dnAttribute` as part of the naming strategy, the value of the `dnAttribute` is taken from the value of the `ldapAttribute` on the `_id` property.

6.3. Connect to a JDBC Repository Over SSL

This procedure assumes that you have already set up your JDBC repository, as described in "*Selecting a Repository*" in the *Installation Guide*. The exact steps to connect to a JDBC repository over SSL depend on your repository. This procedure describes the steps for a MySQL 8 repository. If you are using a different JDBC repository, use the corresponding documentation for that repository, and adjust the steps accordingly.

1. Change the `jdbcUrl` property in your repository connection configuration file (`conf/datasource.jdbc-default.json`).

   The exact value of the `jdbcUrl` property will depend on your JDBC database, and on the version of your JDBC driver:

   The following example shows the configuration for MySQL with JDBC driver version 8.0.12 or earlier:

   ```
   "jdbcUrl" : "jdbc:mysql://&{openidm.repo.host}:&{openidm.repo.port}/openidm?
   allowMultiQueries=true&characterEncoding=utf8&useSSL=true&verifyServerCertificate=true&requireSSL=true"
   ```

   The following example shows the configuration for MySQL with JDBC driver version 8.0.13 or later:

   ```
   "jdbcUrl" : "jdbc:mysql://&{openidm.repo.host}:&{openidm.repo.port}/openidm?
   allowMultiQueries=true&characterEncoding=utf8&sslMode=VERIFY_CA&requireSSL=true"
   ```

   Note

   For Azure MySQL, JDBC Driver Version 8.0.17+ is **required**.

2. Create and verify the SSL certificate and key files required to support encrypted connections to the JDBC repository.

   For MySQL 8, use one of the procedures in the MySQL docs.

3. Configure the JDBC repository to use encrypted connections.

   For MySQL 8, follow the MySQL docs.

4. Check that the connection to the database is over SSL by running a command similar to the following:

```
mysql -u root -P 3306 -p
mysql>show variables like "%have_ssl%";

+---------------+-------+
| Variable_name | Value |
+---------------+-------+
| have_ssl      | YES   |
+---------------+-------+
1 row in set (0.00 sec)
```

5. Convert your MySQL client key and certificate files to a PKCS #12 archive. For example:

```
openssl pkcs12 -export \
 -in client-cert.pem \
 -inkey client-key.pem \
 -name "mysqlclient" \
 -passout pass:changeit \
 -out client-keystore.p12
```

6. Import the `client-keystore.p12` into the IDM keystore:

```
keytool \
 -importkeystore \
 -srckeystore client-keystore.p12 \
 -srcstoretype pkcs12 \
 -srcstorepass changeit \
 -destkeystore /path/to/openidm/security/keystore.jceks \
 -deststoretype jceks \
 -deststorepass changeit
```

Important

For AWS RDS MySQL **and** Azure MySQL, no client certificates are provided. In this case, you must create an empty keystore for client certificates, and add the following to the `jdbcUrl` property in your repository connection configuration file (`conf/datasource.jdbc-default.json`):

```
&clientCertificateKeyStoreUrl=file:/opt/idm/security/
empty.jks&clientCertificateKeyStorePassword=changeit
```

7. Import your MySQL CA certificate into the IDM truststore.

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

You are prompted for a keystore password. You must use the same password as is shown in your `resolver/boot.properties` file. The default truststore password is:

```
openidm.truststore.password=changeit
```

After entering a keystore password, you are prompted with the following question. Assuming you have included an appropriate `ca-cert.pem` file, enter `yes`.

```
Trust this certificate? [no]:
```

8. Open your project's `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=&{idm.install.dir}/security/truststore
```

Even if you are setting up this instance of IDM as part of a cluster, you must configure this initial truststore. After this instance joins a cluster, the SSL keys in this particular truststore are replaced.

6.4. Interacting With the Repository Over REST

The IDM 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 because the endpoint is vulnerable to injection attacks. For more information, see "Running Queries and Commands on the Repository".

6.4.1. 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 "Constructing Queries". Parameterized or predefined queries and commands (using the `_queryId` and `commandId` keywords) can be authorized on the repository for external calls if necessary. For more information, see "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 database table configuration file (either `repo.ds.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 7

Configuring the Server

This chapter describes how IDM loads and stores its configuration, how the configuration can be changed, and specific configuration recommendations in a production environment.

The configuration is defined in a combination of `.properties` files, container configuration files, and dynamic configuration objects. Most of the configuration files are stored in your project's `conf/` directory. Note that you might see files with a `.patch` extension in the `conf/` and `db/repo/conf/` directories. These files specify differences relative to the last released version of IDM and are used by the update mechanism. They do not affect your current configuration.

7.1. Configuration Objects

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

7.1.1. 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 following list describes the single instance configuration objects:

- The `audit` configuration specifies how audit events are logged.
- The `authentication` configuration controls REST access.
- The `cluster` configuration defines how an IDM 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 configured workflows.
- The `repo.`*`repo-type`* configuration such as `repo.ds` or `repo.jdbc` configures the IDM repository.

- The `router` configuration specifies filters to apply for specific operations.
- The `script` configuration defines the parameters that are used when compiling, debugging, and running JavaScript and Groovy scripts.
- The `sync` configuration defines the mappings that IDM uses when it synchronizes and reconciles managed objects.
- The `ui` configuration defines the configurable aspects of the default user interfaces.
- The `workflow` configuration defines the configuration of the workflow engine.

IDM stores managed objects in the repository, and exposes them under `/openidm/managed`. System objects on external resources are exposed under `/openidm/system`.

7.1.2. Multiple Instance Configuration Objects

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

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

IDM provides the following multiple instance configuration objects:

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

7.2. Making Configuration Changes

When you change configuration objects, take the following points into account:

- IDM's authoritative configuration source is its repository. Although the JSON files provide a view of the configuration objects, they do not represent the authoritative source.

  Unless you have disabled file writes, as described in "Disabling Automatic Configuration Updates", IDM updates JSON files after you make configuration changes over REST. You can also edit those JSON files directly.

- IDM recognizes changes to JSON files when it is running. The server *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 repository. Rather, edit the configuration over the REST API, or in the configuration JSON files to ensure consistent behavior and that operations are logged.

- By default, IDM stores its configuration in the repository. If you remove an IDM instance and do not specifically drop the repository, the configuration remains in effect for a new instance that uses that repository. You can disable this *persistent configuration* in your project's `conf/system.properties` file by uncommenting the following line:

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

  Disabling persistent configuration means that IDM stores its configuration in memory only.

7.3. Changing the Default REST Context

By default, IDM objects are accessible over REST at the context path `/openidm/*` where `*` indicates the remainder of the context path, for example `/openidm/managed/user`. You can change the default REST context (`/openidm`) by setting the `openidm.servlet.alias` property in your project's `resolver/boot.properties` file.

The following change to the `boot.properties` file sets the REST context to `/example`:

```
openidm.servlet.alias=/example
```

After this change, objects are accessible at the `/example` context path, for example:

```
$ $ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/example/managed/user?_queryId=query-all-ids"
{
  "result": [
    {
      "_id": "bjensen",
      "_rev": "0000000042b1dcd2"
    },
    {
      "_id": "scarter",
      "_rev": "000000009b54de8a"
    }
  ],
  ...
}
```

To ensure that the Admin UI works with the new REST context, also change the `commonConstants.context` property in the following file:

```
/path/to/openidm/ui/admin/default/org/forgerock/openidm/ui/common/util/Constants.js
```

Note

If you've set up a custom UI per "Customizing the Admin UI" and/or "Customizing the End User UI", the directory with the `Constants.js` file will vary.

Note that changing the REST context impacts the API Explorer, described in "API Explorer". If you want to use the API Explorer with the new REST context, change the `baseUrl` property in the following file:

`/path/to/openidm/ui/api/default/index.html`

Based on the change to the REST context earlier in this section, you'd set the following:

```
//base URL for accessing the OpenAPI JSON endpoint
var baseURL = '/example/';
```

7.4. Configuring the Server for Production

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

7.4.1. Configuring a Production Repository

By default, IDM installs an embedded ForgeRock Directory Services (DS) instance for use as its repository. This makes it easy to get started. Before you use IDM in production, you must replace the embedded DS repository with a supported repository. For more information, see "*Selecting a Repository*" in the *Installation Guide*.

For more information, see "*Selecting a Repository*" in the *Installation Guide*.

7.4.2. Disabling Automatic Configuration Updates

By default, IDM 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 for your project, and uncomment the following line:

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

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

Before you disable automatic polling, you must have started the server at least once to ensure that the configuration has been loaded into the repository. Be aware, if automatic polling is enabled, IDM immediately uses changes to scripts called from a JSON configuration file.

When your configuration is complete, you can disable writes to configuration files. To do so, add the following line to the `conf/config.properties` file for your project:

```
felix.fileinstall.enableConfigSave=false
```

7.4.3. Communicating Through a Proxy Server

To set up IDM to communicate through a proxy server, you can use JVM parameters that identify the proxy host system, and the IDM port number.

If you've configured IDM behind a proxy server, include JVM properties from the following table, in the IDM startup script:

JVM Proxy Properties

JVM Property	Example Values	Description
`-Dhttps.proxyHost`	proxy.example.com, 192.168.0.1	Hostname or IP address of the proxy server
`-Dhttps.proxyPort`	8443, 9443	Port number used by IDM

If an insecure port is acceptable, you can also use the `-Dhttp.proxyHost` and `-Dhttp.proxyPort` options. You can add these JVM proxy properties to the value of `OPENIDM_OPTS` in your startup script (`startup.sh` or `startup.bat`):

```
# Only set OPENIDM_OPTS if not already set
[ -z "$OPENIDM_OPTS" ] && OPENIDM_OPTS="-Xmx1024m -Xms1024m -Dhttps.proxyHost=localhost -
Dhttps.proxyPort=8443"
```

7.5. Configuring the Server Over REST

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

To list the configuration on the local host, perform a GET request on `http://localhost:8080/openidm/config`.

The following REST call includes excerpts of the default configuration for an IDM instance started with the `sync-with-csv` sample:

```
$ curl \
 --request GET \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 http://localhost:8080/openidm/config
{
  "_id": "",
  "configurations": [
    {
      "_id": "router",
      "pid": "router",
      "factoryPid": null
```

```
    },
    {
      "_id": "info/login",
      "pid": "info.f01fc3ed-5871-408d-a5f0-bef00ccc4c8f",
      "factoryPid": "info"
    },
    {
      "_id": "provisioner.openicf/csvfile",
      "pid": "provisioner.openicf.9009f4a1-ea47-4227-94e6-69c345864ba7",
      "factoryPid": "provisioner.openicf"
    },
    {
      "_id": "endpoint/usernotifications",
      "pid": "endpoint.e2751afc-d169-4a23-a88e-7211d340bccb",
      "factoryPid": "endpoint"
    },
    ...
  ]
}
```

Single instance configuration objects are located under `openidm/config/object-name`. The following example shows the `audit` configuration of the `sync-with-csv`. The output has been cropped for legibility:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 "http://localhost:8080/openidm/config/audit"
{
  "_id": "audit",
  "auditServiceConfig": {
    "handlerForQueries": "json",
    "availableAuditEventHandlers": [
      "org.forgerock.audit.handlers.csv.CsvAuditEventHandler",
      "org.forgerock.audit.handlers.elasticsearch.ElasticsearchAuditEventHandler",
      "org.forgerock.audit.handlers.jms.JmsAuditEventHandler",
      "org.forgerock.audit.handlers.json.JsonAuditEventHandler",
      "org.forgerock.audit.handlers.json.stdout.JsonStdoutAuditEventHandler",
      "org.forgerock.openidm.audit.impl.RepositoryAuditEventHandler",
      "org.forgerock.openidm.audit.impl.RouterAuditEventHandler",
      "org.forgerock.audit.handlers.splunk.SplunkAuditEventHandler",
      "org.forgerock.audit.handlers.syslog.SyslogAuditEventHandler"
    ],
    "filterPolicies": {
      "value": {
        "excludeIf": [
          "/access/http/request/cookies/&{com.iplanet.am.cookie.name}",
          "/access/http/request/cookies/session-jwt",
          "/access/http/request/headers/&{com.sun.identity.auth.cookieName}",
          "/access/http/request/headers/&{com.iplanet.am.cookie.name}",
          "/access/http/request/headers/accept-encoding",
          "/access/http/request/headers/accept-language",
          "/access/http/request/headers/Authorization",
          "/access/http/request/headers/cache-control",
          "/access/http/request/headers/connection",
          "/access/http/request/headers/content-length",
          "/access/http/request/headers/content-type",
          "/access/http/request/headers/proxy-authorization",
          "/access/http/request/headers/X-OpenAM-Password",
          "/access/http/request/headers/X-OpenIDM-Password",
```

```
          "/access/http/request/queryParameters/access_token",
          "/access/http/request/queryParameters/IDToken1",
          "/access/http/request/queryParameters/id_token_hint",
          "/access/http/request/queryParameters/Login.Token1",
          "/access/http/request/queryParameters/redirect_uri",
          "/access/http/request/queryParameters/requester",
          "/access/http/request/queryParameters/sessionUpgradeSSOTokenId",
          "/access/http/request/queryParameters/tokenId",
          "/access/http/response/headers/Authorization",
          "/access/http/response/headers/Set-Cookie",
          "/access/http/response/headers/X-OpenIDM-Password"
        ],
        "includeIf": []
      }
    },
    "caseInsensitiveFields": [
      "/access/http/request/headers",
      "/access/http/response/headers"
    ]
  },
  "eventHandlers": [
    {
      "class": "org.forgerock.audit.handlers.json.JsonAuditEventHandler",
      "config": {
        "name": "json",
        "logDirectory": "&{idm.data.dir}/audit",
        "buffering": {
          "maxSize": 100000,
          "writeInterval": "100 millis"
        },
        "topics": [
          "access",
          "activity",
          "recon",
          "sync",
          "authentication",
          "config"
        ]
      }
    }
    ...
  ],
  "eventTopics": {
    ...
  },
  "exceptionFormatter": {
    "type": "text/javascript",
    "file": "bin/defaults/script/audit/stacktraceFormatter.js"
  }
}
```

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

The following example shows the configuration for the CSV connector shown in the `sync-with-csv` sample. The output has been cropped for legibility:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
```

```
 --header "X-OpenIDM-Password: openidm-admin" \
 "http://localhost:8080/openidm/config/provisioner.openicf/csvfile"
{
  "_id": "provisioner.openicf/csvfile",
  "connectorRef": {
    "bundleName": "org.forgerock.openicf.connectors.csvfile-connector",
    "bundleVersion": "[1.5.19.0,1.6.0.0)",
    "connectorName": "org.forgerock.openicf.csvfile.CSVFileConnector"
  },
  "poolConfigOption": {
    "maxObjects": 10,
    "maxIdle": 10,
    "maxWait": 150000,
    "minEvictableIdleTimeMillis": 120000,
    "minIdle": 1
  },
  "operationTimeout": {
    "CREATE": -1,
    "VALIDATE": -1,
    "TEST": -1,
    "SCRIPT_ON_CONNECTOR": -1,
    "SCHEMA": -1,
    "DELETE": -1,
    "UPDATE": -1,
    "SYNC": -1,
    "AUTHENTICATE": -1,
    "GET": -1,
    "SCRIPT_ON_RESOURCE": -1,
    "SEARCH": -1
  },
  "configurationProperties": {
    "csvFile": "&{idm.instance.dir}/data/csvConnectorData.csv"
  },
  "resultsHandlerConfig": {
    "enableAttributesToGetSearchResultsHandler": true
  },
  "syncFailureHandler": {
    "maxRetries": 5,
    "postRetryAction": "logged-ignore"
  },
  "objectTypes": {
    ...
  },
  "operationOptions": {}
}
```

You can change the configuration over REST by using an HTTP PUT or HTTP PATCH request to modify the required configuration object.

The following example uses a PUT request to modify the configuration of the scheduler service, increasing the maximum number of threads that are available for the concurrent execution of scheduled tasks:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PUT \
 --data '{
    "threadPool": {
        "threadCount": 20
    },
    "scheduler": {
        "executePersistentSchedules": {"$bool" : "&{openidm.scheduler.execute.persistent.schedules}"
    }
}' \
 "http://localhost:8080/openidm/config/scheduler"
{
  "_id": "scheduler",
  "threadPool": {
    "threadCount": 20
  },
  "scheduler": {
    "executePersistentSchedules": {
      "$bool": "&{openidm.scheduler.execute.persistent.schedules}"
    }
  }
}
```

The following example uses a PATCH request to reset the number of threads to their original value.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PATCH \
 --data '[
    {
      "operation" : "replace",
      "field" : "/threadPool/threadCount",
      "value" : 10
    }
 ]' \
 "http://localhost:8080/openidm/config/scheduler"
{
  "_id": "scheduler",
  "threadPool": {
    "threadCount": 10
  },
  "scheduler": {
    "executePersistentSchedules": {
      "$bool": "&{openidm.scheduler.execute.persistent.schedules}"
    }
  }
}
```

Note

Multi-version concurrency control (MVCC) is not supported for configuration objects so you do not need to specify a revision during updates to the configuration, and no revision is returned in the output.

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

7.6. Using Property Value Substitution

In an environment where you have more than one IDM instance, you might require a configuration that is similar, but not identical, across the different instances.

Property value substitution lets you achieve the following:

- Define a configuration that is specific to a single 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.

Property value substitution uses *configuration expressions* to introduce variables into the server configuration. You set configuration expressions as the values of configuration properties. The effective property values can be evaluated in a number of ways. For more information about property evaluation, see "Expression Evaluation and Order of Precedence".

Configuration expressions have the following characteristics:

- To distinguish them from static values, configuration expressions are preceded by an ampersand and enclosed in braces. For example: `&{openidm.port.http}`. The configuration token in the example is `openidm.port.http`. The `.` serves as the separator character.
- You can use a default value in a configuration expression by including it after a vertical bar following the token.

  For example, the following expression sets the default HTTP port value to 8080: `&{openidm.port.http|8080}`.

  With this configuration, the server attempts to substitute `openidm.port.http` with a defined configuration token. If no token definition is found, the server uses the default, `8080`.
- A configuration property can include a mix of static values and expressions.

  For example, suppose `hostname` is set to `ds`. Then `&{hostname}.example.com` evaluates to `ds.example.com`.
- Configuration token evaluation is recursive.

For example, suppose `port` is set to `&{port.prefix}389`, and `port.prefix` is set to `2`. Then `&{port}` evaluates to `2389`.

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

Important

Property substitution is *not* available for any configuration not processed by the IDM backend, such as `ui-themeconfig` or any user-supplied configuration.

7.6.1. Expression Evaluation and Order of Precedence

At server startup, expression resolvers evaluate property values to determine the effective configuration. You must define expression values before you start the IDM server that uses them.

When configuration tokens are resolved, the result is always a string. However, you can *coerce* the output type of the evaluated token to match the type that is required by the property. Ultimately, the expression must return the appropriate data type for the configuration property. For example, the `port` property takes an integer. If you set it using an expression, the result of the evaluated expression must be an integer. If the type is wrong, the server fails to start due to a syntax error. For more information about data type coercion, see "Transforming Data Types".

Expression resolvers can obtain values from the following sources:

1. **Environment variables**

   You set an environment variable to hold the property value.

   For example: `export OPENIDM_PORT_HTTP=8080`

   The environment variable name must be composed of uppercase characters and underscores. The name maps to the expression token as follows:

   - Uppercase characters are lower cased.
   - Underscores, `_`, are replaced with `.` characters.

   In other words, the value of `OPENIDM_PORT_HTTP` replaces `&{openidm.port.http}` in the server configuration.

2. **Java system properties**

   You set a Java system property to hold the value.

   Java system property names must match expression tokens exactly. In other words, the value of the `openidm.repo.port` system property replaces `&{openidm.repo.port}` in the server configuration.

Java system properties can be set in a number of ways. One way of setting system properties for IDM servers is to pass them through the `OPENIDM_OPTS` environment variable.

For example: `export OPENIDM_OPTS="-Dopenidm.repo.port=3306"`

System properties can also be declared in your project's `conf/system.properties`.

The following example uses property value substitution with a standard system property. The example modifies the audit configuration, changing the `audit.json` file to redirect JSON audit logs to the user's home directory. The `user.home` property is a default Java System property:

```
"eventHandlers" : [
    {
        "class" : "org.forgerock.audit.handlers.json.JsonAuditEventHandler",
        "config" : {
            "name" : "json",
            "logDirectory" : "&{user.home}/audit",
            ...
        }
    },
...
```

3. **Expression files**

You set a key in a `.json` or `.properties` file to hold the value. To use an expression file, set the `IDM_ENVCONFIG_DIRS` environment variable, or the `idm.envconfig.dirs` Java system property as described below. By default, IDM sets `idm.envconfig.dirs` to `&{idm.install.dir}/resolver/`.

The default property resolver file in IDM is `resolver/boot.properties` but you can specify additional files that might hold property values.

Keys in `.properties` files must match expression tokens exactly. In other words, the value of the `openidm.repo.port` key replaces `&{openidm.repo.port}` in the server configuration.

The following example expression properties file sets the repository port:

```
openidm.repo.port=1389
```

JSON expression files can contain nested objects.

JSON field names map to expression tokens as follows:

- The JSON path name matches the expression token.
- The `.` character serves as the JSON path separator character.

The following example JSON expression file uses property value substitution to set the host in the LDAP connector configuration:

```
{
   "openidm" : {
     "provisioner" : {
       "ldap" : {
         "host" : "ds.example.com"
         }
       }
     }
   }
 }
```

To substitute this value in the configuration, the LDAP provisioner file would include the following:

```
{
   ...
   "configurationProperties" : {
     "host" : &{openidm.provisioner.ldap.host|localhost},
     ...
   }
 }
```

If the server does not find a configuration token for the host name, it substitutes the default (`localhost`).

To use expression files, set the environment variable, `IDM_ENVCONFIG_DIRS`, or the Java system property, `idm.envconfig.dirs`, to a comma-separated list of the directories containing the expression files.

When reading these files, the server browses the directories in the order specified. It reads all the files with `.json` and `.properties` extensions, and attempts to use them to evaluate expression tokens.

For example, if you define `idm.envconfig.dirs=/directory1,/directory2` and a configuration token is defined in both `directory1` and `directory2`, the resolved value will be the value defined in `directory1`. If the configuration token is defined only in `directory2`, the resolved value will be the value defined in `directory2`.

Note the following constraints when using expression files:

- Although IDM scans the directories in a specified order, within a directory IDM scans the files in a nondeterministic order.
- IDM does not scan subdirectories.
- Do *not* define the same configuration token more than once in a file.

  If you define the same property twice in the same file, one definition will be used and the other will be ignored. The server will not throw an error, but because files are scanned in a nondeterministic order, you have no way of knowing which value will be used.
- You cannot define the same configuration token in more than one file in a single directory. The server generates an error in this case.

Important

This constraint implies that you cannot have backup `.properties` and `.json` files, in a single directory if they define the same tokens.

- If the same token occurs once in several files that are located in different directories, IDM uses the first value that is read.

4. **Framework configuration properties**

   You can use the `conf/config.properties` file to override values used by the OSGI framework.

5. **Configuration files**

   All the properties declared in the `.json` files in your project's `conf/` directory.

The preceding list reflects the order of precedence:

- Environment variables override system properties, default token settings, and settings in expression files.
- System properties override default token settings, and any settings in expression files.
- Default token settings.
- If `IDM_ENVCONFIG_DIRS` or `idm.envconfig.dirs` is set, the server uses the settings found in expression files.
- Framework configuration properties
- Hardcoded property values

7.6.2. Transforming Data Types

When configuration tokens are resolved, the result is always a string. However, you can transform the output type of the evaluated token to match the type that is required by the property.

The following example JSON expression file sets the value of the port in the LDAP connector configuration:

```
{
   "openidm" : {
     "provisioner" : {
       "ldap" : {
         "port" : 6389
       }
     }
   }
 }
```

When this expression is evaluated, the port would be evaluated as a `string` value, which would cause an error. To coerce the port value to an integer, you would substitute the value in the LDAP provisioner file as follows:

```
{
   ...
   "configurationProperties" : {
     "port" : {
       "$int" : "&{openidm.provisioner.ldap.port|1389}",
     ...
   }
 }
```

With this configuration, the server evaluates the LDAP port property to the integer `6389`. If the server does not find a configuration token for the port, it substitutes the default (`1389`).

The following coercion types are supported:

- integer (`$int`)
- number (`$number`)

  This type can coerce integers, doubles, longs, and floats.
- boolean (`$bool`)
- array (`$array`)
- object (`$object`)

  This type can coerce a JSON object such as an encrypted password.
- decodeBase64 (`$base64:decode`)

  Transforms a base64-encoded string into a decoded string.
- encodeBase64 (`$base64:encode`)

  Transforms a string into a base64-encoded string.

7.6.3. Limitations of Property Value Substitution

The work you've done to set up property value substitution is limited; different rules apply in the following areas:

- "Property Value Substitution in the Admin UI"
- "Property Value Substitution for Connectors"

7.6.3.1. Property Value Substitution in the Admin UI

Support for property value substitution in the Admin UI is limited to the following categories:

- String substitution, where `&{some.property|DefaultValue}`
- Number and integer substitution, including:
  - `"$number" : "&{openidm.port|1234}"`
  - `"$int" : "&{openidm.port|5678}"`
- Base64 substitution, such as: `"$base64:decode" : "&{openidm.felix.web.console.password|YWRtaW4=}"`
- Cryptographic substitution, where for passwords and client secrets, IDM substitutes `"********"` for `$crypto`

7.6.3.2. Property Value Substitution for Connectors

You cannot use property substitution for connector reference (`connectorRef`) properties. 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" : "[1.5.19.0,1.6.0.0)",
    ...
}
```

7.6.3.3. Property Value Substitution and the Repository

Configuration fields that use property substitution are stored in the repository as variables. You'll need to store the actual values of each variable in `*.properties` files.

You can use different `*.properties` files to vary the configuration for multiple nodes in a cluster.

The properties in the following table can be set through environment variables and more. They're evaluated during the IDM start process, as defined:

Configuration Property Variables

Variable	Description	Environment Variables	System Variables	boot.properties
idm.install.dir	Directory of files from unpacked IDM binary	X	X	X
idm.data.dir	Working location directory	X	X	X
idm.instance.dir	Project directory with IDM configuration files	X	X	X
idm.envconfig.dirs	Directory with environment files, including boot.properties	X	X	

In contrast, configuration properties that are explicitly set in `project-dir/conf/*.json` files are stored in the repository. You can manage these configuration objects by using the REST interface or by using the JSON files themselves. Most aspects of the configuration can also be managed by using the Admin UI, as described in "Configuring the Server from the Admin UI".

You can access configuration properties in scripts using `identityServer.getProperty()`. For more information, see "The `identityServer` Variable".

7.7. Setting the Script Configuration

The script configuration file (`conf/script.json`) lets you modify the parameters that are used when compiling, debugging, and running JavaScript and Groovy scripts.

The default `script.json` file includes the following parameters:

properties

Any custom properties that should be provided to the script engine.

ECMAScript

Specifies JavaScript debug and compile options. JavaScript is an ECMAScript language.

- `javascript.debug` - the JavaScript debugging configuration. By default this is set to the value of the `openidm.script.javascript.debug` property in IDM's `resolver/boot.properties` file.
- `javascript.recompile.minimumInterval` - minimum time after which a script can be recompiled.

The default value is `60000`, or 60 seconds. This means that any changes made to scripts will not get picked up for up to 60 seconds. If you are developing scripts, reduce this parameter to around `100` (100 milliseconds).

If you set the `javascript.recompile.minimumInterval` to `-1`, or remove this property from the `script.json` file, IDM does not poll JavaScript files to check for changes.

Groovy

Specifies compilation and debugging options related to Groovy scripts. Many of these options are commented out in the default script configuration file. Remove the comments to set these properties:

- `groovy.warnings` - the log level for Groovy scripts. Possible values are `none`, `likely`, `possible`, and `paranoia`.
- `groovy.source.encoding` - the encoding format for Groovy scripts. Possible values are `UTF-8` and `US-ASCII`.
- `groovy.target.directory` - the directory to which compiled Groovy classes will be output. The default directory is *`install-dir`*`/classes`.
- `groovy.target.bytecode` - the bytecode version that is used to compile Groovy scripts. The default version is `1.5`.
- `groovy.classpath` - the directory in which the compiler should look for compiled classes. The default classpath is *`install-dir`*`/lib`.

  To call an external library from a Groovy script, you must specify the complete path to the .jar file or files, as a value of this property. For example:

```
"groovy.classpath" : "/&{idm.install.dir}/lib/http-builder-0.7.1.jar:
         /&{idm.install.dir}/lib/json-lib-2.3-jdk15.jar:
         /&{idm.install.dir}/lib/xml-resolver-1.2.jar:
         /&{idm.install.dir}/lib/commons-collections-3.2.1.jar",
```

> **Note**
>
> If you're deploying on Microsoft Windows, use a semicolon (`;`) instead of a colon to separate directories in the `groovy.classpath`.

- `groovy.output.verbose` - specifies the verbosity of stack traces. Boolean, `true` or `false`.
- `groovy.output.debug` - specifies whether debugging messages are output. Boolean, `true` or `false`.
- `groovy.errors.tolerance` - sets the number of non-fatal errors that can occur before a compilation is aborted. The default is `10` errors.
- `groovy.script.extension` - specifies the file extension for Groovy scripts. The default is `.groovy`.

- `groovy.script.base` - defines the base class for Groovy scripts. By default any class extends `groovy.lang.Script`.
- `groovy.recompile` - indicates whether scripts can be recompiled. Boolean, `true` or `false`, with default `true`.
- `groovy.recompile.minimumInterval` - sets the minimum time between which Groovy scripts can be recompiled.

  The default value is `60000`, or 60 seconds. This means that any changes made to scripts will not get picked up for up to 60 seconds. If you are developing scripts, reduce this parameter to around `100` (100 milliseconds).
- `groovy.target.indy` - specifies whether a Groovy indy test can be used. Boolean, `true` or `false`, with default `true`.
- `groovy.disabled.global.ast.transformations` - specifies a list of disabled Abstract Syntax Transformations (ASTs).

sources

Specifies the locations in which IDM expects to find JavaScript and Groovy scripts that are referenced in the configuration.

The following excerpt of the `script.json` file shows the default locations:

```
...
"sources" : {
    "default" : {
        "directory" : "&{idm.install.dir}/bin/defaults/script"
    },
    "install" : {
        "directory" : "&{idm.install.dir}"
    },
    "project" : {
        "directory" : "&{idm.instance.dir}"
    },
    "project-script" : {
        "directory" : "&{idm.instance.dir}/script"
    }
...
```

Note

The order in which locations are listed in the `sources` property is important. Scripts are loaded from the *bottom up* in this list, that is, scripts found in the last location on the list are loaded first.

Note

By default, debug information (such as file name and line number) is excluded from JavaScript exceptions. To troubleshoot script exceptions, you can include debug information by changing the following setting to `true` in IDM's `resolver/boot.properties` file:

```
javascript.exception.debug.info=false
```

Including debug information in a production environment is not recommended.

7.8. Calling a Script From a Configuration File

You can call a script from within a configuration file by providing the script source, or by referencing a file that contains the script source. For example:

```
{
    "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.

The file path must be relative to the *project-dir*. Full file paths are not supported.

The following sample excerpts from configuration files indicate how scripts can be called.

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 a target object should be included in the reconciliation process, or should be 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 IDM 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 the file, *`project-dir`*`/script/createUnixHomeDir.js`:

```
{
    "filters" : [ {
        "pattern" : "^system/solaris/account$",
        "methods" : [ "create" ],
        "onResponse" : {
            "type" : "text/javascript",
            "file" : "script/createUnixHomeDir.js"
        }
    } ]
}
```

Often, script files are reused in different contexts. You can pass variables to your scripts to provide these contextual details at runtime. You pass variables to the scripts that are referenced in configuration files by declaring the variable name in the script reference.

The following example of a scheduled task configuration calls a script named `triggerEmailNotification.js`. The example sets the sender and recipient of the email in the schedule configuration, rather than in the script itself:

```
{
    "enabled" : true,
    "type" : "cron",
    "schedule" : "0 0/1 * * * ?",
    "persisted" : true,
    "invokeService" : "script",
    "invokeContext" : {
        "script": {
            "type" : "text/javascript",
            "file" : "script/triggerEmailNotification.js",
            "fromSender" : "admin@example.com",
            "toEmail" : "user@example.com"
        }
    }
}
```

Tip

In general, you should namespace variables passed into scripts with the `globals` map. Passing variables in this way prevents collisions with the top-level reserved words for script maps, such as `file`, `source`, and `type`. The following example uses the `globals` map to namespace the variables passed in the previous example.

```
"script": {
    "type" : "text/javascript",
    "file" : "script/triggerEmailNotification.js",
    "globals" : {
        "fromSender" : "admin@example.com",
        "toEmail" : "user@example.com"
    }
}
```

Script variables are not necessarily simple `key:value` pairs. A script variable can be any arbitrarily complex JSON object.

7.9. Configuring HTTP Clients

Several IDM modules, such as the external REST service and identity provider service, need to make HTTP(S) requests to external systems.

HTTP client settings can be configured through any expression resolver (in `resolver/boot.properties`, environment variables, or Java system properties). Configuration for specific clients can be set in that client's JSON configuration file. For example `conf/external.rest.json` configures the external REST service and properties set there override the expression resolvers. For more information on property resolution, see "Expression Evaluation and Order of Precedence".

You can set the following properties for HTTP clients:

`openidm.http.client.sslAlgorithm`

The cipher to be used when making SSL/TLS connections, for example, `AES`, `CBC`, or `PKCS5Padding`. Defaults to the system SSL algorithm.

`openidm.http.client.socketTimeout`

The TCP socket timeout, in seconds, when waiting for HTTP responses. The default timeout is 10 seconds.

`openidm.http.client.connectionTimeout`

The TCP connection timeout for new HTTP connections, in seconds. The default timeout is 10 seconds.

`openidm.http.client.reuseConnections` (true or false)

Specifies whether HTTP connections should be kept alive and reused for additional requests. By default, connections will be reused if possible.

`openidm.http.client.retryRequests` (true or false)

Specifies whether requests should be retried if a failure is detected. By default requests will be retried.

`openidm.http.client.maxConnections` (integer)

The maximum number of connections that should be pooled by the HTTP client. At most `64` connections will be pooled by default.

`openidm.http.client.hostnameVerifier` (string)

Specifies whether the client should check that the hostname to which it has connected is allowed by the certificate that is presented by the server.

The property can take the following values:

- `STRICT` - hostnames are validated
- `ALLOW_ALL` - the external REST service does not attempt to match the URL hostname to the SSL certificate Common Name, as part of its validation process

If you do not set this property, the behavior is to validate hostnames (the equivalent of setting `"hostnameVerifier": "STRICT"`). In production environments, you *should* set this property to `STRICT`.

`openidm.http.client.proxy.uri`

Specifies that the client should make its HTTP(S) requests through the specified proxy server.

`openidm.http.client.proxy.userName`

The username of the account for the specified proxy.

`openidm.http.client.proxy.password`

The password of the account for the specified proxy.

`openidm.http.client.proxy.useSystem` (true or false)

If `true`>, specifies a system-wide proxy with the JVM system properties, `http.proxyHost`, `http.proxyPort`, and (optionally) `http.nonProxyHosts`.

If `openidm.http.client.proxy.uri` is set, and not empty, that setting overrides the system proxy setting.

Chapter 8

Accessing Data Objects

IDM 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.

8.1. Accessing Data Objects By Using Scripts

IDM'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 "*Data Models and Objects Reference*". For more information about scripts and the objects available to scripts, see "*Scripting Reference*".

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

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

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

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

```
openidm.update("managed/organization/mysampleorg", rev, object)
openidm.update("system/mysystem/account", rev, object)
```

You can apply a partial update to a managed or system object by using the `patch()` function:

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

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

8.2. Accessing Data Objects By Using the REST API

IDM provides RESTful access to data objects through the ForgeRock Common 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 "*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 `http://localhost:8080/openidm/managed/organization/mysampleorg`.

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

In general, you can map any HTTP request to the corresponding `openidm.method` call. The following example shows how the parameters provided in an `openidm.query` request correspond with the key-value pairs that you would include in a similar HTTP GET request:

Reading an object using the Resource API:

```
openidm.query("managed/user", { "_queryId": "query-all" }, ["userName","sn"])
```

Reading an object using the REST API:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user?_queryId=query-all&_fields=userName,sn"
```

8.3. Defining and Calling Queries

An advanced query model lets you 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.

Tip

For limits on queries in progressive profiling, see "Custom Progressive Profile Conditions".

8.3.1. 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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 'http://localhost:8080/openidm/managed/user?_queryFilter=userName+eq+"smith"'
```

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 "Constructing Queries".

Note

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

8.3.2. Parameterized Queries

Managed objects in the supported 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 backend 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 objectid FROM ${_dbSchema}.${_table} LIMIT ${int:_pageSize} OFFSET
 ${int:_pagedResultsOffset}",
```

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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 "http://localhost:8080/openidm/managed/user?_queryId=query-all-ids"
```

Note

In `repo.jdbc.json`, the `queries` configuration object has a property, `validInRelationshipQuery`, which is an array specifying the query IDs of queries that make use of relationships. If you create additional queries that you expect to use as part of a relationship query, be sure to add the query ID to this array. If no query IDs are specified or the property is missing, relationship information will not be returned in query results, even if requested. For more information about relationships, see "*Managing Relationships Between Objects*".

8.3.3. 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 ICF connectors, queries use the applicable query language of the system resource.

Important

Native query expressions are not supported with the default DS repository.

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

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 "http://localhost:8080/openidm/managed/user?_queryExpression=select+*+from+managed_user"
```

Unless you have specifically enabled native queries over REST, the previous command returns a 403 access denied error message. Native queries 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 in production environments. They should be used only via the internal Resource API. If you want to enable native queries over REST for development, see "Protecting 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.

8.3.4. Constructing Queries

The `openidm.query` function lets you query 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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/openidm/managed/user?_queryFilter=userName+eq+"Smith"'
```

Note the use of double-quotes around the search term: `Smith`. In `_queryFilter` expressions, string values *must* use double-quotes. Numeric and boolean expressions should not use quotes.

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 "Improving Generic Mapping Search Performance (JDBC)".

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.

Note

You can also use the negation operator (*!*) in query construction. For example, a **_queryFilter=!(userName+eq +"jdoe")** query would return every `userName` except for `jdoe`.

You can set up query filters with the following expression types:

8.3.4.1. Comparison Expressions

- Equal queries (see "Querying Objects That Equal a Specified Value")
- Contains queries (see "Querying Objects That Contain a Specified Value")
- Starts with queries (see "Querying Objects That Start With a Specified Value")
- Less than queries (see "Querying Objects That Are Less Than a Specified Value")
- Less than or equal to queries (see "Querying Objects That Are Less Than or Equal to a Specified Value")
- Greater than queries (see "Querying Objects That Are Greater Than a Specified Value")
- Greater than or equal to queries (see "Querying Objects That Are Greater Than or Equal to a Specified Value")

Note

Certain system endpoints also support `EndsWith` and `ContainsAllValues` queries. However, such queries are *not supported* for managed objects and have not been tested with all supported ICF connectors.

8.3.4.1.1. Querying Objects That Equal a Specified Value

This is the associated JSON comparison expression: *`json-pointer` `eq` `json-value`*.

Consider the following 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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/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"
    }
}
```

8.3.4.1.2. Querying Objects That Contain a Specified Value

This is the associated JSON comparison expression: *`json-pointer co json-value`*.

Consider the following example:

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

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

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/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"
    }
,
...
}
```

8.3.4.1.3. Querying Objects That Start With a Specified Value

This is the associated JSON comparison expression: *`json-pointer sw json-value`*.

Consider the following 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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/openidm/managed/user?_queryFilter=sn+sw+"Jen"&_fields=userName'
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 4,
  "result": [
    {
      "userName": "bjensen"
    },
    {
      "userName": "djensen"
    },
    {
      "userName": "cjenkins"
    },
    {
      "userName": "mjennings"
    }
  ]
}
```

8.3.4.1.4. Querying Objects That Are Less Than a Specified Value

This is the associated JSON comparison expression: *`json-pointer lt json-value`*.

Consider the following example:

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

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

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/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"
    }
...
  ]
}
```

8.3.4.1.5. Querying Objects That Are Less Than or Equal to a Specified Value

This is the associated JSON comparison expression: *`json-pointer` `le` `json-value`*.

Consider the following example:

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

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

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
```

```
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/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"
    }
...
  ]
}
```

8.3.4.1.6. Querying Objects That Are Greater Than a Specified Value

This is the associated JSON comparison expression: *`json-pointer`* `gt` *`json-value`*

Consider the following example:

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

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

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/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"
    }
...
  ]
}
```

8.3.4.1.7. Querying Objects That Are Greater Than or Equal to a Specified Value

This is the associated JSON comparison expression: *`json-pointer` `ge` `json-value`*.

Consider the following example:

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

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

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/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"
    }
...
  ]
}
```

8.3.4.2. Presence Expressions

The following examples show how you can build filters using a presence expression, shown as `pr`. The presence expression is a filter that returns all records with a given attribute.

A presence expression filter evaluates to `true` when a *`json-pointer`* `pr` matches any object in which the *json-pointer* is present, and contains a non-null value. Consider the following expression:

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

The following REST call uses that expression to return the mail addresses for all managed users with a `mail` property:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/openidm/managed/user?_queryFilter=mail+pr&_fields=mail'
{
  "remainingPagedResults": -1,
  "pagedResultsCookie": null,
  "resultCount": 2,
  "result": [
    {
      "mail": "jdoe@exampleAD.com"
    },
    {
      "mail": "bjensen@example.com"
    }
  ]
}
```

Depending on the connector, you can apply the presence filter on system objects. The following query returns the email address of all users in a CSV file who have the `email` attribute in their entries:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/openidm/system/csvfile/account?_queryFilter=email+pr&_fields=email'
{
  "result": [
    {
      "_id": "bjensen",
      "email": "bjensen@example.com"
    },
    {
      "_id": "scarter",
      "email": "scarter@example.com"
    }
  ],
  "resultCount": 2,
  "pagedResultsCookie": "MA%3D%3D",
  "totalPagedResultsPolicy": "NONE",
  "totalPagedResults": -1,
  "remainingPagedResults": -1
}
```

Not all connectors support the presence filter. In most cases, you can replicate the behavior of the presence filter with an "equals" (`eq`) query such as `_queryFilter=email+eq"*"`

8.3.4.3. Literal Expressions

A literal expression is a boolean:

- `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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/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"
    }
  ]
}
```

8.3.4.4. 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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/openidm/managed/user/?_queryFilter=city+eq+"London"+and+sn+eq
+"Jensen"&_fields=userName,givenName,sn'
{
  "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"
    }
  ]
}
```

8.3.5. Paging Query Results

The common filter query mechanism supports paged query results for managed objects, and for some system objects, depending on the system resource. There are two ways to page objects in a query:

- Using a cookie based on the value of a specified sort key.
- Using an offset that specifies how many records should be skipped before the first result is returned.

These methods are implemented with the following query parameters:

`_pagedResultsCookie`

Opaque cookie used by the server to keep track of the position in the search results. The format of the cookie is a base-64 encoded version of the value of the unique sort key property. The value of the returned cookie is URL-encoded to prevent values such as `+` from being incorrectly translated.

You cannot page results without sorting them (using the `_sortKeys` parameter). If you do not specify a sort key, the `_id` of the record is used as the default sort key. At least one of the specified sort key properties must be a unique value property, such as `_id`.

Tip

For paged searches on generic mappings with the default DS repository, you should sort on the `_id` property, as this is the only property that is stored outside of the JSON blob. If you sort on something other than `_id`, the search will incur a performance hit because IDM effectively has to pull the entire result set, and then sort it.

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.

The `_pagedResultsCookie` parameter is supported only for filtered queries, that is, when used with the `_queryFilter` parameter. You cannot use the `_pagedResultsCookie` with a `_queryExpression` or a `_queryId`.

The `_pagedResultsCookie` and `_pagedResultsOffset` parameters are mutually exclusive, and cannot be used together.

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 `_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.

`_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.

When a `_pageSize` is specified, and non-zero, the server calculates the `totalPagedResults`, in accordance with the `totalPagedResultsPolicy`, and provides the value as part of the response. If a count policy is specified (`_totalPagedResultsPolicy=EXACT`, The `totalPagedResults` returns the total result count. If no count policy is specified in the query, or if `_totalPagedResultsPolicy=NONE`, result counting is disabled, and the server returns a value of -1 for `totalPagedResults`. The following example shows a query that requests two results with a `totalPagedResultsPolicy` of `EXACT`:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user?
_queryFilter=true&_pageSize=2&_totalPagedResultsPolicy=EXACT"
{
  "result": [
    {
      "_id": "adonnelly",
      "_rev": "0",
      "userName": "adonnelly",
      "givenName": "Abigail",
      "sn": "Donnelly",
      "telephoneNumber": "12345678",
      "active": "true",
      "mail": "adonnelly@example.com",
      "accountStatus": "active",
      "effectiveRoles": [],
      "effectiveAssignments": []
    },
    {
      "_id": "bjensen",
      "_rev": "0",
      "userName": "bjensen",
      "givenName": "Babs",
      "sn": "Jensen",
      "telephoneNumber": "12345678",
      "active": "true",
      "mail": "bjensen@example.com",
      "accountStatus": "active",
      "effectiveRoles": [],
      "effectiveAssignments": []
    }
  ],
  "resultCount": 2,
  "pagedResultsCookie": "eyIvX2lkIjoiYm11cnJheSJ9",
  "totalPagedResultsPolicy": "EXACT",
  "totalPagedResults": 22,
  "remainingPagedResults": -1
}
```

The `totalPagedResults` and `_remainingPagedResults` parameters are not supported for all queries. Where they are not supported, their returned value is always `-1`. In addition, counting query results using these parameters is not currently supported for a ForgeRock Directory Services (DS) repository.

Requesting the total result count (with `_totalPagedResultsPolicy=EXACT`) incurs a performance cost on the query.

Queries that return large data sets will have a significant impact on heap requirements, particularly if they are run in parallel with other large data requests. To avoid out of memory errors, analyze your data requirements, set the heap configuration appropriately, and modify access controls to restrict requests on large data sets.

8.3.6. 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.

Note

When using DS as a repo, pagination using `_pageSize` is recommended if you intend to use `_sortKeys`. If you do not plan to paginate your query, the data you are querying must at least be indexed in DS. For more information about how to set up indexes in DS, see Indexing Attribute Values in the *DS Administration Guide*.

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

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/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"
    }
  ]
}
```

8.3.7. Recalculating Virtual Property Values in Queries

For managed objects IDM includes an `onRetrieve` script hook that lets you recalculate property values when an object is retrieved as the result of a query. To use the `onRetrieve` trigger, the query must include the `executeOnRetrieve` parameter, for example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/openidm/managed/user?_queryFilter=sn+eq+"Jensen"&executeOnRetrieve=true'
```

If a query includes `executeOnRetrieve`, the query recalculates virtual property values, based on the current state of the system. The result of the query will be the same as a `read` on a specific object, because reads always recalculate virtual property values.

If a query does not include `executeOnRetrieve`, the query returns the virtual properties of an object, based on the value that is persisted in the repository. Virtual property values are not recalculated.

For performance reasons, `executeOnRetrieve` is `false` by default.

8.4. Uploading Files to the Server

IDM provides a generic file upload service that lets you upload and save files either to the filesystem or to the repository. The service uses the `multipart/form-data` Content-Type to accept file content, store it, and return that content when it is called over the REST interface.

To configure the file upload service, add one or more `file-`*`description`*`.json` files to your project's `conf` directory, where *description* provides an indication of the purpose of the upload service. For example, you might create a `file-images.json` configuration file to handle uploading image files. Each file upload configuration file sets up a separate instance of the upload service. The *description* in the filename also specifies the endpoint at which the file service will be accessible over REST. In the previous example, `file-images.json`, the service would be accessible at the endpoint `openidm/file/images`.

A sample file upload service configuration file is available in the `/path/to/openidm/samples/example-configurations/conf` directory. The configuration is as follows:

```
{
    "enabled" : true,
    "fileHandler" : {
    "type" : file handler type,
    "root" : directory
    }
}
```

The service supports two *file handlers*—`file` and `repo`. The file handlers are configured as follows:

- `"type" : "file"` specifies that the uploaded content will be stored in the filesystem. If you use the `file` type, you must specify a `root` property to indicate the directory (relative to the IDM installation

directory) in which uploaded content is stored. In the following example, uploaded content is stored in the `/path/to/openidm/images` directory:

```
{
    "enabled" : true,
    "fileHandler" : {
        "type" : "file",
        "root" : "images"
    }
}
```

You cannot use the file upload service to access any files outside the configured `root` directory.

- `"type" : "repo"` specifies that the uploaded content will be stored in the repository. The `root` property does not apply to the repository file handler so the configuration is as follows:

```
{
    "enabled" : true,
    "fileHandler" : {
        "type" : "repo"
    }
}
```

The file upload service performs a multi-part CREATE operation. Each upload request includes two `--form` options. The first option indicates that the uploaded file content will be converted to a base 64-encoded string and inserted into the JSON object as a field named `content` with the following structure:

```
{
    "content" : {
        "$ref" : "cid:filename#content"
    }
}
```

The second `--form` option specifies the file to be uploaded, and the file type. The request loads the entire file into memory, so file size will be constrained by available memory.

You can upload any mime type using this service, however, you must specify a whitelist of mime types that can be *retrieved* over REST. If you specify a mime type that is not in the whitelist during retrieval of the file, the response content defaults to `application/json`. To configure the list of supported mime types, specify a comma-separated list as the value of the `org.forgerock.json.resource.http.safemimetypes` property in the `conf/system.properties` file. For example:

```
org.forgerock.json.resource.http.safemimetypes=application/json,application/pkix-cert,application/x-pem-file
```

You can only select from the following list:

`image/*`
`text/plain`
`text/css`
`application/json`

`application/pkix-cert`
`application/x-pem-file`

The following request uploads an image (PNG) file named `test.png` to the filesystem. The file handler configuration file provides the REST endpoint. In this case `openidm/file/images` references the configuration in the `file-images.json` file:

```
curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --form 'json={"content" : {"$ref" : "cid:test#content"}};type=application/json' \
 --form 'test=@test.png;type=image/png' \
 --request PUT \
 "http://localhost:8080/openidm/file/images/test.png"
{
  "_id": "test.png",
  "content": "aW1hZ2UvcG5n"
}
```

Note that the resource ID is derived directly from the upload filename—system-generated IDs are not supported.

The following request uploads a stylesheet (`css`) file named `test.css` to the same location on the filesystem as the previous request:

```
curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --form 'json={"content" : {"$ref" : "cid:test#content"}};type=application/json' \
 --form '@test.css;type=text/css' \
 --request PUT \
 "http://localhost:8080/openidm/file/images/test.css"
{
  "_id": "test.css",
  "content": "aW1hZ2UvY3N2"
}
```

Files uploaded to the repository are stored as JSON objects in the `openidm.files` table. The following request uploads the same image (PNG) file (`test.png`) to the repository:

```
curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --form 'json={"content" : {"$ref" : "cid:test#content"}};type=application/json' \
 --form 'test=@test.png;type=image/png' \
 --request PUT \
 "http://localhost:8080/openidm/file/repo/test.png"
{
  "_id": "test.png",
  "_rev": "00000000970b4454",
  "content": "aW1hZ2UvcG5n"
}
```

Note that the preceding example assumes the following file upload service configuration (in `file-repo.json`:

```
{
    "enabled" : true,
    "fileHandler" : {
        "type" : "repo"
    }
}
```

The file type is not stored with the file. By default, a READ on uploaded file content returns the content as a base 64-encoded string within the JSON object. For example:

```
curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/file/repo/test.png"
{
  "_id": "test.png",
  "_rev": "00000000970b4454",
  "content": "aW1hZ2UvcG5n"
}
```

Your client can retrieve the file in the correct format by specifying the `content` and `mimeType` parameters in the read request. For example:

```
curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/file/repo/test.css?_fields=content&_mimeType=text/css"
```

To delete uploaded content, send a DELETE request as follows:

```
curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request DELETE \
 "http://localhost:8080/openidm/file/repo/test.png"
{
  "_id": "test.png",
  "_rev": "00000000970b4454",
  "content": "aW1hZ2UvcG5n"
}
```

Chapter 9

Working With Managed Objects

IDM provides a default schema for typical managed object types, such as users and roles, but does not control the structure of objects that you store in the repository. You can modify or extend the schema for the default object types, and you can set up a new managed object type for any item that can be collected in a data set. For example, with the right schema, you can set up any device associated with the Internet of Things (IoT).

This chapter describes how to work with the default managed object types and how to create new object types as required by your deployment. For more information about the IDM object model, see "*Data Models and Objects Reference*".

9.1. Defining the Managed Object Schema

Managed objects and their properties are defined in your project's `conf/managed.json` file. The schema defined in this file is not a comprehensive list of all the properties that can be stored in the managed object repository. If you use a generic object mapping, you can create a managed object with any arbitrary property, and that property will be stored in the repository. However, if you create an object with properties that are not defined in `conf/managed.json`, those properties will not be visible in the UI. In addition, you will not be able configure the "sub-properties" that are described in the following section.

Important

The IDM Admin UI depends on the presence of specific core schema elements, such as users, roles, and assignments (and the default properties nested within them). If you remove such schema elements, and you use the Admin UI to configure IDM, you must modify the Admin UI code accordingly. For example, if you remove the entire `assignment` object from `conf/managed.json`, the UI will throw exceptions wherever it queries this schema element.

For explicit object mappings, the schema must be mapped to tables and columns in the JDBC database or to organizational units in DS.

For more information about explicit and generic object mappings, see "Using Generic and Explicit Object Mappings".

9.2. Creating and Modifying Managed Object Types

If the managed object types provided in the default configuration are not sufficient for your deployment, you can create any number of new managed object types.

The easiest way to create a new managed object type is to use the Admin UI, as follows:

1. Navigate to the Admin UI URL (`https://localhost:8443/admin`) then select Configure > Managed Objects > New Managed Object.

2. Enter a name and readable title for the new managed object. The readable title controls how that object will be referred to in the UI. Optionally, specify an icon that will be displayed for that object type, and a description.

   Click Save.

3. On the Properties tab, specify the schema for the object type, that is, the properties that make up the object.

4. On the Scripts tab, specify any scripts that should be applied on various events associated with that object type, for example, when an object of that type is created, updated or deleted.

You can also create a new managed object type by adding its configuration, in JSON, to your project's `conf/managed.json` file. The following excerpt of the `managed.json` file shows the configuration of a "Phone" object, that was created through the UI.

```
{
    "name": "Phone",
    "schema": {
        "$schema": "http://forgerock.org/json-schema#",
        "type": "object",
        "properties": {
            "brand": {
                "description": "The supplier of the mobile phone",
                "title": "Brand",
                "viewable": true,
                "searchable": true,
                "userEditable": false,
                "policies": [],
                "returnByDefault": false,
                "minLength": "",
                "pattern": "",
                "isVirtual": false,
                "type": [
                    "string",
                    "null"
                ]
            },
            "assetNumber": {
                "description": "The asset tag number of the mobile device",
                "title": "Asset Number",
                "viewable": true,
                "searchable": true,
                "userEditable": false,
```

```
                "policies": [],
                "returnByDefault": false,
                "minLength": "",
                "pattern": "",
                "isVirtual": false,
                "type": "string"
            },
            "model": {
                "description": "The model number of the mobile device, such as 6 plus, Galaxy S4",
                "title": "Model",
                "viewable": true,
                "searchable": false,
                "userEditable": false,
                "policies": [],
                "returnByDefault": false,
                "minLength": "",
                "pattern": "",
                "isVirtual": false,
                "type": "string"
            }
        },
        "required": [],
        "order": [
            "brand",
            "assetNumber",
            "model"
        ]
    }
}
```

Every managed object type has a `name` and a `schema` that describes the properties associated with that object. The managed object `name` can only include the characters `a-z`, `A-Z`, `0-9`, and `_` (underscore).

You can add any arbitrary properties to the schema of a managed object type. A property definition typically includes the following fields:

`title`

The name of the property, in human-readable language, used to display the property in the UI.

`description`

A brief description of the property.

`viewable`

Specifies whether this property is viewable in the object's profile in the UI. Boolean, `true` or `false` (`true` by default).

`searchable`

Specifies whether this property can be searched in the UI. A searchable property is visible within the Managed Object data grid in the End User UI. Note that for a property to be searchable in the UI, it *must be indexed* in the repository configuration. For information on indexing properties in a repository, see "Using Generic and Explicit Object Mappings".

Boolean, `true` or `false` (`false` by default).

`userEditable`

Specifies whether users can edit the property value in the UI. This property applies in the context of the End User UI, where users are able to edit certain properties of their own accounts. Boolean, `true` or `false` (`false` by default).

`isProtected`

Specifies whether reauthentication is required if the value of this property changes.

For certain properties, such as passwords, changing the value of the property should force an end user to reauthenticate. These properties are referred to as *protected properties*. Depending on how the user authenticates (which authentication module is used), the list of protected properties is added to the user's security context. For example, if a user logs in with the login and password of their managed user entry (`MANAGED_USER` authentication module), their security context will include this list of protected properties. The list of protected properties is not included in the security context if the user logs in with a module that does not support reauthentication (such as through a social identity provider).

`minLength`

The minimum number of characters that the value of this property must have.

`pattern`

Any specific pattern to which the value of the property must adhere. For example, a property whose value is a date might require a specific date format.

`policies`

Any policy validation that must be applied to the property. For more information on managed object policies, see "Configuring the Default Policy for Managed Objects".

`required`

Specifies whether the property must be supplied when an object of this type is created. Boolean, `true` or `false`.

> **Important**
>
> The `required` policy is assessed only during object creation, not when an object is updated. You can effectively bypass the policy by updating the object and supplying an empty value for that property. To prevent this inconsistency, set both `required` and `notEmpty` to `true` for required properties. This configuration indicates that the property must exist, and must have a value.

`type`

The data type for the property value; can be `string`, `array`, `boolean`, `integer`, `number`, `object`, `Resource Collection`, or `null`.

Note

If a property (such as a `telephoneNumber`) might not exist for a particular user, you must include `null` as one of the property `type`s. You can set a null property type in the Admin UI (Configure > Managed Objects > User, select the property, and under the Details tab, Advanced Options, set `Nullable` to `true`).

You can also set a null property type directly in your `managed.json` file by setting `"type" : '[ "string" ,"null" ]'` for that property (where `string` can be any other valid property type. This information is validated by the `policy.js` script, as described in "Validation of Managed Object Data Types".

If you're configuring a data `type` of `array` through the Admin UI, you're limited to two values.

`isVirtual`

Specifies whether the property takes a static value, or whether its value is calculated "on the fly" as the result of a script. Boolean, `true` or `false`.

`returnByDefault`

For non-core attributes (virtual attributes and relationship fields), specifies whether the property will be returned in the results of a query on an object of this type *if it is not explicitly requested*. Virtual attributes and relationship fields are not returned by default. Boolean, `true` or `false`. When the property is in an array within a relationship, always set to `false`.

`relationshipGrantTemporalConstraintsEnforced`

For attributes with relationship fields. Specifies whether this relationship should have temporal constraints enforced. Boolean, `true` or `false`. For more information about temporal constraints, see "Using Temporal Constraints to Restrict Effective Roles".

9.3. Working with Managed Users

User objects that are stored in the repository are referred to as *managed users*. For a JDBC repository, IDM stores managed users in the `managedobjects` table. A second table, `managedobjectproperties`, serves as the index table.

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

You can add, change, and delete managed users by using the Admin UI or over the REST interface. To use the Admin UI, select Manage > User. The UI is intuitive as regards user management.

If you are viewing users through the Admin UI, the User List page supports specialized filtering with the Advanced Filter option, which allows you to build many of the queries shown in "Defining and Calling Queries".

The following examples show how to add, change and delete users over the REST interface. For a reference of all managed user endpoints and actions, see "Managing Users Over REST". You can also

use the API Explorer as a reference to the managed object REST API. For more information, see "API Explorer".

The following example retrieves the JSON representation of all managed users in the repository:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/managed/user?_queryId=query-all-ids"
```

The following two examples query all managed users for a user named `scarter`:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
 "http://localhost:8080/openidm/managed/user?_queryFilter=userName+eq+%22scarter%22"
```

In this second example, note the use of single quotes around the URL, to avoid conflicts with the double quotes around the user named `smith`. Note also that the `_queryFilter` requires double quotes (or the URL encoded equivalent `%22`) around the search term:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
'http://localhost:8080/openidm/managed/user?_queryFilter=userName+eq+"scarter"'
```

The following example retrieves the JSON representation of a managed user, specified by his ID, `scarter`:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user/scarter"
```

Note

Some of the examples in this documentation set use client-assigned IDs (such as `bjensen` and `scarter`) when creating objects because it makes the examples easier to read. If you create objects using the Admin UI, they are created with server-assigned IDs (such as `55ef0a75-f261-47e9-a72b-f5c61c32d339`). Generally, immutable server-assigned UUIDs are used in production environments.

The following example adds a user with a specific user ID, `bjensen`:

```
$ curl \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "If-None-Match: *" \
 --request PUT \
 --data '{
    "userName":"bjensen",
    "sn":"Jensen",
    "givenName":"Barbara",
    "mail": "bjensen@example.com",
    "telephoneNumber": "082082082",
    "password":"Passw0rd"
  }' \
"http://localhost:8080/openidm/managed/user/bjensen"
```

The following example adds the same user, but allows IDM to generate the ID:

```
$ curl \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '{
    "userName":"bjensen",
    "sn":"Jensen",
    "givenName":"Barbara",
    "mail": "bjensen@example.com",
    "telephoneNumber": "082082082",
    "password":"Passw0rd"
  }' \
"http://localhost:8080/openidm/managed/user?_action=create"
```

The following example checks whether user `bjensen` exists, then replaces her telephone number with the new data provided in the request body:

```
$ curl \
 --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"
  }]' \
  "http://localhost:8080/openidm/managed/user?_action=patch&_queryId=for-userName&uid=bjensen"
```

The following example deletes user `bjensen`:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request DELETE \
 "http://localhost:8080/openidm/managed/user/bjensen"
```

9.4. Working With Managed Groups

IDM provides support for a managed `group` object. For a JDBC repository, IDM stores managed groups with all other managed objects, in the `managedobjects` table, and uses the `managedobjectproperties` for indexing.

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, IDM provides RESTful access to managed groups, at the context path `/openidm/managed/group`.

For an example of a deployment that uses managed groups, see "*Synchronizing LDAP Groups*" in the *Samples Guide*.

9.5. Tracking Metadata For Managed Objects

Certain self-service features, such as progressive profile completion, privacy and consent, and terms and conditions acceptance, rely on user *metadata* that tracks information related to a managed object state. Such data might include when the object was created, or the date of the most recent change, for example. This metadata is not stored within the object itself, but in a separate resource location.

Because object metadata is stored outside the managed object, state change situations (such as the time of an update) are separate from object changes (the update itself). This separation reduces unnecessary synchronization to targets when the only data that has changed is metadata. Metadata is not returned in a query unless it is specifically requested. Therefore, the volume of data that is retrieved when metadata is not required, is reduced.

To specify which metadata you want to track for an object, add a `meta` stanza to the object definition in your managed object configuration (`managed.json` file). The following default configuration tracks the `createDate` and `lastChanged` date for managed user objects:

```
{
  "objects" : [
    {
      "name" : "user",
      ...
      "schema" : {
        ...
      },
      "meta" : {
        "property" : "_meta",
        "resourceCollection" : "internal/usermeta",
        "trackedProperties" : [
          "createDate",
          "lastChanged"
        ]
      },
      ...
    },
    ...
  ]
}
```

Important

If you are not using the self-service features that require metadata, you can remove the `meta` stanza from your user object definition in `managed.json`. Preventing the creation and tracking of metadata where it is not required will improve performance in that scenario.

The metadata configuration includes the following properties:

`property`

The property that will be dynamically added to the managed object schema for this object.

`resourceCollection`

The resource location in which the metadata will be stored.

Adjust your repository to match the location you specify here. It's recommended that you use an `internal` object path and define the storage in your `repo.jdbc.json` or `repo.ds.json` file.

For a JDBC repository, metadata is stored in the `metaobjects` table by default. The `metaobjectproperties` table is used for indexing.

For a DS repository, metadata is stored under `ou=usermeta,ou=internal,dc=openidm,dc=forgerock,dc=com` by default.

User objects stored in a DS repository must include the `ou` specified in the preceding `dnTemplate` attribute. For example:

```
dn: ou=usermeta,ou=internal,dc=openidm,dc=forgerock,dc=com
objectclass: organizationalunit
objectclass: top
ou: usermeta
```

`trackedProperties`

Lists the properties that will be tracked as metadata for this object. In the previous example, the `createDate` (when the object was created) and the `lastChanged` date (when the object was last modified) are tracked.

You cannot search on metadata and it is not returned in the results of a query unless it is specifically requested. To return all metadata for an object, include `_fields=,_meta/*` in your request. The following example returns a user entry without requesting the metadata:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user/bjensen"
{
  "_id": "bjensen",
  "_rev": "000000000444dd1a",
  "mail": "bjensen@example.com",
  "givenName": "Barbara",
  "sn": "Jensen",
  "description": "Created By CSV",
  "userName": "bjensen",
  "telephoneNumber": "1234567",
  "accountStatus": "active",
  "effectiveRoles": [],
  "effectiveAssignments": []
}
```

The following example returns the same user entry, with their metadata:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user/bjensen?_fields=,_meta/*"
{
  "_id": "bjensen",
  "_rev": "000000000444dd1a",
  "mail": "bjensen@example.com",
  "givenName": "Barbara",
  "sn": "Jensen",
  "description": "Created By CSV",
  "userName": "bjensen",
  "telephoneNumber": "1234567",
  "accountStatus": "active",
  "effectiveRoles": [],
  "effectiveAssignments": []
  "_meta": {
    "_ref": "internal/usermeta/284273ff-5e50-4fa4-9d30-4a3cf4a5f642",
    "_refResourceCollection": "internal/usermeta",
    "_refResourceId": "284273ff-5e50-4fa4-9d30-4a3cf4a5f642",
    "_refProperties": {
      "_id": "30076e2e-8db5-4b4d-ab91-5351d2da4620",
      "_rev": "000000001ad09f00"
    },
    "createDate": "2018-04-12T19:53:19.004Z",
```

```
    "lastChanged": {
      "date": "2018-04-12T19:53:19.004Z"
    },
    "loginCount": 0,
    "_rev": "0000000094605ed9",
    "_id": "284273ff-5e50-4fa4-9d30-4a3cf4a5f642"
  }
}
```

Note

Apart from the `createDate` and `lastChanged` shown previously, the request also returns the `loginCount`. This property is stored by default for all objects, and increments with each login request based on password or social authentication. If the object for which metadata is tracked is not an object that "logs in," this field will remain 0.

The request also returns a `_meta` property that includes relationship information. IDM uses the relationship model to store the metadata. When the `meta` stanza is added to the user object definition, the attribute specified by the `property` (`"property" : "_meta",` in this case) is added to the schema as a uni-directional relationship to the resource collection specified by `resourceCollection`. In this example, the user object's `_meta` field is stored as an `internal/usermeta` object. The `_meta/_ref` property shows the full resource path to the internal object where the metadata for this user is stored.

9.6. Working With Virtual Properties

Properties can be defined to be strictly derived from other properties within an object. This allows computed and composite values to be created in the object. Such properties are named *virtual properties*. The value of a virtual property is calculated only when that property is retrieved, using a script called by `onRetrieve` script hook.

In some cases, the value of a virtual property might change without its object being updated. For example, a change to a related object might affect the value of the virtual property. In this case, you can use the `triggerSyncCheck` action to refresh the managed object, including the values of any virtual attributes. The following command refreshes all properties for the user with ID `9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb`:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
"http://localhost:8080/openidm/managed/user/9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb?_action=triggerSyncCheck"
```

For *relationship* type properties, you can configure how objects are refreshed using the relationship notification mechanism. For more information, see "Configuring Relationship Change Notification".

9.7. Running Scripts on Managed Objects

IDM provides a number of *hooks* that enable you to manipulate managed objects using scripts. These scripts can be triggered during various stages of the lifecycle of the managed object, and are defined in the managed objects configuration file (`managed.json`).

The scripts can be triggered when a managed object is created (onCreate), updated (onUpdate), retrieved (onRetrieve), deleted (onDelete), validated (onValidate), or stored in the repository (onStore). A script can also be triggered when a change to a managed object triggers an implicit synchronization operation (onSync).

You can also use post-action scripts for managed objects, including after the creation of an object (postCreate), after the update of an object (postUpdate), and after the deletion of an object (postDelete).

The following sample extract of a `managed.json` file runs a script to calculate the effective assignments of a managed object, whenever that object is retrieved from the repository:

```
"effectiveAssignments" : {
   "type" : "array",
   "title" : "Effective Assignments",
   "description" : "Effective Assignments",
   "viewable" : false,
   "returnByDefault" : true,
   "isVirtual" : true,
   "usageDescription" : "",
   "isPersonal" : false,
   "onRetrieve" : {
       "type" : "text/javascript",
       "file" : "roles/effectiveAssignments.js",
       "effectiveRolesPropName" : "effectiveRoles"
   },
   "items" : {
       "type" : "object",
       "title" : "Effective Assignments Items"
   }
},
```

9.8. Encoding Attribute Values

There are two ways to encode attribute values for managed objects—reversible encryption and salted hashing algorithms. Attribute values that might be encoded include passwords, authentication questions, credit card numbers, and social security numbers. If passwords are already encoded on the external resource, they are generally excluded from the synchronization process. For more information, see "*Managing Passwords*".

You configure attribute value encoding, per schema property, in the managed object configuration (in your project's `conf/managed.json` file). The following sections show how to use reversible encryption and salted hash algorithms to encode attribute values.

9.8.1. Encoding Attribute Values With Reversible Encryption

The following excerpt of a `managed.json` file shows a managed object configuration that encrypts and decrypts the `password` attribute using the default symmetric key:

```
{
    "objects" : [
        {
            "name" : "user",
            ...
            "schema" : {
                ...
                "properties" : {
                    ...
                    "password" : {
                        "title" : "Password",
                        ...
                        "encryption" : {
                            "purpose" : "idm.password.encryption"
                        },
                        "scope" : "private",
         ...
        }
    ]
}
```

Tip

To configure encryption of properties by using the Admin UI:

1. Select Configure > Managed Objects, and select the object type whose property values you want to encrypt (for example User).
2. On the Properties tab, select the property whose value should be encrypted and select the Encrypt checkbox.

For information about encrypting attribute values from the command-line, see "Using the **encrypt** Subcommand".

Important

Hashing is a one way operation - property values that are hashed can not be "unhashed" in the way that they can be decrypted. Therefore, if you hash the value of any property, you cannot synchronize that property value to an external resource. For managed object properties with hashed values, you must either exclude those properties from the mapping or set a random default value if the external resource requires the property.

9.8.2. Encoding Attribute Values by Using Salted Hash Algorithms

To encode attribute values with salted hash algorithms, add the `secureHash` property to the attribute definition, and specify the algorithm that should be used to hash the value.

IDM supports the following hash algorithms:

`SHA-256`
`SHA-384`
`SHA-512`
`Bcrypt`
`Scrypt`
Password-Based Key Derivation Function 2 (`PBKDF2`)

If you do not specify an algorithm, `SHA-256` is used by default. MD5 and SHA-1 are supported for legacy reasons but you should use a more secure algorithm in production environments.

Warning

Some one-way hash functions are designed to be computationally *expensive*. Functions such as PBKDF2, Bcrypt, and Scrypt are designed to be relatively slow even on modern hardware. This makes them generally less susceptible to brute force attacks. *However*, computationally expensive functions can dramatically increase response times. If you use these functions, be aware of the performance impact and perform extensive testing before deploying your service in production. Do not use functions like PBKDF2 and Bcrypt for any accounts that are used for frequent, short-lived connections.

The following excerpt of a `managed.json` file shows a managed object configuration that hashes the values of the `password` attribute using the `SHA-256` algorithm:

```
{
    "objects" : [
        {
            "name" : "user",
            ...
            "schema" : {
                ...
                "properties" : {
                    ...
                    "password" : {
                        "title" : "Password",
                        ...
                        "secureHash" : {
                            "algorithm" : "SHA-256"
                        },
                        "scope" : "private",
         ...
        }
    ]
}
```

Tip

To configure hashing of properties by using the Admin UI:

1. Select Configure > Managed Objects, and select the object type whose property values you want to hash (for example User).

2. On the Properties tab, select the property whose value must be hashed and select the Hash checkbox.

3. Select the algorithm that should be used to hash the property value.

For information about hashing attribute values from the command-line, see "Using the **secureHash** Subcommand".

9.9. Privacy & Consent

As an end user, you might want to control what happens to your personal data. For IDM, that means control of how your data is shared with external systems. The example in "*Marketo Connector*" in the *Connector Reference* shows how you can generate a marketing leads database, only for those users who have selected a specific preference. Also read "Configuring Privacy & Consent".

IDM allows you to regulate access to two different kinds of personal data:

- *User information*: while marketers want user information such as addresses and telephone numbers, IDM allows you to let individual users decide whether to share that data. For more information, see "Regulating HTTP Access to Personal Data".
- *Account information*: by default, IDM prevents REST-based access to passwords with the `private` scope, as defined in the `managed.json` file. You can extend this protection to other properties. For more information, see "Restricting HTTP Access to Sensitive Data".

To configure Privacy & Consent in the End User UI, see "Configuring Privacy & Consent".

9.9.1. Regulating HTTP Access to Personal Data

In some cases, you might want to allow users to choose whether to share their personal data. "Configuring Synchronization Filters With User Preferences" describes how to allow users to select basic preferences for updates and marketing. They can select these preferences when they register and in the End User UI.

Examine the `managed.json` file for your project. Every relevant property should include two settings that determine whether a user can choose to share or not share that property:

- `isPersonal`: When set to `true`, specifies personally identifying information. By default, the `isPersonal` option for `userName` and `postalAddress` is set to `true`.

  `usageDescription`: Includes additional information that can help users understand the sensitivity of a specific property such as `telephoneNumber`.

The `consentedMappings` property in a managed user object enables the user to specify an array of mappings (target systems) with which they consent to sharing their identifying information. The following sample excerpt of the default managed user object schema shows the `consentedMappings` property definition:

```
"consentedMappings" : {
```

```
    "title" : "Consented Mappings",
    "description" : "Consented Mappings",
    "type" : "array",
    "viewable" : false,
    "searchable" : false,
    "userEditable" : true,
    "usageDescription" : "",
    "isPersonal" : false,
    "items" : {
        "type" : "array",
        "title" : "Consented Mappings Items",
        "items" : {
            "type" : "object",
            "title" : "Consented Mappings Item",
            "properties" : {
                "mapping" : {
                    "title" : "Mapping",
                    "description" : "Mapping",
                    "type" : "string",
                    "viewable" : true,
                    "searchable" : true,
                    "userEditable" : true
                },
                "consentDate" : {
                    "title" : "Consent Date",
                    "description" : "Consent Date",
                    "type" : "string",
                    "viewable" : true,
                    "searchable" : true,
                    "userEditable" : true
                }
            },
            "order" : [
                "mapping",
                "consentDate"
            ],
            "required" : [
                "mapping",
                "consentDate"
            ]
        }
    },
    "returnByDefault" : false,
    "isVirtual" : false
}
```

9.9.2. Restricting HTTP Access to Sensitive Data

You can protect specific sensitive managed data 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` property:

```
{
     "objects": [
         {
             "name": "user",
             "schema": {
                 "id" : "http://jsonschema.net",
                 "title" : "User",
                 ...
                 "properties": {
                 ...
                     {
                         "name": "password",
                         "encryption": {
                             "purpose": "idm.password.encryption"
                         }'
                         "scope" : "private"
                     }
          },
          ...
       }
    ]
 }
```

Tip

To configure private properties by using the Admin UI:

1. Select Configure > Managed Objects, and select the object type whose property values you want to make private (for example User).
2. On the Properties tab, select the property that must be private and select the Private checkbox.

A potential caveat relates to private properties. If you use an HTTP `GET` request, you won't even see private properties. Even if you know all relevant private properties, a `PUT` request would replace the entire object in the repository. In addition, that require would effectively remove all private properties from the object. To work around this limitation, use a `POST` request to update only those properties that require change.

For example, to update the `givenName` of user jdoe, you could run the following command:

```
$ curl \
 --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"
    }
 ]' \
 "http://localhost:8080/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.

Chapter 10

Managing Relationships Between Objects

Relationships are references between managed objects. Roles (described in "*Working With Managed Roles*") are implemented using relationships, but you can create relationships between any managed object type.

10.1. Defining a Relationship Type

Relationships are defined in your project's managed object configuration file (`conf/managed.json`). The default configuration includes a relationship named `manager` that lets you configure a management relationship between two managed users. The `manager` relationship is a good example from which to understand how relationships work.

The default `manager` relationship is configured as follows:

```
"manager" : {
    "type" : "relationship",
    "validate" : true,
    "reverseRelationship" : true,
    "reversePropertyName" : "reports",
    "description" : "Manager",
    "title" : "Manager",
    "viewable" : true,
    "searchable" : false,
    "usageDescription" : "",
    "isPersonal" : false,
    "properties" : {
        "_ref" : {
            "description" : "References a relationship from a managed object",
            "type" : "string"
        },
        "_refProperties" : {
            "description" : "Supports metadata within the relationship",
            "type" : "object",
            "title" : "Manager _refProperties",
            "properties" : {
                "_id" : {
                    "description" : "_refProperties object ID",
                    "type" : "string"
                }
            }
        }
    },
    "resourceCollection" : [
        {
            "path" : "managed/user",
```

```
            "label" : "User",
            "query" : {
                "queryFilter" : "true",
                "fields" : [
                    "userName",
                    "givenName",
                    "sn"
                ]
            }
        }
    ],
    "userEditable" : false
},
```

Most of these properties apply to any managed object type, and are described in "Creating and Modifying Managed Object Types". Relationships have the following specific configurable properties:

`type` (string)

The object type. Must be `relationship` for a relationship object.

`returnByDefault` (boolean `true, false`)

Specifies whether the relationship should be returned as part of the response. The `returnByDefault` property is not specific to relationships — the flag applies to all managed object types. However, it is important to note that by default relationship properties are not returned, unless explicitly requested.

`reverseRelationship` (boolean `true, false`)

Specifies whether this is a bidirectional relationship. For more information, see "Working With Bidirectional Relationships".

`reversePropertyName` (string)

Specifies the corresponding property name in the case of a reverse relationship. For example, the `manager` property has a `reversePropertyName` of `reports`. For more information, see "Working With Bidirectional Relationships".

`_ref` (JSON object)

Specifies how the relationship between two managed objects is referenced.

In the relationship definition, the value of this property is `{ "type" : "string" }`. In a managed user entry, the value of the `_ref` property is the reference to the other resource. The `_ref` property is described in more detail in "Establishing a Relationship Between Two Objects".

`_refProperties` (JSON object)

Specifies any required properties from the relationship that should be included in the managed object. The `_refProperties` field includes a unique ID (`_id`) and the revision (`_rev`) of the object. `_refProperties` can also contain arbitrary fields to support metadata within the relationship.

`resourceCollection` (JSON object)

The collection of resources (objects) on which this relationship is based (for example, `managed/user` objects).

Both managed objects and internal objects can use `resourceCollection`. Resource collections on managed objects are added directly in `managed.json`. Since the schema for internal objects is not editable, resource collections for internal object relationships are made available in `internal.json` in your `conf/` directory.

10.2. Establishing a Relationship Between Two Objects

When you have defined a relationship *type*, (such as the `manager` relationship, described in the previous section), you can *reference* one managed user from another, using the `_ref*` relationship properties. Three properties make up a relationship reference:

- `_refResourceCollection` specifies the container of the referenced object (for example, `managed/user`).
- `_refResourceId` specifies the ID of the referenced object. This is generally a system-generated UUID, such as `9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb`. For clarity, this section uses client-assigned IDs such as `bjensen` and `psmith`.
- `_ref` is a derived path that is a combination of `_refResourceCollection` and a URL-encoded `_refResourceId`.

For example, imagine that you are creating a new user, psmith, and that psmith's manager will be bjensen. You would add psmith's user entry, and *reference* bjensen's entry with the `_ref` property, as follows:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "If-None-Match: *" \
 --header "Content-Type: application/json" \
 --request PUT \
 --data '{
    "sn":"Smith",
    "userName":"psmith",
    "givenName":"Patricia",
    "displayName":"Patti Smith",
    "description" : "psmith - new user",
    "mail" : "psmith@example.com",
    "phoneNumber" : "0831245986",
    "password" : "Passw0rd",
    "manager" : {"_ref" : "managed/user/bjensen"}
  }' \
"http://localhost:8080/openidm/managed/user/psmith"
{
  "_id": "psmith",
  "_rev": "00000000ec41097c",
  "sn": "Smith",
  "userName": "psmith",
  "givenName": "Patricia",
```

```
  "displayName": "Patti Smith",
  "description": "psmith - new user",
  "mail": "psmith@example.com",
  "phoneNumber": "0831245986",
  "accountStatus": "active",
  "effectiveRoles": [],
  "effectiveAssignments": []
}
```

Note that the relationship information is not returned by default. To show the relationship in psmith's entry, you must explicitly request her manager entry, as follows:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
"http://localhost:8080/openidm/managed/user/psmith?_fields=manager"
{
  "_id": "psmith",
  "_rev": "00000000ec41097c",
  "manager": {
    "_ref": "managed/user/bjensen",
    "_refResourceCollection": "managed/user",
    "_refResourceId": "bjensen",
    "_refProperties": {
      "_id": "ffc6f0f3-93db-4939-b9eb-1f8389a59a52",
      "_rev": "0000000081aa991a"
    }
  }
}
```

When a relationship changes, the updated relationship state can be queried when any referenced managed objects are queried. So, after creating user psmith with manager bjensen, a query on bjensen's user entry will show a reference to psmith's entry in her `reports` property (because the `reports` property is configured as the `reversePropertyName` of the `manager` property). The following query shows the updated relationship state for bjensen:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user/bjensen?_fields=reports"
{
  "_id": "bjensen",
  "_rev": "0000000057b5fe9d",
  "reports": [
    {
      "_ref": "managed/user/psmith",
      "_refResourceCollection": "managed/user",
      "_refResourceId": "psmith",
      "_refProperties": {
        "_id": "ffc6f0f3-93db-4939-b9eb-1f8389a59a52",
        "_rev": "0000000081aa991a"
      }
    }
  ]
}
```

IDM maintains referential integrity by deleting the relationship reference, if the object referred to by that relationship is deleted. In our example, if bjensen's user entry is deleted, the corresponding reference in psmith's `manager` property is removed.

10.3. Configuring Relationship Change Notification

A relationship exists between two managed objects. By default, when a relationship changes (when it is created, updated, or deleted), the managed objects on either side of the relationship are not *notified* of that change. This means that the *state* of each object with respect to that relationship field is not recalculated until the object is read. This default behavior improves performance, especially in the case where many objects are affected by a single relationship change.

For `roles`, a special kind of relationship, change notification *is* configured by default. The purpose of this default configuration is to notify managed users when any of the relationships that link users, roles, and assignments are manipulated. For more information about relationship change notification in the specific case of managed roles, see "Roles and Relationship Change Notification".

To change the default configuration, or to set up notification for other relationship changes, use the `notify*` properties in the relationship definition, as described in this section.

A relationship exists between an *origin* object and a *referenced* object. These terms reflect which managed object is specified in the URL (for example `managed/user/psmith`), and which object is referenced by the relationship (`_ref*`) properties. For more information about the relationship properties, see "Establishing a Relationship Between Two Objects".

In the previous example, a PUT on `managed/user/psmith` with `"manager" : {_ref : "managed/user/bjensen"}`, causes `managed/user/psmith` to be the origin object, and `managed/user/bjensen` to be the referenced object for that relationship, as shown in the following illustration:

Relationship Objects

Note that for the reverse relationship (a PUT on `managed/user/bjensen` with `"reports" : [{_ref = "managed/user/psmith"}]`) `managed/user/bjensen` would be the origin object, and `managed/user/psmith` would be the referenced object.

By default, when a relationship changes, neither the origin object nor the referenced object is *notified* of the change. So, with the PUT on `managed/user/psmith` with `"manager" : {_ref : "managed/user/bjensen"}`, neither psmith's object nor bjensen's object is notified.

Note

Auditing is not tied to relationship change notification and is always triggered when a *relationship* changes. Therefore, relationship changes are audited, regardless of the `notify` and `notifySelf` properties.

To configure relationship change notification, set the following properties in your managed object schema (`conf/managed.json`):

The `notify` and `notifySelf` properties specify whether objects that reference relationships are notified of a relationship change:

`notifySelf`

Notifies the origin object of the relationship change.

In our example, if the `manager` definition includes `"notifySelf" : true`, and if the relationship is changed through a URL that references psmith, then psmith's object would be notified of the change. For example, for a CREATE, UPDATE or DELETE request on the `psmith/manager`, psmith would be notified, but the managed object referenced by this relationship (bjensen) would not be notified.

If the relationship were manipulated through a request to `bjensen/reports`, then bjensen would only be notified if the `reports` relationship specified `"notifySelf" : true`.

`notify`

Notifies the referenced object of the relationship change.

This property must be set on the `resourceCollection` of the relationship property. In our example, assume that the `manager` definition has a `resourceCollection` with a `path` of `managed/user`, and that this object specifies `"notify" : true`. If relationship is changed through a CREATE, UPDATE, or DELETE on the URL `psmith/manager`, then the reference object (`managed/user/bjensen`) would be notified of the change to the relationship.

`notifyRelationships`

This property controls the propagation of notifications out of a managed object when one of its properties changes through an update or patch, or when that object receives a notification through one of these fields.

The `notifyRelationships` property takes an array of relationships as a value, for example `"notifyRelationships" : ["relationship1", "relationship2"]`. The relationships specified here are fields defined on the managed object type (which might itself be a relationship).

Notifications are propagated according to the *recipient's* `notifyRelationships` configuration. If a managed object type is notified of a change through one if its relationship fields, the notification is done according to the configuration of the recipient object. To illustrate, look at the `attributes` property in the default `managed/assignment` object:

```
{
    "name" : "assignment",
    "schema" : {
        ...
        "properties" : {
            ...
            "attributes" : {
                "description" : "The attributes operated on by this assignment.",
                "title" : "Assignment Attributes",
                ....
                "notifyRelationships" : ["roles"]
            },
...
```

This configuration means that if an assignment is updated or patched and the assignment's `attributes` change in some way, all the `roles` connected to that assignment are notified. Because the `role` managed object has `"notifyRelationships" : ["members"]` defined on its `assignments` field, the notification that originated from the change to the assignment attribute is propagated to the connected `roles`, and then out to the `members` of those roles.

So the `role` is notified through its `assignments` field because an `attribute` in the assignment changed. This notification is propagated out of the `members` field because the role definition has `"notifyRelationships" : ["members"]` on its `assignments` field.

The default implementation of `roles`, `assignments` and `members` uses relationship change notification to ensure that relationship changes are accurately provisioned.

For example, the default `user` object includes a `roles` property with `notifySelf` set to `true`:

```
{
   "name" : "user",
   ...
   "schema" : {
       ...
       "properties" : {
           ....
           "roles" : {
               "description" : "Provisioning Roles",
               ...
               "items" : {
                   "type" : "relationship",
                   ...
                   "reverseRelationship" : true,
                   "reversePropertyName" : "members",
                   "notifySelf" : true,
                   ...
               }
}
```

In this case, `notifySelf` indicates the origin or `user` object. If any changes are made to a relationship referencing a role through a URL that includes a user, the user will be notified of the change. For example, if there is a CREATE on `managed/user/psmith/roles` which specifies a set of references to existing roles, user `psmith` will be notified of the change.

Similarly, the `role` object includes a `members` property. That property includes the following schema definition:

```
{
    "name" : "role",
    ...
    "schema" : {
        ...
        "properties" : {
            ...
            "members" : {
                ...
                "items" : {
                    "type" : "relationship",
                    ...
                    "properties" : {
                        ...
                        "resourceCollection" : [
                            {
                                "notify" : true,
                                "path" : "managed/user",
                                "label" : "User",
                                ...
                            }
                        ]
                    }
...
```

Notice the `"notify" : true` setting on the `resourceCollection`. This setting indicates that if the relationship is created, updated, or deleted through a URL that references that role, all objects in that resource collection (in this case, `managed/user` objects) that are identified as `members` of that role must be notified of the change.

Important

- To notify an object at the end of a relationship that the relationship has changed (using the `notify` property), the relationship *must* be bidirectional (`"reverseRelationship" : true`). For more information about bidirectional relationships, see "Working With Bidirectional Relationships".

  When an object is notified of a relationship state change (create, delete, or update), part of that notification process involves calculating the changed object state with respect to the changed relationship field. For example, if a managed user is notified that a role has been created, the user object calculates its base state, and the state of its `roles` field, before and after the new role was created. This *before* and *after* state is then reconciled. An object that is referenced by a forward (unidirectional) relationship does not have a field that references that relationship — the object is "pointed-to", but does not "point-back". Because this object cannot calculate its *before* and *after* state with respect to the relationship field, it cannot be notified.

  Similarly, relationships that are notified of changes to the objects that reference them *must* be bidirectional relationships.

  If you configure relationship change notification on a unidirectional relationship, IDM throws an exception.

- You cannot configure relationship change notification in the Admin UI — you must update the managed object schema in the `conf/managed.json` file directly.

10.4. Validating Relationships Between Objects

Optionally, you can specify that a relationship between two objects must be validated when the relationship is created. For example, you can indicate that a user cannot reference a role, if that role does not exist.

When you create a new relationship type, validation is disabled by default as it entails a query to the relationship that can be expensive, if it is not required. To configure validation of a referenced relationship, set `"validate": true` in the object configuration (in `managed.json`). The `managed.json` files provided with the sample configurations enable validation for the following relationships:

- For user objects – roles, managers, and reports
- For role objects – members and assignments
- For assignment objects – roles

The following configuration of the `manager` relationship enables validation, and prevents a user from referencing a manager that has not already been created:

```
"manager" : {
   "type" : "relationship",
   ...
   "validate" : true,
```

10.5. Working With Bidirectional Relationships

In most cases, you define a relationship between two objects *in both directions*. For example, a relationship between a user and his manager might indicate a *reverse relationship* between the manager and her direct report. Reverse relationships are particularly useful in querying. You might want to query jdoe's user entry to discover who his manager is, *or* query bjensen's user entry to discover all the users who report to bjensen.

You declare a reverse relationship as part of the relationship definition in `conf/managed.json`. Consider the following sample excerpt of the default managed object configuration:

```
"reports" : {
   "description" : "Direct Reports",
   "title" : "Direct Reports",
   ...
   "type" : "array",
   "returnByDefault" : false,
   "items" : {
       "type" : "relationship",
       "reverseRelationship" : true,
       "reversePropertyName" : "manager",
       "validate" : true,
   ...
       }
   ...
```

The `reports` property is a `relationship` between users and managers. So, you can *refer* to a managed user's reports by referencing the `reports`. However, the reports property is also a reverse relationship (`"reverseRelationship" : true`) which means that you can list all users that reference that report.

You can list all users whose `manager` property is set to the currently queried user.

The reverse relationship includes an optional `resourceCollection` that allows you to query a set of objects, based on specific fields:

```
"resourceCollection" : [
   {
       "path" : "managed/user",
       "label" : "User",
       "query" : {
           "queryFilter" : "true",
           "fields" : [
               "userName",
               "givenName",
               "sn"
           ]
       }
   }
]
```

The `path` property of the `resourceCollection` points to the set of objects to be queried. If this path is not in the local repository, the link expansion can incur a significant performance cost. Although the `resourceCollection` is optional, the same performance cost is incurred if the property is absent.

The `query` property indicates how you will query this resource collection to configure the relationship. In this case, `"queryFilter" : "true",` indicates that you can search on any of the properties listed in the `fields` array when you are assigning a manager to a user or a new report to a manager. To configure these relationships from the Admin UI, see "Managing Relationships Through the Admin UI".

10.6. Working with Conditional Relationships

Relationships can be granted dynamically, based on a specified condition. In order to conditionally grant a relationship, the schemas for the resources you are creating a relationship between need to be configured to support conditional association. To do this, three fields in the schema are used:

`conditionalAssociation`

Boolean. This property is applied to the `resourceCollection` for the grantor of the relationship. For example, the `members` relationship on `managed/role` specifies that there is a conditional association with the `managed/user` resource:

```
"resourceCollection" : [
    {
        "notify" : true,
        "conditionalAssociation" : true,
        "path" : "managed/user",
        "label" : "User",
        "query" : {
            "queryFilter" : "true",
            "fields" : [
                "userName",
                "givenName",
                "sn"
            ]
        }
    }
]
```

`conditionalAssociationField`

This property is a string, specifying the field used to determine whether a conditional relationship is granted. The field is applied to the `resourceCollection` of the grantee of the relationship. For example, the `roles` relationship on `managed/user` specifies that the conditional association with `managed/role` is defined by the `condition` field in `managed/role`:

```
"resourceCollection" : [
    {
        "path" : "managed/role",
        "label" : "Role",
        "conditionalAssociationField" : "condition",
        "query" : {
            "queryFilter" : "true",
            "fields" : [
                "name"
            ]
        }
    }
]
```

The field name specified will usually be `condition` if you are using default schema, but can be any field that evaluates a condition and has been flagged as `isConditional`.

`isConditional`

Boolean. This is applied to the field you wish to check to determine whether membership in a relationship is granted. Only one field on a resource can be marked as `isConditional`. For example, in the relationship between `managed/user` and `managed/role`, conditional membership in the relationship is determined by the query filter specified in the `managed/role` `condition` field:

```
"condition" : {
    "description" : "A conditional filter for this role",
    "title" : "Condition",
    "viewable" : false,
    "searchable" : false,
    "isConditional" : true,
    "type" : "string"
},
```

Conditions can be a powerful tool for dynamically creating relationships between two objects. An example of conditional relationships in use can be seen in "Granting Roles Based on a Condition".

10.7. Viewing Relationships Over REST

By default, information about relationships is not returned as the result of a GET request on a managed object. You must explicitly include the relationship property in the request, for example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user/psmith?_fields=manager"
{
  "_id": "psmith",
  "_rev": "000000007e0e0a09",
  "manager": {
    "_ref": "managed/user/bjensen",
    "_refResourceCollection": "managed/user",
    "_refResourceId": "bjensen",
    "_refProperties": {
      "_id": "6714cf83-c32e-45fa-9cba-faecfdb700d1",
      "_rev": "000000009e919882"
    }
  }
}
```

To obtain more information about the referenced object (psmith's manager, in this case), you can include additional fields from the referenced object in the query, using the syntax `object/property` (for a simple string value) or `object/*/property` (for an array of values).

The following example returns the email address and contact number for psmith's manager:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user/psmith?_fields=manager/mail,manager/telephoneNumber"
{
  "_id": "psmith",
  "_rev": "000000007e0e0a09",
  "manager": {
    "_ref": "managed/user/bjensen",
    "_refResourceCollection": "managed/user",
    "_refResourceId": "bjensen",
    "_refProperties": {
      "_id": "6714cf83-c32e-45fa-9cba-faecfdb700d1",
      "_rev": "000000009e919882"
    },
    "mail": "bjensen@example.com",
    "telephoneNumber": "1234567",
    "_rev": "000000001ed4ff4f",
    "_id": "bjensen"
  }
}
```

To query all the relationships associated with a managed object, query the reference (`*_ref`) property of that object. For example, the following query shows all the objects that are referenced by psmith's entry:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user/psmith?_fields=*_ref"
{
  "_id": "psmith",
  "_rev": "000000007e0e0a09",
  "reports": [],
  "manager": {
    "_ref": "managed/user/bjensen",
    "_refResourceCollection": "managed/user",
    "_refResourceId": "bjensen",
    "_refProperties": {
      "_id": "6714cf83-c32e-45fa-9cba-faecfdb700d1",
      "_rev": "000000009e919882"
    }
  },
  "authzRoles": [
    {
      "_ref": "internal/role/openidm-authorized",
      "_refResourceCollection": "internal/role",
      "_refResourceId": "openidm-authorized",
      "_refProperties": {
        "_id": "6e2ddf00-d693-4038-ae63-b56b2447b49e",
        "_rev": "000000000508a08f"
      }
    }
  ],
  "roles": []
}
```

To expand that query to show all fields within each relationship, add a wildcard as follows:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user/psmith?_fields=*_ref/*"
{
  "_id": "psmith",
  "_rev": "000000007e0e0a09",
  "reports": [],
  "roles": [],
  "authzRoles": [
    {
      "_ref": "internal/role/openidm-authorized",
      "_refResourceCollection": "internal/role",
      "_refResourceId": "openidm-authorized",
      "_refProperties": {
        "_id": "6e2ddf00-d693-4038-ae63-b56b2447b49e",
        "_rev": "000000000508a08f"
      },
      "_id": "openidm-authorized",
      "description": "Basic minimum user",
      "_rev": "0000000068832d1e"
    }
  ],
```

```
  "manager": {
    "_ref": "managed/user/bjensen",
    "_refResourceCollection": "managed/user",
    "_refResourceId": "bjensen",
    "_refProperties": {
      "_id": "6714cf83-c32e-45fa-9cba-faecfdb700d1",
      "_rev": "000000009e919882"
    },
    "mail": "bjensen@example.com",
    "givenName": "Barbara",
    "sn": "Jensen",
    "description": "Created By CSV",
    "userName": "bjensen",
    "telephoneNumber": "1234567",
    "accountStatus": "active",
    "_meta": {
      "_ref": "internal/usermeta/8a4ec527-7a8d-4873-ae5c-7a9bafe43cbd",
      "_refResourceCollection": "internal/usermeta",
      "_refResourceId": "8a4ec527-7a8d-4873-ae5c-7a9bafe43cbd",
      "_refProperties": {
        "_id": "a4d045eb-527f-42df-a6d1-6cb136014457",
        "_rev": "000000002d5a9e93"
      },
      "createDate": "2018-04-12T21:50:18.097Z",
      "lastChanged": {
        "date": "2018-04-12T21:50:18.097Z"
      },
      "loginCount": 0,
      "_rev": "0000000008e85fab",
      "_id": "8a4ec527-7a8d-4873-ae5c-7a9bafe43cbd"
    }
    "effectiveRoles": [],
    "effectiveAssignments": [],
    "_rev": "000000001ed4ff4f",
    "_id": "bjensen"
  }
}
```


Note

Metadata is implemented using the relationships mechanism so when you request all relationships for a user (with `_ref/`), you will also get all the metadata for that user, if metadata is being tracked. For more information, see "Tracking Metadata For Managed Objects".

10.8. Viewing Relationships in Graph Form

The *Identity Relationships widget* gives a visual display of the relationships between objects.

This widget is not displayed on any dashboard by default. You can add it as follows:

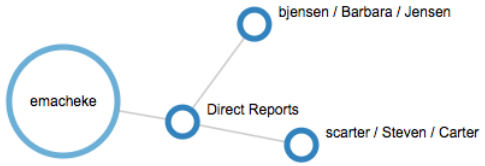
1. Log into the Admin UI.
2. Select Dashboards, and choose the dashboard to which you want to add the widget.

For more information about managing dashboards in the UI, see "Managing Dashboards".

3. Select Add Widget.
4. In the Add Widget window, scroll down to the Utilities item, select Identity Relationships, then click Settings.
5. Choose the Widget Size (small, medium, or large).
6. From the Chart Type list, select Collapsible Tree Layout or Radial Layout.

   The Collapsible Tree Layout looks something like this:

   The Radial Layout looks something like this:

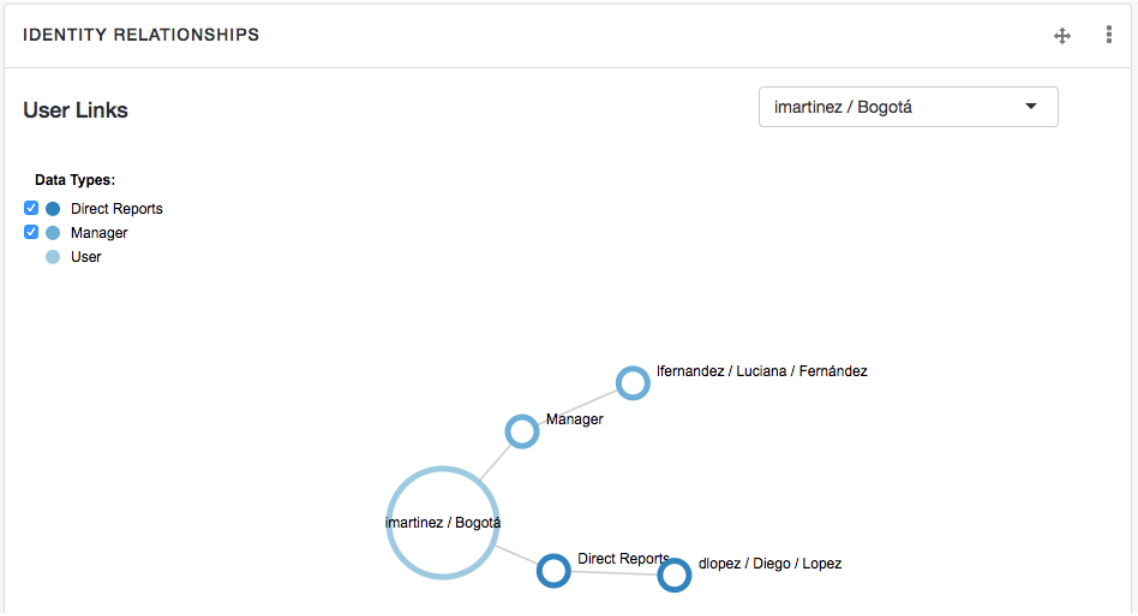


7. Select the object for which you want to display relationships, for example, `User`.
8. Select the property or properties that will be used to search on that object, and that will be displayed in the widget, for example, `userName` and `city`.

   Optionally, select Preview for an idea of what the data represented by widget will look like. Select Settings to return to the Add Widget window.
9. Click Add to add the widget to the dashboard.

When you have added the Identity Relationships widget, select the user whose relationships you want to search.

The following graph shows all of imartinez's relationships. The graph shows imartinez's manager and her direct reports.



Select or deselect the Data Types on the left of the screen to control how much information is displayed.

Select and move the graph for a better view. Double-click on any user in the graph to view that user's profile.

10.9. Managing Relationships Through the Admin UI

This section describes how to set up relationships between managed objects by using the Admin UI. You can set up a relationship between any object types. The examples in this section demonstrate how to set up a relationship between users and devices, such as IoT devices.

For illustration purposes, these examples assume that you have started IDM and already have some managed users. If this is not the case, start the server with the sample configuration described in "*Synchronizing Data From a CSV File to IDM*" in the *Samples Guide*, and run a reconciliation to populate the managed user repository.

In the following procedures, you will:

- Create a new managed object type named `Device` and add a few devices, each with unique serial numbers (see "To Create a New Device Object Type").
- Set up a bi-directional relationship between the Device object and the managed User object (see "To Configure the Relationship Between a Device and a User").

- Demonstrate the relationships, assign devices to users, and show relationship validation (see "To Demonstrate the Relationship").

To Create a New Device Object Type

This procedure illustrates how to set up a new Device managed object type, adding properties to collect information such as model, manufacturer, and serial number for each device. In the next procedure, you will set up the relationship.

1. Click Configure > Managed Objects > New Managed Object.

   Give the object an appropriate name and Readable Title. For this procedure, specify `Device` for both these fields.

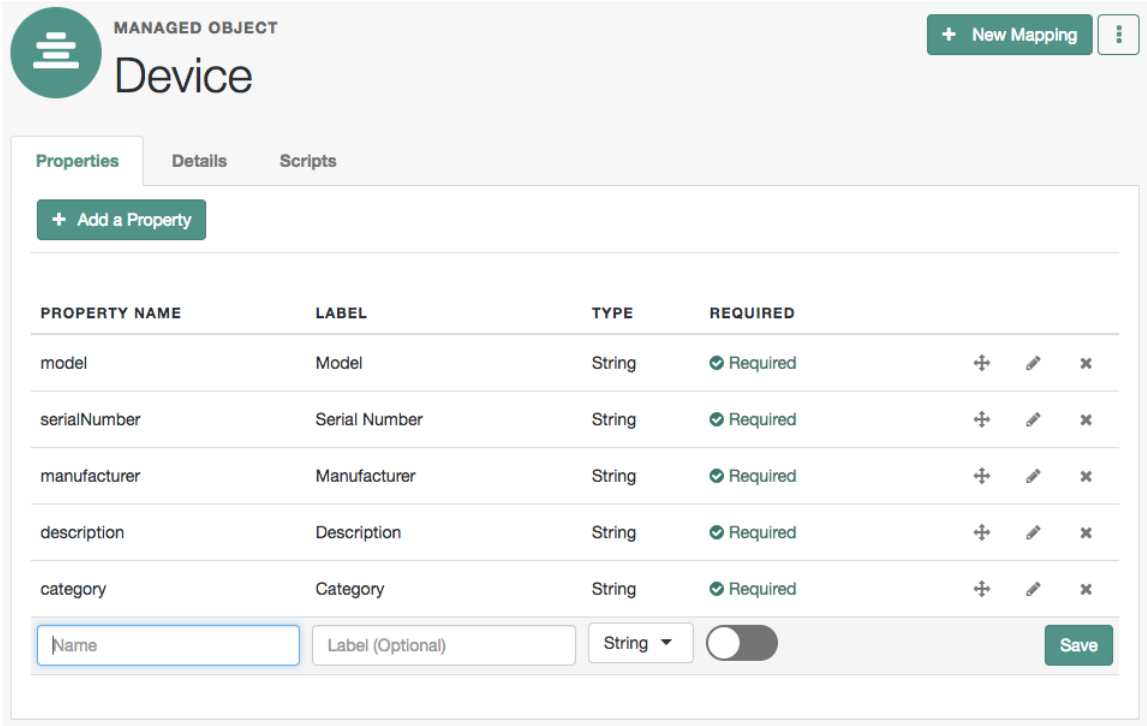
   Enter a description for the object, select an icon that represents the object, and click Save.

   You should now see three tabs: Properties, Details, and Scripts. Select the Properties tab.

2. Click Add a Property to set up the schema for the device.

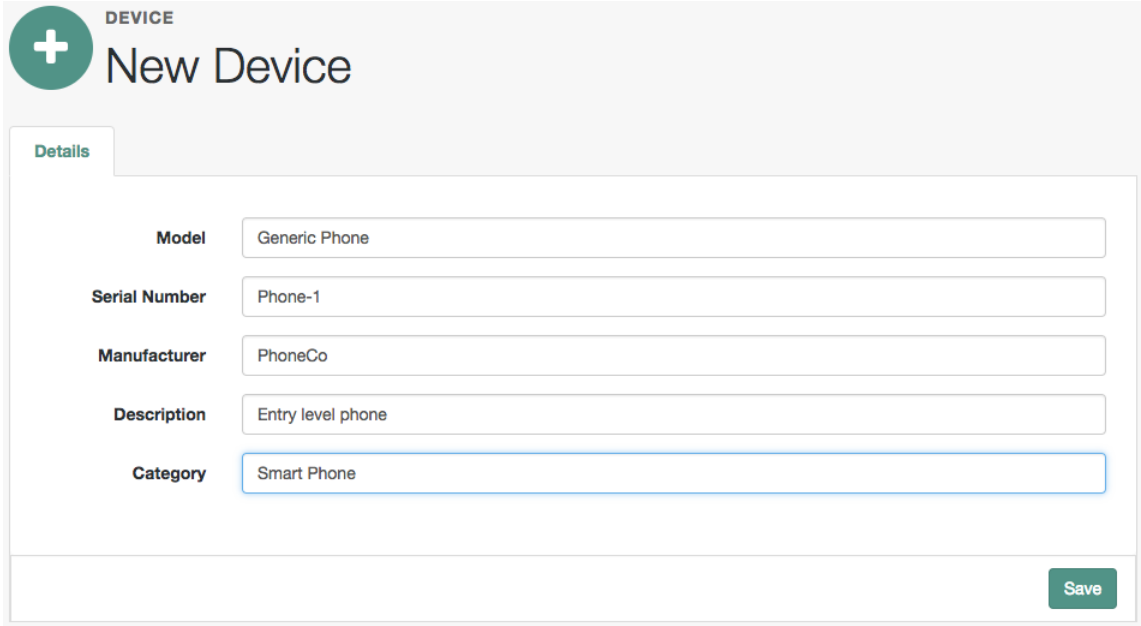
   For each property, enter a Name, and Label, select the data Type for the property, and specify whether that property is required for an object of this type.

   For the purposes of this example, include the properties shown in the following image: model, serialNumber, manufacturer, description, and category.



When you save the properties for the new managed object type, IDM saves those entries in your project's `conf/managed.json` file.

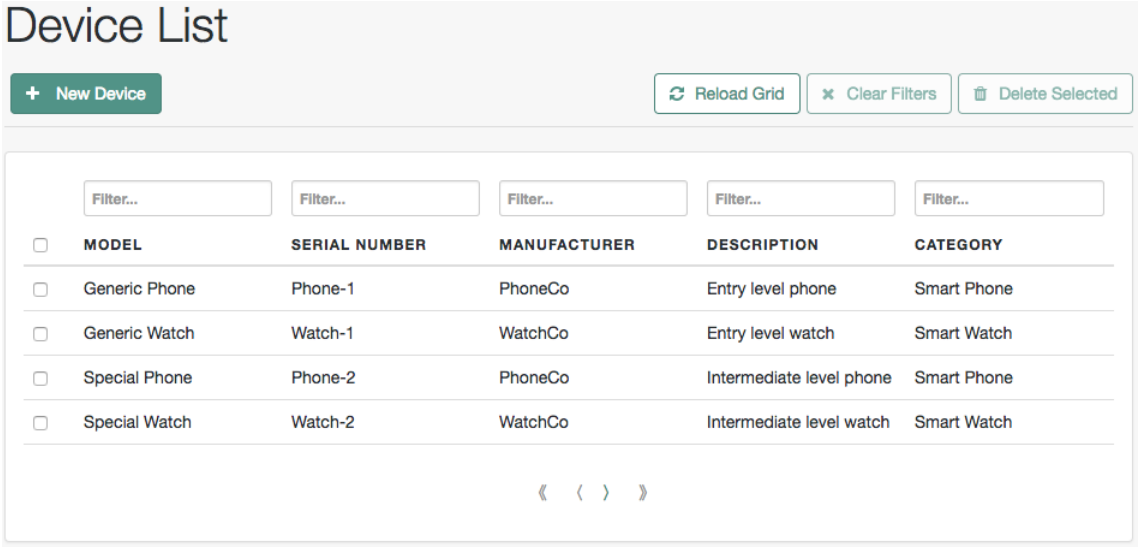
3. Now select Manage > Device > New Device and add a device as shown in the following image:



4. Continue adding new devices to the Device object.

   When you have finished, select Manage > Device to view the complete list of Devices.

   The remaining procedures in this section assume that you have added devices similar to the following:



5. (Optional) To change the order in which properties of the Device managed object are displayed, select Configure > Managed Objects > Device. Select the property that you want to move and drag it up or down the list.

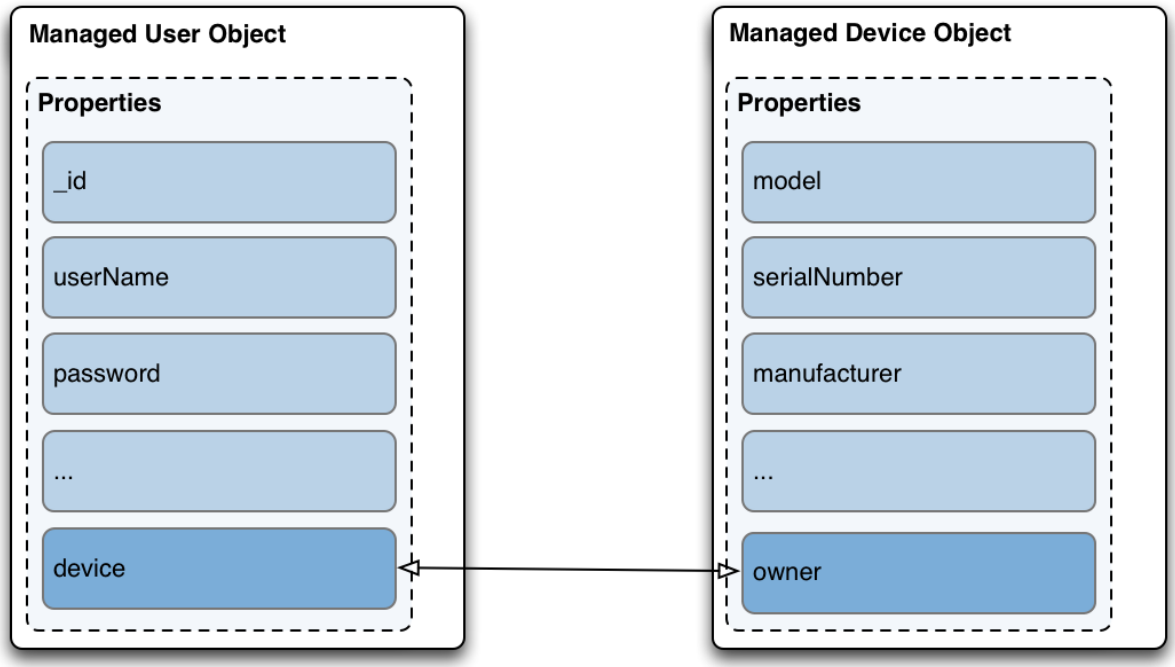
   Alternatively, you can make the same changes to this schema (or any managed object schema) in your project's `conf/managed.json` file.

To Configure the Relationship Between a Device and a User

To set up a relationship between the Device object type and the User object type, you must identify the specific property on each object that will form the basis of the relationship. For example, a device must have an *owner* and a user can own one or more *devices*. The property *type* for each of these must be *relationship*.

In this procedure, you will update the managed Device object type to add a new Relationship type property named `owner`. You will then link that property to a new property on the managed User object, named `device`. At the end of the procedure, the updated object types will look as follows:

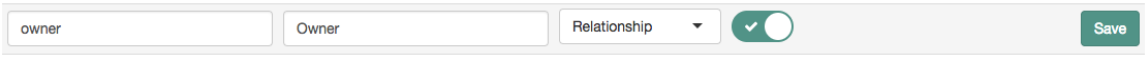
Relationship Properties on User and Device Objects



1. Create a new relationship property on the Device object:

   a. Select Configure > Managed Objects and select the Device object that you created previously.

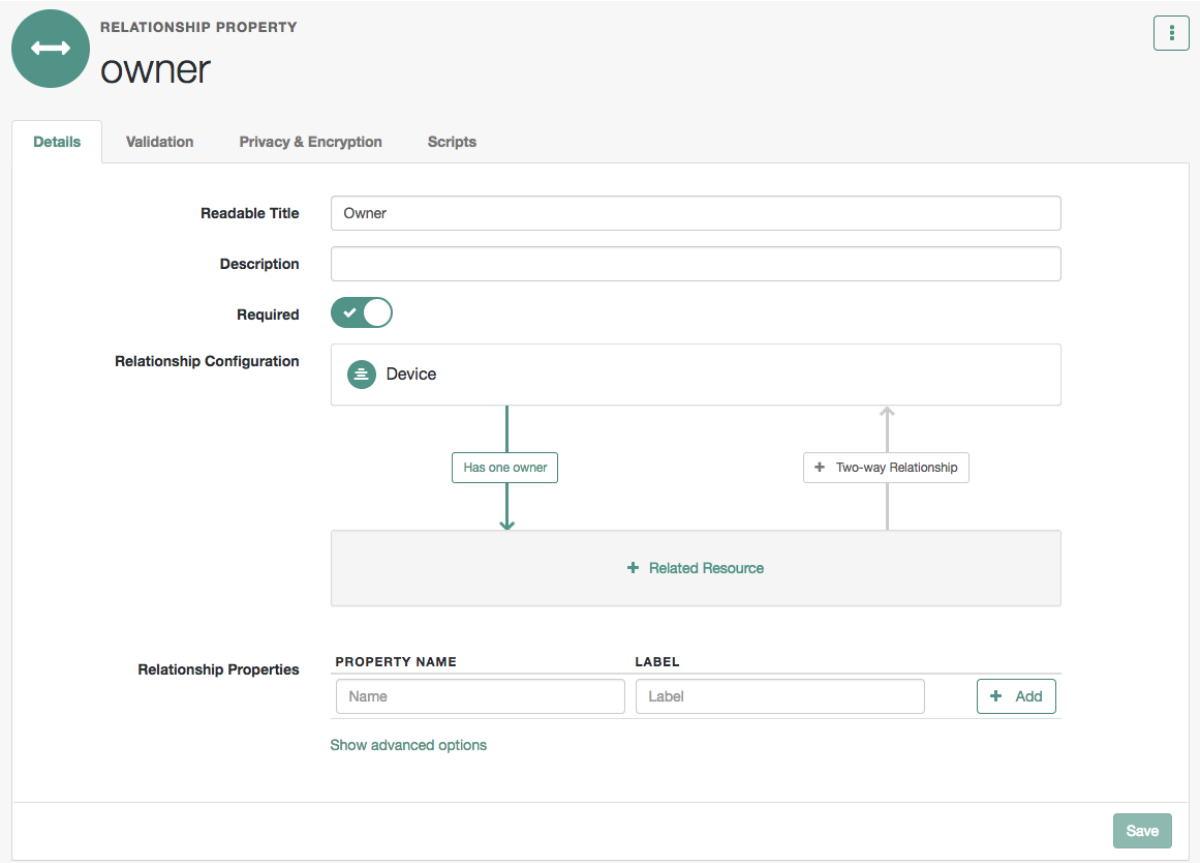
   b. On the Properties tab, add a new property named `owner`. Select Relationship as the property Type. Select Required, as all device objects *must* have an owner:



Note

You cannot change the Type of a property after it has been created. If you create the property with an incorrect Type, you must delete the property and recreate it.

2. When you have saved the Owner property, select it to show the relationship on the Details tab:



3. Click the + Related Resource item and select `user` as the Resource.

   This sets up a relationship between the new Device object and the managed User object.

   Under Display Properties, select all of the properties of the user object that should be visible when you display a user's devices in the UI. For example, you might want to see the user's name, email address and telephone number.

   Note that this list of Display Properties also specifies how you can *search* for user objects when you are assigning a device to a user.

   Click Show advanced options. Notice that the Query Filter field is set to `true`. This setting allows you to search on any of the Display Properties that you have selected, when you are assigning a device to a user.

   Click Save to continue.

You now have a one-way relationship between a device and a user.

4. Click the + Two-way Relationship item to configure the reverse relationship:

   a. Select Has Many to indicate that a single user can have more than one device.

   b. In the Reverse property name field, enter the new property name that will be created in the managed User object type. As shown in "Relationship Properties on User and Device Objects", that property is `device` in this example.

   c. Under Display Properties, select all of the properties of the device object that should be visible when you display a user in the UI. For example, you might want to see the model and serial number of each device.

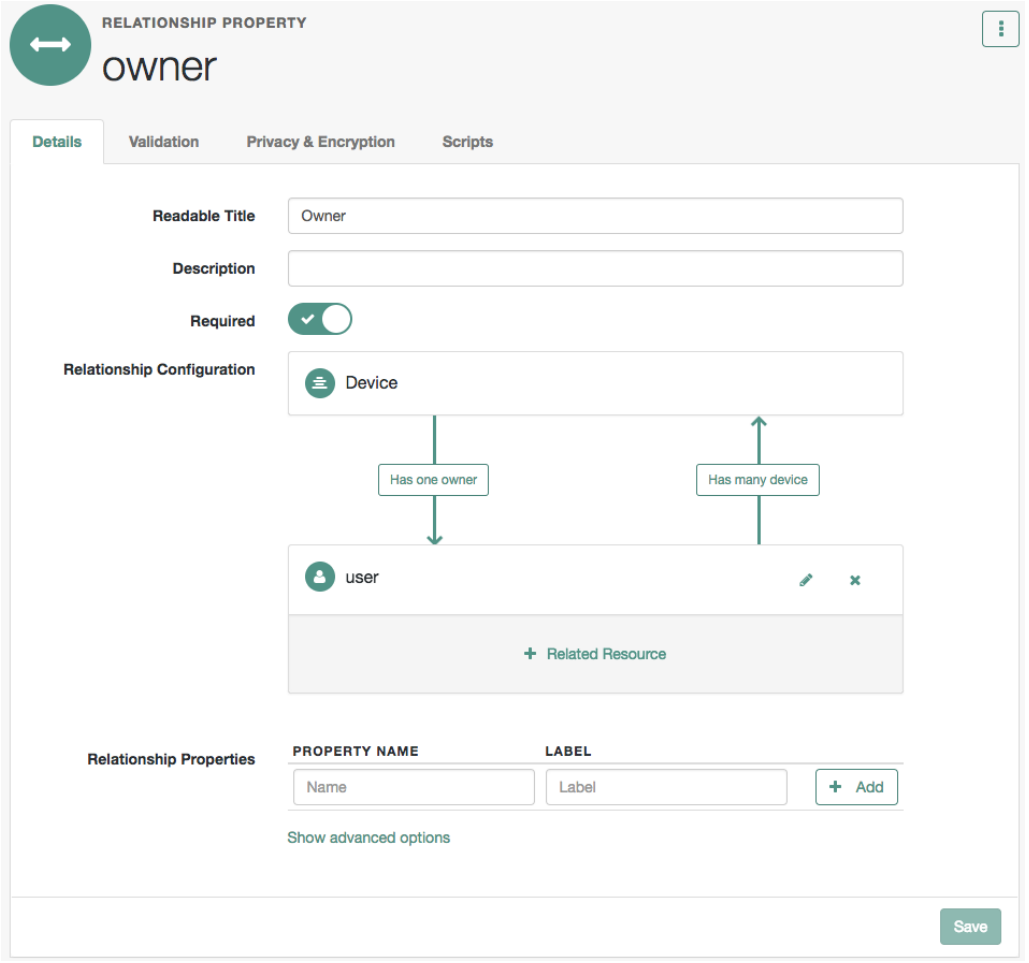
   d. Click Show advanced options. Notice that the Query Filter field is set to `true`. This setting allows you to search on any of the Display Properties that you have selected, when you are assigning a device to a user.

   e. Select Validate relationship.

      This setting ensures that the relationship is valid when a device is assigned to a user. IDM verifies that both the user and device objects exist, and that that specific device has not already been assigned to user.

   f. Click Save to continue.

5. You should now have the following reverse relationship configured between User objects and Device objects:



Select Configure > Managed Objects > User.

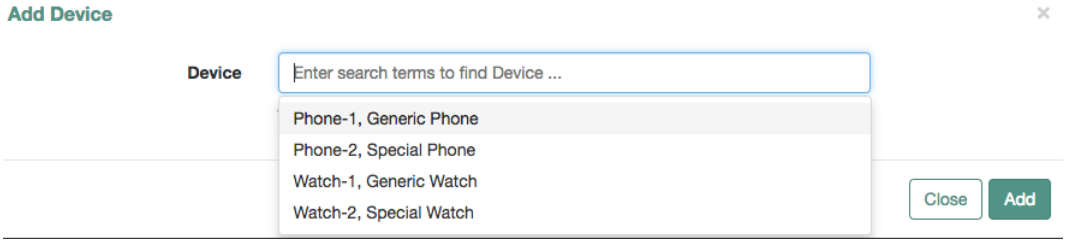
Scroll down to the end of the Properties tab and notice that the `device` property was created automatically when you configured the relationship.

To Demonstrate the Relationship

This procedure demonstrates how devices can be assigned to users, based on the relationship configuration that you set up in the previous two procedures.

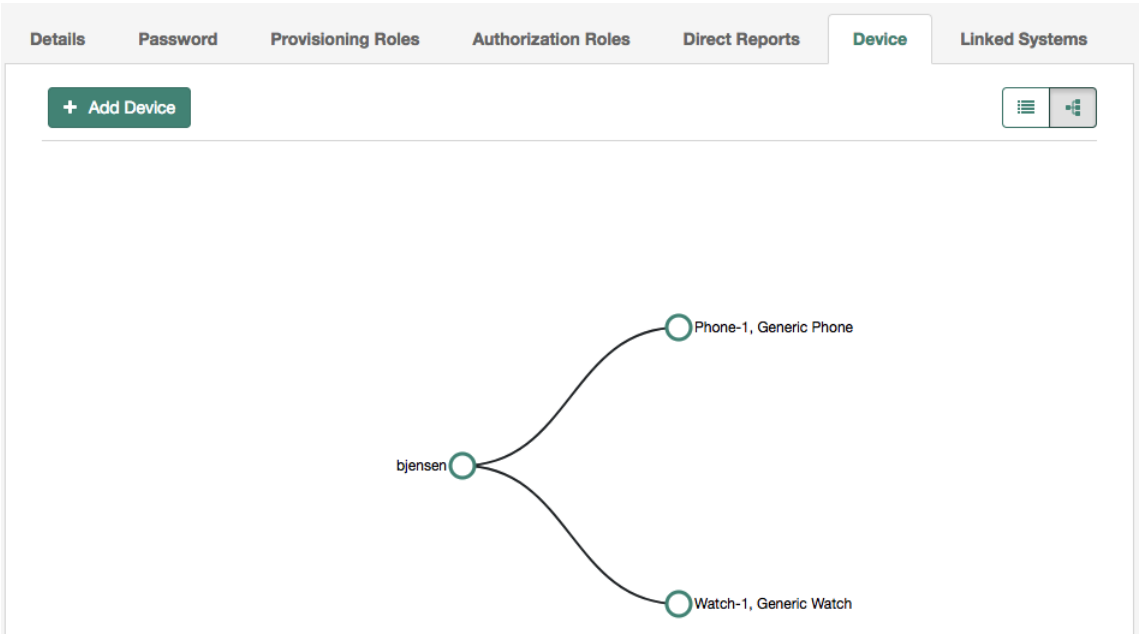
1. Select Manage > User, click on a user entry and select the new Device tab.

2. Click Add Device and click in the Device field to display the list of devices that you added in the previous procedure.



3. Select two devices and click Add.
4. On the Device tab, click the Show Chart icon at the top right.

   A graphical representation of the relationship between the user and her devices is displayed:



5. You can also assign an owner to a device.

   Select Manage > Device, and select one of the devices that you did not assign in the previous step.

   Click Add Owner and search for the user to whom the device should be assigned.

6. To demonstrate the relationship validation, try to assign a device that has already been assigned to a different user.

The UI displays the error: `Conflict with Existing Relationship`.

10.10. Viewing the Relationship Configuration in the UI

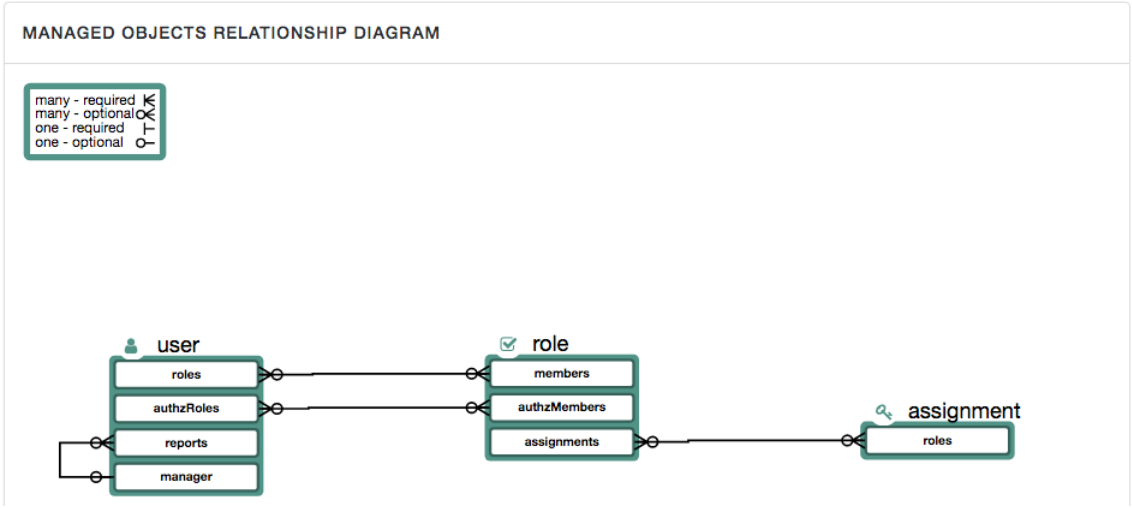
The *Managed Objects Relationship Diagram* provides a visual display of the relationship configuration between managed objects. Unlike the Identity Relationships widget, described in "Viewing Relationships in Graph Form", this widget does not show the actual relationship data, but rather shows the configured relationship types.

This widget is not displayed on any dashboard by default. You can add it as follows:

1. Log into the Admin UI.
2. Select Dashboards, and choose the dashboard to which you want to add the widget.

   For more information about managing dashboards in the UI, see "Managing Dashboards".
3. Select Add Widget.
4. In the Add Widget window, scroll down to the Utilities item and select Managed Objects Relationship Diagram.

   There are no configurable settings for this widget.
5. The Preview button shows the current relationship configuration. The following image shows the relationship configuration for a basic IDM installation with no specific configuration:



The legend indicates which relationships are required, which are optional, and which are one to one or one to many. In the default relationship configuration shown in the previous image, you

can see that a user can have one or more roles and a role can have one or more users. A manager can have one or more reports but a user can have only one manager. There are no mandatory relationships in this default configuration.

Chapter 11
Working With Managed Roles

This chapter describes a specific managed object type — the managed *role* object. Managed roles use the *relationships* mechanism, described in "*Managing Relationships Between Objects*". It is useful to understand how relationships work before you read about roles in IDM.

IDM supports two types of roles:

- *Provisioning roles* - used to specify how objects are provisioned to an external system.
- *Authorization roles* - used to specify the authorization rights of a managed object internally, within IDM.

Provisioning roles are always created as managed roles, at the context path `openidm/managed/role/role-name`. Provisioning roles are granted to managed users as values of the user's `roles` property.

Authorization roles can be created either as managed roles (at the context path `openidm/managed/role/role-name`) or as internal roles (at the context path `openidm/internal/role/role-name`). Authorization roles are granted to managed users as values of the user's `authzRoles` property.

Both provisioning roles and authorization roles use the relationships mechanism to link the role to the managed object to which it applies. For more information about relationships between objects, see "*Managing Relationships Between Objects*".

This section describes how to create and use *managed roles*, either managed provisioning roles, or managed authorization roles. For more information about internal authorization roles, and how IDM controls authorization to its own endpoints, see "Authorization".

Managed roles are defined like any other managed object, and are granted to users through the *relationships* mechanism.

A managed role can be granted manually, as a static value of the user's `roles` or `authzRoles` attribute, or dynamically, as a result of a condition or script. For example, a user might be granted a role such as `sales-role` dynamically, if that user is in the `sales` organization.

A managed user's `roles` and `authzRoles` attributes take an array of *references* as a value, where the references point to the managed roles. For example, if user bjensen has been granted two provisioning roles (`employee` and `supervisor`), the value of bjensen's `roles` attribute would look something like the following:

```
"roles": [
  {
    "_ref": "managed/role/employee",
    "_refResourceCollection": "managed/role",
    "_refResourceId": "employee",
    "_refProperties": {
      "_grantType": "",
      "_id": "bb399428-21a9-4b01-8b74-46a7ac43e0be",
      "_rev": "00000000e43e9ba7"
    }
  },
  {
    "_ref": "managed/role/supervisor",
    "_refResourceCollection": "managed/role",
    "_refResourceId": "supervisor",
    "_refProperties": {
      "_grantType": "",
      "_id": "9f7d124b-c7b1-4bcf-9ece-db4900e37c31",
      "_rev": "00000000e9c19d26"
    }
  }
]
```


The `_refResourceCollection` is the container that holds the role and the `_refResourceId` the ID of the role. The `_ref` property is a resource path that is derived from the `_refResourceCollection` and the URL-encoded `_refResourceId`. The `_refProperties` property provides more information about the relationship.

Important

Some of the examples in this documentation set use client-assigned IDs (such as `bjensen` and `scarter`) for the user objects because it makes the examples easier to read. If you create objects using the Admin UI, they are created with server-assigned IDs (such as `55ef0a75-f261-47e9-a72b-f5c61c32d339`). This particular example uses a client-assigned role ID that is the same as the role name. All other examples in this chapter use server-assigned IDs. Generally, immutable server-assigned UUIDs are used for all managed objects in production environments.

The following sections describe how to create, read, update, and delete managed roles, and how to grant roles to users. For information about how roles are used to provision users to external systems, see "Working With Role Assignments".

11.1. Creating a Role

The easiest way to create a new role is by using the Admin UI. Select Manage > Role and select New Role on the Role List page. Enter a name and description for the new role and select Save.

Optionally, select Temporal Constraint to restrict the role grant to a set time period or Condition to define a query filter that will allow the role to be granted to members dynamically. For more information on these options, see "Using Temporal Constraints to Restrict Effective Roles" and "Granting Roles Dynamically".

To create a managed role over REST, send a PUT or POST request to the `/openidm/managed/role` context path. The following example creates a managed role named `employee`:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
     "name" : "employee",
     "description" : "Role granted to workers on the company payroll"
 }' \
 "http://localhost:8080/openidm/managed/role?_action=create"
{
  "_id": "5790220a-719b-49ad-96a6-6571e63cbaf1",
  "_rev": "0000000079c6644f",
  "name": "employee",
  "description": "Role granted to workers on the company payroll"
}
```

At this stage, the `employee` role has no corresponding *assignments*. Assignments are what enables the provisioning logic to the external system. Assignments are created and maintained as separate managed objects, and are referred to within role definitions. For more information about assignments, see "Working With Role Assignments".

11.2. Listing Existing Roles

You can display a list of all configured managed roles over REST or by using the Admin UI.

To list the managed roles in the Admin UI, select Manage > Role.

If you have many managed roles, the Role List page now supports specialized filtering, with the Advanced Filter option, which allows you to build many of the queries shown in "Defining and Calling Queries".

To list the managed roles over REST, query the `openidm/managed/role` endpoint. The following example shows the `employee` role that you created in the previous section:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/role?_queryFilter=true"
{
  "result": [
    {
      "_id": "5790220a-719b-49ad-96a6-6571e63cbaf1",
      "_rev": "0000000079c6644f",
      "name": "employee",
      "description": "Role granted to workers on the company payroll"
    }
  ]
,
...
}
```

11.3. Granting a Role to a User

Roles are granted to users through the relationship mechanism. Relationships are essentially references from one managed object to another, in this case from a user object to a role object. For more information about relationships, see "*Managing Relationships Between Objects*".

Roles can be granted manually or dynamically.

To grant a role manually, you must do one of the following:

- Update the value of the user's `roles` property (if the role is a provisioning role) or `authzRoles` property (if the role is an authorization role) to reference the role.
- Update the value of the role's `members` property to reference the user.

Manual role grants are described further in "Granting Roles Manually".

Dynamic role grants use the result of a condition or script to update a user's list of roles. Dynamic role grants are described in detail in "Granting Roles Dynamically".

11.3.1. Granting Roles Manually

To grant a role to a user manually, use the Admin UI or the REST interface as follows:

Using the Admin UI

Use one of the following UI methods to grant a role to a user:

- Update the user entry:
  1. Select Manage > User and select the user to whom you want to grant the role.

2. Select the Provisioning Roles tab and select Add Provisioning Roles.
3. Select the role from the dropdown list and select Add.

- Update the role entry:

1. Select Manage > Role and select the role that you want to grant.
2. Select the Role Members tab and select Add Role Members.
3. Select the user from the dropdown list and select Add.

Over the REST interface

Use one of the following methods to grant a role to a user over REST:

- Update the user's `roles` property to refer to the role.

  The following sample command grants the `employee` role (with ID `5790220a-719b-49ad-96a6-6571e63cbaf1`) to user scarter:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PATCH \
 --data '[
    {
       "operation": "add",
       "field": "/roles/-",
       "value": {"_ref" : "managed/role/5790220a-719b-49ad-96a6-6571e63cbaf1"}
    }
 ]' \
 "http://localhost:8080/openidm/managed/user/scarter"
{
  "_id": "scarter",
  "_rev": "000000003be825ce",
  "mail": "scarter@example.com",
  "givenName": "Steven",
  "sn": "Carter",
  "description": "Created By CSV",
  "userName": "scarter",
  "telephoneNumber": "1234567",
  "accountStatus": "active",
  "effectiveRoles": [
    {
      "_ref": "managed/role/5790220a-719b-49ad-96a6-6571e63cbaf1"
    }
  ],
  "effectiveAssignments": []
}
```

  Note that scarter's `effectiveRoles` attribute has been updated with a reference to the new role. For more information about effective roles and effective assignments, see "Understanding Effective Roles and Effective Assignments".

When you update a user's existing roles array, you must use the `-` special index to add the new value to the set. For more information, see *Set semantic arrays* in "Patch Operation: Add".

- Update the role's `members` property to refer to the user.

  The following sample command makes scarter a member of the `employee` role:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PATCH \
 --data '[
    {
       "operation": "add",
       "field": "/members/-",
       "value": {"_ref" : "managed/user/scarter"}
    }
 ]' \
 "http://localhost:8080/openidm/managed/role/5790220a-719b-49ad-96a6-6571e63cbaf1"
{
  "_id": "5790220a-719b-49ad-96a6-6571e63cbaf1",
  "_rev": "0000000079c6644f",
  "name": "employee",
  "description": "Role granted to workers on the company payroll"
}
```

  Note that the `members` property of a role is not returned by default in the output. To show all members of a role, you must specifically request the relationship properties (`*_ref`) in your query. The following sample command lists the members of the `employee` role (currently only scarter):

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/role/5790220a-719b-49ad-96a6-6571e63cbaf1?_fields=*_ref
,name"
{
  "_id": "5790220a-719b-49ad-96a6-6571e63cbaf1",
  "_rev": "0000000079c6644f",
  "name": "employee",
  "authzMembers": [],
  "assignments": [],
  "members": [
    {
      "_ref": "managed/user/scarter",
      "_refResourceCollection": "managed/user",
      "_refResourceId": "scarter",
      "_refProperties": {
        "_id": "7ad15a7b-6806-487b-900d-db569927f56d",
        "_rev": "0000000075e09cbf"
      }
    }
  ]
}
```

- You can replace an existing role grant with a new one by using the `replace` operation in your patch request.

  The following command replaces scarter's entire `roles` entry (that is, overwrites any existing roles) with a single entry, the reference to the `employee` role (ID `5790220a-719b-49ad-96a6-6571e63cbaf1`):

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PATCH \
 --data '[
   {
     "operation": "replace",
     "field":"/roles",
     "value":[
          {"_ref":"managed/role/5790220a-719b-49ad-96a6-6571e63cbaf1"}
     ]
   }
 ]' \
 "http://localhost:8080/openidm/managed/user/scarter"
{
  "_id": "scarter",
  "_rev": "00000000da112702",
  "mail": "scarter@example.com",
  "givenName": "Steven",
  "sn": "Carter",
  "description": "Created By CSV",
  "userName": "scarter",
  "telephoneNumber": "1234567",
  "accountStatus": "active",
  "effectiveRoles": [
    {
      "_ref": "managed/role/5790220a-719b-49ad-96a6-6571e63cbaf1"
    }
  ],
  "effectiveAssignments": []
}
```

11.3.2. Granting Roles Dynamically

The previous section showed how to grant roles to a user manually, by listing a reference to the role as a value of the user's `roles` attribute. You can also grant a role *dynamically* by using one of the following methods:

- Granting a role based on a condition, where that condition is expressed in a query filter in the role definition. If the condition is `true` for a particular member, that member is granted the role. Conditions can be used in both managed and internal roles.

- Using a custom script to define a more complex role granting strategy.

11.3.2.1. Granting Roles Based on a Condition

A role that is granted based on a defined condition is called a *conditional role*. To create a conditional role, include a query filter in the role definition.

Important

Properties that are used as the basis of a conditional role query *must* be configured as `searchable` and must be indexed in the repository configuration. To configure a property as `searchable`, update the schema in your `conf/managed.json` file. For more information, see "Creating and Modifying Managed Object Types".

To create a conditional role by using the Admin UI, select Condition on the role Details page, then define the query filter that will be used to assess the condition.

To create a conditional role over REST, include the query filter as a value of the `condition` property in the role definition. The following command creates a role, `fr-employee`, that will be granted only to those users who live in France (whose `country` property is set to `FR`):

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
    "name": "fr-employee",
    "description": "Role granted to employees resident in France",
    "condition": "/country eq \"FR\""
 }' \
 "http://localhost:8080/openidm/managed/role?_action=create"
 {
  "_id": "eb18a2e2-ee1e-4cca-83fb-5708a41db94f",
  "_rev": "000000004085704c",
  "name": "fr-employee",
  "description": "Role granted to employees resident in France",
  "condition": "/country eq \"FR\""
}
```

When a conditional role is created or updated, IDM automatically assesses all managed users, and recalculates the value of their `roles` property, if they qualify for that role. When a condition is removed from a role, that is, when the role becomes an unconditional role, all conditional grants removed. So, users who were granted the role based on the condition have that role removed from their `roles` property.

Caution

When a conditional role is defined in an existing data set, every user entry (including the mapped entries on remote systems) must be updated with the assignments implied by that conditional role. The time that it takes to create a new conditional role is impacted by the following items:

- The number of managed users affected by the condition
- The number of assignments related to the conditional role

- The average time required to provision updates to all remote systems affected by those assignments

In a data set with a very large number of users, creating a new conditional role can therefore incur a significant performance cost at the time of creation. Ideally, you should set up your conditional roles at the beginning of your deployment to avoid performance issues later.

11.3.2.2. Granting Roles By Using Custom Scripts

The easiest way to grant roles dynamically is to use conditional roles, as described in "Granting Roles Based on a Condition". If your deployment requires complex conditional logic that cannot be achieved with a query filter, you can create a custom script to grant the role, as follows:

1. Create a `roles` directory in your project's `script` directory and copy the default effective roles script to that new directory:

   ```
   $ mkdir project-dir/script/roles/
   $ 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 script to reference additional roles that have not been granted manually, or as the result of a conditional grant. The effective roles script calculates the grants that are in effect when the user is retrieved.

   For example, the following addition to the `effectiveRoles.js` script grants the roles `dynamic-role1` and `dynamic-role2` to all active users (managed user objects whose `accountStatus` value is `active`). This example assumes that you have already created the managed roles, `dynamic-role1` (with ID `d2e29d5f-0d74-4d04-bcfe-b1daf508ad7c`) and `dynamic-role2` (with ID `709fed03-897b-4ff0-8a59-6faaa34e3af6`, and their corresponding assignments:

   ```
   // 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.accountStatus === 'active') {
       effectiveRoles = effectiveRoles.concat([
         {"_ref": "managed/role/d2e29d5f-0d74-4d04-bcfe-b1daf508ad7c"},
         {"_ref": "managed/role/709fed03-897b-4ff0-8a59-6faaa34e3af6"}
       ]);
   }
   ```

Note

For conditional roles, the user's `roles` property is updated if the user meets the condition. For custom scripted roles, the user's `effectiveRoles` property is calculated when the user is retrieved and includes the dynamic roles according to the custom script.

If you make any of the following changes to a scripted role grant, you must perform a manual reconciliation of all affected users before assignment changes will take effect on an external system:

- If you create a new scripted role grant.
- If you change the definition of an existing scripted role grant.
- If you change any of the assignment rules for a role that is granted by a custom script.

11.4. Using Temporal Constraints to Restrict Effective Roles

You can use temporal constraints to restrict the period a role is effective in. Temporal constraints can be applied to both managed and internal roles, and can also be applied to role grants on a per-user basis.

For example, you might want a role such as `contractors-2018` which you want to apply to all contract employees for the year 2018. In this case, you would set the temporal constraint on the role. Alternatively, you might want to assign a `contractors` role to apply to an individual user only for the period of their contract of employment.

The following sections describe how to set temporal constraints on role definitions, and on individual role grants.

11.4.1. Adding a Temporal Constraint to a Role Definition

When you create a role, you can include a temporal constraint in the role definition that restricts the validity of the entire role, regardless of how that role is granted. Temporal constraints are expressed as a time interval in ISO 8601 date and time format. For more information on this format, see the ISO 8601 standard.

To restrict the period during which a role is valid by using the Admin UI, select Temporal Constraint on the role Details tab, then select a timezone offset relative to GMT and the start and end dates for the required period.

The following example adds a `contractor` role over the REST interface. The role is effective from March 1st, 2018 to August 31st, 2018:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
     "name" : "contractor",
     "description" : "Role granted to contract workers for 2018",
     "temporalConstraints" : [
        {
            "duration": "2018-03-01T00:00:00.000Z/2018-08-31T00:00:00.000Z"
        }
     ]
 }' \
 "http://localhost:8080/openidm/managed/role?_action=create"
{
  "_id": "6c0afad4-645f-4573-a896-2ad2ae76c29a",
  "_rev": "00000000533c7a94",
  "name": "contractor",
  "description": "Role granted to contract workers for 2018",
  "temporalConstraints": [
    {
      "duration": "2018-03-01T00:00:00.000Z/2018-08-31T00:00:00.000Z"
    }
  ]
}
```

The preceding example specifies the time zone as Coordinated Universal Time (UTC) by appending `Z` to the time. If no time zone information is provided, the time zone is assumed to be local time. To specify a different time zone, include an offset (from UTC) in the format `±hh:mm`. For example, an interval of `2018-03-01T00:00:00.000-07:00/2018-08-31T00:00:00.000-07:00` specifies a time zone that is seven hours behind UTC.

When the period defined by the constraint has ended, the role object remains in the repository but the effective roles script will not include the role in the list of effective roles for any user.

The following example assumes that user scarter has been granted a role `contractor-february`. A temporal constraint has been included in the `contractor-february` definition that specifies that the role should be applicable only during the month of February 2018. At the end of this period, a query on scarter's entry shows that his `roles` property still includes the `contractor-february` role (with ID `6c0afad4-645f-4573-a896-2ad2ae76c29a`), but his `effectiveRoles` property does not:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user/scarter?_fields=_id,userName,roles,effectiveRoles"
{
  "_id": "scarter",
  "_rev": "00000000c1481582",
  "userName": "scarter",
  "effectiveRoles": [],
  "roles": [
    {
      "_ref": "managed/role/6c0afad4-645f-4573-a896-2ad2ae76c29a",
      "_refResourceCollection": "managed/role",
      "_refResourceId": "6c0afad4-645f-4573-a896-2ad2ae76c29a",
      "_refProperties": {
        "_grantType": "",
        "_id": "d3e045ea-af80-4699-9aae-120bc2a75cab",
        "_rev": "00000000d5a1a32c"
      }
    }
  ]
}
```

The role is still in place but is no longer effective.

11.4.2. Adding a Temporal Constraint to a Role Grant

To restrict the validity of a role for individual users, you can apply a temporal constraint at the grant level, rather than as part of the role definition. In this case, the temporal constraint is taken into account per user, when the user's effective roles are calculated. Temporal constraints that are defined at the grant level can be different for each user who is a member of that role.

To restrict the period during which a role grant is valid by using the Admin UI, set a temporal constraint when you add the member to the role.

For example, to specify that bjensen be added to a Contractor role only for the period of her employment contract, select Manage > Role, select the Contractor role, then select Add Role Members. On the Add Role Members screen, select bjensen from the list, then enable the Temporal Constraint and specify the start and end date of her contract.

To apply a temporal constraint to a grant over the REST interface, include the constraint as one of the `_refProperties` of the relationship between the user and the role. The following example assumes a `contractor` role, with ID `6c0afad4-645f-4573-a896-2ad2ae76c29a`. The command adds user bjensen as a member of that role, with a temporal constraint that specifies that she be a member of the role only for one year, from January 1st, 2018 to January 1st, 2019:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PATCH \
 --data '[
    {
     "operation": "add",
     "field": "/members/-",
     "value": {
      "_ref" : "managed/user/bjensen",
      "_refProperties": {
       "temporalConstraints": [{"duration": "2018-01-01T00:00:00.000Z/2019-01-01T00:00:00.000Z"}]
      }
     }
    }
 ]' \
 "http://localhost:8080/openidm/managed/role/6c0afad4-645f-4573-a896-2ad2ae76c29a"
{
  "_id": "6c0afad4-645f-4573-a896-2ad2ae76c29a",
  "_rev": "000000007b0475fc",
  "name": "contractor",
  "description": "Role granted to contract workers"
}
```

A query on bjensen's roles property shows that the temporal constraint has been applied to this grant:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user/bjensen/roles?_queryFilter=true"
{
  "result": [
    {
      "_id": "ff9ed5a7-4cb1-461e-a59a-d793b6f35808",
      "_rev": "0000000035aab598",
      "_ref": "managed/role/6c0afad4-645f-4573-a896-2ad2ae76c29a",
      "_refResourceCollection": "managed/role",
      "_refResourceId": "6c0afad4-645f-4573-a896-2ad2ae76c29a",
      "_refProperties": {
        "temporalConstraints": [
          {
            "duration": "2018-01-01T00:00:00.000Z/2019-01-01T00:00:00.000Z"
          }
        ],
        "_id": "ff9ed5a7-4cb1-461e-a59a-d793b6f35808",
        "_rev": "0000000035aab598"
      }
    }
  ],
  ...
}
```

11.5. Querying a User's Manual and Conditional Roles

The easiest way to check what roles have been granted to a user, either manually, or as the result of a condition, is to look at the user's entry in the Admin UI. Select Manage > User, select the user whose roles you want to see, and select the Provisioning Roles tab.

If you have many managed roles, use the Advanced Filter option on the Role List page to build a custom query.

To obtain a similar list over the REST interface, query the user's `roles` property. The following sample query shows that scarter has been granted two roles - an `employee` role (with ID `5790220a-719b-49ad-96a6-6571e63cbaf1`) and an `fr-employee` role (with ID `eb18a2e2-ee1e-4cca-83fb-5708a41db94f`).

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user/scarter/roles?_queryFilter=true&_fields=_ref/*,name"
{
  "result": [
    {
      "_id": "053705c1-1759-4776-80de-3af89fe7b107",
      "_rev": "000000005e55a064",
      "_ref": "managed/role/5790220a-719b-49ad-96a6-6571e63cbaf1",
      "_refResourceCollection": "managed/role",
      "_refResourceId": "5790220a-719b-49ad-96a6-6571e63cbaf1",
      "_refProperties": {
        "_grantType": "",
        "_id": "053705c1-1759-4776-80de-3af89fe7b107",
        "_rev": "000000005e55a064"
      }
    },
    {
      "_id": "16e5e25e-eb92-43b1-9013-806289574d44",
      "_rev": "00000000a0f6a6d6",
      "_ref": "managed/role/eb18a2e2-ee1e-4cca-83fb-5708a41db94f",
      "_refResourceCollection": "managed/role",
      "_refResourceId": "eb18a2e2-ee1e-4cca-83fb-5708a41db94f",
      "_refProperties": {
        "_grantType": "conditional",
        "_id": "16e5e25e-eb92-43b1-9013-806289574d44",
        "_rev": "00000000a0f6a6d6"
      }
    }
  ],
  ...
}
```

Note that the `fr-employee` role indicates a `_grantType` of `conditional`. This property indicates *how* the role was granted to the user. If the `_grantType` is empty, the role was granted manually.

Querying a user's roles in this way *does not* return any roles that would be in effect as a result of a custom script, or of any temporal constraint applied to the role. To return a complete list of *all* the roles in effect at a specific time, you need to query the user's `effectiveRoles` property, as follows:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user/scarter?_fields=effectiveRoles"
```

11.6. Deleting a User's Roles

Roles that have been granted manually can be removed from a user's entry in two ways:

- Update the value of the user's `roles` property (if the role is a provisioning role) or `authzRoles` property (if the role is an authorization role) to remove the reference to the role.
- Update the value of the role's `members` property to remove the reference to that user.

Both of these actions can be achieved by using the Admin UI, or over REST.

Using the Admin UI

Use one of the following methods to remove a user's roles:

- Select Manage > User and select the user whose role or roles you want to remove.

  Select the Provisioning Roles tab, select the role that you want to remove, then select Remove Selected Provisioning Roles.

- Select Manage > Role and select on the role whose members you want to remove.

  Select the Role Members tab, select the member or members that that you want to remove, then select Remove Selected Role Members.

Over the REST interface

Use one of the following methods to remove a role grant from a user:

- Delete the role from the user's `roles` property, including the reference ID (the ID of the relationship between the user and the role) in the delete request:

  The following sample command removes the `employee` role from user scarter. The role ID is `5790220a-719b-49ad-96a6-6571e63cbaf1` but the ID required in the DELETE request is the reference ID (`053705c1-1759-4776-80de-3af89fe7b107`):

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request DELETE \
 "http://localhost:8080/openidm/managed/user/scarter/roles/053705c1-1759-4776-80de-3af89fe7b107"
{
  "_id": "053705c1-1759-4776-80de-3af89fe7b107",
  "_rev": "000000005e55a064",
  "_ref": "managed/role/5790220a-719b-49ad-96a6-6571e63cbaf1",
  "_refResourceCollection": "managed/role",
  "_refResourceId": "5790220a-719b-49ad-96a6-6571e63cbaf1",
  "_refProperties": {
    "_grantType": "",
    "_id": "053705c1-1759-4776-80de-3af89fe7b107",
    "_rev": "000000005e55a064"
  }
}
```

- PATCH the user entry to remove the role from the array of roles, specifying the *value* of the role object in the JSON payload.

Caution

When you remove a role in this way, you must include the *entire object* in the value, as shown in the following example:

```
$ curl \
 --header "Content-type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request PATCH \
 --data '[
    {
      "operation" : "remove",
      "field" : "/roles",
      "value" : {
        "_ref": "managed/role/5790220a-719b-49ad-96a6-6571e63cbaf1",
        "_refResourceCollection": "managed/role",
        "_refResourceId": "5790220a-719b-49ad-96a6-6571e63cbaf1",
        "_refProperties": {
          "_grantType": "",
          "_id": "cec1fabc-894b-4963-ab44-e7dc8ca89927",
          "_rev": "000000002c5fa279"
        }
      }
    }
  ]' \
 "http://localhost:8080/openidm/managed/user/scarter"
{
  "_id": "scarter",
  "_rev": "000000009f853b33",
  "mail": "scarter@example.com",
  "givenName": "Steven",
  "sn": "Carter",
  "description": "Created By CSV",
```

```
  "userName": "scarter",
  "telephoneNumber": "1234567",
  "accountStatus": "active",
  "effectiveRoles": [
    {
      "_ref": "managed/role/eb18a2e2-ee1e-4cca-83fb-5708a41db94f"
    }
  ],
  "effectiveAssignments": [],
  "preferences": {
    "updates": false,
    "marketing": false
  },
  "country": "FR"
}
```

- Delete the user from the role's `members` property, including the reference ID (the ID of the relationship between the user and the role) in the delete request.

  The following example first queries the members of the `employee` role, to obtain the ID of the relationship, then removes bjensen's membership from that role:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/role/5790220a-719b-49ad-96a6-6571e63cbaf1/members?
_queryFilter=true"
{
  "result": [
    {
      "_id": "0d7ded4c-600e-42ae-ac99-3edbd5348d3f",
      "_rev": "000000002651a299",
      "_ref": "managed/user/bjensen",
      "_refResourceCollection": "managed/user",
      "_refResourceId": "bjensen",
      "_refProperties": {
        "_grantType": "",
        "_id": "0d7ded4c-600e-42ae-ac99-3edbd5348d3f",
        "_rev": "000000002651a299"
      }
    }
  ],
  ...
}
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request DELETE \
 "http://localhost:8080/openidm/managed/role/5790220a-719b-49ad-96a6-6571e63cbaf1/members/0d7ded4c
-600e-42ae-ac99-3edbd5348d3f"
{
  "_id": "0d7ded4c-600e-42ae-ac99-3edbd5348d3f",
  "_rev": "000000002651a299",
  "_ref": "managed/user/bjensen",
  "_refResourceCollection": "managed/user",
  "_refResourceId": "bjensen",
  "_refProperties": {
```

```
    "_grantType": "",
    "_id": "0d7ded4c-600e-42ae-ac99-3edbd5348d3f",
    "_rev": "000000002651a299"
  }
}
```

Note

Roles that have been granted as the result of a condition can only be removed when the condition is changed or removed, or when the role itself is deleted.

11.7. Deleting a Role Definition

You can delete a managed provisioning or authorization role by using the Admin UI, or over the REST interface.

To delete a role by using the Admin UI, select Manage > Role, select the role you want to remove then Delete Selected.

To delete a role over the REST interface, simply delete that managed object. The following command deletes the `employee` role created in the previous section:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request DELETE \
 "http://localhost:8080/openidm/managed/role/5790220a-719b-49ad-96a6-6571e63cbaf1"
{
  "_id": "5790220a-719b-49ad-96a6-6571e63cbaf1",
  "_rev": "0000000079c6644f",
  "name": "employee",
  "description": "Role granted to workers on the company payroll"
}
```

Note

You cannot delete a role if it is currently granted to one or more users. If you attempt to delete a role that is granted to a user (either over the REST interface, or by using the Admin UI), IDM returns an error. The following command indicates an attempt to remove the `contractor` role while it is still granted to user scarter:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request DELETE \
 "http://localhost:8080/openidm/managed/role/6c0afad4-645f-4573-a896-2ad2ae76c29a"
{
  "code": 409,
  "reason": "Conflict",
  "message": "Cannot delete a role that is currently granted"
}
```

11.8. Working With Role Assignments

Authorization roles control access to IDM itself. *Provisioning roles* define rules for how attribute values are updated on external systems. These rules are configured through *assignments* that are attached to a provisioning role definition. The purpose of an assignment is to provision an attribute or set of attributes, based on an object's role membership.

The synchronization mapping configuration between two resources (defined in the `sync.json` file) provides the basic account provisioning logic (how an account is mapped from a source to a target system). Role assignments provide additional provisioning logic that is not covered in the basic mapping configuration. The attributes and values that are updated by using assignments might include group membership, access to specific external resources, and so on. A group of assignments can collectively represent a *role*.

Assignment objects are created, updated and deleted like any other managed object, and are attached to a role by using the relationships mechanism, in much the same way as a role is granted to a user. Assignment are stored in the repository and are accessible at the context path `/openidm/managed/assignment`.

This section describes how to manipulate managed assignments over the REST interface, and by using the Admin UI. When you have created an assignment, and attached it to a role definition, all user objects that reference that role definition will, as a result, reference the corresponding assignment in their `effectiveAssignments` attribute.

11.8.1. Creating an Assignment

The easiest way to create an assignment is by using the Admin UI, as follows:

1. Select Manage > Assignment then select New Assignment on the Assignment List page.
2. Enter a name and description for the new assignment.
3. Select the mapping to which the assignment should apply. The mapping indicates the target resource, that is, the resource on which the attributes specified in the assignment will be adjusted.

   Select Save to add the assignment.

4. Select the Attributes tab and select the attribute or attributes whose values will be adjusted by this assignment.

   - If a regular text field appears, specify what the value of the attribute should be, when this assignment is applied.
   - If an Item button appears, you can specify a managed object type, such as an object, relationship, or string.
   - If a Properties button appears, you can specify additional information such as an array of role references.

5. Select the assignment operation from the dropdown list:

   - `Merge With Target` - the attribute value will be added to any existing values for that attribute. This operation merges the existing value of the target object attribute with the value(s) from the assignment. If duplicate values are found (for attributes that take a list as a value), each value is included only once in the resulting target. This assignment operation is used only with complex attribute values like arrays and objects, and does not work with strings or numbers. (Property: `mergeWithTarget`.)
   - `Replace Target` - the attribute value will overwrite any existing values for that attribute. The value from the assignment becomes the authoritative source for the attribute. (Property: `replaceTarget`.)

   Select the unassignment operation from the dropdown list. You can set the unassignment operation to one of the following:

   - `Remove From Target` - the attribute value is removed from the system object when the user is no longer a member of the role, or when the assignment itself is removed from the role definition. (Property: `removeFromTarget`.)
   - `No Operation` - removing the assignment from the user's `effectiveAssignments` has no effect on the current state of the attribute in the system object. (Property: `noOp`.)

6. (Optional) Select the Events tab to specify any scriptable events associated with this assignment.

   The assignment and unassignment operations described in the previous step operate at the *attribute level*. That is, you specify what should happen with each attribute affected by the assignment when the assignment is applied to a user, or removed from a user.

   The scriptable *On assignment* and *On unassignment* events operate at the *assignment level*, rather than the attribute level. You define scripts here to apply additional logic or operations that should be performed when a user (or other object) receives or loses an entire assignment. This logic can be anything that is not restricted to an operation on a single attribute.

   For information about the variables available to these scripts, see "Variables Available to Role Assignment Scripts".

7. Select the Roles tab to attach this assignment to an existing role definition.

To create a new assignment over REST, send a PUT or POST request to the `/openidm/managed/assignment` context path.

The following example creates a new managed assignment named `employee`. The JSON payload in this example shows the following:

- The assignment is applied for the mapping `managedUser_systemLdapAccounts`, so attributes will be updated on the external LDAP system specified in this mapping.
- The name of the attribute on the external system whose value will be set is `employeeType` and its value will be set to `Employee`.
- When the assignment is applied during a sync operation, the attribute value `Employee` will be added to any existing values for that attribute. When the assignment is removed (if the role is deleted, or if the managed user is no longer a member of that role), the attribute value `Employee` will be removed from the values of that attribute.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
   "name" : "employee",
   "description": "Assignment for employees.",
   "mapping" : "managedUser_systemLdapAccount",
   "attributes": [
       {
           "name": "employeeType",
           "value": [
               "Employee"
           ],
           "assignmentOperation" : "mergeWithTarget",
           "unassignmentOperation" : "removeFromTarget"
       }
   ]
 }' \
 "http://localhost:8080/openidm/managed/assignment?_action=create"
{
  "_id": "5a145b08-d885-4fba-be21-08f2733ac1c5",
  "_rev": "00000000f26f9b5c",
  "name": "employee",
  "description": "Assignment for employees.",
  "mapping": "managedUser_systemLdapAccount",
  "attributes": [
    {
      "name": "employeeType",
      "value": [
        "Employee"
      ],
      "assignmentOperation": "mergeWithTarget",
      "unassignmentOperation": "removeFromTarget"
    }
  ]
}
```

Note that at this stage, the assignment is not linked to any role, so no user can make use of the assignment. You must add the assignment to a role, as described in the following section.

11.8.2. Adding an Assignment to a Role

When you have created a managed role, and a managed assignment, you create a *relationship* between the assignment and the role, in much the same way as a user references a role.

You can update a role definition to include one or more assignments, either by using the Admin UI, or over the REST interface.

Using the Admin UI

1. Select Manage > Role and select the role to which you want to add an assignment.
2. Select the Managed Assignments tab and select Add Managed Assignments.
3. Select the assignment that you want to add to the role then select Add.

Over the REST interface

Update the role definition to include a reference to the ID of the assignment in the `assignments` property of the role. The following sample command adds the `employee` assignment (with ID `5a145b08-d885-4fba-be21-08f2733ac1c5`) to an existing `employee` role (whose ID is `a2e7a145-3d7d-4878-8b41-4d1a224ab53f`):

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PATCH \
 --data '[
   {
       "operation" : "add",
       "field" : "/assignments/-",
       "value" : { "_ref": "managed/assignment/5a145b08-d885-4fba-be21-08f2733ac1c5" }
   }
 ]' \
 "http://localhost:8080/openidm/managed/role/a2e7a145-3d7d-4878-8b41-4d1a224ab53f"
{
  "_id": "a2e7a145-3d7d-4878-8b41-4d1a224ab53f",
  "_rev": "00000000fd4060d9",
  "name": "employee",
  "description": "Role granted to members on the payroll"
}
```

To check that the assignment was added successfully, query the `assignments` property of the role:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/role/a2e7a145-3d7d-4878-8b41-4d1a224ab53f/assignments?
_queryFilter=true&_fields=_ref/*,name"
{
  "result": [
    {
      "_id": "ef3ed499-8a66-4020-8cc0-3924054188dc",
      "_rev": "000000004318a7d5",
      "_ref": "managed/assignment/5a145b08-d885-4fba-be21-08f2733ac1c5",
      "_refResourceCollection": "managed/assignment",
      "_refResourceId": "5a145b08-d885-4fba-be21-08f2733ac1c5",
      "_refProperties": {
        "_id": "ef3ed499-8a66-4020-8cc0-3924054188dc",
        "_rev": "000000004318a7d5"
      }
    }
  ]
,
...
}
```

Note that the role's `assignments` property now references the assignment that you created in the previous step.

To remove an assignment from a role definition, remove the reference to the assignment from the role's `assignments` property.

11.8.3. Deleting an Assignment

You can delete an assignment by using the Admin UI, or over the REST interface.

To delete an assignment by using the Admin UI, select Manage > Assignment, select the assignment you want to remove, then select Delete.

To delete an assignment over the REST interface, simply delete that object. The following command deletes the `employee` assignment created in the previous section:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request DELETE \
 "http://localhost:8080/openidm/managed/assignment/5a145b08-d885-4fba-be21-08f2733ac1c5"
{
  "_id": "5a145b08-d885-4fba-be21-08f2733ac1c5",
  "_rev": "00000000f26f9b5c",
  "name": "employee",
  "description": "Assignment for employees.",
  "mapping": "managedUser_systemLdapAccount",
  "attributes": [
    {
      "name": "employeeType",
      "value": [
        "Employee"
      ],
      "assignmentOperation": "mergeWithTarget",
      "unassignmentOperation": "removeFromTarget"
    }
  ]
}
```

Note

You *can* delete an assignment, even if it is referenced by a managed role. When the assignment is removed, any users to whom the corresponding roles were granted will no longer have that assignment in their list of `effectiveAssignments`. For more information about effective roles and effective assignments, see "Understanding Effective Roles and Effective Assignments".

11.8.4. Synchronizing Roles and Assignments

If you have mapped roles and assignments to properties on a target system, and you are preloading the result set into memory, make sure that your `targetQuery` returns the mapped property. For example, if you have mapped a specific role to the `ldapGroups` property on the target system, the target query must include the `ldapGroups` property when it returns the object.

The following excerpt of a mapping indicates that the target query must return the `_id` of the object as well as its `ldapGroups` property:

```
"targetQuery": {
    "_queryFilter" : true,
    "_fields" : "_id,ldapGroups"
},
```

For more information about preloading the result set for reconciliation operations, see "Improving Reconciliation Query Performance".

11.9. Understanding Effective Roles and Effective Assignments

Effective roles and *effective assignments* are virtual properties of a user object. Their values are calculated *on the fly* by the `openidm/bin/defaults/script/roles/effectiveRoles.js` and `openidm/bin/defaults/script/roles/effectiveAssignments.js` scripts. These scripts are triggered when a managed user is retrieved and are referenced in `onRetrieve` hooks in the managed user schema.

The `effectiveRoles.js` and `effectiveAssignments.js` scripts *must* be executed in a specific order. First the `effectiveRoles.js` script determines the role grants for a user, processes any temporal constraints, and sets the `effectiveRoles` field in the user object. Then the `effectiveAssignments.js` script calculates the set of effective assignments, based on the value of the user's `effectiveRoles` property. The scripts are executed in the order in which they appear in the `managed.json` file, so you must ensure that the `effectiveRoles` property is declared first.

The following excerpt of a `managed.json` file shows how these two virtual properties are constructed for each managed user object:

```
"effectiveRoles" : {
    "type" : "array",
    "title" : "Effective Roles",
    "description" : "Effective Roles",
    "viewable" : false,
    "returnByDefault" : true,
    "isVirtual" : true,
    "usageDescription" : "",
    "isPersonal" : false,
    "onRetrieve" : {
        "type" : "text/javascript",
        "source" : "require('roles/effectiveRoles').calculateEffectiveRoles(object, 'roles');"
    },
    "items" : {
        "type" : "object",
        "title" : "Effective Roles Items"
    }
},
    "effectiveAssignments" : {
    "type" : "array",
    "title" : "Effective Assignments",
    "description" : "Effective Assignments",
    "viewable" : false,
    "returnByDefault" : true,
    "isVirtual" : true,
    "usageDescription" : "",
    "isPersonal" : false,
    "onRetrieve" : {
        "type" : "text/javascript",
        "file" : "roles/effectiveAssignments.js",
        "effectiveRolesPropName" : "effectiveRoles"
    },
    "items" : {
        "type" : "object",
        "title" : "Effective Assignments Items"
    }
```

```
},
```

When a role references an assignment, and a user references the role, that user automatically references the assignment in its list of effective assignments.

The `effectiveRoles.js` script uses the `roles` attribute of a user entry to calculate the grants (manual or conditional) that are currently in effect at the time of retrieval, based on temporal constraints or other custom scripted logic.

The `effectiveAssignments.js` script uses the virtual `effectiveRoles` attribute to calculate that user's effective assignments. The synchronization engine reads the calculated value of the `effectiveAssignments` attribute when it processes the user. The target system is updated according to the configured `assignmentOperation` for each assignment.

Do not change the default `effectiveRoles.js` and `effectiveAssignments.js` scripts. If you need to change the logic that calculates `effectiveRoles` and `effectiveAssignments`, create your own custom script and include a reference to it in your project's `conf/managed.json` file. For more information about using custom scripts, see "*Scripting Reference*".

When a user entry is retrieved, IDM calculates the `effectiveRoles` and `effectiveAssignments` for that user based on the current value of the user's `roles` property, and on any roles that might be granted dynamically through a custom script. The previous set of examples showed the creation of a role `employee` that referenced an assignment `employee` and was granted to user bjensen. Querying that user entry would show the following effective roles and effective assignments:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin"  \
 --request GET \
 "http://localhost:8080/openidm/managed/user/bjensen?_fields=userName,roles,effectiveRoles
,effectiveAssignments"
{
  "_id": "bjensen",
  "_rev": "00000000edea91fa",
  "userName": "bjensen",
  "effectiveRoles": [
    {
      "_ref": "managed/role/a2e7a145-3d7d-4878-8b41-4d1a224ab53f"
    }
  ],
  "effectiveAssignments": [
    {
      "name": "employee",
      "description": "Assignment for employees.",
      "mapping": "managedUser_systemLdapAccount",
      "attributes": [
        {
          "assignmentOperation": "mergeWithTarget",
          "name": "employeeType",
          "unassignmentOperation": "removeFromTarget",
          "value": [
            "employee"
          ]
        }
```

```
      ],
      "_rev": "00000000e2c8b067",
      "_id": "4038e228-7477-4b70-b059-542f30c5be19"
    }
  ],
  "roles": [
    {
      "_ref": "managed/role/a2e7a145-3d7d-4878-8b41-4d1a224ab53f",
      "_refResourceCollection": "managed/role",
      "_refResourceId": "a2e7a145-3d7d-4878-8b41-4d1a224ab53f",
      "_refProperties": {
        "_grantType": "",
        "_id": "71d12cf2-3c33-4ec8-9c66-b78c33012bbf",
        "_rev": "00000000f007a17e"
      }
    }
  ]
}
```

In this example, synchronizing the managed/user repository with the external LDAP system defined in the mapping should populate user bjensen's `employeeType` attribute in LDAP with the value `employee`.

11.10. Roles and Relationship Change Notification

Before you read this section, see "Configuring Relationship Change Notification" to understand the `notify` and `notifyRelationships` properties, and how change notification works for relationships in general. In the case of roles, the change notification configuration exists to ensure that managed users are notified when any of the relationships that link users, roles, and assignments are manipulated (that is, created, updated, or deleted).

Consider the situation where a user has role `R`. A new assignment `A` is created that references role `R`. Ultimately, we want to notify all users that have role `R` so that their reconciliation state will reflect any attributes in the new assignment `A`. We achieve this notification with the following configuration:

In the managed object schema, the `assignment` object definition has a `roles` property that includes a `resourceCollection`. The `path` of this resource collection is `managed/role` and `"notify" : true` for the resource collection:

```
{
    "name" : "assignment",
    "schema" : {
        ...
        "properties" : {
            ...
            "roles" : {
                ...
                "items" : {
                    ...
                    "resourceCollection" : [
                        {
                            "notify" : true,
                            "path" : "managed/role",
                            "label" : "Role",
                            "query" : {
                                "queryFilter" : "true",
                                "fields" : [
                                    "name"
                                ]
                            }
                        }
                    ...
}
```

With this configuration, when assignment `A` is created, with a reference to role `R`, role `R` is notified of the change. However, we still need to propagate that notification to any `users` who are `members` of role `R`. To do this, we configure the `role` object as follows:

```
{
    "name" : "role",
    "schema" : {
        ...
        "properties" : {
            ...
            "assignments" : {
                ...
                "notifyRelationships" : ["members"]
            }
    ...
}
```

When role `R` is notified of the creation of a new relationship to assignment `A`, the notification is propagated through the `assignments` property. Because `"notifyRelationships" : ["members"]` is set on the `assignments` property, the notification is propagated across role `R` to all members of role `R`.

11.11. Managed Role Script Hooks

Like any other managed object, a role has script hooks that enable you to configure role behavior. The default role definition in `conf/managed.json` includes the following script hooks:

```
{
    "name" : "role",
    "onDelete" : {
        "type" : "text/javascript",
        "file" : "roles/onDelete-roles.js"
    },
    "postCreate" : {
        "type" : "text/javascript",
        "source" : "require('roles/postOperation-roles').manageTemporalConstraints(resourceName);"
    },
    "postUpdate" : {
        "type" : "text/javascript",
        "source" : "require('roles/postOperation-roles').manageTemporalConstraints(resourceName);"
    },
    "postDelete" : {
        "type" : "text/javascript",
        "source" : "require('roles/postOperation-roles').manageTemporalConstraints(resourceName);"
    },
    ...
```

When a role is deleted, the `onDelete` script hook calls the `bin/default/script/roles/onDelete-roles.js` script.

Directly after a role is created, updated or deleted, the `postCreate`, `postUpdate`, and `postDelete` hooks call `roles/postOperation-roles`, which can be found in `bin/defaults/script/roles/postOperation-roles.js`. Depending on when this script is called, it either creates or removes the scheduled jobs required to manage temporal constraints on roles.

Chapter 12

Configuring Social Identity Providers

IDM provides a standards-based solution for social authentication requirements, based on the OAuth 2.0 and OpenID Connect 1.0 standards. They are similar, as OpenID Connect 1.0 is an authentication layer built on OAuth 2.0.

This chapter describes how to configure IDM to register and authenticate users with multiple social identity providers.

To configure different social identity providers, you'll take the same general steps:

- Set up the provider. You'll need information such as a `Client ID` and `Client Secret` to set up an interface with IDM.
- Configure the provider on IDM.
- Set up User Registration. Activate `Social Registration` in the applicable Admin UI screen or configuration file.
- After configuration is complete, test the result. For a common basic procedure, see "Testing Social Identity Providers".

You can configure how IDM handles authentication using social identity providers by opening the Admin UI and selecting Configure > Authentication > Modules > Social Providers. The Social Providers authentication module is enabled by default. For more information, see "Configuring the Social Providers Authentication Module".

To understand how data is transmitted between IDM and a social identity provider, read "OpenID Connect Authorization Code Flow".

Note

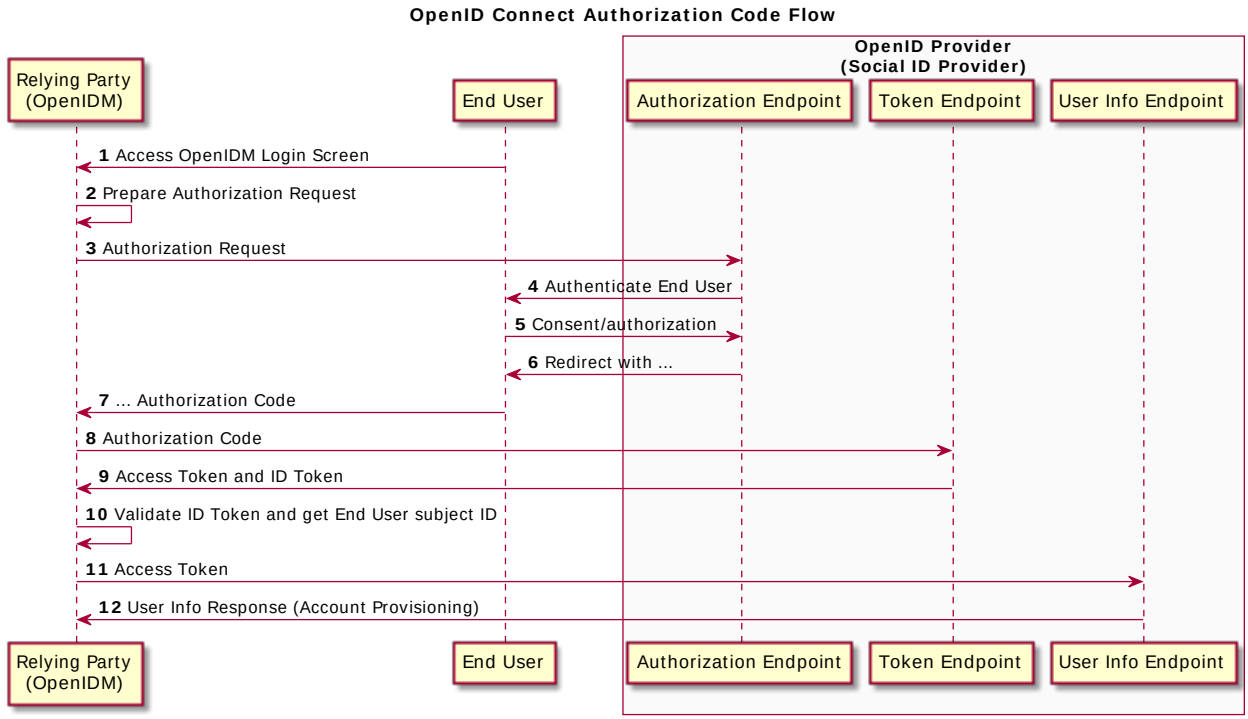
For all social identity providers, set up a FQDN for IDM, along with information in a DNS server, or system `hosts` files. For test purposes, FQDNs that comply with RFC 2606, such as `localhost` and `openidm.example.com`, are acceptable.

12.1. OpenID Connect Authorization Code Flow

The OpenID Connect Authorization Code Flow specifies how IDM (Relying Party) interacts with the OpenID Provider (Social ID Provider), based on the use of the OAuth 2.0 authorization grant. The following sequence diagram illustrates successful processing from the authorization request, through

grant of the authorization code, access token, ID token, and provisioning from the social identity provider to IDM.

OpenID Connect Authorization Code Flow for Social ID Providers



The following list describes details of each item in the authorization flow:

1. A user navigates to the IDM End User UI, and selects the `Sign In` link for the desired social identity provider.
2. IDM prepares an authorization request.
3. IDM sends the request to the Authorization Endpoint that you configured for the social identity provider, with a Client ID.
4. The social identity provider requests end user authentication and consent.
5. The end user transmits authentication and consent.
6. The social identity provider sends a redirect message, with an authorization code, to the end user's browser. The redirect message goes to an `oauthReturn` endpoint, configured in `ui.context-oauth.json` in your project's `conf/` directory.

When you configure a social identity provider, you'll find the endpoint in the applicable configuration file with the following property: `redirectUri`.

7. The browser transmits the redirect message, with the authorization code, to IDM.
8. IDM records the authorization code, and sends it to the social identity provider Token Endpoint.
9. The social identity provider token endpoint returns access and ID tokens.
10. IDM validates the token, and sends it to the social identity provider User Info Endpoint.
11. The social identity provider responds with information on the user's account, that IDM can provision as a new Managed User.

You'll configure these credentials and endpoints, in some form, for each social identity provider.

12.2. Many Social Identity Providers, One Schema

Most social identity providers include common properties, such as name, email address, icon configuration, and location.

IDM includes two sets of property maps that translate information from a social identity provider to your managed user objects. These property maps are as follows:

- The `identityProviders.json` file includes a `propertyMap` code block for each supported provider. This file maps properties from the provider to a generic managed user object. You should not customize this file.
- The `selfservice.propertymap.json` file translates the generic managed user properties to the managed user schema that you have defined in `managed.json`. If you have customized the managed user schema, this is the file that you must change, to indicate how your custom schema maps to the generic managed user schema.

Examine the `identityProviders.json` file in the `conf/` subdirectory for your project. The following excerpt represents the Facebook `propertyMap` code block from that file:

```
"propertyMap" : [
   {
      "source" : "id",
      "target" : "id"
   },
   {
      "source" : "name",
      "target" : "displayName"
   },
   {
      "source" : "first_name",
      "target" : "givenName"
   },
   {
      "source" : "last_name",
      "target" : "familyName"
   },
   {
      "source" : "email",
      "target" : "email"
   },
   {
      "source" : "email",
      "target" : "username"
   },
   {
      "source" : "locale",
      "target" : "locale"
   }
]
```

The source lists the Facebook property, the target lists the corresponding property for a generic managed user.

IDM then processes that information through the `selfservice.propertymap.json` file, where the source corresponds to the generic managed user and the target corresponds to your customized managed user schema (defined in your project's `managed.json` file).

```
{
   "properties" : [
      {
         "source" : "givenName",
         "target" : "givenName"
      },
      {
         "source" : "familyName",
         "target" : "sn"
      },
      {
         "source" : "email",
         "target" : "mail"
      },
      {
         "source" : "postalAddress",
         "target" : "postalAddress",
         "condition" : "/object/postalAddress  pr"
      },
```

```
      {
         "source" : "addressLocality",
         "target" : "city",
         "condition" : "/object/addressLocality  pr"
      },
      {
         "source" : "addressRegion",
         "target" : "stateProvince",
         "condition" : "/object/addressRegion  pr"
      },
      {
         "source" : "postalCode",
         "target" : "postalCode",
         "condition" : "/object/postalCode  pr"
      },
      {
         "source" : "country",
         "target" : "country",
         "condition" : "/object/country  pr"
      },
      {
         "source" : "phone",
         "target" : "telephoneNumber",
         "condition" : "/object/phone  pr"
      },
      {
         "source" : "username",
         "target" : "userName"
      }
   ]
}
```

Tip

To take additional information from a social identity provider, make sure the property is mapped through the `identityProviders.json` and `selfservice.propertymap.json` files.

Several of the property mappings include a `pr` presence expression which is a filter that returns all records with the given attribute. For more information, see "Presence Expressions".

12.3. Setting Up Google as a Social Identity Provider

Take the following basic steps to configure Google as a social identity provider for IDM:

- "Setting Up Google".
- "Configuring a Google Social Identity Provider".
- "Configuring User Registration to Link to Google".

12.3.1. Setting Up Google

To set up Google as a social identity provider, navigate to the *Google API Manager*. You'll need a Google account. If you have GMail, you already have a Google account. While you could use a personal Google account, it is best to use an organizational account to avoid problems if specific individuals leave your organization. When you set up a Google social identity provider, you'll need to perform the following tasks:

Plan ahead. It may take some time before the `Google+` API that you configure for IDM is ready for use.

- In the Google API Manager, select and enable the `Google+` API. It is one of the Google "social" APIs.
- Create a project for IDM.
- Create OAuth client ID credentials. You'll need to configure an `OAuth consent screen` with at least a product name and email address.
- When you set up a Web application for the client ID, you'll need to set up a web client with:
  - `Authorized JavaScript origins`

    The origin URL for IDM, typically a URL such as `https://openidm.example.com:8443`
  - `Authorized redirect URIs`

    The redirect URI after users are authenticated, typically, `https://openidm.example.com:8443/`
- In the list of credentials, you'll see a unique `Client ID` and `Client secret`. You'll need this information when you configure the Google social identity provider, as described in "Configuring a Google Social Identity Provider".

For Google's procedure, see the Google Identity Platform documentation on *Setting Up OAuth 2.0*.

12.3.2. Configuring a Google Social Identity Provider

1. To configure a Google social identity provider, log into the Admin UI and navigate to Configure > Social ID Providers.
2. Enable the Google social identity provider, and if needed, select the edit icon.
3. Include the Google values for `Client ID` and `Client Secret` for your project, as described earlier in this section.
4. Under regular and `Advanced Options`, include the options shown in the following appendix: "Google Social Identity Provider Configuration Details".

When you enable a Google social identity provider in the Admin UI, IDM generates the `identityProvider-google.json` file in your project's `conf/` subdirectory.

When you review that file, you should see information from what you configured in the Admin UI, and beyond. The first part of the file includes the name of the provider, endpoints, as well as the values for `clientId` and `clientSecret`.

```
{
    "enabled" : true,
    "authorizationEndpoint" : "https://accounts.google.com/o/oauth2/v2/auth",
    "tokenEndpoint" : "https://www.googleapis.com/oauth2/v4/token",
    "userInfoEndpoint" : "https://www.googleapis.com/oauth2/v3/userinfo",
    "wellKnownEndpoint" : "https://accounts.google.com/.well-known/openid-configuration"
    "clientId" : "<someUUID>",
    "clientSecret" : {
        "$crypto" : {
            "type" : "x-simple-encryption",
            "value" : {
               "cipher" : "AES/CBC/PKCS5Padding",
               "stableId" : "openidm-sym-default",
               "salt" : "<hashValue>",
               "data" : "<encryptedValue>",
               "keySize" : 16,
               "purpose" : "idm.config.encryption",
               "iv" : "<encryptedValue>",
               "mac" : "<hashValue>"
            }
        }
    },
...
```

You should also see UI settings related to the social identity provider icon (badge) and the sign-in button, described in "Social Identity Provider Button and Badge Properties".

You'll see links related to the `authenticationIdKey`, `redirectUri`, `scopes`, and `configClass`; the location may vary.

The file includes `schema` information, which includes properties for each social identity account, as collected by IDM, as well as the order in which it appears in the Admin UI. When you've registered a user with a Google social identity, you can verify this by selecting Manage > Google, and then selecting a user.

Another part of the file includes a `propertyMap`, which maps user information entries between the `source` (social identity provider) and the `target` (IDM).

If you need more information about the properties in this file, refer to the following appendix: "Google Social Identity Provider Configuration Details".

12.3.3. Configuring User Registration to Link to Google

Once you've configured the Google social identity provider, you can activate it through User Registration. To do so in the Admin UI, select Configure > User Registration, and under the Social tab, enable the option associated with Social Registration. For more information on user self-service features, see "*Configuring User Self-Service*".

When you enable social registration, you're allowing users to register on IDM through all active social identity providers.

12.4. Setting Up LinkedIn as a Social Identity Provider

As suggested in the introduction to this chapter, you'll need to take the following basic steps to configure LinkedIn as a social identity provider for IDM:

- "Setting Up LinkedIn".
- "Configuring a LinkedIn Social Identity Provider".
- "Configuring User Registration With LinkedIn".

12.4.1. Setting Up LinkedIn

To set up LinkedIn as a social identity provider, navigate to the *LinkedIn Developers* page for `My Applications`. You'll need a LinkedIn account. While you could use a personal LinkedIn account, it is best to use an organizational account to avoid problems if specific individuals leave your organization. When you set up a LinkedIn social identity provider, you'll need to perform the following tasks:

- In the LinkedIn Developers page for My Applications, select Create Application.
- You'll need to include the following information when creating an application:
  - Company Name
  - Application Name
  - Description
  - Application Logo
  - Application Use
  - Website URL
  - Business Email
  - Business Phone
- When you see Authentication Keys for your LinkedIn application, save the `Client ID` and `Client Secret`.
- Enable the following default application permissions:
  - `r_basicprofile`

  - `r_emailaddress`

- When you set up a Web application for the client ID, you'll need to set up a web client with OAuth 2.0 Authorized Redirect URLs. For example, if your IDM FQDN is `openidm.example.com`, add the following URL:

  - `http://openidm.example.com:8080/`

  You can ignore any LinkedIn URL boxes related to OAuth 1.0a.

For LinkedIn's procedure, see their documentation on *Authenticating with OAuth 2.0*.

12.4.2. Configuring a LinkedIn Social Identity Provider

1. To configure a LinkedIn social identity provider, log into the Admin UI and navigate to Configure > Social ID Providers.

2. Enable the LinkedIn social identity provider.

3. Include the values that LinkedIn created for `Client ID` and `Client Secret`, as described in "Setting Up LinkedIn".

4. Under regular and `Advanced Options`, include the options shown in the following appendix: "LinkedIn Social Identity Provider Configuration Details".

When you enable a LinkedIn social identity provider, IDM generates the `identityProvider-linkedIn.json` file in your project's `conf/` subdirectory.

When you review that file, you should see information beyond what you see in the Admin UI. The first part of the file includes the name of the provider, endpoints, as well as the values for `clientId` and `clientSecret`.

```
{
   "provider" : "linkedIn",
   "authorizationEndpoint" : "https://www.linkedin.com/oauth/v2/authorization",
   "tokenEndpoint" : "https://www.linkedin.com/oauth/v2/accessToken",
   "userInfoEndpoint" : "https://api.linkedin.com/v1/people/~:(id,formatted-name,first-name,last-
name,email-address,location)?format=json"
   "provider" : "linkedIn",
   "clientId" : "<someUUID>",
   "clientSecret" : {
       "$crypto" : {
           "type" : "x-simple-encryption",
           "value" : {
               "cipher" : "AES/CBC/PKCS5Padding",
               "stableId" : "openidm-sym-default",
               "salt" : "<hashValue>",
               "data" : "<encryptedValue>",
               "keySize" : 16,
               "purpose" : "idm.config.encryption",
               "iv" : "<encryptedValue>",
               "mac" : "<hashValue>"
           }
       }
   },
   "scope" : [
       "r_basicprofile",
       "r_emailaddress"
   ],
...
```

You should also see UI settings related to the social identity provider icon (badge) and the sign-in button, described in "Social Identity Provider Button and Badge Properties".

You'll see links related to the `authenticationIdKey`, `redirectUri`, and `configClass`; the location may vary.

Another part of the file includes a `propertyMap`, which maps user information entries between the `source` (social identity provider) and the `target` (IDM).

The file includes `schema` information, which includes properties for each social identity account, as collected by IDM, as well as the order in which it appears in the Admin UI. When you've registered a user with a LinkedIn social identity, you can verify this by selecting Manage > LinkedIn, and then selecting a user.

If you need more information about the properties in this file, refer to the following appendix: "LinkedIn Social Identity Provider Configuration Details".

12.4.3. Configuring User Registration With LinkedIn

Once you've configured the LinkedIn social identity provider, you can activate it through User Registration. To do so in the Admin UI, select Configure > User Registration. Under the Social tab, enable the option associated with Social Registration. For more information about user self-service features, see "*Configuring User Self-Service*".

When you enable social registration, you're allowing users to register on IDM through all active social identity providers.

12.5. Setting Up Facebook as a Social Identity Provider

As suggested in the introduction to this chapter, you'll need to take the following basic steps to configure Facebook as a social identity provider for IDM:

- "Setting Up Facebook"
- "Configuring a Facebook Social Identity Provider"
- "Configuring User Registration to Link to Facebook"

Note

As of October 2018, Facebook as a social identity provider requires access over secure HTTP (HTTPS).

12.5.1. Setting Up Facebook

To set up Facebook as a social identity provider, navigate to the *Facebook for Developers* page. You'll need a Facebook account. While you could use a personal Facebook account, it is best to use an organizational account to avoid problems if specific individuals leave your organization. When you set up a Facebook social identity provider, you'll need to perform the following tasks:

- In the Facebook for Developers page, select My Apps and Add a New App. For IDM, you'll create a `Website` application.
- You'll need to include the following information when creating a Facebook website application:
  - Display Name
  - Contact Email
  - IDM URL
- When complete, you should see your App. Navigate to Basic Settings.
- Make a copy of the `App ID` and `App Secret` for when you configure the Facebook social identity provider in IDM.
- In the settings for your App, you should see an entry for `App Domains`, such as `example.com`, as well as a Website Site URL, such as `https://idm.example.com/`.

For Facebook's documentation on the subject, see *Facebook Login for the Web with the JavaScript SDK*.

12.5.2. Configuring a Facebook Social Identity Provider

1. To configure a Facebook social identity provider, log into the Admin UI and navigate to Configure > Social ID Providers.
2. Enable the Facebook social identity provider.
3. Include the values that Facebook created for `App ID` and `App Secret`, as described in "Setting Up Facebook".
4. Under regular and `Advanced Options`, include the options shown in the following appendix: "Facebook Social Identity Provider Configuration Details".

When you enable a Facebook social identity provider in the Admin UI, IDM generates the `identityProvider-facebook.json` file in your project's `conf/` subdirectory.

It includes parts of the file that you may have configured through the Admin UI. While the labels in the UI specify App ID and App Secret, you'll see them as `clientId` and `clientSecret`, respectively, in the configuration file.

```
{
   "provider" : "facebook",
   "authorizationEndpoint" : "https://www.facebook.com/dialog/oauth",
   "tokenEndpoint" : "https://graph.facebook.com/v2.7/oauth/access_token",
   "userInfoEndpoint" : "https://graph.facebook.com/me?
fields=id,name,picture,email,first_name,last_name,locale"
   "clientId" : "<someUUID>",
   "clientSecret" : {
       "$crypto" : {
           "type" : "x-simple-encryption",
           "value" : {
             "cipher" : "AES/CBC/PKCS5Padding",
             "stableId" : "openidm-sym-default",
             "salt" : "<hashValue>",
             "data" : "<encryptedValue>",
             "keySize" : 16,
             "purpose" : "idm.config.encryption",
             "iv" : "<encryptedValue>",
             "mac" : "<hashValue>"
           }
       }
   },
   "scope" : [
       "email",
       "user_birthday"
   ],
...
```

You should also see UI settings related to the social identity provider icon (badge) and the sign-in button, described in "Social Identity Provider Button and Badge Properties".

You'll see links related to the `authenticationIdKey`, `redirectUri`, and `configClass`; the location may vary.

The file includes `schema` information, which includes properties for each social identity account, as collected by IDM, as well as the order in which it appears in the Admin UI. When you've registered a

user with a Facebook social identity, you can verify this by selecting Manage > Facebook, and then selecting a user.

Another part of the file includes a `propertyMap`, which maps user information entries between the `source` (social identity provider) and the `target` (IDM).

If you need more information about the properties in this file, refer to the following appendix: "Facebook Social Identity Provider Configuration Details".

12.5.3. Configuring User Registration to Link to Facebook

Once you've configured the Facebook social identity provider, you can activate it through User Registration. To do so in the Admin UI, select Configure > User Registration, and under the Social tab, enable the option associated with Social Registration. For more information about user self-service features, see "*Configuring User Self-Service*".

When you enable social registration, you're allowing users to register on IDM through all active social identity providers.

12.6. Setting Up Amazon as an IDM Social Identity Provider

As suggested in the introduction to this chapter, you'll need to take the following basic steps to configure Amazon as a social identity provider for IDM:

- "Setting Up Amazon"
- "Configuring an Amazon Social Identity Provider"
- "Configuring User Registration to Link to Amazon"

Note

Amazon as a social identity provider requires access over secure HTTP (HTTPS).

12.6.1. Setting Up Amazon

To set up Amazon as a social identity provider, navigate to the following Amazon page: *Register Your Website With Login With Amazon* . You'll need an Amazon account. You'll also need to register a security profile.

When you set up Amazon as a social identity provider, navigate to the Amazon *Security Profile Management* page. You'll need to enter the following:

- Security Profile Name (The name of your app)

- Security Profile Description
- Consent Privacy Notice URL
- Consent Logo Image (optional)

When complete and saved, you should see a list of security profiles with `OAuth2` credentials. You should be able to find the `Client ID` and `Client Secret` from this screen.

However, you still need to configure the web settings for your new Security Profile. You can find a list of your existing Security Profiles on the *Login with Amazon Developer Console Page* . You can access that page from the Amazon Developer Console dashboard by selecting Apps and Services > Login with Amazon. You can then `Manage` the `Web Settings` for that app.

In the `Web Settings` for your app, you'll need to set either of the following properties:

- Allowed Origins, which should match the URL for your registration page, such as `https://openidm.example.com:8443`
- Allowed Return URLs, which should match the redirect URIs described in "Configuring an Amazon Social Identity Provider". You may see URIs such as `https://openidm.example.com:8443/`.

12.6.2. Configuring an Amazon Social Identity Provider

1. To configure an Amazon social identity provider, log into the Admin UI and navigate to Configure > Social ID Providers.
2. Enable the Amazon social identity provider.

   In the `Amazon Provider` pop-up that appears, the values for `Redirect URI` should match the values that you've entered for Allowed Return URLs in "Setting Up Amazon".
3. Include the values that Amazon created for `Client ID` and `Client Secret`, as described in "Setting Up Amazon".
4. Under regular and `Advanced Options`, include the options shown in the following appendix: "Amazon Social Identity Provider Configuration Details".

When you enable an Amazon social identity provider in the Admin UI, IDM generates the `identityProvider-amazon.json` file in your project's `conf/` subdirectory.

When you review that file, you should see information beyond what you see in the Admin UI. The first part of the file includes the name of the provider, endpoints, as well as the values for `clientId` and `clientSecret`.

```
{
   "provider" : "amazon",
   "authorizationEndpoint" : "https://www.amazon.com/ap/oa",
   "tokenEndpoint" : "https://api.amazon.com/auth/o2/token",
   "userInfoEndpoint" : "https://api.amazon.com/user/profile"
   "enabled" : true,
   "clientId" : "<someUUID>",
   "clientSecret" : {
       "$crypto" : {
           "type" : "x-simple-encryption",
           "value" : {
               "cipher" : "AES/CBC/PKCS5Padding",
               "stableId" : "openidm-sym-default",
               "salt" : "<hashValue>",
               "data" : "<encryptedValue>",
               "keySize" : 16,
               "purpose" : "idm.config.encryption",
               "iv" : "<encryptedValue>",
               "mac" : "<hashValue>"
           }
       }
   },
   "scope" : [
       "profile"
   ],
...
```

You should also see UI settings related to the social identity provider icon (badge) and the sign-in button, described in "Social Identity Provider Button and Badge Properties".

You'll see links related to the `authenticationIdKey`, `redirectUri`, and `configClass`; the location may vary.

The file includes `schema` information, which includes properties for each social identity account, as collected by IDM, as well as the order in which it appears in the Admin UI. When you've registered a user with an Amazon social identity, you can verify this by selecting Manage > Amazon, and then selecting a user.

Another part of the file includes a `propertyMap`, which maps user information entries between the `source` (social identity provider) and the `target` (IDM).

If you need more information about the properties in this file, refer to the following appendix: "Amazon Social Identity Provider Configuration Details".

12.6.3. Configuring User Registration to Link to Amazon

Once you've configured the Amazon social identity provider, you can activate it through User Registration. To do so in the Admin UI, select Configure > User Registration, and activate that feature. Under the Social tab that appears, enable Social Registration. For more information on IDM user self-service features, see "*Configuring User Self-Service*".

When you enable Social Registration, you're allowing users to register on IDM through all active social identity providers.

12.7. Setting Up Microsoft as an IDM Social Identity Provider

As suggested in the introduction to this chapter, you'll need to take the following basic steps to configure Microsoft as a social identity provider for IDM:

- "Setting Up Microsoft"
- "Configuring a Microsoft Social Identity Provider"
- "Configuring User Registration to Link to Microsoft"

Note

Microsoft as a social identity provider requires access over secure HTTP (HTTPS). This example assumes that you've configured IDM on `https://openidm.example.com:8443`. Substitute your URL for `openidm.example.com`.

12.7.1. Setting Up Microsoft

For Microsoft documentation on how to set up a social identity provider, navigate to the following article: *Sign-in Microsoft Account & Azure AD users in a single app* . You'll need a Microsoft account.

To set up Microsoft as a social identity provider:

- Navigate to the Microsoft app registration portal at https://apps.dev.microsoft.com/ and sign in with your Microsoft account.
- Select *Add an App* and give your app a name.

  The portal will assign your app a unique `Application ID`.
- To find your `Application Secret`, select *Generate New Password*. That password is your Application Secret.

  Tip

  Save your new password. It is the only time you'll see the `Application Secret` for your new app.

- Select Add Platform. You'll choose a `Web` platform, enable `Allow Implicit Flow` and set up the following value for `Redirect URI`:
  - `https://openidm.example.com:8443/`

If desired, you can also enter the following information:

- Logo image
- Terms of Service URL
- Privacy Statement URL

The `OAuth2` credentials for your new Microsoft App include an `Application ID` and `Application Secret` for your app.

12.7.2. Configuring a Microsoft Social Identity Provider

1. To configure a Microsoft social identity provider, log into the Admin UI and navigate to Configure > Social ID Providers.
2. Enable the Microsoft social identity provider.

   In the `Microsoft Provider` pop-up that appears, the values for `Redirect URI` should match the values that you've entered for Allowed Return URLs in "Setting Up Microsoft".
3. Include the values that Microsoft created for `Client ID` and `Client Secret`, as described in "Setting Up Microsoft".
4. Under regular and `Advanced Options`, include the options shown in the following appendix: "Microsoft Social Identity Provider Configuration Details".

When you enable a Microsoft social identity provider in the Admin UI, IDM generates the `identityProvider-microsoft.json` file in your project's `conf/` subdirectory.

It includes parts of the file that you may have configured through the Admin UI. While the labels in the UI specify Application ID and Application Secret, you'll see them as `clientId` and `clientSecret`, respectively, in the configuration file.

```
"provider" : "microsoft",
   "authorizationEndpoint" : "https://login.microsoftonline.com/common/oauth2/v2.0/authorize",
   "tokenEndpoint" : "https://login.microsoftonline.com/common/oauth2/v2.0/token",
   "userInfoEndpoint" : "https://graph.microsoft.com/v1.0/me"
   "clientId" : "<someUUID>",
   "clientSecret" : {
       "$crypto" : {
           "type" : "x-simple-encryption",
           "value" : {
               "cipher" : "AES/CBC/PKCS5Padding",
               "stableId" : "openidm-sym-default",
               "salt" : "<hashValue>",
               "data" : "<encryptedValue>",
               "keySize" : 16,
               "purpose" : "idm.config.encryption",
               "iv" : "<encryptedValue>",
               "mac" : "<hashValue>"
           }
       }
   },
   "scope" : [
       "User.Read"
   ],
...
```

You should also see UI settings related to the social identity provider icon (badge) and the sign-in button, described in "Social Identity Provider Button and Badge Properties".

You'll see links related to the `authenticationIdKey`, `redirectUri`, and `configClass`; the location may vary.

The file includes `schema` information, which includes properties for each social identity account, as collected by IDM, as well as the order in which it appears in the Admin UI. When you've registered a user with a Microsoft social identity, you can verify this by selecting Manage > Microsoft, and then selecting a user.

Another part of the file includes a `propertyMap`, which maps user information entries between the `source` (social identity provider) and the `target` (IDM).

If you need more information about the properties in this file, refer to the following appendix: "Microsoft Social Identity Provider Configuration Details".

12.7.3. Configuring User Registration to Link to Microsoft

Once you've configured the Microsoft social identity provider, you can activate it through User Registration. To do so in the Admin UI, select Configure > User Registration, and activate that feature. Under the Social tab that appears, enable Social Registration. For more information on IDM user self-service features, see "*Configuring User Self-Service*".

When you enable Social Registration, you're allowing users to register on IDM through all active social identity providers.

12.8. Setting Up WordPress as an IDM Social Identity Provider

As suggested in the introduction to this chapter, you'll need to take the following basic steps to configure WordPress as a social identity provider for IDM:

- "Setting Up WordPress"
- "Configuring a WordPress Social Identity Provider"
- "Configuring User Registration to Link to WordPress"

12.8.1. Setting Up WordPress

To set up WordPress as a social identity provider, navigate to the following WordPress Developers page: *Developer Resources* . You'll need a WordPress account. You can then navigate to the WordPress *My Applications* page, where you can create a new web application, with the following information:

- Name
- Description
- Website URL, which becomes your Application URL
- Redirect URL(s); for IDM, normally `http://openidm.example.com:8080/`

- Type, which allows you to select Web clients

When complete and saved, you should see a list of `OAuth Information` for your new web application. That information should include your `Client ID` and `Client Secret`.

12.8.2. Configuring a WordPress Social Identity Provider

1. To configure a WordPress social identity provider, log into the Admin UI and navigate to Configure > Social ID Providers.
2. Enable the WordPress social identity provider.

   In the `WordPress Provider` pop-up that appears, the values for `Redirect URI` should match the values that you've entered for Allowed Return URLs in "Setting Up WordPress".
3. Include the values that WordPress created for `Client ID` and `Client Secret`, as described in "Setting Up WordPress".
4. Under regular and `Advanced Options`, include the options shown in the following appendix: "WordPress Social Identity Provider Configuration Details".

When you enable a WordPress social identity provider in the Admin UI, IDM generates the `identityProvider-wordpress.json` file in your project's `conf/` subdirectory.

When you review that file, you should see information beyond what you see in the Admin UI. The first part of the file includes the name of the provider, endpoints, as well as the values for `clientId` and `clientSecret`.

```
{
    "provider" : "wordpress",
    "authorizationEndpoint" : "https://public-api.wordpress.com/oauth2/authorize",
    "tokenEndpoint" : "https://public-api.wordpress.com/oauth2/token",
    "userInfoEndpoint" : "https://public-api.wordpress.com/rest/v1.1/me/",
    "enabled" : true,
    "clientId" : "<someUUID>",
    "clientSecret" : {
       "$crypto" : {
           "type" : "x-simple-encryption",
           "value" : {
               "cipher" : "AES/CBC/PKCS5Padding",
               "stableId" : "openidm-sym-default",
               "salt" : "<hashValue>",
               "data" : "<encryptedValue>",
               "keySize" : 16,
               "purpose" : "idm.config.encryption",
               "iv" : "<encryptedValue>",
               "mac" : "<hashValue>"
           }
       }
    },
    "scope" : [
        "auth"
    ],
...
```

You should also see UI settings related to the social identity provider icon (badge) and the sign-in button, described in "Social Identity Provider Button and Badge Properties".

You'll see links related to the `authenticationIdKey`, `redirectUri`, and `configClass`; the location may vary.

The file includes `schema` information, which includes properties for each social identity account, as collected by IDM, as well as the order in which it appears in the Admin UI. When you've registered a user with a Wordpress social identity, you can verify this by selecting Manage > Wordpress, and then selecting a user.

Another part of the file includes a `propertyMap`, which maps user information entries between the `source` (social identity provider) and the `target` (IDM).

If you need more information about the properties in this file, refer to the following appendix: "WordPress Social Identity Provider Configuration Details".

12.8.3. Configuring User Registration to Link to WordPress

Once you've configured the WordPress social identity provider, you can activate it through User Registration. To do so in the Admin UI, select Configure > User Registration, and activate that feature. Under the Social tab that appears, enable Social Registration. For more information on IDM user self-service features, see "*Configuring User Self-Service*".

When you enable Social Registration, you're allowing users to register on IDM through all active social identity providers.

12.9. Setting Up WeChat as an IDM Social Identity Provider

As suggested in the introduction to this chapter, you'll need to take the following basic steps to configure WeChat as a social identity provider for IDM:

- "Setting Up WeChat"
- "Configuring a WeChat Social Identity Provider"
- "Configuring User Registration to Link to WeChat"

These requirements assume that you have a WeChat developer account where you can get access to create WeChat web application credentials. To verify access, you'll need the WeChat app on your mobile phone.

12.9.1. Setting Up WeChat

To set up WeChat as a social identity provider, you'll need to get the following information for your WeChat app. The name may be different in WeChat.

- Client ID (WeChat uses `appid` as of this writing.)
- Client Secret (WeChat uses `secret` as of this writing.)
- Scope
- Authorization Endpoint URL
- Token Endpoint URL
- User Info Endpoint URL
- Redirect URI, normally something like `http://openidm.example.com/`

WeChat Unique Requirements

Before testing WeChat, be prepared for the following special requirements:

- WeChat works only if you deploy IDM on one of the following ports: *80* or *443*.

  For more information on how to configure IDM to use these ports, see "*Host and Port Information*".
- For registration and sign-in, WeChat requires the use of a mobile device with a Quick Response (QR) code reader.
- For sign-in, you'll also need to install the WeChat app on your mobile device.

12.9.2. Configuring a WeChat Social Identity Provider

1. To configure a WeChat social identity provider, log into the Admin UI and navigate to Configure > Social ID Providers.
2. Enable the WeChat social identity provider.

   In the `WeChat Provider` pop-up that appears, the values for `Redirect URI` should match the values that you've entered for Allowed Return URLs in "Setting Up WeChat".
3. Include the values that WeChat created for `Client ID` and `Client Secret`, as described in "Setting Up WeChat".
4. Under regular and `Advanced Options`, include the options shown in the following appendix: "WeChat Social Identity Provider Configuration Details".

When you enable a WeChat social identity provider in the Admin UI, IDM generates the `identityProvider-wechat.json` file in your project's `conf/` subdirectory.

When you review that file, you should see information from what you configured in the Admin UI, and beyond. The first part of the file includes the name of the provider, endpoints, scopes, as well as the values for `clientId` and `clientSecret`.

```
{
    "provider" : "wechat",
    ...
    "clientId" : "<someUUID>",
    "clientSecret" : {
       "$crypto" : {
           "type" : "x-simple-encryption",
              "value" : {
                "cipher" : "AES/CBC/PKCS5Padding",
                "stableId" : "openidm-sym-default",
                "salt" : "<hashValue>",
                "data" : "<encryptedValue>",
                "keySize" : 16,
                "purpose" : "idm.config.encryption",
                "iv" : "<encryptedValue>",
                "mac" : "<hashValue>"
           }
       }
    },
    "authorizationEndpoint" : "https://open.weixin.qq.com/connect/qrconnect",
    "tokenEndpoint" : "https://api.wechat.com/sns/oauth2/access_token",
    "refreshTokenEndpoint" : "https://api.wechat.com/sns/oauth2/refresh_token",
    "userInfoEndpoint" : "https://api.wechat.com/sns/userinfo",
    "redirectUri" : "http://openidm.example.com:8080/",
    "scope" : [
        "snsapi_login"
    ],
...
```

You should also see UI settings related to the social identity provider icon (badge) and the sign-in button, described in "Social Identity Provider Button and Badge Properties".

You'll see links related to the `authenticationIdKey`, `redirectUri`, and `configClass`; the location may vary.

The file includes `schema` information, which includes properties for each social identity account, as collected by IDM, as well as the order in which it appears in the Admin UI. When you've registered a user with a WeChat social identity, you can verify this by selecting Manage > WeChat, and then selecting a user.

Another part of the file includes a `propertyMap`, which maps user information entries between the `source` (social identity provider) and the `target` (IDM).

If you need more information about the properties in this file, refer to the following appendix: "WeChat Social Identity Provider Configuration Details".

12.9.3. Configuring User Registration to Link to WeChat

Once you've configured the WeChat social identity provider, you can activate it through User Registration. To do so in the Admin UI, select Configure > User Registration, and activate that feature. Under the Social tab that appears, enable Social Registration. For more information on IDM user self-service features, see "*Configuring User Self-Service*".

When you enable Social Registration, you're allowing users to register on IDM through all active social identity providers.

12.10. Setting Up Instagram as an IDM Social Identity Provider

As suggested in the introduction to this chapter, you'll need to take the following basic steps to configure Instagram as a social identity provider for IDM:

- "Setting Up Instagram"
- "Configuring an Instagram Social Identity Provider"
- "Configuring User Registration to Link to Instagram"

12.10.1. Setting Up Instagram

To set up Instagram as a social identity provider, navigate to the following page: *Instagram Developer Documentation* . You'll need an Instagram account. You can then navigate to the *Manage Clients* page, where you can follow the Instagram process to create a new web application. As of this writing, you can do so on their *Register a new Client ID* page, where you'll need the following information:

- Application Name
- Description
- Website URL for your app, such as `http://openidm.example.com:8080`
- Redirect URL(s); for IDM: `http://openidm.example.com:8080/`

When complete and saved, you should see a list of `OAuth Information` for your new webapp. That information should be included in your `Client ID` and `Client Secret`.

12.10.2. Configuring an Instagram Social Identity Provider

1. To configure an Instagram social identity provider, log into the Admin UI and navigate to Configure > Social ID Providers.
2. Enable the Instagram social identity provider.

   In the `Instagram Provider` pop-up that appears, the values for `Redirect URI` should match the values that you've entered for Valid Redirect URIs in "Setting Up Instagram".
3. Include the values that Instagram created for `Client ID` and `Client Secret`, as described in "Setting Up Instagram".

4. Under regular and `Advanced Options`, include the options shown in the following appendix: "Instagram Social Identity Provider Configuration Details".

When you enable an Instagram social identity provider in the Admin UI, IDM generates the `identityProvider-instagram.json` file in your project's `conf/` subdirectory.

When you review that file, you should see information from what you configured in the Admin UI, and beyond. The first part of the file includes the name of the provider, endpoints, scopes, as well as the values for `clientId` and `clientSecret`.

```
{
   "provider" : "instagram",
   ...
   "clientId" : "<Client_ID_Name>",
   "clientSecret" : {
      "$crypto" : {
         "type" : "x-simple-encryption",
         "value" : {
            "cipher" : "AES/CBC/PKCS5Padding",
            "stableId" : "openidm-sym-default",
            "salt" : "<hashValue>",
            "data" : "<encryptedValue>",
            "keySize" : 16,
            "purpose" : "idm.config.encryption",
            "iv" : "<encryptedValue>",
            "mac" : "<hashValue>"
         }
      }
   },
   "authorizationEndpoint" : "https://api.instagram.com/oauth/authorize/",
   "tokenEndpoint" : "https://api.instagram.com/oauth/access_token",
   "userInfoEndpoint" : "https://api.instagram.com/v1/users/self/",
   "redirectUri" : "http://openidm.example.com:8080/",
   "scope" : [
       "basic",
       "public_content"
   ],
...
```

Another part of the file includes a `propertyMap`, which maps user information entries between the `source` (social identity provider) and the `target` (IDM).

The file includes `schema` information, which includes properties for each social identity account, as collected by IDM, as well as the order in which it appears in the Admin UI. When you've registered a user with an Instagram social identity, you can verify this by selecting Manage > Instagram, and then selecting a user.

If you need more information about the properties in this file, refer to the following appendix: "Instagram Social Identity Provider Configuration Details".

12.10.3. Configuring User Registration to Link to Instagram

Once you've configured the Instagram social identity provider, you can activate it through User Registration. To do so in the Admin UI, select Configure > User Registration, and activate that

feature. Under the Social tab that appears, enable Social Registration. For more information on IDM user self-service features, see "*Configuring User Self-Service*".

When you enable Social Registration, you're allowing users to register on IDM through all active social identity providers.

12.11. Setting Up Vkontakte as an IDM Social Identity Provider

As suggested in the introduction to this chapter, you'll need to take the following basic steps to configure Vkontakte as a social identity provider for IDM:

- "Setting Up Vkontakte"
- "Configuring a Vkontakte Social Identity Provider"
- "Configuring User Registration to Link to Vkontakte"

Note

When you configure a Vkontakte app, look for an *Application ID* and a *Secure Key*. IDM uses this information as a `clientId` and `clientSecret`, respectively.

12.11.1. Setting Up Vkontakte

To set up Vkontakte as a social identity provider, navigate to the following Vkontakte page: *Vkontakte Developers Page* . You'll need a Vkontakte account. Find a *My Apps* link. You can then create an application with the following information:

- Title (The name of your app)
- Platform (Choose Website)
- Site Address (The URL of your IDM deployment, such as `http://openidm.example.com:8080/`
- Base domain (Example: `example.com`)
- Authorized Redirect URI (Example: `http://openidm.example.com:8080/`)
- API Version; for the current VKontakte API version, see *VK Developers Documentation, API Versions* section. The default VKontakte API version used for IDM 6.5 is 5.73.

If you leave and need to return to Vkontakte, navigate to `https://vk.com/dev` and select *My Apps*. You can then *Manage* the new apps that you've created.

Navigate to the *Settings* for your app, where you'll find the *Application ID* and *Secure Key* for your app. You'll use that information as shown here:

- Vkontakte Application ID = IDM Client ID
- Vkontakte Secure Key = IDM Client Secret

12.11.2. Configuring a Vkontakte Social Identity Provider

1. To configure a Vkontakte social identity provider, log into the Admin UI and navigate to Configure > Social ID Providers.
2. Enable the Vkontakte social identity provider.

   In the `Vkontakte Provider` pop-up that appears, the values for `Redirect URI` should match the values that you've entered for Authorized Redirect URI in "Setting Up Vkontakte".
3. Include the values that Vkontakte created for `Client ID` and `Client Secret`, as described in "Setting Up Vkontakte".
4. Under regular and `Advanced Options`, include the options shown in the following appendix: "Vkontakte Social Identity Provider Configuration Details".

When you enable a Vkontakte social identity provider in the Admin UI, IDM generates the `identityProvider-vkontakte.json` file in your project's `conf/` subdirectory.

When you review that file, you should see information beyond what you see in the Admin UI. The first part of the file includes the name of the provider, endpoints, as well as information from the *Consumer Key* and *Consumer Secret*, you'll see them as `clientId` and `clientSecret`, respectively, in the configuration file.

```
{
    "provider" : "vkontakte",
    "configClass" : "org.forgerock.oauth.clients.vk.VKClientConfiguration",
    "basicAuth" : false,
    "clientId" : "<someUUID>",
    "clientSecret" : {
        "$crypto" : {
            "type" : "x-simple-encryption",
            "value" : {
                "cipher" : "AES/CBC/PKCS5Padding",
                "stableId" : "openidm-sym-default",
                "salt" : "<hashValue>",
                "data" : "<encryptedValue>",
                "keySize" : 16,
                "purpose" : "idm.config.encryption",
                "iv" : "<encryptedValue>",
                "mac" : "<hashValue>"
            }
        }
    },
    "authorizationEndpoint" : "https://oauth.vk.com/authorize",
    "tokenEndpoint" : "https://oauth.vk.com/access_token",
    "userInfoEndpoint" : "https://api.vk.com/method/users.get",
    "redirectUri" : "http://openidm.example.com:8080/",
    "apiVersion" : "5.73",
    "scope" : [
        "email"
    ],
...
```

You should also see UI settings related to the social identity provider icon (badge) and the sign-in button, described in "Social Identity Provider Button and Badge Properties".

You'll see links related to the `authenticationIdKey`, `redirectUri`, and `configClass`; the location may vary.

The file includes `schema` information, which includes properties for each social identity account, as collected by IDM, as well as the order in which it appears in the Admin UI. When you've registered a user with a Vkontakte social identity, you can verify this by selecting Manage > Vkontakte, and then selecting a user.

Another part of the file includes a `propertyMap`, which maps user information entries between the `source` (social identity provider) and the `target` (IDM).

If you need more information about the properties in this file, refer to the following appendix: "Vkontakte Social Identity Provider Configuration Details".

12.11.3. Configuring User Registration to Link to Vkontakte

Once you've configured the Vkontakte social identity provider, you can activate it through User Registration. To do so in the Admin UI, select Configure > User Registration, and activate that feature. Under the Social tab that appears, enable Social Registration. For more information on IDM user self-service features, see "*Configuring User Self-Service*".

When you enable Social Registration, you're allowing users to register on IDM through all active social identity providers.

12.12. Setting Up Salesforce as an IDM Social Identity Provider

As suggested in the introduction to this chapter, you'll need to take the following basic steps to configure Salesforce as a social identity provider for IDM:

- "Setting Up Salesforce"
- "Configuring a Salesforce Social Identity Provider"
- "Configuring User Registration to Link to Salesforce"

Note

When you configure a Salesforce app, look for a *Consumer Key* and a *Consumer Secret*. IDM uses this information as a `clientId` and `clientSecret`, respectively.

For reference, read through the following Salesforce documentation: *Connected Apps Overview*.

12.12.1. Setting Up Salesforce

To set up Salesforce as a social identity provider, you will need a Salesforce developer account. Log in to the *Salesforce Developers Page* with your developer account credentials and create a new Connected App.

Note

These instructions were written with the Winter '19 Release of the Salesforce API. The menu items might differ slightly if you are working with a different version of the API.

Under App Setup, select Create > Apps > Connected Apps > New. You will need to add the following information:

- Connected App Name
- API Name (defaults to the Connected App Name)
- Contact Email
- Activate the following option: *Enable OAuth Settings*
- Callback URL (also known as the *Redirect URI* for other providers), for example `https://localhost:8443/`.

The Callback URL must correspond to the URL that you use to log in to the IDM Admin UI.

- Add the following OAuth scopes:
  - Access and Manage your data (api)
  - Access your basic information (id, profile, email, address, phone)
  - Perform requests on your behalf at any time (refresh_token, offline_access)
  - Provide access to your data via the Web (web)

  Note that these must be added even if you are otherwise planning to use the `full` OAuth scope.

After you have saved the Connected App, it might take a few minutes for the new app to appear under Administration Setup > Manage Apps > Connected Apps.

Select the new Connected App then locate the *Consumer Key* and *Consumer Secret* (under the API list). You'll use that information as shown here:

- Salesforce Consumer Key = IDM Client ID
- Salesforce Consumer Secret = IDM Client Secret

12.12.2. Configuring a Salesforce Social Identity Provider

1. To configure a Salesforce social identity provider, log into the Admin UI and navigate to Configure > Social ID Providers.
2. Enable the Salesforce social identity provider.

   In the `Salesforce Provider` pop-up that appears, the values for `Redirect URI` should match the value that you've entered for Callback URL in "Setting Up Salesforce".
3. Include the values that Salesforce created for `Consumer Key` and `Consumer Secret`, as described in "Setting Up Salesforce".
4. Under regular and `Advanced Options`, include the options shown in the following appendix: "Salesforce Social Identity Provider Configuration Details".

When you enable a Salesforce social identity provider in the Admin UI, IDM generates the `identityProvider-salesforce.json` file in your project's `conf/` subdirectory.

It includes parts of the file that you may have configured through the Admin UI. While the labels in the UI specify Consumer Key and Consumer Secret, you'll see them as `clientId` and `clientSecret`, respectively, in the configuration file.

```
{
    "provider" : "salesforce",
    "authorizationEndpoint" : "https://login.salesforce.com/services/oauth2/authorize",
    "tokenEndpoint" : "https://login.salesforce.com/services/oauth2/token",
    "userInfoEndpoint" : "https://login.salesforce.com/services/oauth2/userinfo",
    "clientId" : "<someUUID>",
    "clientSecret" : {
       "$crypto" : {
           "type" : "x-simple-encryption",
           "value" : {
               "cipher" : "AES/CBC/PKCS5Padding",
               "stableId" : "openidm-sym-default",
               "salt" : "<hashValue>",
               "data" : "<encryptedValue>",
               "keySize" : 16,
               "purpose" : "idm.config.encryption",
               "iv" : "<encryptedValue>",
               "mac" : "<hashValue>"
           }
       }
    },
    "scope" : [
        "id",
        "api",
        "web"
    ],
```

You should also see UI settings related to the social identity provider icon (badge) and the sign-in button, described in "Social Identity Provider Button and Badge Properties".

You'll see links related to the `authenticationIdKey`, `redirectUri`, and `configClass`; the location may vary.

The file includes `schema` information, which includes properties for each social identity account, as collected by IDM, as well as the order in which it appears in the Admin UI. When you've registered a user with a Salesforce social identity, you can verify this by selecting Manage > Salesforce, and then selecting a user.

Another part of the file includes a `propertyMap`, which maps user information entries between the `source` (social identity provider) and the `target` (IDM).

If you need more information about the properties in this file, refer to the following appendix: "Salesforce Social Identity Provider Configuration Details".

12.12.3. Configuring User Registration to Link to Salesforce

Once you've configured the Salesforce social identity provider, you can activate it through User Registration. To do so in the Admin UI, select Configure > User Registration, and activate that feature. Under the Social tab that appears, enable Social Registration. For more information on IDM user self-service features, see "*Configuring User Self-Service*".

When you enable Social Registration, you're allowing users to register on IDM through all active social identity providers.

12.13. Setting Up Yahoo as an IDM Social Identity Provider

As suggested in the introduction to this chapter, you'll need to take the following basic steps to configure Yahoo as a social identity provider for IDM:

- "Setting Up Yahoo"
- "Configuring Yahoo as a Social Identity Provider"
- "Configuring User Registration to Link to Yahoo"

12.13.1. Setting Up Yahoo

To set up Yahoo as a social identity provider, navigate to the following page: *Yahoo OAuth 2.0 Guide*. You'll need a Yahoo account. You can then navigate to the *Create an App* page, where you can follow the Yahoo process to create a new web application with the following information:

- Application Name
- Web Application
- Callback Domain, such as `openidm.example.com`; required for IDM
- API Permissions; for whatever you select, choose *Read/Write*. IDM only reads Yahoo user information.

When complete and saved, you should see a `Client ID` and `Client Secret` for your new web app.

Note

Yahoo supports URLs using only HTTPS, only on port 443. For more information on how to configure IDM to use these ports, see "*Host and Port Information*".

12.13.2. Configuring Yahoo as a Social Identity Provider

1. To configure Yahoo as a social identity provider, log in to the Admin UI and navigate to Configure > Social ID Providers.
2. Enable the Yahoo social identity provider.

   In the `Yahoo Provider` pop-up that appears, the values for `Redirect URI` should use the same *Callback Domain* as shown in "Setting Up Yahoo".
3. Include the values that Yahoo created for `Client ID` and `Client Secret`, as described in "Setting Up Yahoo".

4. Under regular and `Advanced Options`, if necessary, include the options shown in the following appendix: "Yahoo Social Identity Provider Configuration Details".

When you enable a Yahoo social identity provider in the Admin UI, IDM generates the `identityProvider-yahoo.json` file in your project's `conf/` subdirectory.

When you review that file, you should see information beyond what you see in the Admin UI. The first part of the file includes the name of the provider, the scope, and UI settings related to the social identity provider icon (badge) and the sign-in button. For more information on the icon and button, see "Social Identity Provider Button and Badge Properties".

```
{
    "provider" : "yahoo",
    "scope" : [
        "openid",
        "sdpp-w"
    ],
    "uiConfig" : {
        "iconBackground" : "#7B0099",
        "iconClass" : "fa-yahoo",
        "iconFontColor" : "white",
        "buttonClass" : "fa-yahoo",
        "buttonDisplayName" : "Yahoo",
        "buttonCustomStyle" : "background-color: #7B0099; border-color: #7B0099; color:white;",
        "buttonCustomStyleHover" : "background-color: #7B0099; border-color: #7B0099; color:white;"
    },
```

Another part of the file includes a `propertyMap`, which maps user information entries between the `source` (social identity provider) and the `target` (IDM).

The next part of the file includes `schema` information, which includes properties for each social identity account, as collected by IDM, as well as the order in which it appears in the Admin UI. When you've registered a user with a Yahoo social identity, you can verify this by selecting Manage > Yahoo, and then selecting a user.

Next, there's the part of the file that you may have configured through the Admin UI, plus additional information on the `redirectUri`, the `configClass`, and the `authenticationIdKey`:

```
  "authorizationEndpoint" : "https://api.login.yahoo.com/oauth2/request_auth",
  "tokenEndpoint" : "https://api.login.yahoo.com/oauth2/get_token",
  "wellKnownEndpoint" : "https://login.yahoo.com/.well-known/openid-configuration",
  "clientId" : "<Client_ID_Name>",
  "clientSecret" : {
    "$crypto" : {
      "type" : "x-simple-encryption",
      "value" : {
        "cipher" : "AES/CBC/PKCS5Padding",
        "stableId" : "openidm-sym-default",
        "salt" : "<hashValue>",
        "data" : "<encryptedValue>",
        "keySize" : 16,
        "purpose" : "idm.config.encryption",
        "iv" : "<encryptedValue>",
        "mac" : "<hashValue>"
      }
    }
  },
  "authenticationIdKey" : "sub",
  "redirectUri" : "https://openidm.example.com/",
  "basicAuth" : false,
  "configClass" : "org.forgerock.oauth.clients.oidc.OpenIDConnectClientConfiguration",
  "enabled" : true
}
```

If you need more information about the properties in this file, refer to the following appendix: "Yahoo Social Identity Provider Configuration Details".

12.13.3. Configuring User Registration to Link to Yahoo

Once you've configured the Yahoo social identity provider, you can activate it through User Registration. To do so in the Admin UI, select Configure > User Registration, and activate that feature. Under the Social tab that appears, enable Social Registration. For more information on IDM user self-service features, see "*Configuring User Self-Service*".

When you enable Social Registration, you're allowing users to register on IDM through all active social identity providers.

12.14. Setting Up Twitter as an IDM Social Identity Provider

As suggested in the introduction to this chapter, you'll need to take the following basic steps to configure Twitter as a social identity provider for IDM:

- "Setting Up Twitter"
- "Configuring Twitter as a Social Identity Provider"
- "Configuring User Registration to Link to Twitter"

12.14.1. Setting Up Twitter

To set up Twitter as a social identity provider, navigate to the following page: *Single-user OAuth with Examples* . You'll need a Twitter account. You can then navigate to the Twitter *Application Management* page, where you can select *Create New App* and enter at least the following information:

- Name
- Description
- Website, such as `http://openidm.example.com:8080`
- Callback URL, such as `http://openidm.example.com:8080/`; required for IDM; for other providers, known as `RedirectURI`

When complete and saved, you should see a `Consumer Key` and `Consumer Secret` for your new web app.

Note

Twitter Apps use the OAuth 1.0a protocol. Fortunately, with IDM, you can use the same process used to configure OIDC and OAuth 2 social identity providers.

12.14.2. Configuring Twitter as a Social Identity Provider

1. To configure Twitter as a social identity provider, log in to the Admin UI and navigate to Configure > Social ID Providers.
2. Enable the Twitter social identity provider.

   In the `Twitter Provider` pop-up that appears, the values for `Callback URL` should use the same value shown in "Setting Up Twitter".
3. Include the values that Twitter created for `Consumer Key` and `Consumer Secret`, as described in "Setting Up Twitter".
4. Under regular and `Advanced Options`, if necessary, include the options shown in the following appendix: "Twitter Social Identity Provider Configuration Details".

When you enable a Twitter social identity provider in the Admin UI, IDM generates the `identityProvider-twitter.json` file in your project's `conf/` subdirectory.

When you review that file, you should see information beyond what you see in the Admin UI. The first part of the file includes the name of the provider, endpoints, as well as information from the *Consumer Key* and *Consumer Secret*, you'll see them as `clientId` and `clientSecret`, respectively, in the configuration file.

```
{
    "provider" : "twitter",
    "requestTokenEndpoint" : "https://api.twitter.com/oauth/request_token",
    "authorizationEndpoint" : "https://api.twitter.com/oauth/authenticate",
    "tokenEndpoint" : "https://api.twitter.com/oauth/access_token",
    "userInfoEndpoint" : "https://api.twitter.com/1.1/account/verify_credentials.json",
    "clientId" : "<Client_ID_Name>",
    "clientSecret" : {
      "$crypto" : {
          "type" : "x-simple-encryption",
          "value" : {
              "cipher" : "AES/CBC/PKCS5Padding",
              "stableId" : "openidm-sym-default",
              "salt" : "<hashValue>",
              "data" : "<encryptedValue>",
              "keySize" : 16,
              "purpose" : "idm.config.encryption",
              "iv" : "<encryptedValue>",
              "mac" : "<hashValue>"
          }
      }
    },
```

You should also see UI settings related to the social identity provider icon (badge) and the sign-in button, described in "Social Identity Provider Button and Badge Properties".

You'll see links related to the `authenticationIdKey`, `redirectUri`, and `configClass`.

The next part of the file includes `schema` information, which includes properties for each social identity account, as collected by IDM, as well as the order in which it appears in the Admin UI. When you've registered a user with a Twitter social identity, you can verify this by selecting Manage > Twitter, and then selecting a user.

Another part of the file includes a `propertyMap`, which maps user information entries between the `source` (social identity provider) and the `target` (IDM).

If you need more information about the properties in this file, refer to the following appendix: "Twitter Social Identity Provider Configuration Details".

12.14.3. Configuring User Registration to Link to Twitter

Once you've configured the Twitter social identity provider, you can activate it through User Registration. To do so in the Admin UI, select Configure > User Registration, and activate that feature. Under the Social tab that appears, enable Social Registration. For more information on IDM user self-service features, see "*Configuring User Self-Service*".

When you enable Social Registration, you're allowing users to register on IDM through all active social identity providers.

12.15. Set Up Apple as an IDM Social Identity Provider

To configure "Sign in with Apple", you'll need an Apple developer account.

- "Configure Apple Login"
- "Configure an Apple Identity Provider"
- "Configure User Registration through Apple"

Configure Apple Login

You need a client ID and client secret for your application. In the Apple developer portal, the client ID is called a `Services ID`.

1. Log into the Apple Developer Portal.
2. Select Certificates, Identifiers and Profiles > Identifiers.
3. On the Identifiers page, select Register a New Identifier, then select Services IDs.
4. Enter a Description and Identifier for this Services ID, and make sure that Sign in With Apple is enabled.

   Important

   The Identifier you specify here will be your OAuth Client ID.

5. Click Configure.
6. On the Web Authentication Configuration screen, enter the Web Domain on which IDM runs, and specify the redirect URL used during the OAuth flow (Return URLs).

   The redirect URL must have the following format:

   ```
   https://idm.example.com?redirect=apple
   ```

   Note

   You must use a real domain (FQDN) here. Apple does not allow `localhost` URLs. If you enter an IP address such as `127.0.0.1`, it will fail later in the OAuth flow.

7. Click Save > Continue > Register.
8. Generate the client secret.

   Instead of using simple strings as OAuth client secrets, Apple uses a public/private key pair, where the client secret is a signed JWT. To register the private key with Apple:

a. Select Certificates, Identifiers and Profiles > Keys, then click the `+` icon to register a new key.

b. Enter a Key Name and enable Sign In with Apple.

c. Click Configure, then select the primary App ID that you created previously.

d. Apple generates a new private key, in a `.p8` file.

> **Caution**
>
> You can only download this key *once*. Ensure that you save this file, because you will not be able to download it again.

Rename the file to `key.txt`, then locate the Key ID in that file.

e. Use this private key to generate a client secret JWT. Sign the JWT with your private key, using an ES256 algorithm.

Configure an Apple Identity Provider

1. To configure an Apple social identity provider, log into the Admin UI and select Configure > Social ID Providers.
2. Enable the Apple social identity provider.

   In the Apple Provider window, enter the Redirect URI that you set up in "Configure Apple Login".
3. Enter your Client ID and Client Secret.

Configure User Registration through Apple

When you have configured the Apple social identity provider, you can activate it through User Registration.

1. In the Admin UI, select Configure > User Registration> Enable User Registration.
2. On the Social tab, enable Social Registration.

   For more information, see "*Configuring User Self-Service*".

12.16. Setting Up a Custom Social Identity Provider

As suggested in the introduction to this chapter, you'll need to take four basic steps to configure a custom social identity provider:

- "Preparing IDM"

- "Setting Up a Custom Social Identity Provider"
- "Configuring a Custom Social Identity Provider"
- "Configuring User Registration to Link to a Custom Provider"

Note

These instructions require the social identity provider to be *fully* compliant with *The OAuth 2.0 Authorization Framework* or the *OpenID Connect* standards.

12.16.1. Preparing IDM

While IDM includes provisions to work with OpenID Connect 1.0 and OAuth 2.0 social identity providers, connections to those providers are not supported, other than those specifically listed in this chapter.

To set up another social provider, first add a code block to the `identityProviders.json` file, such as:

```
{
    "provider" : "<providerName>",
    "authorizationEndpoint" : "",
    "tokenEndpoint" : "",
    "userInfoEndpoint" : "",
    "wellKnownEndpoint" : "",
    "clientId" : "",
    "clientSecret" : "",
    "uiConfig" : {
         "iconBackground" : "",
         "iconClass" : "",
         "iconFontColor" : "",
         "buttonImage" : "",
         "buttonClass" : "",
         "buttonCustomStyle" : "",
         "buttonCustomStyleHover" : "",
         "buttonDisplayName" : ""
    },
    "scope" : [ ],
    "authenticationIdKey" : "",
    "schema" : {
       "id" : "urn:jsonschema:org:forgerock:openidm:identityProviders:api:<providerName>",
       "viewable" : true,
       "type" : "object",
       "$schema" : "http://json-schema.org/draft-03/schema",
       "properties" : {
          "id" : {
             "title" : "ID",
             "viewable" : true,
             "type" : "string",
             "searchable" : true
          },
          "name" : {
             "title" : "Name",
             "viewable" : true,
             "type" : "string",
```

```
            "searchable" : true
         },
         "first_name" : {
            "title" : "First Name",
            "viewable" : true,
            "type" : "string",
            "searchable" : true
         },
         "last_name" : {
            "title" : "Last Name",
            "viewable" : true,
            "type" : "string",
            "searchable" : true
         },
         "email" : {
            "title" : "Email Address",
            "viewable" : true,
            "type" : "string",
            "searchable" : true
         },
         "locale" : {
            "title" : "Locale Code",
            "viewable" : true,
            "type" : "string",
            "searchable" : true
         }
      },
      "order" : [
         "id",
         "name",
         "first_name",
         "last_name",
         "email",
         "locale"
      ],
      "required" : [ ]
   },
   "propertyMap" : [
      {
         "source" : "id",
         "target" : "id"
      },
      {
         "source" : "name",
         "target" : "displayName"
      },
      {
         "source" : "first_name",
         "target" : "givenName"
      },
      {
         "source" : "last_name",
         "target" : "familyName"
      },
      {
         "source" : "email",
         "target" : "email"
      },
      {
```

```
            "source" : "email",
            "target" : "username"
        },
        {
            "source" : "locale",
            "target" : "locale"
        }
    ],
    "redirectUri" : "http://openidm.example.com:8080/",
    "configClass" : "org.forgerock.oauth.clients.oidc.OpenIDConnectClientConfiguration",
    "basicAuth" : false,
    "enabled" : true
},
```

Modify this code block for your selected social provider. Some of these properties may appear under other names. For example, some providers specify an `App ID` that you'd include as a `clientId`.

Additional changes may be required, especially depending on how the provider implements the OAuth2 or OpenID Connect standards.

In the `propertyMap` code block, you should substitute the properties from the selected social identity provider for various values of `source`. Make sure to trace the property mapping through `selfservice.propertymap.json` to the Managed User property shown in `managed.json`. For more information on this multi-step mapping, see "Many Social Identity Providers, One Schema".

As shown in "OpenID Connect Authorization Code Flow", user provisioning information goes through the User Info Endpoint. Some providers, such as LinkedIn and Facebook, may require a list of properties with the endpoint. Consult the documentation for your provider for details.

For more information on the `uiConfig` code block, see "Social Identity Provider Button and Badge Properties".

Both files, `identityProviders.json` and `identityProvider-custom.json`, should include the same information for the new `custom` identity provider. For property details, see "Custom Social Identity Provider Configuration Details".

Once you've included information from your selected social identity provider, proceed with the configuration process. You'll use the same basic steps described for other specified social providers.

12.16.2. Setting Up a Custom Social Identity Provider

Every social identity provider should be able to provide the information you need to specify properties in the code block shown in "Preparing IDM".

In general, you'll need an `authorizationEndpoint`, a `tokenEndpoint` and a `userInfoEndpoint`. To link to the custom provider, you'll also have to copy the `clientId` and `clientSecret` that you created with that provider. In some cases, you'll get this information in a slightly different format, such as an `App ID` and `App Secret`.

For the `propertyMap`, check the `source` properties. You may need to revise these properties to match those available from your custom provider.

For examples, refer to the specific social identity providers documented in this chapter.

12.16.3. Configuring a Custom Social Identity Provider

1. To configure a custom social identity provider, log into the Admin UI and navigate to Configure > Social ID Providers.

2. Enable the custom social identity provider. The name you see is based on the `name` property in the relevant code block in the `identityProviders.json` file.

3. If you haven't already done so, include the values provided by your social identity provider for the properties shown. For more information, see the following appendix: "Custom Social Identity Provider Configuration Details".

12.16.4. Configuring User Registration to Link to a Custom Provider

Once you've configured a custom social identity provider, you can activate it through User Registration. To do so in the Admin UI, select Configure > User Registration, and under the Social tab, enable the option associated with Social Registration. For more information about user self-service features, see "*Configuring User Self-Service*".

When you enable social identity providers, you're allowing users to register on IDM through all active social identity providers.

12.17. Configuring the Social Providers Authentication Module

The `SOCIAL_PROVIDERS` authentication module incorporates the requirements from social identity providers who rely on either the OAuth2 or the OpenID Connect standards. The Social Providers authentication module is turned on by default. To configure or disable this module in the Admin UI, select Configure > Authentication, choose the Modules tab, then select Social Providers from the list of modules.

Authentication settings can be configured from the Admin UI, or by making changes directly in the `authentication.json` file for your project. IDM includes the following code block in the `authentication.json` file for your project:

```
{
   "name" : "SOCIAL_PROVIDERS",
   "properties" : {
       "defaultUserRoles" : [
           "internal/role/openidm-authorized"
       ],
       "augmentSecurityContext" : {
           "type" : "text/javascript",
           "globals" : { },
           "file" : "auth/populateAsManagedUserFromRelationship.js"
       },
       "propertyMapping" : {
           "userRoles" : "authzRoles"
       }
   },
   "enabled" : true
}
```

For more information on these options, see "Common Module Properties".

12.18. Managing Social Identity Providers Over REST

You can identify the current status of configured social identity providers with the following REST call:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
http://localhost:8080/openidm/authentication
```

The output that you see includes JSON information from each configured social identity provider, as described in the `identityProvider-provider` file in your project's `conf/` subdirectory.

One key line from this output specifies whether the social identity provider is enabled:

```
"enabled" : true
```

If the `SOCIAL_PROVIDERS` authentication module is disabled, you'll see the following output from that REST call:

```
{
   "providers" : [ ]
}
```

For more information, see "Configuring the Social Providers Authentication Module".

If the `SOCIAL_PROVIDERS` module is disabled, you can still review the standard configuration of each social provider (enabled or not) by running the same REST call on a different endpoint (do not forget the `s` at the end of `identityProviders`):

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
http://localhost:8080/openidm/identityProviders
```

Note

If you have not configured a social identity provider, you'll see the following output from the REST call on the `openidm/identityProviders` endpoint:

```
{
    "providers" : [ ]
}
```

You can still get information about the available configuration for social identity providers on a slightly different endpoint:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
http://localhost:8080/openidm/config/identityProviders
```

The `config` in the endpoint refers to the configuration, starting with the `identityProviders.json` configuration file. Note how it matches the corresponding term in the endpoint.

You can review information for a specific provider by including the name with the endpoint. For example, if you've configured LinkedIn as described in "Setting Up LinkedIn as a Social Identity Provider", run the following command:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
http://localhost:8080/openidm/config/identityProvider/linkedIn
```

The above command differs in subtle ways. The `config` in the endpoint points to configuration data. The `identityProvider` at the end of the endpoint is singular, which matches the corresponding configuration file, `identityProvider-linkedIn.json`. And `linkedIn` includes a capital `I` in the middle of the word.

In a similar fashion, you can delete a specific provider:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request DELETE \
http://localhost:8080/openidm/config/identityProvider/linkedIn
```

If you have the information needed to set up a provider, such as the output from the previous two REST calls, you can use the following command to add a provider:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-type: application/json" \
 --request PUT
 \
--data '{
 <Include content from an identityProvider-linkedIn.json file>
}' \
http://localhost:8080/openidm/config/identityProvider/linkedIn
```

IDM incorporates the given information in a file named for the provider, in this case, `identityProvider-linkedIn.json`.

You can even disable a social identity provider with a `PATCH` REST call, as shown:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-type: application/json"
 \
--request PATCH
 \
--data '[
   {
      "operation":"replace",
      "field" : "enabled",
      "value" : false
   }
]' \
http://localhost:8080/openidm/config/identityProvider/linkedIn
```

You can reverse the process by substituting `true` for `false` in the previous `PATCH` REST call.

You can manage the social identity providers associated with individual users over REST, as described in "Managing Social Identity Providers Over REST".

12.19. Testing Social Identity Providers

In all cases, once configuration is complete, you should test the social identity provider. To do so, go through the steps in the following procedure:

1. Navigate to the login screen for the End User UI, `https://openidm.example.com:8443`.
2. Select the `Register` link (after the "Don't have an account?" question) on the login page.
3. You should see a link to sign in with your selected social identity provider. Select that link.

   Note

   If you do not see a link to sign in with any social identity provider, you probably did not enable the option associated with Social Registration. To make sure, access the Admin UI, and select Configure > User Registration.

   Warning

   If you see a redirect URI error from a social identity provider, check the configuration for your web application in the social identity provider developer console. There may be a mistake in the redirect URI or redirect URL.

4. Follow the prompts from your social identity provider to log into your account.

   Note

   If there is a problem with the interface to the social identity provider, you might see a Register Your Account screen with information acquired from that provider.

5. Because security questions are enabled by default, you must add at least one security question and answer to proceed. For more information, see "Configuring Security Questions".

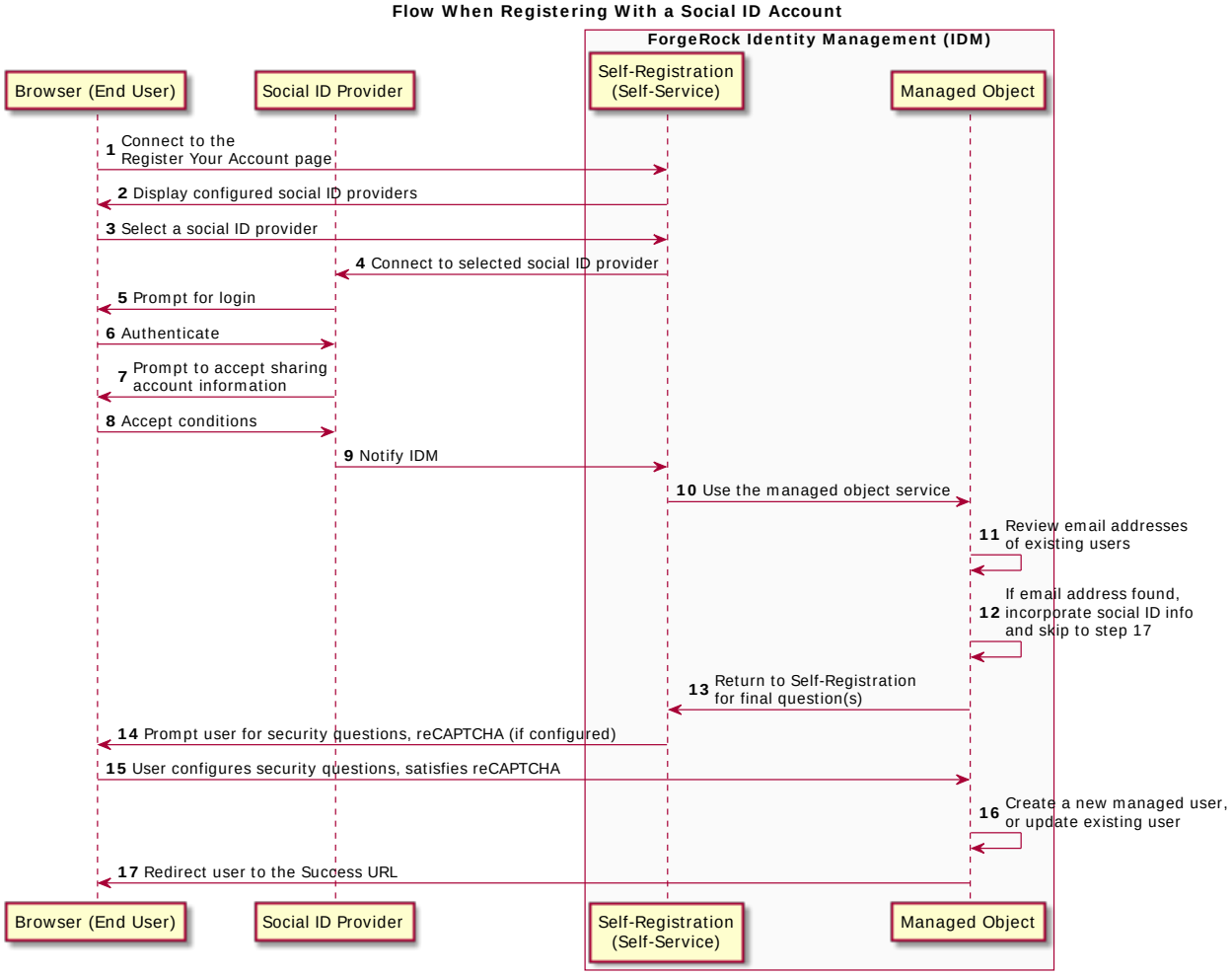
   When the Social ID registration process is complete, you are redirected to the End User UI at `https://openidm.example.com:8443`.

6. You should now be able to use the sign in link for your social identity provider to log into IDM.

12.20. Scenarios When Registering With a Social ID

When users connect to IDM with a social identity provider, it could be the first time they're connecting to your system. They could already have an regular IDM account. They could already have registered with a different social identity provider. This section describes what happens during the self-registration process. The process varies depending on whether there's an existing account in the IDM managed user store.

When Registering Social Identity Providers on IDM



The following list describes each item in the flow shown in the adjacent figure:

1. From the IDM End User UI, the user selects the `Register` link
2. The self-registration Interface returns a `Register Your Account` page at `http://localhost:8080/#/registration` with a list of configured providers.
3. The user then selects one configured social identity provider.
4. IDM connects to the selected social identity provider.

5. The social identity provider requests end user authentication.
6. The end user authenticates with the social identity provider.
7. The social identity provider prompts the user to accept sharing selected account information.
8. The user accepts the conditions presented by the social identity provider.
9. The social identity provider notifies IDM of the user registration request.
10. IDM passes responsibility to the administrative interface.
11. IDM uses the email address from the social identity provider, and compares it with email addresses of existing managed users.
12. If the email address is found, IDM links the social identity information to that account (and skips to step 16).
13. IDM returns to the self-registration (Self-Service) interface.
14. The self-registration interface prompts the user for additional information, such as security questions, and reCAPTCHA, if configured per "Configuring Google reCAPTCHA".
15. The user responds appropriately.
16. IDM creates a new managed user. If the user has already been created, IDM reviews data from the social identity provider, and updates the user data for the managed/*provider* to conform. In this case, the *provider* is a social identity provider such as Google.
17. The user is redirected to the `Success URL`.

12.21. Social Identity Widgets

The Admin UI includes widgets that can help you measure the success of your social identity efforts. To add these widgets, take the following steps:

1. Log into the Admin UI.
2. Select Dashboards, and choose the dashboard to which you want to add the widget.

   For more information about managing dashboards in the UI, see "Managing Dashboards".
3. Select Add Widget.

   In the Add Widget window, scroll down to the Social item which includes the following graphical widgets:

   - Social Registration (year)

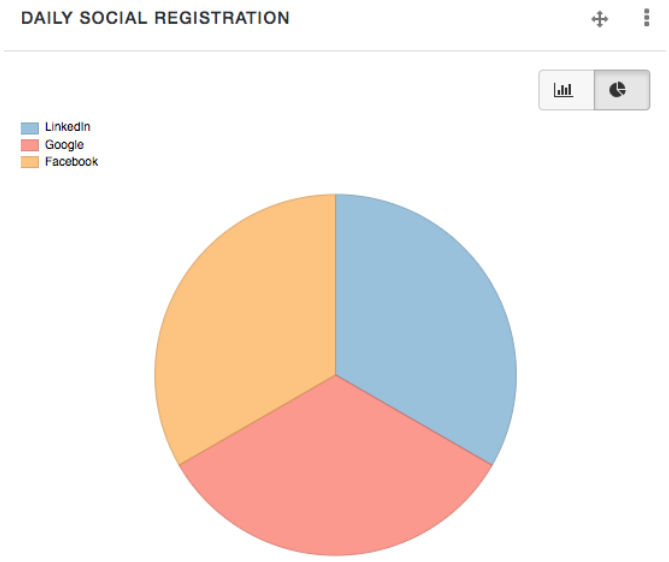
- Daily Social Registration
- Daily Social Logins

4. Select the widget you want to add and select Settings to configure the widget.

   Optionally, select Preview to see what the widget will look like with the configuration you have applied. Your IDM system must contain some social data to display the preview.

The following example shows daily social registrations, in pie chart form:

Daily Social Registrations on IDM



Chapter 13

Using Policies to Validate Data

IDM provides an extensible policy service that lets you apply specific validation requirements to various components and properties. This chapter describes the policy service, and provides instructions on configuring policies for managed objects.

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 are generally applied to user passwords, but can also be applied to any managed or system object, and to internal user objects.

The policy service lets you accomplish the following tasks:

- 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.

The router service limits policy application to managed, system, and internal user objects. To apply policies to additional objects, such as the audit service, you must modify your project's `conf/router.json` file. For more information about the router service, see "*Router Service Reference*".

A default policy applies to all managed objects. You can configure this default policy to suit your requirements, or you can extend the policy service by supplying your own scripted policies.

13.1. Configuring the Default Policy for Managed Objects

Policies applied to managed objects are configured in two files:

- A policy script file (`openidm/bin/defaults/script/policy.js`) that defines each policy and specifies how policy validation is performed. For more information, see "Understanding the Policy Script File".
- A managed object policy configuration element, defined in your project's `conf/managed.json` file, that specifies which policies are applicable to each managed resource. For more information, see "Understanding the Policy Configuration Element".

Note

The configuration for determining which policies apply to resources *other than managed objects* is defined in your project's `conf/policy.json` file. The default `policy.json` file includes policies that are applied to internal user objects, but you can extend the configuration in this file to apply policies to system objects.

13.1.1. Understanding the Policy Script File

The policy script file (`openidm/bin/defaults/script/policy.js`) separates policy configuration into two parts:

- A policy configuration object, which defines each element of the policy. For more information, see "Policy Configuration Objects".
- 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 applied policy. The following excerpt of a 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 `policyId` from the preceding example is applied to the appropriate resource (`managed/user/*`). The required number of capital

letters is defined in the policy configuration element of the managed object configuration file (see "Understanding the Policy Configuration Element".

13.1.1.1. Policy Configuration Objects

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" : "minLength",
    "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 "Policy Implementation Functions".
- `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.

13.1.1.2. Policy Implementation Functions

Each policy ID has a corresponding policy implementation function that performs the validation. Implementation 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 [];
}
```

13.1.2. Understanding the Policy Configuration Element

The configuration of a managed object property (in the `managed.json` file) can include a `policies` element that specifies how policy validation should be applied to that property. The following excerpt of the default `managed.json` file shows how policy validation is applied to the `password` and `_id` properties of a managed/user object:

```
{
    "objects" : [
        {
            "name" : "user",
            ...
            "schema" : {
                "id" : "http://jsonschema.net",
                ...
                "properties" : {
                    "_id" : {
                        "description" : "User ID",
                        "type" : "string",
                        "viewable" : false,
                        "searchable" : false,
                        "userEditable" : false,
                        "usageDescription" : "",
                        "isPersonal" : false,
                        "policies" : [
                            {
                                "policyId" : "cannot-contain-characters",
                                "params" : {
                                    "forbiddenChars" : [ "/" ]
                                }
                            }
                        ]
                    },
                    "password" : {
                        "title" : "Password",
                        "description" : "Password",
                        "type" : "string",
                        "viewable" : false,
                        "searchable" : false,
                        "minLength" : 8,
                        "userEditable" : true,
                        "encryption" : {
                            "purpose" : "idm.password.encryption"
                        },
                        "scope" : "private",
                        "isProtected": true,
                        "usageDescription" : "",
                        "isPersonal" : false,
```

```
                    "policies" : [
                        {
                            "policyId" : "at-least-X-capitals",
                            "params" : {
                                "numCaps" : 1
                            }
                        },
                        {
                            "policyId" : "at-least-X-numbers",
                            "params" : {
                                "numNums" : 1
                            }
                        },
                        {
                            "policyId" : "cannot-contain-others",
                            "params" : {
                                "disallowedFields" : [
                                    "userName",
                                    "givenName",
                                    "sn"
                                ]
                            }
                        }
                    ]
                }
                ...
            }
```

Note that the policy for the `_id` property references the function `cannot-contain-characters`, that is defined in the `policy.js` file. The policy for the `password` property references the functions `at-least-X-capitals`, `at-least-X-numbers`, and `cannot-contain-others`, that are defined in the `policy.js` file. The parameters that are passed to these functions (number of capitals required, and so forth) are specified in the same element.

13.1.3. Validation of Managed Object Data Types

The `type` property of a managed object specifies the data type of that property, for example, `array`, `boolean`, `integer`, `number`, `null`, `object`, or `string`. For more information about data types, see the JSON Schema Primitive Types section of the JSON Schema standard.

The `type` property is subject to policy validation when a managed object is created or updated. Validation fails if data does not match the specified `type`, such as when the data is an `array` instead of a `string`. The `valid-type` policy in the default `policy.js` file enforces the match between property values and the `type` defined in the `managed.json` file.

IDM supports multiple valid property types. For example, you might have a scenario where a managed user can have more than one telephone number, or a *null* telephone number (when the user entry is first created and the telephone number is not yet known). In such a case, you could specify the accepted property type as follows in your `managed.json` file:

```
"telephoneNumber" : {
    "description" : "",
    "title" : "Telephone Number",
    "viewable" : true,
    "searchable" : false,
    "userEditable" : true,
    "policies" : [ ],
    "returnByDefault" : false,
    "minLength" : null,
    "pattern" : "^\\+?([0-9\\- \\(\\)])*$",
    "type" : [
        "string",
        "null"
    ]
},
```

In this case, the `valid-type` policy from the `policy.js` file checks the telephone number for an accepted `type` and `pattern`, either for a real telephone number or a `null` entry.

13.1.4. Configuring Policy Validation in the UI

The Admin UI provides rudimentary support for applying policy validation to managed object properties. To configure policy validation for a managed object type update the configuration of the object type in the UI. For example, to specify validation policies for specific properties of managed user objects, select Configure > Managed Objects then click on the User object. Scroll down to the bottom of the Managed Object configuration, then update, or add, a validation policy. The `Policy` field here refers to a function that has been defined in the policy script file. For more information, see "Understanding the Policy Script File". You cannot define additional policy functions by using the UI.

Note

Take care with Validation Policies. If it relates to an array of relationships, such as between a user and multiple devices, "Return by Default" should always be set to false. You can verify this in the `managed.json` file for your project, with the `"returnByDefault" : false` entry for the applicable managed object, whenever there are `items` of `"type" : "relationship"`.

13.2. Extending the Policy Service

You can extend the policy service by adding custom scripted policies, and by adding policies that are applied only under certain conditions.

13.2.1. Adding Custom Scripted Policies

If your deployment requires additional validation functionality that is not supplied by the default policies, you can add your own policy scripts to your project's `script` directory, and reference them from your project's `conf/policy.json` file.

Do not modify the default policy script file (`openidm/bin/defaults/script/policy.js`) as doing so might result in interoperability issues in a future release. To reference additional policy scripts, set the `additionalFiles` property `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) {
      var requireNotNull = [
        {"policyRequirement": "NOT_NULL"}
      ];
      return requireNotNull;
   }
   return [];
}
```

The `mypolicy.js` policy is referenced in the `policy.json` configuration file as follows:

```
{
    "type" : "text/javascript",
    "file" : "policy.js",
    "additionalFiles" : ["script/mypolicy.js"],
    "resources" : [
        {
...
```

Note

In cases where you are using the Admin UI, both `policy.js` and `mypolicy.js` will be run within the client, and then again by the the server. When creating new policies, be aware that these policies may be run in both contexts.

13.2.2. Adding Conditional Policy Definitions

You can extend the policy service to support policies that are applied only under specific conditions. To apply a conditional policy to managed objects, add the policy to your project's `managed.json` file. To apply a conditional policy to other objects, add it to your project's `policy.json` file.

The following excerpt of a `managed.json` file shows a sample conditional policy configuration for the `"password"` property of managed user objects. The policy indicates that sys-admin users have a more lenient password policy than regular employees:

```
{
    "objects" : [
        {
```

```
            "name" : "user",
            ...
                "properties" : {
                ...
                    "password" : {
                        "title" : "Password",
                        "type" : "string",
                        ...
                        "conditionalPolicies" : [
                            {
                                "condition" : {
                                    "type" : "text/javascript",
                                    "source" : "(fullObject.org === 'sys-admin')"
                                },
                                "dependencies" : [ "org" ],
                                "policies" : [
                                    {
                                        "policyId" : "max-age",
                                        "params" : {
                                            "maxDays" : ["90"]
                                        }
                                    }
                                ]
                            },
                            {
                                "condition" : {
                                    "type" : "text/javascript",
                                    "source" : "(fullObject.org === 'employees')"
                                },
                                "dependencies" : [ "org" ],
                                "policies" : [
                                    {
                                        "policyId" : "max-age",
                                        "params" : {
                                            "maxDays" : ["30"]
                                        }
                                    }
                                ]
                            }
                        ],
                        "fallbackPolicies" : [
                            {
                                "policyId" : "max-age",
                                "params" : {
                                    "maxDays" : ["7"]
                                }
                            }
                        ]
            }
```

To understand how a conditional policy is defined, examine the components of this sample policy. For more information on the policy function, see "Policy Implementation Functions".

There are two distinct scripted conditions (defined in the `condition` elements). The first condition asserts that the user object, contained in the `fullObject` argument, is a member of the `sys-admin` org. If that assertion is true, the `max-age` policy is applied to the `password` attribute of the user object, and the maximum number of days that a password may remain unchanged is set to `90`.

The second condition asserts that the user object is a member of the `employees` org. If that assertion is true, the `max-age` policy is applied to the `password` attribute of the user object, and the maximum number of days that a password may remain unchanged is set to `30`.

In the event that neither condition is met (the user object is not a member of the `sys-admin` org or the `employees` org), an optional fallback policy can be applied. In this example, the fallback policy also references the `max-age` policy and specifies that for such users, their password must be changed after 7 days.

The `dependencies` field prevents the condition scripts from being run at all, if the user object does not include an `org` attribute.

Note

This example assumes that a custom `max-age` policy validation function has been defined, as described in "Adding Custom Scripted Policies".

Tip

These scripted conditions do not apply to progressive profiling. For more information, see "Custom Progressive Profile Conditions".

13.3. Disabling Policy Enforcement

Policy enforcement is the automatic validation of data 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 your `resolver/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 UI 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.

You should not disable policy enforcement permanently, in a production environment.

13.4. 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.

13.4.1. Listing the Defined Policies

The following REST call displays a list of all the policies defined in `policy.json` (policies for objects other than managed objects). The policy objects are returned in JSON format, with one object for each defined policy ID:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/policy"
{
  "_id": "",
  "resources": [
    ...
    {
      "resource": "internal/user/*",
      "properties": [
        {
          "name": "_id",
          "policies": [
            {
              "policyId": "cannot-contain-characters",
              "params": {
                "forbiddenChars": [ "/" ]
              },
              "policyFunction": "\nfunction (fullObject, value, params, property) {\n    ...",
              "policyRequirements": [
                "CANNOT_CONTAIN_CHARACTERS"
              ]
            }
          ],
          "policyRequirements": [
            "CANNOT_CONTAIN_CHARACTERS"
          ]
        }
        ...
      ]
      ...
    }
  ]
}
```

To display the policies that apply to a specific resource, include the resource name in the URL. For example, the following REST call displays the policies that apply to managed users:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/policy/managed/user/*"
{
  "_id": "*",
  "resource": "managed/user/*",
  "properties": [
    {
```

```
      "policyRequirements": [
        "VALID_TYPE",
        "CANNOT_CONTAIN_CHARACTERS"
      ],
      "fallbackPolicies": null,
      "name": "_id",
      "policies": [
        {
          "policyRequirements": [
            "VALID_TYPE"
          ],
          "policyId": "valid-type",
          "params": {
            "types": [
              "string"
            ]
          }
        },
        {
          "policyId": "cannot-contain-characters",
          "params": {
            "forbiddenChars": [ "/" ]
          },
          "policyFunction": "...",
          "policyRequirements": [
            "CANNOT_CONTAIN_CHARACTERS"
          ]
        }
      ],
      "conditionalPolicies": null
    }
    ...
  ]
}
```

13.4.2. Validating Objects and Properties Over REST

To verify that an object adheres to the requirements of all applied policies, include the `validateObject` action in the request.

The following example verifies that a new managed user object is acceptable, in terms of the policy requirements. Note that the ID in the URL (`test` in this example) is ignored—the action simply validates the object in the JSON payload:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request POST
 \
--data '{
  "sn":"Jones",
  "givenName":"Bob",
```

```
  "telephoneNumber":"0827878921",
  "passPhrase":null,
  "mail":"bjones@example.com",
  "accountStatus":"active",
  "userName":"bjones@example.com",
  "password":"123"
}' \
"http://localhost:8080/openidm/policy/managed/user/test?_action=validateObject"
{
  "result": false,
  "failedPolicyRequirements": [
    {
      "policyRequirements": [
        {
          "policyRequirement": "MIN_LENGTH",
          "params": {
            "minLength": 8
          }
        }
      ],
      "property": "password"
    },
    {
      "policyRequirements": [
        {
          "policyRequirement": "AT_LEAST_X_CAPITAL_LETTERS",
          "params": {
            "numCaps": 1
          }
        }
      ],
      "property": "password"
    }
  ]
}
```

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 a user's new password (`12345`) is acceptable:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request POST
 \
--data '{ "password" : "12345" }' \
"http://localhost:8080/openidm/policy/managed/user/9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb?
_action=validateProperty"
{
```

```
  "result": false,
  "failedPolicyRequirements": [
    {
      "policyRequirements": [
        {
          "policyRequirement": "MIN_LENGTH",
          "params": {
            "minLength": 8
          }
        }
      ],
      "property": "password"
    },
    {
      "policyRequirements": [
        {
          "policyRequirement": "AT_LEAST_X_CAPITAL_LETTERS",
          "params": {
            "numCaps": 1
          }
        }
      ],
      "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 fulfills the policy requirements returns a `true` result, for example:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request POST
 \
--data '{ "password" : "1NewPassword" }' \
"http://localhost:8080/openidm/policy/managed/user/9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb?
_action=validateProperty"
{
  "result": true,
  "failedPolicyRequirements": []
}
```

13.4.2.1. Validate Field Removal

To validate field removal, specify the fields to remove when calling the policy `validateProperty` action. You cannot remove fields that:

- Are required in the `required` schema array.

- Have a `required` policy.
- Have a default value.

The following example validates the removal of the fields `description` and `givenName`:

```
curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Accept-API-Version: resource=1.0"
 \
--header "Content-Type: application/json"
 \
--request POST
 \
--data '{
  "_remove": [ "description", "givenName" ]
}' \
"http://localhost:8080/openidm/policy/managed/user/ca5a3196-2ed3-4a76-8881-30403dee70e9?
_action=validateProperty"
{
  "result": false,
  "failedPolicyRequirements": [
    {
      "policyRequirements": [
        {
          "policyRequirement": "REQUIRED"
        }
      ],
      "property": "givenName"
    }
  ]
}
```

13.4.2.2. Validate Properties to Unknown Resource Paths

To perform a `validateProperty` action to a path that is unknown (`*`), such as `managed/user/*` or `managed/user/userDoesntExistYet`, the payload must include:

- An `object` field that contains the object details.
- A `properties` field that contains the properties to be evaluated.

A common use case for validating properties for unknown resources is prior to object creation, such as during pre-registration.

1. Always pass the object and properties content in the POST body because IDM has no object to look up.
2. Use any placeholder id in the request URL, as `*` has no special meaning in the API.

This example uses a conditional policy for any object with the description `test1`:

```
"password" : {
    ...
    "conditionalPolicies" : [
        {
            "condition" : {
                "type" : "text/javascript",
                "source" : "(fullObject.description === 'test1')"
            },
            "dependencies" : [ "description" ],
            "policies" : [
                {
                    "policyId" : "at-least-X-capitals",
                    "params" : {
                        "numCaps" : 1
                    }
                }
            ]
        }
    ],
```

Using the above conditional policy, you could perform a `validateProperty` action to `managed/user/*` with the request:

```
curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Accept-API-Version: resource=1.0"
 \
--header "Content-Type: application/json"
 \
--request POST
 \
--data '{
  "object": {
    "description": "test1"
  },
  "properties": {
    "password": "passw0rd"
  }
}' \
"http://localhost:8080/openidm/policy/managed/user/*?_action=validateProperty"
{
  "result": false,
  "failedPolicyRequirements": [
    {
      "policyRequirements": [
        {
          "params": {
            "numCaps": 1
          },
          "policyRequirement": "AT_LEAST_X_CAPITAL_LETTERS"
        }
      ],
      "property": "password"
    }
  ]
}
```

Chapter 14

Configuring Server Logs

In this chapter, you will learn about server logging, that is, the messages that IDM logs related to server activity.

Server logging is separate from *auditing*. Auditing logs activity on the IDM system, such as access and synchronization. For information about audit logging, see "*Setting Up Audit Logging*". To configure server logging, edit the `logging.properties` file in your *`project-dir`*`/conf` directory.

Important

When you change the logging settings you must restart the server for those changes to take effect. Alternatively, you can use JMX via jconsole to change the logging settings, in which case changes take effect without restarting the server.

14.1. Specify Where Messages Are Logged

The way in which messages are logged is set in the `handlers` property in the `logging.properties` file. This property has the following value by default:

```
handlers=java.util.logging.FileHandler, java.util.logging.ConsoleHandler
```

Two handlers are listed by default:

- `FileHandler` writes formatted log records to a single file or to a set of rotating log files. By default, log files are written to `logs/openidm*.log` files.
- `ConsoleHandler` writes formatted logs to `System.err`.

Additional log message handlers are listed in the `logging.properties` file.

14.2. Set the Log Message Format

IDM supports the two default log formatters included with Java. These are set in the `conf/logging.properties` file:

- `java.util.logging.SimpleFormatter.format` outputs a text log file that is human-readable. This formatter is used by default.

- `java.util.logging.XMLFormatter` outputs logs as XML, for use in logging software that can read XML logs.

IDM extends the Java `SimpleFormatter` with the following formatting options:

- `org.forgerock.openidm.logger.SanitizedThreadIdLogFormatter`

  This is the default formatter for console and file logging. It extends the `SimpleFormatter` to include the thread ID of the thread that generated each message. The thread ID helps with debugging when reviewing the logs.

  In the following example log excerpt, the thread ID is `[19]`:

  ```
  [19] May 23, 2018 10:30:26.959 AM org.forgerock.openidm.repo.opendj.impl.Activator start
  INFO: Registered bootstrap repository service
  [19] May 23, 2018 10:30:26.960 AM org.forgerock.openidm.repo.opendj.impl.Activator start
  INFO: DS bundle started
  ```

  The `SanitizedThreadIdLogFormatter` also encodes all control characters (such as newline characters) using URL-encoding, to protect against log forgery. Control characters in stack traces are not encoded.

- `org.forgerock.openidm.logger.ThreadIdLogFormatter`

  Similar to the `SanitizedThreadIdLogFormatter`, but does not encode control characters. If you do not want to encode control characters in file and console log messages, change the file and console handlers in `conf/logging.properties` as follows:

  ```
  java.util.logging.FileHandler.formatter = org.forgerock.openidm.logger.ThreadIdLogFormatter
  ```

  ```
  java.util.logging.ConsoleHandler.formatter = org.forgerock.openidm.logger.ThreadIdLogFormatter
  ```

The `SimpleFormatter` (and, by extension, the `SanitizedThreadIdLogFormatter` and `ThreadIdLogFormatter`) lets you customize what information to include in log messages, and how this information is laid out. By default, log messages include the date, time (down to the millisecond), log level, source of the message, and the message sent (including exceptions). To change the defaults, adjust the value of `java.util.logging.SimpleFormatter.format` in your `conf/logging.properties` file. For more information on how to customize the log message format, see the related Java documentation.

14.3. Set the Logging Level

By default, IDM logs messages at the `INFO` level. This logging level is specified with the following global property in `conf/logging.properties`:

```
.level=INFO
```

You can specify different separate logging levels for individual server features which override the global logging level. Set the log level, per package to one of the following:

```
SEVERE (highest value)
WARNING
INFO
CONFIG
FINE
FINER
FINEST (lowest value)
```

For example, the following setting decreases the messages logged by the embedded PostgreSQL database:

```
# reduce the logging of embedded postgres since it is very verbose
ru.yandex.qatools.embed.postgresql.level = SEVERE
```

Set the log level to `OFF` to disable logging completely (see in "Disable Logs"), or to `ALL` to capture all possible log messages.

If you use `logger` functions in your JavaScript scripts, set the log level for the scripts as follows:

```
org.forgerock.openidm.script.javascript.JavaScript.level=level
```

You can override the log level settings, per script, with the following setting:

```
org.forgerock.openidm.script.javascript.JavaScript.script-name.level
```

For more information about using `logger` functions in scripts, see "Logging Functions".

Important

It is strongly recommended that you do *not* log messages at the `FINE` or `FINEST` levels in a production environment. Although these levels are useful for debugging issues in a test environment, they can result in accidental exposure of sensitive data. For example, a password change patch request can expose the updated password in the Jetty logs.

14.4. Disable Logs

If required, you can also disable logs. For example, to disable `ConsoleHandler` logging, make the following changes in your project's `conf/logging.properties` file before you start IDM.

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 15

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 IDM operations; however, the resources shown here support most of the CRUD operations, and also reconciliation and liveSync.

Resources refer to external systems, databases, directory servers, and other sources of identity data that are managed and audited by the identity management system. To connect to resources, IDM loads the ForgeRock Open Identity Connector Framework (OpenICF). ICF avoids the need to install agents to access resources, instead using the resources' native protocols. For example, ICF 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**.

IDM provides several connectors by default, in the `path/to/openidm/connectors` directory. You can download additional connectors from the ForgeRock BackStage download site.

For details about all connectors supported for use with IDM, see Connector Reference.

15.1. The ForgeRock Identity Connector Framework (ICF)

ICF provides a common interface to allow identity services access to the resources that contain user information. IDM loads the ICF API as one of its OSGi modules. ICF uses *connectors* to separate the IDM implementation from the dependencies of the resource to which IDM is connecting. A specific connector is required for each remote resource. Connectors can run locally (on the IDM host) or remotely.

Local connectors are loaded by ICF as regular bundles in the OSGi container. Most connectors run locally. Remote connectors must be executed on a remote *connector server*. If a resource requires access libraries that cannot be included as part of the IDM process, you must use a connector server. For example, ICF connects to Microsoft Active Directory through a remote connector server that is implemented as a .NET service.

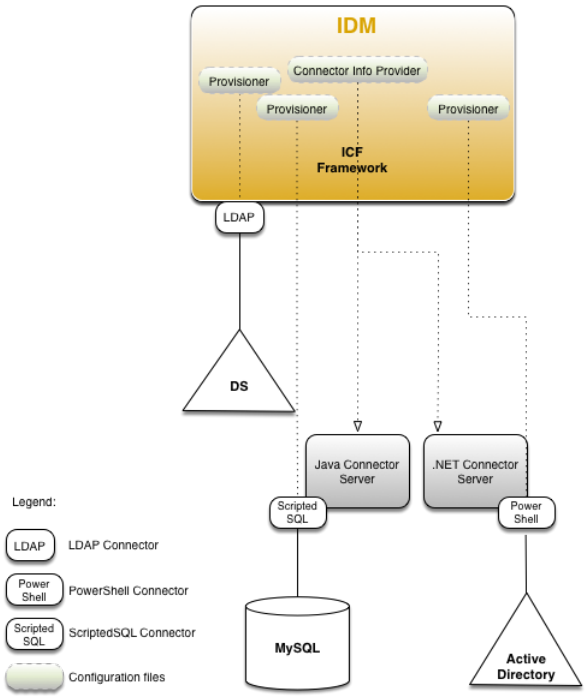
Connections to remote connector servers are configured in a single *connector info provider* configuration file, located in your project's `conf/` directory.

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 `conf/` directory.

A number of sample connector configurations are available in the `openidm/samples/example-configurations/provisioners` directory. To use these connectors, edit the configuration files as required, and copy them to your project's `conf/` directory.

The following figure shows how IDM 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.

How IDM Uses the ICF Framework and Connectors



Tip

Connectors that use the .NET framework *must* run remotely. Java connectors can be run locally or remotely. You might run a Java connector remotely for security reasons (firewall constraints), for geographical reasons, or if the JVM version that is required by the connector conflicts with the JVM version that is required by IDM.

15.2. Configuring Connectors

Connectors are configured through the ICF provisioner service. Each connector configuration is stored in a file in your project's `conf/` directory, and accessible over REST at the `openidm/conf` endpoint. Connector configuration files are named *`project-dir`*`/conf/provisioner.openicf-`*`name`* where *name* corresponds to the name of the connector.

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.

You can create a connector configuration in the following ways:

- Start with the sample provisioner files in the `/path/to/openidm/samples/example-configurations/provisioners` directory. For more information, see "Using the Sample Provisioner Files".
- Set up connectors with the help of the Admin UI. Log in to the Admin UI at `https://localhost:8443/admin`, then continue with the process described in "Creating Connector Configurations With the Admin UI".
- Use the service that IDM exposes through the REST interface to create basic connector configuration files. For more information, see "Creating Connector Configurations Over REST".
- Use the **cli.sh** or **cli.bat** scripts to generate a basic connector configuration. For more information, see "Using the **configureconnector** Subcommand".

15.2.1. Using the Sample Provisioner Files

A number of sample connector configurations are available in the `openidm/samples/example-configurations/provisioners` directory. To use these connector configurations, edit the configuration files as required, and copy them to your project's `conf` directory.

The following example shows a high-level connector configuration. The individual configuration objects are described in detail later in this section:

```
{
  "connectorRef"               : connector-ref-object,
  "producerBufferSize"         : integer,
  "connectorPoolingSupported"  : boolean, true/false,
  "poolConfigOption"           : pool-config-option-object,
  "operationTimeout"           : operation-timeout-object,
  "configurationProperties"    : configuration-properties-object,
  "syncFailureHandler"         : sync-failure-handler-object,
  "resultsHandlerConfig"       : results-handler-config-object,
  "objectTypes"                : object-types-object,
  "operationOptions"           : operation-options-object
 }
```

15.2.2. Creating Connector Configurations With the Admin UI

To configure connectors in the Admin UI, select Configure > Connector. If your project has an existing connector configuration (for example, if you have started IDM with one of the sample configurations) click on that connector to edit it. If you're starting with a new project, click New Connector to configure a new connector.

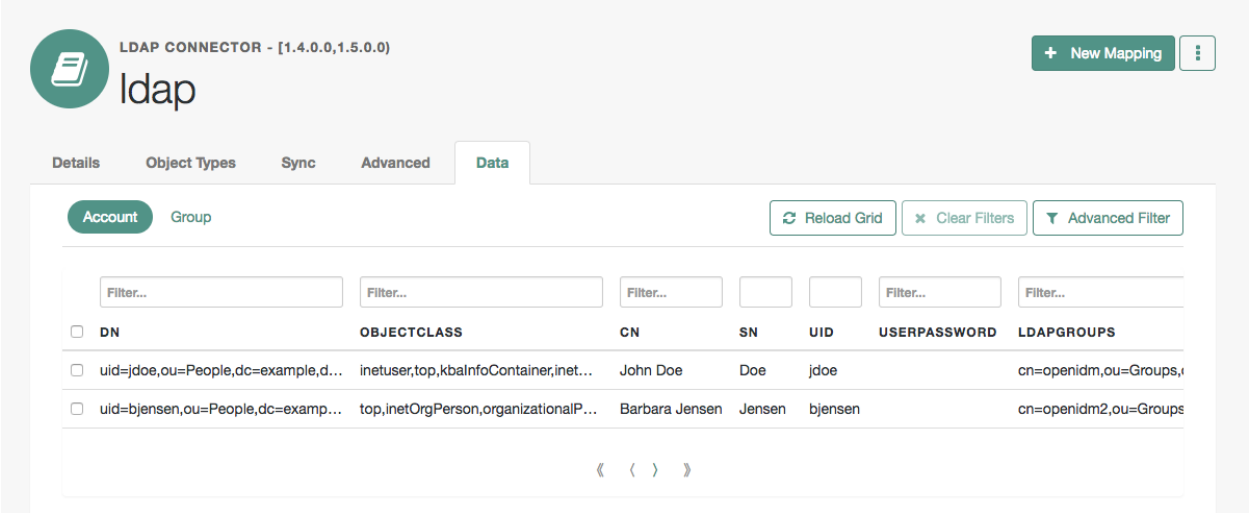
The connectors displayed on the Connectors page reflect the provisioner files that are in your project's `conf/` directory. To add a new connector configuration, you can also copy a provisioner file from the `/path/to/openidm/samples/example-configurations/provisioners` directory, then edit it to fit your deployment.

When you add a new connector, the Connector Type dropdown list reflects the actual connector JARs that are in the `/path/to/openidm/connectors` directory. You can have more than one connector configuration for a specific connector type. For example, you might use the LDAP connector to set up two connector configurations - one to an Active Directory server and one to a ForgeRock Directory Services (DS) instance. The Connector Types listed here do not include all supported connectors - only those that are bundled with IDM. You can download additional connectors from the ForgeRock BackStage download site and place them in the `/path/to/openidm/connectors` directory. For information on all supported connectors and how to configure them, see the Connector Reference.

The tabs on the connector configuration screens correspond to the objects and properties described in the remaining sections of this chapter.

When a connector configuration is complete, and IDM is able to establish the connection to the remote resource, the Data tab displays the objects in that remote resource. For example, the following image shows the contents of a connected LDAP resource:

Data Tab For a Connected LDAP Resource



You can search through these objects with either the Basic Filter shown in each column, or the Advanced Filter option, which allows you to build many of the queries shown in "Defining and Calling Queries".

15.2.3. Creating Connector Configurations Over REST

You create a new connector configuration over REST 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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/system?_action=availableConnectors"
```

Available connectors are installed in `openidm/connectors`. IDM bundles the connectors described in "Supported Connector Versions" in the *Release Notes*.

The preceding command therefore returns the following output:

```
{
  "connectorRef": [
```

```
    {
      "displayName": "Workday Connector",
      "bundleVersion": "1.5.20.8",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.workday-connector",
      "connectorName": "org.forgerock.openicf.connectors.workday.WorkdayConnector"
    },
    {
      "displayName": "SSH Connector",
      "bundleVersion": "1.5.20.8",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.ssh-connector",
      "connectorName": "org.forgerock.openicf.connectors.ssh.SSHConnector"
    },
    {
      "displayName": "ServiceNow Connector",
      "bundleVersion": "1.5.20.8",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.servicenow-connector",
      "connectorName": "org.forgerock.openicf.connectors.servicenow.ServiceNowConnector"
    },
    {
      "displayName": "Scripted SQL Connector",
      "bundleVersion": "1.5.20.8",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.scriptedsql-connector",
      "connectorName": "org.forgerock.openicf.connectors.scriptedsql.ScriptedSQLConnector"
    },
    {
      "displayName": "Scripted REST Connector",
      "bundleVersion": "1.5.20.8",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.scriptedrest-connector",
      "connectorName": "org.forgerock.openicf.connectors.scriptedrest.ScriptedRESTConnector"
    },
    {
      "displayName": "Scim Connector",
      "bundleVersion": "1.5.20.8",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.scim-connector",
      "connectorName": "org.forgerock.openicf.connectors.scim.ScimConnector"
    },
    {
      "displayName":"Salesforce Connector",
      "bundleVersion":"1.5.20.8",
      "systemType":"provisioner.openicf",
      "bundleName":"org.forgerock.openicf.connectors.salesforce-connector",
      "connectorName":"org.forgerock.openicf.connectors.salesforce.SalesforceConnector"
    },
    {
      "displayName": "MongoDB Connector",
      "bundleVersion": "1.5.20.8",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.mongodb-connector",
      "connectorName": "org.forgerock.openicf.connectors.mongodb.MongoDBConnector"
    },
    {
      "displayName": "Marketo Connector",
      "bundleVersion": "1.5.20.8",
```

```
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.marketo-connector",
      "connectorName": "org.forgerock.openicf.connectors.marketo.MarketoConnector"
    },
    {
      "displayName": "LDAP Connector",
      "bundleVersion": "1.5.20.8",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.ldap-connector",
      "connectorName": "org.identityconnectors.ldap.LdapConnector"
    },
    {
      "displayName": "Kerberos Connector",
      "bundleVersion": "1.5.20.8",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.kerberos-connector",
      "connectorName": "org.forgerock.openicf.connectors.kerberos.KerberosConnector"
    },
    {
      "displayName": "Scripted Poolable Groovy Connector",
      "bundleVersion": "${scriptedPoolableConnectorVersion}",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.groovy-connector",
      "connectorName": "org.forgerock.openicf.connectors.groovy.ScriptedPoolableConnector"
    },
    {
      "displayName": "Scripted Groovy Connector",
      "bundleVersion": "1.5.20.8",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.groovy-connector",
      "connectorName": "org.forgerock.openicf.connectors.groovy.ScriptedConnector"
    },
    {
      "displayName": "GoogleApps Connector",
      "bundleVersion": "1.5.20.8",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.googleapps-connector",
      "connectorName": "org.forgerock.openicf.connectors.googleapps.GoogleAppsConnector"
    },
    {
      "displayName": "Database Table Connector",
      "bundleVersion": "1.5.20.8",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.databasetable-connector",
      "connectorName": "org.identityconnectors.databasetable.DatabaseTableConnector"
    },
    {
      "displayName": "CSV File Connector",
      "bundleVersion": "1.5.20.8",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.csvfile-connector",
      "connectorName": "org.forgerock.openicf.csvfile.CSVFileConnector"
    },
    {
      "displayName": "Adobe Marketing Cloud Connector",
      "bundleVersion": "1.5.20.8",
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.adobecm-connector",
      "connectorName": "org.forgerock.openicf.acm.ACMConnector"
```

```
    }
  ]
}
```

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 in the following command for the CSV file connector:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request POST
 \
--data '{"connectorRef":
    {
      "systemType": "provisioner.openicf",
      "bundleName": "org.forgerock.openicf.connectors.csvfile-connector",
      "connectorName": "org.forgerock.openicf.csvfile.CSVFileConnector",
      "displayName": "CSV File Connector",
      "bundleVersion": "[1.5.19.0,1.6.0.0)"
    }
 }' \
 "http://localhost:8080/openidm/system?_action=createCoreConfig"
```

This command returns a core connector configuration, similar to the following:

```
{
  "connectorRef": {
    "systemType": "provisioner.openicf",
    "bundleName": "org.forgerock.openicf.connectors.csvfile-connector",
    "connectorName": "org.forgerock.openicf.csvfile.CSVFileConnector",
    "displayName": "CSV File Connector",
    "bundleVersion": "[1.5.19.0,1.6.0.0)"
  },
  "poolConfigOption": {
    "maxObjects": 10,
    "maxIdle": 10,
    "maxWait": 150000,
    "minEvictableIdleTimeMillis": 120000,
    "minIdle": 1
  },
  "resultsHandlerConfig": {
    "enableNormalizingResultsHandler": false,
    "enableFilteredResultsHandler": false,
    "enableCaseInsensitiveFilter": false,
    "enableAttributesToGetSearchResultsHandler": true
  },
  "operationTimeout": {
    "CREATE": -1,
    "UPDATE": -1,
    "DELETE": -1,
    "TEST": -1,
    "SCRIPT_ON_CONNECTOR": -1,
    "SCRIPT_ON_RESOURCE": -1,
```

```
    "GET": -1,
    "RESOLVEUSERNAME": -1,
    "AUTHENTICATE": -1,
    "SEARCH": -1,
    "VALIDATE": -1,
    "SYNC": -1,
    "SCHEMA": -1
  },
  "configurationProperties": {
    "headerPassword": "password",
    "spaceReplacementString": "_",
    "csvFile": null,
    "newlineString": "\n",
    "headerUid": "uid",
    "quoteCharacter": "\"",
    "fieldDelimiter": ",",
    "syncFileRetentionCount": 3
  }
}
```

The configuration that is returned is not yet functional. It does not contain the required system-specific `configurationProperties`, such as the host name and port for an external system, or the `csvFile` for the CSV file connector. In addition, the configuration does not include the complete list of `objectTypes` and `operationOptions`.

To generate the final configuration, add values for the required `configurationProperties` to the core configuration, and use the updated configuration as the body for the next command:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request POST
 \
--data '{
  "configurationProperties": {
    "headerPassword": "password",
    "spaceReplacementString": "_",
    "csvFile": "&{idm.instance.dir}/data/csvConnectorData.csv",
    "newlineString": "\n",
    "headerUid": "uid",
    "quoteCharacter": "\"",
    "fieldDelimiter": ",",
    "syncFileRetentionCount": 3
  },
  "connectorRef": {
    "systemType": "provisioner.openicf",
    "bundleName": "org.forgerock.openicf.connectors.csvfile-connector",
    "connectorName": "org.forgerock.openicf.csvfile.CSVFileConnector",
    "displayName": "CSV File Connector",
    "bundleVersion": "[1.5.19.0,1.6.0.0)"
  },
  "poolConfigOption": {
    "maxObjects": 10,
    "maxIdle": 10,
```

```
    "maxWait": 150000,
    "minEvictableIdleTimeMillis": 120000,
    "minIdle": 1
  },
  "resultsHandlerConfig": {
    "enableNormalizingResultsHandler": true,
    "enableFilteredResultsHandler": true,
    "enableCaseInsensitiveFilter": false,
    "enableAttributesToGetSearchResultsHandler": true
  },
  "operationTimeout": {
    "CREATE": -1,
    "UPDATE": -1,
    "DELETE": -1,
    "TEST": -1,
    "SCRIPT_ON_CONNECTOR": -1,
    "SCRIPT_ON_RESOURCE": -1,
    "GET": -1,
    "RESOLVEUSERNAME": -1,
    "AUTHENTICATE": -1,
    "SEARCH": -1,
    "VALIDATE": -1,
    "SYNC": -1,
    "SCHEMA": -1
  }
}   ' \
"http://localhost:8080/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 new line in the content. You can therefore pass the `--data '...'` option on a single line, or including line feeds.

IDM attempts to read the schema, if available, from the external resource in order to generate output. IDM 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 IDM 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, IDM 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.

When you have the complete connector configuration, save that configuration in a file named `provisioner.openicf-`*`name`*`.json` (where name corresponds to the name of the connector) and place it in the `conf` directory of your project.

15.2.4. Setting the Connector Reference Properties

The following example shows a connector reference object:

```
"connectorRef" : {
    "bundleName"    : "org.forgerock.openicf.connectors.csvfile-connector",
    "bundleVersion" : "[1.5.19.0,1.6.0.0)",
    "connectorName" : "org.forgerock.openicf.csvfile.CSVFileConnector",
    "connectorHostRef" : "csv"
},
```

`bundleName`

string, required

The `ConnectorBundle-Name` of the ICF connector.

`bundleVersion`

string, required

The `ConnectorBundle-Version` of the ICF connector. The value can be a single version (such as `1.4.0.0`) or a range of versions, which lets you 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, IDM 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 connector 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"`.

15.2.5. Setting the Pool Configuration

The `poolConfigOption` specifies the pool configuration for poolable connectors only (connectors that have `"connectorPoolingSupported" : true`). 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.

15.2.6. Setting the Operation Timeouts

The operation timeout property lets you configure timeout values per operation type. By default, no timeout is 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.

15.2.7. Setting the Connection Configuration

The `configurationProperties` object specifies 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 CSV sample resource connector:

```
"configurationProperties" : {
    "csvFile" : "&{idm.instance.dir}/data/csvConnectorData.csv"
},
```

property

Individual properties depend on the type of connector.

15.2.8. Setting the Synchronization Failure Configuration

The `syncFailureHandler` object specifies what should happen if a liveSync operation reports a failure for an operation. The following example shows a synchronization failure configuration:

```
{
    "maxRetries" : 5,
    "postRetryAction" : "logged-ignore"
}
```

`maxRetries`

positive integer or `-1`, required

The number of attempts that IDM should make to process a failed modification. 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` object) indicates that failed modifications should be retried an infinite number of times. In this case, no post retry action is executed.

`postRetryAction`

string, required

The action that should be taken if the synchronization operation fails after the specified number of attempts. The post retry action can be one of the following:

- `logged-ignore` - IDM ignores the failed modification, and logs its occurrence.
- `dead-letter-queue` - IDM saves 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 more information, see "Configuring the LiveSync Retry Policy".

15.2.9. Configuring How Results Are Handled

The `resultsHandlerConfig` object specifies how OpenICF returns results. These configuration properties do not apply to all connectors and depend on the interfaces that are implemented by each connector. For information about the interfaces that connectors support, see the Connector Reference.

The following example shows a results handler configuration object:

```
"resultsHandlerConfig" : {
    "enableNormalizingResultsHandler" : true,
    "enableFilteredResultsHandler" : false,
    "enableCaseInsensitiveFilter" : false,
    "enableAttributesToGetSearchResultsHandler" : false
}
```

`enableNormalizingResultsHandler`

boolean, false by default

When this property is enabled, ICF normalizes returned attributes to ensure that they are filtered consistently. If the connector implements the attribute normalizer interface, enable the interface

by setting this property to `true`. If the connector does not implement the attribute normalizer interface, the value of this property has no effect.

`enableFilteredResultsHandler`

boolean, false by default

Most connectors use the filtering and search capabilities of the remote connected system. In these cases, you can leave this property set to `false`. If the connector does not use the remote system's filtering and search capabilities, you *must* set this property to `true`.

All the non-scripted connectors, apart from the CSV connector use the filtering mechanism of the remote system. In the case of the CSV connector, the remote resource has no filtering mechanism, so you must set `enableFilteredResultsHandler` to `true`. For the scripted connectors, the setting will depend on how you have implemented the connector.

`enableCaseInsensitiveFilter`

boolean, false by default

This property applies only if `enableFilteredResultsHandler` is set to `true`. The filtered results handler is case-sensitive by default. For example, a search for `lastName = "Jensen"` will not match a stored user with `lastName : jensen`. When the filtered results handler is enabled, you can use this property to enable case-insensitive filtering. If you leave this property set to `false`, searches on that resource will be case-sensitive.

`enableAttributesToGetSearchResultsHandler`

boolean, false by default

By default, IDM determines which attributes should be retrieved in a search. If you set this property to `true`, the ICF framework removes *all* attributes from the READ/QUERY response, except for those that are specifically requested. For performance reasons, you should set this property to `false` for local connectors and to `true` for remote connectors.

15.2.10. Specifying the Supported Object Types

The `objectTypes` configuration specifies the object types (user, group, account, and so on) that are supported by the connector. The object names that you define here determine how the object is accessed in the URI. For example:

```
system/systemName/objectType
```

This configuration is based on the JSON Schema with the extensions described in the following section.

Attribute names that start or end with `__` are regarded as *special attributes* by OpenICF. The purpose of the special attributes in ICF is to enable someone who is developing a *new* connector to create

a contract regarding how a property can be referenced, regardless of the application that is using the connector. In this way, the connector can map specific object information between an arbitrary application and the resource, without knowing how that information is referenced in the application.

These attributes have no specific meaning in the context of IDM, although some of the connectors that are bundled with IDM use these attributes. The generic LDAP connector, for example, can be used with ForgeRock Directory Services (DS), Active Directory, OpenLDAP, and other LDAP directories. Each of these directories might use a different attribute name to represent the same type of information. For example, Active Directory uses `unicodePassword` and DS uses `userPassword` to represent the same thing, a user's password. The LDAP connector uses the special OpenICF `__PASSWORD__` attribute to abstract that difference. In the same way, the LDAP connector maps the `__NAME__` attribute to an LDAP `dn`.

The ICF `__UID__` is a special case. The `__UID__` *must not* be included in the IDM configuration or in any update or create operation. This attribute denotes the unique identity attribute of an object and IDM always maps it to the `_id` of the object.

The following excerpt shows the configuration of an `account` object type:

```
{
  "account" :
  {
    "$schema" : "http://json-schema.org/draft-03/schema",
    "id" : "__ACCOUNT__",
    "type" : "object",
    "nativeType" : "__ACCOUNT__",
    "absentIfEmpty" : false,
    "absentIfNull" : true,
    "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"
         },
    }
  }
}
```

ICF supports an `__ALL__` object type that 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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/system/ldap?_action=liveSync"
```

Note

Using 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 ForgeRock Directory Services (DS), Oracle DSEE, and the legacy Sun Directory Server, cannot use the `__ALL__` object type by default. Such servers 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.

15.2.10.1. Adding Objects and Properties Using the UI

To add object types and properties to a connector configuration by using the Admin UI, select Configure > Connectors. Select the connector that you want to change, then select the Object Types tab.

In the case of the LDAP connector, the connector reads the schema from the remote resource to determine the object types and properties that can be added to its configuration. When you select one of these object types, you can think of it as a template. Edit the basic object type, as required, to suit your deployment.

To add a property to an object type, select the Edit icon next to the object type, then select Add Property.

15.2.10.2. Extending the Object Type Configuration

`nativeType`

string, optional

The native ICF 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__`.

15.2.10.3. Specifying the Behavior For Empty Attributes

The `absentIfEmpty` and `absentIfNull` object class properties enable you to specify how attributes are handled during synchronization if their values are null (for single-valued attributes) or empty (for multi-valued attributes). You can set these properties per object type.

By default, these properties are set as follows:

`"absentIfEmpty" : false`

Multi-valued attributes whose values are empty are included in the resource response during synchronization.

`"absentIfNull" : true`

Single-valued attributes whose values are null are removed from the resource response during synchronization.

15.2.10.4. Extending the Property Type Configuration

`nativeType`

string, optional

The native ICF 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
```

Note

The `JAVA_TYPE_DATE` property is deprecated. Functionality may be removed in a future release. This property-level extension is an alias for `string`. Any dates assigned to this extension should be formatted per ISO 8601.

`nativeName`

string, optional

The native ICF attribute name.

`flags`

string, optional

The native ICF attribute flags. ICF supports the following attribute flags:

- `MULTIVALUED` - specifies that the property can be multivalued.

For multi-valued properties, if the property value type is anything other than a `string`, you *must* include an `items` property that declares the data type.

The following example shows the `entries` property of the `authentication` object in a provisioner file. The `entries` property is multi-valued, and its elements are of type `object`:

```
"authentication" : {
...
    "properties" : {
        ...
        "entries" : {
            "type" : "object",
            "required" : false,
            "nativeName" : "entries",
            "nativeType" : "object",
                "items" : {
                    "type" : "object"
                },
            "flags" : [
                "MULTIVALUED"
            ]
        },
...
```

- `NOT_CREATABLE`, `NOT_READABLE`, `NOT_UPDATEABLE`

  In some cases, the connector might not support manipulating an attribute because the attribute can only be changed directly on the remote system. For example, if the `name` attribute of an account can only be created by Active Directory, and *never* changed by IDM, you would add `NOT_CREATABLE` and `NOT_UPDATEABLE` to the provisioner configuration for that attribute.

- `NOT_RETURNED_BY_DEFAULT`

  Certain attributes such as LDAP groups or other calculated attributes might be expensive to read. To avoid returning these attributes in a default read of the object, unless they are explicitly requested, add the `NOT_RETURNED_BY_DEFAULT` flag to the provisioner configuration for that attribute.

  You can also use this flag to prevent properties from being read by default during a synchronization operation. To synchronize changes to a target object, IDM performs an UPDATE rather than a PATCH. This causes *all* attributes that are mapped from the source to the target to be modified when the synchronization is processed (rather than only those attributes that have changed). Although the *value* of a property might not change, the property still registers an update. This behavior can be problematic for properties such as the `password`, which might have restrictions on updating with a similar value. To prevent such properties from being updated during synchronization, set the `NOT_RETURNED_BY_DEFAULT` flag, which effectively prevents the property from being read from the source during the synchronization. For example:

```
"__PASSWORD__" : {
    "type" : "string",
    "nativeName" : "__PASSWORD__",
    "nativeType" : "JAVA_TYPE_GUARDEDSTRING",
    "flags" : [
        "NOT_RETURNED_BY_DEFAULT"
    ],
    "runAsUser" : true
},
```

- `REQUIRED` - specifies that the property is required in create operations. This flag sets the `required` property of an attribute as follows:

```
"required" : true
```

You can configure connectors to enable provisioning of any arbitrary property. For example, the following property definitions would enable you to provision image files, used as avatars, to `account` objects in a system resource. The first definition would work for a single photo encoded as a base64 string. The second definition would work for 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"
 },
```

Note

Do not use the dash character (`-`) in property names, like `last-name`. Dashes in names make JavaScript syntax more complex. If you cannot avoid the dash, write `source['last-name']` instead of `source.last-name` in your JavaScript scripts.

15.2.11. Configuring the Operation Options

The `operationOptions` object lets you deny specific operations on a resource. For example, you can use this configuration object to deny `CREATE` and `DELETE` operations on a read-only resource to avoid IDM accidentally updating the 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",
            "type" : "object",
            "properties" :
            {
              "_OperationOption-float" :
              {
                 "type" : "number",
                 "nativeType" : "JAVA_TYPE_PRIMITIVE_FLOAT"
              }
            }
          }
        },
        "__GROUP__" :
        {
          "denied" : false,
          "onDeny" : "DO_NOTHING"
        }
      }
    }
  }
...
```

The ICF Framework supports the following operations:

- `AUTHENTICATE`
- `CREATE`
- `DELETE`
- `GET`
- `RESOLVEUSERNAME`
- `SCHEMA`
- `SCRIPT_ON_CONNECTOR`
- `SCRIPT_ON_RESOURCE`
- `SEARCH`
- `SYNC`
- `TEST`

- `UPDATE`
- `VALIDATE`

For detailed information on these operations, see the ICF API documentation.

The `operationOptions` object has the following configurable properties:

`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.

15.3. Accessing Remote Connectors

When you configure a remote connector, you use the *connector info provider service* to connect through a remote connector server. To configure a connector info provider service, you'll need to set up a `provisioner.openicf.connectorinfoprovider.json` file in your project's `conf/` subdirectory. You can find a sample version of this file in the `openidm/samples/example-configurations/provisioners/` directory.

The sample connector info provider configuration is as follows:

```
{
   "remoteConnectorServers" :
      [
         {
            "name" : "dotnet",
            "host" : "127.0.0.1",
            "port" : 8759,
            "useSSL" : false,
            "timeout" : 0,
            "protocol" : "websocket",
            "key" : "Passw0rd"
         }
      ]
}
```

You can configure the following remote connector server 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; an IP address is acceptable.

`port`

integer, optional

The remote port; set to 8759 by default.

`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.

`protocol`

string

The connector server uses the `websocket` communication protocol.

`key`

string, required

The secret key, or password, to use to authenticate to the remote connector server.

15.3.1. 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 IDM to access the connector.

For a list of supported connector server versions, and compatibility between versions, see "IDM / ICF Compatibility Matrix" in the *Release Notes*.

Important

In addition to the connector server, you must copy the connector .jar itself to the `/path/to/openicf/bundles` directory and any connector dependencies to the `/path/to/openicf/lib/` directory on the remote machine. For a list of dependencies for each connector, see "Installing Connector Dependencies".

This section describes the steps to install a .NET connector server and a remote Java Connector Server.

15.3.1.1. 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.

By default, the connector server outputs log messages to a file named `connectorserver.log`, in the `\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>
```

Installing the .NET Connector Server

1. The .NET connector server is distributed in two file formats:

   - `openicf-version-dotnet.msi` is a wizard that installs the Connector Server as a Windows service.
   - `openicf-version-dotnet.zip` is simply a bundle of the files required to run the Connector Server.

   Depending on how you want to install the Connector Server, download the corresponding file from the ForgeRock BackStage download site:

   - If you do *not* want to run the Connector Server as a Windows service, download and extract the `.zip` file, then move on to "Configuring the .NET Connector Server".

     If you have extracted the `.zip` file and then decide to run the Connector Server as a service, install the service manually with the following command:

```
.\ConnectorServerService.exe /install /serviceName service-name
```

Then proceed to "Configuring the .NET Connector Server".

- To install the Connector Server as a Windows service automatically, follow the remaining steps in this section.

2. Double-click the `openicf-version-dotnet.msi` installation file and complete the wizard.

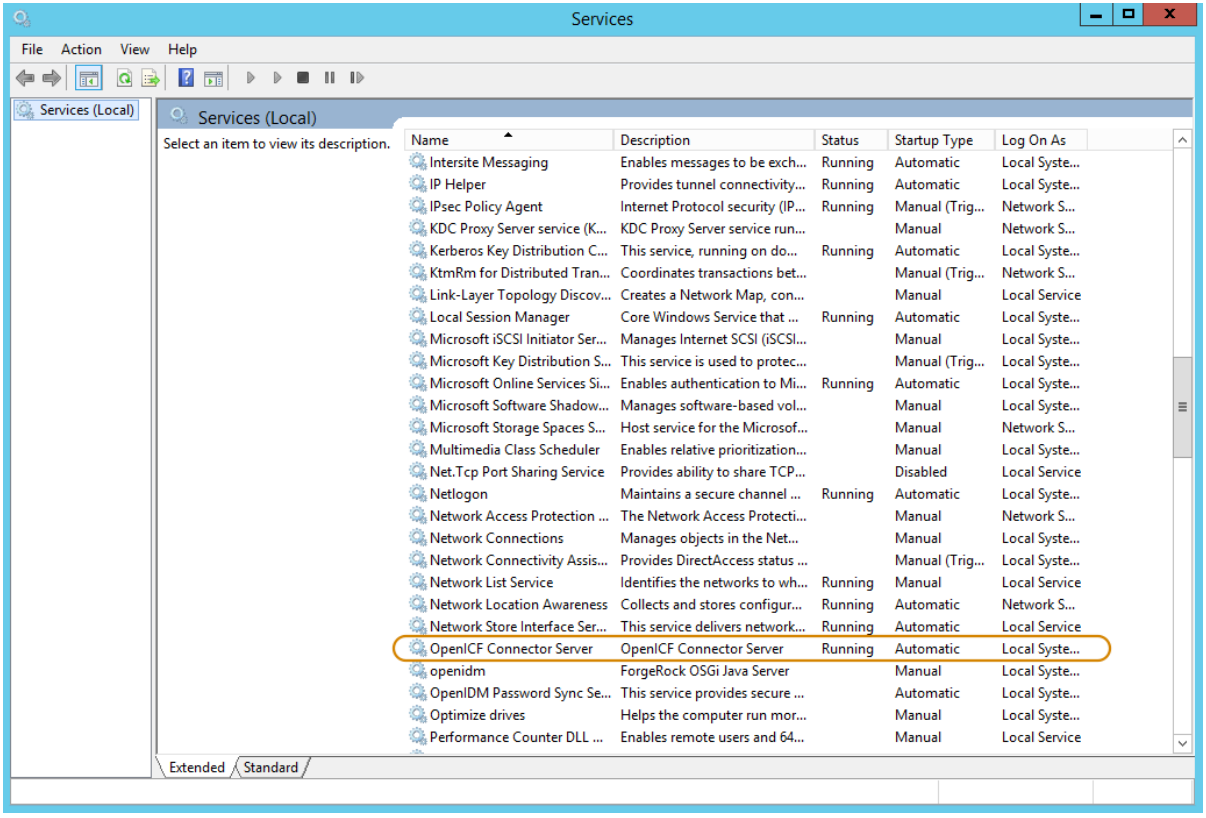
   You must run the wizard as a user who has permissions to start and stop a Windows service, otherwise the service will not start.

   Select Typical as the Setup Type.

   When the wizard has completed, the Connector Server is installed as a Windows Service.

3. Open the Microsoft Services Console and make sure that the Connector Server is listed there.

   The name of the service is `OpenICF Connector Server`, by default.



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 Microsoft Services Console to stop it.

2. At the command prompt, change to the directory where the Connector Server was installed:
   ```
   cd "c:\Program Files (x86)\ForgeRock\OpenICF"
   ```

3. Run the **ConnectorServerService /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`:
   ```
   ConnectorServerService /setkey Passw0rd
   Key has been successfully updated.
   ```
   This key is used by clients connecting to the Connector Server. The key that you set here must also be set in the IDM connector info provider configuration file (`conf/provisioner.openicf.connectorinfoprovider.json`). For more information, see "Configuring IDM to Connect to the .NET Connector Server".

4. Edit the Connector Server configuration.

   The Connector Server configuration is saved in a file named `ConnectorServerService.exe.Config` (in the directory in which the Connector Server is installed).

   Check and edit this file, as necessary, to reflect your installation. Specifically, verify that the `baseAddress` reflects the host and port on which the connector server is installed:
   ```
   <system.serviceModel>
     <services>
       <service name="Org.ForgeRock.OpenICF.Framework.Service.WcfServiceLibrary.WcfWebsocket">
         <host>
           <baseAddresses>
             <add baseAddress="http://0.0.0.0:8759/openicf" />
           </baseAddresses>
         <host>
       </service>
     </services>
   </system.serviceModel>
   ```
   The `baseAddress` specifies the host and port on which the Connector Server listens, and is set to `http://0.0.0.0:8759/openicf` by default. If you set a host value other than the default `0.0.0.0`, connections from all IP addresses other than the one specified are denied.

   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, IDM will be unable to contact the Connector Server. For more information, see the corresponding Microsoft documentation.

5. Optionally, configure the Connector Server to use SSL:

a. Open a Powershell terminal as a user with administrator privileges, then change to the ICF installation directory:

```
cd 'C:\Program Files (x86)\ForgeRock\OpenICF'
```

b. Use an existing CA certificate, or use the `New-SelfSignedCertificate` cmdlet to create a self-signed certificate:

```
New-SelfSignedCertificate -DnsName "dotnet", "dotnet.example.com" -CertStoreLocation "cert:
\LocalMachine\My"
PSParentPath: Microsoft.PowerShell.Security\Certificate::LocalMachine\My

Thumbprint                                Subject
----------                                -------
770F531F14AF435E963E14AD82B70A47A4BFFBF2  CN=dotnet
```

c. Assign the certificate to the Connector Server:

```
.\ConnectorServerService.exe /setCertificate

Select certificate you want to use:
Index  Issued To               Thumbprint
-----  ---------               -------------------------

   0)  dotnet                   770F531F14AF435E963E14AD82B70A47A4BFFBF2

0
Certificate Thumbprint has been successfully updated to 770F531F14AF435E963E14AD82B70A47A4BFFBF2.
```

d. Bind the certificate to the Connector Server port (`8759` by default). To bind the certificate:

i. Use `uuidgen.exe` to generate a new UUID:

```
& 'C:\Program Files (x86)\Windows Kits\10\bin\10.0.15063.0\x64\uuidgen.exe'
058d7a64-8628-49ec-a417-a70c8974046d
```

ii. Enter the `netsh http` console and add the certificate thumbprint generated in the previous step and the UUID that you have just generated:

```
netsh
netsh>http
netsh http>add sslcert ipport=0.0.0.0:8759 certhash=770F5...FFBF2 appid={058d7...4046d}
SSL Certificate successfully added
```

e. Change the Connector Server configuration (in the `ConnectorServerService.exe.Config` file) to use HTTPS and not HTTP.

Change `baseAddress="http..."` to `baseAddress="https..."`:

```
<host>
  <baseAddresses>
    ...
    <add baseAddress="https://0.0.0.0:8759/openicf"/>
  </baseAddresses>
</host>
```

Change `httpTransport` to `httpsTransport`:

```
  <httpsTransport authenticationScheme="Basic" realm="OpenICF">
    <webSocketSettings transportUsage="Always" createNotificationOnConnection="true" .../>
  </httpsTransport>
```

f. Export the certificate:

1. Launch the certificate management MMC (`certlm.msc`).
2. Locate the `dotnet` certificate then right-click and select All Tasks > Export.

   The Certificate Export Wizard is launched.
3. Select Next > No, do not export the private key > DER encoded binary X.509 (.CER) > Next.
4. Save the file in an accessible location (for example, `C:\Users\Administrator\Desktop\dotnet.cer`) then select Finish.

g. Import the certificate into the IDM truststore:

1. Transfer the certificate from the Windows machine to the machine that's running IDM.
2. Change to the `openidm/security` directory and use the Java `keytool` command to import the certificate:

```
$ cd /path/to/openidm/security
$ keytool -import -alias dotnet -file ~/Downloads/dotnet.cer -keystore ./truststore
Enter keystore password: changeit
Owner: CN=dotnet
Issuer: CN=dotnet
Serial number: 1e3af7baed05ce834da5cd1bf1241835
Valid from: Tue Aug 08 15:58:32 SAST 2017 until: Wed Aug 08 16:18:32 SAST 2018
Certificate fingerprints:
  MD5:  D1:B7:B7:46:C2:59:1A:3C:94:AA:65:99:B4:43:3B:E8
  SHA1: 77:0F:53:1F:14:AF:43:5E:96:3E:14:AD:82:B7:0A:47:A4:BF:FB:F2
  SHA256:
 C0:52:E2:E5:E5:72:9D:69:F8:11:4C:B8:4C:E4:E3:1C:19:95:86:19:70:E5:31:FA:D8:81:4B:F2:AC:30:9C:73
  Signature algorithm name: SHA256withRSA
  Version: 3

...

Trust this certificate? [no]: yes
Certificate was added to keystore
```

h. Update your project's connector server configuration file (`conf/provisioner.openicf.connectorinfoprovider.json`) to use SSL:

```
$ cd /path/to/my-project/conf
$ more provisioner.openicf.connectorinfoprovider.json
"remoteConnectorServers" : [
    {
        "name" : "dotnet",
        "host" : "my-windows-host",
        "port" : 8759,
        "protocol" : "websocket",
        "useSSL" : true,
        "timeout" : 0,
        "key" : {...}
    }
]
```

6. Check the trace settings, in the same Connector Server configuration file, under the `system.diagnostics` item:

```
<system.diagnostics>
  <trace autoflush="true" indentsize="4">
    <listeners>
      <remove name="Default" />
      <add name="console" />
      <add name="file" />
    </listeners>
  </trace>
  <sources>
    <source name="ConnectorServer" switchName="switch1">
      <listeners>
        <remove name="Default" />
        <add name="file" />
      </listeners>
    </source>
  </sources>
  <switches>
    <add name="switch1" value="Information" />
  </switches>
  <sharedListeners>
    <add name="console" type="System.Diagnostics.ConsoleTraceListener" />
    <add name="file" type="System.Diagnostics.TextWriterTraceListener"
            initializeData="logs\ConnectorServerService.log"
            traceOutputOptions="DateTime">
        <filter type="System.Diagnostics.EventTypeFilter" initializeData="Information" />
    </add>
  </sharedListeners>
</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, set the EventTypeFilter's `initializeData` to `Warning` or `Error`. For very verbose logging set the value to `Verbose` or `All`. The

logging level has a direct effect on the performance of the Connector Servers, so take care when setting this level.

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 (`ICF 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:\> cd "c:\Program Files (x86)\ForgeRock\OpenICF"`.

   Start the server with the following command:

   ```
   ConnectorServerService.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.

Configuring IDM to Connect to the .NET Connector Server

The connector info provider service configures one or more remote connector servers to which IDM can connect. The connector info provider configuration is stored in a file named *`project-dir`*`/conf/provisioner.openicf.connectorinfoprovider.json`. A sample connector info provider configuration file is located in `openidm/samples/example-configurations/provisioners/`.

To configure IDM to use the remote .NET connector server, follow these steps:

1. Start IDM, if it is not already running.

2. Copy the sample connector info provider configuration file to your project's `conf/` directory:

   ```
   $ cd /path/to/openidm
   $ cp samples/example-configurations/provisioners/provisioner.openicf.connectorinfoprovider
   .json project-dir/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,
        "protocol" : "websocket",
        "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 name is referenced in the `connectorHostRef` property of the connector configuration file (`provisioner.openicf-ad.json`).

`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 `ConnectorServerService.exe.config` file.

For more information, see "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 `ConnectorServerService.exe.config` file.

`timeout`

Specifies the length of time, in seconds, that IDM should attempt to connect to the Connector Server before abandoning the attempt. To disable the timeout, set `"timeout" : 0,`.

`protocol`

Version 1.5.20.8 of the ICF framework supports a new communication protocol with remote connector servers. This property is enabled by default, and should be set to `websocket` for version 1.5.20.8.

key

Specifies the connector server key. This property matches the `key` property in the `ConnectorServerService.exe.config` file. For more information, see "Configuring the .NET Connector Server".

The string value that you enter here is encrypted as soon as the file is saved.

15.3.1.2. 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.

Installing a Remote Java Connector Server for Unix/Linux

1. Download the ICF Java Connector Server from the ForgeRock BackStage download site.
2. Change to the appropriate directory and unpack the zip file. The following command unzips the file in the current directory:

```
$ unzip openicf-zip-1.5.20.8.zip
```

3. Change to the `openicf` directory:

```
$ cd path/to/openicf
```

4. 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
$  bin/ConnectorServer.sh /setkey Passw0rd
Key has been successfully updated.
```

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\=
```

The `connectorserver.usessl` parameter 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:

```
$ bin/ConnectorServer.sh /run
```

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.

Installing a Remote Java Connector Server for Windows

1. Download the ICF Java Connector Server from the ForgeRock BackStage download 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 IDM 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\framework
\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 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 Services 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
```

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`.

15.3.2. Installing Connector Dependencies

Many connectors depend on third-party libraries. In most cases, IDM bundles these libraries, but some libraries need to be downloaded and placed in the `path/to/openidm/lib` directory, if you are running the connector locally.

When you run a connector on a remote machine (using a connector server), you must copy the connector itself as well as *all* connector dependencies to the remote machine. If the connector dependencies are bundled, they can be found in two locations in an IDM installation: `/path/to/openidm/bundles/`and `/path/to/openidm/lib/`. To run a connector remotely, download its dependencies or locate them in your IDM installation, then copy those files to the `/path/to/openicf/lib/` directory on the remote machine.

The following table lists the connector dependencies and indicates which ones must be downloaded:

Dependencies for bundled connectors	
Connector	**Dependencies**
Adobe Marketing Cloud Connector	• `bundle/httpclient-osgi-4.5.2.jar`
CSV File Connector	• `bundle/super-csv-2.4.0.jar`
Database Table Connector	No external dependencies. However, you must include the JDBC driver for the database that you are targeting in the `/path/to/openidm/lib/` directory.
GoogleApps Connector	• `bundle/httpclient-osgi-4.5.2.jar` • `bundle/httpcore-osgi-4.4.5.jar` • `bundle/jackson-core-2.9.4.jar` • `lib/google-api-client-1.19.0.jar`

Dependencies for bundled connectors	
Connector	**Dependencies**
	• `lib/google-api-services-admin-directory-directory_v1-rev41-1.19.0.jar` • `lib/google-api-services-licensing-v1-rev34-1.19.0.jar` • `lib/google-http-client-1.19.0.jar` • `lib/google-http-client-jackson2-1.19.0.jar` • `lib/google-oauth-client-1.19.0.jar` • `lib/google-oauth-client-java6-1.19.0.jar`
Scripted Groovy Connector	No external dependencies
Scripted Poolable Groovy Connector	No external dependencies
Kerberos Connector	• `lib/groovy-connector-1.5.20.8` • `lib/ssh-connector-1.5.20.8`
LDAP Connector	No external dependencies
Marketo Connector	• `lib/groovy-connector-1.5.20.8`
MongoDB Connector	• `bundle/bson-3.6.3.jar` • `bundle/mongodb-driver-core-3.6.3.jar` • `lib/groovy-connector-1.5.20.8` • `lib/mongodb-driver-3.6.3.jar`
PeopleSoft Connector	• `psjoa.jar` • `psft.jar`
SCIM Connector	• `bundle/httpclient-osgi-4.5.2.jar` • `bundle/httpcore-osgi-4.4.5.jar` • `bundle/jackson-annotations-2.9.4.jar` • `bundle/jackson-core-2.9.4.jar` • `bundle/jackson-databind-2.9.4.jar`
Scripted CREST Connector	• `bundle/chf-http-core-23.0.0-alpha-49.jar` • `bundle/httpasyncclient-osgi-4.1.2.jar` • `bundle/httpclient-osgi-4.5.2.jar` • `bundle/httpcore-osgi-4.4.5.jar`

Dependencies for bundled connectors	
Connector	**Dependencies**
	• `bundle/jackson-annotations-2.9.4.jar` • `bundle/json-resource-23.0.0-alpha-49.jar` • `lib/groovy-connector-1.5.20.8`
Scripted REST Connector	• `bundle/httpclient-osgi-4.5.2.jar` • `bundle/httpcore-osgi-4.4.5.jar` • `lib/commons-collections-3.2.2.jar` • `lib/groovy-connector-1.5.20.8` • `lib/http-builder-0.7.1.jar` • `lib/json-lib-2.3-jdk15.jar` • `lib/xml-resolver-1.2.jar`
Scripted SQL Connector	• `bundle/tomcat-juli-8.5.23.jar` • `lib/groovy-connector-1.5.20.8` • `lib/tomcat-jdbc-8.5.23.jar`
ServiceNow Connector	• `bundle/httpclient-osgi-4.5.2.jar` • `lib/json-20170516.jar`
SSH Connector	• `lib/expect4j-1.9.jar` • `lib/groovy-connector-1.5.20.8` • `lib/jsch-0.1.54.jar`
Workday Connector	The following dependencies are bundled with IDM but need to be copied to the remote connector server if you are running the connector remotely: • `bundle/wsdl4j-1.6.3.jar` • `bundle/xmlschema-core-2.2.3.jar` • `bundle/xmlsec-2.1.1.jar` • `lib/cxf-rt-frontend-jaxws-3.2.2.jar` • `lib/cxf-rt-transports-http-3.2.5.jar` • `lib/cxf-rt-ws-security-3.2.2.jar` • `lib/wss4j-policy-2.2.1.jar` • `lib/wss4j-ws-security-common-2.2.1.jar`

Dependencies for bundled connectors	
Connector	**Dependencies**
	• `lib/wss4j-ws-security-dom-2.2.1.jar` • `lib/wss4j-ws-security-policy-stax-2.2.1.jar` • `lib/wss4j-ws-security-stax-2.2.1.jar` The following libraries are *not* bundled with IDM and must be downloaded separately, even if you are running the connector locally. Place these dependencies in the `lib` directory: • `cxf-core-3.2.2.jar` • `cxf-rt-bindings-soap-3.2.2.jar` • `cxf-rt-databinding-jaxb-3.2.2.jar` • `cxf-rt-frontend-simple-3.2.2.jar` • `cxf-rt-security-3.2.2.jar` • `cxf-rt-wsdl-3.2.2.jar` • `wss4j-bindings-2.2.1.jar`

15.3.2.1. Example: Using the CSV Connector to Reconcile Users in a Remote CSV Data Store

This example demonstrates reconciliation of users stored in a CSV file on a remote machine. The remote Java Connector Server enables IDM to synchronize its repository with the remote CSV repository.

The example assumes that a remote Java Connector Server is installed on a host named `remote-host`. For instructions on setting up the remote Java Connector Server, see "Installing a Remote Java Connector Server for Unix/Linux" or "Installing a Remote Java Connector Server for Windows".

Configuring the Remote Connector Server for the CSV Connector Example

This example assumes that the Java Connector Server is running on the machine named `remote-host`. The example uses the small CSV data set provided with the *Getting Started* sample (`hr.csv`). The CSV connector runs as a *remote connector*, that is, on the remote host on which the Java Connector Server is installed. Before you start, copy the sample data file, and the CSV connector itself over to the remote machine.

1. Shut down the remote connector server, if it is running. In the connector server terminal window, type `q`:

```
q
INFO: Stopped listener bound to [0.0.0.0:8759]
May 30, 2016 12:33:24 PM INFO  o.f.o.f.server.ConnectorServer: Server is
 shutting down org.forgerock.openicf.framework.server.ConnectorServer@171ba877
```

2. Copy the CSV data file from the *Getting Started* sample (`/path/to/openidm/samples/getting-started/data/hr.csv`) to an accessible location on the machine that hosts the remote Java Connector Server. For example:

```
$ cd /path/to/openidm/samples/getting-started/data/
$ scp hr.csv testuser@remote-host:/home/testuser/csv-sample/data/
Password:********
hr.csv     100%  651     0.6KB/s   00:00
```

3. Copy the CSV connector .jar from the IDM installation to the `openicf/bundles` directory on the remote host:

```
$ cd path/to/openidm
$ scp connectors/csvfile-connector-1.5.20.8.jar testuser@remote-host:/path/to/openicf/bundles/
Password:********
csvfile-connector-1.5.20.8.jar    100%   40KB  39.8KB/s   00:00
```

4. The CSV connector depends on the Super CSV library, that is bundled with IDM. Copy the Super CSV library (`super-csv-2.4.0.jar`) from the `openidm/bundle` directory to the `openicf/lib` directory on the remote server:

```
$ cd path/to/openidm
$ scp bundle/super-csv-2.4.0.jar testuser@remote-host:/path/to/openicf/lib/
Password:********
super-csv-2.4.0.jar              100%   96KB  95.8KB/s   00:00
```

5. On the remote host, restart the Connector Server so that it picks up the new CSV connector and its dependent libraries:

```
$ cd /path/to/openicf
$ bin/ConnectorServer.sh /run
...
May 30, 2016 3:58:29 PM INFO  o.i.f.i.a.l.LocalConnectorInfoManagerImpl: Add ConnectorInfo
 ConnectorKey(
 bundleName=org.forgerock.openicf.connectors.csvfile-connector bundleVersion="[1.5.19.0,1.6.0.0)"
 connectorName=org.forgerock.openicf.csvfile.CSVFileConnector ) to Local Connector Info Manager from
 file:/path/to/openicf/bundles/csvfile-connector-1.5.20.8.jar
May 30, 2016 3:58:30 PM org.glassfish.grizzly.http.server.NetworkListener start
INFO: Started listener bound to [0.0.0.0:8759]
May 30, 2016 3:58:30 PM org.glassfish.grizzly.http.server.HttpServer start
INFO: [ICF Connector Server] Started.
May 30, 2016 3:58:30 PM INFO  o.f.openicf.framework.server.Main: ConnectorServer
 listening on: ServerListener[0.0.0.0:8759 - plain]
```

The connector server logs are noisy by default. You should, however, notice the addition of the CSV connector.

Configuring IDM for the Remote CSV Connector Example

Before you start, copy the following files to your `/path/to/openidm/conf` directory:

- A customised mapping file required for this example.
- `/openidm/samples/example-configurations/provisioners/provisioner.openicf.connectorinfoprovider.json` The sample connector server configuration file.
- `/openidm/samples/example-configurations/provisioners/provisioner.openicf-csvfile.json`

  The sample connector configuration file.

1. Edit the remote connector server configuration file (`provisioner.openicf.connectorinfoprovider.json`) to match your network setup.

   The following example indicates that the Java connector server is running on the host `remote-host`, listening on the default port, and configured with a secret key of `Passw0rd`:

   ```
   {
       "remoteConnectorServers" : [
           {
               "name" : "csv",
               "host" : "remote-host",
               "port" : 8759,
               "useSSL" : false,
               "timeout" : 0,
               "protocol" : "websocket",
               "key" : "Passw0rd"
           }
       ]
   }
   ```

   The `name` that you set in this file will be referenced in the `connectorHostRef` property of the connector configuration, in the next step.

   The `key` that you specify here must match the password that you set when you installed the Java connector server.

2. Edit the CSV connector configuration file (`provisioner.openicf-csvfile.json`) as follows:

   ```
   {
       "connectorRef" : {
           "connectorHostRef" : "csv",
           "bundleName" : "org.forgerock.openicf.connectors.csvfile-connector",
           "bundleVersion" : "[[1.5.19.0,1.6.0.0)",
           "connectorName" : "org.forgerock.openicf.csvfile.CSVFileConnector"
       },
       ...
       "configurationProperties" : {
           "csvFile" : "/home/testuser/csv-sample/data/hr.csv"
       }
   }
   ```

- The `connectorHostRef` property indicates which remote connector server to use, and refers to the `name` property you specified in the `provisioner.openicf.connectorinfoprovider.json` file.
- The `bundleVersion : "[1.5.19.0,1.6.0.0)",` must either be exactly the same as the version of the CSV connector that you are using or, if you specify a range, the CSV connector version must be included in this range.
- The `csvFile` property must specify the absolute path to the CSV data file that you copied to the remote host on which the Java Connector Server is running.

3. Start IDM:

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

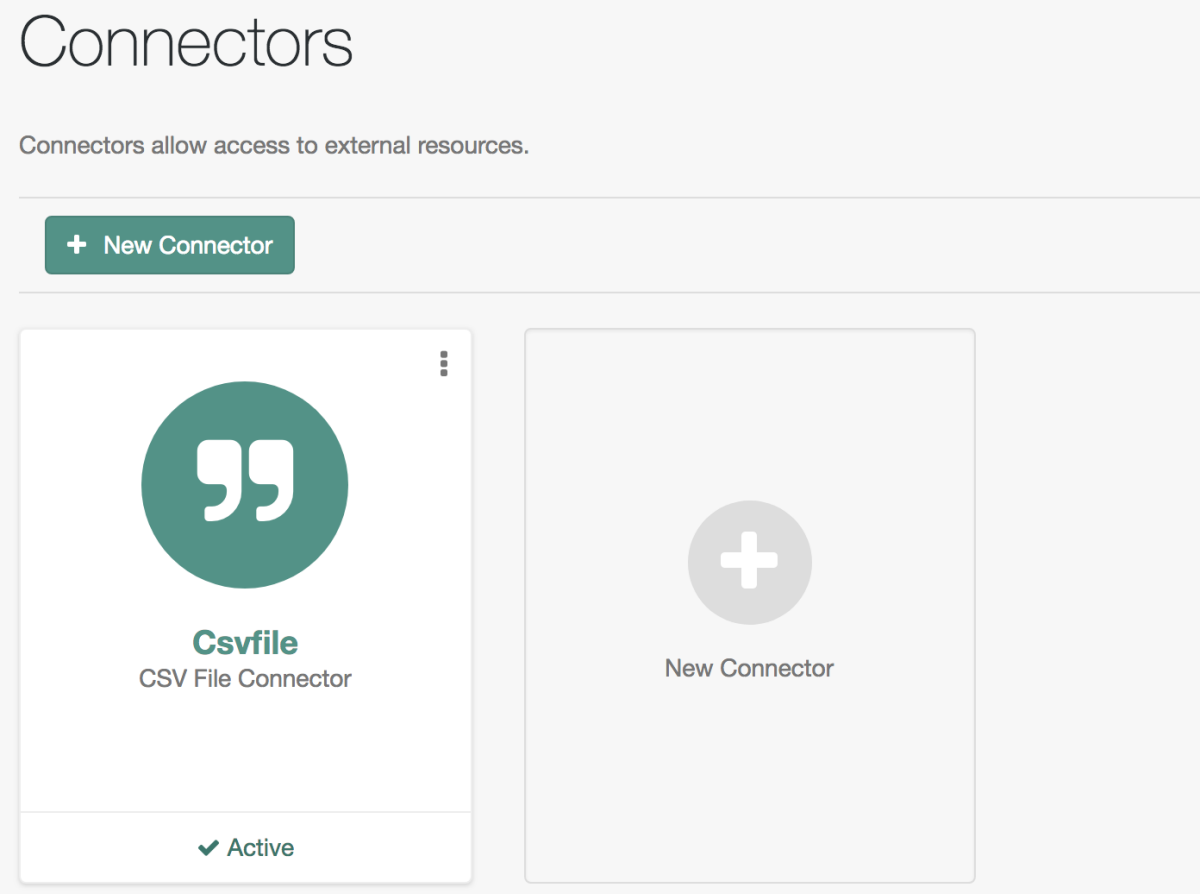
4. Verify that IDM can reach the remote connector server and that the CSV connector has been configured correctly:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/system?_action=test"
[
  {
    "name": "csv",
    "enabled": true,
    "config": "config/provisioner.openicf/csv",
    "objectTypes": [
      "__ALL__",
      "account"
    ],
    "connectorRef": {
      "bundleName": "org.forgerock.openicf.connectors.csvfile-connector",
      "connectorName": "org.forgerock.openicf.csvfile.CSVFileConnector",
      "bundleVersion": "[1.5.19.0,1.6.0.0)"
    },
    "displayName": "CSV File Connector",
    "ok": true
  }
]
```

The connector must return `"ok": true`.

Alternatively, use the Admin UI to verify that IDM can reach the remote connector server and that the CSV connector is active. Log in to the Admin UI (`https://localhost:8443/openidm/admin`) and select Configure > Connectors. The CSV connector should be listed on the Connectors page, and its status should be Active.

Connectors Tab Showing an Active CSV Connector



5. To test that the connector has been configured correctly, run a reconciliation operation as follows:

   1. Select Configure > Mappings and click the systemCsvAccounts_managedUser mapping.

   2. Click Reconcile.

   If the reconciliation is successful, the three users from the remote CSV file should have been added to the managed user repository.

   To check this, select Manage > User.

15.3.3. Configuring Failover Between Remote Connector Servers

To prevent the connector server from being a single point of failure, you can specify a list of remote connector servers that the connector can target. This failover configuration is included in your project's `conf/provisioner.openicf.connectorinfoprovider.json` file. The connector attempts to contact the first connector server in the list. If that connector server is down, it proceeds to the next connector server.

The following sample configuration defines two remote connector servers, on hosts `remote-host-1` and `remote-host-2`. These servers are listed, by their `name` property in a group, specified in the `remoteConnectorServersGroups` property. You can configure multiple servers per group, and multiple groups in a single remote connector server configuration file.

```
{
    "connectorsLocation" : "connectors",
    "remoteConnectorServers" : [
        {
            "name" : "dotnet1",
            "host" : "remote-host-1",
            "port" : 8759,
            "protocol" : "websocket",
            "useSSL" : false,
            "timeout" : 0,
            "key" : "password"
        },
        {
            "name" : "dotnet2",
            "host" : "remote-host-2",
            "port" : 8759,
            "protocol" : "websocket",
            "useSSL" : false,
            "timeout" : 0,
            "key" : "password"
         }
    ],
    "remoteConnectorServersGroups" : [
        {
            "name" : "dotnet-ha",
            "algorithm" : "failover",
            "serversList" : [
                {"name": "dotnet1"},
                {"name": "dotnet2"}
            ]
        }
    ]
}
```

The `algorithm` can be either `failover` or `roundrobin`. If the algorithm is `failover`, requests are always sent to the first connector server in the list, unless it is unavailable, in which case requests are sent to the next connector server in the list. If the algorithm is `roundrobin`, requests are distributed equally between the connector servers in the list, in the order in which they are received.

Your connector configuration file (`provisioner.openicf-connector-name.json`) references the remote connector server group, rather than a single remote connector server. For example, the following

excerpt of a PowerShell connector configuration file references the `dotnet-ha` connector server group from the previous configuration:

```
{
  "connectorRef" : {
    "bundleName" : "MsPowerShell.Connector",
    "connectorName" : "Org.ForgeRock.OpenICF.Connectors.MsPowerShell.MsPowerShellConnector",
    "connectorHostRef" : "dotnet-ha",
    "bundleVersion" : "[1.4.2.0,1.5.0.0)"
  },
  ...
```

15.4. 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 `http://localhost:8080/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 IDM instance, use the `test` action on the URL `http://localhost:8080/openidm/system/`. The following example shows an IDM system with two connected LDAP systems:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/system?_action=test"
[
  {
    "name": "ldap",
    "enabled": true,
    "config": "config/provisioner.openicf/ldap",
    "connectorRef": {
      "bundleVersion": "[1.5.19.0,1.6.0.0)",
      "bundleName": "org.forgerock.openicf.connectors.ldap-connector",
      "connectorName": "org.identityconnectors.ldap.LdapConnector"
    },
    "displayName": "LDAP Connector",
    "objectTypes": [
      "__ALL__",
      "account",
      "group"
    ],
    "ok": true
  },
  {
    "name": "ldap2",
    "enabled": true,
    "config": "config/provisioner.openicf/ldap2",
    "connectorRef": {
      "bundleVersion": "[1.5.19.0,1.6.0.0)",
      "bundleName": "org.forgerock.openicf.connectors.ldap-connector",
      "connectorName": "org.identityconnectors.ldap.LdapConnector"
    },
```

```
    "displayName": "LDAP Connector",
    "objectTypes": [
      "__ALL__",
      "account",
      "group"
    ],
    "ok": true
  }
]
```

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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/system/ldap?_action=test"
{
  "name": "ldap",
  "enabled": true,
  "config": "config/provisioner.openicf/ldap",
  "connectorRef": {
    "bundleVersion": "[1.5.19.0,1.6.0.0)",
    "bundleName": "org.forgerock.openicf.connectors.ldap-connector",
    "connectorName": "org.identityconnectors.ldap.LdapConnector"
  },
  "displayName": "LDAP Connector",
  "objectTypes": [
    "__ALL__",
    "account",
    "group"
  ],
  "ok": true
}
```

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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/system/ldap?_action=test"
{
  "name": "ldap",
  "enabled": true,
  "config": "config/provisioner.openicf/ldap",
  "connectorRef": {
    "bundleVersion": "[1.5.19.0,1.6.0.0)",
    "bundleName": "org.forgerock.openicf.connectors.ldap-connector",
    "connectorName": "org.identityconnectors.ldap.LdapConnector"
  },
  "displayName": "LDAP Connector",
  "objectTypes": [
    "__ALL__",
    "account",
    "group"
  ],
  "error": "javax.naming.CommunicationException: localhost:1389 [Root exception
  is java.net.ConnectException: Connection refused (Connection refused)]",
  "ok": false
}
```

To test the validity of a connector configuration, use the `testConfig` action and include the configuration in the command. For example:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request POST
 \
--data '{
  "configurationProperties": {
    "headerPassword": "password",
    "csvFile": "&{idm.instance.dir}/data/csvConnectorData.csv",
    "newlineString": "\n",
    "headerUid": "uid",
    "quoteCharacter": "\"",
    "fieldDelimiter": ",",
    "syncFileRetentionCount": 3
  },
  "connectorRef": {
    "systemType": "provisioner.openicf",
    "bundleName": "org.forgerock.openicf.connectors.csvfile-connector",
    "connectorName": "org.forgerock.openicf.csvfile.CSVFileConnector",
    "displayName": "CSV File Connector",
    "bundleVersion": "[1.5.19.0,1.6.0.0)"
  },
  "poolConfigOption": {
    "maxObjects": 10,
    "maxIdle": 10,
    "maxWait": 150000,
```

```
    "minEvictableIdleTimeMillis": 120000,
    "minIdle": 1
  },
  "resultsHandlerConfig": {
    "enableNormalizingResultsHandler": true,
    "enableFilteredResultsHandler": true,
    "enableCaseInsensitiveFilter": false,
    "enableAttributesToGetSearchResultsHandler": true
  },
  "operationTimeout": {
    "CREATE": -1,
    "UPDATE": -1,
    "DELETE": -1,
    "TEST": -1,
    "SCRIPT_ON_CONNECTOR": -1,
    "SCRIPT_ON_RESOURCE": -1,
    "GET": -1,
    "RESOLVEUSERNAME": -1,
    "AUTHENTICATE": -1,
    "SEARCH": -1,
    "VALIDATE": -1,
    "SYNC": -1,
    "SCHEMA": -1
  }
 }' \
 "http://localhost:8080/openidm/system?_action=testConfig"
```

If the configuration is valid, the command returns `"ok": true`, for example:

```
{
   "ok": true
}
```

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": "ldap",
  "ok": false
}
```

The `testConfig` action requires a running IDM instance, as it uses the REST API, but does not require an active connector instance for the connector whose configuration you want to test.

15.5. Removing a Connector

If you have reason to remove a connector, be careful. If you remove a connector used in a mapping, while it's part of a scheduled task, you may see unintended consequences.

If you're removing a connector, consider the following checklist. Depending on your configuration, this list may not be comprehensive:

- Consider the remote resource. Make sure you no longer need data from that resource, and that the resource no longer requires data from IDM.
- Open the `sync.json` file for your project. Delete the code block associated with the mapping.
- Review the `schedule-recon.json` file. If it contains the schedule for a single operation, delete the file or update it as a schedule for a different mapping.

When these steps are complete, you can delete the connector configuration file, typically named `provisioner-*.json`.

You can also delete the connector via the Admin UI. Log in as `openidm-admin` and select Configure > Connectors. Find the target connector, select the vertical ellipsis. In the pop-up menu that appears, press Delete. The Admin UI will automatically make the specified changes to the noted configuration files.

Chapter 16

Synchronizing Data Between Resources

One of the core IDM services is synchronizing identity data between resources. In this chapter, you will learn about the different types of synchronization, and how to configure the flexible synchronization mechanism.

16.1. Types of Synchronization

Synchronization happens either when IDM receives a change directly, or when IDM discovers a change on an external resource. An *external resource* can be any system that holds identity data, such as Active Directory, DS, a CSV file, a JDBC database, and so on. IDM connects to external resources by using *connectors*. For more information, see "*Connecting to External Resources*".

For direct changes to managed objects, IDM immediately synchronizes those changes to all mappings configured to use those objects as their source. 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.

- IDM discovers and synchronizes changes from external resources by using *reconciliation* and *liveSync*.
- IDM synchronizes changes made to its internal repository with external resources by using *implicit synchronization*.

Reconciliation

Reconciliation is the process of ensuring that the objects in two different data stores are synchronized. Traditionally, reconciliation applies mainly to user objects, but IDM can reconcile any objects, such as groups, roles, and devices.

In any reconciliation operation, there is a *source system* (the system that contains the changes) and a *target system* (the system to which the changes will be propagated). The source and target system are defined in a *mapping*. The IDM repository can be either the source or the target in a mapping. You can configure multiple mappings for one IDM instance, depending on the external resources to which you are connecting.

To perform reconciliation, IDM analyzes both the source system *and* the target system, to discover 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 liveSync. 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 IDM. IDM uses the defined mappings to replay the changes where they are required; either in the 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 any other method of recording changes that have occurred on the system. For example, ForgeRock Directory Services (DS) implements a change log that provides IDM 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 that are made in the IDM repository to external systems.

Note that implicit synchronization only synchronizes *changed objects* to the external data sources. To synchronize a complete data set, you must start with a reconciliation operation. The entire changed object is synchronized. If you want to synchronize only the attributes that have changed, you can modify the `onUpdate` script in your mapping to compare attribute values before pushing changes.

IDM uses mappings, configured in your project's `conf/sync.json` file, to determine which data to synchronize, and how that data must be synchronized. You can schedule reconciliation operations, and the frequency with which IDM polls for liveSync changes, as described in "*Scheduling Tasks and Events*".

IDM logs reconciliation and synchronization operations in the audit logs by default. For information about querying the reconciliation and synchronization logs, see "Querying Audit Logs Over REST".

16.2. Defining Your Data Mapping Model

In general, identity management software implements one of the following data models:

- A meta-directory data model, where all data are mirrored in a central repository.

  The meta-directory model offers fast access at the risk of getting outdated data.

- 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 virtual model guarantees fresh data, but pays for that guarantee in terms of performance.

IDM leaves the data model choice up to you. You determine the right trade offs for a particular deployment. IDM 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 IDM 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.

16.3. Configuring Synchronization Between Two Resources

This section describes the high-level steps required to set up synchronization between two resources. A basic synchronization configuration involves the following steps:

1. Set up the connector configuration.

   Connector configurations are defined in `conf/provisioner-*.json` files. One provisioner file must be defined for each external resource to which you are connecting.

2. Map source objects to target objects.

   Mappings are defined in your project's `conf/sync.json` file. There is only one `sync.json` file per IDM instance, but multiple mappings can be defined in that file.

Mappings are synchronized in the order in which they are specified in the `sync.json` file. To change the synchronization order, move the position of the mapping in that file or drag the mapping to a different position in the Admin UI. For information about configuring mappings in the Admin UI, see "Setting Up Mappings in the Admin UI".

If you are configuring social identity (see "*Configuring Social Identity Providers*"), you can also define mappings between the social identity provider and IDM in the `conf/selfservice.propertymap.json` file.

3. Configure any scripts that are required to check source and target objects, and to manipulate attributes.
4. In addition to these configuration elements, IDM stores a `links` table in its repository. The links table maintains a record of relationships established between source and target objects.

16.3.1. Setting Up the Connector Configuration

Connector configuration files map external resource objects to IDM objects, and are described in detail in "*Connecting to External Resources*". Connector configuration files are stored in the `conf/` directory of your project, and are named `provisioner.`*`resource-name`*`.json`, where *resource-name* reflects the connector technology and the external resource, for example, `openicf-csv`.

You can create and modify connector configurations through the Admin UI or directly in the configuration files, as described in the following sections.

16.3.1.1. Setting up and Modifying Connector Configurations in the Admin UI

The easiest way to set up and modify connector configurations is to use the Admin UI.

To add or modify a connector configuration in the Admin UI:

1. Log in to the UI (`http://localhost:8080/admin`) as an administrative user. The default administrative username and password is `openidm-admin` and `openidm-admin`.
2. Select Configure > Connectors.
3. Click on the connector that you want to modify (if there is an existing connector configuration) or click New Connector to set up a new connector configuration.

16.3.1.2. Editing Connector Configuration Files

A number of sample provisioner files are provided in `path/to/openidm/samples/example-configurations/provisioners`. To modify connector configuration files directly, edit one of the sample provisioner files that corresponds to the resource to which you are connecting.

The following excerpt of an example LDAP connector configuration shows the 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 that is used in IDM. The `sn` attribute in LDAP is mapped to `lastName` in IDM. The `homePhone` attribute is defined as an array, because it can have multiple values:

```
{
    ...
    "objectTypes": {
        "account": {
            "lastName": {
                "type": "string",
                "required": true,
                "nativeName": "sn",
                "nativeType": "string"
            },
            "homePhone": {
                "type": "array",
                "items": {
                    "type": "string",
                    "nativeType": "string"
                },
                "nativeName": "homePhone",
                "nativeType": "string"
            }
        }
    }
}
```

For IDM 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 IDM objects. To construct attributes and to manipulate their values, you use the synchronization mappings file, described in the following section.

16.3.2. Mapping Source Objects to Target Objects

A synchronization mapping specifies a relationship between objects and their attributes in two data stores. A typical attribute mapping, between objects in an external LDAP directory and an internal Managed User data store, is:

```
"source": "lastName",
"target": "sn"
```

In this case, the `lastName` source attribute is mapped to the `sn` (surname) attribute on the target.

The core synchronization configuration is defined in your project's synchronization mappings file (`conf/sync.json`). The mappings file contains one or more mappings for every resource that must be synchronized.

Mappings are always defined from a *source* resource to a *target* resource. To configure bidirectional synchronization, you must define two mappings. For example, to configure bidirectional synchronization between an LDAP server and a local repository, you would define the following two mappings:

- LDAP Server > Local Repository

- Local Repository > LDAP Server

With bidirectional synchronization, IDM includes a `links` property that lets you reuse the links established between objects, for both mappings. For more information, see "Reusing Links Between Mappings".

You can update a mapping while the server is running. To avoid inconsistencies between repositories, do not update a mapping while a reconciliation is in progress *for that mapping*.

16.3.2.1. Specifying the Resource Mapping

Objects in external resources are specified in a mapping 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. Objects in the repository are specified in the mapping as `managed/object-type`, where *object-type* is defined in your project's managed objects configuration file (`conf/managed.json`).

External resources, and IDM managed objects, can be the *source* or the *target* in a mapping. By convention, the mapping name is a string of the form `source_target`, as shown in the following example:

```
{
    "mappings": [
        {
            "name": "systemLdapAccounts_managedUser",
            "source": "system/ldap/account",
            "target": "managed/user",
            "properties": [
                {
                    "source": "lastName",
                    "target": "sn"
                },
                {
                    "source": "telephoneNumber",
                    "target": "telephoneNumber"
                },
                {
                    "target": "phoneExtension",
                    "default": "0047"
                },
                {
                    "source": "email",
                    "target": "mail",
                    "comment": "Set mail if non-empty.",
                    "condition": {
                        "type": "text/javascript",
                        "source": "(object.email != null)"
                    }
                },
                {
                    "source": "",
                    "target": "displayName",
                    "transform": {
                        "type": "text/javascript",
```

```
                    "source": "source.lastName +', ' + source.firstName;"
                }
             },
            {
                "source" : "uid",
                "target" : "userName",
                "condition" : "/linkQualifier eq \"user\""
                }
            },
        ]
    }
  ]
}
```

In this example, the *name* of the source is the external resource (`ldap`), and the target is IDM's user repository, specifically `managed/user`. The `properties` defined in the mapping reflect attribute names that are defined in the IDM configuration. For example, the source attribute `uid` is defined in the `ldap` connector configuration file, rather than on the external resource itself.

Note

You can configure mappings between social identity providers and IDM properties, based on the `selfservice.propertymap.json` file, but these mappings are not reconciled or synchronized.

16.3.2.1.1. Setting Up Mappings in the Admin UI

The Admin UI is a front end to the configuration files. Changes you make to mappings in the Admin UI are written to your project's `conf/sync.json` file

To set up a new synchronization mapping in the Admin UI:

1. Select Configure > Mappings.
2. Click New Mapping, then select a source and target resource from the configured resources at the bottom of the window.

   You can filter these resources to display only connector configurations or managed objects.
3. Select Add property on the Attributes Grid to map a target property to its corresponding source property.

   The Property list shows all configured properties on the target resource. If the target resource is specified in a connector configuration, the Property list shows all properties configured for this connector. If the target resource is a managed object, the Property list shows the list of properties (defined in `managed.json` for that object).

   Tip

   - Select Add Missing Required Properties to add all the properties that are configured as *required* on the target resource. You can then map these required properties individually.

- Select Quick Mapping to show all source and target properties simultaneously. Drag a source property onto its corresponding target property, or the inverse.

  Select Save to complete the quick mapping.

To test your mapping configuration on a single source entry, select the Behaviors tab and scroll down to Single Record Reconciliation. Search for the entry you want to reconcile. The UI displays a preview of the target entry after a reconciliation. You can then select Reconcile Selected Record to actually perform the reconciliation on that one source entry.

16.3.2.2. Transforming Attributes in a Mapping

Use a mapping to define attribute transformations during synchronization. In the following sample mapping excerpt, the value of the `displayName` attribute on the target is set using a combination of the `lastName` and `firstName` attribute values from the source:

```
{
    "source": "",
    "target": "displayName",
    "transform": {
        "type": "text/javascript",
        "source": "source.lastName +', ' + source.firstName;"
    }
},
```

For transformations, the `source` property is optional. However, a 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" : ""`.

If you set `"source" : ""` (not specifying an attribute), the entire object is regarded as the source, and you must include the attribute name in the transformation script. For example, to transform the source username to lower case, your script would be `source.mail.toLowerCase();`. If you do specify a source attribute (for example `"source" : "mail"`), just that attribute is regarded as the source. In this case, the transformation script would be `source.toLowerCase();`.

To set up a transformation script in the Admin UI:

1. Select Configure > Mappings, and select the Mapping.
2. Select the line with the target attribute whose value you want to set.
3. On the Transformation Script tab, select `Javascript` or `Groovy`, and enter the transformation as an `Inline Script` or specify the path to the file containing your transformation script.

When you use the UI to map a property whose value is encrypted, you are prompted to set up a transformation script to decrypt the value when that property is synchronized. The resulting mapping in `sync.json` looks similar to the following, which shows the transformation of a user's `password` property:

```
{
    "target" : "userPassword",
    "source" : "password",
    "transform" : {
        "type" : "text/javascript",
        "globals" : { },
        "source" : "openidm.decrypt(source);"
    },
    "condition" : {
        "type" : "text/javascript",
        "globals" : { },
        "source" : "object.password != null"
    }
}
```

16.3.2.3. Using Scriptable Conditions in a Mapping

By default, IDM synchronizes all attributes in a mapping. To facilitate more complex relationships between source and target objects, you can define conditions for which IDM maps certain attributes. You can define two types of mapping conditions:

- *Scriptable conditions*, in which an attribute is mapped only if the defined script evaluates to `true`
- *Condition filters*, a declarative filter that sets the conditions under which the attribute is mapped. Condition filters can include a *link qualifier*, that identifies the *type* of relationship between the source object and multiple target objects. For more information, see "Mapping a Single Source Object to Multiple Target Objects".

  Examples of condition filters include:

  - `"condition": "/object/country eq 'France'"` - only map the attribute if the object's `country` attribute equals `France`.
  - `"condition": "/object/password pr"` - only map the attribute if the object's `password` attribute is present.
  - `"/linkQualifier eq 'admin'"` - only map the attribute if the link between this source and target object is of type `admin`.

To set up mapping conditions in the Admin UI, select Configure > Mappings. Click the mapping for which you want to configure conditions. On the Properties tab, click on the attribute that you want to map, then select the Conditional Updates tab.

Configure the filtered condition on the `Condition Filter` tab, or a scriptable condition on the `Script` tab.

Scriptable conditions create mapping logic, based on the result of the condition script. If the script does not return `true`, IDM does not manipulate the target attribute during a synchronization operation.

In the following excerpt, the value of the target `mail` attribute is set to the value of the source `email` attribute *only if* the source attribute is not empty:

```
{
    "target": "mail",
        "comment": "Set mail if non-empty.",
        "source": "email",
        "condition": {
            "type": "text/javascript",
            "source": "(object.email != null)"
        }
...
```

Tip

You can add comments to JSON files. While this example includes a property named `comment`, you can use any unique property name, as long as it is not used elsewhere in the server. IDM ignores unknown property names in JSON configuration files.

16.3.2.4. Creating Default Attributes in a Mapping

You can use a mapping to *create* attributes on the target resource. In the preceding example, the mapping creates a `phoneExtension` attribute with a default value of `0047` on the target object.

The `default` property specifies a value to assign to the attribute on the target object. Before IDM determines the value of the target attribute, it first evaluates any applicable conditions, followed by any transformation scripts. If the `source` property and the `transform` script yield a null value, it then applies the default value, create and update actions. The default value overrides the target value, if one exists.

To set up attributes with default values in the Admin UI:

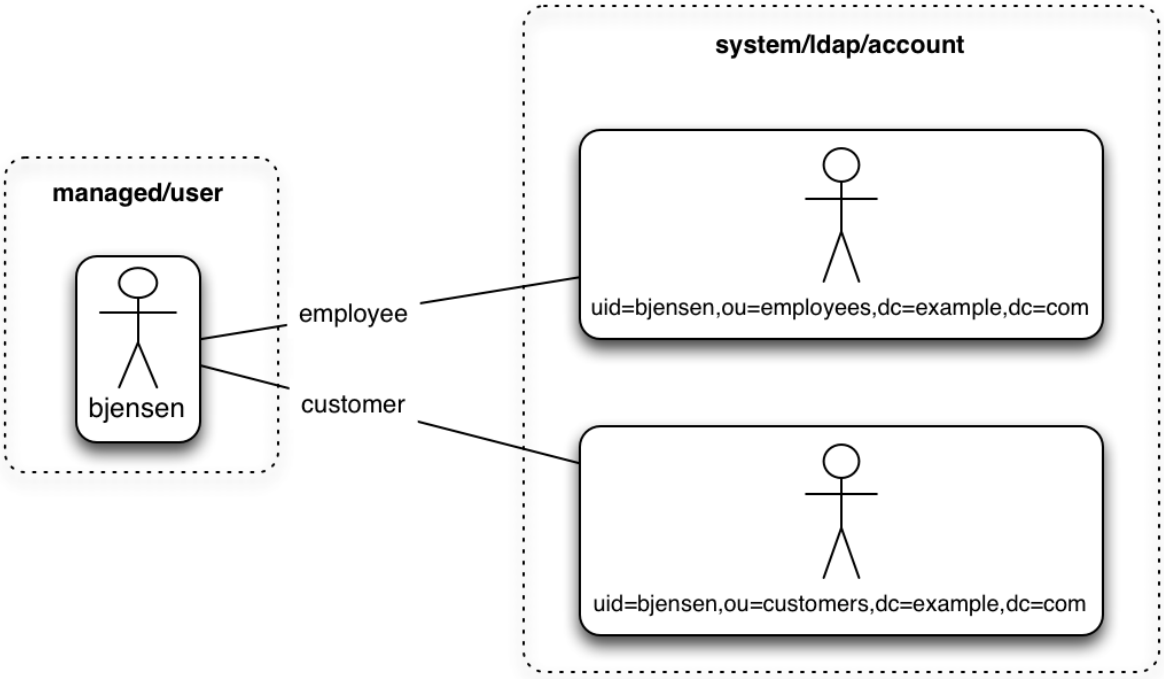
1. Select Configure > Mappings, and click on the Mapping you want to edit.
2. Click on the Target Property that you want to create (`phoneExtension` in the previous example), select the Default Values tab, and enter a default value for that property mapping.

16.3.2.5. Mapping a Single Source Object to Multiple Target Objects

In certain cases, you might have a single object in a resource that maps to more than one object in another resource. For example, assume that managed user, bjensen, has two distinct accounts in an LDAP directory: an `employee` account (under `uid=bjensen,ou=employees,dc=example,dc=com`) and a `customer` account (under `uid=bjensen,ou=customers,dc=example,dc=com`). You want to map both of these LDAP accounts to the same managed user account.

IDM uses *link qualifiers* to manage this one-to-many scenario. To map a single source object to multiple target objects, you indicate how the source object should be linked to the target object by defining link qualifiers. A link qualifier is essentially a label that identifies the *type* of link (or relationship) between each object.

In the previous example, you would define two link qualifiers that enable you to link both of bjensen's LDAP accounts to her managed user object, as shown in the following diagram:



Note from this diagram that the link qualifier is a property of the *link* between the source and target object, and not a property of the source or target object itself.

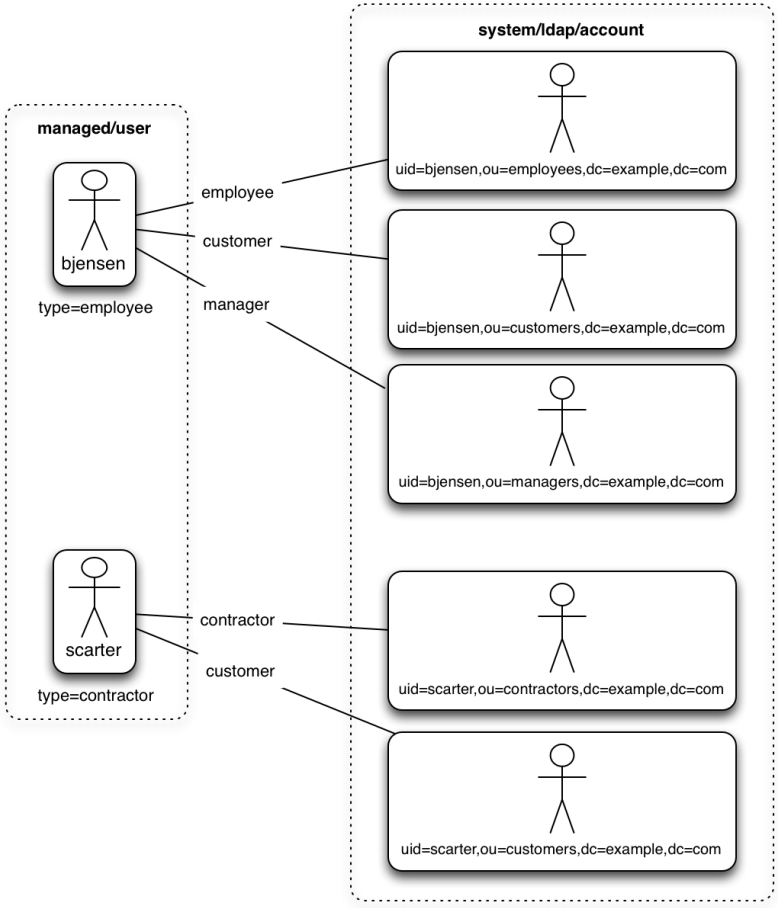
Link qualifiers are defined as part of the mapping (in your project's `conf/sync.json` file). Each link qualifier must be unique within the mapping. If no link qualifier is specified (when only one possible matching target object exists), IDM uses a default link qualifier with the value `default`.

Link qualifiers can be defined as a static list, or dynamically, using a script. The following excerpt from a sample mapping shows the two static link qualifiers, `employee` and `customer`, described in the previous example:

```
{
    "mappings": [
        {
            "name": "managedUser_systemLdapAccounts",
            "source": "managed/user",
            "target": "system/MyLDAP/account",
            "linkQualifiers" : [ "employee", "customer" ],
...
```

The list of static link qualifiers is evaluated for *every* source record. That is, every reconciliation processes all synchronization operations, for each link qualifier, in turn.

A dynamic link qualifier script returns a list of link qualifiers applicable for each source record. For example, suppose you have two *types* of managed users - employees and contractors. For employees, a single managed user (source) account can correlate with three different LDAP (target) accounts - employee, customer, and manager. For contractors, a single managed user account can correlate with only two separate LDAP accounts - contractor, and customer. The possible linking situations for this scenario are shown in the following diagram:



In this scenario, you could write a script to generate a dynamic list of link qualifiers, based on the managed user type. For employees, the script would return `[employee, customer, manager]` in its list of possible link qualifiers. For contractors, the script would return `[contractor, customer]` in its list of possible link qualifiers. A reconciliation operation would then only process the list of link qualifiers applicable to each source object.

If your source resource includes a large number of records, you should use a dynamic link qualifier script instead of a static list of link qualifiers. Generating the list of applicable link qualifiers dynamically avoids unnecessary additional processing for those qualifiers that will never apply to specific source records. Synchronization performance is therefore improved for large source data sets.

You can include a dynamic link qualifier script inline (using the `source` property), or by referencing a JavaScript or Groovy script file (using the `file` property). The following link qualifier script sets up the dynamic link qualifier lists described in the previous example.

Note

The `source` property value has been formatted into multiple lines to be more clear to readers. If you use this content, it needs to be formatted as a single line.

```
{
  "mappings": [
    {
      "name": "managedUser_systemLdapAccounts",
      "source": "managed/user",
      "target": "system/MyLDAP/account",
      "linkQualifiers" : {
        "type" : "text/javascript",
        "globals" : { },
        "source" : "if (returnAll) {
                      ['contractor', 'employee', 'customer', 'manager']
                    } else {
                      if(object.type === 'employee') {
                        ['employee', 'customer', 'manager']
                      } else {
                        ['contractor', 'customer']
                      }
                    }"
      }
...
```

To reference an external link qualifier script, provide a link to the file in the `file` property:

```
{
    "mappings": [
        {
            "name": "managedUser_systemLdapAccounts",
            "source": "managed/user",
            "target": "system/MyLDAP/account",
            "linkQualifiers" : {
                "type" : "text/javascript",
                "file" : "script/linkQualifiers.js"
            }
...
```

Dynamic link qualifier scripts must return all valid link qualifiers when the `returnAll` global variable is true. The `returnAll` variable is used during the target reconciliation phase to check whether there are any target records that are unassigned, for each known link qualifier.

If you configure dynamic link qualifiers through the UI, the complete list of dynamic link qualifiers is displayed in the Generated Link Qualifiers item below the script. This list represents the values returned by the script when the `returnAll` variable is passed as `true`. For a list of the variables available to a dynamic link qualifier script, see "Script Triggers Defined in `sync.json`".

On their own, link qualifiers have no functionality. However, they can be referenced by various aspects of reconciliation to manage the situations where a single source object maps to multiple target objects. The following examples show how link qualifiers can be used in reconciliation operations:

- Use link qualifiers during object creation, to create multiple target objects per source object.

  The following excerpt of a sample mapping defines a transformation script that generates the value of the `dn` attribute on an LDAP system. If the link qualifier is `employee`, the value of the target `dn` is set to `"uid=userName,ou=employees,dc=example,dc=com"`. If the link qualifier is `customer`, the value of the target `dn` is set to `"uid=userName,ou=customers,dc=example,dc=com"`. The reconciliation operation iterates through the link qualifiers for each source record. In this case, two LDAP objects, with different `dn`s are created for each managed user object.

  ```
  {
      "target" : "dn",
      "transform" : {
          "type" : "text/javascript",
          "globals" : { },
          "source" : "if (linkQualifier === 'employee')
                { 'uid=' + source.userName + ',ou=employees,dc=example,dc=com'; }
              else
              if (linkQualifier === 'customer')
                { 'uid=' + source.userName + ',ou=customers,dc=example,dc=com'; }"
      },
      "source" : ""
  }
  ```

- Use link qualifiers in conjunction with a *correlation query* that assigns a link qualifier based on the values of an existing target object.

  During source synchronization, IDM queries the target system for every source record *and* link qualifier, to check if there are any matching target records. If a match is found, the sourceId, targetId, and linkQualifier are all saved as the *link*.

  The following excerpt of a sample mapping shows the two link qualifiers described previously (`employee` and `customer`). The correlation query first searches the target system for the `employee` link qualifier. If a target object matches the query, based on the value of its `dn` attribute, IDM creates a link between the source object and that target object and assigns the `employee` link qualifier to that link. This process is repeated for all source records. Then, the correlation query searches the target system for the `customer` link qualifier. If a target object matches that query, IDM creates a link between the source object and that target object and assigns the `customer` link qualifier to that link.

```
"linkQualifiers" : ["employee", "customer"],
  "correlationQuery" : [
    {
      "linkQualifier" : "employee",
      "type" : "text/javascript",
      "source" : "var query = {'_queryFilter': 'dn co \"' + uid=source.userName + 'ou=employees\"'};
 query;"
    },
    {
      "linkQualifier" : "customer",
      "type" : "text/javascript",
      "source" : "var query = {'_queryFilter': 'dn co \"' + uid=source.userName + 'ou=customers\"'};
 query;"
    }
  ]
...
```

For more information about correlation queries, see "Correlating Source Objects With Existing Target Objects".

- Use link qualifiers during policy validation to apply different policies based on the link type.

  The following excerpt of a sample `sync.json` file shows two link qualifiers, `user` and `test`. Depending on the link qualifier, different actions are taken when the target record is ABSENT:

```
{
    "mappings" : [
        {
            "name" : "systemLdapAccounts_managedUser",
            "source" : "system/ldap/account",
            "target" : "managed/user",
            "linkQualifiers" : [
                "user",
                "test"
        ],
    "properties" : [
    ...
    "policies" : [
        {
            "situation" : "CONFIRMED",
            "action" : "IGNORE"
        },
        {
            "situation" : "FOUND",
            "action" : "UPDATE
        }
        {
            "condition" : "/linkQualifier eq \"user\"",
            "situation" : "ABSENT",
            "action" : "CREATE",
            "postAction" : {
                "type" : "text/javascript",
                "source" : "java.lang.System.out.println('Created user: \');"
            }
        },
        {
            "condition" : "/linkQualifier eq \"test\"",
```

```
            "situation" : "ABSENT",
            "action" : "IGNORE",
            "postAction" : {
                "type" : "text/javascript",
                "source" : "java.lang.System.out.println('Ignored user: ');"
            }
        },
        ...
```

With this sample mapping, the synchronization operation creates an object in the target system only if the potential match is assigned a `user` link qualifier. If the match is assigned a `test` qualifier, no target object is created. In this way, the process avoids creating duplicate *test-related* accounts in the target system.

Tip

To set up link qualifiers in the Admin UI select Configure > Mappings. Select a mapping, and click Properties > Link Qualifiers.

For an example that uses link qualifiers in conjunction with roles, see "*Linking Multiple Accounts to a Single Identity*" in the *Samples Guide*.

16.3.2.6. Correlating Source Objects With Existing Target Objects

When IDM creates an object on a target system during synchronization, it also creates a *link* between the source and target object. IDM then uses that link to determine the object's *synchronization situation* during later synchronization operations. For a list of synchronization situations, see "How Synchronization Situations Are Assessed".

With every synchronization operation, IDM can *correlate* existing source and target objects. Correlation matches source and target objects, based on the results of a query or script, and creates links between matched objects.

Correlation queries and correlation scripts are defined in your project's mapping (`conf/sync.json`) file. Each query or script is specific to the mapping for which it is configured. You can also configure correlation by using the Admin UI. Select Configure > Mappings, and click on the mapping for which you want to correlate. On the Association tab, expand Association Rules, and select Correlation Queries or Correlation Script from the list.

The following sections describe how to write correlation queries and scripts.

16.3.2.6.1. Writing Correlation Queries

IDM processes a correlation query by constructing a query map. The content of the query is generated dynamically, using values from the source object. For each source object, a new query is sent to the target system, using (possibly transformed) values from the source object for its execution.

Queries are 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.

Correlation queries can be expressed using a query filter (`_queryFilter`), a predefined query (`_queryId`), or a native query expression (`_queryExpression`). For more information on these query types, see "Defining and Calling Queries". The synchronization process executes the correlation query to search through the target system for objects that match the current source object.

The preferred syntax for a correlation query is a filtered query, using the `_queryFilter` keyword. Filtered queries should work in the same way on any backend, whereas other query types are generally specific to the backend. Predefined queries (using `_queryId`) and native queries (using `_queryExpression`) can also be used for correlation queries on managed resources. Note that `system` resources do not support native queries or predefined queries other than `query-all-ids` (which serves no purpose in a correlation query).

To configure a correlation query, define a script whose source returns a query that uses the `_queryFilter`, `_queryId`, or `_queryExpression` keyword. For example:

- For a `_queryId`, the value is the named query. Named parameters in the query map are expected by that query.

  ```
  {'_queryId' : 'for-userName', 'uid' : source.name}
  ```

- For a `_queryFilter`, the value is the abstract filter string:

  ```
  { "_queryFilter" : "uid eq \"" + source.userName + "\"" }
  ```

- For a `_queryExpression`, the value is the system-specific query expression, such as raw SQL.

```
{'_queryExpression': 'select * from managed_user where givenName = \"' + source.firstname + '\"' }
```

Caution

Using a query expression in this way is not recommended as it exposes your system to SQL injection exploits.

16.3.2.6.1.1. Using Filtered Queries to Correlate Objects

For filtered queries, the script that is defined or referenced in the `correlationQuery` property must return an object with the following elements:

- The element that is being compared on the target object, for example, `uid`.

  The element on the target object is not necessarily a single attribute. Your query filter can be simple or complex; valid query filters range from a single operator to an entire boolean expression tree.

If the target object is a system object, this attribute must be referred to by its IDM name rather than its ICF `nativeName`. For example, given the following provisioner configuration excerpt, the attribute to use in the correlation query 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. However, it does not have to match the value of a single source object property. You can define how your script uses the values from the source object to find a matching record in the target system.

  You might use a transformation of a source object property, such as `toUpperCase()`. You can concatenate that output with other strings or properties. You can also use this value to call an external REST endpoint, and redirect the response to the final "value" portion of the query.

The following correlation query matches source and target objects if the value of the `uid` attribute on the target is the same as the `userName` attribute on the source:

```
"correlationQuery" : {
    "type" : "text/javascript",
    "source" : "var qry = {'_queryFilter': 'uid eq \"' + source.userName + '\"'}; qry"
},
```

The query can return zero or more objects. The situation that IDM assigns to the source object depends on the number of target objects that are returned, and on the presence of any *link qualifiers* in the query. For information about synchronization situations, see "How Synchronization Situations Are Assessed". For information about link qualifiers, see "Mapping a Single Source Object to Multiple Target Objects".

16.3.2.6.1.2. Using Predefined Queries to Correlate Objects

For correlation queries on *managed objects*, you can use a query that has been predefined in the database table configuration file for the repository, either `conf/repo.jdbc.json` or `conf/repo.ds.json`. You reference the query ID in your project's `conf/sync.json` file.

The following example shows a query defined in the DS repository configuration (`conf/repo.ds.json`) that can be used as the basis for a correlation query:

```
"for-userName": {
        "_queryFilter": "/userName eq \"${uid}\""
},
```

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;"
    }
  }
```

In this correlation query, the `_queryId` property value (`for-userName`) matches the name of the query specified in `conf/repo.ds.json`. The `source.name` value replaces `${uid}` in the query.

16.3.2.6.1.3. Using the Expression Builder to Create Correlation Queries

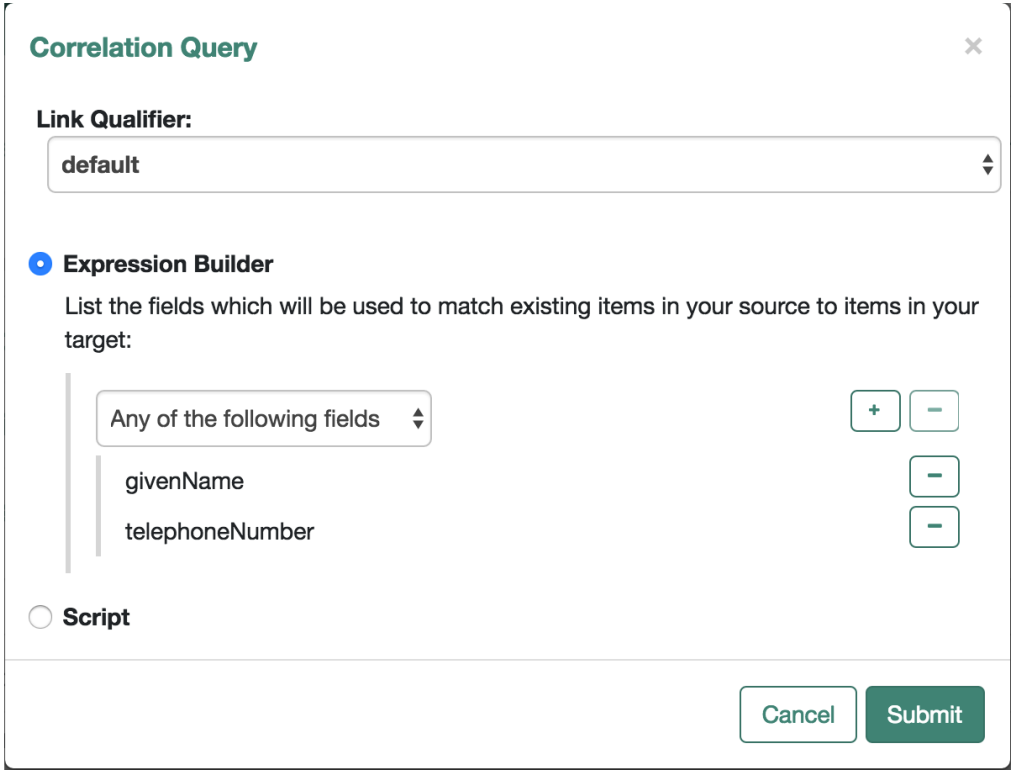
The *expression builder* is a declarative correlation mechanism that makes it easier to configure correlation queries.

The easiest way to use the expression builder to create a correlation query is through the Admin UI:

1. Select Configure > Mappings and select the mapping for which you want to configure a correlation query.
2. On the Association tab, expand the Association Rules item and select Correlation Queries.
3. Click Add Correlation query.
4. In the Correlation Query window, select a link qualifier.

   If you do not need to correlate multiple potential target objects per source object, select the `default` link qualifier. For more information about linking to multiple target objects, see "Mapping a Single Source Object to Multiple Target Objects".
5. Select Expression Builder, and add or remove the fields whose values in the source and target must match.

   The following image shows how you can use the expression builder to build a correlation query for a mapping from `managed/user` to `system/ldap/accounts` objects. The query will create a match between the source (managed) object and the target (LDAP) object if the value of the `givenName` or the `telephoneNumber` of those objects is the same.



6. Click Submit to exit the Correlation Query pop-up then click Save.

The correlation query created in the previous steps displays as follows in the mapping configuration (`sync.json`):

```
"correlationQuery" : [
    {
        "linkQualifier" : "default",
        "expressionTree" : {
            "any" : [
                "givenName",
                "telephoneNumber"
            ]
        },
        "mapping" : "managedUser_systemLdapAccounts",
        "type" : "text/javascript",
        "file" : "ui/correlateTreeToQueryFilter.js"
    }
]
```

16.3.2.6.2. Writing Correlation Scripts

If you need a more powerful correlation mechanism than a simple query can provide, you can write a correlation script with additional logic. Correlation scripts are generally more complex than correlation queries and impose no restrictions on the methods used to find matching objects. A correlation script must execute a query and return the result of that query.

The result of a correlation script is a list of maps, each of which contains a candidate `_id` value. If no match is found, the script returns a zero-length list. If exactly one match is found, the script returns a single-element list. If there are multiple ambiguous matches, the script returns a list with multiple elements. There is no assumption that the matching target record or records can be found by a simple query on the target system. All of the work necessary to find matching records is left to the script.

In general, a correlation query should meet the requirements of most deployments. Correlation scripts can be useful, however, if your query needs extra processing, such as fuzzy-logic matching or out-of-band verification with a third-party service over REST.

The following example shows a correlation script that uses link qualifiers. The script returns `resultData.result` - a list of maps, each of which has an `_id` entry. These entries will be the values that are used for correlation.

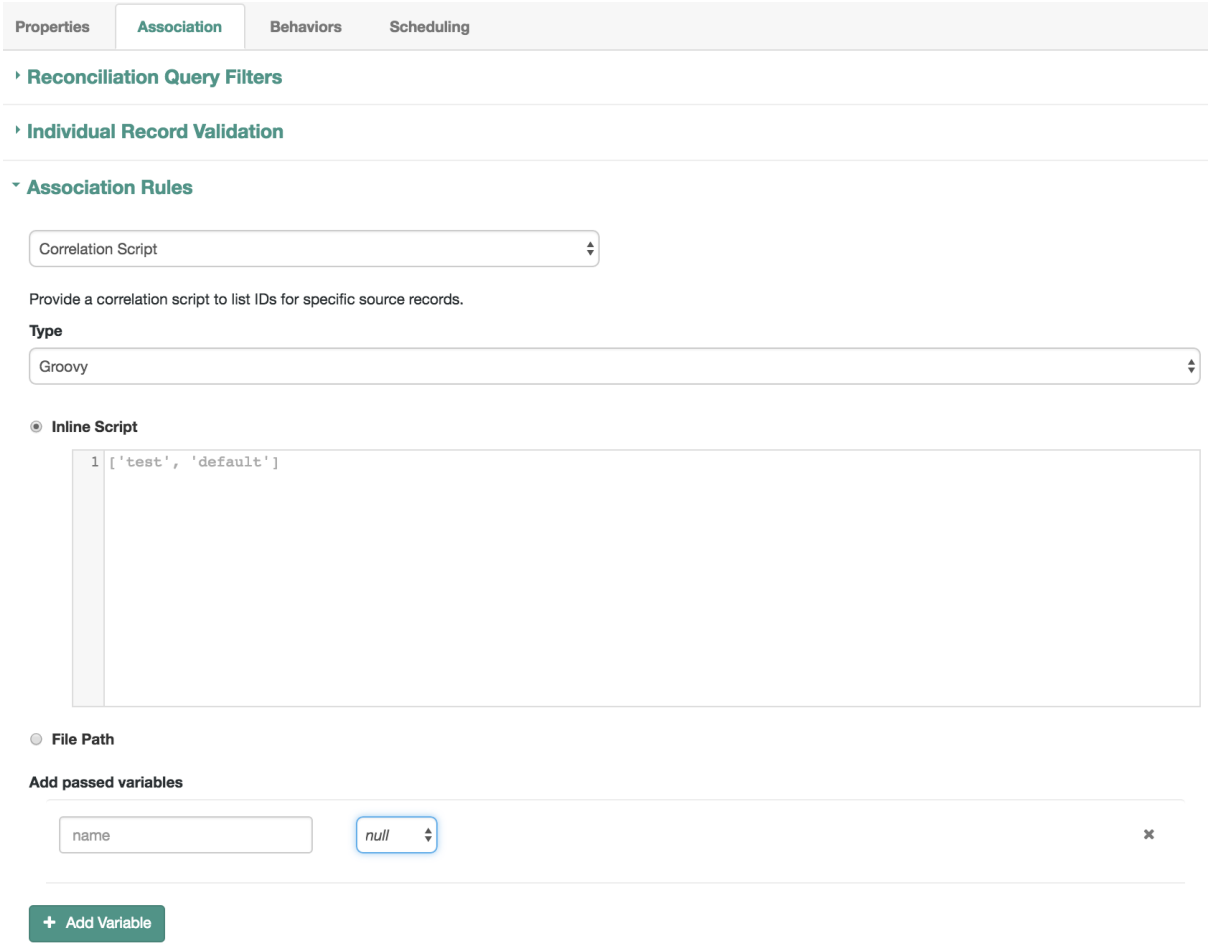
Correlation Script Using Link Qualifiers

```
(function () {
    var query, resultData;
    switch (linkQualifier) {
        case "test":
            logger.info("linkQualifier = test");
         query = {'_queryFilter': 'uid eq \"' + source.userName + '-test\"'};
            break;
        case "user":
            logger.info("linkQualifier = user");
         query = {'_queryFilter': 'uid eq \"' + source.userName + '\"'};
            break;
        case "default":
            logger.info("linkQualifier = default");
         query = {'_queryFilter': 'uid eq \"' + source.userName + '\"'};
            break;
        default:
            logger.info("No linkQualifier provided.");
         break;
    }
    var resultData = openidm.query("system/ldap/account", query);
    logger.info("found " + resultData.result.length + " results for link qualifier " + linkQualifier)
    for (i=0;i<resultData.result.length;i++) {
        logger.info("found target: " + resultData.result[i]._id);
    }
    return resultData.result;
} ());
```

To configure a correlation script in the Admin UI, follow these steps:

1. Select Configure > Mappings and select the mapping for which you want to configure the correlation script.

2. On the Association tab, expand the Association Rules item and select Correlation Script from the list.



3. Select a script type (either JavaScript or Groovy) and either enter the script source in the Inline Script box, or specify the path to a file that contains the script.

   To create a correlation script, use the details from the source object to find the matching record in the target system. If you are using link qualifiers to match a single source record to multiple target records, you must also use the value of the `linkQualifier` variable within your correlation script to find the target ID that applies for that qualifier.

4. Click Save to save the script as part of the mapping.

16.3.3. Filtering Synchronized Objects

By default, IDM 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. You can also filter the source or target objects that are included in a synchronization operation. To apply these filters, use the `validSource`, `validTarget`, or `sourceCondition` 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 the second 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 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'"
    }
}
```

`sourceCondition`

The `sourceCondition` element defines an additional filter that must be met for a source object's inclusion in a mapping.

This condition works like a `validSource` script. Its value can be either a `queryFilter` string, or a script configuration. `sourceCondition` is used principally to specify that a mapping applies only to a particular role or entitlement.

The following `sourceCondition` restricts synchronization to those user objects whose account status is `active`:

```
{
    "mappings": [
        {
            "name": "managedUser_systemLdapAccounts",
            "source": "managed/user",
            "sourceCondition": "/source/accountStatus eq \"active\"",
        ...
        }
    ]
}
```

During synchronization, your scripts and filters 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;}"
    }
}
```

In addition, the `sourceCondition` filter has the `linkQualifier` variable in its scope.

For more information about scripting, see "*Scripting Reference*".

16.3.4. Configuring Synchronization Filters With User Preferences

For all regular users (other than `openidm-admin`), you can set up preferences, such as those related to marketing and news updates. You can then use those preferences as a filter when reconciling users to a target repository.

IDM includes default user preferences defined for the managed user object, available in the Admin UI and configured in the `managed.json` file.

16.3.4.1. Configuring End User Preferences

In the default project, common marketing preference options are included for the managed user object. To find these preferences in the Admin UI, select Configure > Managed Objects and select the User managed object. Under the Preferences tab, you'll see keys and descriptions. You can also see these preferences in the `managed.json` file, illustrated here:

```
"preferences" : {
    "title" : "Preferences",
    "description" : "Preferences",
    "viewable" : true,
    "searchable" : false,
    "userEditable" : true,
    "type" : "object",
    "usageDescription" : "",
    "isPersonal" : false,
    "properties" : {
        "updates" : {
            "description" : "Send me news and updates",
            "type" : "boolean"
        },
        "marketing": {
            "description" : "Send me special offers and services",
            "type" : "boolean"
        }
    },
    "order": [
        "updates",
        "marketing"
    ],
    "required": []
},
```

16.3.4.2. Reviewing Preferences as an End User

When regular users log into the End User UI, they'll see the preferences described in "Configuring End User Preferences". When they accept the preferences, their managed user objects are updated with entries similar to the following:

```
"preferences" : {
     "updates" : true,
     "marketing" : true
},
```

16.3.4.3. User Preferences and Reconciliation

You can configure user preferences as a filter for reconciliation. For example, if some of your users do not want marketing emails, you can filter those users out of any reconciliation operation.

1. To configure user preferences as a filter, log into the Admin UI.
2. Select Configure > Mappings. Choose a mapping.
3. Under the Association tab, select Individual Record Validation.
4. Based on the options in the Valid Source drop down text box, you can select `Validate based on user preferences`. Users who have selected a preference such as `Send me special offers` will then be reconciled from the source to the target repository.

Note

What IDM does during this reconciliation depends on the policy associated with the `UNQUALIFIED` situation for a `validSource`. The default action is to delete the target object (user). For more information, see "How Synchronization Situations Are Assessed".

Alternatively, you can edit the `sync.json` file directly. The following code block includes `preferences` as conditions to define a `validSource` on an individual record validation. IDM applies these conditions at the next reconciliation.

```
"validSource" : {
    "type" : "text/javascript",
    "globals" : {
        "preferences" : [
            "updates",
            "marketing"
        ]
    },
    "file" : "ui/preferenceCheck.js"
},
"validTarget" : {
    "type" : "text/javascript",
    "globals" : { },
    "source" : ""
}
```

16.3.5. Preventing Accidental Deletion of a Target System

If a source resource is empty, the default behavior is to exit without failure and to log a warning similar to the following:

```
2015-06-05 10:41:18:918 WARN Cannot reconcile from an empty data
    source, unless allowEmptySourceSet is true.
```

The reconciliation summary is also logged in the reconciliation audit log.

This behavior prevents reconciliation operations from accidentally deleting everything in a target resource. In the event that a source system is unavailable but erroneously reports its status as up, the absence of source objects should not result in objects being removed on the target resource.

When you *do* want reconciliations of an empty source resource to proceed, override the default behavior by setting the `allowEmptySourceSet` property to `true` in the mapping. For example:

```
{
    "mappings" : [
        {
        "name" : "systemCsvfileAccounts_managedUser",
        "source" : "system/csvfile/account",
        "allowEmptySourceSet" : true,
        ...
```

When an empty source is reconciled, the target is wiped out.

16.3.5.1. Preventing Accidental Deletion in the Admin UI

To change the `allowEmptySourceSet` option in the Admin UI, choose Configure > Mappings. Select the desired mapping. In the Advanced tab, enable or disable the following option:

- Allow Reconciliations From an Empty Source

16.4. Constructing and Manipulating Attributes With Scripts

IDM provides a number of *script hooks* to construct and manipulate attributes. These scripts can be triggered during various stages of the synchronization process, and are defined as part of the mapping, in the `sync.json` file.

The scripts can be triggered when a managed or system object is created (`onCreate`), updated (`onUpdate`), or deleted (`onDelete`). Scripts can also be triggered when a link is created (`onLink`) or removed (`onUnlink`).

In the default synchronization mapping, changes are *always* written to target objects, not to source objects. However, you can explicitly include a call to an action that should be taken on the source object within the script.

Note

The `onUpdate` script is *always* called for an UPDATE situation, even if the synchronization process determines that there is no difference between the source and target objects, and that the target object will not be updated.

If, subsequent to the `onUpdate` script running, the synchronization process determines that the target value to set is the same as its existing value, the change is prevented from synchronizing to the target.

The following sample extract of a `sync.json` file 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'"
    }
}
```

16.5. Advanced Use of Scripts in Mappings

"Constructing and Manipulating Attributes With Scripts" shows how to manipulate attributes with scripts when objects are created and updated. You might want to trigger scripts in response to other synchronization actions. For example, you might not want IDM to delete a managed user directly when an external account record is deleted, but instead unlink the objects and deactivate the user in another resource. (Alternatively, you might delete the object in IDM but nevertheless execute a

script.) The following example shows a more advanced mapping configuration that exposes the script hooks available during synchronization.

```
{
    "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

validSource, 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/9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb");
```

The following example reads an account from an external LDAP resource:

```
externalAccount = openidm.read("system/ldap/account/uid=bjensen,ou=People,dc=example,dc=com");
```

Important

For illustration purposes, this 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 you *can* use a DN (or any unique attribute) for the `_id`, as a best practice use an attribute that is both unique and immutable, such as the `entryUUID`.

Using Scripts to Generate Log Messages

IDM provides a `logger` object with `debug()`, `error()`, `info()`, `trace()`, and `warn()` functions that you can use to log messages to the OSGi console and to the log files from scripts defined within your mapping.

Consider the following mapping excerpt:

```
{
    "mappings" : [
        {
            "name" : "systemCsvfileAccounts_managedUser",
            "source" : "system/csvfile/account",
            "target" : "managed/user",
            "correlationQuery" : {
                "type" : "text/javascript",
                "source" : "var query = {'_queryId' : 'for-userName', 'uid' :  source.name};query;"
            },
            "onCreate" : {
                "type" : "text/javascript",
                "source" : "logger.warn('Case onCreate: the source object contains: = {} ', source);
 source;"
            },
            "onUpdate" : {
                "type" : "text/javascript",
                "source" : "logger.warn('Case onUpdate: the source object contains: = {} ', source);
 source;"
            },
            "result" : {
                "type" : "text/javascript",
                "source" : "logger.warn('Case result: the source object contains: = {} ', source);
 source;"
            },
            "properties" : [
                {
                    "transform" : {
                        "type" : "text/javascript",
                        "source" : "logger.warn('Case no Source: the source object contains: = {} ',
 source); source;"
                    },
                    "target" : "sourceTest1Nosource"
                },
                {
                    "source" : "",
                    "transform" : {
                        "type" : "text/javascript",
                        "source" : "logger.warn('Case emptySource: the source object contains: = {} ',
 source); source;"
                    },
                    "target" : "sourceTestEmptySource"
                },
                {
                    "source" : "description",
                    "transform" : {
                        "type" : "text/javascript",
                        "source" : "logger.warn('Case sourceDescription: the source object contains: = {}
 ', source); source"
                    },
                    "target" : "sourceTestDescription"
                },
                ...
            ]
        }
    ]
}
```

Notice the scripts that are defined for `onCreate`, `onUpdate` and `result`. These scripts log a warning message to the console whenever an object is created or updated, or when a result is returned. The script result includes the full source object.

Notice too, the scripts that are defined in the `properties` section of the mapping. These scripts log a warning message if the property in the source object is missing or empty. The last script logs a warning message that includes the description of the source object.

During a reconciliation operation, these scripts would generate output in the OSGi console, similar to the following:

```
2017-02... WARN Case no Source: the source object contains: = null  [9A00348661C6790E7881A7170F747F...]
2017-02... WARN Case emptySource: the source object contains: = {roles=openidm-..., lastname=Jensen...]
2017-02... WARN Case no Source: the source object contains: = null  [9A00348661C6790E7881A7170F747F...]
2017-02... WARN Case emptySource: the source object contains: = {roles=openidm..., lastname=Carter,...]
2017-02... WARN Case sourceDescription: the source object contains: = null  [EEE2FF4BCE9748927A1832...]
2017-02... WARN Case sourceDescription: the source object contains: = null  [EEE2FF4BCE9748927A1832...]
2017-02... WARN Case onCreate: the source object contains: = {roles=openidm-..., lastname=Carter,  ...]
2017-02... WARN Case onCreate: the source object contains: = {roles=openidm-..., lastname=Jensen,  ...]
2017-02... WARN Case result: the source object contains: = {SOURCE_IGNORED={count=0, ids=[]}, FOUND_AL..
.]
```

You can use similar scripts to inject logging into any aspect of a mapping. You can also call the `logger` functions from any configuration file that has scripts hooks. For more information about the `logger` functions, see "Logging Functions".

16.6. Reusing Links Between Mappings

When two mappings synchronize the same objects bidirectionally, use the `links` property in one mapping to have IDM use the same internally managed link for both mappings. If you do not specify a `links` property, IDM maintains a separate 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 indicates that IDM should 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"
        }
    ]
}
```

16.7. Managing Reconciliation

Reconciliation is the synchronization of objects between two data stores. You can trigger, cancel, and monitor reconciliation operations over REST, using the REST endpoint `http://localhost:8080/openidm/recon`. You can also perform most of these actions through the Admin UI.

16.7.1. Triggering a Reconciliation

The following example triggers a reconciliation operation over REST based on the `systemLdapAccounts_managedUser` mapping. The mapping is defined in the file `conf/sync.json`:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/recon?_action=recon&mapping=systemLdapAccounts_managedUser"
```

By default, a 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 an example, see "Obtaining the Details of a Reconciliation".

The reconciliation run initiated previously would return something similar to the following:

```
{"_id":"9f4260b6-553d-492d-aaa5-ae3c63bd90f0-14","state":"ACTIVE"}
```

To complete the reconciliation operation before the reconciliation run ID is returned, set the `waitForCompletion` property to `true` when the reconciliation is initiated:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/recon?
_action=recon&mapping=systemLdapAccounts_managedUser&waitForCompletion=true"
```

16.7.1.1. Triggering a Reconciliation in the Admin UI

You can also trigger this reconciliation through the Admin UI. Select Configure > Mappings. In the mapping of your choice select Reconcile.

If you're reconciling a large number of items, the Admin UI shares the following message with you, possibly with numbers for entries reconciled and total entries.

```
In progress: reconciling source entries
```

Note

In the Admin UI, if you select `Cancel Reconciliation` before it is complete, you'll have to start the process again.

16.7.2. Canceling a Reconciliation

You can cancel a reconciliation in progress by specifying the reconciliation run ID. The following REST call cancels the reconciliation run initiated in the previous section:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request POST \
"http://localhost:8080/openidm/recon/0890ad62-4738-4a3f-8b8e-f3c83bbf212e?_action=cancel"
```

The output for a reconciliation cancellation request is similar to the following:

```
{
    "status":"INITIATED",
    "action":"cancel",
    "_id":"0890ad62-4738-4a3f-8b8e-f3c83bbf212e"
}
```

If the reconciliation run is waiting for completion before its ID is returned, obtain the reconciliation run ID from the list of active reconciliations, as described in the following section.

16.7.2.1. Canceling a Reconciliation in the Admin UI

To cancel a reconciliation run in progress through the Admin UI, select Configure > Mappings, click on the mapping whose reconciliation you want to cancel and click `Cancel Reconciliation`.

16.7.3. Listing a History of Reconciliations

Display a list of reconciliation processes that have completed, and those that are in progress, by running a RESTful GET on `"http://localhost:8080/openidm/recon"`.

The following example displays all reconciliation runs:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/recon"
```

The output is similar to the following, with one item for each reconciliation run:

```
"reconciliations": [
  {
```

```
    "_id": "c06505a1-db7b-49e4-b588-28fc235e8008-955",
    "mapping": "systemLdapAccounts_managedUser",
    "state": "SUCCESS",
    "stage": "COMPLETED_SUCCESS",
    "stageDescription": "reconciliation completed.",
    "progress": {
      "source": {
        "existing": {
          "processed": 2,
          "total": "2"
        }
      },
      "target": {
        "existing": {
          "processed": 0,
          "total": "0"
        },
        "created": 2
      },
      "links": {
        "existing": {
          "processed": 0,
          "total": "0"
        },
        "created": 2
      }
    },
    "situationSummary": {
      "SOURCE_IGNORED": 0,
      "FOUND_ALREADY_LINKED": 0,
      "UNQUALIFIED": 0,
      "ABSENT": 2,
      "TARGET_IGNORED": 0,
      "MISSING": 0,
      "ALL_GONE": 0,
      "UNASSIGNED": 0,
      "AMBIGUOUS": 0,
      "CONFIRMED": 0,
      "LINK_ONLY": 0,
      "SOURCE_MISSING": 0,
      "FOUND": 0
    },
    "statusSummary": {
      "SUCCESS": 2,
      "FAILURE": 0
    },
    "durationSummary": {
      ...
    },
    "parameters": {
      "sourceQuery": {
        "resourceName": "system/ldap/account",
        "queryId": "query-all-ids"
      },
      "targetQuery": {
        "resourceName": "managed/user",
        "queryId": "query-all-ids"
      }
    },
```

```
    "started": "2018-05-14T22:09:05.965Z",
    "ended": "2018-05-14T22:09:06.679Z",
    "duration": 714,
    "sourceProcessedByNode": {}
  }
]
```

In contrast, the Admin UI displays the results of only the most recent reconciliation. For more information, see "Obtaining the Details of a Reconciliation in the Admin UI".

Each reconciliation run includes 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. 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
  }
},
```

16.7.4. Obtaining the Details of a Reconciliation

Display the details of a specific reconciliation over REST, by including the reconciliation run ID in the URL. The following call shows the details of the reconciliation run initiated in "Triggering a Reconciliation".

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/recon/31505cd1-edde-4ade-849a-979aef491c3c-950"
{
  "_id": "31505cd1-edde-4ade-849a-979aef491c3c-950",
  "mapping": "systemLdapAccounts_managedUser",
  "state": "SUCCESS",
  "stage": "COMPLETED_SUCCESS",
  "stageDescription": "reconciliation completed.",
  "progress": {
    "source": {
      "existing": {
        "processed": 2,
        "total": "2"
      }
    },
    "target": {
      "existing": {
        "processed": 0,
        "total": "0"
      },
      "created": 2
    },
    "links": {
      "existing": {
```

```
        "processed": 0,
        "total": "0"
      },
      "created": 2
    }
  },
  "situationSummary": {
    "SOURCE_IGNORED": 0,
    "FOUND_ALREADY_LINKED": 0,
    "UNQUALIFIED": 0,
    "ABSENT": 2,
    "TARGET_IGNORED": 0,
    "MISSING": 0,
    "ALL_GONE": 0,
    "UNASSIGNED": 0,
    "AMBIGUOUS": 0,
    "CONFIRMED": 0,
    "LINK_ONLY": 0,
    "SOURCE_MISSING": 0,
    "FOUND": 0
  },
  "statusSummary": {
    "SUCCESS": 2,
    "FAILURE": 0
  },
  "durationSummary": {
    ...
  },
  "parameters": {
    "sourceQuery": {
      "resourceName": "system/ldap/account",
      "queryId": "query-all-ids"
    },
    "targetQuery": {
      "resourceName": "managed/user",
      "queryId": "query-all-ids"
    }
  },
  "started": "2018-05-15T21:25:48.611Z",
  "ended": "2018-05-15T21:25:49.396Z",
  "duration": 785,
  "sourceProcessedByNode": {}
}
```


16.7.4.1. Obtaining the Details of a Reconciliation in the Admin UI

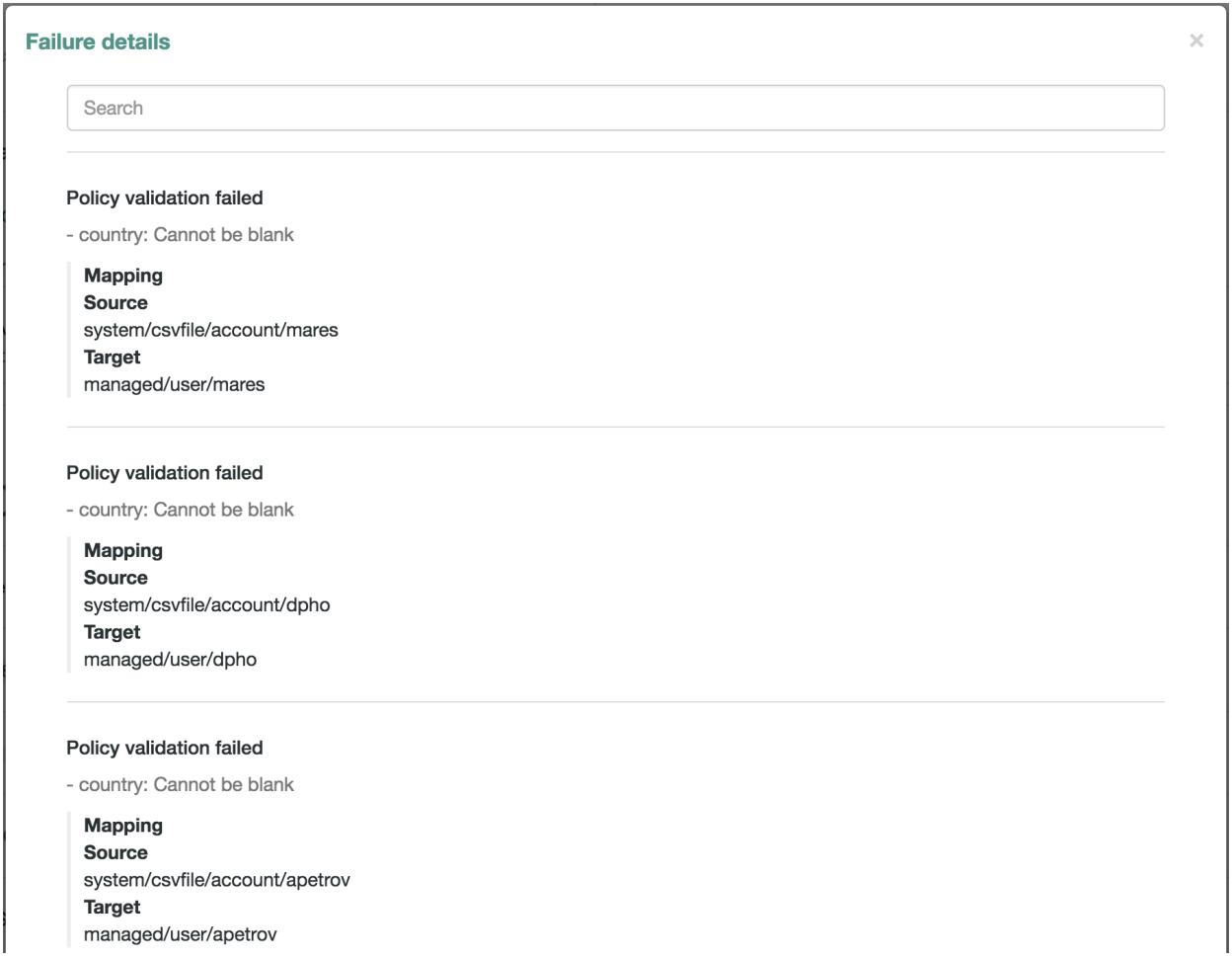
You can display the details of the most recent reconciliation in the Admin UI. Select the mapping. In the page that appears, you'll see a message similar to:

```
Completed: Last reconciled July 29, 2016 14:13
```

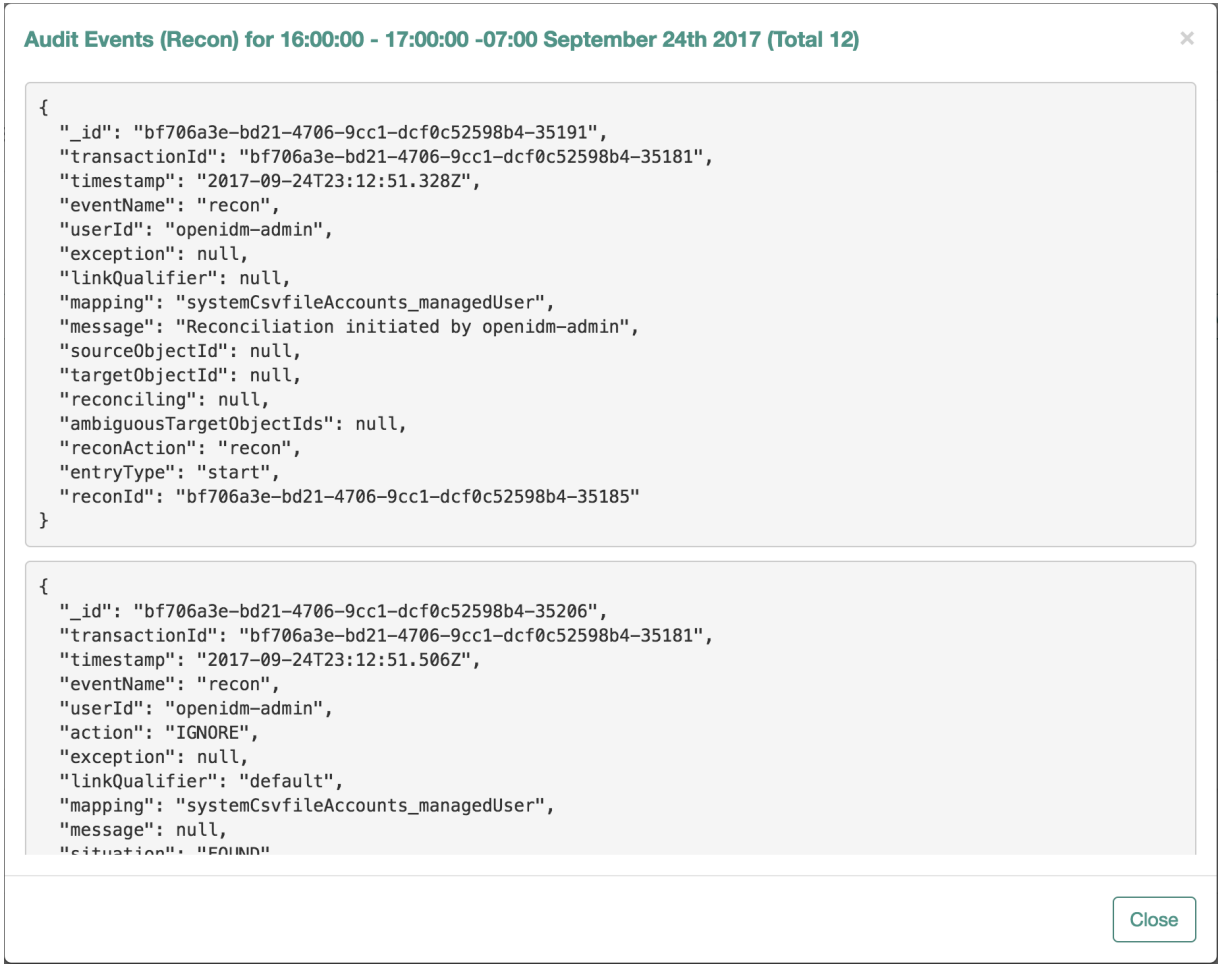
When you select this option, the details of the reconciliation appear. Click Reconciliation Results for additional information on the reconciliation run.

If a reconciliation fails, select the Failure Summary tab to obtain information about the reasons for the failure. Select the Information icon (ⓘ) for a breakdown of failure reasons per entry. The

following screen shows that reconciliation failed for a number of user accounts because they were missing the `country` property:



You can also view reconciliation audit logs in the Admin UI by adding an Audit widget to your dashboard. For more information, see "Viewing Audit Events in the Admin UI". The reconciliation Audit Widget shows the same information that you can obtain over REST, for example:



16.7.5. Triggering LiveSync

You can trigger LiveSync over REST or through the Admin UI. But before you do so, you should modify the DS change log.

The DS change log (`cn=changelog`) can be read only by `cn=directory manager` by default. If you are configuring liveSync with DS, the `principal` that is defined in the LDAP connector configuration must have access to the change log. For information about allowing a regular user to read the change log, see *To Allow a User to Read the Change Log* in the *Administration Guide* for DS.

Note

If you see the following error message, you may have forgotten to set `changelog-read` access for a regular user:

```
Unable to locate the DS replication change log suffix. Please make
sure it's enabled, and changelog-read access is granted.
```

16.7.5.1. Triggering LiveSync Over REST

Because you can trigger liveSync operations over REST (or by using the resource API) you can use an external scheduler to trigger liveSync operations, rather than using the IDM scheduling mechanism.

There are two ways to trigger liveSync over REST:

- Use the `_action=liveSync` parameter directly on the resource. This is the recommended method. The following example calls liveSync on the user accounts in an external LDAP system:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request POST \
"http://localhost:8080/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 \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request POST \
"http://localhost:8080/openidm/system?_action=liveSync&source=system/ldap/account"
```

A successful liveSync operation returns the following response:

```
{
     "_rev": "000000001ade755f",
     "_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, include an optional parameter (`detailedFailure`) to return additional information. For example:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request POST \
"http://localhost:8080/openidm/system/ldap/account?_action=liveSync&detailedFailure=true"
```

Note

The first time liveSync is called, it does not have a synchronization token 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.

16.7.5.2. Triggering LiveSync Through the UI

LiveSync operations are specific to a system object type (such as `system/ldap/account`). Apart from scheduling liveSync, as described in "Configuring LiveSync Through the UI", you can launch a liveSync operation on demand for a particular system object type as follows:

1. Select Configure > Connectors > *connector-name* and select the Object Types tab.
2. Select the Edit icon (✎) next to the object type that you want to synchronize.
3. Select the Sync tab and select Sync Now.

   The Sync Token field displays the current synchronization token for that object type.

Note

In the case of DS, the change log (`cn=changelog`) can be read only by `cn=directory manager` by default. If you are configuring liveSync with DS, the `principal` that is defined in the LDAP connector configuration must have access to the change log. For information about allowing a regular user to read the change log, see *To Allow a User to Read the Change Log* in the *Administration Guide* for DS.

If you see the following error message, you may have forgotten to set `changelog-read` access for a regular user:

```
Unable to locate the DS replication change log suffix. Please make
sure it's enabled, and changelog-read access is granted.
```

16.8. 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.

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. You can use 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 the query is to 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. If you wanted to reconcile all employee entries, and not just the permanent employees, you would run the reconciliation operation as follows:

```
$ curl \
 --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"}}' \
 "http://localhost:8080/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). 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,
   ...
```

16.8.1. Restricting Reconciliation in the Admin UI, With Queries

You can also restrict reconciliation by using queries through the Admin UI. Select Configure > Mappings, select a Mapping > Association > Reconciliation Query Filters. You can then specify desired source and target queries.

16.9. Restricting Reconciliation to a Specific ID

You can restrict reconciliation to a specific record in much the same way as you restrict reconciliation by using queries.

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 `id` parameter. Reconciling more than one ID with the `reconById` action is not currently supported.

The following command reconciles only the user with ID `b3c2f414-e7b3-46aa-8ce6-f4ab1e89288c`, for the mapping `managedUser_systemLdapAccounts`. The command synchronizes this particular user account in LDAP with the data from the managed user repository. 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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/recon?_action=reconById&mapping=managedUser_systemLdapAccounts&id=b3c2f414
-e7b3-46aa-8ce6-f4ab1e89288c"
```

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.

16.10. Configuring the LiveSync Retry Policy

You can specify the results when a liveSync operation reports a failure. Configure the liveSync retry policy to specify the number of times a failed modification should be reattempted and what should happen if the modification is unsuccessful after the specified number of attempts. If no retry policy is configured, IDM 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 liveSync, restrict the number of times that the same modification is attempted. You can then specify what happens to 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 IDM 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 IDM 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 liveSync. Therefore, if retries are enabled and a liveSync modification fails, IDM will retry the modification the next time that liveSync is invoked.

The `postRetryAction` field indicates what should happen if 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` - IDM should ignore the failed modification, and log its occurrence.
- `dead-letter-queue` - IDM 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 "*Scripting Reference*".

  In addition to the regular objects described in "*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`

  Two synchronization failure handlers are provided by default:

- `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);
```

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
```

IDM 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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/repo/synchronisation/deadLetterQueue/ldap?_queryId=query-all-ids"
{
    "result":
        [
            {
                "_id": "4",
                "_rev": "000000001298f6a6"
            }
        ],
    ...
}
```

To view the details of a specific failed modification, include its ID in the URL:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/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": "000000001298f6a6",
  "_id": "4"
}
```

16.11. Disabling Automatic Synchronization Operations

By default, all mappings are automatically synchronized. 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.

To prevent automatic synchronization for a specific mapping, set 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.

16.12. Restricting Implicit Synchronization to Specific Property Changes

For a mapping that has managed objects as the source, an implicit synchronization is triggered if *any* source property changes, regardless of whether the modified property is explicitly defined as a `source` property in the mapping.

This default behavior is helpful in situations where no source properties are explicitly defined—any property within the object is included as part of the mapping.

However, this behavior adds a processing overhead because every mapping from the managed object is invoked when *any* managed object property changes. If several mappings are configured from the managed object, this default behavior can cause performance issues.

In these situations, you can restrict the properties that should trigger an implicit synchronization *per mapping*, using the `triggerSyncProperties` attribute. This attribute contains an array of JSON pointers to the properties that must change before an implicit synchronization to the target is triggered. If none of these properties changes, no synchronization is triggered even if other properties in the object change.

In the following example, implicit synchronization is triggered *only* if the `mail`, `telephoneNumber`, or `userName` of an object changes:

```
{
    "mappings" : [
        {
            "name" : "managedUser_systemLdapAccounts",
            "source" : "managed/user",
            "target" : "system/ldap/account",
            "enableLinking" : false,
            "triggerSyncProperties" : [
                "/mail",
                "/telephoneNumber",
                "/userName"
            ],
            "properties" : [],
            "policies" : []
        }
    ]
}
```

If any other property changes on the managed object, no implicit synchronization is triggered.

16.13. Improving Performance With Implicit Synchronization

By default, IDM implicitly synchronizes managed object changes out to all resources for which the managed object is configured as a source. If there are several targets that must be synchronized, these targets are synchronized one at a time, one after the other. If any of the targets is remote or

has a high latency, the implicit synchronization operation can negatively affect performance, delaying the successful return of the managed object change.

In addition, if implicit synchronization fails for one target resource (for example, due to a policy validation failure on the target, or the target being unavailable), the synchronization operation stops at that point. The effect is that a record might be changed in the repository, and in the targets on which synchronization was successful, but not on the failed target, or any targets that would have been synchronized after the failure. This situation can result in disparate data sets across resources. While a reconciliation operation would eventually bring all targets back in sync, reconciliation can be an expensive operation with large data sets.

There are two ways to mitigate the performance impact of implicit synchronization operations with many mappings or large data sets:

- Queued Synchronization
- Synchronization Failure Compensation

16.13.1. Queued Synchronization

When you configure queued synchronization, implicit synchronization events are persisted to the IDM repository. Queued events are then read from the repository and executed according to the queued synchronization configuration.

The following illustration shows how synchronization operations are added to a local, in-memory queue. Note that this queue is distinct from the repository queue for synchronization events:

Queued Synchronization

Queued synchronization is disabled by default. To enable it, add a `queuedSync` object to your mapping, as follows:

```
{
    "mappings" : [
        {
            "name" : "managedUser_systemLdapAccounts",
            "source" : "managed/user",
            "target" : "system/ldap/account",
            "links" : "systemLdapAccounts_managedUser",
            "queuedSync" : {
                "enabled" : true,
                "pageSize" : 100,
                "pollingInterval" : 1000,
                "maxQueueSize" : 20000,
                "maxRetries" : 5,
                "retryDelay" : 1000,
                "postRetryAction" : "logged-ignore"
            },
            ...
        }
    ]
}
```

Note that these settings apply *only* to the implicit synchronization operations for that mapping. Reconciliation is unaffected by queued synchronization settings. Events associated with mappings where queued synchronization is enabled are submitted to the synchronization queue for asynchronous processing. Events associated with mappings where queued synchronization is not enabled are processed immediately and block further event processing until they are complete.

The `queuedSync` object has the following configuration:

`enabled`

Specifies whether queued synchronization is enabled for that mapping. Boolean, `true` or `false`.

`pageSize` (integer)

Specifies the maximum number of events to retrieve from the repository queue within a single polling interval. The default is `100` events.

`pollingInterval` (integer)

Specifies the repository queue polling interval, in milliseconds. The default is `1000` ms.

`maxQueueSize` (integer)

Specifies the maximum number of synchronization events that can be accepted into the in-memory queue. The default is `20000` events.

`maxRetries` (integer)

Specifies the number of retries to perform before invoking the `postRetry` action. The default is `5` events retry attempts.

`retryDelay` (integer)

In the event of a failed queued synchronization operation, this parameter specifies the number of milliseconds to delay before attempting the operation again. The default is `1000` ms.

`postRetryAction`

The action to perform after the retries have been exhausted. Possible options are `logged-ignore`, `dead-letter-queue`, and `script`. These options are described in "Configuring the LiveSync Retry Policy". The default action is `logged-ignore`.

Note

Retries occur synchronously to the failure. For example, if the `maxRetries` is set to `10`, at least 10 seconds will pass between the failing sync event and the next sync. (There are 10 retries, and the `retryDelay` is 1 second by default.) These 10 seconds do not take into account the latency of the ten sync requests. This behavior is different to the liveSync retry behavior, where retries apply across liveSync invocations. So, for queued sync, you should avoid setting a large `maxRetries` or a large `retryDelay` because the failure of a single sync event can delay the synchronization of all subsequently generated sync events.

16.13.1.1. Tuning Queued Synchronization

Queued synchronization employs a single worker thread. While implicit synchronization operations are being generated, that worker thread should always be occupied. The occupation of the worker thread is a function of the `pageSize`, the `pollingInterval`, the latency of the poll request, and the latency of each synchronization operation for the mapping.

For example, assume that a poll takes 500 milliseconds to complete. Your system must provide operations to the worker thread at approximately the same rate at which the thread can consume events (based on the page size, poll frequency and poll latency). Operation consumption is a function of the `notify`*`action`*`.execution` for that particular mapping. If the system does not provide operations fast enough, implicit synchronization will not occur as optimally as it could. If the system provides operations too quickly, the operations in the queue could exceed the default maximum of `20000`. If the `maxQueueSize` is reached, additional synchronization events will result in a `RejectedExecutionException`.

Depending on your hardware and workload, you might need to adjust the default `pageSize`, `pollingInterval`, and `maxQueueSize`.

Monitor the queued synchronization metrics, specifically the `rejected-executions`, and adjust the `maxQueueSize` accordingly. Set a large enough `maxQueueSize` to prevent slow mappings and heavy load from causing newly-submitted synchronization events to be rejected.

Monitor the synchronization latency using the `sync.queue.`*`mapping-name`*`.poll-pending-events` metric.

For more information on monitoring metrics, see "Metrics and Monitoring".

16.13.1.2. Managing the Synchronization Queue

You can manage queued synchronization events over the REST interface, at the `openidm/sync/queue` endpoint. The following examples show the operations that are supported on this endpoint:

List all events in the synchronization queue:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/sync/queue?_queryFilter=true"
{
  "result": [
    {
      "_id": "03e6ab3b-9e5f-43ac-a7a7-a889c5556955",
      "_rev": "0000000034dba395",
      "mapping": "managedUser_systemLdapAccounts",
      "resourceId": "e6533cfe-81ad-4fe8-8104-55e17bd9a1a9",
      "remainingRetries": 5,
      "syncAction": "notifyCreate",
      "state": "PENDING",
      "resourceCollection": "managed/user",
      "nodeId": null,
      "createDate": "2018-11-12T07:45:00.072Z"
    },
    {
      "_id": "ed940f4b-ce80-4a7f-9690-1ad33ad309e6",
      "_rev": "000000007878a376",
      "mapping": "managedUser_systemLdapAccounts",
      "resourceId": "28b1bd90-f647-4ba9-8722-b51319f68613",
      "remainingRetries": 5,
      "syncAction": "notifyCreate",
      "state": "PENDING",
      "resourceCollection": "managed/user",
      "nodeId": null,
      "createDate": "2018-11-12T07:45:00.150Z"
    },
    {
      "_id": "f5af2eed-d83f-4b70-8001-8bc86075134f",
      "_rev": "00000000099aa321",
      "mapping": "managedUser_systemLdapAccounts",
      "resourceId": "d2691a45-0a10-4f51-aa2a-b6854b2f8086",
      "remainingRetries": 5,
      "syncAction": "notifyCreate",
      "state": "PENDING",
      "resourceCollection": "managed/user",
      "nodeId": null,
      "createDate": "2018-11-12T07:45:00.276Z"
    },
    ...
  ],
  "resultCount": 8,
  "pagedResultsCookie": null,
  "totalPagedResultsPolicy": "NONE",
  "totalPagedResults": -1,
  "remainingPagedResults": -1
}
```

The predefined query `"http://localhost:8080/openidm/sync/queue?_queryId=query-all"` will also return all events in the queue.

Query the queued synchronization events based on the following properties:

- `mapping`—the mapping associated with this event. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/sync/queue?_queryFilter=mapping+eq+'managedUser_systemLdapAccount'"
```

- `nodeId`—the ID of the node that has acquired this event.
- `resourceId`—the source object resource ID.
- `resourceCollection`—the source object resource collection.
- `_id`—the ID of this sync event.
- `state`—the state of the synchronization event. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/sync/queue?_queryFilter=state+eq+'PENDING'"
```

  The `state` of a queued synchronization event is one of the following:

  `PENDING`—the event is waiting to be processed.
  `ACQUIRED`—the event is being processed by a node.
  `COMPLETED`—the event was processed successfully by a node.
  `EXPIRED`—the event was discarded because the source object was modified.

- `remainingRetries`—the number of retries available for this synchronization event before it is abandoned. For more information about how synchronization events are retried, see "Configuring the LiveSync Retry Policy". For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/sync/queue?_queryFilter=remainingRetries+lt+2"
```

- `syncAction`—the synchronization action that initiated this event. Possible synchronization actions are `notifyCreate`, `notifyUpdate`, and `notifyDelete`. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/sync/queue?_queryFilter=syncAction+eq+'notifyCreate'"
```

- `createDate`—the date that the event was created.

Delete a queued event, based on its ID. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request DELETE \
 "http://localhost:8080/openidm/sync/queue/eventID"
```

16.13.1.3. Recovering Mappings When Nodes Are Down

Synchronization events for mappings with queued synchronization enabled are processed by a single cluster node. While a node is present in the cluster, that node holds a *lock* on the specific mapping. The node can release or reacquire the mapping lock if a balancing event occurs (see "Balancing Mapping Locks Across Nodes"). However, the mapping lock is held across all events on that mapping. In a stable running cluster, a single node will hold the lock for a mapping indefinitely.

It is possible that a node goes down, or is removed from the cluster, while holding a mapping lock on operations in the synchronization queue. To prevent these operations being lost, the queued synchronization facility includes a *recovery monitor* that checks for any *orphaned* mappings in the cluster.

A mapping is considered orphaned in the following cases:

- No active node holds a lock on the mapping
- The node that holds a lock on the mapping has an instance state of `STATE_DOWN`
- The node that holds a lock on the mapping does not exist in the cluster

The recovery monitor periodically checks for orphaned mappings and, when all orphaned mappings have been recovered, attempts to initialize new queue consumers.

The recovery monitor is enabled by default and executes every 300 seconds. To change the default behavior for a mapping, add the following to your synchronization configuration (`sync.json`) and change the parameters as required:

```
{
    "mappings" : [...],
    "queueRecovery" : {
        "enabled" : true,
        "recoveryInterval" : 300
    }
}
```

Important

If a queued synchronization job has already been claimed by a node, and that node is *shut down*, IDM notifies the entire cluster of the shutdown. This enables a different node to pick up the job in progress. The recovery monitor takes over jobs in a synchronization queue that have not been fully processed by an available cluster

node, so no job should be lost. If you have configured queued synchronization for one or more mappings, do not use the `enabled` flag in `conf/cluster.json` to remove a node from the cluster. Instead, shut down the node so that the remaining nodes in the cluster can take over the queued synchronization jobs.

16.13.1.4. Balancing Mapping Locks Across Nodes

Queued synchronization mapping locks are balanced equitably across cluster nodes. At a specified interval, each node attempts to release and acquire mapping locks, based on the number of running cluster nodes. When new cluster nodes come online, existing nodes release sufficient mapping locks for new nodes to pick them up, resulting in an equitable distribution of locks.

Lock balancing is enabled by default and the interval at which nodes attempt to balance locks in the queue is 5 seconds. To change the default configuration, add a `queueBalancing` object to your synchronization configuration (`sync.json`) and set the following parameters:

```
{
    "mappings" : [...],
    "queueBalancing" : {
        "enabled" : true,
        "balanceInterval" : 5
    }
}
```

16.13.2. Synchronization Failure Compensation

This mechanism involves reverting a implicit synchronization operation if it is not completely successful across all configured mappings.

Failure compensation ensures that either all resources are synchronized successfully, or that the original change is rolled back. This mechanism uses an `onSync` script hook in the managed object configuration (`conf/managed.json` file). The `onSync` hook references a script (`compensate.js`) located in the `/path/to/openidm/bin/defaults/script` directory. This script prevents partial synchronization by "reverting" a partial change in the event that all resources are not synchronized.

The following excerpt of a sample `managed.json` file shows the addition of the `onSync` hook:

```
...
"onDelete" : {
    "type" : "text/javascript",
    "file" : "onDelete-user-cleanup.js"
},
"onSync" : {
    "type" : "text/javascript",
    "file" : "compensate.js"
},
"properties" : [
    ...
```

With this configuration, a change to a managed object triggers an implicit synchronization for each configured mapping, in the order in which the mappings are specified in `sync.json`. If synchronization is successful for all configured mappings, IDM exits from the script. If synchronization fails for

a particular resource, the `onSync` hook invokes the `compensate.js` script, which 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 a second time. This time, however, the script recognizes that the change was originally called as a result of a compensation and aborts. IDM 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 result in out of sync data stores, as discussed in the earlier Human Resources example.

With the `compensate.js` script, any such errors will result in each data store retaining the information it had before implicit synchronization started. That information is stored, temporarily, in the `oldObject` variable.

In the previous Human Resources example, managers should see that new employees are not shown in their database. Administrators can then check log files for errors, address them, and restart the synchronization process with a new REST call.

16.14. Synchronization Situations and Actions

During synchronization IDM assesses source and target objects, and the links between them, and determines the *synchronization situation* that applies to each object. IDM then performs a specific action, usually on the target object, depending on the assessed situation.

The action that is taken for each situation is defined in the `policies` section of your synchronization mapping. The following excerpt of the `sync.json` file from the sample described in "*Two Way Synchronization Between LDAP and IDM*" in the *Samples Guide* shows the defined actions in that sample:

```
{
    "policies": [
        {
            "situation": "CONFIRMED",
            "action": "UPDATE"
        },
        {
            "situation": "FOUND",
            "action": "LINK"
        },
        {
            "situation": "ABSENT",
            "action": "CREATE"
        },
        {
            "situation": "AMBIGUOUS",
            "action": "IGNORE"
        },
        {
```

```
            "situation": "MISSING",
            "action": "IGNORE"
        },
        {
            "situation": "SOURCE_MISSING",
            "action": "DELETE"
        },
        {
            "situation": "UNQUALIFIED",
            "action": "IGNORE"
        },
        {
            "situation": "UNASSIGNED",
            "action": "IGNORE"
        }
    ]
}
```

You can also define these actions in the Admin UI. Select Configure > Mappings, click on the required Mapping, then select the Behaviors tab to specify different actions per situation.

If you do not define an action for a particular situation, IDM takes the *default action* for that situation. The following section describes how situations are assessed, lists all possible situations and describes the default actions taken for each situation.

16.14.1. How Synchronization Situations Are Assessed

Reconciliation is performed in two phases:

1. *Source reconciliation* accounts for source objects and associated links based on the configured mapping.

2. *Target reconciliation* iterates over the target objects that were not processed in the first phase.

   For example, if a source object was deleted, the *source reconciliation* phase will not identify the target object that was previously linked to that source object. Instead, this *orphaned* target object is detected during the second phase.

During source reconciliation IDM iterates through the objects in the source resource and evaluates the following conditions:

1. Is the source object valid?

   Valid source objects are categorized `qualifies=1`. Invalid source objects are categorized `qualifies=0`. Invalid objects include objects that were filtered out by a `validSource` script or `sourceCondition`. For more information, see "Filtering Synchronized Objects".

2. Does the source object have a record in the links table?

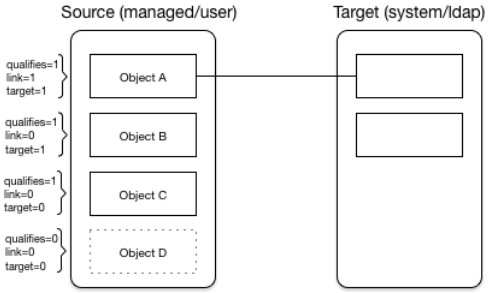
   Source objects that have a corresponding link in the repository's `links` table are categorized `link=1`. Source objects that do not have a corresponding link are categorized `link=0`.

3. Does the source object have a corresponding valid target object?

   Source objects that have a corresponding object in the target resource are categorized `target=1`. Source objects that do not have a corresponding object in the target resource are categorized `target=0`.

The following diagram illustrates the categorization of four sample objects during source reconciliation. In this example, the source is the managed user repository and the target is an LDAP directory.

Object Categorization During the Source Synchronization Phase



Based on the categorizations of source objects during the source reconciliation phase, IDM assesses a *situation* for each source object. Not all situations are detected in all synchronization types. The following list describes the set of synchronization situations, when they can be detected, the default action taken for that situation, and valid alternative actions that can be defined for the situation:

Situations detected during reconciliation and source change events

`CONFIRMED` **(qualifies=1, link=1, target=1)**

The source object qualifies for a target object, and is linked to an existing target object.

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 is not linked to an existing target object. There is a single target object that correlates with this source object, according to the logic in the correlation.

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 is not linked to an existing target object. There is a single target object that correlates with this source object, according to the logic in the correlation, but that target object is already linked to a different source object.

Default action: throw an `EXCEPTION`.

Other valid actions: `IGNORE, REPORT, NOREPORT, ASYNC`

`ABSENT` (qualifies=1, link=0, target=0)

The source object qualifies for a target object, is not linked to an existing target object, and no correlated target object is found.

Default action: `CREATE` a target object.

Other valid actions: `EXCEPTION, 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.

Default action: `DELETE` the target object or objects.

Other valid actions: `EXCEPTION, IGNORE, REPORT, NOREPORT, ASYNC`

`AMBIGUOUS` (qualifies=1, link=0, target>1)

The source object qualifies for a target object, is not linked 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).

Default action: throw 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 is linked to a target object, but the target object is missing.

Default action: throw an `EXCEPTION`.

Other valid actions: `CREATE, UNLINK, DELETE, IGNORE, REPORT, NOREPORT, ASYNC`

Note

If the action is CREATE for the situation MISSING, the orphaned link associated with the source object is updated to point to the new target object.

When a target object is deleted, the link from the target to the corresponding source object is not deleted automatically. This allows IDM to detect and report items that might have been removed

without permission or might need review. If you need to remove the corresponding link when a target object is deleted, change the action to UNLINK to remove the link, or to DELETE to remove the target object and the link.

`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.

Default action: `IGNORE` the source object.

Other valid actions: `EXCEPTION, REPORT, NOREPORT, ASYNC`

Situations detected only during source change events:

`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 differs from the `UNQUALIFIED` situation, based on the status of the link and the 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`

`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.

Default action: throw 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:

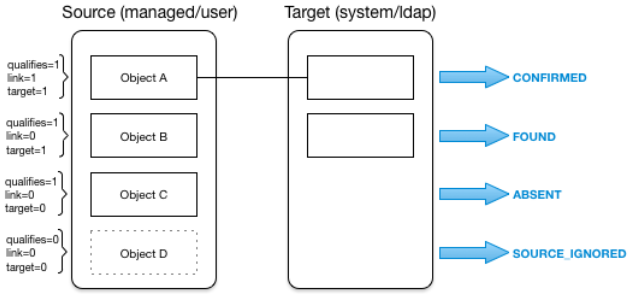
- No previous source object can be found.
- There is no correlation logic.
- A previous source object was found, and correlation logic exists, but no corresponding target was found.

Default action: `IGNORE` the source object.

Other valid actions: `EXCEPTION, REPORT, NOREPORT, ASYNC`

Based on this list, the following situations would be assigned to the previous diagram:

Situation Assignment During the Source Synchronization Phase



During target reconciliation, IDM iterates through the objects in the target resource that were not accounted for during source reconciliation, and evaluates the following conditions:

1. Is the target object valid?

   Valid target objects are categorized `qualifies=1`. Invalid target objects are categorized `qualifies=0`. Invalid objects include objects that were filtered out by a `validTarget` script. For more information, see "Filtering Synchronized Objects".

2. Does the target object have a record in the links table?

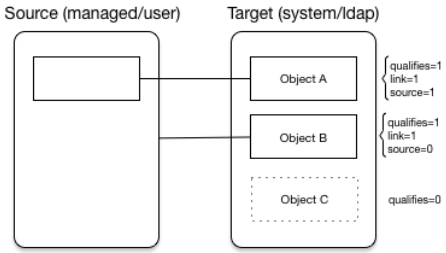
   Target objects that have a corresponding link in the repository's `links` table are categorized `link=1`. Target objects that do not have a corresponding link are categorized `link=0`.

3. Does the target object have a corresponding valid source object?

   Target objects that have a corresponding object in the source resource are categorized `source=1`. Target objects that do not have a corresponding object in the source resource are categorized `source=0`.

The following diagram illustrates the categorization of three sample objects during target reconciliation.

Object Categorization During the Target Synchronization Phase



Based on the categorizations of target objects during the target reconciliation phase, a *situation* is assessed for each remaining target object. Not all situations are detected in all synchronization types. The following list describes the set of synchronization situations, when they can be detected, the default action taken for that situation, and valid alternative actions that can be defined for the situation:

Situations detected only during reconciliation:

`TARGET_IGNORED` **(qualifies=0)**

During target reconciliation, the target becomes unqualified by the `validTarget` script.

Default action: `IGNORE` the target object.

Other valid actions: `DELETE, UNLINK, REPORT, NOREPORT, ASYNC`

`UNASSIGNED` **(qualifies=1, link=0)**

A valid target object exists but does not have a link.

Default action: throw 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.

Default action: `UPDATE` the target object.

Other valid actions: `IGNORE, REPORT, NOREPORT`

Situations detected during reconciliation and target change events:

`UNQUALIFIED` **(qualifies=0, link=1, source=1, but source does not qualify)**

The target object is unqualified (by the `validTarget` script). There is a link to an existing source object, which is also unqualified.

Default action: `DELETE` the target object.

Other valid actions: `UNLINK, EXCEPTION, IGNORE, REPORT, NOREPORT, ASYNC`

`SOURCE_MISSING` **(qualifies=1, link=1, source=0)**

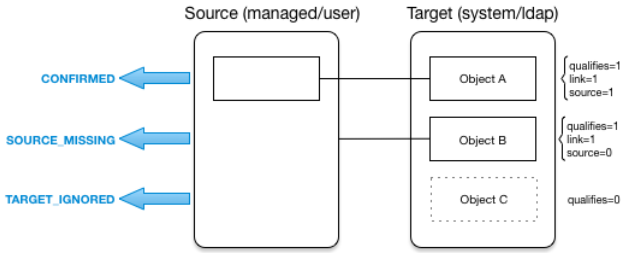
The target object qualifies and a link is found, but the source object is missing.

Default action: throw an `EXCEPTION`.

Other valid actions: `DELETE, UNLINK, IGNORE, REPORT, NOREPORT, ASYNC`

Based on this list, the following situations would be assigned to the previous diagram:

Situation Assignment During the Target Synchronization Phase



The following sections walk you through how situations are assigned during source and target reconciliation.

16.14.2. Source Reconciliation

Both reconciliation and liveSync start 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. IDM can filter objects from the list by using the script specified in the `validSource` property, or the query specified in the `sourceCondition` property.

IDM then iterates the list, checking each entry against the `validSource` and `sourceCondition` filters, and classifying objects according to their situations as described in "How Synchronization Situations Are Assessed". IDM uses the list of links for the current mapping to classify objects. Finally, IDM executes the action that is configured for each situation.

The following table shows how the appropriate situation is assigned during source reconciliation, depending on whether a valid source exists (Source Qualifies), whether a link exists in the repository (Link Exists), and the number of target objects found, based either on links or on the results of the correlation.

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
	X		X			X	UNQUALIFIED
	X	X		X			UNQUALIFIED
	X	X			X		TARGET_IGNORED
	X	X				X	UNQUALIFIED
X			X	X			ABSENT

Source Qualifies?		Link Exists?		Target Objects Found[a]			Situation
Yes	No	Yes	No	0	1	> 1	
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 IDM executes correlation logic. If no previous object is available, IDM cannot correlate.
[b]A link exists from the target object but it is not for this specific source object.

16.14.3. Target Reconciliation

During source reconciliation, IDM cannot detect situations where no source object exists, such as the `UNASSIGNED` situation. When no source object exists, IDM detects the situation during the second reconciliation phase, target reconciliation. During target reconciliation, IDM iterates 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 IDM 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.

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

16.14.4. Situations Specific to Implicit Synchronization and LiveSync

Certain situations occur only during implicit synchronization (when changes made in the repository are pushed out to external systems) and liveSync (when IDM 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.

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, IDM executes any included correlation logic. If a link exists, correlation does not apply.

16.14.5. Synchronization Actions

When a situation has been assigned to an object, IDM takes the actions configured in the mapping. If no action is configured, IDM takes the default action for that situation. The following actions can be taken:

`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.

Do 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 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.

16.14.6. Launching 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 script can be either JavaScript or Groovy, and can be provided inline (with the `"source"` property), or referenced from a file, (with the `"file"` property).

The following excerpt of a sample `sync.json` file specifies that an inline script should be invoked when a synchronization operation assesses an entry as `ABSENT` in the target system. The script checks whether the `employeeType` property of the corresponding source entry is `contractor`. If so, the entry is ignored. Otherwise, the entry is created on the target system:

```
{
    "situation" : "ABSENT",
    "action" : {
        "type" : "text/javascript",
        "globals" : { },
        "source" : "if (source.employeeType === 'contractor') {action='IGNORE'}
                    else {action='CREATE'};action;"
    },
}
```

Note that the CREATE action updates the target data set automatically. For other actions, you must call `openidm.update` explicitly, in the script. For example, if you simply want to update the value of the `description` attribute on the target object, and then ignore the object, your script might look as follows:

```
"var action = 'IGNORE';
target.description='This entry has been deleted';
openidm.update('system/ldap/account/' + target._id, null, target);
action"
```

The variables available to a script that is called as an action are `source`, `target`, `linkQualifier`, and `recon` (where `recon.actionParam` contains information about the current reconciliation operation). For more information about the variables available to scripts, see "Variables Available to Scripts".

The result obtained from evaluating this script must be a string whose value is one of the synchronization actions listed in "Synchronization Actions". This resulting action will be shown in the reconciliation log.

To launch a script as a synchronization action in the Admin UI:

1. Select Configure > Mappings.
2. Select the mapping that you want to change.
3. On the Behaviors tab, click the pencil icon next to the situation whose action you want to change.
4. On the Perform this Action tab, click Script, then enter the script that corresponds to the action.

16.14.7. Launching a Workflow As an Action

The `triggerWorkflowFromSync.js` script launches a predefined workflow when a synchronization operation assesses a particular situation. The mechanism for triggering this script is the same as for any other script. The script is provided in the `openidm/bin/defaults/script/workflow` directory. If you customize the script, copy it to the `script` directory of your project to ensure that your customizations are preserved during an upgrade.

The parameters for the workflow are passed as properties of the `action` parameter.

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:

```
{
    "situation" : "ABSENT",
    "action" : {
        "workflowName" : "managedUserApproval",
        "type" : "text/javascript",
        "file" : "workflow/triggerWorkflowFromSync.js"
    }
}
```

To launch a workflow as a synchronization action in the Admin UI:

1. Select Configure > Mappings.
2. Select the mapping that you want to change.
3. On the Behaviors tab, click the pencil icon next to the situation whose action you want to change.
4. On the Perform this Action tab, click Workflow, then enter the details of the workflow you want to launch.

16.15. 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, after the management approval has been received.

In this scenario, the defined script returns `ASYNC` 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/sync-asynchronous`, and described in "*Asynchronous Reconciliation Using a Workflow*" in the *Samples Guide*.

Configuring asynchronous reconciliation using a workflow 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 "*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', content, 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: `CREATE, UPDATE, DELETE, LINK, UNLINK, EXCEPTION, REPORT, NOREPORT, ASYNC, IGNORE`.

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 repository.

Note that the `_id` must be URL-encoded in the REST call:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/sync?_action=performAction&sourceId=uid%3Dbjensen%2Cou%3DPeople%2Cdc
%3Dexample%2Cdc%3Dcom&mapping=
 systemLdapAccounts_ManagedUser&action=DELETE"
{
    "status": "OK"
}
```

The following example creates a link between a managed object and its corresponding system object. Such a call is useful in the context of manual data association, when correlation logic has linked an incorrect object, or when IDM has been unable to determine the correct target object.

In this example, there are two separate target accounts (`scarter.user` and `scarter.admin`) that should be mapped to the managed object. This call creates a link to the `user` account and specifies a link qualifier that indicates the type of link that will be created:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/sync?_action=performAction&action=LINK
   &sourceId=4b39f74d-92c1-4346-9322-d86cb2d828a8&targetId=scarter.user
   &mapping=managedUser_systemCsvfileAccounts&linkQualifier=user"
{
    "status": "OK"
}
```

For more information about linking to multiple accounts, see "Mapping a Single Source Object to Multiple Target Objects".

16.16. Configuring Case Sensitivity For Data Stores

IDM is case-sensitive, which means that an upper case ID is considered different from an otherwise identical lower case ID during reconciliation. In contrast, ForgeRock Directory Services (DS) is case-insensitive. This can be problematic during reconciliation with DS, because the ID of the links created by reconciliation might not match the case of the IDs expected by IDM.

If a mapping inherits links by using the `links` property, you do not need to set case-sensitivity, because the mapping uses the setting of the referred links.

Alternatively, you can address case-sensitivity issues from a data store in one of the following ways:

- Specify a case-insensitive data store. To do so, set the `sourceIdsCaseSensitive` or `targetIdsCaseSensitive` properties to `false` in the mapping for those links. For example, if the source 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" : [
    ...
```

You may also need to modify the ICF provisioner to make it case-insensitive. To do so, open your provisioner configuration file, and set the `enableFilteredResultsHandler` property to `false`:

```
"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.

- Use a case-insensitive option from your data store. For example, in MySQL, you can change the collation of `managedobjectproperties.propvalue` to `utf8_general_ci`. For more information, see "Configuring Case Insensitivity For a JDBC Repository" in the *Installation Guide*.

In general, to address case-sensitivity, focus on database, table, or column level collation settings. Queries performed against repositories configured in this way are subject to the collation, and are used for comparison.

16.17. Optimizing Reconciliation Performance

By default, reconciliation is configured to function optimally, with regard to performance. Some of these optimizations might, however, be unsuitable for your environment. The following sections describe the default optimizations and how they can be configured, as well as additional methods you can use to improve the performance of reconciliation operations.

16.17.1. Correlating Empty Target Sets

To optimize performance, reconciliation does not 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 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.

16.17.1.1. Correlating Empty Target Sets in the Admin UI

To change the `correlateEmptyTargetSet` option in the Admin UI, choose Configure > Mappings. Select the desired mapping. In the Advanced tab, enable or disable the following option:

- Correlate Empty Target Objects

16.17.2. Prefetching Links

All links are queried at the start of reconciliation and the results of that query are used. You can disable the link prefetching so that the reconciliation 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.

16.17.2.1. Prefetching Links in the Admin UI

To change the `prefetchLinks` option in the Admin UI, choose Configure > Mappings. Select the desired mapping. In the Advanced tab, enable or disable the following option:

- Pre-fetch Links

16.17.3. Parallel Reconciliation Threads

By default, reconciliation is multithreaded; numerous threads are dedicated to the same reconciliation run. Multithreading generally improves reconciliation performance. The default number of threads for a single reconciliation run is 10 (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" : "systemCsvfileAccounts_managedUser",
        "source" : "system/csvfile/account",
        "target" : "managed/user",
        "taskThreads" : 20
        ...
    }
]
```

A zero value runs reconciliation as a serialized process, on the main reconciliation thread.

16.17.3.1. Parallel Reconciliation Threads in the Admin UI

To change the `taskThreads` option in the Admin UI, choose Configure > Mappings. Select the desired mapping. In the Advanced tab, adjust the number of threads in the following text box:

- Threads Per Reconciliation

16.17.4. Improving Reconciliation Query Performance

Reconciliation operations are processed in two phases; a *source phase* and a *target phase*. 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:

```
"mappings" : [
    {
        "name" : "systemLdapAccounts_managedUser",
        "source" : "system/ldap/account",
        "target" : "managed/user",
        "sourceQuery" : {
            "_queryFilter" : "true"
        },
    ...
```

IDM attempts to detect what data has been returned. The autodetection 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 autodetection 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 autodetect logic would assume that the complete object was being returned. IDM 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 indicates that the full objects are returned and that IDM should not autodetect the result set:

```
"mappings" : [
    {
        "name" : "systemLdapAccounts_managedUser",
        "source" : "system/ldap/account",
        "target" : "managed/user",
        "sourceQueryFullEntry" : true,
        "sourceQuery" : {
            "_queryFilter" : "true"
        },
    ...
```

By default, all the attributes that are defined in the connector configuration file are loaded into memory. If your mapping uses only a small subset of the attributes in the connector configuration file, you can restrict your query to return only those attributes required for synchronization by using the `_fields` parameter with the query filter.

The following excerpt loads only a subset of attributes into memory, for all users in an LDAP directory.

```
"mappings" : [
    {
        "name" : "systemLdapAccounts_managedUser",
        "source" : "system/ldap/account",
        "target" : "managed/user",
        "sourceQuery" : {
            "_queryFilter" : "true",
            "_fields" : "cn, sn, dn, uid, employeeType, mail"
        },
    ...
```

Note

The default source query for non-clustered, non-paged reconciliation operations is `query-all-ids`. The default source query for clustered reconciliations and for paged reconciliations is a `queryFilter`-based construct that returns the full source objects, not just their IDs. So, source queries for clustered and paged reconciliations are optimized for performance by default.

16.17.5. Improving Role-Based Provisioning Performance With an `onRecon` Script

IDM provides an `onRecon` script that runs once, at the beginning of each reconciliation. This script can perform any setup or initialization operations that are appropriate for the reconciliation run.

In addition, a `reconContext` variable is added to a request's context chain when reconciliation runs. The `reconContext` can store pre-loaded data that can be used by other IDM components (such as the managed object service) to improve performance.

The default `onRecon` script (`openidm/bin/default/script/roles/onRecon.groovy`) loads the `reconContext` with all the roles and assignments that are required for the current mapping. The `effectiveAssignments` script checks the `reconContext` first. If a `reconContext` is present, the script uses that `reconContext` to populate the array of `effectiveAssignments`. This prevents a read operation to `managed/role` or `managed/assignment` every time reconciliation runs, and greatly improves the overall performance for role-based provisioning.

You can customize the `onRecon`, `effectiveRoles`, and `effectiveAssignments` scripts to provide additional business logic during reconciliation. If you customize these scripts, copy the default scripts from `openidm/bin/defaults/scripts` into your project's `script` directory, and make the changes there.

16.17.6. Paging Reconciliation Query Results

"Improving Reconciliation Query Performance" describes how to improve reconciliation performance by loading all entries into memory to avoid making individual requests to the external system for every ID. However, this optimization depends on the entire result set fitting into the available memory on the system for which it is enabled. For particularly large data sets (for example, data sets of hundreds of millions of users), having the entire data set in memory might not be feasible.

To alleviate this constraint, you can use reconciliation paging, which breaks down extremely large data sets into chunks. It also lets you specify the number of entries that should be reconciled in each chunk or page.

Reconciliation paging is disabled by default, and can be enabled per mapping (in the `sync.json` file). To configure reconciliation paging, set the `reconSourceQueryPaging` property to `true` and set the `reconSourceQueryPageSize` in the synchronization mapping, for example:

```
{
    "mappings" : [
        {
            "name" : "systemLdapAccounts_managedUser",
            "source" : "system/ldap/account",
            "target" : "managed/user",
            "reconSourceQueryPaging" : true,
            "reconSourceQueryPageSize" : 100,
            ...
        }
```

The value of `reconSourceQueryPageSize` must be a positive integer, and specifies the number of entries that will be processed in each page. If reconciliation paging is enabled but no page size is set, a default page size of `1000` is used.

Important

If you are reconciling from a JDBC database using the Database Table connector, you *must* set the `_sortkeys` property in the source query and ensure that the corresponding column is indexed in the database.

The following excerpt of a sample `sync.json` file configures paged reconciliation queries using the Database Table connector:

```
{
    "mappings" : [
        {
            "name" : "systemHrdb_managedUser",
            "source" : "system/db/users",
            "target" : "managed/user",
            "reconSourceQueryPaging" : true,
            "reconSourceQueryPageSize" : 1000,
            "sourceQueryFullEntry" : true,
            "sourceQuery" : {
                "_queryFilter" : "true",
                "_sortKeys" : "email"
            },
        ...
    ]
}
```

16.18. Scheduling Synchronization

You can schedule synchronization operations, such as liveSync and reconciliation, using Quartz triggers. IDM supports simple triggers and cron triggers.

Use the trigger type that suits your scheduling requirements. Because simple triggers are not bound to the local timezone, they are better suited to scenarios such as liveSync where the requirement is to trigger the schedule at regular intervals, regardless of the local time. For more information, see the Quartz documentation on SimpleTriggers and CronTriggers.

This section describes scheduling specifically for reconciliation and liveSync, and shows simple triggers in all the examples. You can use the 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, see "*Scheduling Tasks and Events*".

16.18.1. Configuring Scheduled Synchronization

Each scheduled reconciliation and liveSync task requires a schedule configuration file in your project's `conf` directory. By convention, schedule configuration files are named `schedule-`*`schedule-name`*`.json`, where *schedule-name* is a logical name for the scheduled synchronization operation, such as `reconcile_systemCsvAccounts_managedUser`.

Schedule configuration files have the following format:

```
{
 "enabled"        : boolean, true/false
 "type"           : "string",
 "repeatInterval" : long integer,
 "repeatCount"    : integer,
 "persisted"      : boolean, true/false
 "startTime"      : "(optional) time",
 "endTime"        : "(optional) time",
 "schedule"       : "cron expression",
 "misfirePolicy"  : "optional, string",
 "invokeService"  : "service identifier",
 "invokeContext"  : "service specific context info"
}
```

These properties are specific to the scheduler service, and are explained in "*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 referenced by its name in the `conf/sync.json` file.

For liveSync, the properties are set as follows:

```
{
    "invokeService": "provisioner",
    "invokeContext": {
        "action": "liveSync",
        "source": "system/ldap/account"
    }
}
```

The `source` property follows the convention for a pointer to an external resource object and takes the form `system/resource-name/object-type`.

Important

When you schedule a reconciliation operation to run at regular intervals, do not set `"concurrentExecution" : true`. This parameter enables multiple scheduled operations to run concurrently. You cannot launch multiple reconciliation operations for a single mapping concurrently.

16.18.1.1. Configuring LiveSync Through the UI

To configure liveSync through the UI, set up a liveSync schedule as follows:

1. Select Configure > Schedules > Add Schedule.
2. Complete the schedule configuration. For more information about these fields, see "Configuring Scheduled Synchronization".

   Note

   The scheduler configuration assumes a `simple` trigger type by default, so the `Cron-like Trigger` field is disabled. You should use simple triggers for liveSync schedules to avoid problems related to daylight savings time. For more information, see "Schedules and Daylight Savings Time".

3. By default, the UI creates schedules using the scheduler service, rather than the configuration service. To create this schedule in the configuration service, select the Save as Config Object option. If your deployment enables writes to configuration files, this option also creates a corresponding `schedule-schedule-name.json` file in your project's `conf` directory.

   For more information on the distinction between the scheduler service and the configuration service, see "Managing Schedules Over REST".

16.19. Distributing Reconciliation Operations Across a Cluster

In a clustered deployment, you can configure reconciliation jobs to be distributed across multiple nodes in the cluster. Clustered reconciliation improves reconciliation performance, particularly

for very large data sets. Clustered reconciliation uses the paged reconciliation mechanism and the scheduler service to divide the *source* data set into pages, and then to schedule reconciliation "sub-jobs" per page, distributing these sub-jobs across the nodes in the cluster.

Regular (non-clustered) reconciliation has two phases - a source phase and a target phase. Clustered reconciliation effectively has three phases:

- A source page phase.

  During this phase, a set of reconciliation sub-jobs are scheduled in succession, page by page. Each source page job does the following:

  - Executes a source query using the paging cookie from the invocation context.
  - Schedules the next source page job.
  - Performs the reconciliation of the source IDs returned by the query.
  - Writes statistics summary information which is aggregated so that you can obtain the status of the complete reconciliation run by performing a GET on the `recon` endpoint.
  - On completion, writes the `repo_id`, `source_id`, and `target_id` to the repository.

- A source phase completion check.

  This phase is scheduled when the source query returns null. This check runs, and continues to re-schedule itself, as long as source page jobs are running. When the completion check determines that all the source page jobs are complete, it schedules the target phase.

- A target phase.

  This phase queries the target IDs, then removes all of the IDs that correspond to the `repo_id`, `source_id`, and `target_id` written by the source pages. The remaining target IDs are used to run the target phase, taking into account all records on the target system that were not correlated to a source ID during the source phase sub-jobs.

16.19.1. Configuring Clustered Reconciliation for a Mapping

To specify that the reconciliation for a specific mapping should be distributed across a cluster, add the `clusteredSourceReconEnabled` property to the mapping and set it to `true`. For example:

```
{
     "mappings" : [
         {
             "name" : "systemLdapAccounts_managedUser",
             "source" : "system/ldap/account",
             "target" : "managed/user",
             "clusteredSourceReconEnabled" : true,
 ...
 }
```

Note

When clustered reconciliation is enabled, source query paging is enabled automatically, regardless of the value that you set for the `reconSourceQueryPaging` property in the mapping.

By default, the number of records per page is 1000. Increase the page size for large data sets. For example, a reconciliation of data set of 1,000,000 entries would perform better with a page size of 10,000. To change the page size, set the `reconSourceQueryPageSize` property, for example:

```
{
     "mappings" : [
         {
             "name" : "systemLdapAccounts_managedUser",
             "source" : "system/ldap/account",
             "target" : "managed/user",
             "clusteredSourceReconEnabled" : true,
             "reconSourceQueryPageSize" : 10000
 ...
 }
```

To set these properties in the Admin UI, select Configure > Mappings, click on the mapping that you want to change, and select the Advanced tab.

Important

Be aware of the following limitations when implementing clustered reconciliation:

- A complete non-clustered reconciliation run is synchronous with the single reconciliation invocation.

  By contrast, a clustered reconciliation is not synchronous. In a clustered reconciliation, the first execution is synchronous only with the reconciliation of the first page. This job also schedules the subsequent pages of the clustered reconciliation to run on other cluster nodes. When you schedule a clustered reconciliation or call the operation over REST, do not set `waitForCompletion` to `true`, since you cannot wait for the operation to complete before the next operation starts.

  Because this first execution does not encompass the entire reconciliation operation for that mapping, you cannot rely on the Quartz `concurrentExecution` property to prevent two reconciliation operations from running concurrently. If you use Quartz to schedule clustered reconciliations (as described in "Configuring Scheduled Synchronization"), make sure that the interval between scheduled operations exceeds the known run of the entire clustered reconciliation. The run-length of a specific clustered reconciliation can vary. You should therefore build in appropriate buffer times between schedules, or use a scheduled script that performs a GET on the `recon/` endpoint, and dispatches the next reconciliation on a mapping only when the previous reconciliation run has completed.

- If one node in the cluster is down or goes offline during a clustered reconciliation run, the reconciliation is canceled.

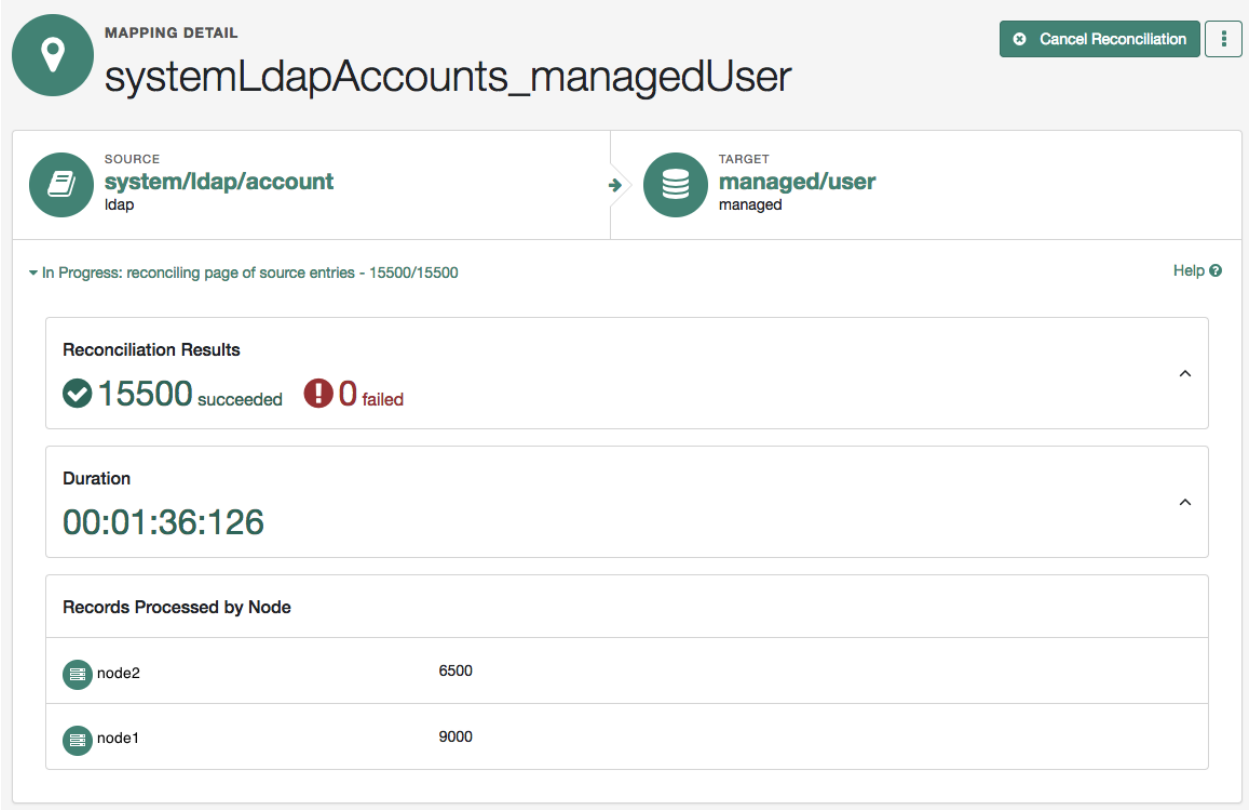
16.19.2. Viewing Clustered Reconciliation Progress

The `sourceProcessedByNode` property indicates how many records are processed by each node. You can verify the load distribution per node by running a GET on the recon endpoint, for example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/recon"
...
    "started": "2017-05-11T10:04:59.563Z",
    "ended": "",
    "duration": 342237,
    "sourceProcessedByNode": {
        "node2": 21500,
        "node1": 22000
    }
 }
```

Alternatively, you can display the nodes responsible for each source page in the Admin UI. Click on the relevant mapping and expand the "In Progress" or "Reconciliation Results" item. The following image shows a clustered reconciliation in progress. The details include the number of records that have been processed, the current duration of the reconciliation, and the load distribution, per node:

Clustered Reconciliation Results



16.19.3. Canceling a Clustered Reconciliation Operation

You cancel a clustered reconciliation in the same way as a non-clustered reconciliation, for example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
    "http://localhost:8080/openidm/recon/90892122-5ceb-4bbe-86f7-94272df834ad-406025?_action=cancel"
{
  "_id": "90892122-5ceb-4bbe-86f7-94272df834ad-406025",
  "action": "cancel",
  "status": "INITIATED"
 }
```

When the cancellation has completed, a query on that reconciliation ID will show the state and stage of the reconciliation as follows:

```
{
  "_id": "90892122-5ceb-4bbe-86f7-94272df834ad-406025",
  "mapping": "systemLdapAccounts_managedUser",
  "state": "CANCELED",
  "stage": "COMPLETED_CANCELED",
  "stageDescription": "reconciliation aborted.",
  "progress": {
    "source": {
      "existing": {
        "processed": 23500,
        "total": "23500"
      }
    },
    "target": {
      "existing": {
        "processed": 23498,
        "total": "?"
    }
,
...
```

In a clustered environment, *all* reconciliation operations are considered to be "cluster-friendly". This means that even if a mapping is configured as `"clusteredSourceReconEnabled" : false` you can view the in progress operation on *any* node in the cluster, even if that node is not currently processing the reconciliation. You can also cancel a reconciliation in progress from any node in the cluster.

16.19.4. Purging Reconciliation Statistics From the Repository

By default, the statistics for the last 50 clustered reconciliation runs are stored in the repository. You can change this default by adding the `openidm.recon.maxcompletedruns` property to your `resolver/boot.properties` file. The following example retains the last 100 completed reconciliation runs in the repository:

```
openidm.recon.maxcompletedruns=100
```

When the number of reconciliation runs reaches this figure, statistic are purged automatically each time a new reconciliation run is added. Statistics for the oldest reconciliation runs are purged first.

To purge reconciliation statistics from the repository manually, run a DELETE command on the reconciliation run ID. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request DELETE \
 "http://localhost:8080/openidm/recon/0890ad62-4738-4a3f-8b8e-f3c83bbf212e"
```

16.20. Understanding Reconciliation Duration Metrics

"Obtaining the Details of a Reconciliation" describes how to obtain the details of a reconciliation run over REST. This section provides more information on the metrics returned when you query the

`recon` endpoint. Reconciliation is processed as a series of distinct tasks. The `durationSummary` property indicates the period of time spent on each task. You can use this information to address reconciliation performance bottlenecks.

The following sample output shows the kind of information returned for each reconciliation run:

```
{
    "_id": "3bc72717-a4bb-4871-b936-3a5a560c1a7c-37",
    "duration": 781561,
    "durationSummary": {
        "auditLog": {
            ...
        },
        ...
        "sourceObjectQuery": {
            "count": 100,
            "max": 96,
            "mean": 14,
            "min": 6,
            "stdDev": 16,
            "sum": 1450
        },
        "sourcePagePhase": {
            "count": 1,
            "max": 20944,
            "mean": 20944,
            "min": 20944,
            "stdDev": 0,
            "sum": 20944
        },
        "sourceQuery": {
            "count": 1,
            "max": 120,
            "mean": 120,
            "min": 120,
            "stdDev": 0,
            "sum": 120
        },
        "targetPhase": {
            "count": 1,
            "max": 0,
            "mean": 0,
            "min": 0,
            "stdDev": 0,
            "sum": 0
        },
        "targetQuery": {
            "count": 1,
            "max": 19657,
            "mean": 19657,
            "min": 19657,
            "stdDev": 0,
            "sum": 19657
        }
    },
    ...
}
```

The specific reconciliation tasks that are run depend on the configuration for that mapping. For example, the `sourcePagePhase` is run only if paging is enabled. The `linkQuery` is run only for non-clustered reconciliation operations because an initial query of all links does not make sense if a single source page query is being run.

The following list describes all the possible tasks that can be run for a single reconciliation:

`sourcePhase`

This phase runs only for non-clustered, non-paged reconciliations. The total duration (`sum`) is the time spent processing all records on the source system.

`sourcePagePhase`

Queries and processes individual objects in a page, based on their IDs. This phase is run only for clustered reconciliations or for non-clustered reconciliations that have source paging configured. The total duration (`sum`) is the total time spent processing source pages across all cluster nodes. This processing occurs in parallel across all cluster nodes, so it is normal for the `sourcePagePhase` duration to exceed the total reconciliation duration.

`sourceQuery`

Obtains all IDs on the source system, or in a specific source page.

> **Note**
>
> When the `sourceQuery` returns a null paging cookie, indicating that there are no more source IDs to reconcile, the clustered reconciliation process dispatches a scheduled job named `sourcePageCompletionCheck`.
>
> This job checks for remaining source page jobs on the scheduler. If there are no remaining source page jobs, the `sourcePageCompletionCheck` schedules the target phase. If there are still source page jobs to process, the `sourcePageCompletionCheck` schedules another instance of itself to perform these checks again after a few seconds.
>
> Because the target phase reconciles all IDs that were not reconciled during the source phase, it cannot start until all of the source pages are complete. Final reconciliation statistics cannot be generated and logged until all source page jobs have completed, so the `sourcePageCompletionCheck` runs even if the target phase is not enabled.

`sourceObjectQuery`

Queries the individual objects on the source system or page, based on their IDs.

`validSourceScript`

Processes any scripts that should be run to determine if a source object is valid to be mapped.

`linkQuery`

Queries any existing links between source and target objects.

This phase includes the following tasks:

`sourceLinkQuery`

Queries any existing links from source objects to target objects.

`targetLinkQuery`

Queries any existing links from target objects that were not processed during the `sourceLinkQuery` phase.

`linkQualifiersScript`

Runs any link qualifier scripts. For more information, see "Mapping a Single Source Object to Multiple Target Objects".

`onLinkScript`

Processes any scripts that should be run when source and target objects are linked.

`onUnlinkScript`

Processes any scripts that should be run when source and target objects are unlinked.

`deleteLinkObject`

Deletes any links that are no longer relevant between source and target objects.

`correlationQuery`

Processes any configured correlation queries. For more information, see "Writing Correlation Queries".

`correlationScript`

Processes any configured correlation scripts. For more information, see "Writing Correlation Scripts".

`defaultMappingScript`

For roles, processes the script that applies the effective assignments as part of the mapping.

`activePolicyScript`

Sets the action and active policy based on the current situation.

`activePolicyPostActionScript`

Processes any scripts configured to run after policy validation.

`targetPhase`

The aggregated result for time spent processing records on the target system.

`targetQuery`

Queries all IDs on the target system. The list of IDs is restricted to IDs that have not already been linked to a source ID during the source phase. The target query generates a list of *orphan* IDs that must be reconciled if the target phase is not disabled.

`targetObjectQuery`

Queries the individual objects on the target system, based on their IDs.

`validTargetScript`

Processes any scripts that should be run to determine if a target object is valid to be mapped.

`onCreateScript`

Processes any scripts that should be run when a new target object is created.

`updateTargetObject`

Updates existing linked target objects, based on the configured situations and actions.

`onUpdateScript`

Processes any scripts that should be run when a target object is updated.

`deleteTargetObject`

Deletes any objects on the target resource that must be removed in accordance with the defined synchronization actions.

`onDeleteScript`

Processes any scripts that should be run when a target object is deleted.

`resultScript`

Processes the script that is executed for every mapping event, regardless of the operation.

`propertyMappingScript`

Runs any scripts configured for when source and target properties are mapped.

`postMappingScript`

Processes any scripts that should be run when synchronization has been performed on the managed/user object.

`onReconScript`

Processes any scripts that should be run after source and target systems are reconciled.

`auditLog`

Writes reconciliation results to the audit log.

For each phase, the following metrics are collected:

`count`

The number of objects or records processed during that phase. For the `sourcePageQuery` phase, the `count` parameter refers to the page size.

When the `count` statistic of a particular task refers to the number of records being reconciled, the `sum` statistic of that task represents the total time across the total number of threads running in all nodes in the cluster. For example:

```
"updateTargetObject": {
    "count": 1000000,
    "max": 1193,
    "mean": 35,
    "min": 11,
    "stdDev": 0,
    "sum": 35065991
}
```

`max`

The maximum time, in milliseconds, spent processing a record during that phase.

`mean`

The average time, in milliseconds, spent processing a record during that phase.

`min`

The minimum time, in milliseconds, spent processing a record during that phase.

`stdDev`

The standard deviation, which measures the variance of the individual values from the mean.

`sum`

The total amount of time, in milliseconds, spent during that phase.

Chapter 17

Extending IDM Functionality By Using Scripts

Scripting lets you customize various aspects of IDM functionality, for example, by providing custom logic between source and target mappings, defining correlation rules, filters, and triggers, and so on.

IDM supports scripts written in JavaScript and Groovy. IDM uses Rhino version 1.7R4 to run JavaScript (which is compliant with version 1.7 of the JavaScript standard). IDM uses Groovy version 2.5.7 to run Groovy scripts. The bundled connectors that are based on Groovy use Groovy version 3.0.4 to run their scripts.

Script options, and the locations in which IDM expects to find scripts, are configured in the `conf/script.json` file for your project. For more information, see "Setting the Script Configuration".

Several default scripts are included in the directory `/path/to/openidm/bin/defaults/script/`. Do not modify or remove any of the scripts in this directory. IDM 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, for example, `path/to/openidm/samples/sync-with-ldap/script/`.

Caution

IDM uses BouncyCastle 1.67 for signing JWTs. The BouncyCastle .JAR file that is bundled with IDM includes the `org.bouncycastle.asn1.util.Dump` command-line utility. Although this utility is not used directly by IDM, it is possible to reference the utility in your scripts. Due to a security vulnerability in this utility, you should *not* reference it in your scripts. For more information, see the corresponding BouncyCastle issue.

17.1. Validating Scripts Over REST

IDM exposes a `script` endpoint over which scripts can be validated, by specifying the script parameters as part of the JSON payload. This functionality lets you 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 registry service supports calls to other scripts. 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 lets you call one from the other on the IDM router.

The `script` endpoint supports two actions - `eval` and `compile`.

The `eval` action evaluates a script, by taking any actions referenced in the script, such as router calls to affect the state of an object. For JavaScript scripts, 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 \
 --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
     }
   }
 }' \
 "http://localhost:8080/openidm/script?_action=eval"

"Must choose to either purge by expired or number of recons to keep"
```

Tip

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`.

The `compile` action compiles a script, but does not execute it. This action is used primarily by the UI, to validate scripts that are entered in the UI. A successful compilation returns `true`. An unsuccessful compilation returns the reason for the failure.

The following REST call tests whether a transformation script will compile.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
   "type":"text/javascript",
   "source":"source.mail ? source.mail.toLowerCase() : null"
 }' \
 "http://localhost:8080/openidm/script?_action=compile"
True
```

If the script is not valid, the action returns an indication of the error, for example:

```
$ curl \
   --header "X-OpenIDM-Username: openidm-admin" \
   --header "X-OpenIDM-Password: openidm-admin" \
   --header "Content-Type: application/json" \
   --request POST \
   --data '{
       "type":"text/javascript",
       "source":"source.mail ? source.mail.toLowerCase()"
   }' \
   "http://localhost:8080/openidm/script?_action=compile"
{
    "code": 400,
    "reason": "Bad Request",
    "message": "missing : in conditional expression
        (3864142CB836831FAB8EAB662F566139CDC22BF2#1)
        in 3864142CB836831FAB8EAB662F566139CDC22BF2
        at line number 1 at column number 39"
}
```

17.2. Creating Custom Endpoints to Launch Scripts

Custom endpoints enable you to run arbitrary scripts through the REST URI.

Custom endpoints are configured in files named `conf/endpoint-name.json`, where *name* generally describes the purpose of the endpoint. The endpoint configuration file includes an inline script or a reference to a script file, in either JavaScript or Groovy. The referenced script provides the endpoint functionality.

A sample custom endpoint configuration is provided in the `openidm/samples/example-configurations/custom-endpoint` directory. The sample includes three files:

conf/endpoint-echo.json

Provides the configuration for the endpoint.

script/echo.js

Provides the endpoint functionality in JavaScript.

script/echo.groovy

Provides the endpoint functionality in Groovy.

This sample endpoint is described in detail in "*Creating a Custom Endpoint*" in the *Samples Guide*.

Endpoint configuration files and scripts are discussed further in the following sections.

17.2.1. Creating a Custom Endpoint Configuration File

An endpoint configuration file includes the following elements:

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

`context`

string, optional

The context path under which the custom endpoint is registered, in other words, the *route* to the endpoint. An endpoint with the context `endpoint/test` is addressable over REST at the URL `http://localhost:8080/openidm/endpoint/test` or by using a script such as `openidm.read("endpoint/test")`.

Endpoint contexts support wild cards, as shown in the preceding example. The `endpoint/linkedview/*` route matches the following patterns:

```
endpoint/linkedView/managed/user/bjensen
endpoint/linkedView/system/ldap/account/bjensen
endpoint/linkedView/
endpoint/linkedView
```

The `context` parameter is not mandatory in the endpoint configuration file. If you do not include a `context`, the route to the endpoint is identified by the name of the file. For example, in the sample endpoint configuration provided in `openidm/samples/example-configurations/custom-endpoint/conf/endpoint-echo.json`, the route to the endpoint is `endpoint/echo`.

Note that this `context` path is not the same as the *context chain* of the request. For information about the request context chain, see "Understanding the Request Context Chain".

`type`

string, required

The type of script to be executed, either `text/javascript` or `groovy`.

`file` or `source`

The path to the script file, or the script itself, inline.

For example:

```
"file" : "workflow/gettasksview.js"
```

or

```
"source" : "require('linkedView').fetch(request.resourcePath);"
```

You must set authorization appropriately for any custom endpoints that you add, for example, by restricting the appropriate methods to the appropriate roles. For more information, see "Authorization".

17.2.2. Writing Custom Endpoint Scripts

The custom endpoint script files in the `samples/example-configurations/custom-endpoint/script` directory demonstrate all the HTTP operations that can be called by a script. Each HTTP operation is associated with a `method` - `create`, `read`, `update`, `delete`, `patch`, `action` or `query`. Requests sent to the custom endpoint return a list of the variables available to each method.

All scripts are invoked with a global `request` variable in their scope. This request structure carries all the information about the request.

Warning

Read requests on custom endpoints must not modify the state of the resource, either on the client or the server, as this can make them susceptible to CSRF exploits.

The standard READ endpoints are safe from Cross Site Request Forgery (CSRF) exploits because they are inherently read-only. That is consistent with the *Guidelines for Implementation of REST*, from the US National Security Agency, as "... CSRF protections need only be applied to endpoints that will modify information in some way."

Custom endpoint scripts *must* return a JSON object. The structure of the return object depends on the `method` in the request.

The following example shows the `create` method in the `echo.js` file:

```
if (request.method === "create") {
   return {
       method: "create",
       resourceName: request.resourcePath,
       newResourceId: request.newResourceId,
       parameters: request.additionalParameters,
       content: request.content,
       context: context.current
   }
}
```

The following example shows the `query` method in the `echo.groovy` file:

```
else if (request instanceof QueryRequest) {
    // query results must be returned as a list of maps
    return [
        [
            method: "query",
            resourceName: request.resourcePath,
            pagedResultsCookie: request.pagedResultsCookie,
            pagedResultsOffset: request.pagedResultsOffset,
            pageSize: request.pageSize,
            queryExpression: request.queryExpression,
            queryId: request.queryId,
            queryFilter: request.queryFilter.toString(),
            parameters: request.additionalParameters,
            context: context.toJsonValue().getObject()
        ]
    ]
}
```

Depending on the method, the variables available to the script can include the following:

`resourceName`

The name of the resource, without the `endpoint/` prefix, such as `echo`.

`newResourceId`

The identifier of the new object, available as the results of a `create` request.

`revision`

The revision of the object.

`parameters`

Any additional parameters provided in the request. The sample code returns request parameters from an HTTP GET with `?param=x`, as `"parameters":{"param":"x"}`.

`content`

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

`context`

The context of the request, including headers and security. For more information, see "Understanding the Request Context Chain".

Paging parameters

The `pagedResultsCookie`, `pagedResultsOffset` and `pageSize` parameters are specific to `query` methods. For more information see "Paging Query Results".

Query parameters

The `queryExpression`, `queryId` and `queryFilter` parameters are specific to `query` methods. For more information see "Constructing Queries".

17.2.3. Setting Up Exceptions in Scripts

When you create a custom endpoint script, you might need to build exception-handling logic. To return meaningful messages in REST responses and in logs, you must comply with the language-specific method of throwing errors.

A script written in JavaScript should comply with the following exception format:

```
throw {
    "code": 400, // any valid HTTP error code
    "message": "custom error message",
    "detail" : {
        "var": parameter1,
        "complexDetailObject" : [
            "detail1",
            "detail2"
        ]
    }
}
```

Any exceptions will include the specified HTTP error code, the corresponding HTTP error message, such as `Bad Request`, a custom error message that can help you diagnose the error, and any additional detail that you think might be helpful.

A script written in Groovy should comply with the following exception format:

```
import org.forgerock.json.resource.ResourceException
import org.forgerock.json.JsonValue

throw new ResourceException(404, "Your error message").setDetail(new JsonValue([
    "var": "parameter1",
    "complexDetailObject" : [
        "detail1",
        "detail2"
    ]
]))
```

17.3. Registering Custom Scripted Actions

You can register custom scripts that initiate some arbitrary action on a managed object endpoint. You can declare any number of actions in your managed object schema and associate those actions with a script.

Custom scripted actions have access to the following variables: `context`, `request`, `resourcePath`, and `object`. For more information, see "Variables Available to Scripts".

Custom scripted actions facilitate arbitrary behavior on managed objects. For example, imagine a scenario where you want your managed users to be able to indicate whether they receive update notifications. You can define an *action* that toggles the value of a specific property on the user object. You can implement this scenario by following these steps:

- Add an `updates` property to the managed user schema (in your project's `conf/managed.json` file) as follows:

```
"properties": {
    ...
    "updates": {
        "title": "Automatic Updates",
        "viewable": true,
        "type": "boolean",
        "searchable": true,
        "userEditable": true
    },
...
}
```

- Add an action named `toggleUpdates` to the managed user object definition as follows:

```
{
  "objects" : [
    {
      "name" : "user",
      "onCreate" : {
        ...
      },
      ...
      "actions" : {
        "toggleUpdates" : {
          "type" : "text/javascript",
          "source" : "openidm.patch(resourcePath, null, [{ 'operation' : 'replace', 'field' : '/
updates', 'value' : !object.updates }])"
        }
      },
...
```

  Note that the `toggleUpdates` action calls a script that changes the value of the user's `updates` property.

- Call the script by specifying the ID of the action in a POST request on the user object, for example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/managed/user/ID?_actionId=toggleUpdate"
```

You can test this functionality as follows:

1. Create a managed user, bjensen, with an `updates` property that is set to `true`:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
  "userName":"bjensen",
  "sn":"Jensen",
  "givenName":"Barbara",
  "mail":"bjensen@example.com",
  "telephoneNumber":"5556787",
  "description":"Created by OpenIDM REST.",
  "updates": true,
  "password":"Passw0rd"
 }' \
 "http://localhost:8080/openidm/managed/user?_action=create"
{
  "_id": "9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb",
  "_rev": "0000000050c62938",
  "userName": "bjensen",
  "sn": "Jensen",
  "givenName": "Barbara",
  "mail": "bjensen@example.com",
  "telephoneNumber": "5556787",
  "description": "Created by OpenIDM REST.",
  "updates": true,
  "accountStatus": "active",
  "effectiveRoles": [],
  "effectiveAssignments": []
}
```

2. Run the `toggleUpdates` action on bjensen's entry:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/managed/user/9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb?
_action=toggleUpdates"
{
  "_id": "9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb",
  "_rev": "00000000a92657c7",
  "userName": "bjensen",
  "sn": "Jensen",
  "givenName": "Barbara",
  "mail": "bjensen@example.com",
  "telephoneNumber": "5556787",
  "description": "Created by OpenIDM REST.",
  "updates": false,
  "accountStatus": "active",
  "effectiveRoles": [],
  "effectiveAssignments": []
}
```

Note in the command output that this action has set bjensen's `updates` property to `false`.

The return value of a custom scripted action is ignored. The managed object is returned as the response of the scripted action, whether that object has been updated by the script or not.

Chapter 18
Scheduling Tasks and Events

The scheduler service lets you schedule reconciliation and synchronization tasks, trigger scripts, collect and run reports, trigger workflows, and perform custom logging.

The scheduler service depends on the Quartz Scheduler (bundled with IDM), and supports Quartz simple triggers and cron triggers. Use the trigger type that suits your scheduling requirements. For more information, see the Quartz documentation on SimpleTriggers and CronTriggers.

By default, IDM picks up changes to scheduled tasks and events dynamically, during initialization and also at runtime. For more information, see "Making Configuration Changes".

In addition to the fine-grained scheduling facility, you can perform a scheduled batch scan for a specified date in IDM data, and then automatically run a task when this date is reached. For more information, see "Scanning Data to Trigger Tasks".

18.1. Configuring the Scheduler Service

There is a distinction between the configuration of the scheduler service, and the configuration of individual scheduled tasks and events. The scheduler service is configured in your project's `conf/scheduler.json` file. This file has the following format:

```
{
    "threadPool" : {
        "threadCount" : 10
    },
    "scheduler" : {
        "executePersistentSchedules" : {
            "$bool" : "&{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 running scheduled tasks concurrently.
- `executePersistentSchedules` allows you to disable persistent schedules 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 run any persistent schedules. The value of this property can be a string or boolean. Its default value (set in `resolver/boot.properties`) is `true`.

- `advancedProperties` (optional) lets you configure additional properties for the Quartz Scheduler.

For details of all the configurable properties for the Quartz Scheduler, see the *Quartz Scheduler Configuration Reference*.

18.2. Configuring Schedules

To schedule tasks and events, select Configure > Schedules > Add Schedule in the Admin UI, or create schedule configuration files in your project's `conf` directory. By convention, IDM 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_systemCsvAccounts_managedUser.json`. There are several example schedule configuration files in the `openidm/samples/example-configurations/schedules` directory.

Each schedule configuration file has the following format:

```
{
 "enabled"             : boolean,
 "persisted"           : boolean,
 "recoverable"         : boolean,
 "concurrentExecution" : boolean,
 "type"                : "simple | cron",
 "repeatInterval"      : (optional) integer,
 "repeatCount"         : (optional) integer,
 "startTime"           : "(optional) time",
 "endTime"             : "(optional) time",
 "schedule"            : "cron expression",
 "misfirePolicy"       : "optional, string",
 "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 `false`, IDM considers the schedule configuration dormant, and does not allow it to be triggered or launched.

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 *only* 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 "Configuring Persistent Schedules".

Note

If the schedule is stored only in RAM, the schedule will be lost when IDM is restarted.

`recoverable` **(optional)**

Specifies whether jobs that have failed mid-execution (as a result of a JVM crash or otherwise unexpected termination) should be recovered. Boolean (`true` or `false`), `false` by default.

`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 before the same operation was launched again. To enable multiple schedules to run concurrently, set this parameter to `true`. The behavior of missed scheduled tasks is governed by the `misfirePolicy`.

`type`

The trigger type, either `simple` or `cron`.

To decide which trigger type to use, see the Quartz documentation on SimpleTriggers and CronTriggers.

`repeatCount`

Used only for simple triggers (`"type" : "simple"`).

The number of times the schedule must be repeated. The repeat count can be zero, a positive integer, or -1. A value of -1 indicates that the schedule should repeat indefinitely.

If you do not specify a repeat count, the value defaults to -1.

`repeatInterval`

Used only for simple triggers (`"type" : "simple"`).

Specifies the interval, in milliseconds, between trigger firings. The repeat interval must be zero or a positive long value. If you set the repeat interval to zero, the scheduler will trigger `repeatCount` firings concurrently (or as close to concurrently as possible).

If you do not specify a repeat interval, the value defaults to 0.

`startTime` **(optional)**

This parameter starts the schedule at some time in the future. If the 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'T'HH:mm:ss`).

To specify a time zone, include the time zone at the end of the `startTime`, in the format `+|-hh:mm`, for example `2017-10-31T15:53:00+05:00`. If you specify both a `startTime` and an `endTime`, they must have the same time zone.

`endTime` (optional)

Specifies when the schedule must end, in ISO 8601 format (`yyyy-MM-dd'T'HH:mm:ss+|-hh:mm`.

`schedule`

Used only for cron triggers (`"type" : "cron"`).

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 run of a missed schedule is immediately launched when the server is back online. Subsequent runs 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.

`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
- `taskScanner` to define a scheduled task that queries a set of objects. For more information, see "Scanning Data to Trigger Tasks".

`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"
    }
}
```

The following example invokes a liveSync operation:

```
{
    "invokeService": "provisioner",
    "invokeContext": {
        "action": "liveSync",
        "source": "system/ldap/__ACCOUNT__"
    }
}
```

For scheduled liveSync tasks, the `source` property follows IDM'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 `It is working: 26` to the console. A similar sample schedule is provided in `schedule-script.json` in the `/path/to/openidm/samples/example-configurations/schedules` directory.

```
{
    "invokeService": "script",
    "invokeContext": {
        "script" : {
            "type" : "text/javascript",
            "source" : "java.lang.System.out.println('It is working: ' + input.edit);",
            "input": { "edit": 26}
        }
    }
}
```

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 you should adjust the log level 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`

18.3. Schedules and Daylight Savings Time

The scheduler service supports Quartz cron triggers and simple triggers. Cron triggers schedule jobs to fire at specific times with respect to a calendar (rather than every *N* milliseconds). This scheduling can cause issues when clocks change for daylight savings time (DST) if the trigger time falls around the clock change time in your specific time zone.

Depending on the trigger schedule, and on the daylight event, the trigger might be skipped or might appear not to fire for a short period. This interruption can be particularly problematic for liveSync where schedules execute continuously. In this case, the time change (for example, from 02:00 back to 01:00) causes an hour break between each liveSync execution.

To prevent DST from having an impact on your schedules, use simple triggers instead of cron triggers.

For more information about Quartz schedules and DST, see the Quartz Documentation.

18.4. Configuring Persistent Schedules

By default, scheduling information, such as schedule state and details of the schedule run, is stored in RAM. This means that such information is lost when the server is rebooted. The schedule configuration itself (defined in your project's `conf/schedule-schedule-name.json` file) is not lost when the server is shut down, and normal scheduling continues when the server is restarted. However, there are no details of missed schedule runs 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 the server is shut down. Any previously scheduled jobs can be rescheduled automatically when the server is restarted.

Persistent schedules also enable you to manage scheduling across a cluster (multiple IDM instances). When scheduling is persistent, a particular schedule will be launched only once across the cluster, rather than once on every instance. For example, if your deployment includes a cluster of nodes for high availability, you can use persistent scheduling to start a reconciliation operation on only one node in the cluster, instead of starting several competing reconciliation operations on each node.

Important

Persistent schedules rely on timestamps. In a deployment where IDM instances run on separate machines, you *must* synchronize the system clocks of these machines using a time synchronization service that runs regularly.

The clocks of all machines involved in persistent scheduling must be within one second of each other. For information on how you can achieve this using the Network Time Protocol (NTP) daemon, see the NTP RFC.

To configure persistent schedules, set `persisted` to `true` in the schedule configuration file (`schedule-schedule-name.json`).

If the server is down when a scheduled task was set to occur, one or more runs 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 IDM should do if scheduled tasks are missed. Possible values are as follows:

- `fireAndProceed`. The first run of a missed schedule is immediately implemented when the server is back online. Subsequent runs 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.

18.5. Schedule Examples

The following example shows a schedule for reconciliation that is not enabled. When the schedule is enabled (`"enabled" : true,`), reconciliation runs every 30 minutes (1800000 milliseconds), and repeats indefinitely:

```
{
    "enabled": false,
    "persisted": true,
    "type": "simple",
    "repeatInterval": 1800000,
    "invokeService": "sync",
    "invokeContext": {
        "action": "reconcile",
        "mapping": "systemLdapAccounts_managedUser"
    }
}
```

The following example shows a schedule for liveSync enabled to run every 15 seconds, repeating indefinitely. Note that the schedule is persisted, that is, stored in the repository rather than in memory. If one or more liveSync runs are missed, as a result of the server being unavailable, the first run of the liveSync operation is implemented when the server is back online. Subsequent runs are discarded. After this, the normal schedule is resumed:

```
{
    "enabled": true,
    "persisted": true,
    "misfirePolicy" : "fireAndProceed",
    "type": "simple",
    "repeatInterval": 15000,
    "invokeService": "provisioner",
    "invokeContext": {
        "action": "liveSync",
        "source": "system/ldap/account"
    }
}
```

18.6. Managing Schedules Over REST

The scheduler service is exposed under the `/openidm/scheduler` context path. Within this context path, the defined scheduled jobs are accessible at `/openidm/scheduler/job`. A job is the actual task that is run. Each job contains a *trigger* that starts the job. The trigger defines the schedule according to which the job is executed. You can read and query the existing triggers on the `/openidm/scheduler/trigger` context path.

The following examples show how schedules are validated, created, read, queried, updated, and deleted, over REST, by using the scheduler service. The examples also show how to pause and resume scheduled jobs, when an instance is placed in maintenance mode. For information about placing a server in maintenance mode, see "Placing a Server in Maintenance Mode" in the *Installation Guide*.

Note

When you configure schedules over REST, changes made to the schedules are not pushed back into the configuration service. Managing schedules by using the `/openidm/scheduler/job` context path essentially bypasses the configuration service and sends the request directly to the scheduler.

If you need to perform an operation on a schedule that was created by using the configuration service (by placing a schedule file in the `conf/` directory), you must direct your request to the `/openidm/config` context path, and not to the `/openidm/scheduler/job` context path.

PATCH operations are not supported on the `scheduler` context path. To patch a schedule, use the `config` context path.

18.6.1. Validating Cron Trigger Expressions

Schedules are defined using Quartz cron or simple triggers. If you use a cron trigger, you can validate your cron expression by sending the expression as a JSON object to the `scheduler` context path. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
    "cronExpression":"0 0/1 * * * ?"
 }' \
 "http://localhost:8080/openidm/scheduler?_action=validateQuartzCronExpression"
{
  "valid": true
}
```

18.6.2. Defining a Schedule

To define a new schedule, send a PUT or POST request to the `scheduler/job` context path with the details of the schedule in the JSON payload. A PUT request allows you to specify the ID of the schedule while a POST request 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 "Configuring the Scheduler Service":

```
$ curl \
 --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"
        }
    }
 }' \
 "http://localhost:8080/openidm/scheduler/job/testlog-schedule"
{
  "_id": "testlog-schedule",
  "enabled": true,
  "persisted": true,
  "recoverable": false,
  "misfirePolicy": "fireAndProceed",
  "schedule": "0/1 * * * * ?",
  "repeatInterval": 0,
  "repeatCount": 0,
  "type": "cron",
  "invokeService": "org.forgerock.openidm.script",
  "invokeContext": {
    "script": {
      "type": "text/javascript",
```

```
      "file": "script/testlog.js"
    }
  },
  "invokeLogLevel": "info",
  "startTime": null,
  "endTime": null,
  "concurrentExecution": false,
  "triggers": [
    {
      "serialized": "rO0ABXNyABZvcmcucXV...shw4eHNxAH4ANXcIAAABY6iyHDh4",
      "name": "trigger-testlog-schedule",
      "group": "scheduler-service-group",
      "previous_state": 0,
      "state": 4,
      "acquired": true,
      "nodeId": "node1",
      "jobName": "testlog-schedule",
      "_rev": "00000000a6d5c8fa",
      "_id": "scheduler-service-group_$x$x$_trigger-testlog-schedule"
    }
  ],
  "nextRunDate": "2018-05-28T21:40:36.000Z"
}
```

Note that the output includes the `trigger` that was created as part of the scheduled job, as well as the `nextRunDate` for the job. For more information about the `trigger` properties, see "Querying Schedule Triggers".

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 \
 --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"
        }
    }
 }' \
 "http://localhost:8080/openidm/scheduler/job?_action=create"
{
  "_id": "8bc9ecc8-a737-4010-ae4a-ffaae8ef337b",
  "enabled": true,
  "persisted": true,
  "recoverable": false,
  "misfirePolicy": "fireAndProceed",
  "schedule": "0/1 * * * * ?",
```

```
  "repeatInterval": 0,
  "repeatCount": 0,
  "type": "cron",
  "invokeService": "org.forgerock.openidm.script",
  "invokeContext": {
    "script": {
      "type": "text/javascript",
      "file": "script/testlog.js"
    }
  },
  "invokeLogLevel": "info",
  "startTime": null,
  "endTime": null,
  "concurrentExecution": false,
  "triggers": [
    {
      "serialized": "rO0ABXNyABZvcmcuc...N03sqgeHNxAH4ANXcIAAABY3TeyqB4",
      "name": "trigger-8bc9ecc8-a737-4010-ae4a-ffaae8ef337b",
      "group": "scheduler-service-group",
      "previous_state": 0,
      "state": 4,
      "acquired": true,
      "nodeId": "node1",
      "jobName": "8bc9ecc8-a737-4010-ae4a-ffaae8ef337b",
      "_rev": "00000000403cedd7",
      "_id": "scheduler-service-group_$x$x$_trigger-8bc9ecc8-a737-4010-ae4a-ffaae8ef337b"
    }
  ],
  "nextRunDate": "2018-05-18T20:09:09.000Z"
}
```


The output includes the generated `_id` of the schedule, in this case `"_id": "8bc9ecc8-a737-4010-ae4a-ffaae8ef337b"`.

18.6.3. Obtaining the Details of a Scheduled Job

The following example displays the details of the schedule created in the previous section. Specify the job ID in the URL:


```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/scheduler/job/testlog-schedule"
{
    "_id": "testlog-schedule",
    "enabled": true,
    "persisted": true,
    "recoverable": false,
    "misfirePolicy": "fireAndProceed",
    "schedule": "0/1 * * * * ?",
    "repeatInterval": 0,
    "repeatCount": 0,
    "type": "cron",
    "invokeService": "org.forgerock.openidm.script",
    "invokeContext": {
```

```
      "script": {
        "type": "text/javascript",
        "file": "script/testlog.js"
      }
    },
    "invokeLogLevel": "info",
    "startTime": null,
    "endTime": null,
    "concurrentExecution": false,
    "triggers": [
      {
        "serialized": "rO0ABXNyABZvcmcucXV...shw4eHNxAH4ANXcIAAABY6iyHDh4",
        "name": "trigger-testlog-schedule",
        "group": "scheduler-service-group",
        "previous_state": -1,
        "state": 0,
        "acquired": true,
        "nodeId": "node1",
        "jobName": "testlog-schedule",
        "_rev": "00000000a6d5c8fa",
        "_id": "scheduler-service-group_$x$x$_trigger-testlog-schedule"
      }
    ],
    "nextRunDate": "2018-05-28T21:40:36.000Z"
}
```

18.6.4. Querying Scheduled Jobs

You can query defined and running scheduled jobs using a regular query filter or a parameterized query. Support for parameterized queries is restricted to `_queryId=query-all-ids`. For more information about query filters, see "Constructing Queries".

The following query returns the IDs of all defined schedules:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/scheduler/job?_queryId=query-all-ids"
{
  "result": [
    {
      "_id": "reconcile_systemLdapAccounts_managedUser"
    },
    {
      "_id": "testlog-schedule"
    }
  ]
  ...
}
```

The following query returns the IDs, enabled status, and next run date of all defined schedules:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/scheduler/job?_queryFilter=true&_fields=_id,enabled,nextRunDate"
{
  "result": [
    {
      "_id": "reconcile_systemLdapAccounts_managedUser",
      "enabled": false,
      "nextRunDate": null
    },
    {
      "_id": "testlog-schedule",
      "enabled": true,
      "nextRunDate": "2016-09-28T10:11:06.000Z"
    }
  ]
  ...
}
```

18.6.5. Updating a Schedule

To update a schedule definition, use a PUT request and update all the static properties of the object.

The following example disables the testlog schedule created in the previous section by setting `"enabled":false`:

```
$ curl \
 --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"
        }
    }
 }' \
 "http://localhost:8080/openidm/scheduler/job/testlog-schedule"
   {
  "_id": "testlog-schedule",
  "enabled": false,
  "persisted": true,
  "recoverable": false,
  "misfirePolicy": "fireAndProceed",
  "schedule": "0/1 * * * * ?",
  "repeatInterval": 0,
```

```
  "repeatCount": 0,
  "type": "cron",
  "invokeService": "org.forgerock.openidm.script",
  "invokeContext": {
    "script": {
      "type": "text/javascript",
      "file": "script/testlog.js"
    }
  },
  "invokeLogLevel": "info",
  "startTime": null,
  "endTime": null,
  "concurrentExecution": false,
  "triggers": [],
  "nextRunDate": null
}
```

When you disable a schedule, all triggers are removed and the `nextRunDate` is set to `null`. If you re-enable the schedule, a new trigger is generated, and the `nextRunDate` is recalculated.

18.6.6. Deleting a Schedule

To delete a schedule, send a DELETE request to the schedule ID. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request DELETE \
 "http://localhost:8080/openidm/scheduler/job/testlog-schedule"
{
  "_id": "testlog-schedule",
  "enabled": true
,
...
}
```

The DELETE request returns the entire JSON object.

18.6.7. Obtaining a List of Running Scheduled Jobs

The following command returns a list of the jobs that are currently executing. This list lets you decide whether to wait for a specific job to complete before you place a server in maintenance mode.

This action does not list the jobs across a cluster, only the jobs currently executing on the node to which the request is routed.

Note that this list is accurate only at the moment the request was issued. The list can change at any time after the response is received.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/scheduler/job?_action=listCurrentlyExecutingJobs"
[
  {
    "enabled": true,
    "persisted": true,
    "misfirePolicy": "fireAndProceed",
    "type": "simple",
    "repeatInterval": 3600000,
    "repeatCount": -1,
    "invokeService": "org.forgerock.openidm.sync",
    "invokeContext": {
      "action": "reconcile",
      "mapping": "systemLdapAccounts_managedUser"
    },
    "invokeLogLevel": "info",
    "timeZone": null,
    "startTime": null,
    "endTime": null,
    "concurrentExecution": false
  }
]
```

18.6.8. Pausing Scheduled Jobs

In preparation for placing a server in maintenance mode, you can temporarily suspend all scheduled jobs. This action does not cancel or interrupt jobs that are already in progress - it simply prevents any scheduled jobs from being invoked during the suspension period.

The following command suspends all scheduled tasks and returns `true` if the tasks could be suspended successfully.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/scheduler/job?_action=pauseJobs"
{
    "success": true
}
```

18.6.9. Resuming All Scheduled Jobs

When an update has been completed, and your instance is no longer in maintenance mode, you can resume scheduled jobs to start them up again. Any jobs that were missed during the downtime will follow their configured misfire policy to determine whether they should be reinvoked.

The following command resumes all scheduled jobs and returns `true` if the jobs could be resumed successfully.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/scheduler/job?_action=resumeJobs"
{
    "success": true
}
```

18.6.10. Querying Schedule Triggers

When a scheduled job is created, a trigger for that job is created automatically and is included in the schedule definition. The trigger is essentially what causes the job to be started. You can read all the triggers that have been generated on a system with the following query on the `openidm/scheduler/trigger` context path:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/scheduler/trigger?_queryFilter=true"
{
  "result": [
    {
      "_id": "scheduler-service-group_$x$x$_trigger-testlog-schedule",
      "_rev": "000000009013c7cc",
      "serialized": "rO0ABXNyABZvcmcucXVhcn...eHNxAH4ANXcIAAABY7LP8FB4",
      "name": "trigger-testlog-schedule",
      "group": "scheduler-service-group",
      "previous_state": -1,
      "state": 0,
      "acquired": true,
      "nodeId": "node1",
      "jobName": "testlog-schedule"
    }
  ]
  ...
}
```

The contents of a trigger object are as follows:

`_id`

The ID of the trigger. The trigger ID takes the form *`group_$x$x$_trigger-schedule-id`*

`_rev`

The revision of the trigger object. This property is reserved for internal use and specifies the revision of the object in the repository. This is the same value that is exposed as the object's ETag through the REST API. The content of this property is not defined. No consumer should make any assumptions of its content beyond equivalence comparison.

`previous_state`

The previous state of the trigger, before its current state. For a description of Quartz trigger states, see the Quartz API documentation.

`name`

The trigger name, in the form `trigger-schedule-id`

`state`

The current state of the trigger. For a description of Quartz trigger states, see the Quartz API documentation.

`nodeId`

The ID of the node that has acquired the trigger, useful in a clustered deployment.

`acquired`

Whether the trigger has already been acquired by a node. Boolean, true or false.

`serialized`

The Base64 serialization of the trigger class.

`group`

The name of the group that the trigger is in, always `scheduler-service-group`.

To read the contents of a specific trigger send a GET request to the trigger ID, for example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/scheduler/trigger/scheduler-service-group_\$x\$x\$_trigger-testlog-
schedule"
{
  "_id": "scheduler-service-group_$x$x$_trigger-testlog-schedule",
  "_rev": "00000000e2a3c8f0",
  "serialized": "rO0ABXNyABZvcmcucXV...QeHNxAH4ANXcIAAABY7Li1EB4",
  "name": "trigger-testlog-schedule",
  "group": "scheduler-service-group",
  "previous_state": -1,
  "state": 0,
  "acquired": true,
  "nodeId": "node1",
  "jobName": "testlog-schedule"
}
```

Note that you need to escape the `$` signs in the URL.

To view the triggers that have been acquired, per node, send a GET request to the `scheduler/acquiredTriggers` context path. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/scheduler/acquiredTriggers"
{
  "_id": "acquiredTriggers",
  "_rev": "00000000c7554e13",
  "node1": [
    "scheduler-service-group_$x$x$_trigger-testlog-schedule"
  ]
}
```

To view the triggers that have not yet been acquired by any node, send a GET request to the `scheduler/waitingTriggers` context path. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/scheduler/waitingTriggers"
{
  "_id": "waitingTriggers",
  "_rev": "000000004cab60c8",
  "names": [
    "scheduler-service-group_$x$x$_trigger-0da27688-7ece-4799-bca4-09e185a6b0f4",
    "scheduler-service-group_$x$x$_trigger-0eeaf861-604b-4cf4-a044-bbbc78377070",
    "scheduler-service-group_$x$x$_trigger-136b7a1a-3aee-4321-8b6a-3e860e7b0292",
    "scheduler-service-group_$x$x$_trigger-1f6b116b-aa06-41da-9c19-80314373a20f",
    "scheduler-service-group_$x$x$_trigger-659b2bb0-53b8-4a4e-8347-8ed1ed5286af",
    "scheduler-service-group_$x$x$_trigger-testlog-schedule",
    "scheduler-service-group_$x$x$_trigger-ad9db1c7-a06d-4dc9-83b9-0c2e405dde1f"
  ]
}
```

18.7. Managing Schedules Through the Admin UI

To manage schedules through the Admin UI, select Configure > Schedules. By default, only persisted schedules are shown in the Schedules list. To show non-persisted (in memory) schedules, select Filter by Type > In Memory.

18.8. Scanning Data to Trigger Tasks

In addition to the fine-grained scheduling facility described previously, IDM provides a task scanning mechanism. The task scanner enables you to scan a set of properties with a complex query filter, at a scheduled interval. The task scanner then launches a script on the objects returned by the query.

For example, the task scanner can scan all `managed/user` objects for a "sunset date" and can invoke a script that launches a "sunset task" on the user object when this date is reached.

18.8.1. Configuring the Task Scanner

The task scanner is essentially a scheduled task that queries a set of managed users, then launches a script based on the query results. 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 launched when the specified condition is triggered.

The following example defines a scheduled scanning task that triggers a sunset script. This sample schedule configuration file is provided in `openidm/samples/example-configurations/task-scanner/conf/schedule-taskscan_sunset.json`. To use the sample file, copy it to your project's `conf` directory and edit it as required.

```
{
  "enabled" : true,
  "type" : "simple",
  "repeatInterval" : 3600000,
  "persisted": true,
  "concurrentExecution" : false,
  "invokeService" : "taskscanner",
  "invokeContext" : {
    "waitForCompletion" : false,
    "numberOfThreads" : 5,
    "scan" : {
      "_queryFilter" : "((/sunset/date lt \"${Time.now}\") AND !(/sunset/task-completed pr))",
      "object" : "managed/user",
      "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 `openidm/samples/example-configurations/task-scanner/script/sunset.js` to your project's `script` directory. You will also need to assign a user a sunset date. The task will only execute on users who have a valid sunset date field. The sunset date field can be added manually to users, but will need to be added to the `managed/user` schema if you want the field to be visible from the Admin UI.

The following example command adds a sunset date field to the user `bjensen` using the REST interface:

```
curl \
--header "Content-Type: application/json"
 \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request POST
 \
--data '[{
 "operation" : "add",
 "field" : "sunset/date",
 "value" : "2017-12-20T12:00:00Z"
}]' \
"http://localhost:8080/openidm/managed/user?_action=patch&_queryId=for-userName&uid=bjensen"
```

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 10. To change this default, set the `numberOfThreads` property. The sample configuration sets the default number of threads to 5.

`scan`

Defines the details of the scan. The following properties are defined:

`_queryFilter`, `_queryId`, or `_queryExpression`

A query filter, predefined query, or query expression that identifies the entries for which this task should be run. Query filters are recommended but you can also use native query expressions and parameterized, or predefined queries to identify the entries to be scanned.

The query filter provided in the sample schedule configuration (`(/sunset/date lt \"${Time.now}\") AND !(/sunset/task-completed pr))`) identifies managed users whose `sunset/date` property is before the current date and for whom the sunset task has not yet completed.

The sample query supports time-based conditions, with the time specified in ISO 8601 format (Zulu time). You can write any query to target the set of entries that you want to scan.

For time-based queries, it's possible to use the `${Time.now}` macro object (which fetches the current time). You can also specify any date/time in relation to the current time, using the `+` or `-` operator, and a duration modifier. For example: changing the sample query to `${Time.now + 1d}` would return all user objects whose `/sunset/date` is the following day (current time plus one day). Note: 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

`object`

Defines the managed object type against which the query should be performed, as defined in the `managed.json` file.

`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. For clustered IDM instances, there might be more than one task scanner running at a time. A task cannot be launched 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, either JavaScript or Groovy.
- `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 IDM scripts):

- `input` – the individual object that is retrieved from the query (in the example, this is the individual user object).
- `objectID` – 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/example-configurations/task-scanner/script/sunset.js`. To use this sample file, copy it to your project's `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, see "*Scripting Reference*".

18.8.2. Managing Scanning Tasks Over REST

You can trigger, cancel, and monitor scanning tasks over the REST interface, using the REST endpoint `http://localhost:8080/openidm/taskscanner`.

18.8.2.1. Creating a Scanning Task

You can define a scanning task in a configuration file or directly over the REST interface. For an example of a file-based scanning task, see the file `/path/to/openidm/samples/example-configurations/task-scanner/conf/schedule-taskscan_sunset.json`.

The following command defines a scanning task named `sunsetTask` over REST:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-type: application/json" \
 --request PUT \
 --data '{
  "enabled" : true,
  "type" : "simple",
  "repeatInterval" : 3600000,
  "persisted": true,
  "concurrentExecution" : false,
  "invokeService" : "taskscanner",
  "invokeContext" : {
    "waitForCompletion" : false,
    "numberOfThreads" : 5,
    "scan" : {
      "_queryFilter" : "((/sunset/date lt \"${Time.now}\") AND !(${taskState.completed} pr))",
      "object" : "managed/user",
      "taskState" : {
        "started" : "/sunset/task-started",
        "completed" : "/sunset/task-completed"
      },
      "recovery" : {
        "timeout" : "10m"
      }
```

```
    },
    "task" : {
      "script" : {
        "type" : "text/javascript",
        "file" : "script/sunset.js"
      }
    }
  }
}' \
"http://localhost:8080/openidm/scheduler/job/sunsetTask" | jq .

{
  "_id": "sunsetTask",
  "enabled": true,
  "persisted": true,
  "recoverable": false,
  "misfirePolicy": "fireAndProceed",
  "schedule": null,
  "repeatInterval": 3600000,
  "repeatCount": -1,
  "type": "simple",
  "invokeService": "org.forgerock.openidm.taskscanner",
  "invokeContext": {
    "waitForCompletion": false,
    "numberOfThreads": 5,
    "scan": {
      "_queryFilter": "((/sunset/date lt \"${Time.now}\") AND !(${taskState.completed} pr))",
      "object": "managed/user",
      "taskState": {
        "started": "/sunset/task-started",
        "completed": "/sunset/task-completed"
      },
      "recovery": {
        "timeout": "10m"
      }
    },
    "task": {
      "script": {
        "type": "text/javascript",
        "file": "script/sunset.js"
      }
    }
  },
  "invokeLogLevel": "info",
  "startTime": "2018-01-17T11:25:59.382+02:00",
  "endTime": null,
  "concurrentExecution": false,
  "triggers": [
    {
      "serialized": "rO0ABXNyABZvcmcucXVhcnR6LkNyb25UcmlnZ2VyiAb06o3becICAA...",
      "name": "trigger-sunsetTask",
      "group": "scheduler-service-group",
      "previous_state": -1,
      "state": 0,
      "acquired": false,
      "nodeId": null,
      "jobName": "testSchedule",
      "_rev": "00000000cde2bd84",
      "_id": "scheduler-service-group_$x$x$_trigger-sunsetTask"
```

```
    }
  ],
  "nextRunDate": "2018-01-17T10:00:00.000Z"
}
```

18.8.2.2. Triggering a Scanning Task

To trigger a scanning task over REST, use the `execute` action and specify the `name` of the task (effectively the scheduled job name). To obtain a list of task names, you can query the `/openidm/scheduler/job` endpoint. Note, however, that not all jobs are scanning tasks. Only those jobs that have which have the correct task scanner `invokeContext` can be triggered in this way.

The following example triggers the `sunsetTask` defined in the previous example:

```
$ curl \
  --header "X-OpenIDM-Username: openidm-admin" \
  --header "X-OpenIDM-Password: openidm-admin" \
  --request POST \
  "http://localhost:8080/openidm/taskscanner?_action=execute&name=sunsetTask"
{
  "_id": "9f2564c8-193c-4871-8869-6080f374b1bd-2073"
}
```

For scanning tasks that are defined in configuration files, you can determine the task name from the file name, for example, `schedule-task-name.json`. The following example triggers a task named `taskscan_sunset` that is defined in a file named `conf/schedule-taskscan_sunset.json`:

```
$ curl \
  --header "X-OpenIDM-Username: openidm-admin" \
  --header "X-OpenIDM-Password: openidm-admin" \
  --request POST \
  "http://localhost:8080/openidm/taskscanner?_action=execute&name=taskscan_sunset"
{
  "_id": "8d7742f0-5245-41cf-89a5-de32fc50e326-3323"
}
```

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.

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`).

18.8.2.3. Canceling a Scanning Task

To cancel a scanning task that is in progress, send 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 \
  --header "X-OpenIDM-Username: openidm-admin" \
  --header "X-OpenIDM-Password: openidm-admin" \
  --request POST \
  "http://localhost:8080/openidm/taskscanner/9f2564c8-193c-4871-8869-6080f374b1bd-2073?_action=cancel"
 {
     "_id":"9f2564c8-193c-4871-8869-6080f374b1bd-2073",
     "status":"SUCCESS"
 }
```

Note

You cannot cancel a scanning task that has already completed.

18.8.2.4. Listing the Scanning Tasks

To retrieve a list of scanning tasks, query the `openidm/taskscanner` context path. The following example displays *all* scanning tasks, regardless of their state:

```
$ curl \
  --header "X-OpenIDM-Username: openidm-admin" \
  --header "X-OpenIDM-Password: openidm-admin" \
  --request GET \
  "http://localhost:8080/openidm/taskscanner?_queryFilter=true"
 {
  "result": [
    {
      "_id": "9f2564c8-193c-4871-8869-6080f374b1bd-2073",
      "name": "schedule/taskscan_sunset",
      "progress": {
        "state": "COMPLETED",
        "processed": 0,
        "total": 0,
        "successes": 0,
        "failures": 0
      },
      "started": "2017-12-19T11:45:53.433Z",
      "ended": "2017-12-19T11:45:53.438Z"
    },
    {
      "_id": "b32aafe5-b484-4d00-89ff-83554341f321-9970",
      "name": "schedule/taskscan_sunset",
      "progress": {
        "state": "ACTIVE",
        "processed": 80,
        "total": 980,
        "successes": 80,
        "failures": 0
      },
      "started": "2017-12-19T16:41:04.185Z",
      "ended": null
    }
  ]
  ...
}
```

Each scanning task has the following properties:

`_id`

The unique ID of that task instance.

`name`

The name of the scanning task, determined by the name of the schedule configuration file or over REST when the task is executed.

`started`

The time at which the scanning task started.

`ended`

The time at which the scanning task ended.

`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 current state of the task, `INITIALIZED`, `ACTIVE`, `COMPLETED`, `CANCELLED`, or `ERROR`

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.

18.8.3. Managing Scanning Tasks Through the UI

The task scanner queries a set of managed objects, then executes a script on the objects returned in the query result. The scanner then sets a field on a specific managed object property to indicate the state of the task. Before you start, you must set up this object type property on the managed user object.

In the example that follows, the task scanner queries managed user objects and returns objects whose `sunset` property holds a date that is prior to the current date. The scanner then sets the state of the task in the `task-completed` field of the user's `sunset` property:

To configure this scanning task through the UI, follow these steps:

1. Select Configure > Schedules and click Add Schedule.

2. Enable the schedule, and set the times that the task should run, as for any other schedule.

3. Under Perform Action, select "Execute a script on objects returned by a query (Task Scanner)".
4. Select the managed object on which the query should be run, in this case, `user`.
5. Build the query that will be run against the managed user objects.

   The following query (based on the example schedule available in `/path/to/openidm/samples/example-configurations/task-scanner`) returns all managed users whose `sunset` date is prior to the current date (`${Time.now}`) and for whom the `sunset` task has not already completed (`${taskState.completed} pr`):

   ```
   ((/sunset/date lt \"${Time.now}\") AND !(${taskState.completed} pr))
   ```

6. In the Object Property Field, enter the property whose values will determine the state of the task, in this case `sunset`.
7. In the Script field, enter an inline script, or a path to the file containing the script that should be launched on the results of the query.

   The sample task scanner runs the following script on the managed users returned by the previous query:

   ```
   var patch = [{ "operation" : "replace", "field" : "/active", "value" : false },{ "operation"
    : "replace", "field" : "/accountStatus", "value" : "inactive" }];
   openidm.patch(objectID, null, patch);
   ```

   This script essentially deactivates the accounts of users returned by the query by setting the value of their `active` property to `false`.
8. (Optional) Configure the advanced properties of the schedule described in "Configuring Schedules".

Chapter 19
Managing Passwords

IDM provides password management features that help you enforce password policies, limit the number of passwords users must remember, and allow users to reset and change their passwords.

19.1. 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.

IDM enforces password policy rules as part of the general policy service. For more information about the policy service, see "*Using Policies to Validate Data*". The default password policy applies the following rules to passwords as 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 change these validation requirements, or include additional requirements, by configuring the policy for passwords. For more information, see "Configuring the Default Policy for Managed Objects".

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, IDM controls password values as they are provisioned.

To change the default administrative user password, `openidm-admin`, see "Replacing Default Security Settings".

Password recovery

Password recovery involves recovering a password or setting a new password when the password has been forgotten.

The End User UI allows for password changes, password recovery, and password reset. For more information, see "*Configuring User Self-Service*".

Password history

You can add checks to prevent reuse of previous password values. For more information, see "Creating a Password History Policy".

Password expiration

You can use workflows to ensure that users are able to change expiring passwords or to reset expired passwords.

19.1.1. Creating a Password History Policy

The sample described in "*Storing Multiple Passwords For Managed Users*" in the *Samples Guide* shows how to set up a password history policy in a scenario where users have multiple different passwords across resources. You can use the scripts provided in that sample to set up a simple password history policy that prevents managed users from setting the same password that they used previously.

To create a password history policy based on the scripts in the multiple passwords sample, make the following changes to your project:

1. Copy the `pwpolicy.js` script from the multiple passwords sample to your project's `script` directory:

   ```
   $ cd /path/to/openidm
   $ cp samples/multiple-passwords/script/pwpolicy.js /my-project-dir/script/
   ```

   The `pwpolicy.js` script contains an `is-new` policy definition that compares a new field value with the list of historical values for that field.

   The `is-new` policy takes a `historyLength` parameter that specifies the number of historical values on which the policy should be enforced. This number must not exceed the `historySize` that you set in `conf/managed.json` to be passed to the `onCreate` and `onUpdate` scripts.

2. Copy the `onCreate-user-custom.js`, `onUpdate-user-custom.js` scripts to your project's `script` directory:

   ```
   $ cp samples/multiple-passwords/script/onCreate-user-custom.js /my-project-dir/script/
   ```

   ```
   $ cp samples/multiple-passwords/script/onUpdate-user-custom.js /my-project-dir/script/
   ```

   These scripts validate the password history policy when a managed user is created or updated.

3. Update your policy configuration (`conf/policy.json`) to reference the new policy definition by adding the policy script to the `additionalFiles` array:

```
{
    "type" : "text/javascript",
    "file" : "policy.js",
    "additionalFiles": [ "script/pwpolicy.js" ],
...
```

4. Update your project's `conf/managed.json` file as follows:

   - Add a `fieldHistory` property to the managed user object:

```
"fieldHistory" : {
    "title" : "Field History",
    "type" : "object",
    "viewable" : false,
    "searchable" : false,
    "userEditable" : false,
    "scope" : "private"
},
```

     The value of this field is a map of field names to a list of historical values for that field. These lists of values are used by the `is-new` policy to determine if a new value has already been used.

   - Update the managed user object to call the scripts when a user is created, updated:

```
"name" : "user",
"onCreate" : {
    "type" : "text/javascript",
    "file" : "script/onCreate-user-custom.js",
    "historyFields" : [
        "password"
    ],
    "historySize" : 4
},
"onUpdate" : {
    "type" : "text/javascript",
    "file" : "script/onUpdate-user-custom.js",
    "historyFields" : [
        "password"
    ],
    "historySize" : 4
},
...
```

     Important

     If you have any other script logic that is executed on these events, you must update the scripts to include that logic, or add the password history logic to your current scripts.

   - Add the `is-new` policy to the list of policies enforced on the `password` property of a managed user. Specify the number of historical values that the policy should check in `historyLength` property:

```
"password" : {
   ...
   "policies" : [
       {
           "policyId" : "at-least-X-capitals",
           "params" : {
               "numCaps" : 1
           }
       },
       ...
       {
           "policyId" : "is-new",
           "params" : {
               "historyLength" : 4
           }
       },
       ...
   ]
},
```

You should now be able to test the password history policy by creating a new managed user, and having that user update their password. If the user specifies the same password used within the previous four passwords, the update request is denied with a policy error.

19.2. Storing Separate Passwords Per Linked Resource

You can store multiple passwords in a single managed user entry to enable synchronization of different passwords on different external resources.

To store multiple passwords, extend the managed user schema to include additional properties for each target resource. You can set separate policies on each of these new properties, to ensure that the stored passwords adhere to the password policies of the specific external resources.

The following addition to a sample `managed.json` configuration shows an `ldapPassword` property that has been added to managed user objects. This property will be mapped to the password property on an LDAP system:

```
"ldapPassword" : {
    "title" : "Password",
    "type" : "string",
    "viewable" : false,
    "searchable" : false,
    "minLength" : 8,
    "userEditable" : true,
    "scope" : "private",
    "secureHash" : {
        "algorithm" : "SHA-256"
    },
    "policies" : [
        {
            "policyId" : "at-least-X-capitals",
            "params" : {
```

```
                "numCaps" : 2
            }
        },
        {
            "policyId" : "at-least-X-numbers",
            "params" : {
                "numNums" : 1
            }
        },
        {
            "policyId" : "cannot-contain-others",
            "params" : {
                "disallowedFields" : [
                    "userName",
                    "givenName",
                    "sn"
                ]
            }
        },
        {
            "policyId" : "is-new",
            "params" : {
                "historyLength" : 2
            }
        }
    ]
},
```

This property definition shows that the `ldapPassword` will be hashed, with an SHA-256 algorithm, and sets the policy that will be applied to values of this property.

To use this custom managed object property and its policies to update passwords on an external resource, you must make the corresponding configuration and script changes in your deployment. For a detailed sample that implements multiple passwords, see "*Storing Multiple Passwords For Managed Users*" in the *Samples Guide*. That sample can also help you set up password history policies.

19.3. Generating Random Passwords

There are many situations when you might want to generate a random password for one or more user objects.

You can customize your user creation logic to include a randomly generated password that complies with the default password policy. This functionality is included in the default crypto script, `bin/defaults/script/crypto.js`, but is not invoked by default. For an example of how this functionality might be used, see the `openidm/bin/defaults/script/onCreateUser.js` script. The following section of that file (commented out by default) means that users created by using the Admin UI, or directly over the REST interface, will have a randomly generated, password added to their entry:

```
if (!object.password) {

    // generate random password that aligns with policy requirements
    object.password = require("crypto").generateRandomString([
        { "rule": "UPPERCASE", "minimum": 1 },
        { "rule": "LOWERCASE", "minimum": 1 },
        { "rule": "INTEGERS", "minimum": 1 },
        { "rule": "SPECIAL", "minimum": 1 }
    ], 16);

}
```

Comment out this section to invoke the random password generation when users are created. Note that changes made to scripts take effect after the time set in the `recompile.minimumInterval`, described in "Setting the Script Configuration".

The generated password can be encrypted, or hashed, in accordance with the managed user schema, defined in `conf/managed.json`. For more information, see "Encoding Attribute Values".

You can use this random string generation in a number of situations. Any script handler that is implemented in JavaScript can call the `generateRandomString` function.

19.4. Modifying the `password` Property

If you want to change the `password` property in IDM, you'll have to change it in the following files:

`policy.json`

This file is critical. If you want to enforce complexity rules on a different password property, update the `password` property in this file.

`managed.json`

Modify the `password` code block in this file, which also includes password complexity policies.

`sync.json`

If you change the `password` property, be careful. Make sure to limit the change to the appropriate system, designated as `source` or `target`.

`selfservice-reset.json`

If you're setting up self-service password reset as discussed in "User Password Reset", change the value of `identityPasswordField` from `password` to the desired new property.

Every UI file which includes `password` as a property name

Whenever there's a way for a user to enter a password, the associated `HTML` page will include a password entry. For example, the `LoginTemplate.html` file includes the `password` property. A full list of default files with the `password` property include:

`_passwordFields.html`
`_resetPassword.html`
`ConfirmPasswordDialogTemplate.html`
`EditPasswordPageView.html`
`LoginTemplate.html`
`MandatoryPasswordChangeDialogTemplate.html`
`resetStage-initial.html`
`UserPasswordTab.html`

This list does not include any custom UI files that you may have created.

Chapter 20

Managing Authentication, Authorization and Role-Based Access Control

IDM provides a flexible authentication and authorization mechanism, based on REST interface URLs and on managed roles. This chapter describes how to configure the supported authentication modules and how roles are used to support authentication, authorization, and access control.

20.1. The Authentication Model

You *must* authenticate before you can access the IDM REST interface. User self-registration requires anonymous access. For this purpose, IDM includes an `anonymous` user, with the password `anonymous`. For more information, see "Internal Users".

IDM supports an enhanced authentication mechanism over the REST interface, that is compatible with the AJAX framework. Although IDM understands the authorization header of the HTTP basic authorization contract, it deliberately does not utilize the full contract. IDM does not cause the browser built in mechanism to prompt for username and password. However, it does understand utilities such as `curl` that can send the username and password in the Authorization header.

In general, the HTTP basic authentication mechanism does not work well with client side web applications, and applications that need to render their own login screens. Because the browser stores and sends the username and password with each request, HTTP basic authentication has significant security vulnerabilities. You can therefore send the username and password via the authorization header, and IDM returns a token for subsequent access.

This document uses the IDM authentication headers in all REST examples, for example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 ...
```

The IDM `X-OpenIDM-Reauth-Password` header is *required* for password changes that use PUT or PATCH requests. If you do not include the `X-OpenIDM-Reauth-Password` header, the server returns a `403` error.

For example, the following password change request fails:

```
$ curl \
 --header "Content-Type: application/json" \
  --header "X-OpenIDM-Username: bjensen" \
  --header "X-OpenIDM-Password: Passw0rd" \
  --header "If-Match: *" \
  --request PUT \
  --data '{
    "userName":"bjensen",
    "givenName":"Babs",
    "sn":"Jensen",
    "mail":"babs.jensen@example.com",
    "telephoneNumber":"555-123-1234",
    "password":"NewPassw0rd"
  }' \
 http://localhost:8080/openidm/managed/user/0638da14-e02e-4904-9076-b8ce8f700eb4
{
  "code": 403,
  "reason": "Forbidden",
  "message": "Access denied"
}
```

The same request, including the `X-OpenIDM-Reauth-Password` header, succeeds:

```
$ curl \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: bjensen" \
 --header "X-OpenIDM-Password: Passw0rd" \
 --header "X-OpenIDM-Reauth-Password: Passw0rd" \
 --header "If-Match: *" \
 --request PUT \
 --data '{
   "userName":"bjensen",
   "givenName":"Babs",
   "sn":"Jensen",
   "mail":"babs.jensen@example.com",
   "telephoneNumber":"555-123-1234",
   "password":"NewPassw0rd"
 }' \
 http://localhost:8080/openidm/managed/user/0638da14-e02e-4904-9076-b8ce8f700eb4
{
  "_id": "0638da14-e02e-4904-9076-b8ce8f700eb4",
  "_rev": "00000000fa190282",
  "userName": "bjensen",
  "givenName": "Babs",
  "sn": "Jensen",
  "mail": "babs.jensen@example.com",
  "telephoneNumber": "555-123-1234",
  ...
}
```

You can use RFC 5987-encoded characters in all three IDM authentication headers (`X-OpenIDM-Username`, `X-OpenIDM-Password`, and `X-OpenIDM-Reauth-Password`). This lets you use non-ASCII characters in these header values. The RFC 5987-encoding is automatically detected and decoded when present. As per the RFC 5987 specification, the following character sets are supported:

- UTF-8

- ISO-8859-1

The following command shows a request for a user (openidm-admin) whose password is `Passw£rd123`. The Unicode `£` sign (U+00A3) is encoded into the octet sequence C2 A3 using UTF-8 character encoding, then percent-encoded.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: UTF-8''Passw%C2%A3rd123" \
 --request GET \
 "http://localhost:8080/openidm/managed/user?_queryId=query-all-ids"
```

For more information, see RFC 5987.

For more information about alternative IDM authentication mechanisms in REST, "Using Message Level Security".

20.1.1. Authenticating Users

IDM stores two types of users in its repository - internal users and managed users. The way in which both of these user types are authenticated is defined in your project's `conf/authentication.json` file.

20.1.1.1. Internal Users

IDM creates two internal users by default in `repo.init.json`: `anonymous` and `openidm-admin`. These internal user accounts are separated from other user accounts to protect them from any reconciliation or synchronization processes.

IDM stores internal users and their role membership in a table in the repository. The two default internal users have the following functions:

anonymous

This user enables anonymous access to IDM. It is used to interact with IDM in limited ways without further authentication, such as when a user has not yet logged in and makes a login request. The anonymous user is also used to allow self-registration. For more information about self-registration, see "User Self-Registration".

By default, the anonymous user has the `openidm-reg` internal role.

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 the event that other users are locked out of their accounts. Do not use `openidm-admin` for regular tasks. Under normal circumstances, the `openidm-admin` account does not represent a regular user, so audit log records for this account do not represent the actions of any real person.

The default password for the `openidm-admin` user (also `openidm-admin`) is not encrypted, and is not secure. In production environments, you must change this password to a more secure one, as described in the following section. The new password will be encoded using a salted hash algorithm, when it is changed.

You can manage internal users as described in "Managing Users With the `openidm-admin` Role".

20.1.1.1.1. Managing Internal Users Over REST

Like any other user in the repository, you can manage internal users over the REST interface.

To list the internal users over REST, query the `repo` endpoint as follows:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET  \
 "http://localhost:8080/openidm/internal/user?_queryId=query-all-ids"
{
  "result": [
    {
      "_id": "openidm-admin",
      "_rev": "00000000c7554e13"
    },
    {
      "_id": "anonymous",
      "_rev": "000000000cde398e"
    }
  ],
  "resultCount": 2,
  "pagedResultsCookie": null,
  "totalPagedResultsPolicy": "NONE",
  "totalPagedResults": -1,
  "remainingPagedResults": -1
}
```

To query the details of an internal user, include the user's ID in the request, for example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET  \
 "http://localhost:8080/openidm/internal/user/openidm-admin"
{
  "_id": "openidm-admin",
  "_rev": "00000000c7554e13"
}
```

To change the password of the default administrative user, PATCH the user object as follows:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PATCH \
 --data '[ {
   "operation" : "replace",
   "field" : "password",
   "value" : "NewPassw0rd"
 } ]' \
 "http://localhost:8080/openidm/internal/user/openidm-admin"
{
 "_id": "openidm-admin",
 "_rev": "00000000555c83ed"
}
```

To identify the authorization roles (`authzRoles`) for the `openidm-admin` internal user, create and manage other internal users, see "Managing Users With the `openidm-admin` Role".

20.1.1.2. Managed Users

External users that are managed by IDM are known as managed users.

The table in which managed users are stored depends on the type of repository. For JDBC repositories, IDM stores managed users in the managed objects table, named `managedobjects`, and indexes those objects in a table named `managedobjectproperties`.

IDM provides RESTful access to managed users, at the context path `/openidm/managed/user`. For more information, see "Managing Users Over REST".

20.1.1.3. Authenticating Internal and Managed Users

By default, the attribute names that are used to authenticate managed and internal users are `username` and `password`, respectively.

You can authenticate internal and managed users by sending a POST to the `openidm/authentication` endpoint, with `_action=login`

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request POST  \
"http://localhost:8080/openidm/authentication?_action=login"
```

If you apply this REST call to an end user, that action increments the `loginCount` property shown in the `activity.audit.json` file:

```
$ curl \
--header "X-OpenIDM-Username: bjensen"
 \
--header "X-OpenIDM-Password: Passw0rd"
 \
--request POST  \
"http://localhost:8080/openidm/authentication?_action=login"
```

If you're testing "Progressive Profile Completion", the noted REST call can help you trigger conditions such as `loginCount`. Alternatively, if you only need login information, see "Obtaining Session Information".

In addition, you can explicitly define the properties that constitute usernames, passwords, or roles with the `propertyMapping` object in the `conf/authentication.json` file. The following excerpt of the `authentication.json` file shows the default property mapping object:

```
...
    "propertyMapping" : {
        "authenticationId" : "username",
        "userCredential" : "password",
        "userRoles" : "roles"
    },
 ...
```

If you change the attribute names that are used for authentication, you must adjust the following authentication queries (defined in the repository configuration file, `openidm/conf/repo.repo-type.json`).

Two queries are defined by default.

`credential-internaluser-query`

This query uses the `username` attribute for login, for internal users. For example, the following `credential-internaluser-query` is defined in the default repository configuration file for a MySQL repository.

```
"credential-internaluser-query" : "SELECT objectid, pwd, roles FROM
        ${_dbSchema}.${_table} WHERE objectid = ${username}",
```

`credential-query`

This query uses the `username` attribute for login, for managed users. For example, the following `credential-query` is defined in the default repository configuration file for a MySQL repository.

```
"credential-query" : "SELECT * FROM ${_dbSchema}.${_table} WHERE
        userName = ${username} and accountStatus = 'active'",
```

The query that is used for a particular resource is specified by the `queryId` property in the `authentication.json` file. The following sample excerpt of that file shows that the `credential-query` is used when validating managed user credentials.

```
{
    "queryId" : "credential-query",
    "queryOnResource" : "managed/user",
...
}
```

20.1.2. Supported Authentication and Session Modules

The authentication configuration is defined in `conf/authentication.json`. This file configures the methods by which a user request is authenticated. It includes both session and authentication module configuration.

You can review and configure supported local modules in the Admin UI. To do so, log into `https://localhost:8443/admin`, and select Configure > Authentication. Choose Local when asked to select an authentication provider, and select the Session and then the Modules tab.

Whenever you modify an authentication module in the Admin UI, that may affect your current session. IDM prompts you with the following message:

```
Your current session may be invalid. Click here
to logout and re-authenticate.
```

When you select the *Click here* link, IDM logs you out of any current session and returns you to the login screen.

20.1.2.1. Supported Session Module

At this time, IDM includes one supported session module. The JSON Web Token session module configuration specifies keystore information, and details about the session lifespan. The default `JWT_SESSION` configuration is as follows:

```
"sessionModule" : {
    "name" : "JWT_SESSION",
    "properties" : {
        "maxTokenLifeMinutes" : 120,
        "tokenIdleTimeMinutes" : 30,
        "sessionOnly" : true,
        "isHttpOnly" : true,
        "enableDynamicRoles" : false
    }
},
```

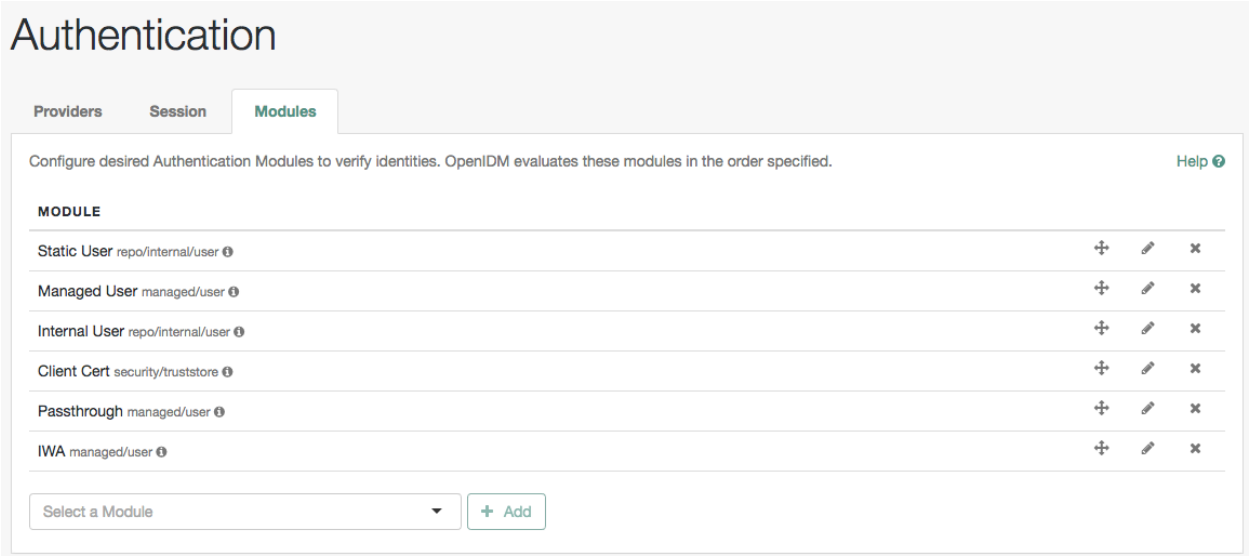
If you're reviewing the `authentication.audit.json` file, in the `/path/to/openidm` directory, for authenticated requests, look for the `JwtSession moduleId`. For an example on how you can query this log, see "Querying the Authentication Audit Log".

For more information about this module, see the Class JwtSessionModule JavaDoc.

20.1.2.2. Supported Authentication Modules

IDM evaluates modules in the order shown in the `authentication.json` file for your project. When IDM finds a module to authenticate a user, it does not evaluate subsequent modules.

You can also configure the order of authentication modules in the Admin UI. After logging in, choose Configure > Authentication, and select the Modules tab. The following figure illustrates how you might include the IWA module in the Admin UI.



You must prioritize the authentication modules that query IDM resources. Prioritizing the modules that query external resources might lead to authentication problems for internal users such as `openidm-admin`.

STATIC_USER

`STATIC_USER` authentication provides an anonymous authentication mechanism that bypasses any database lookups if the headers in a request indicate that the user is `anonymous`. The following sample REST call uses `STATIC_USER` authentication in the self-registration process:

```
$ curl \
 --header "X-OpenIDM-Password: anonymous" \
 --header "X-OpenIDM-Username: anonymous" \
 --header "Content-Type: application/json" \
 --data '{
       "userName":"steve",
       "givenName":"Steve",
       "sn":"Carter",
       "telephoneNumber":"0828290289",
       "mail":"scarter@example.com",
       "password":"Passw0rd"
       }' \
 --request POST \
 "http://localhost:8080/openidm/managed/user/?_action=create"
```

Note that this is not the same as an anonymous request that is issued without headers.

Authenticating with the `STATIC_USER` module avoids the performance cost of reading the database for self-registration, certain UI requests, and other actions that can be performed anonymously. Authenticating the anonymous user with the `STATIC_USER` module is identical to authenticating the anonymous user with the `INTERNAL_USER` module, except that the database is not accessed. So,

`STATIC_USER` authentication provides an authentication mechanism for the anonymous user that avoids the database lookups incurred when using `INTERNAL_USER`.

A sample `STATIC_USER` authentication configuration follows:

```
{
    "name" : "STATIC_USER",
    "enabled" : true,
    "properties" : {
        "queryOnResource" : "internal/user",
        "username" : "anonymous",
        "password" : "anonymous",
        "defaultUserRoles" : [
            "internal/role/openidm-reg"
        ]
    }
}
```

TRUSTED_ATTRIBUTE

The `TRUSTED_ATTRIBUTE` authentication module allows you to configure IDM to trust the `HttpServletRequest` attribute of your choice. You can configure it by adding the `TRUSTED_ATTRIBUTE` module to your `authentication.json` file, as shown in the following code block:

```
...
{
    "name" : "TRUSTED_ATTRIBUTE",
    "properties" : {
        "queryOnResource" : "managed/user",
        "propertyMapping" : {
            "authenticationId" : "username",
            "userRoles" : "authzRoles"
        },
        "defaultUserRoles" : [ ],
        "authenticationIdAttribute" : "X-ForgeRock-AuthenticationId",
        "augmentSecurityContext" : {
            "type" : "text/javascript",
            "file" : "auth/populateRolesFromRelationship.js"
        }
    },
    "enabled" : true
}
...
```

`TRUSTED_ATTRIBUTE` authentication queries the `managed/user` repository, and allows authentication when credentials match, based on the `username` and `authzRoles` assigned to that user, specifically the `X-ForgeRock-AuthenticationId` attribute.

For a sample implementation of a custom servlet filter and the Trusted Request Attribute Authentication Module, see "*Authenticating Using a Trusted Servlet Filter*" in the *Samples Guide*.

MANAGED_USER

`MANAGED_USER` authentication queries the repository, specifically the `managed/user` objects, and allows authentication if the credentials match. The default configuration uses the `username` and `password` of the managed user to authenticate, as shown in the following sample configuration:

```
{
    "name" : "MANAGED_USER",
    "enabled" : true,
    "properties" : {
        "augmentSecurityContext": {
            "type" : "text/javascript",
            "source" : "require('auth/customAuthz').setProtectedAttributes(security)"
        },
        "queryId" : "credential-query",
        "queryOnResource" : "managed/user",
        "propertyMapping" : {
            "authenticationId" : "username",
            "userCredential" : "password",
            "userRoles" : "roles"
        },
        "defaultUserRoles" : [ ]
    }
},
```

The `augmentSecurityContext` property can be used to add custom properties to the security context of users who authenticate with this module. By default, this property adds a list of *protected properties* to the user's security context. These protected properties are defined in the managed object schema. For more information, see the `isProtected` property described in "Creating and Modifying Managed Object Types".

INTERNAL_USER

`INTERNAL_USER` authentication queries the `internal/user` objects in the repository and allows authentication if the credentials match. The default configuration uses the `username` and `password` of the internal user to authenticate, as shown in the following sample configuration:

```
{
    "name" : "INTERNAL_USER",
    "enabled" : true,
    "properties" : {
        "queryId" : "credential-internaluser-query",
        "queryOnResource" : "internal/user",
        "propertyMapping" : {
            "authenticationId" : "username",
            "userCredential" : "password",
            "userRoles" : "roles"
        },
        "defaultUserRoles" : [ ]
    }
},
```

CLIENT_CERT

The client certificate module, `CLIENT_CERT`, authenticates by validating a client certificate, transmitted through an HTTP request. IDM compares the subject DN of the request certificate with the subject DN of the truststore.

A sample `CLIENT_CERT` authentication configuration follows:

```
{
   "name" : "CLIENT_CERT",
   "properties" : {
     "augmentSecurityContext" : {
       "type" : "text/javascript",
       "globals" : { },
       "file" : "auth/mapUserFromClientCert.js"
     },
     "queryOnResource" : "managed/user",
     "defaultUserRoles" : [
       "internal/role/openidm-cert",
       "internal/role/openidm-authorized"
     ],
     "allowedAuthenticationIdPatterns" : [
       ".*CN=localhost, O=ForgeRock.*"
     ]
   },
   "enabled" : true
 },
```

For more information about certificate-based authentication, see "Authenticating With Client Certificates".

The modules that follow point to external systems. In the `authentication.json` file, you should generally include these modules after any modules that query internal IDM resources.

PASSTHROUGH

`PASSTHROUGH` authentication queries an external system, such as an LDAP server, and allows authentication if the provided credentials match those in the external system. The following sample configuration shows pass-through authentication using the user objects in the system endpoint `system/ldap/account`. For more information on pass-through authentication, see "Configuring Pass-Through Authentication".

IWA

The `IWA` module enables users to authenticate by using Integrated Windows Authentication (IWA), rather than by providing a username and password. For information about configuring the IWA module with IDM, see "Configuring IWA Authentication".

SOCIAL_PROVIDERS

The `SOCIAL_PROVIDERS` module supports configuration of social identity providers that comply with OAuth 2.0 and OpenID Connect 1.0 standards. For information about configuring this module with social identity providers such as Google, LinkedIn, and Facebook, see "Configuring the Social Providers Authentication Module".

In audit logs, namely in the `authentication.audit.json` file in the `/path/to/openidm/audit` directory, you'll find the corresponding `SOCIAL_AUTH` module, which is used to handle authentication for each individual social identity provider. For an example of how you can query this log, see "Querying the Authentication Audit Log".

OAUTH_CLIENT

The OAUTH_CLIENT module works only with the OAuth 2.0 standards. For information about configuring this module with IDM, see "Configuring Authentication With OAuth 2.0".

The OAUTH_CLIENT module also supports integration with AM. For an example of this integration, follow the procedure described in "*Integrating IDM With the ForgeRock Identity Platform*" in the *Samples Guide*.

20.1.3. Configuring Pass-Through Authentication

With pass-through authentication, the credentials included with the REST request are validated against those stored in a remote system, such as an LDAP server.

The following excerpt of an `authentication.json` shows a pass-through authentication configuration for an LDAP system:

```
"authModules" : [
    {
       "name" : "PASSTHROUGH",
       "enabled" : true,
       "properties" : {
          "augmentSecurityContext": {
             "type" : "text/javascript",
             "file" : "auth/populateAsManagedUser.js"
          },
          "queryOnResource" : "system/ldap/account",
          "propertyMapping" : {
             "authenticationId" : "uid",
             "groupMembership" : "ldapGroups"
          },
          "groupRoleMapping" : {
             "internal/role/openidm-admin" : ["cn=admins,ou=Groups,dc=example,dc=com"]
          },
          "managedUserLink" : "systemLdapAccounts_managedUser",
          "defaultUserRoles" : [
             "internal/role/openidm-authorized"
          ]
       },
    },
    ...
 ]
```

For more information on authentication module properties, see "*Authentication and Session Module Configuration Details*".

The IDM samples, described in "*Overview of the Samples*" in the *Samples Guide*, include several examples of pass-through authentication configuration. The `sync-with-ldap*` samples use an external LDAP system for authentication. The `scripted-rest-with-dj` sample uses a scripted REST connector to authenticate against a ForgeRock Directory Services (DS) server.

For information about using group membership to authenticate users with pass-through authentication, see "Building Role-Based Access Control".

20.1.4. Configuring Authentication With OAuth 2.0

The `OAUTH_CLIENT` authentication module complies with OAuth 2.0 standards.

If you want to enable a social identity provider that fully complies with OAuth 2.0 standards, IDM includes an authentication module wrapper known as `SOCIAL_PROVIDERS`. It is a specialized facility for sharing a social identity provider configuration with the authentication service, which you can configure as if it were a separate authentication module. For more information, see "Configuring the Social Providers Authentication Module".

The following excerpt of an `authentication.json` shows the default configuration associated with the `OAUTH` authentication module, as configured for use with ForgeRock Access Management.

```
{
    "name" : "OAUTH_CLIENT",
    "properties" : {
        "augmentSecurityContext" : {
            "type" : "text/javascript",
            "globals" : {
                "sessionValidationBaseEndpoint" : "http://openam.example.com:8080/openam/json/sessions/"
            },
            "file" : "auth/amSessionCheck.js"
        },
        "propertyMapping" : {
            "authenticationId" : "uid",
            "userRoles" : "authzRoles"
        },
        "defaultUserRoles" : [
            "internal/role/openidm-authorized"
        ],
        "idpConfig" : {
            "provider" : "OPENAM",
            "icon" : "<button class=\"btn btn-lg btn-default btn-block btn-social-provider\"><img src=
\"images/forgerock_logo.png\">Sign in</button>"
            "scope" : [
                "openid"
            ],
            "authenticationIdKey" : "sub",
            "clientId" : "openidm",
            "clientSecret" : {
                "$crypto" : {
                    "type" : "x-simple-encryption",
                    "value" : {
                        "cipher" : "AES/CBC/PKCS5Padding",
                        "stableId" : "openidm-sym-default",
                        "salt" : "<someSaltedValue>",
                        "data" : "<someEncryptedValue>",
                        "keySize" : 16,
                        "purpose" : "idm.config.encryption",
                        "iv" : "<someCipherValue>",
                        "mac" : "<someCode>"
                    }
                }
            },
            "authorizationEndpoint" : "http://openam.example.com:8080/openam/oauth2/authorize",
            "tokenEndpoint" : "http://openam.example.com:8080/openam/oauth2/access_token",
            "endSessionEndpoint" : "http://openam.example.com:8080/openam/oauth2/connect/endSession",
```

```
            "wellKnownEndpoint" : "http://openam.example.com:8080/openam/oauth2/.well-known/openid-
configuration",
            "redirectUri" : "http://openidm.example.com:8080/",
            "configClass" : "org.forgerock.oauth.clients.oidc.OpenIDConnectClientConfiguration",
            "displayIcon" : "forgerock",
            "enabled" : true
        },
        "queryOnResource" : "system/ldap/account"
    },
    "enabled" : true
}
```

For more information on authentication module properties, see the following: "*Authentication and Session Module Configuration Details*".

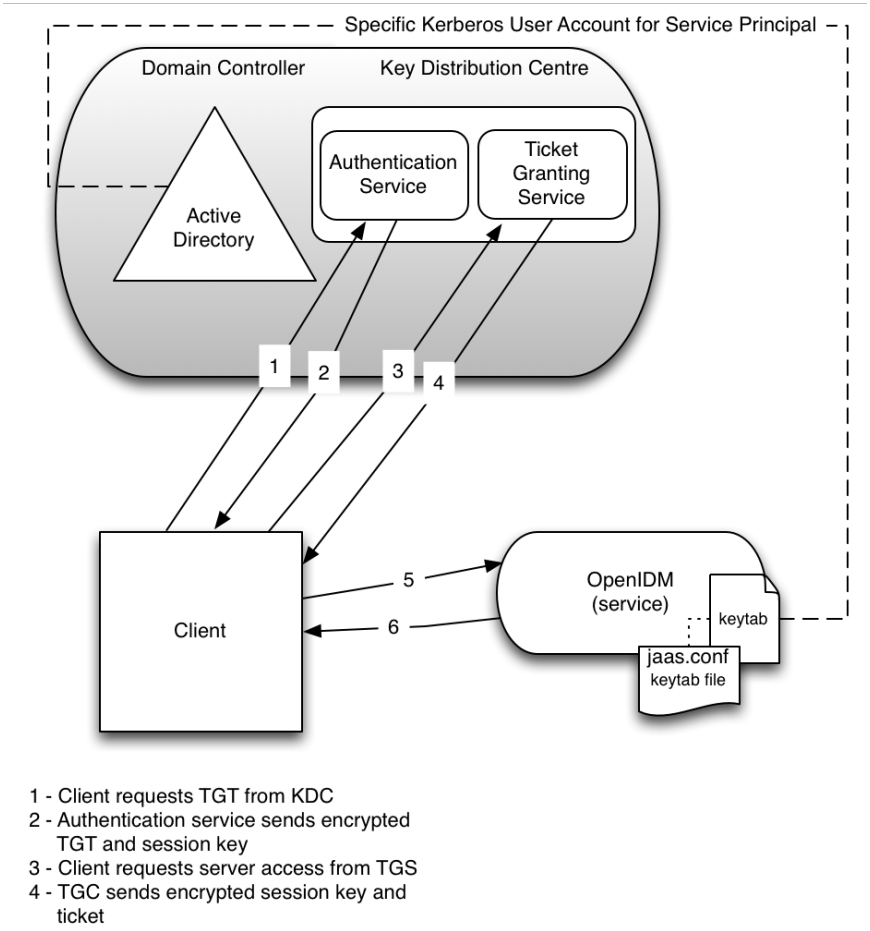
20.1.5. Configuring IWA Authentication

When IDM is configured for IWA authentication, client browsers can authenticate using a Kerberos ticket.

To enable Kerberos authentication, IDM needs a specific Kerberos user account in Active Directory, and a keytab file that maps the service principal to this user account. When this is set up, the client presents IDM with a Kerberos ticket. If IDM can validate that ticket, the client is granted an encrypted session key for the IDM service. That client can then access IDM without providing a username or password, for the duration of the session.

The complete Kerberos authentication process is shown in the following diagram:

Client Authentication to IDM Using a Kerberos Ticket



This section assumes that you have an active Kerberos server acting as a Key Distribution Center (KDC). If you are running Active Directory in your deployment, that service includes a Kerberos KDC by default.

The steps required to set up IWA with IDM are described in the following sections:

1. "Creating a Specific Kerberos User Account"
2. "Creating a Keytab File"
3. "Configuring IDM for IWA"

20.1.5.1. Creating a Specific Kerberos User Account

To authenticate IDM to the Kerberos KDC you must create a specific user entry in Active Directory whose credentials will be used for this authentication. This Kerberos user account must not be used for anything else.

The Kerberos user account is used to generate the Kerberos keytab. If you change the password of this Kerberos user after you have set up IWA authentication, you must update the keytab accordingly.

Create a new user in Active Directory as follows:

1. Select New > User and provide a login name for the user that reflects its purpose, for example, openidm@example.com.

2. Enter a password for the user. Check the *Password never expires* option and leave all other options unchecked.

   If the password of this user account expires, and is reset, you must update the keytab with the new password. It is therefore easier to create an account with a password that does not expire.

3. Click Finish to create the user.

20.1.5.2. Creating a Keytab File

A Kerberos keytab file (`krb5.keytab`) enables IDM to validate the Kerberos tickets that it receives from client browsers. You must create a Kerberos keytab file for the host on which IDM is running.

This section describes how to use the **ktpass** command, included in the Windows Server toolkit, to create the keytab file. Run the **ktpass** command on the Active Directory domain controller. Pay close attention to the use of capitalization in this example because the keytab file is case-sensitive. Note that you must disable UAC or run the **ktpass** command as a user with administration privileges.

The following command creates a keytab file (named `openidm.HTTP.keytab`) for the IDM service located at `openidm.example.com`.

```
C:\Users\Administrator>ktpass ^
 -princ HTTP/openidm.example.com@EXAMPLE.COM ^
 -mapUser EXAMPLE\openidm ^
 -mapOp set ^
 -pass Passw0rd1 ^
 -crypto ALL
 -pType KRB5_NT_PRINCIPAL ^
 -kvno 0 ^
 -out openidm.HTTP.keytab

Targeting domain controller: host.example.com
Using legacy password setting method
Successfully mapped HTTP/openidm.example.com to openidm.
Key created.
Output keytab to openidm.HTTP.keytab:
Keytab version: 0x502
keysize 79 HTTP/openidm.example.com@EXAMPLE.COM ptype 1 (KRB5_NT_PRINCIPAL)
 vno 0 etype 0x1 (DES-CBC-CRC) keylength 8 (0x73a28fd307ad4f83)
keysize 79 HTTP/openidm.example.com@EXAMPLE.COM ptype 1 (KRB5_NT_PRINCIPAL)
 vno 0 etype 0x3 (DES-CBC-MD5) keylength 8 (0x73a28fd307ad4f83)
keysize 87 HTTP/openidm.example.com@EXAMPLE.COM ptype 1 (KRB5_NT_PRINCIPAL)
 vno 0 etype 0x17 (RC4-HMAC) keylength 16 (0xa87f3a337d73085c45f9416be5787d86)
keysize 103 HTTP/openidm.example.com@EXAMPLE.COM ptype 1 (KRB5_NT_PRINCIPAL)
 vno 0 etype 0x12 (AES256-SHA1) keylength 32 (0x6df9c282abe3be787553f23a3d1fcefc
  6fc4a29c3165a38bae36a8493e866d60)
keysize 87 HTTP/openidm.example.com@EXAMPLE.COM ptype 1 (KRB5_NT_PRINCIPAL)
 vno 0 etype 0x11 (AES128-SHA1) keylength 16 (0xf616977f071542cd8ef3ff4e2ebcc09c)
```

The **ktpass** command takes the following options:

- `-princ` specifies the service principal name in the format *`service/host-name@realm`*

  In this example (`HTTP/openidm.example.com@EXAMPLE.COM`), the client browser constructs an SPN based on the following:

  - The service name (HTTP).

    The service name for SPNEGO web authentication *must* be HTTP.

  - The FQDN of the host on which IDM runs (`openidm.example.com`).

    This example assumes that users will access IDM at the URL `https://openidm.example.com:8443`.

  - The Kerberos realm name (`EXAMPLE.COM`).

    The realm name must be in upper case. A Kerberos realm defines the area of authority of the Kerberos authentication server.

- `-mapUser` specifies the name of the Kerberos user account to which the principal should be mapped (the account that you created in "Creating a Specific Kerberos User Account"). The username must be specified in down-level logon name format (DOMAIN\UserName). In our example, the Kerberos user name is `EXAMPLE\openidm`.

- `-mapOp` specifies how the Kerberos user account is linked. Use `set` to set the first user name to be linked. The default (`add`) adds the value of the specified local user name if a value already exists.
- `-pass` specifies a password for the principal user name. Use "*" to prompt for a password.
- `-crypto` Specifies the cryptographic type of the keys that are generated in the keytab file. Use `ALL` to specify all crypto types.

  This procedure assumes a 128-bit cryptosystem, with a default RC4-HMAC-NT cryptography algorithm. You can use the **ktpass** command to view the crypto algorithm, as follows:

```
C:\Users\Administrator> ktpass -in .\openidm.HTTP.keytab
Existing keytab:
Keytab version: 0x502
keysize 79 HTTP/openidm.example.com@EXAMPLE.COM ptype 1 (KRB5_NT_PRINCIPAL)
 vno 0 etype 0x1 (DES-CBC-CRC) keylength 8 (0x73a28fd307ad4f83)
keysize 79 HTTP/openidm.example.com@EXAMPLE.COM ptype 1 (KRB5_NT_PRINCIPAL)
 vno 0 etype 0x3 (DES-CBC-MD5) keylength 8 (0x73a28fd307ad4f83)
keysize 87 HTTP/openidm.example.com@EXAMPLE.COM ptype 1 (KRB5_NT_PRINCIPAL)
 vno 0 etype 0x17 (RC4-HMAC) keylength 16 (0xa87f3a337d73085c45f9416be5787d86)
keysize 103 HTTP/openidm.example.com@EXAMPLE.COM ptype 1 (KRB5_NT_PRINCIPAL)
 vno 0 etype 0x12 (AES256-SHA1) keylength 32 (0x6df9c282abe3be787553f23a3d1fcefc6
 fc4a29c3165a38bae36a8493e866d60)
keysize 87 HTTP/openidm.example.com@EXAMPLE.COM ptype 1 (KRB5_NT_PRINCIPAL)
 vno 0 etype 0x11 (AES128-SHA1) keylength 16 (0xf616977f071542cd8ef3ff4e2ebcc09c)
```

- `-ptype` Specifies the principal type. Use `KRB5_NT_PRINCIPAL`.
- `-kvno` specifies the key version number. Set the key version number to 0.
- `-out` specifies the name of the keytab file that will be generated, for example, `openidm.HTTP.keytab`.

  Note that the keys that are stored in the keytab file are similar to user passwords. You must therefore protect the Kerberos keytab file in the same way that you would protect a file containing passwords.

For more information about the **ktpass** command, see the ktpass reference in the Windows server documentation.

20.1.5.3. Configuring IDM for IWA

To configure the IWA authentication module, you must do the following:

1. Add the `IWA` authentication module to your project's `conf/authentication.json` file.
2. Modify your project's `conf/system.properties` file to include a pointer to your login configuration for JAAS.

This section assumes that the connection from IDM to the Active Directory Server is through an LDAP connector, and that the mapping from managed users to the users in Active Directory (in your

project's `conf/sync.json` file) identifies the Active Directory target as `system/ad/account`. If you have named the target differently, modify the `"queryOnResource" : "system/ad/account"` property accordingly.

Add the IWA authentication module towards the end of your `conf/authentication.json` file. For example:

```
"authModules" : [
    ...
    {
        "name" : "IWA",
        "properties": {
            "servicePrincipal" : "HTTP/openidm.example.com@EXAMPLE.COM",
            "keytabFileName" : "C:\\Users\\Administrator\\openidm\\security\\openidm.HTTP.keytab",
            "kerberosRealm" : "EXAMPLE.COM",
            "kerberosServerName" : "kdc.example.com",
            "queryOnResource" : "system/ad/account",
            "maxTokenSize": 48000,
            "propertyMapping" : {
                "authenticationId" : "sAMAccountName",
                "groupMembership" : "memberOf"
            },
            "groupRoleMapping" : {
                "internal/role/openidm-admin": [ ]
            },
            "groupComparisonMethod": "ldap",
            "defaultUserRoles" : [
                "internal/role/openidm-authorized"
            ],
            "augmentSecurityContext" : {
                "type" : "text/javascript",
                "file" : "auth/populateAsManagedUser.js"
            }
        },
        "enabled" : true
    }
```

The IWA authentication module includes the following configurable properties:

`servicePrincipal`

The Kerberos principal for authentication, in the following format:

```
HTTP/host.domain@DC-DOMAIN-NAME
```

host and *domain* correspond to the host and domain names of the IDM server. *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 IDM server.

`keytabFileName`

The full path to the keytab file for the Service Principal. On Windows systems, any backslash (`\`) characters in the path must be escaped, as shown in the previous example.

`kerberosRealm`

The Kerberos Key Distribution Center realm. For the Windows Kerberos service, this is the domain controller server domain name.

`kerberosServerName`

The fully qualified domain name of the Kerberos Key Distribution Center server, such as that of the domain controller server.

`queryOnResource`

The IDM resource to check for the authenticating user; for example, `system/ad/account`.

`maxTokenSize`

During the Kerberos authentication process, the Windows server builds a token to represent the user for authorization. This property sets the maximum size of the token, to prevent DoS attacks, if the SPENGO token in the request being made is amended with extra data. The default maximum token size is `48000` bytes.

`groupRoleMapping`

Lets you grant different roles to users who are authenticated through the `IWA` module.

You can use the `IWA` module in conjunction with the `PASSTHROUGH` authentication module. In this case, a failure in the `IWA` module allows users to revert to forms-based authentication.

To add the `PASSTHROUGH` module, follow "Configuring Pass-Through Authentication".

When you have included the `IWA` module in your `conf/authentication.json` file, edit the `conf/system.properties` file to include a pointer to your login configuration file for JAAS. For example:

```
java.security.auth.login.config=&{idm.instance.dir}/conf/gssapi_jaas.conf
```

Your `gssapi_jaas.conf` file must include the following information related to the LDAP connector:

```
org.identityconnectors.ldap.LdapConnector {
    com.sun.security.auth.module.Krb5LoginModule required
    client=TRUE
    principal="openidm.example.com@EXAMPLE.COM"
    useKeyTab=true
    keyTab="C:\\Users\\Administrator\\openidm\\security\\openidm.HTTP.keytab";
};
```

The value of the `principal` property must reflect the username. The value of the `keyTab` property must match what you have configured in your `authentication.json` file.

20.1.6. Authenticating With Client Certificates

An alternative to authenticating users with a username and password combination is to validate the user's public certificate against a certificate stored in the IDM truststore. Client certificate authentication occurs as part of the SSL or TLS handshake, which takes place before any data is transmitted in an SSL or TLS session. This is also called *mutual SSL authentication* and is typically used in the following scenarios:

- When the client is a password plugin, such as those described in the Password Synchronization Plugin Guide, the client authenticates with IDM using the `CLIENT_CERT` module. This process is similar to an administrative request to modify the passwords of regular users.
- When users have secure certificates that they install in their browsers for authentication and authorization.

To enable IDM to authenticate client certificates, add the `CLIENT_CERT` module to your project's `conf/authentication.json` file and modify the module to match your deployment. You can use the sample file, `/path/to/openidm/samples/example-configurations/conf/client-cert/authentication.json`, as a basis for your configuration.

Note

When a user authenticates with a client certificate, they receive the roles listed in the `defaultUserRoles` property of the `CLIENT_CERT` module. There is no further role retrieval and population.

If the client certificate is self-signed or is signed by an unknown CA, you must add the client certificate to the IDM truststore. If the client certificate was signed by a CA that is already trusted, you can skip this step. Otherwise, import the client certificate into the IDM truststore, as follows:

```
keytool \
 -importcert \
 -alias alias \
 -file user_public_cert.pem \
 -keystore /path/to/openidm/security/truststore \
 -storetype JKS
```

To configure the client certificate module, add it to your project's `conf/authentication.json` file as follows:

```
{
    "name" : "CLIENT_CERT",
    "properties" : {
      "augmentSecurityContext" : {
        "type" : "text/javascript",
        "globals" : { },
        "file" : "auth/mapUserFromClientCert.js"
      },
      "queryOnResource" : "managed/user",
      "defaultUserRoles" : [
        "internal/role/openidm-cert",
        "internal/role/openidm-authorized"
      ],
      "allowedAuthenticationIdPatterns" : [
        ".*CN=localhost, O=ForgeRock.*"
      ]
    },
    "enabled" : true
}
```

The `allowedAuthenticationIdPatterns` property is unique to this authentication module. This property contains a regular expression that defines which user distinguished names (DNs) are allowed to authenticate with a certificate.

By default users can authenticate only if their certificates have been issued by a Certificate Authority (CA) that is listed in the truststore. The default truststore includes several trusted root CA certificates and any user certificate issued by those CAs will be trusted. Change the value of this property to restrict certificates to those issued to users in your domain, or use some other regular expression to limit who will be trusted. If you leave this property empty, no certificates will be trusted.

The following procedure shows client certificate authentication with a self-signed certificate. At the end of this procedure, you will verify the certificate over port 8444 as defined in your project's `resolver/boot.properties` file:

```
openidm.auth.clientauthonlyports=8444
```

Testing the Client Certificate Authentication

This procedure demonstrates client certificate authentication by generating a self-signed certificate, adding that certificate to the truststore, then authenticating with the certificate.

The example assumes an existing managed user, bjensen, with email address `bjensen@example.com`.

1. Create a self-signed certificate for user bjensen as follows:

```
openssl req \
 -x509 \
 -newkey rsa:1024 \
 -keyout /path/to/key.pem \
 -out /path/to/cert.pem \
 -days 3650 \
 -nodes
Generating a 1024 bit RSA private key
................+++++
+
..................++++++
writing new private key to 'key
.pem'
-----
You are about to be asked to enter information that will be incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank
.
-----
Country Name (2 letter code) []:US
State or Province Name (full name) []:Washington
Locality Name (eg, city) []:Vancouver
Organization Name (eg, company) []:Example.com
Organizational Unit Name (eg, section) []:
Common Name (eg, fully qualified host name) []:localhost
Email Address []:bjensen@example.com
```

   The important part of this information is the `Email Address` as that is used by the `mapUserFromClientCert.js` to map the user against an existing managed user.

2. Import the client certificate into the IDM truststore:

```
keytool \
 -importcert \
 -keystore /path/to/openidm/security/truststore \
 -storetype JKS \
 -storepass changeit \
 -file /path/to/cert.pem \
 -trustcacerts \
 -noprompt \
 -alias client-cert-example
Certificate was added to keystore
```

3. Edit your project's `conf/authentication.json` file. Add the `CLIENT_CERT` module, and add at least the email address from the certificate subject DN to the `allowedAuthenticationIdPatterns`:

```
...{
    "name" : "CLIENT_CERT",
    "properties" : {
        "augmentSecurityContext" : {
            "type" : "text/javascript",
            "globals" : { },
            "file" : "auth/mapUserFromClientCert.js"
        },
        "queryOnResource" : "managed/user",
        "defaultUserRoles" : [
            "internal/role/openidm-cert",
            "internal/role/openidm-authorized"
        ],
        "allowedAuthenticationIdPatterns" : [
            ".*EMAILADDRESS=bjensen@example.com.*"
        ]
    },
    "enabled" : true
},...
```

4. Send an HTTP request with your certificate file `cert.pem` to the secure port:

```
curl \
 --insecure \
 --cert-type PEM \
 --key /path/to/key.pem \
 --key-type PEM \
 --cert /path/to/cert.pem \
 --request GET "https://localhost:8444/openidm/info/login"
{
  "_id": "login",
  "authenticationId": "EMAILADDRESS=bjensen@example.com, CN=localhost, O=Example.com, L=Vancouver,
 ST=Washington, C=US",
  "authorization": {
    "userRolesProperty": "authzRoles",
    "component": "managed/user",
    "authLogin": false,
    "roles": [
      "internal/role/openidm-cert",
      "internal/role/openidm-authorized"
    ],
    "ipAddress": "0:0:0:0:0:0:0:1",
    "id": "aba3e666-c0db-4669-8760-0eb21f310649",
    "moduleId": "CLIENT_CERT"
  }
}
```

Note

Because we have used a self-signed certificate in this example, you must include the `--insecure` option. You should not include this option if you are using a CA cert.

20.1.7. Authenticating as a Different User

The `X-OpenIDM-RunAs` header enables an administrative user to *masquerade* as a regular user, without needing that user's password. To support this header, you must add a `runAsProperties` object to the required authentication module configuration.

The sample `authentication.json` file in `openidm/samples/example-configurations/conf/runas/` adds support for the header to the `INTERNAL_USER` module. This means that users or clients who authenticate using the `INTERNAL_USER` module can masquerade as other users.

The `runAsProperties` object has the following configuration:

```
"runAsProperties" : {
     "adminRoles" : [
         "internal/role/openidm-admin"
     ],
     "disallowedRunAsRoles" : [
         "internal/role/openidm-admin"
     ],
     "queryId" : "credential-query",
     "queryOnResource" : "managed/user",
     "propertyMapping" : {
         "authenticationId" : "username",
         "userRoles" : "authzRoles"
     },
     "augmentSecurityContext" : {
         "type" : "text/javascript",
         "source" : "require('auth/customAuthz').setProtectedAttributes(security)"
     }
 }
```

This configuration allows a user authenticated with the `openidm-admin` role to masquerade as any user except one with the `openidm-admin` role.

In the following example, the `openidm-admin` user authenticates with the `INTERNAL_USER` module, and can run REST calls as user `bjensen` without requiring that user's password:

```
curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "X-OpenIDM-RunAs: bjensen" \
 --request GET \
 "http://localhost:8080/openidm/info/login"
        {
   "_id" : "login",
   "authenticationId" : "bjensen",
   "authorization" : {
     "component" : "managed/user",
     "authLogin" : false,
     "adminUser" : "openidm-admin",
     "roles" : [ "internal/role/openidm-authorized" ],
     "ipAddress" : "127.0.0.1",
     "protectedAttributeList" : [ "password" ],
     "id" : "847fe36b-115b-4769-b74a-d546f0d0ffc8",
     "moduleId" : "INTERNAL_USER"
   }
 }
```

The authentication output shows that the request was made as user `bjensen` but with an `adminUser` of `openidm-admin`. Note that this information is also logged in the authentication audit log.

If you were to actually authenticate as user `bjensen`, without the `runAs` header, the user is authenticated with the `MANAGED_USER` authentication module. The output still shows an `authenticationId` of `bjensen` but there is no reference to an `adminUser`:

```
curl \
 --header "X-OpenIDM-Username: bjensen" \
 --header "X-OpenIDM-Password: Passw0rd" \
 --request GET \
 "http://localhost:8080/openidm/info/login"
 {
   "_id" : "login",
   "authenticationId" : "bjensen",
   "authorization" : {
     "component" : "managed/user",
     "authLogin" : false,
     "roles" : [ "internal/role/openidm-authorized" ],
     "ipAddress" : "127.0.0.1",
     "protectedAttributeList" : [ "password" ],
     "id" : "847fe36b-115b-4769-b74a-d546f0d0ffc8",
     "moduleId" : "MANAGED_USER"
   }
 }
```

20.1.8. Configuring Authentication for Metrics

To support metrics collection, IDM includes a second `STATIC_USER` authentication module for access to the endpoint described in "Prometheus Endpoint". A sample configuration follows:

```
{
    "name" : "STATIC_USER",
    "properties" : {
        "queryOnResource" : "internal/user",
        "username" : "&{openidm.prometheus.username}",
        "password" : "&{openidm.prometheus.password}",
        "defaultUserRoles" : [
            "openidm-prometheus"
        ]
    },
    "enabled" : true
}
```

20.1.9. Interactions Between Modules in the Stack

IDM supports integration with ForgeRock's Access Management product, also known as AM. When you set up IDM modules as described in "*Integrating IDM With the ForgeRock Identity Platform*" in the *Samples Guide*, you'll set up interactions as described in *OpenID Connect Authorization Code Flow* in the *AM OpenID Connect 1.0 Guide*.

This integration between IDM and AM involves several different factors, described in the following sections:

20.1.9.1. Standards-Based Integration

When you integrate IDM with AM, you're setting up IDM as a Relying Party, fully compliant with the OpenID Connect Discovery specification. The following list depicts each relevant standard

associated with the IDM implementation of the OAUTH_CLIENT module, as described in "Configuring Authentication With OAuth 2.0".

- *Relying Party*

  As the Relying Party, IDM registers OAuth 2.0 client profiles with AM.

- *OpenID Provider*

  AM acts as the OpenID Provider with configuration information.

- *Scope*

  Per the Scope Values section of the OpenID Connect specification, `openid` is a required scope for OpenID Connect requests.

- *Well-known endpoint*

  Per *Obtaining OpenID Provider Configuration Information*, "OpenID Providers supporting Discovery MUST make a JSON document available at the path formed by concatenating the string /.well-known/openid-configuration to the Issuer." ForgeRock complies with this by concatenating the noted string to the end of the related OAuth 2.0 URL; a typical wellKnownEndpoint endpoint URL might be: `http://openam.example.com:8080/openam/oauth2/.well-known/openid-configuration`.

- *clientId*

  A client identifier valid at the authorization server; in this case, IDM is the client and AM is the authorization server.

- *clientSecret*

  The client secret, in this case, is the password associated with the `clientId`. Clients authenticate with AM (as an authorization server) by including the client credentials in the request body after receiving a `clientSecret` value.

- *authorizationEndpoint*

  As noted in *RFC 6749*, the authorization endpoint is used to interact with the resource owner and obtain an authorization grant. For the AM implementation of the authorization endpoint, see *OAuth 2.0 Client and Resource Server Endpoints* in the *AM OAuth 2.0 Guide*.

- *tokenEndpoint*

  Also known as the Access Token Endpoint, this AM endpoint receives an authorization code and returns an access token to IDM. If you're using the AM top-level realm, the endpoint will resemble `http://openam.example.com:8080/openam/oauth2/access_token`.

  If you're using an AM sub-realm, as described in *Setting Up Realms* chapter of the *AM Setup and Maintenance Guide*, you'd include the name of the realm in the URL, such as: `http://openam.example.com:8080/openam/oauth2/access_token?realm=/someRealm`.

- *endSessionEndpoint*

  The End Session Endpoint allows a relying party (IDM) to request logging out an end user at the OpenID Connect Party (AM), at an endpoint such as: `http://openam.example.com:8080/openam/oauth2/connect/endSession`. For more information, see the *IDM OpenID Connect 1.0 Guide* *Reference* chapter.

20.1.9.2. Using the IDM Session Module

When integrating IDM and AM, both servers have a session module. When you log into IDM in the integrated configuration, the IDM JWT_SESSION module is used solely as a client-side cache.

Without the IDM JWT_SESSION module, the OAUTH_CLIENT authentication module would have to call the AM session module for *every* request. In contrast, with the IDM JWT_SESSION module, it validates the OAUTH_CLIENT token only after the JWT_SESSION module times out.

While fewer calls ot the AM session module improves performance, that can lead to a problem; if a user logs out of AM (or if that user's AM session has timed out), that user's IDM session may still be active. To minimize that issue, you can reduce the timeout associated with that user's IDM JWT_SESSION, as shown in "Supported Session Module".

20.1.9.3. REST Calls and Integration

When you run a REST call on the integrated IDM/AM system, the application should have an OIDC token obtained from AM. Caching is the responsibility of the REST application.

For more information, see the following Knowledge Base article: *How does the OIDC authorization flow work when IDM (All versions) is integrated with AM?*

20.1.9.4. Mapping Admin Users

When you integrate IDM with AM, you're integrating their administrative accounts, and potentially more. For an example of how this is done, review the `amSessionCheck.js` file, as described in "Understanding the Integrated AM Administrative User" in the *Samples Guide*.

20.2. Roles and Authentication

IDM includes a number of default internal roles, and supports the configuration of managed and internal roles, enabling you to customize the roles mechanism as needed.

The following roles are configured by default in `repo.init.json`:

internal/role/openidm-reg

Role assigned to users who access IDM with the default anonymous account.

The `openidm-reg` role is excluded from the reauthorization required policy definition by default.

internal/role/openidm-admin

IDM administrator role, excluded from the reauthorization required policy definition by default.

internal/role/openidm-authorized

Default role for any user who has authenticated with a user name and password.

internal/role/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.

internal/role/openidm-tasks-manager

Role for users who can be assigned to workflow tasks.

internal/role/openidm-prometheus

Role for users who can view the prometheus metrics endpoint. For more information about this service, see "Prometheus Endpoint".

Managed and internal roles can both be used for authentication, but there are a few differences:

- Internal roles are not meant to be provisioned or synced with external systems.
- Assignments don't work with internal roles.
- Event scripts (such as `onCreate`) can't be attached to internal roles.
- The internal role schema is not configurable.

When a user authenticates, IDM calculates that user's roles as follows:

- If the authentication module with which the user authenticates includes a `defaultUserRoles` property, IDM assigns those roles to the user on authentication. The `defaultUserRoles` property is specified as an array.
- The `userRoles` property is a mapping that specifies the attribute or list of attributes in the user entry that contains that specific user's authorization roles. For example, the following excerpt indicates that the `userRoles` should be taken from the user's `authzRoles` property on authentication:

  ```
  "userRoles" : "authzRoles"
  ```

  Any internal roles that are conditionally applied are also calculated and included in the user's `authzRoles` property at this point.
- If the authentication module includes a `groupRoleMapping`, `groupMembership`, or `groupComparison` property, IDM can assign additional roles to the user, depending on the user's group membership on an external system. For more information, see "Building Role-Based Access Control".

Note

You can set IDM to dynamically recalculate role assignments without requiring reauthentication by enabling `enableDynamicRoles` in the `JWT_SESSION` session module in `authentication.json`. For more information, see "Dynamic Role Calculation".

The roles calculated in sequence are cumulative.

For users who have authenticated with mutual SSL authentication, the module is `CLIENT_CERT` and the default roles for such users are `openidm-cert` and `openidm-authorized`. These roles are configured in the `defaultUserRoles` property in the `CLIENT_CERT` auth module:

```
{
    "name" : "CLIENT_CERT",
    "properties" : {
        "augmentSecurityContext" : {
            "type" : "text/javascript",
            "globals" : { },
            "file" : "auth/mapUserFromClientCert.js"
        },
        "queryOnResource" : "managed/user",
        "defaultUserRoles" : [
            "internal/role/openidm-cert",
            "internal/role/openidm-authorized"
        ],
        "allowedAuthenticationIdPatterns" : [".*" ],
    }
    "enabled" : true
},
```

Access control for such users is configured in the `access.js` file. For more information, see "Authorization".

20.2.1. Dynamic Role Calculation

It is possible to have IDM dynamically recalculate role membership for users with each request, instead of only when a user reauthenticates. To enable this feature, set `enableDynamicRoles` to `true` in the `JWT_SESSION` session module in `authentication.json`:

```
"enableDynamicRoles" : true,
```

This can also be enabled through the Admin UI, by navigating to Configure > Authentication > Session, then selecting Enable Dynamic Roles.

If you enable dynamic role calculation, note that any `defaultUserRoles` or `groupRoleMapping` properties set in other authentication modules will also need to be set in the `JWT_SESSION` module. Otherwise, these roles will not be included when IDM recalculates the user's roles.

For example, if you added a new internal role called `newRole` and made it a default user role for `STATIC_USER`, you would also add this as a default user role in the `JWT_SESSION` session module. This can be seen in the example below:

```
{
    "sessionModule" : {
        "name" : "JWT_SESSION",
        "properties" : {
            "maxTokenLifeMinutes" : 120,
            "tokenIdleTimeMinutes" : 30,
            "sessionOnly" : true,
            "isHttpOnly" : true,
            "enableDynamicRoles" : true,
            "defaultUserRoles" : [
                "internal/role/newRole"
            ]
        }
    },
    "authModules" : [
        {
            "name" : "STATIC_USER",
            "properties" : {
                "queryOnResource" : "internal/user",
                "username" : "anonymous",
                "password" : "anonymous",
                "defaultUserRoles" : [
                    "internal/role/openidm-reg",
                    "internal/role/newRole"
                ]
            },
            "enabled" : true
        },
    ...
    ]
}
```

Note

Dynamic role calculation can be used independently of privileges, but is required for privileges to work. For more information about privileges, see "Privileges and Delegation".

20.3. Authorization

IDM provides role-based authorization that restricts direct HTTP access to REST interface URLs. The default authorization configuration grants access rights to users, based on the following *internal* roles:

`openidm-admin`
`openidm-authorized`
`openidm-cert`
`openidm-prometheus`
`openidm-reg`
`openidm-tasks-manager`

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 roles are referenced in a user's `authzRoles` property, and are implemented using the relationships mechanism, described in "*Managing Relationships Between Objects*".

By default, all managed users have the `openidm-authorized` role. The following request shows the authorization roles for a user with ID `42f8a60e-2019-4110-a10d-7231c3578e2b`:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/managed/user/42f8a60e-2019-4110-a10d-7231c3578e2b?_fields=authzRoles"
{
  "_id": "42f8a60e-2019-4110-a10d-7231c3578e2b",
  "_rev": "000000004cab60c8",
  "authzRoles": [
    {
      "_ref": "internal/role/openidm-authorized",
      "_refProperties": {
        "_id": "8e7b2c97-dfa8-4eec-a95b-b40b710d443d",
        "_rev": "0000000040b78633"
      }
    }
  ]
}
```

The authorization implementation is configured in two script files:

- `openidm/bin/defaults/script/router-authz.js`
- *`project-dir`*`/script/access.js`

IDM calls the `router-authz.js` script for each request, through an `onRequest` hook that is defined in the `router.json` file. `router-authz.js` calls your project's access configuration script (`access.js`) to determine the allowed HTTP requests. If access is denied, according to the configuration defined in `access.js`, the `router-authz.js` script throws an exception, and IDM denies the request.

`router.json` also defines an `onResponse` script, `relationshipFilter`. This provides additional filtering to ensure the user has the appropriate access to see the data of the related object. This behavior can be modified by extending or updating `/bin/defaults/script/relationshipFilter.js`, or by removing the onResponse script if you don't want additional filtering on relationships. (For more information about relationships, see "*Managing Relationships Between Objects*".)

20.3.1. Understanding the Router Authorization Script (`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 indicated in the comments in the file.

20.3.2. Understanding the Access Configuration Script (`access.js`)

This file defines the access configuration for HTTP requests and references the methods defined in `router-authz.js`. Each entry, or rule, 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.

Each rule in `access.js` is tested in the order in which it appears in the file. It is possible to have more than one rule defined for the same pattern. If one rule passes, the request is allowed. If all the rules fail, the request is denied.

The following rule (from a default `access.js` file) shows some of the configurable parameters. Note that the `actions` shown in the default `access.js` file do not list all possible actions available on each endpoint:

```
{
    "pattern"   : "system/*",
    "roles"     : "internal/role/openidm-admin",
    "methods"   : "action",
    "actions"   : "test,testConfig,createconfiguration,liveSync,authenticate"
},
```

This rule affects users with the `openidm-admin` role and indicates that these users can perform the listed actions on all `system` endpoints.

The configurable parameters in each access rule 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 comma-separated list of the roles to which this access configuration applies.

The `roles` referenced here align with the details that are read from an object's security context (`security.authorization.roles`). The `authzRoles` relationship property of a managed user produces this security context value during authentication.

`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 resource (URL) that is being exposed. For a list of possible actions allowed on each resource, see Supported Actions Per Resource.

A value of `"*"` indicates that all actions exposed for that resource 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. Custom functions are defined in `router-authz.js`.

`excludePatterns`

An optional parameter that enables you to specify particular endpoints to which access should not be granted.

20.3.3. Granting Internal Authorization Roles

Internal authorization roles can be granted to users through the Admin UI or over the REST interface, in much the same way as managed roles are granted. For more information about granting managed roles, see "Granting a Role to a User". To manually grant an internal role to a user through the Admin UI:

1. Select Manage > User and click the user to whom you want to grant the role.
2. Select the Authorization Roles tab and click Add Authorization Roles.
3. Select Internal Role as the Type, click in the Authorization Roles field to select from the list of defined Internal Roles, then click Add.

To manually grant an internal role over REST, add a reference to the internal role to the user's `authzRoles` property. The following command adds the `openidm-admin` role to user bjensen (with ID `9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb`):

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PATCH \
 --data '[
    {
       "operation": "add",
       "field": "/authzRoles/-",
       "value": {"_ref" : "internal/role/openidm-admin"}
    }
 ]' \
 "http://localhost:8080/openidm/managed/user/9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb"
{
  "_id": "9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb",
  "_rev": "0000000050c62938",
  "mail": "bjensen@example.com",
  "givenName": "Barbara",
  "sn": "Jensen",
  "description": "Created By XML1",
  "userName": "bjensen@example.com",
  "telephoneNumber": "1234567",
  "accountStatus": "active",
  "effectiveRoles": [],
  "effectiveAssignments": []
}
```

You can also dynamically assign internal roles, in a similar manner to managed roles. For more information about dynamically assigning roles using conditions, see "Granting Roles Based on a Condition".

Note

Because internal roles are not managed objects, you cannot manipulate them in the same way as managed roles. Therefore you cannot add a user to an internal role, as you would to a managed role.

To add users directly to an internal role, you can add users to the `authzMembers` property. This can be accomplished in the REST API using the create action on the `authzMembers` endpoint for a role. For example:

```
curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{"_ref":"managed/user/bjensen"}' \
"http://localhost:8080/openidm/internal/role/3042798d-37fd-49aa-bae3-52598d2c8dc4/authzMembers?
_action=create"
```

20.3.4. 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`.

20.3.5. Managing User Access to Workflows

The End User 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 End User UI is provided in `openidm/samples/provisioning-with-workflow`, and documented in "*Using a Workflow to Provision User Accounts*" in the *Samples Guide*. Follow the steps in that sample for an understanding of how the workflow integration works.

General access to workflow-related endpoints is based on the access rules defined in the `script/access.js` file. The configuration defined in the `conf/process-access.json` file determines who can invoke workflows. 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" : "internal/role/openidm-authorized"
            }
        },
        {
            "propertiesCheck" : {
                "property" : "_id",
                "matches" : ".*",
                "requiresRole" : "internal/role/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 authorization 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 authorization roles. For example, if you want to allow access to users with a role of `ldap`, add the following code block to the `process-access.json` file:

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

20.3.5.1. Adding Another Role to a Workflow

Sometimes, you'll want to configure multiple roles with access to the same workflow process. For example, if you want users with a role of doctor and nurse to both have access to certain workflows, you could set up the following code block within the `process-access.json` file:

```
{
     "propertiesCheck" : {
          "property" : "_id",
          "matches" : ".*",
          "requiresRole" : "doctor"
     }
},
{
     "propertiesCheck" : {
          "property" : "_id",
          "matches" : ".*",
          "requiresRole" : "nurse"
     }
}
```

You could add more `requiresRole` code blocks, such as:

```
{
     "propertiesCheck" : {
          "property" : "_id",
          "matches" : ".*",
          "requiresRole" : "medic"
     }
}
```

20.4. Privileges and Delegation

Privileges provide a way to give roles access to specific endpoints and objects, without needing to grant full administrative access. For example, you may wish to allow a help desk or support role to update the information of another user, but may not wish to allow deleting accounts or changing IDM system configuration.

Privileges can be used to delegate some administrative capabilities to non-administrative users, without exposing the Admin UI to those users. For example, if a user has been granted a privilege allowing them to see a list of users and user information, they can access this list directly through the End User UI.

Privileges require dynamic role calculation to work. This is disabled by default in new IDM installations, but can be enabled by setting the `enableDynamicRoles` property in `authentication.json` to `true`:

```
"enableDynamicRoles" : true,
```

This can also be enabled through the Admin UI, by navigating to Configure > Authentication > Session, then selecting Enable Dynamic Roles. For more information about dynamic role calculation, see "Dynamic Role Calculation".

20.4.1. Determining Access Privileges

IDM determines what access a user has in the following order:

- IDM checks the `onRequest` script specified in `router.json`. By default, this calls `router-authz.js` and `access.js`.
- If access requirements still haven't been satisfied, IDM then checks for any privileges associated with the user's roles.

`onResponse` and `onFailure` scripts are supported when using privileges, though `onFailure` scripts will only be called if both the `onRequest` scripts *and* the privilege filter fail. `onRequest`, `onResponse`, and `onFailure` scripts are not required for privileges to work.

20.4.2. Creating Privileges

Privileges are assigned to internal roles. Each privilege specifies the service path you wish to make available, the methods and actions you wish to allow on that path, and specific access to each attribute of the objects found at that path. Privileges can also be filtered to only apply to a subset of managed objects, using a query filter within the privilege.

The easiest way to create and apply privileges is through the admin UI. Open the admin UI and select Manage > Roles, then select Internal. Select any existing role (or create a new internal role), then select Privileges. From here, you can create and apply privileges to the selected role.

Privileges can also be created and applied through the REST API for internal roles. As an example, if you wanted to create a new support role, and wished to give members of this role the ability to view, create, and update information about other users (but not allow them to delete), you might create a privilege like this:

```
$ curl \
 --header "X-OpenIDM-UserName: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PUT \
 --data '{
    "name": "support",
    "description": "Support Role",
    "privileges": [ {
        "name": "support",
        "description": "Support access to user information.",
```

```
        "path": "managed/user",
        "permissions": [
            "VIEW", "UPDATE", "CREATE"
        ],
        "actions": [],
        "filter": null,
        "accessFlags": [
            {
                "attribute" : "userName",
                "readOnly" : false
            },
            {
                "attribute" : "mail",
                "readOnly" : false
            },
            {
                "attribute" : "givenName",
                "readOnly" : false
            },
            {
                "attribute" : "sn",
                "readOnly" : false
            },
            {
                "attribute" : "accountStatus",
                "readOnly" : true
            }
        ]
    } ]
}' \
"http://localhost:8080/openidm/internal/role/support"
{
  "_id": "support",
  "_rev": "00000000bfbac2ed",
  "name": "support",
  "description": "Support Role",
  "temporalConstraints": null,
  "condition": null,
  "privileges": [
    {
      "name": "support",
      "description": "Support access to user information.",
      "path": "managed/user",
      "permissions": [
        "VIEW",
        "UPDATE",
        "CREATE"
      ],
      "actions": [],
      "filter": null,
      "accessFlags": [
        {
          "attribute": "userName",
          "readOnly": false
        },
        {
          "attribute": "mail",
          "readOnly": false
        },
```

```
        {
          "attribute": "givenName",
          "readOnly": false
        },
        {
          "attribute": "sn",
          "readOnly": false
        },
        {
          "attribute": "accountStatus",
          "readOnly": true
        }
      ]
    }
  ]
}
```

Note

If you are creating an internal authorization role that allows users to access the Admin UI, you must *also* add the new role to the `roles` list in the `/path/to/openidm/conf/ui-configuration.json` file. For example:

```
"roles" : {
    "internal/role/openidm-authorized" : "ui-user",
    "internal/role/openidm-admin" : "ui-admin",
    "internal/role/support" : "ui-admin"
},
```

If you do not add the role here, users attempting to log into the Admin UI will see the following error:

```
You are logged in but do not have access to this page.
```

The privileges property is an array, and can contain multiple privileges. Each privilege can contain:

accessFlags

A list of attributes within a managed object that you wish to give access to. Each attribute has two fields:

- `attribute` - the name of the property you are granting access to.
- `readOnly` (boolean) - determines what level of access is allowed.

Attributes marked as `"readOnly": true` can be viewed but not edited. If `readOnly` is false, the contents of the attribute can be both viewed and edited. Any attribute not listed in accessFlags will not be viewable or editable.

Note

Privileges are not automatically aware of changes to the schema of a managed object. This means if new properties are added, removed, or made required, you must update any existing privileges to account for these changes.

IDM includes policy-based validation when creating or updating a privilege, to ensure that all required properties are writable when the `CREATE` permission is assigned. This validation does not run when schema changes are made, however, so administrators will need to remember to check any existing privileges.

Note

Attributes that are relationships to another object (such as the roles property in `managed/user`) are unavailable through privileges.

actions

A list of the specific actions allowed if the `ACTION` permission has been specified. Allowed actions must be explicitly listed.

description (optional)

A description of the privilege.

filter (optional)

This property allows you to apply a query filter to the privilege, which can be used to limit the scope of what the privilege allows the user to access. For example, if you wished to only allow a delegated administrator to access information about users in California, you might include a filter of:

```
filter : "stateProvince eq \"California\""
```

When using query filters, you will be unable to edit the properties used by that filter in ways that would cause the privilege to lose access to the object you are updating. For example, if your privilege used the filter above, and a user with that privilege attempted to edit a user's `stateProvince` field to Oregon, the request would return a `403 Forbidden` error.

Note

Fields need to be searchable by IDM in order to be used in a privilege filter. Please ensure the field you are filtering on has `"searchable" : true` set in `repo.jdbc.json`. (DS and PostgreSQL do not need this set.)

Note

Note that privilege filters are another layer of filter *in addition to* any other query filters you create. This means any output will have to satisfy both filters to be included.

name

The name of the privilege being created.

path

The path to the service you want to allow members of this privilege to access. For example, `managed/user`.

permissions

A list of permissions this privilege allows for the given path. The following permissions are available:

- `VIEW` - allows reading and querying the path, such as viewing and querying managed users.
- `CREATE` - allows creation at the path, such as creating new managed users.
- `UPDATE` - allows updating or patching existing information, such as editing managed user details.
- `DELETE` - allows deletion, such as deleting users from `managed/user`.
- `ACTION` - allows users to perform actions at the given path, such as custom scripted actions.

For more information about creating and managing privileges, see "Managing Privileges Over REST".

20.4.2.1. Policies Related to Privileges

When creating privileges, policies found in `policy.json` and `policy.js` are run. This includes four policies that are used for validating privileges:

`valid-accessFlags-object`

Verifies that `accessFlag` objects are correctly formatted. Only two fields are permitted in an `accessFlag` object: `readOnly`, which must be a boolean; and `attribute`, which must be a string.

valid-array-items

Verifies that each item in an array contains the properties specified in `policy.json`, and that each of those properties satisfies any specific policies applied to it. By default, this is used to verify each privilege contains `name`, `path`, `accessFlags`, `actions`, and `permissions` properties, and that the `filter` property is valid if included.

`valid-permissions`

Verifies the permissions set on the privilege are all valid and can be achieved with the `accessFlags` that have been set. It checks:

- `CREATE` permissions must have write access to all properties required to create a new object.
- `CREATE` and `UPDATE` permissions must have write access to at least one property.
- `ACTION` permissions must include a list of allowed actions, with at least one action included.
- If any attributes have write access, then the privilege must also have either `CREATE` or `UPDATE` permission.
- All permissions listed must be valid types of permission: `VIEW`, `CREATE`, `UPDATE`, `ACTION`, or `DELETE`. Also, no permissions are repeated.

`valid-privilege-path`

Verifies the `path` specified in the privilege is a valid object with a schema for IDM to reference. Only objects with a schema (such as `managed/user`) can have privileges applied.

More information about policies and creating custom policies can be found in "*Using Policies to Validate Data*".

20.4.3. Getting Privileges on a Resource

To determine which privileges a user has on a service, you can query the privilege endpoint for a given resource path or object, based on the user you are currently logged in as. For example, if bjensen is a member of the support role mentioned in the previous example, checking their privileges for the `managed/user` resource would look like this:

```
$ curl \
 --header "X-OpenIDM-UserName: bjensen" \
 --header "X-OpenIDM-Password: Passw0rd" \
 --request GET \
 "http://localhost:8080/openidm/privilege/managed/user"
{
  "VIEW": {
    "allowed": true,
    "properties": [
      "userName",
      "givenName",
      "sn",
      "mail",
      "accountStatus"
    ]
  },
  "CREATE": {
    "allowed": true,
    "properties": [
      "userName",
      "givenName",
      "sn",
      "mail"
    ]
  },
  "UPDATE": {
    "allowed": true,
    "properties": [
      "userName",
      "givenName",
      "sn",
      "mail"
    ]
  },
  "DELETE": {
    "allowed": false
  },
  "ACTION": {
    "allowed": false,
    "actions": []
  }
```

```
}
```

In the above example, `accountStatus` is listed as a property for `VIEW`, but not for `CREATE` or `UPDATE`, because the privilege sets this property to be read only. Since both `CREATE` and `UPDATE` need the ability to write to a property, setting `readOnly` to false applies to both permissions. If you need more granular control, split these permissions into two privileges.

In addition to checking privileges for a resource, it is also possible to check privileges for specific objects within a resource, such as `managed/user/scarter`.

20.4.4. Using Privileges with the UI

Privileges are a part of internal roles, which can be assigned to users. They can be created and managed by using IDM's admin UI, by selecting Manage > Roles > Internal, then either creating a new internal role, or editing an existing role.

The privilege creation UI allows you to specify the privilege name, which managed object you are granting privileges to, which permissions you are allowing, the permissions you are granting for each attribute of the object, and any query filter you are applying to the privilege. These correlate to the `name`, `path`, `permissions`, `accessFlags`, and `filter` properites of the privilege object, respectively.

20.5. Building Role-Based Access Control

Role-Based Access Control (RBAC) governs access to *external systems*, based on one or more *provisioning roles*. Provisioning roles can be granted to users in a number of ways. Provisioning roles are cumulative, and are calculated for a user object in the following order:

1. Roles set specifically in the user's `userRoles` property
2. Group roles—based on group membership in the external system

   Group roles are controlled with the following properties in the authentication configuration:

   - `groupMembership`—the property on the external system that represents group membership. On a DS directory server, that property is `ldapGroups` by default. On an Active Directory server, the property is `memberOf` by default. For example:

     ```
     "groupMembership" : "ldapGroups"
     ```

     Note that the value of the `groupMembership` property must be the ICF property name defined in the provisioner file, rather than the property name on the external system.

   - `groupRoleMapping`—a mapping between an IDM role and a group on the external system. Setting this property ensures that if a user authenticates through pass-through authentication, they are given specific IDM roles depending on their membership of groups on the external system. In the following example, users who are members of the group `cn=admins,ou=Groups,dc=example,dc=com` are given the internal `openidm-admin` role when they authenticate:

```
"groupRoleMapping" : {
    "internal/role/openidm-admin" : ["cn=admins,ou=Groups,dc=example,dc=com"]
},
```

- `groupComparisonMethod`—the method used to check whether the authenticated user's group membership matches one of the groups mapped to an IDM role (in the `groupRoleMapping` property).

  The `groupComparisonMethod` can be one of the following:

  - `equals`—a case-sensitive equality check
  - `caseInsensitive`—a case-insensitive equality check
  - `ldap`—a case-insensitive and whitespace-insensitive equality check. Because LDAP directories do not take case or whitespace into account in group DNs, you must set the `groupComparisonMethod` if you are using passthrough authentication with an LDAP directory.

20.5.1. Roles, Authentication, and the Security Context

The Security Context (`context.security`), consists of a principal (defined by the `authenticationId` property) and an access control element (defined by the `authorization` property).

If authentication is successful, the authentication framework sets the principal. IDM stores that principal as the `authenticationId`. For more information, see the authentication components defined in "Supported Authentication Modules".

The `authorization` property includes an `id`, an array of `roles` (see "Roles and Authentication"), and a `component`, that specifies the resource against which authorization is validated. For more information, see "Configuring Pass-Through Authentication".

Chapter 21

Securing and Hardening Servers

This chapter outlines the specific security procedures that you should follow before deploying IDM in a production environment.

Note

In a production environment, avoid the use of communication over insecure HTTP, self-signed certificates, and certificates associated with insecure ciphers.

21.1. Accessing IDM Keys and Certificates

IDM stores keystore and truststore files in the `/path/to/openidm/security` directory. These can be managed using the **keytool** command, which is included in your Java installation. For information about using the **keytool** command, see https://docs.oracle.com/javase/8/docs/technotes/tools/unix/keytool.html.

You can rotate encryption keys, as defined in "Rotating Encryption Keys". Rotation means that the active encryption key may not be the correct key to use for decryption. If you've used IDM in the past, you may have some data such as passwords saved through non-active encryption keys. For more information, see "Encryption and JSON Blob Code Blocks".

21.1.1. Encryption and JSON Blob Code Blocks

You can find JSON blobs with encryption keys especially for passwords. The content of these JSON blobs has changed. For example, you might see the following JSON blob for the password when configuring an email server, as described in "*Configuring Outbound Email*". This is an excerpt from the IDM 6 version of the `external.email.json` file, where the encryption key is defined as `openidm-sym-default`.

```
"password" : {
        "$crypto" : {
            "type" : "x-simple-encryption",
            "value" : {
                "cipher" : "AES/CBC/PKCS5Padding",
                "salt" : "acWiPvgU+Cqoeg4wJzBI/g==",
                "data" : "N5vumgu5wiFe5ibIZg20vQ==",
                "iv" : "OezNmWBvmjZzREX1v6AZkQ==",
                "key" : "openidm-sym-default",
                "mac" : "KgJ3otfc29svYLykxRMrUg=="
            }
        }
    }
```

The JSON blob format has changed, starting with IDM 6.5. The corresponding excerpt is different:

```
"password" : {
        "$crypto" : {
            "type" : "x-simple-encryption",
            "value" : {
                "cipher" : "AES/CBC/PKCS5Padding",
                "stableId" : "openidm-sym-default",
                "salt" : "cQT6VZXz9G91RV87dbLM+A==",
                "data" : "YTpjLiT1igQ1ATrHIKcsiQ==",
                "keySize" : 16,
                "purpose" : "idm.config.encryption",
                "iv" : "CaorpaRq6v410nPFRjmIXw==",
                "mac" : "Q+GQGOQllGy4DPq8Ti88MQ=="
            }
        }
    }
```

Note the differences:

- The alias was labeled with `key`; it's now labeled with `stableId`, to distinguish it from a potential key rotation.
- The new JSON blob includes a `keySize`, which specifies the number of bits in the encryption key.
- The new JSON blob includes a `purpose`, which you can cross-reference in `secrets.json` for aliases and whether the aliases are used for encryption or signatures.

Many of you may have updated from an earlier version of IDM, with passwords configured like the first JSON blob. To decrypt such blobs, IDM includes an `idm.default` `secretId` for decryption.

If you're using configurations and passwords from older versions of IDM, review the relevant JSON blobs. Find the `key` associated with such blobs. If the `key` is other than `openidm-sym-default`, include that key in the `idm.default` list of `aliases` in your `secrets.json` file.

Warning

Retain legacy encryption keys until all relevant encrypted information, including passwords, have been converted to the newer dot-delimited keys.

21.1.1.1. Encrypting and Decrypting Information

Use the `openidm.encrypt` and `openidm.decrypt` functions with the `eval` action on the `script` endpoint to encrypt and decrypt values.

The following example encrypts a password value:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request POST
 \
--data '{
  "type": "text/javascript",
  "globals": {
    "val": {
      "myKey": "myPassword"
    }
  },
  "source":"openidm.encrypt(val,null,\"idm.password.encryption\");"
}' \
"http://localhost:8080/openidm/script?_action=eval"
{
  "$crypto": {
    "type": "x-simple-encryption",
    "value": {
      "cipher": "AES/CBC/PKCS5Padding",
      "stableId": "openidm-sym-default",
      "salt": "Rx93hbONw6axgSgV8bQLYA==",
      "data": "HDHSZATc9rleZSReOIi0Vyrk7VTjfDj6xVIFnT4SX9Y=",
      "keySize": 16,
      "purpose": "idm.password.encryption",
      "iv": "gqtILRen8XWgUnrrGxRHTw==",
      "mac": "8pkfkZsqk1Peruq3SCHo5Q=="
    }
  }
}
```

For more information, see "openidm.encrypt(value, cipher, alias)".

Use the `openidm.decrypt` function to decrypt the encrypted password:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request POST
 \
--data '{
 "type": "text/javascript",
 "globals": {
  "val": {
   "$crypto": {
    "type": "x-simple-encryption",
    "value": {
     "cipher": "AES/CBC/PKCS5Padding",
     "stableId": "openidm-sym-default",
     "salt": "Rx93hbONw6axgSgV8bQLYA==",
     "data": "HDHSZATc9rleZSReOIi0Vyrk7VTjfDj6xVIFnT4SX9Y=",
     "keySize": 16,
     "purpose": "idm.password.encryption",
     "iv": "gqtILRen8XWgUnrrGxRHTw==",
     "mac": "8pkfkZsqk1Peruq3SCHo5Q=="
    }
   }
  }
 },
 "source": "openidm.decrypt(val);"
}' \
"http://localhost:8080/openidm/script?_action=eval"
{
  "myKey": "myPassword"
}
```

For more information, see "openidm.decrypt(value)".

21.1.2. Configuring the Keystore and Truststore

The IDM keystore and truststore are configured in your `conf/secrets.json` file for your project. By default, that file includes a `mainKeyStore` and a `mainTrustStore`. These secrets stores are associated with the following files in the `/path/to/openidm/security` directory:

- `keystore.jceks` represents the `mainKeyStore` as a Java Cryptography Extension Keystore (JCEKS).
- `truststore` represents the `mainTrustStore`

Before IDM can start, it requires both a keystore and a truststore which are mapped to the following properties:

- `mainKeyStore`
- `mainTrustStore`

Do not change these names, as they are provided to third-party products that require a single keystore and a single truststore.

If you want to configure IDM for an HSM provider, see "Configuring IDM to Support an HSM Provider".

Note

Encryption also affects passwords in the `managed.json` file for your project. For IDM 6, this was configured with the `openidm-sym-default` key. For IDM 6.5, this is configured in `secrets.json` with the `idm.password.encryption purpose` as part of the `mainKeyStore`.

21.1.2.1. Reserved Keystore and Truststore Properties

IDM includes several *reserved* properties related to keystores and truststores. In other words, the following properties have specific purposes as defined in the following table:

IDM Keystore and Truststore Properties

Property	Description
`openidm.keystore.location`	File with the IDM keystore; default is `/path/to/openidm/keystore.jceks`
`openidm.keystore.password`	Password for the IDM keystore
`openidm.keystore.type`	Type of keystore; default is JCEKS
`openidm.keystore.provider`	Keystore provider; default is SunJCE
`openidm.truststore.location`	File with the IDM truststore; default is `/path/to/openidm/truststore`
`openidm.truststore.password`	Password for the IDM truststore
`openidm.truststore.type`	Type of keystore; default is JKS
`openidm.truststore.provider`	Truststore provider; default is SUN

By default, you can find these properties in the `secrets.json` file, in the `mainKeyStore` and `mainTrustStore` sections. You can also find these properties in the IDM 6 version of `boot.properties`. If you've updated from IDM 6 (or earlier), you should move these properties from `boot.properties`, as IDM may override these values as defined in "Using Property Value Substitution".

Once configured, you can also use these *reserved* properties to supply keystore and truststore information to third-party products.

21.1.2.2. Configuration Options in `secrets.json`

When configuring `mainKeyStore` and `mainTrustStore` options in the `secrets.json`, consider the options described in the following table:

Alias and `secretId` Values in `secrets.json`

secretId	alias	Description	IDM 6 use in boot.properties
idm.default	openidm-sym-default	Encryption keystore for older JSON blobs	openidm.config.crypto.alias
idm.config.encryption	openidm-sym-default	Encrypts configuration information	openidm.config.crypto.alias
idm.password.encryption	openidm-sym-default	Encrypts managed user passwords	openidm.config.crypto.alias
idm.jwt.session.module.encryption	openidm-localhost	Encrypts JWT session tokens	openidm.https.keystore.cert.alias
idm.jwt.session.module.signing	openidm-jwtsessionhmac-key	Signs JWT session tokens using HMAC	openidm.config.crypto.jwtsession.hmackey.alias
idm.selfservice.signing	selfservice	Signs JWT session tokens using RSA	n/a
idm.selfservice.encryption	openidm-selfservice-key	Encrypts JWT tokens	openidm.config.crypto.selfservice.sharedkey.alias

Note

For IDM 6, key aliases may be specified in the `boot.properties` file, in the `/path/to/openidm/resolver/` directory. These same aliases will work in IDM 6, but may not work in later versions.

While key aliases specified in `boot.properties` may be consumed by the `secrets.json` file for your project, these properties will not be used in other parts of IDM.

The key aliases specified in `secrets.json` are considered in order; for example, for the following `idm.config.encryption` secretId, the active key is `openidm.config.crypto.alias`:

```
{
  "secretId" : "idm.config.encryption",
  "types": [ "ENCRYPT", "DECRYPT" ],
  "aliases": [ "&{openidm.config.crypto.alias|openidm-sym-default}" ]
},
```

21.1.3. Displaying the Contents of the Keystore

IDM generates a number of encryption keys in a JCEKS keystore the first time the server starts up. Note that the keystore, and the keys, are generated at startup and are not prepackaged. The keys are generated *only* if they do not already exist.

To use a different keystore type, such as PKCS12, create the keystore and generate the keys before you start IDM. This will prevent IDM from generating the keys on startup. You can also convert the existing JCEKS keystore to a PKCS12 keystore. Note that if you use a different keystore type, you must edit the `openidm.keystore.type` property in the `openidm/resolver/boot.properties` file to match the new type.

Use the **keytool** command to obtain a list of the default encryption keys, as follows:

```
$ keytool \
-list
 \
-keystore /path/to/openidm/security/keystore.jceks
 \
-storepass changeit
 \
-storetype JCEKS
openidm-sym-default, Nov 5, 2018, SecretKeyEntry,
openidm-jwtsessionhmac-key, Nov 5, 2018, SecretKeyEntry,
selfservice, Nov 5, 2018, PrivateKeyEntry,
Certificate fingerprint (SHA-256):
 77:03:A9:A8:5B:39:5E:80:77:83:D4:0A:69:E2:3C:C4:C8:BA:6C:F7:9D:77:15:C7:C1:B0:AD:93:39:E9:A7:63
openidm-selfservice-key, Nov 5, 2018, SecretKeyEntry,
openidm-localhost, Nov 5, 2018, PrivateKeyEntry,
Certificate fingerprint (SHA-256):
 C8:99:CC:5A:25:B6:44:31:3C:5D:76:96:13:D2:D6:32:BC:30:5A:C3:5B:D1:20:D8:60:9D:FD:9B:6F:63:49:2E
server-cert, Nov 5, 2018, PrivateKeyEntry,
Certificate fingerprint (SHA-256):
 71:0C:09:A3:58:33:AE:F9:44:34:DD:6A:A6:72:91:36:11:DE:E1:1D:E1:22:C7:84:74:82:9D:B8:28:90:3D:D1
```

For more information on these aliases, see "Configuration Options in `secrets.json`".

Note

If you are using IDM in a cluster, you must share the keys among all nodes in the cluster. The easiest way to do this is to generate a keystore with the appropriate keys and share the keystore in some way, for example by using a filesystem that is shared between the nodes.

21.1.4. Importing a Signed Certificate into the Keystore

If you have an existing CA-signed certificate, you can import it into the IDM keystore using the **keytool** command.

The following process imports a CA-signed certificate, with the alias *example-com* into the keystore. Replace this with the alias of your certificate.

This procedure assumes that you have the following items, in .PEM format:

- A CA-signed certificate
- The private key associated with the Certificate Signing Request (CSR) that was used to request the signed certificate

- Optionally, any intermediary and root certificates from the Certificate Authority

  If there are multiple intermediary CA certificates, you can concatenate them with the root certificate into a single .PEM file.

1. Stop the server.

2. Back up your existing `openidm/security/keystore` and `openidm/security/truststore` files.

3. Generate a new PKCS12 keystore using the existing CA-signed certificate, private key and CA certificate chain:

```
$ openssl pkcs12 \
-export
 \
-in cert.pem
 \
-inkey key.pem
 \
-certfile chain.pem
 \
-name example-com
 \
-out cert.pkcs12
Enter Export Password: changeit
Verifying - Enter Export Password: changeit
```

Important

When you generate the new PKCS12 keystore file, you are prompted to set an export password. This password *must* be the same as the existing IDM keystore password. If you have not changed the default keystore password, it is `changeit`. In a production environment, you *should* change this password. For more information, see "To Change the Default Keystore Password".

4. Import the PKCS12 keystore that you generated in the previous step into the IDM keystore:

```
$ keytool \
-importkeystore
 \
-srckeystore cert.pkcs12
 \
-srcstoretype pkcs12
 \
-destkeystore /path/to/openidm/security/keystore.jceks
 \
-storetype jceks
Enter destination keystore password: changeit
Enter source keystore password: changeit
Entry for alias example-com successfully imported.
Import command completed:  1 entries successfully imported, 0 entries failed or cancelled
```

5. Import the certificate into the IDM truststore:

```
$ keytool \
-import
 \
-file cert.pem
 \
-keystore /path/to/openidm/security/truststore
 \
-alias example-com
Enter keystore password: changeit
Owner: EMAILADDRESS=admin@example.com, CN=example, OU=admin, O=www.example.com, ST=WA,
 C=US
...
Certificate fingerprints:
MD5:  C2:06:DE:B0:AD:C7:28:14:1D:B6:BE:4A:CC:A1:CA:A0
SHA1: F9:D7:6A:AE:47:99:61:0A:3C:90:4D:F0:73:DC:79:F4:30:B4:08:B1
SHA256:
 6C:1A:0F:AF:16:89:8B:EE:1E:AE:A9:19:56:29:D8:6D:C1:4D:82:58:C0:43:66:08:C4:C9:16:1D:BA:C5:D6:5D
Signature algorithm name: SHA1withRSA
Version: 3
...
Trust this certificate? [no]:  yes
Certificate was added to keystore
```

6. Edit your `secrets.json` file and configure the `idm.jwt.session.module.encryption` code block to the alias of the signed certificate, for example:

```
"idm.jwt.session.module.encryption": {
  "types": [ "ENCRYPT", "DECRYPT" ],
  "aliases": [ "example-com", "&{openidm.https.keystore.cert.alias|openidm-localhost}" ]
}
```

7. Restart the server for the new certificate to be taken into account.

Important

If you are using Oracle JDK 8 and you use 2048-bit SSL certificates, you *must* install the Unlimited JCE policy to enable IDM to use those certificates. For more information, see "Preparing the Java Environment" in the *Release Notes*.

21.1.5. Generating a Self-Signed Certificate

To generate a self-signed certificate, use the `genkeypair` action on the **keytool** command. The generated certificate is stored in the IDM keystore.

Specify the details of the certificate. For example:

```
$ keytool \
-genkeypair
 \
-keyalg RSA
 \
-sigalg SHA512withRSA
 \
-keysize 2048
 \
-dname "CN=www.example.com, O=Example, OU=None, L=None, ST=None, C=None"
 \
-startdate "2017/09/01 00:00:01"
 \
-validity 365
 \
-alias "new-alias"
 \
-keystore /path/to/openidm/security/keystore.jceks
 \
-storetype JCEKS
```

You will be prompted to give the keystore password, and (if desired) a separate password for the new certificate.

The following certificate details can be specified:

`keyalg` (optional)

The public key algorithm, for example, `RSA`.

`sigalg` (optional)

The signature type, for example, `SHA512WithRSA`.

`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.

`dname`

The distinguished name related to the certificate, for example `CN=www.example.com, O=Example, OU=None, L=None, ST=None, C=None`. If no distinguished name is specified, the user is prompted to enter the information before the certificate is generated.

`startdate` and `validity` (optional)

The validity period of the certificate, starting from a set date. For example `2017/09/01 00:00:01`. If no values are specified, the certificate is valid for one year from the current date.

`alias`

The keystore alias or string that identifies the certificate, for example `openidm-localhost`.

21.1.6. Deleting Certificates

If you have a CA-signed certificate, you might want to delete the default certificate from the keystore and the truststore. You can delete certificates from a keystore using the **keytool** command.

The following example deletes the `openidm-localhost` certificate from the keystore:

```
$ keytool \
-delete
 \
-alias openidm-localhost
 \
-keystore /path/to/openidm/security/keystore.jceks
 \
-storetype JCEKS
 \
-storepass changeit
```

The following example deletes the `openidm-localhost` certificate from the truststore:

```
$ keytool \
-delete
 \
-alias openidm-localhost
 \
-keystore /path/to/openidm/security/truststore
 \
-storepass changeit
```

You can use similar commands to delete custom certificates from the keystore and truststore, specifying the certificate alias in the request.

21.1.7. Updating Encryption Keys

You can update encryption keys in several ways, including:

- "Rotating Encryption Keys"
- "Using Scheduled Tasks to Rotate Keys"
- "Changing the Active Alias for Managed Object Encryption"

21.1.7.1. Rotating Encryption Keys

You can change the key that is used to encrypt managed password and configuration data in an existing deployment. By default, IDM uses `openidm-sym-default`.

IDM evaluates keys in `secrets.json` sequentially. For example, assume you've added a new key named `my-new-key` to the keystore, as described in "Importing a Signed Certificate into the Keystore".

To incorporate this key in the IDM rotation, for passwords, you'd include `my-new-key` as the *first alias* in the `idm.password.encryption` code block:

```
{
        "secretId" : "idm.password.encryption",
        "types": [ "ENCRYPT", "DECRYPT" ],
        "aliases": [ "my-new-key", "&{openidm.config.crypto.alias|openidm-sym-default}" ]
},
```

For passwords, this information is read in the `password` code block, as the `idm.password.encryption` *purpose*:

```
"password" : {
    "title" : "Password",
    "type" : "string",
    ...
    "encryption" : {
        "purpose" : "idm.password.encryption"
    },
```

The affected properties are re-encrypted with the new key the next time the managed object is *updated*, as any other JSON configuration file. You do not need to restart IDM.

Note

If you want to set up encryption for configuration, you'd apply the same `my-new-key` to the `idm.config.encryption` code block:

```
{
    "secretId" : "idm.config.encryption",
    "types": [ "ENCRYPT", "DECRYPT" ],
    "aliases": [ "my-new-key", "&{openidm.config.crypto.alias|openidm-sym-default}" ]
},
```

Important

With key rotation, you must keep all applicable keys in `secrets.json`, until every object that is encrypted with old keys have been updated with the newest key.

You can force the key rotation on all managed objects by running the `triggerSyncCheck` action on the entire managed object data set. The `triggerSyncCheck` action examines the crypto blob of each object and updates the encrypted property with the correct key. For example, the following command forces all managed user objects to use the new key:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "http://localhost:8080/openidm/managed/user/?_action=triggerSyncCheck"

{
    "status":"OK",
    "countTriggered":10
}
```

In a large managed object set, the `triggerSyncCheck` action can take a very long time to run on only a single node. You should therefore avoid using this action if your data set is large. An alternative to running `triggerSyncCheck` over the entire data set is to iterate over the managed data set and call `triggerSyncCheck` on each individual managed object. You can call this action manually or by using a script.

The following example shows the manual commands that must be run to launch the `triggerSyncCheck` action on all managed users. The first command uses a query filter to return all managed user IDs. The second command iterates over the returned IDs calling `triggerSyncCheck` on each ID:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 "http://localhost:8080/openidm/managed/user?_queryFilter=true&_fields=_id"

{
  "result": [
    {
      "_id": "9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb",
      "_rev": "000000004988917b"
    },
    {
      "_id": "55ef0a75-f261-47e9-a72b-f5c61c32d339",
      "_rev": "00000000dd89d671"
    },
    {
      "_id": "998a6181-d694-466a-a373-759a05840555",
      "_rev": "000000006fea54ad"
    },
 ...
```

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
"http://localhost:8080/openidm/managed/user/9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb?_action=triggerSyncCheck"
```

In large data sets, the most efficient way to achieve key rotation is to use the scheduler service to launch these commands. The following example uses the scheduler service for this purpose.

21.1.7.2. Using Scheduled Tasks to Rotate Keys

This example uses a script to generate multiple scheduled tasks. Each scheduled task iterates over a subset of the managed object set (defined by the `pageSize`). The generated scheduled task then calls another script that launches the `triggerSyncCheck` action on each managed object in that subset.

You can set up a similar schedule as follows:

1. Create a schedule configuration named `schedule-triggerSyncCheck.json` in your project's `conf` directory. That schedule should look as follows:

```
{
    "enabled" : true,
    "persisted" : true,
    "type" : "cron",
    "schedule" : "0 * * * * ? *",
    "concurrentExecution" : false,
    "invokeService" : "script",
    "invokeContext" : {
        "waitForCompletion" : false,
        "script": {
            "type": "text/javascript",
            "name": "sync/scheduleTriggerSyncCheck.js"
        },
        "input": {
            "pageSize": 2,
            "managedObjectPath" : "managed/user",
            "quartzSchedule" : "0 * * * * ? *"
        }
    }
}
```

You can change the following parameters of this schedule configuration to suit your deployment:

`pageSize`

The number of objects that each generated schedule will handle. This value should be high enough not to create too many schedules. The number of schedules that is generated is equal to the number of objects in the managed object store, divided by the page size.

For example, if there are 500 managed users and a page size of 100, five schedules will be generated (500/100).

`managedObjectPath`

The managed object set over which the scheduler iterates. For example, `managed/user` if you want to iterate over the managed user object set.

`quartzSchedule`

The schedule at which these tasks should run. For example, to run the task every minute, this value would be `` `0 * * * * ? *` ``.

2. The schedule calls a `scheduleTriggerSyncCheck.js` script, located in a directory named *`project-dir/script/sync`*. Create the `sync` directory, and add that script as follows:

```
var managedObjectPath = object.managedObjectPath;
var pageSize = object.pageSize;
var quartzSchedule = object.quartzSchedule;

var managedObjects = openidm.query(managedObjectPath, {
    "_queryFilter": "true",
    "_fields" : "_id"
});
```

```
var numberOfManagedObjects = managedObjects.result.length;

for (var i = 0; i < numberOfManagedObjects; i += pageSize) {
    var scheduleId = java.util.UUID.randomUUID().toString();
 var ids = managedObjects.result.slice(i, i + pageSize).map(function (obj) { return obj._id});
    var schedule = newSchedule(scheduleId, ids);
    openidm.create("/scheduler", scheduleId, schedule);
}

function newSchedule (scheduleId, ids) {
 var schedule = {
    "enabled" : true,
    "persisted" : true,
    "type" : "cron",
    "schedule" : quartzSchedule,
    "concurrentExecution" : false,
    "invokeService" : "script",
    "invokeContext" : {
        "waitForCompletion" : true,
        "script": {
            "type": "text/javascript",
            "name": "sync/triggerSyncCheck.js"
        },
        "input": {
            "ids" : ids,
            "managedObjectPath" : managedObjectPath,
            "scheduleId" : scheduleId
        }
    }
 };
 return schedule;
}
```

3. Each generated scheduled task calls a script named `triggerSyncCheck.js`. Create that script in your project's `script/sync` directory. The contents of the script are as follows:

```
var ids = object.ids;
var scheduleId = object.scheduleId;
var managedObjectPath = object.managedObjectPath;

for (var i = 0; i < ids.length; i++) {
    openidm.action(managedObjectPath + "/" + ids[i], "triggerSyncCheck", {}, {});
}

openidm.delete("scheduler/" + scheduleId, null);
```

4. When you have set up the schedule configuration and the two scripts, you can test this key rotation as follows:

   a. Edit your project's `conf/managed.json` file to return user passwords by default by setting `"scope" : "public"`.

```
"password" : {
    ...
    "encryption" : {
        "purpose" : "idm.password.encryption"
    },
    "scope" : "public",
....
```

Because passwords are not returned by default, you will not be able to see the new encryption on the password unless you change the property's `scope`.

b. Perform a GET request to return any managed user entry in your data set. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
"http://localhost:8080/openidm/managed/user/ccd92204-aee6-4159-879a-46eeb4362807"
         {
  "_id" : "ccd92204-aee6-4159-879a-46eeb4362807",
  "_rev" : "0000000009441230",
  "preferences" : {
    "updates" : false,
    "marketing" : false
  },
  "mail" : "bjensen@example.com",
  "sn" : "Jensen",
  "givenName" : "Babs",
  "userName" : "bjensen",
  "password" : {
    "$crypto" : {
      "type" : "x-simple-encryption",
      "value" : {
        "cipher" : "AES/CBC/PKCS5Padding",
        "stableId" : "openidm-sym-default",
        "salt" : "CVrKDuzfzunXfTDbCwU1Rw==",
        "data" : "1I5tWT5aRH/12hf5DgofXA==",
        "keySize" : 16,
        "purpose" : "idm.password.encryption",
        "iv" : "LGE+jnC3ZtyvrE5pfuSvtA==",
        "mac" : "BEXQ1mftxA63dXhJO6dDZQ=="
      }
    }
  },
  "accountStatus" : "active",
  "effectiveRoles" : [ ],
  "effectiveAssignments" : [ ]
}
```

Notice that the user's password is encrypted with the default encryption key (`openidm-sym-default`).

c. Create a new encryption key in the IDM keystore:

```
$ keytool \
 -genseckey \
 -alias my-new-key \
 -keyalg AES \
 -keysize 128 \
 -keystore /path/to/openidm/security/keystore.jceks \
 -storetype JCEKS
```

d. Shut down the server for keystore to be reloaded.

e. Change your project's `conf/managed.json` file to change the encryption purpose for managed user passwords:

```
"password" : {
    ...
    "encryption" : {
        "purpose" : "idm.password.encryption2"
    },
    "scope" : "public",
....
```

f. Add the corresponding `purpose` to the `secrets.json` file in the `mainKeyStore` code block:

```
"idm.password.encryption2": {
  "types": [ "ENCRYPT", "DECRYPT" ],
  "aliases": [
    {
      "alias": "my-new-key"
    }
  ]
},
```

g. Restart the server and wait one minute for the first scheduled task to fire.

h. Perform a GET request again to return the entry of the managed user that you returned previously:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
"http://localhost:8080/openidm/managed/user/ccd92204-aee6-4159-879a-46eeb4362807"
{
  "_id" : "ccd92204-aee6-4159-879a-46eeb4362807",
  "_rev" : "0000000009441230",
  "preferences" : {
    "updates" : false,
    "marketing" : false
  },
  "mail" : "bjensen@example.com",
  "sn" : "Jensen",
  "givenName" : "Babs",
  "userName" : "bjensen",
  "password" : {
    "$crypto" : {
      "type" : "x-simple-encryption",
```

```
      "value" : {
        "cipher" : "AES/CBC/PKCS5Padding",
        "stableId" : "my-new-key",
        "salt" : "CVrKDuzfzunXfTDbCwU1Rw==",
        "data" : "1I5tWT5aRH/12hf5DgofXA==",
        "keySize" : 16,
        "purpose" : "idm.password.encryption2",
        "iv" : "LGE+jnC3ZtyvrE5pfuSvtA==",
        "mac" : "BEXQ1mftxA63dXhJO6dDZQ=="
      }
    }
  },
  "accountStatus" : "active",
  "effectiveRoles" : [ ],
  "effectiveAssignments" : [ ]
}
```


Notice that the user password is now encrypted with `my-new-key`.

21.1.7.3. Changing the Active Alias for Managed Object Encryption

This example describes how you can configure and then change the managed object encryption key with a scheduled task. You'll create a new key, set up a managed user, add the key to `secrets.json`, restart IDM, run a `triggerSyncCheck`, and review the result.

1. Create a new key for the IDM keystore in the `security/keystore.jceks` file:

```
$ keytool -genseckey
 \
-alias my-new-key
 \
-keyalg AES
 \
-keysize 128
 \
-keystore /path/to/openidm/security/keystore.jceks
 \
-storetype JCEKS
```

2. Solely for the purpose of this exercise, in `managed.json`, set `"scope" : "public",` to expose the applied password encryption key.

3. Start IDM.

```
$ cd /path/to/openidm
```

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

4. Create a managed user:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PUT \
 --data '{
  "userName":"rsutter",
  "sn":"Sutter",
  "givenName":"Rick",
  "mail":"rick@example.com",
  "telephoneNumber":"6669876987",
  "description":"Another user",
  "country": "USA",
  "password":"Passw0rd"
 }' \
"http://localhost:8080/openidm/managed/user/ricksutter"
```

5. Add the newly created `my-new-key` alias to the `secrets.json` file for your project, in the `idm.password.encryption` code block:

```
"idm.password.encryption": {
  "types": [ "ENCRYPT", "DECRYPT" ],
  "aliases": [ "my-new-key", "&{openidm.config.crypto.alias|openidm-sym-default}" ]
},
```

6. To apply the new key to your configuration, shut down and restart IDM.

7. Force IDM to update the key for your users with the `triggerSyncCheck` action:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "http://localhost:8080/openidm/managed/user/?_action=triggerSyncCheck"
```

8. Now review the result for the newly created user, `ricksutter`:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET  \
 "http://localhost:8080/openidm/managed/user/ricksutter"
```

9. In the output, you should see the new `my-new-key` encryption key applied to that user's password:

```
...
 "password": {
   "$crypto": {
     "type": "x-simple-encryption",
     "value": {
       "cipher": "AES/CBC/PKCS5Padding",
       "stableId": "my-new-key",
       "salt": "bGyKG3PKmwHONOfxerr1Qg==",
       "data": "6vXZiJ3ZNN/UUnsrT7dTQw==",
       "keySize": 16,
       "purpose": "idm.password.encryption",
       "iv": "doAdtxfWfFbrPIIfubGi5g==",
       "mac": "OML6xd9qvDtD5AvMc1Tc3A=="
     }
   }
 },
...
```

21.2. Security Precautions for a Production Environment

Out of the box, IDM is set up for ease of development and deployment. When you deploy IDM 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.

21.2.1. Using SSL and HTTPS

Disable plain HTTP access, as described in "Restricting REST Access to the HTTPS Port".

Use TLS/SSL to access IDM, 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.

21.2.2. Enabling HTTP Strict-Transport-Security

HTTP Strict-Transport-Security (HSTS) is a web security policy that forces browsers to make secure HTTPS connections to specified web applications. HSTS can protect websites against passive eavesdropper and active man-in-the-middle attacks.

IDM provides an HSTS configuration but it is disabled by default. To enable HSTS, locate the following excerpt in your `conf/jetty.xml` file:

```
<New id="tlsHttpConfig" class="org.eclipse.jetty.server.HttpConfiguration">
    ...
    <Call name="addCustomizer">
        <Arg>
            <New class="org.eclipse.jetty.server.SecureRequestCustomizer">
                <!-- Enable SNI Host Check when true -->
                <Arg name="sniHostCheck" type="boolean">true</Arg>
                <!-- Enable Strict-Transport-Security header and define max-age when >= 0 seconds -->
                <Arg name="stsMaxAgeSeconds" type="long">-1</Arg>
                <!-- If enabled, add includeSubDomains to Strict-Transport-Security header when true -->
                <Arg name="stsIncludeSubdomains" type="boolean">false</Arg>
            </New>
        </Arg>
    </Call>
...
```

Set the following arguments:

`stsMaxAgeSeconds`

This parameter sets the length of time, in seconds, that the browser should remember that a site can only be accessed using HTTPS.

For example, the following setting applies the HSTS policy and remains in effect for five minutes:

```
<Arg name="stsMaxAgeSeconds" type="long">3600</Arg>
```

`stsMaxAgeSeconds`

If this parameter is `true>`, the HSTS policy is applied to the domain of the issuing host as well as its subdomains:

```
<Arg name="stsIncludeSubdomains" type="boolean">true</Arg>
```

For more information about HSTS, read this article.

21.2.3. Restricting the HTTP Payload Size

Restricting the size of HTTP payloads can protect the server against large payload HTTP DDoS attacks. IDM includes a servlet filter that limits the size of an incoming HTTP request payload, and returns a `413 Request Entity Too Large` response when the maximum payload size is exceeded.

By default, the maximum payload size is 5MB. You can configure the maximum size in your project's `conf/servletfilter-payload.json` file. That file has the following structure by default:

```
{
     "classPathURLs" : [ ],
     "systemProperties" : { },
     "requestAttributes" : { },
     "scriptExtensions" : { },
     "initParams" : {
         "maxRequestSizeInMegabytes" : 5
     },
     "urlPatterns" : [
         "/*"
     ],
     "filterClass" : "org.forgerock.openidm.jetty.LargePayloadServletFilter"
 }
```

Change the value of the `maxRequestSizeInMegabytes` property to set a different maximum HTTP payload size. The remaining properties in this file are described in "Registering Additional Servlet Filters".

21.2.4. Deploying Securely Behind a Load Balancer

By default, IDM listens for HTTP and HTTPS connections on ports 8080 and 8443, respectively. To change these port numbers, edit the following settings in your `resolver/boot.properties` file:

- `openidm.port.http`
- `openidm.port.https`

When you deploy IDM in production, you *must* set `openidm.host` to the URL of your deployment, in the same `resolver/boot.properties` file. Otherwise, calls to the `/admin` endpoint are not properly redirected.

IDM prevents URL-hijacking, with the following code block in the `conf/jetty.xml` file:

```
<!-- Prevent host header changes that may
occur from URL hijacking attempts -->
<Set name="hostHeader">
    <Call class="org.forgerock.openidm.jetty.Param" name="getProperty">
        <Arg>openidm.host</Arg>
    </Call>:
    <Call class="org.forgerock.openidm.jetty.Param" name="getProperty">
        <Arg>openidm.port.http</Arg>
    </Call>
</Set>
```

This configuration won't work if you're deploying IDM behind a system such as a load balancer, a firewall, or a reverse proxy. If you're deploying in this way:

- Edit your project's `conf/jetty.xml` file. Comment out the noted section that prevents host header changes.
- In your firewall, reverse proxy, or load balancer, set up a configuration that prevents URL-hijacking in the same way.

21.2.5. Restricting REST Access to the HTTPS Port

In a production environment, you should restrict REST access to a secure port. To do so, make the following changes to a default installation:

- Edit your project's `conf/jetty.xml` configuration file.

  Comment out or delete the `<Call name="addConnector">` code block that includes the `openidm.port.http` property. Keep the `<Call name="addConnector">` code blocks that contain the `openidm.port.https` and `openidm.port.mutualauth` properties.

  You can modify `openidm.port.https` and `openidm.port.mutualauth` in the `resolver/boot.properties` file. You could also remove the property that was commented out or deleted, `openidm.port.http`.

- Edit your project's `conf/config.properties` 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
  ```

When possible, use a certificate to secure REST access, over HTTPS. For production, that certificate should be signed by a certificate authority.

IDM generates a self-signed certificate when it first starts up. You can use this certificate to test secure REST access. To do so, create a self-signed certificate file, `self-signed.crt`, using the following procedure:

Note

This procedure works only on a fresh installation of IDM.

1. Edit the `boot.properties` file. Change the following property to the hostname for your IDM deployment. For this procedure, set:

   ```
   openidm.https.keystore.cert.alias=localhost
   ```

2. Extract the certificate that is generated when IDM starts up:

   ```
   $ openssl s_client -showcerts -connect localhost:8443 </dev/null
   ```

   This command outputs the entire certificate to the terminal.

3. 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-----
```

4. 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,
   "remainingPagedResults": -1
}
```

21.2.6. Managing Users With the `openidm-admin` Role

Anyone who is familiar with IDM should know that `openidm-admin` is the default administrative user. To enhance security, you may want to replace this user with a managed or an internal user with the same roles, specifically `openidm-admin` and `openidm-authorized` roles.

To create a user with the same roles as the default `openidm-admin` user, set up managed and/or internal users with the `openidm-admin` and `openidm-authorized` roles.

- To set up a managed user with the noted roles, see the following section: "Granting Internal Authorization Roles".
- To set up a new internal administrative user with the noted roles, see "Adding a New Internal Administrative User".

  For other techniques to manage internal users and associated roles, see the following section: "Managing Internal Users Over REST".

To change the password of the `openidm-admin` internal user, see the following section: "Replacing Default Security Settings".

Only after you've set up a second administrative user, you can disable or delete the `openidm-admin` user, as described in "Disabling or Deleting `openidm-admin`".

21.2.6.1. Adding a New Internal Administrative User

Before deleting the `openidm-admin` user, you may want to create a different internal user with the same roles. First, to verify the roles associated with `openidm-admin`, run the following command:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
'http://localhost:8080/openidm/internal/user/?_queryFilter=/_id+eq+"openidm-admin"&_fields=*,authzRoles'
```

In the output, you should see `authzRoles` with a `_ref` to:

- `internal/role/openidm-admin`
- `internal/role/openidm-authorized`

Now, to create a user named `admin` with these same roles, run the following command:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request PUT
 \
--data '{
  "password" : "Passw0rd",
  "authzRoles" : [
    {
      "_ref": "internal/role/openidm-admin"
    },
    {
      "_ref": "internal/role/openidm-authorized"
    }
  ]
}' \
"http://localhost:8080/openidm/internal/user/admin"
```

If you see the following error message:

```
The update request cannot be processed because it attempts to modify the read-only field '/_id'
```

You may have already created an internal user with the given `_id`, in this case, `admin`.

To verify the result, you should be able to run any existing REST call with the newly created internal user. Alternatively, you could log into the IDM Admin UI with the same credentials.

21.2.6.2. Disabling or Deleting `openidm-admin`

Warning

To prevent locking yourself out of IDM, do not delete the `openidm-admin` user (or remove the `openidm-admin` role from that user, *unless* you have set up another user with the `openidm-admin` role.

You can set up a managed user with the `openidm-admin` role, as described in the following section: "Granting Internal Authorization Roles".

Alternatively, you can set up a new internal user with the `openidm-admin` role, as described in "Adding a New Internal Administrative User".

To confirm the `authzRoles` associated with `openidm-admin`, run the following command:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
'http://localhost:8080/openidm/internal/user/?_queryFilter=/_id+eq+"openidm-admin"&_fields=*,authzRoles'

    {
  "result" : [ {
    "_id" : "openidm-admin",
    "_rev" : "00000000d1ada0ad",
    "authzRoles" : [ {
      "_ref" : "internal/role/openidm-admin",
      "_refResourceCollection" : "internal/role",
      "_refResourceId" : "openidm-admin",
      "_refProperties" : {
        "_id" : "35c7b47f-ff0d-4fa8-ab49-7f44777815e4",
        "_rev" : "00000000c7a3a16a"
      }
    }
 ...
}
```

Copy the `_ref*` data from the `authzRoles` for the `openidm-admin` user. You'll paste that information into a `--data` code block in the REST call that follows.

After you've set up one or more users with the `openidm-admin` role, you can safely remove that role from the `openidm-admin` user account with the following command:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--header "Content-Type: application/json"
 \
--request
 PATCH
--data '[
  {
    "operation" : "remove",
    "field" : "/authzRoles",
    "value" : {
    "_ref": "internal/role/openidm-admin",
    "_refResourceCollection": "internal/role",
    "_refResourceId": "openidm-admin",
    "_refProperties": {
      "_id" : "35c7b47f-ff0d-4fa8-ab49-7f44777815e4",
      "_rev" : "00000000c7a3a16a"
    }
  }
}\
"http://localhost:8080/openidm/internal/user/openidm-admin"
```

You can also delete the `openidm-admin` user with the following command:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request DELETE \
"http://localhost:8080/openidm/internal/user/openidm-admin"
```

Prevent the `openidm-admin` user from being recreated on startup by deleting the following lines from the `internal/user` array in `conf/repo.init.json`:

```
{
    "id" : "openidm-admin",
    "password" : "&{openidm.admin.password}"
}
```

21.2.7. Encrypting Data Internally and Externally

Beyond relying on end-to-end availability of TLS/SSL to protect data, IDM 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.

IDM 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.

IDM automatically encrypts sensitive data in configuration files, such as passwords. IDM replaces clear text values when the system first reads the configuration file. Take care with configuration files that contain clear text values that IDM has not yet read and encrypted.

21.2.8. Removing Unused CA Digital Certificates

The Java keystore and IDM truststore files include a number of root CA certificates. While the probability of a compromised root CA is low, best practices in security suggest that you should delete root CA certificates that are not used in your deployment.

To review the current list of root CA certificates in the IDM truststore, run the following command:

```
$ keytool \
-storepass \
changeit \
-list
 \
-keystore
 \
/path/to/openidm/security/truststore
```

On UNIX/Linux systems, you can find additional lists of root CA certificates in files named `cacerts`. They include root CA certificates associated with your Java environment, such as Oracle JDK or OpenJDK. You should be able to find that file in the following location: `${JAVA_HOME}/jre/lib/security/cacerts`.

Before doing anything with your Java environment keystore files, make sure the Java-related `cacerts` files are up to date. Install the latest supported version, as shown in "*Before You Install*" in the *Release Notes*.

You can remove root CA certificates with the **keytool** command. For example, the following command removes the hypothetical `examplecomca2` certificate from the truststore:

```
$ keytool \
-storepass \
changeit \
-delete
 \
-keystore
 \
/path/to/openidm/security/truststore
 \
-alias \
examplecomca2
```

Repeat the process for all root CA certificates that are not used in your deployment.

On Windows systems, you can manage certificates with the Microsoft Management Console (MMC) snap-in tool. For more information, see the following Microsoft Documentation on *Working With Certificates*. With this MMC snap-in, you can add and delete certificates.

21.2.9. Using Message Level Security

Message level security forces authentication before granting access. Authentication works by means of a filter-based mechanism that lets you use either an HTTP Basic like mechanism or IDM-specific headers, setting a cookie in the response that you can use for subsequent authentication. If you attempt to access IDM URLs without the appropriate headers or session cookie, IDM 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.

21.2.9.1. Message Level Security with Logins

The following examples show successful authentication attempts.

```
$ curl \
 --dump-header /dev/stdout \
 --user openidm-admin:openidm-admin \
 "http://localhost:8080/openidm/managed/user?_queryId=query-all-ids"
HTTP/1.1 200 OK
Date: Wed, 07 Sep 2016 12:27:39 GMT
Cache-Control: no-cache
Content-Type: application/json; charset=UTF-8
Set-Cookie: session-jwt=eyJ0eXAiOiJKV1QiLCJjd...; Path=/
Vary: Accept-Encoding, User-Agent
Transfer-Encoding: chunked

{
  "result" : [ ],
  "resultCount" : 0,
  "pagedResultsCookie" : null,
  "totalPagedResultsPolicy" : "NONE",
  "totalPagedResults" : -1,
  "remainingPagedResults" : -1
}

$ curl \
 --dump-header /dev/stdout \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 "http://localhost:8080/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 \
 --header "Cookie: session-jwt=2l0zobpuk6st1b2m7gvhg5zas ..." \
 --header "X-Requested-With: OpenIDM Plugin" \
```

```
 "http://localhost:8080/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 that IDM 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, IDM 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 \
 --header "X-OpenIDM-NoSession: true" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 "http://localhost:8080/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}
```

21.2.9.2. Sessions and the JWT Cookie

IDM maintains sessions with a JWT session cookie, stored in a client browser. By default, it deletes the cookie when you log out. Alternatively, if you delete the cookie, that ends your session.

You can modify what happens to the session after a browser restart. Open the `authentication.json` file, and change the value of the `sessionOnly` property. For more information on `sessionOnly`, see "Session Module".

The JWT session cookie is based on the `JWT_SESSION` module, described in "Supported Authentication and Session Modules".

21.2.10. Replacing Default Security Settings

The default security settings are adequate for evaluation purposes. In production environments, change at least the following settings:

- The password of the default administrative user (`openidm-admin`)
- The default keystore password

To Change the Default Administrator Password

1. To change the password of the default administrative user, PATCH the user object as follows:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request PATCH \
 --data '[ {
   "operation" : "replace",
   "field" : "password",
   "value" : "NewPassw0rd"
 } ]' \
 "http://localhost:8080/openidm/internal/user/openidm-admin"
{
 "_id": "openidm-admin",
 "_rev": "00000000555c83ed"
}
```

2. Test that the update has been successful by querying IDM with the new credentials:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: NewPassw0rd" \
 --request GET \
 "http://localhost:8080/openidm/internal/user/openidm-admin"
{
  "_id": "openidm-admin",
  "_rev": "00000000555c83ed"
}
```

Tip

An administrative user can also reset their password in the End User UI.

To Change the Default Keystore Password

The default keystore password is `changeit`. You should change this password in a production environment.

To change the default keystore password, follow these steps:

1. Shut down the server if it is running:

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

2. Use the **keytool** command to change the keystore password. The following command changes the keystore password to `newPassword`:

```
$ keytool \
 -storepasswd \
 -keystore /path/to/openidm/security/keystore.jceks \
 -storetype jceks
Enter keystore password: changeit
New keystore password: newPassword
Re-enter new keystore password: newPassword
```

3. IDM uses a number of encryption keys by default. The passwords of these keys must match the password of the keystore.

   To obtain a list of the keys in the keystore, run the following command:

```
$ keytool \
 -list \
 -keystore /path/to/openidm/security/keystore.jceks \
 -storetype jceks\
 -storepass newPassword
Keystore type: JCEKS
Keystore provider: SunJCE

Your keystore contains 6 entries

openidm-sym-default, 18 May 2018, SecretKeyEntry,
selfservice, 18 May 2018, PrivateKeyEntry,
Certificate fingerprint (SHA1): F2:CF:3D:76:74:05:DC:90:13:FE:D4:1F:EF:91:E1:89:8A:A0:31:B5
openidm-jwtsessionhmac-key, 18 May 2018, SecretKeyEntry,
openidm-localhost, 18 May 2018, PrivateKeyEntry,
Certificate fingerprint (SHA1): 70:5D:11:CF:42:C1:B4:B5:C3:52:AC:D8:0D:E2:CD:13:3B:58:4D:31
pkopenidm-selfservice-key, 18 May 2018, SecretKeyEntry,
server-cert, 18 May 2018, PrivateKeyEntry,
Certificate fingerprint (SHA1): A0:A4:CB:A2:81:6A:25:A6:52:12:C5:30:B0:E6:F2:D5:3D:3A:77:5F
```

   Change the passwords of each of the default encryption keys as follows:

```
$ keytool \
 -keypasswd \
 -alias openidm-localhost \
 -keystore /path/to/openidm/security/keystore.jceks \
 -storetype jceks \
 -storepass newPassword
Enter key password for <openidm-localhost> changeit
New key password for <openidm-localhost>: newPassword
Re-enter new key password for <openidm-localhost>: newPassword

$ keytool \
 -keypasswd \
 -alias openidm-sym-default \
 -keystore /path/to/openidm/security/keystore.jceks \
 -storetype jceks \
 -storepass newPassword
```

```
Enter key password for <openidm-sym-default> changeit
New key password for <openidm-sym-default>: newPassword
Re-enter new key password for <openidm-sym-default>: newPassword

$ keytool \
 -keypasswd \
 -alias openidm-selfservice-key \
 -keystore /path/to/openidm/security/keystore.jceks \
 -storetype jceks \
 -storepass newPassword
Enter key password for <openidm-selfservice-key> changeit
New key password for <openidm-selfservice-key>: newPassword
Re-enter new key password for <openidm-selfservice-key>: newPassword

$ keytool \
 -keypasswd \
 -alias selfservice \
 -keystore /path/to/openidm/security/keystore.jceks \
 -storetype jceks \
 -storepass newPassword
Enter key password for <selfservice> changeit
New key password for <selfservice>: newPassword
Re-enter new key password for <selfservice>: newPassword

$ keytool \
 -keypasswd \
 -alias openidm-jwtsessionhmac-key \
 -keystore /path/to/openidm/security/keystore.jceks \
 -storetype jceks \
 -storepass newPassword
Enter key password for <openidm-jwtsessionhmac-key> changeit
New key password for <openidm-jwtsessionhmac-key>: newPassword
Re-enter new key password for <openidm-jwtsessionhmac-key>: newPassword

$ keytool \
 -keypasswd \
 -alias server-cert \
 -keystore /path/to/openidm/security/keystore.jceks \
 -storetype jceks \
 -storepass newPassword
Enter key password for <server-cert> changeit
New key password for <server-cert>: newPassword
Re-enter new key password for <server-cert>: newPassword
```

4. Generate an obfuscated and an encrypted version of your new password by using the crypto bundle provided with IDM.

   The following example generates an obfuscated and encrypted version of the password `newPassword`:

```
$ java -jar /path/to/openidm/bundle/openidm-util-6.5.2.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:newPassword
OBF:1uo91vn61ymf1sgo1v1p1ym71v2p1siu1ylz1vnw1unp
CRYPT:dc5aa3ee8f58f7e2c04bbb0d09118199
```

5. Open your `resolver/boot.properties` file and comment out the default keystore password.

   Paste the obfuscated or the encrypted password as the value of the `openidm.keystore.password` property. For example, the following excerpt of a `boot.properties` file removes the default keystore password and sets the keystore password to the obfuscated value of `newPassword`:

   ```
   $ more resolver/boot.properties
   ...
   # Keystore password, adjust to match your keystore and protect this file
   openidm.keystore.password=OBF:1uo91vn61ymf1sgo1v1p1ym71v2p1siu1ylz1vnw1unp
   openidm.truststore.password=changeit
   ```

   Set *either* the obfuscated or the encrypted password value here, not both.

6. If you are testing this procedure with the default embedded DS repository, you must also change the keystore PIN for the IDM Key Manager Provider in the DS configuration.

   Open the `/path/to/openidm/db/openidm/opendj/config/config.ldif` file and replace the following:

   ```
   dn: cn=OpenIDM Key Manager Provider,cn=Key Manager Providers,cn=config
   ...
   ds-cfg-key-store-pin: changeit
   ```

   with the new keystore password, for example:

   ```
   dn: cn=OpenIDM Key Manager Provider,cn=Key Manager Providers,cn=config
   ...
   ds-cfg-key-store-pin: newPassword
   ```

   Note

   This step leaves the keystore password in clear text in the DS configuration file. This should be acceptable for testing purposes. The embedded DS repository is not supported in a production environment.

7. Restart the server.

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

Important

Repeat this procedure on each node if you run multiple nodes in a cluster to ensure that the new password is present on all nodes.

21.2.11. Protecting 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.

For an example that shows how to protect sensitive URLs, see "Understanding the Access Configuration Script (`access.js`)".

IDM supports native query expressions on the repository, and you can enable these over HTTP.

Note

Native queries on the default DS are *not* supported.

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:

```
// openidm-admin can request nearly anything (except query expressions on repo endpoints)
{
    "pattern"   : "*",
    "roles"     : "internal/role/openidm-admin",
    "methods"   : "*", // default to all methods allowed
    "actions"   : "*", // default to all actions allowed
 // "customAuthz" : "disallowQueryExpression()",
    "excludePatterns": "repo,repo/*"
},
// additional rules for openidm-admin that selectively enable certain parts of system/
{
    "pattern"   : "system/*",
    "roles"     : "internal/role/openidm-admin",
    "methods"   : "create,read,update,delete,patch,query", // restrictions on 'action'
    "actions"   : ""
 // "customAuthz" : "disallowQueryExpression()"
},
```

21.2.12. Protecting Sensitive Files and Directories

Protect IDM files from access by unauthorized users. In particular, prevent other users from reading files in at least the `openidm/resolver/` 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.

Protecting Key Files in Unix

1. Make sure that user and group ownership of the installation and project directories is limited to the user running the IDM 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 .
   ```

Protecting Key Files in Windows

1. The IDM process in Windows is normally run by the `Local System` service account.
2. If you are concerned about the security of this account, you can set up a service account that only has permissions for IDM-related directories, then remove User access to the directories noted above. You should also configure the service account to deny local and remote login. For more information, see the User Rights Assignment article in Microsoft's documentation.

21.2.13. Removing or Protecting Development and Debug Tools

Before you deploy IDM in production, remove or protect development and debug tools, including the Felix web console that is exposed under `/system/console`. Authentication for this console is not integrated with authentication for IDM.

- To remove the Felix web console, remove the web console bundle and all of the plugin bundles related to the web console, as follows:

```
$ cd /path/to/openidm/bundle
$ rm org.apache.felix.webconsole*.jar
$ rm openidm-felix-webconsole-6.5.2.jar
```

  Also remove the `felix.webconsole.json` from your project's `conf` directory.

```
$ cd /path/to/project-dir
$ rm conf/felix.webconsole.json
```

- Alternatively, protect access to the Felix web console by changing the credentials in your project's `conf/felix.webconsole.json` file. This file contains the username and password to access the console, by default:

```
{
  "username" : "admin",
  "password" : "admin"
}
```

21.2.14. Protecting the Repository

You must use a supported repository in production (see "*Selecting a Repository*" in the *Installation Guide*).

For JDBC repositories, use a strong password for the connection and change at least the password of the database user (`openidm` by default). When you change the database username and/or password, you must update the database connection configuration file (`datasource.jdbc-default.json`) for your repository type.

For a DS repository, change the `bindDN` and `bindPassword` for the directory server user in the `ldapConnectionFactories` property in the `repo.ds.json` file.

You can use property substitution to set the database password and protect access to the `resolver/boot.properties` file, or you can pass the password in using the `OPENIDM_OPTS` environment variable.

The following excerpt of a MySQL connection configuration file sets the database password to the value of the `openidm.repo.password` property.

```
{
    "driverClass" : "com.mysql.jdbc.Driver",
    "jdbcUrl" : "jdbc:mysql://&{openidm.repo.host}:&{openidm.repo.port}/openidm?
allowMultiQueries=true&characterEncoding=utf8",
    "databaseName" : "openidm",
    "username" : "openidm",
    "password" : "&{openidm.repo.password}",
    "connectionTimeout" : 30000,
    "connectionPool" : {
        "type" : "hikari",
        "minimumIdle" : 20,
        "maximumPoolSize" : 50
    }
}
```

Use a case sensitive database, particularly if you work with systems with different identifiers that match except for case. Otherwise correlation queries or correlation scripts can pick up identifiers that should not be considered the same.

21.2.15. Adjusting Log Levels

Leave log levels at `INFO` in production to ensure that you capture enough information to help diagnose issues. For more information, see "*Configuring Server Logs*".

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.

21.2.16. Setting Up Restart At System Boot

You can run IDM 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, Stopping, and Running the Server*".

See your operating system documentation for information on configuring a service, such as IDM, to be started at boot and shut down at system shutdown.

21.2.17. Disabling the API Explorer

As described in "API Explorer", IDM includes an implementation of the *OpenAPI Initiative Specification*, also known as Swagger.

The API Explorer can help you identify endpoints, and run REST calls against those endpoints. To hide that information in production, disable the following property in your `resolver/boot.properties` file:

```
openidm.apidescriptor.enabled=false
```

You can also remove this property from `boot.properties`, as it is `false` by default.

21.3. Configuring IDM For a Hardware Security Module (HSM) Device

You can configure an external PKCS #11 (HSM) device to manage the keys that are used to secure IDM transactions.

Note

On Windows systems using the 64-bit JDK, the Sun PKCS #11 provider is available *only* from JDK version 1.8b49 onwards. If you want to use a PKCS #11 device on Windows, either use the 32-bit version of the JDK, or upgrade your 64-bit JDK to version 1.8b49 or higher.

21.3.1. Setting Up the HSM Configuration

This section assumes that you have access to an HSM device (or a software emulation of an HSM device, such as SoftHSM) and that the HSM provider has been configured and initialized.

The command-line examples in this section use SoftHSM for testing purposes. Before you start, set the correct environment variable for the SoftHSM configuration, for example:

```
$ export SOFTHSM2_CONF=/usr/local/Cellar/softhsm/2.0.0/etc/softhsm2.conf
```

Also initialize slot `0` on the provider, with a command similar to the following:

```
$ softhsm2-util --init-token --slot 0 --label "My token 1"
```

This token initialization requests two PINs—an SO PIN and a user PIN. You can use the SO PIN to reinitialize the token. The user PIN is provided to IDM so that it can interact with the token. Remember the values of these PINs because you will use them later in this section.

The PKCS#11 standard uses a configuration file to interact with the HSM device. The following example shows a basic configuration file for SoftHSM:

```
name = softHSM
library = /usr/local/Cellar/softhsm/2.0.0/lib/softhsm/libsofthsm2.so
slot = 1
attributes(generate, *, *) = {
   CKA_TOKEN = true
}
attributes(generate, CKO_CERTIFICATE, *) = {
   CKA_PRIVATE = false
}
attributes(generate, CKO_PUBLIC_KEY, *) = {
   CKA_PRIVATE = false
}
attributes(*, CKO_SECRET_KEY, *) = {
   CKA_PRIVATE = false
   CKA_EXTRACTABLE = true
}
```

Your HSM configuration file *must* include at least the following settings:

`name`

A suffix to identify the HSM provider. This example uses the `softHSM` provider.

`library`

The path to the PKCS #11 library.

`slot`

The slot number to use, specified as a string. Make sure that the slot you specify here has been initialized on the HSM device.

The `attributes` properties specify additional PKCS #11 attributes that are set by the HSM. For a complete list of these attributes, see the PKCS #11 Reference.

Important

If you are using the JWT Session Module, you *must* set `CKA_EXTRACTABLE = true` for secret keys in your HSM configuration file. For example:

```
attributes(*, CKO_SECRET_KEY, *) = {
   CKA_PRIVATE = false
   CKA_EXTRACTABLE = true
}
```

The HSM provider must allow secret keys to be extractable because the authentication service serializes the JWT Session Module key and passes it to the authentication framework as a base 64-encoded string.

The section that follows assumes that your HSM configuration file is located at `/path/to/hsm/hsm.conf`.

21.3.2. Populating the Default Encryption Keys

When IDM first starts up, it generates a number of encryption keys required to encrypt specific data. If you are using an HSM provider, you must generate these keys manually. The secret keys must use an HMAC algorithm. The following steps set up the required encryption keys:

1. The `openidm-sym-default` key is the default symmetric key required to encrypt the configuration. The following command generates that key in the HSM provider. The `-providerArg` must point to the HSM configuration file described in "Setting Up the HSM Configuration".

   ```
   $ keytool -genseckey \
    -alias openidm-sym-default \
    -keyalg HmacSHA256 \
    -keysize 256 \
    -keystore NONE \
    -storetype PKCS11 \
    -providerClass sun.security.pkcs11.SunPKCS11 \
    -providerArg /path/to/hsm/hsm.conf
   Enter keystore password:
   ```

   Enter the password of your HSM device. If you are using SoftHSM, enter your user PIN as the keystore password. The remaining sample steps use *user PIN* as the password.

2. The `openidm-selfservice-key` is used by the Self-Service UI to encrypt managed user passwords and other sensitive data. Generate that key with a command similar to the following:

   ```
   $ keytool -genseckey \
    -alias openidm-selfservice-key \
    -keyalg HmacSHA256 \
    -keysize 256 \
    -keystore NONE \
    -storetype PKCS11 \
    -providerClass sun.security.pkcs11.SunPKCS11 \
    -providerArg /path/to/hsm/hsm.conf
   Enter keystore password: user PIN
   ```

   Enter the password of your HSM device. If you are using SoftHSM, enter your user PIN as the keystore password.

3. The `openidm-jwtsessionhmac-key` is used by the JWT session module to encrypt JWT session cookies. For more information about the JWT session module, see "Supported Session Module". Generate the JWT session module key with a command similar to the following:

   ```
   $ keytool -genseckey \
    -alias openidm-jwtsessionhmac-key \
    -keyalg HmacSHA256 \
    -keysize 256 \
    -keystore NONE \
    -storetype PKCS11 \
    -providerClass sun.security.pkcs11.SunPKCS11 \
    -providerArg /path/to/hsm/hsm.conf
   Enter keystore password: user PIN
   ```

4. The `openidm-localhost` certificate is used to support SSL/TLS. Generate that certificate with a command similar to the following:

```
$ keytool -genkey \
 -alias openidm-localhost \
 -keyalg RSA \
 -keysize 2048 \
 -keystore NONE \
 -storetype PKCS11 \
 -providerClass sun.security.pkcs11.SunPKCS11 \
 -providerArg /path/to/hsm/hsm.conf
Enter keystore password: user PIN
What is your first and last name?
  [Unknown]:  localhost
What is the name of your organizational unit?
  [Unknown]:
What is the name of your organization?
  [Unknown]:  OpenIDM Self-Signed Certificate
What is the name of your City or Locality?
  [Unknown]:
What is the name of your State or Province?
  [Unknown]:
What is the two-letter country code for this unit?
  [Unknown]:
Is CN=localhost, OU=Unknown, O=OpenIDM Self-Signed Certificate, L=Unknown, ST=Unknown, C=Unknown
 correct?
  [no]:  yes
```

5. If you are using the default embedded DS repository, the `server-cert` certificate is used to support SSL/TLS requests to the repository. Generate that certificate with a command similar to the following:

```
$ keytool -genkey \
 -alias server-cert \
 -keyalg RSA \
 -keysize 2048 \
 -keystore NONE \
 -storetype PKCS11 \
 -providerClass sun.security.pkcs11.SunPKCS11 \
 -providerArg /path/to/hsm/hsm.conf
Enter keystore password: user PIN
What is your first and last name?
  [Unknown]:  localhost
What is the name of your organizational unit?
  [Unknown]:
What is the name of your organization?
  [Unknown]:  OpenDJ RSA Self-Signed Certificate
What is the name of your City or Locality?
  [Unknown]:
What is the name of your State or Province?
  [Unknown]:
What is the two-letter country code for this unit?
  [Unknown]:
Is CN=localhost, O=OpenDJ RSA Self-Signed Certificate, OU=None, L=None, ST=None, C=None?
  [no]:  yes
```

6. The `selfservice` certificate secures requests from the End User UI. Generate that certificate with a command similar to the following:

```
$ keytool -genkey \
 -alias selfservice \
 -keyalg RSA \
 -keysize 2048 \
 -keystore NONE \
 -storetype PKCS11 \
 -providerClass sun.security.pkcs11.SunPKCS11 \
 -providerArg /path/to/hsm/hsm.conf
Enter keystore password: user PIN
What is your first and last name?
  [Unknown]:  localhost
What is the name of your organizational unit?
  [Unknown]:
What is the name of your organization?
  [Unknown]:  OpenIDM Self Service Certificate
What is the name of your City or Locality?
  [Unknown]:
What is the name of your State or Province?
  [Unknown]:
What is the two-letter country code for this unit?
  [Unknown]:
Is CN=localhost,O=OpenIDM Self Service Certificate,OU=None,L=None,ST=None,C=None?
  [no]:  yes
```

7. If you are *not* using the HSM provider for the truststore, you must add the certificates generated in the previous two steps to the default IDM truststore.

   If you *are* using the HSM provider for the truststore, you can skip this step.

   To add the `openidm-localhost` certificate to the IDM truststore, export the certificate from the HSM provider, then import it into the truststore, as follows:

```
$ keytool -export \
 -alias openidm-localhost \
 -file exportedCert \
 -keystore NONE \
 -storetype PKCS11 \
 -providerClass sun.security.pkcs11.SunPKCS11 \
 -providerArg /path/to/hsm/hsm.conf
Enter keystore password: user PIN
Certificate stored in file exportedCert
$ keytool -import \
 -alias openidm-localhost \
 -file exportedCert \
 -keystore /path/to/openidm/security/truststore

Enter keystore password: changeit
Owner: CN=localhost, OU=Unknown, O=OpenIDM Self-Signed Certificate, L=...
Issuer: CN=localhost, OU=Unknown, O=OpenIDM Self-Signed Certificate, L=...
Serial number: 5d2554bd
Valid from: Fri Aug 19 13:11:54 SAST 2016 until: Thu Nov 17 13:11:54 SAST 2016
Certificate fingerprints:
  MD5:  F1:9B:72:7F:7B:79:58:29:75:85:82:EC:79:D8:F9:8D
  SHA1: F0:E6:51:75:AA:CB:14:3D:C5:E2:EB:E5:7C:87:C9:15:43:19:AF:36
  SHA256: 27:A5:B7:0E:94:9A:32:48:0C:22:0F:BB:7E:3C:22:2A:64:B5:45:24:14:70:...
  Signature algorithm name: SHA256withRSA
  Version: 3
```

```
Extensions:

#1: ObjectId: 2.5.29.14 Criticality=false
SubjectKeyIdentifier [
KeyIdentifier [
0000: 7B 5A 26 53 61 44 C2 5A   76 E4 38 A8 52 6F F2 89  .Z&SaD.Zv.8.Ro..
0010: 20 04 52 EE                                        .R.
]
]
Trust this certificate? [no]:  yes
Certificate was added to keystore
```

The default truststore password is *changeit*.

Follow the same procedure to add the `server-cert` certificate to the IDM truststore.

The name of this key is set in `boot.properties`, as the keystore certificate for IDM's instance of embedded DS.

```
openidm.config.crypto.opendj.localhost.cert
```

21.3.3. Configuring IDM to Support an HSM Provider

To enable support for an HSM provider, you'll need to edit two files in your project's `conf/` directory:`secrets.json` and `java.security`.

To configure an HSM provider in `secrets.json` for the IDM keystore, edit the `secrets.json` file for your project and add the following code block, based on the options described in "Configuring IDM For a Hardware Security Module (HSM) Device".

```
{
  "stores": [
    {
      "name": "mainKeyStore",
      "class": "org.forgerock.openidm.secrets.config.HsmBasedStore",
      "config": {
        "storetype": "&{openidm.keystore.type|PKCS11}",
        "providerName": "&{openidm.keystore.provider|SunPKCS11-softHSM}",
        "storePassword": "&{openidm.keystore.password|changeit}",
        "mappings": [
          {
            "secretId" : "idm.default",
            "types": [ "ENCRYPT", "DECRYPT" ],
            "aliases": [ "&{openidm.config.crypto.alias|openidm-sym-default}" ]
          },
          {
            "secretId" : "idm.config.encryption",
            "types": [ "ENCRYPT", "DECRYPT" ],
            "aliases": [ "&{openidm.config.crypto.alias|openidm-sym-default}" ]
          },
          {
            "secretId" : "idm.password.encryption",
            "types": [ "ENCRYPT", "DECRYPT" ],
            "aliases": [ "&{openidm.config.crypto.alias|openidm-sym-default}" ]
```

```
          },
          {
            "secretId" : "idm.jwt.session.module.encryption",
            "types": [ "ENCRYPT", "DECRYPT" ],
            "aliases": [ "&{openidm.https.keystore.cert.alias|openidm-localhost}" ]
          },
          {
            "secretId" : "idm.jwt.session.module.signing",
            "types": [ "SIGN", "VERIFY" ],
            "aliases": [ "&{openidm.config.crypto.jwtsession.hmackey.alias|openidm-jwtsessionhmac-key}" ]
          },
          {
            "secretId" : "idm.selfservice.signing",
            "types": [ "SIGN", "VERIFY" ],
            "aliases": [ "selfservice" ]
          },
          {
            "secretId" : "idm.selfservice.encryption",
            "types": [ "ENCRYPT", "DECRYPT" ],
            "aliases": [ "&{openidm.config.crypto.selfservice.sharedkey.alias|openidm-selfservice-key}" ]
          }
        ]
      }
    },
    {
      "name": "mainTrustStore",
      "class": "org.forgerock.openidm.secrets.config.HsmBasedStore",
      "config": {
        "storetype": "&{openidm.keystore.type|PKCS11}",
        "providerName": "&{openidm.keystore.provider|SunPKCS11-softHSM}",
        "storePassword": "&{openidm.keystore.password|changeit}",
        "mappings": [
        ]
      }
    }
  ],
  "populateDefaults": false
}
```

You'll also need to specify the location for your PKCS11 configuration file. Default pointers are included in the `java.security` file in your project's `conf/` subdirectory. Use the pointer that matches your version of `java`. Templates for the referenced `pkcs11.conf` file are included in various PKCS packages.

You should now be able to start IDM with the keys in the HSM provider.

Chapter 22

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.

IDM 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.

This chapter describes how to configure the Activiti engine, and how to manage workflow tasks and processes over the REST interface. You can also manage workflows in the Admin UI by selecting Manage > Workflow and then selecting Tasks or Processes.

22.1. 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.

BPMN 2.0 lets you add artifacts that describe your workflows and business processes to IDM, for provisioning and other purposes. You can define workflows in a text editor or using an Eclipse plugin. The Eclipse plugin provides visual design capabilities, simplifying packaging and deployment of the artifact to IDM. For instructions on installing the Activiti Eclipse Designer, see the corresponding Activiti documentation. Also, read the section covering BPMN 2.0 Constructs, which describes 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, IDM functions cannot be called from a JavaScript task in a workflow. Therefore, you can use JavaScript for non-IDM workflow tasks, but you must use the `activiti:expression` construct to call IDM functions.

22.2. Enabling Workflows

IDM embeds an Activiti Process Engine that is started in the OSGi container. When you have started IDM, run the **scr list** command in the OSGi console to check that the workflow bundle is enabled:

```
-> OpenIDM ready
scr list
 BundleId Component Name Default State
    Component Id State      PIDs (Factory PID)
...
 [ 174]   org.forgerock.openidm.workflow  enabled
...
```

Workflows are not active by default. To activate the workflow bundle, IDM requires two configuration files:

- `workflow.json` specifies the configuration of the Activiti engine, including the data source that the Activiti engine will use.
- `datasource.jdbc-default.json` the default data source for Activiti.

To enable workflows, log in to the Admin UI and select Configure > System Preferences > Workflow, then select the Enable switch and click Save. Enabling workflows through the UI creates the default workflow configuration files in your project's `conf/` directory. To change the default Activiti configuration, see "Configuring the Activiti Engine". You must change the data store that Activiti uses based on your installed JDBC, see "Configuring the Activiti Data Source".

22.2.1. Configuring the Activiti Engine

The default `workflow.json` file that is created by the UI has the following structure:

```
{
    "useDataSource" : "default",
    "workflowDirectory" : "&{idm.instance.dir}/workflow"
}
```

`useDataSource`

Specifies the datasource configuration file that points to the repository where Activiti should store its data.

By default, this is the `datasource.jdbc-default.json` file. For information about changing the data store that Activiti uses, see "Configuring the Activiti Data Source".

`workflowDirectory`

Specifies the location in which IDM expects to find workflow processes. By default, IDM looks for workflow processes in the `project-dir/workflow` directory.

In addition to these default properties, you can configure the `history` level of the Activiti engine:

```
{
    "history" : "audit"
}
```

The Activiti history level determines how much historical information is retained when workflows are executed. The history level can be one of the following:

- `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.

22.2.2. Configuring the Activiti Data Source

The Activiti engine requires a JDBC database. The connection details to the database are specified in the `datasource.jdbc-default.json` file. If you are using a JDBC repository for IDM data, you will already have a `datasource.jdbc-default.json` file in your project's `conf/` directory. In this case, when you enable workflows, IDM uses the existing JDBC repository and creates the required Activiti tables in that JDBC repository.

Important

If you are using a DS repository for IDM data, you must configure a separate JDBC repository as the workflow datasource. For more information, see "*Selecting a Repository*" in the *Installation Guide*.

To specify that Activiti should use a data source that is separate to your existing IDM JDBC repository, create a new datasource configuration file in your project's `conf/` directory (for example `datasource.jdbc-activiti.json`) with the connection details to the separate data source. Then reference that file in the `useDataSource` property of the `workflow.json` file (for example, `"useDataSource" : "activiti"`.

For more information about the fields in this file, see "Understanding the JDBC Connection Configuration File".

22.3. Testing the Workflow Integration

IDM reads workflow definitions from the `/path/to/openidm/workflow` directory.

The `/path/to/openidm/samples/provisioning-with-workflow/` sample provides a workflow definition (`contractorOnboarding.bar`) that you can use to test the workflow integration. Create a `workflow` directory in your project directory and copy the sample workflow to that directory:

```
$ cd project-dir
$ mkdir workflow
$ cp samples/provisioning-with-workflow/workflow/contractorOnboarding.bar workflow/
```

Verify the workflow integration by using the REST API. The following REST call lists the defined workflows:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/processdefinition?_queryId=query-all-ids"
```

The sample workflow definition that you copied in the previous step is named `contractorOnboarding`. The result of the preceding REST call is therefore similar to the following:


```
{
  "result": [
    {
      "_id": "contractorOnboarding:1:5",
      "_rev": "1",
      "candidateStarterGroupIdExpressions": [],
      "candidateStarterUserIdExpressions": [],
      "category": "Examples",
      "deploymentId": "1",
      "description": null,
      "eventSupport": {},
      "executionListeners": {},
      "graphicalNotationDefined": false,
      "hasStartFormKey": true,
      "historyLevel": null,
      "ioSpecification": null,
      "key": "contractorOnboarding",
      "laneSets": [],
      "name": "Contractor onboarding process",
      "participantProcess": null,
      "processDiagramResourceName": "contractorOnboarding.contractorOnboarding.png",
      "properties": {},
      "resourceName": "contractorOnboarding.bpmn20.xml",
      "revisionNext": 2,
      "startFormHandler": null,
      "suspended": false,
      "suspensionState": 1,
      "taskDefinitions": null,
      "tenantId": "",
      "variables": null,
      "version": 1
    }
  ],
  "resultCount": 1,
  "pagedResultsCookie": null,
  "totalPagedResultsPolicy": "NONE",
  "totalPagedResults": -1,
  "remainingPagedResults": -1
}
```


For more information about this workflow, see "*Using a Workflow to Provision User Accounts*" in the *Samples Guide*.

For more information about managing workflows over REST, see "Managing Workflows Over the REST Interface".

22.4. Defining Activiti Workflows

The following section outlines the process to follow when you create an Activiti workflow for IDM.

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. Save the workflow definition with a `bpmn20.xml` extension.

   Note that each workflow definition references a script, in the `<scriptTask>` element. The `scriptFormat` of these scripts is always `groovy`. Currently only Groovy script is supported for workflow scripts.

3. 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.

4. Copy the `.bar` file to the `openidm/workflow` directory.

5. Invoke the workflow using a script (in `openidm/script/`) or directly using the REST interface. For more information, see "Invoking Activiti Workflows".

   You can also schedule the workflow to be invoked repeatedly, or at a future time. For more information, see "*Scheduling Tasks and Events*".

22.5. Invoking Activiti Workflows

You can invoke workflows and business processes from any trigger point within IDM, 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 "openidm.create(resourceName, newResourceId, content, params, fields)".

You can invoke the same workflow from the REST interface with the following REST call:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{"_key":"myWorkflow"}' \
 "http://localhost:8080/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";
  ```

  To obtain the `processDefinitionId`, query 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.

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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '{"_key":"myWorkflow", "_businessKey":"newOrder"}' \
 "http://localhost:8080/openidm/workflow/processinstance?_action=create"
```

Access to workflows is based on IDM roles, and is configured in your project's `conf/process-access.json` file. For more information, see "Managing User Access to Workflows".

22.6. 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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/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
```

22.7. Using Custom Templates for Activiti Workflows

The embedded Activiti engine is integrated with the default End User UI. For simple custom workflows, you can use the standard Activiti form properties, and have the UI render the corresponding generic forms automatically. If you require more complex functionality, (including input validation, rich input field types, complex CSS, and so forth) you must define a custom form template.

The default workflows that are provided with IDM use the Vue JS framework for display in the End User UI. To write a custom form template, you must have a basic understanding of the Vue JS framework and how to create components. A sample workflow template is provided in `/path/to/samples/provisioning-with-workflow/workflow/contractorOnboarding.bar`. To extract the archive, run the following command:

```
jar -xvf contractorOnboarding.bar
 inflated: contractorForm.js
 inflated: contractorOnboarding.bpmn20.xml
```

The archive includes the workflow definition (`contactorOnboarding.bpmn20.xml`) and the corresponding JavaScript template (`contractorForm.js`) to render the workflow in the UI.

For more information, see the Vue JS documentation.

22.8. 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/sync-asynchronous`. For a complete reference of all the context paths related to workflows, see "Managing Workflows Over REST".

openidm/workflow/processdefinition

- List the available workflow definitions:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/processdefinition?_queryId=query-all-ids"
{
  "result" : [ {
    "_id" : "managedUserApproval:1:4",
    "_rev" : "1",
    "candidateStarterGroupIdExpressions" : [ ],
    "candidateStarterUserIdExpressions" : [ ],
    "category" : "Examples",
    "deploymentId" : "1",
    "description" : null,
    "eventSupport" : { },
    "executionListeners" : { },
    "graphicalNotationDefined" : false,
    "hasStartFormKey" : false,
    "historyLevel" : null,
    "ioSpecification" : null,
    "key" : "managedUserApproval",
    "laneSets" : [ ],
    "name" : "Managed User Approval Workflow",
    "participantProcess" : null,
    "processDiagramResourceName" : "OSGI-INF/activiti/managedUserApproval.managedUserApproval.png",
    "properties" : { },
    "resourceName" : "OSGI-INF/activiti/managedUserApproval.bpmn20.xml",
    "revisionNext" : 2,
    "startFormHandler" : null,
    "suspended" : false,
    "suspensionState" : 1,
    "taskDefinitions" : null,
    "tenantId" : "",
    "variables" : null,
    "version" : 1
  } ],
  "resultCount" : 1,
```

```
  "pagedResultsCookie" : null,
  "totalPagedResultsPolicy" : "NONE",
  "totalPagedResults" : -1,
  "remainingPagedResults" : -1
}
```

- List the workflow definitions, based on certain filter criteria:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/processdefinition?_queryId=filtered-query&category=Examples"
{
  "result" : [ {
    "_id" : "managedUserApproval:1:4",
    ...
    "category" : "Examples",
    ...
    "name" : "Managed User Approval Workflow",
    ...
  } ],
  ...
}
```

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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/processdefinition/managedUserApproval:1:4"
{
  "_id" : "managedUserApproval:1:4",
  "_rev" : "2",
  "candidateStarterGroupIdExpressions" : [ ],
  "candidateStarterUserIdExpressions" : [ ],
  "category" : "Examples",
  "deploymentId" : "1",
  "description" : null,
  "eventSupport" : { },
  "executionListeners" : {
    "end" : [ { } ]
  },
  "graphicalNotationDefined" : true,
  "hasStartFormKey" : false,
  "historyLevel" : null,
  "ioSpecification" : null,
  "key" : "managedUserApproval",
  "laneSets" : [ ],
  "name" : "Managed User Approval Workflow",
  "participantProcess" : null,
  "processDiagramResourceName" : "OSGI-INF/activiti/managedUserApproval.managedUserApproval.png",
  "properties" : {
```

```
    "documentation" : null
  },
  "resourceName" : "OSGI-INF/activiti/managedUserApproval.bpmn20.xml",
  "revisionNext" : 3,
  "startFormHandler" : {
    "deploymentId" : "1",
    "formKey" : null,
    "formPropertyHandlers" : [ ]
  },
  "suspended" : false,
  "suspensionState" : 1,
  "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" : [ { } ],
        "complete" : [ {
          "className" : "org.activiti.engine.impl.bpmn.listener.ScriptTaskListener",
          "multiInstanceActivityBehavior" : null
        } ]
      }
    }
  },
  "tenantId" : "",
  "variables" : { },
  "version" : 1,
  "formProperties" : [ ]
}
```

- 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.

  IDM 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:

  ```
  $ curl \
   --header "X-OpenIDM-Username: openidm-admin" \
   --header "X-OpenIDM-Password: openidm-admin" \
   --header "If-Match: *" \
   --request DELETE \
   "http://localhost:8080/openidm/workflow/processdefinition/managedUserApproval:1:3"
  ```

  The delete request returns the contents of the deleted workflow definition.

  Note

  Although there is only one representation of a workflow definition in the filesystem, 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*.

  When you delete a process definition, associated process instances are *not* deleted by default. To specify that all associated process instances are deleted when a process definition is deleted, set `deleteInstances=true` in the delete request. For example:

  ```
  curl \
   --header "X-OpenIDM-Username: openidm-admin" \
   --header "X-OpenIDM-Password: openidm-admin" \
   --header "If-Match: *" \
   --request DELETE \
   "http://localhost:8080/openidm/workflow/processdefinition/managedUserApproval:1:3?deleteInstances=true"
  ```

openidm/workflow/processinstance

- Start a workflow process instance. For example:

```
$ curl \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --data '{"_key":"managedUserApproval"}' \
 --request POST \
 "http://localhost:8080/openidm/workflow/processinstance?_action=create"
{
  "_id" : "42",
  "processInstanceId" : "42",
  "processDefinitionId" : "managedUserApproval:1:4",
  "businessKey" : null,
  "status" : "suspended"
}
```

- Obtain the list of running workflows (process instances). The query returns a list of IDs. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/processinstance?_queryId=query-all-ids"
{
  "result" : [ {
    "_id" : "42",
    "businessKey" : null,
    "deleteReason" : null,
    "durationInMillis" : null,
    "endActivityId" : null,
    "endTime" : null,
    "processDefinitionId" : "managedUserApproval:1:4",
    "processInstanceId" : "42",
    "processVariables" : { },
    "queryVariables" : null,
    "startActivityId" : "start",
    "startTime" : "2018-01-09T14:15:36.550Z",
    "startUserId" : "openidm-admin",
    "superProcessInstanceId" : null,
    "tenantId" : "",
    "processDefinitionResourceName" : "Managed User Approval Workflow"
  } ],
  "resultCount" : 1,
  "pagedResultsCookie" : null,
  "totalPagedResultsPolicy" : "NONE",
  "totalPagedResults" : -1,
  "remainingPagedResults" : -1
}
```

- Obtain the list of running workflows based on specific filter criteria.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/processinstance?_queryId=filtered-
query&businessKey=myBusinessKey"
```

openidm/workflow/processinstance/{id}

- Obtain the details of the specified process instance. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/processinstance/42"
{
  "_id" : "42",
  "businessKey" : null,
  "deleteReason" : null,
  "durationInMillis" : null,
  "endActivityId" : null,
  "endTime" : null,
  "processDefinitionId" : "managedUserApproval:1:4",
  "processInstanceId" : "42",
  "processVariables" : {
    ...
  },
  "queryVariables" : [ {
    ...
  } ],
  "startActivityId" : "start",
  "startTime" : "2018-01-09T14:15:36.550Z",
  "startUserId" : "openidm-admin",
  "superProcessInstanceId" : null,
  "tenantId" : "",
  "openidmObjectId" : "openidm-admin",
  "processDefinitionResourceName" : "Managed User Approval Workflow",
  "tasks" : [ {
    ...
  } ]
}
```

- Stop the specified process instance. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request DELETE \
 "http://localhost:8080/openidm/workflow/processinstance/42"
{
  "_id" : "42",
  "businessKey" : null,
  "deleteReason" : null,
  "durationInMillis" : null,
  "endActivityId" : null,
  "endTime" : null,
  "processDefinitionId" : "managedUserApproval:1:4",
  "processInstanceId" : "42",
  "processVariables" : { },
  "queryVariables" : null,
  "startActivityId" : "start",
  "startTime" : "2018-01-09T14:15:36.550Z",
  "startUserId" : "openidm-admin",
  "superProcessInstanceId" : null,
  "tenantId" : ""
}
```

The delete request returns the contents of the deleted process instance.

openidm/workflow/processinstance/history

- List the running and completed workflows (process instances).

  The following query returns two process instances - one that has completed (`"endActivityId": "end"`) and one that is still running (`"endActivityId": null`):

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/processinstance/history?_queryId=query-all-ids"
{
  "result" : [ {
    "_id" : "35",
    "businessKey" : null,
    "deleteReason" : "Deleted by Openidm",
    "durationInMillis" : 310686,
    "endActivityId" : null,
    "endTime" : "2018-01-09T14:20:28.342Z",
    "processDefinitionId" : "managedUserApproval:1:4",
    "processInstanceId" : "35",
    "processVariables" : { },
    "queryVariables" : null,
    "startActivityId" : "start",
    "startTime" : "2018-01-09T14:15:17.656Z",
    "startUserId" : "openidm-admin",
    "superProcessInstanceId" : null,
    "tenantId" : "",
    "processDefinitionResourceName" : "Managed User Approval Workflow"
  }, {
```

```
    "_id" : "42",
    "businessKey" : null,
    "deleteReason" : null,
    "durationInMillis" : null,
    "endActivityId" : null,
    "endTime" : null,
    "processDefinitionId" : "managedUserApproval:1:4",
    "processInstanceId" : "42",
    "processVariables" : { },
    "queryVariables" : null,
    "startActivityId" : "start",
    "startTime" : "2018-01-09T14:15:36.550Z",
    "startUserId" : "openidm-admin",
    "superProcessInstanceId" : null,
    "tenantId" : "",
    "processDefinitionResourceName" : "Managed User Approval Workflow"
  } ],
  "resultCount" : 2,
  "pagedResultsCookie" : null,
  "totalPagedResultsPolicy" : "NONE",
  "totalPagedResults" : -1,
  "remainingPagedResults" : -1
}
```


- Obtain the list of running and completed workflows, based on specific filter criteria.

  The following command returns the running and completed workflows that were launched by `user.0`.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/processinstance/history?_queryId=filtered-
query&startUserId=user.0"
{
  "result" : [ {
    "_id" : "79",
    "businessKey" : null,
    "deleteReason" : null,
    "durationInMillis" : null,
    "endActivityId" : null,
    "endTime" : null,
    "processDefinitionId" : "managedUserApproval:1:4",
    "processInstanceId" : "79",
    "processVariables" : { },
    "queryVariables" : null,
    "startActivityId" : "start",
    "startTime" : "2018-01-09T14:35:02.514Z",
    "startUserId" : "user.0",
    "superProcessInstanceId" : null,
    "tenantId" : "",
    "processDefinitionResourceName" : "Managed User Approval Workflow"
  } ],
  "resultCount" : 1,
  "pagedResultsCookie" : null,
  "totalPagedResultsPolicy" : "NONE",
  "totalPagedResults" : -1,
  "remainingPagedResults" : -1
}
```

For large result sets, you can use the `_sortKeys` parameter with a `filtered-query` to order search results by one or more fields. You can prefix a `-` character to the field name to specify that results should be returned in descending order, rather than ascending order.

The following query orders results according to their `startTime`. The `-` character in this case indicates that results should be sorted in reverse order, that is, with the most recent results returned first.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/processinstance/history?_queryId=filtered-query&_sortKeys=-
startTime"
{
  "result" : [ {
    "_id" : "79",
    "businessKey" : null,
    "deleteReason" : null,
    "durationInMillis" : null,
    "endActivityId" : null,
    "endTime" : null,
    "processDefinitionId" : "managedUserApproval:1:4",
    "processInstanceId" : "79",
    "processVariables" : { },
```

```
    "queryVariables" : null,
    "startActivityId" : "start",
    "startTime" : "2018-01-09T14:35:02.514Z",
    "startUserId" : "user.0",
    "superProcessInstanceId" : null,
    "tenantId" : "",
    "processDefinitionResourceName" : "Managed User Approval Workflow"
   }, {
    "_id" : "42",
    "businessKey" : null,
    "deleteReason" : "Deleted by Openidm",
    "durationInMillis" : 347254,
    "endActivityId" : null,
    "endTime" : "2018-01-09T14:21:23.804Z",
    "processDefinitionId" : "managedUserApproval:1:4",
    "processInstanceId" : "42",
    "processVariables" : { },
    "queryVariables" : null,
    "startActivityId" : "start",
    "startTime" : "2018-01-09T14:15:36.550Z",
    "startUserId" : "openidm-admin",
    "superProcessInstanceId" : null,
    "tenantId" : "",
    "processDefinitionResourceName" : "Managed User Approval Workflow"
   }, {
    "_id" : "6",
    "businessKey" : "sourceId: bjensen, targetId: undefined, reconId: 89945d65-9a5f-4dc5-b201-
ef6e167c2921-703",
    "deleteReason" : "Deleted by Openidm",
    "durationInMillis" : 695804,
    "endActivityId" : null,
    "endTime" : "2018-01-09T14:20:35.272Z",
    "processDefinitionId" : "managedUserApproval:1:4",
    "processInstanceId" : "6",
    "processVariables" : { },
    "queryVariables" : null,
    "startActivityId" : "start",
    "startTime" : "2018-01-09T14:08:59.468Z",
    "startUserId" : "openidm-admin",
    "superProcessInstanceId" : null,
    "tenantId" : "",
    "processDefinitionResourceName" : "Managed User Approval Workflow"
   } ],
   "resultCount" : 3,
   "pagedResultsCookie" : null,
   "totalPagedResultsPolicy" : "NONE",
   "totalPagedResults" : -1,
   "remainingPagedResults" : -1
}
```


Caution

The Activiti engine treats certain property values as *strings*, regardless of their actual data type. This might result in results being returned in an order that is different to what you might expect. For example, if you wanted to sort the following results by their `_id` field, `"88", "45", "101"`, you would expect them to be

returned in the order `"45", "88", "101"`. Because Activiti treats IDs as strings, rather than numbers, they would be returned in the order `"101", "45", "88"`.

openidm/workflow/processdefinition/{id}/taskdefinition

- Query the list of tasks defined for a specific process definition. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/processdefinition/managedUserApproval:1:4/taskdefinition?
_queryId=query-all-ids"
{
  "result" : [ {
    "_id" : "evaluateRequest",
    "assignee" : {
      "expressionText" : "openidm-admin"
    },
    "categoryExpression" : null,
    "descriptionExpression" : null,
    "dueDate" : 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
    } ]
    },
```

```
    "name" : {
      "expressionText" : "Evaluate request"
    },
    "ownerExpression" : null,
    "priority" : null,
    "taskCandidateGroup" : [ ],
    "taskCandidateUser" : [ ],
    "taskListeners" : {
      "assignment" : [ { } ],
      "create" : [ { } ],
      "complete" : [ {
        "className" : "org.activiti.engine.impl.bpmn.listener.ScriptTaskListener",
        "multiInstanceActivityBehavior" : null
      } ]
    },
    "formResourceKey" : null
  } ],
  "resultCount" : 1,
  "pagedResultsCookie" : null,
  "totalPagedResultsPolicy" : "NONE",
  "totalPagedResults" : -1,
  "remainingPagedResults" : -1
}
```


- Query a task definition based on the process definition ID and the task name (`taskDefinitionKey`). For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/processdefinition/managedUserApproval:1:4/taskdefinition/evaluateRequest"
{
  "_id" : "evaluateRequest",
  "assignee" : {
    "expressionText" : "openidm-admin"
  },
  "categoryExpression" : null,
  "descriptionExpression" : null,
  "dueDate" : 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
    } ]
  },
  "name" : {
    "expressionText" : "Evaluate request"
  },
  "ownerExpression" : null,
  "priority" : null,
  "taskCandidateGroup" : [ ],
  "taskCandidateUser" : [ ],
  "taskListeners" : {
    "assignment" : [ { } ],
    "create" : [ { } ],
    "complete" : [ {
      "className" : "org.activiti.engine.impl.bpmn.listener.ScriptTaskListener",
      "multiInstanceActivityBehavior" : null
    } ]
  }
}
```

openidm/workflow/taskinstance

- Query all running task instances. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/taskinstance?_queryId=query-all-ids"
{
  "result" : [ {
    "_id" : "85",
    "_rev" : "1",
    "activityInstanceVariables" : { },
    "cachedElContext" : null,
    "category" : null,
    "createTime" : "2018-01-09T14:35:02.514Z",
    "delegationState" : null,
    "delegationStateString" : null,
    "deleted" : false,
    "description" : null,
    "dueDate" : null,
    "eventName" : null,
    "executionId" : "79",
    "name" : "Evaluate request",
```

```
    "owner" : null,
    "parentTaskId" : null,
    "priority" : 50,
    "processDefinitionId" : "managedUserApproval:1:4",
    "processInstanceId" : "79",
    "processVariables" : { },
    "queryVariables" : null,
    "revisionNext" : 2,
    "suspended" : false,
    "suspensionState" : 1,
    "taskDefinitionKey" : "evaluateRequest",
    "taskLocalVariables" : { },
    "tenantId" : "",
    "assignee" : "openidm-admin"
  } ],
  "resultCount" : 1,
  "pagedResultsCookie" : null,
  "totalPagedResultsPolicy" : "NONE",
  "totalPagedResults" : -1,
  "remainingPagedResults" : -1
}
```

- Query task instances based on candidate users or candidate groups. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/taskinstance?_queryId=filtered-
query&taskCandidateUser=manager1"
```

or

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/workflow/taskinstance/34"
{
  "_id" : "34",
  "_rev" : "1",
  "activityInstanceVariables" : { },
  "cachedElContext" : null,
```

```
  "category" : null,
  "createTime" : "2018-01-10T11:19:15.699Z",
  "delegationState" : null,
  "delegationStateString" : null,
  "deleted" : false,
  "description" : null,
  "dueDate" : null,
  "eventName" : null,
  "executionId" : "5",
  "name" : "Evaluate request",
  "owner" : null,
  "parentTaskId" : null,
  "priority" : 50,
  "processDefinitionId" : "managedUserApproval:1:4",
  "processInstanceId" : "5",
  "processVariables" : { },
  "queryVariables" : null,
  "revisionNext" : 2,
  "suspended" : false,
  "suspensionState" : 1,
  "taskDefinitionKey" : "evaluateRequest",
  "taskLocalVariables" : { },
  "tenantId" : "",
  "formProperties" : [ {
    "requesterName" : "bjensen"
  }, {
    "requestApproved" : null
  } ],
  "assignee" : "manager",
  "openidmAssigneeId" : "09bd693a-1c73-45d4-b33b-b0ddfed275be",
  "variables" : {
    "sourceId" : "bjensen",
    "mapping" : "systemCsvfileAccounts_managedUser",
    "openidmObjectId" : "openidm-admin",
    "ambiguousTargetIds" : null,
    "action" : "CREATE",
    "linkQualifier" : "default",
    "_action" : "performAction",
    "reconId" : "bbaa07d5-4d08-4406-80cd-05d7beaa786e-847",
    "situation" : "ABSENT"
  },
  "candidates" : {
    "candidateUsers" : [ "manager" ],
    "candidateGroups" : [ ]
  }
}
```


- Update task-related data stored in the Activiti workflow engine. For example:

```
$ curl \
 --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"}' \
 "http://localhost:8080/openidm/workflow/taskinstance/34"
```

Note that you can only update the following attributes of a task:

`assignee`
`description`
`name`
`owner`

Changes to any other attribute are silently discarded.

- Complete the specified task. The variables required by the task are provided in the request body. For example:

```
$ curl \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '{"requestApproved":"true"}' \
 "http://localhost:8080/openidm/workflow/taskinstance/34?_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 \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '{"userId":"manager1"}' \
 "http://localhost:8080/openidm/workflow/taskinstance/34?_action=claim"
```

Chapter 23
Setting Up Audit Logging

The audit service publishes and logs information to one or more specified targets, including local data files, the repository, and remote systems.

Audit logs help you to record activity by account. With audit data, you can monitor logins, identify problems such as unresponsive devices, and collect information to comply with regulatory requirements.

The audit service logs information related to the following events: system access, system activity, authentication operations, configuration changes, reconciliations, and synchronizations. You can customize what is logged for each event type. Auditing provides the data for all relevant reports, including those related to orphan accounts.

When you first start IDM, an audit log file is created in the `/path/to/openidm/audit` directory, for each configured audit event topic. These files remain empty until there is a corresponding event to be audited.

Once IDM sends data to these audit logs, you can query them over the REST interface. For more information, see "Querying Audit Logs Over REST".

23.1. Configuring the Audit Service

The audit logging configuration is accessible over REST under the `openidm/config/audit` context path and in the file *`project-dir`*`/conf/audit.json`. To configure the audit service, edit the `audit.json` file or use the Admin UI. Select Configure > System Preferences and click on the Audit tab. The fields on that form correspond to the configuration parameters described in this section.

The following list describes the major options that you can configure for the audit service.

- IDM provides a number of configurable *audit event handlers*. These audit event handlers are listed in the `availableAuditEventHandlers` property in your project's `conf/audit.json` file.

  For details of each audit event handler, see "Choosing Audit Event Handlers".

- You *must* configure one audit event handler to manage queries on the audit logs.

  For more information, see "Specifying the Audit Query Handler".

- To configure the audit service to log an event, include it in the list of `events` for the specified audit event handler.

For more information, see "Logging Audit Events".

- You can allow a common `transactionId` for audit data from all ForgeRock products. To do so, edit the `system.properties` file in your *`project-dir`*`/conf` directory and set:

```
org.forgerock.http.TrustTransactionHeader=true
```

23.2. Specifying the Audit Query Handler

By default, queries on the audit logs are managed by the JSON audit event handler. You can configure one of the other available event handlers to handle queries. The audit event handler that you configure to manage queries must be `enabled`, either by including its definition in `audit.json`, or setting it to Enabled in the Admin UI.

To specify which audit event handler should be used for queries, set the `handlerForQueries` property in the `audit.json` file, as follows:

```
{
    "auditServiceConfig" : {
        "handlerForQueries" : "json",
        "availableAuditEventHandlers" : [
            "org.forgerock.audit.handlers.csv.CsvAuditEventHandler",
            "org.forgerock.audit.handlers.elasticsearch.ElasticsearchAuditEventHandler",
            "org.forgerock.audit.handlers.jms.JmsAuditEventHandler",
            "org.forgerock.audit.handlers.json.JsonAuditEventHandler",
            "org.forgerock.audit.handlers.json.stdout.JsonStdoutAuditEventHandler",
            "org.forgerock.openidm.audit.impl.RepositoryAuditEventHandler",
            "org.forgerock.openidm.audit.impl.RouterAuditEventHandler",
            "org.forgerock.audit.handlers.splunk.SplunkAuditEventHandler",
            "org.forgerock.audit.handlers.syslog.SyslogAuditEventHandler"
        ],
    ...
}
```

In this case, the `handlerForQueries` is set to `json`, which is the `name` of the `JsonAuditEventHandler`.

Important

- Do not use a file-based audit event handler, such as CSV or JSON, to handle queries *in a clustered environment*. Rather use the repo audit event handler or an external database for queries, in conjunction with your file-based audit handler.

  In a clustered environment, file-based audit logs are really useful only for offline review and parsing with external tools.

  You can use a file-based audit handler for queries in a non-clustered demonstration or evaluation environment. However, be aware that these handlers do not implement paging, and are therefore subject to general query performance limitations.

- The JMS, Syslog, and Splunk handlers can *not* be used as the handler for queries.

- Logging via CSV or JSON may lead to errors in one or more mappings in the Admin UI.

23.3. Choosing Audit Event Handlers

An audit event handler manages audit events, sends audit output to a defined location, and controls the output format. Several default audit event handlers are provided, plus audit event handlers for third-party log management tools, as described in "*Audit Log Reference*".

Each audit event handler has a set of basic configuration properties, listed in "Common Audit Event Handler Property Configuration". Specific audit event handlers have additional configuration properties described, per handler, in "Audit Event Handler Configuration".

The following sections illustrate how you can configure the standard audit event handlers. For additional audit event handlers, see "*Audit Log Reference*".

23.3.1. JSON Audit Event Handler

The JSON audit event handler logs events as JSON objects to a set of JSON files. This is the default handler for queries on the audit logs.

The following excerpt of an `audit.json` file shows a sample JSON audit event handler configuration:

```
"eventHandlers" : [
    {
        "class" : "org.forgerock.audit.handlers.json.JsonAuditEventHandler",
        "config" : {
            "name" : "json",
            "logDirectory" : "&{idm.data.dir}/audit",
            "buffering" : {
                "maxSize" : 100000,
                "writeInterval" : "100 millis"
            },
            "topics" : [
                "access",
                "activity",
                "recon",
                "sync",
                "authentication",
                "config"
            ]
        }
    },
```

A JSON audit event handler configuration includes the following mandatory properties:

`name`

The audit event handler name (`json`).

`logDirectory`

The name of the directory in which the JSON log files should be written, relative to the *working location*. For more information on the working location, see "Specifying the Startup Configuration".

You can use property value substitution to direct log files to another location on the filesystem. For more information, see "Using Property Value Substitution".

`buffering` - `maxSize`

The maximum number of events that can be buffered. The default (and minimum) number of buffered events is 100000.

`buffering` - `writeInterval`

The delay after which the file-writer thread is scheduled to run after encountering an empty event buffer. The default delay is 100 milliseconds.

`topics`

The list of topics for which audit events are logged.

One JSON file is created for each audit topic that is included in this list:

- `access.audit.json`
- `activity.audit.json`
- `authentication.audit.json`
- `config.audit.json`
- `recon.audit.json`
- `sync.audit.json`

For a description of all the configurable properties of the JSON audit event handler, see "JSON Audit Event Handler `config` Properties".

The following excerpt of an `authentication.audit.json` file shows the log message format for authentication events:

```
{
 "context": {
  "ipAddress": "0:0:0:0:0:0:0:1"
 },
 "entries": [{
  "moduleId": "JwtSession",
  "result": "FAILED",
  "reason": {},
  "info": {}
 },
 ...
 {
  "moduleId": "INTERNAL_USER",
  "result": "SUCCESSFUL",
```

```
  "info": {
   "org.forgerock.authentication.principal": "openidm-admin"
  }
 }],
 "principal": ["openidm-admin"],
 "result": "SUCCESSFUL",
 "userId": "openidm-admin",
 "transactionId": "94b9b85f-fbf1-4c4c-8198-ab1ff52ed0c3-24",
 "timestamp": "2016-10-11T12:12:03.115Z",
 "eventName": "authentication",
 "trackingIds": ["5855a363-a1e0-4894-a2dc-fd5270fb99d1"],
 "_id": "94b9b85f-fbf1-4c4c-8198-ab1ff52ed0c3-30"
} {
 "context": {
  "component": "internal/user",
  "roles": ["internal/role/openidm-admin", "internal/role/openidm-authorized"],
  "ipAddress": "0:0:0:0:0:0:0:1",
  "id": "openidm-admin",
  "moduleId": "INTERNAL_USER"
 }...
```

23.3.2. JSON Standard Output Audit Event Handler

Standard output is also known as `stdout`. A JSON stdout handler sends messages to standard output. The following code is an excerpt of the `audit.json` file, which depicts a sample JSON stdout audit event handler configuration:

```
{
    "class" : "org.forgerock.audit.handlers.json.stdout.JsonStdoutAuditEventHandler",
    "config" : {
        "elasticsearchCompatible" : true,
        "name" : "StdOut",
        "topics" : [
            "config",
            "activity",
            "authentication",
            "access",
            "recon",
            "sync"
        ],
        "enabled" : true
    }
}...
```

There's one optional property of interest, `elasticSearchCompatible`, which would work with "Elasticsearch Audit Event Handler".

Audit file names are fixed and correspond to the event being audited:

`access.audit.json`
`activity.audit.json`
`authentication.audit.json`
`config.audit.json`
`recon.audit.json`

`sync.audit.json`

23.3.2.1. Configuring the JSON Standard Output Audit Handler via the UI

To configure this event handler through the Admin UI, click Configure > System Preferences > Audit. Select `JsonStdoutAuditEventHandler` from the drop-down text box, select Add Event Handler, and configure it in the window that appears.

23.3.3. CSV Audit Event Handler

The CSV audit event handler logs events to a comma-separated value (CSV) file.

Important

The CSV handler does not sanitize messages when writing to CSV log files.

Do not open CSV logs in spreadsheets and other applications that treat data as code.

The following excerpt of the `audit.json` file depicts a sample CSV handler configuration:

```
"eventHandlers" : [
{
    "class" : "org.forgerock.audit.events.handlers.csv.CSVAuditEventHandler",
    "config" : {
        "name" : "csv",
        "logDirectory" : "&{idm.data.dir}/audit",
        "topics" : [ "access", "activity", "recon", "sync", "authentication", "config" ]
    }
}
```

The `logDirectory` property indicates the name of the directory in which log files should be written, relative to the *working location*. For more information on the working location, see "Specifying the Startup Configuration".

You can use property value substitution to direct logs to another location on the filesystem. For more information, see "Using Property Value Substitution".

If you set up a custom CSV handler, you may configure over 20 different properties, as described in "Common Audit Event Handler Property Configuration".

Audit file names are fixed and correspond to the event being audited:

`access.csv`
`activity.csv`
`authentication.csv`
`config.csv`
`recon.csv`
`sync.csv`

23.3.3.1. Minimum Admin UI CSV Audit Handler Configuration Requirements

If you configure the CSV handler in the Admin UI, set at least the following properties:

- The `logDirectory`, the full path to the directory with audit logs, such as `/path/to/openidm/audit`. You can substitute &{idm.install.dir} for `/path/to/openidm`.
- Differing entries for the quote character, `quoteChar` and delimiter character, `delimiterChar`.

  After you have set these options, *do not change them* through the Admin UI. Rather, rotate any CSV audit files and edit the configuration properties directly in the `audit.json` file. Changing the properties in the Admin UI generates an error in the console.
- If you enable the CSV tamper-evident configuration, include the `keystoreHandlerName`, *or* a `filename` and `password`. Do not include all three options.

  Before including tamper-evident features in the audit configuration, set up the keys as described in "Configuring Keys to Protect Audit Logs Against Tampering".

Note

The `signatureInterval` property supports time settings in a human-readable format (default = 1 hour). Examples of allowable `signatureInterval` settings are:

- 3 days, 4 m
- 1 hour, 3 sec

Allowable time units include:

- days, day, d
- hours, hour, h
- minutes, minute, min, m
- seconds, second, sec, s

23.3.3.2. Configuring Keys to Protect Audit Logs Against Tampering

If the integrity of your audit files is important, you can configure the CSV handler for tamper detection. Before you do so, you must set the keys required to support tamper detection.

IDM includes a Java Cryptography Extension Keystore (JCEKS), `keystore.jceks`, in the `/path/to/openidm/security` directory.

You'll need to initialize a key pair using the RSA encryption algorithm, using the SHA256 hashing mechanism.

```
$ cd /path/to/openidm
$ keytool \
 -genkeypair \
 -alias "Signature" \
 -dname CN=openidm \
 -keystore security/keystore.jceks \
 -storepass changeit \
 -storetype JCEKS \
 -keypass changeit \
 -keyalg RSA \
 -sigalg SHA256withRSA
```

You can now set up a secret key, in Hash-based message authentication code, using the SHA256 hash function (HmacSHA256)

```
$ keytool \
 -genseckey \
 -alias "Password" \
 -keystore security/keystore.jceks \
 -storepass changeit \
 -storetype JCEKS \
 -keypass changeit \
 -keyalg HmacSHA256 \
 -keysize 256
```

To verify your new entries, run the following command:

```
$ keytool \
 -list \
 -keystore security/keystore.jceks \
 -storepass changeit \
 -storetype JCEKS
    Keystore type: JCEKS
Keystore provider: SunJCE

Your keystore contains 5 entries

signature, May 10, 2016, PrivateKeyEntry,
Certificate fingerprint (SHA1): 62:2E:E4:36:74:F1:7F:E9:06:08:8D:77:82:1C:F6:D4:05:D1:20:01
openidm-sym-default, May 10, 2016, SecretKeyEntry,
password, May 10, 2016, SecretKeyEntry,
openidm-selfservice-key, May 10, 2016, SecretKeyEntry,
openidm-localhost, May 10, 2016, PrivateKeyEntry,
Certificate fingerprint (SHA1): 31:D2:33:93:E3:63:E8:06:66:CC:C1:4F:7F:DF:0A:F8:C4:D8:0E:BD
```

23.3.3.3. Configuring Tamper Protection for CSV Audit Logs

Tamper protection can ensure the integrity of audit logs written to CSV files. You can activate tamper protection in the `audit.json` file directly, or by editing the CSV Audit Event Handler through the Admin UI.

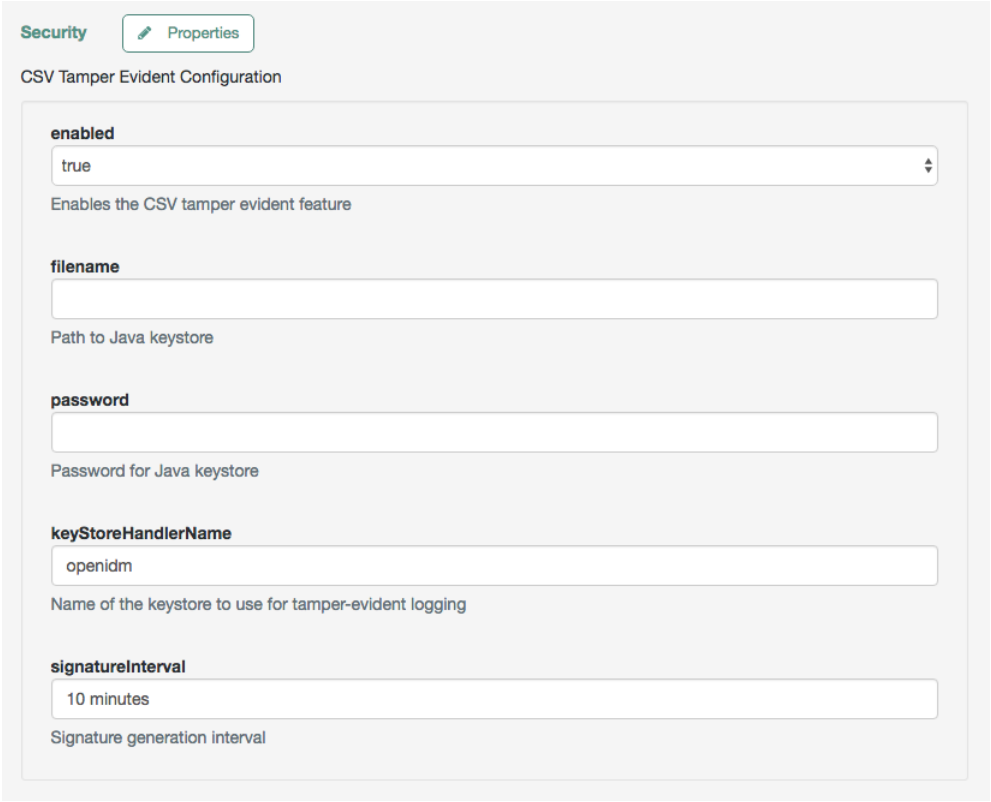
Once configured, the relevant code snippet in your *`project-dir`*`/conf/audit.conf` file should appear as follows:

```
{
   "class" : "org.forgerock.audit.handlers.csv.CsvAuditEventHandler",
   "config" : {
   ...
      "security" : {
        "enabled" : true,
        "filename" : "",
        "password" : "",
        "keyStoreHandlerName" : "openidm",
        "signatureInterval" : "10 minutes"
      },
     ...
```

This particular code snippet reflects a tamper-evident configuration where a signature is written to a new line in each CSV file, every 10 minutes. That signature uses the default keystore, configured in the *install-dir*`/resolver/boot.properties` file. The properties are described in "Common Audit Event Handler Property Configuration".

To import a certificate into the keystore, or create your own self-signed certificate, read "Configuring Keys to Protect Audit Logs Against Tampering".

To make these same changes in the Admin UI, log into `https://localhost:8443/admin`, and click Configure > System Preferences > Audit. You can either edit an existing CSV audit event handler, or create one of your own, with the options just described.



Before saving these tamper-evident changes to your audit configuration, move or delete any current audit CSV files with commands such as:

```
$ cd /path/to/openidm
$ mv audit/*.csv /tmp
```

Once you've saved tamper-evident configuration changes, you should see the following files in the `/path/to/openidm/audit` directory:

```
tamper-evident-access.csv
tamper-evident-access.csv.keystore
tamper-evident-activity.csv
tamper-evident-activity.csv.keystore
tamper-evident-authentication.csv
tamper-evident-authentication.csv.keystore
tamper-evident-config.csv
tamper-evident-config.csv.keystore
tamper-evident-recon.csv
tamper-evident-recon.csv.keystore
tamper-evident-sync.csv
tamper-evident-sync.csv.keystore
```

23.3.3.4. Checking the Integrity of Audit Log Files

Now that you've configured keystore and tamper-evident features, you can periodically check the integrity of your log files.

For example, the following command can verify the CSV files in the **--archive** subdirectory (`audit/`), which belong to the access **--topic**, verified with the `keystore.jceks` keystore, using the CSV audit handler bundle, `forgerock-audit-handler-csv-version.jar`:

```
$ java -jar \
bundle/forgerock-audit-handler-csv-version.jar
 \
--archive audit/
 \
--topic access
 \
--keystore security/keystore.jceks
 \
--password changeit
```

If there are changes to your `tamper-evident-access.csv` file, you'll see a message similar to:

```
    FAIL tamper-evident-access.csv-2016.05.10-11.05.43 The HMac at row 3 is not correct.
```

Note

Note the following restrictions on verification of CSV audit files:

- You can only verify audit files that have already been rotated. You cannot verify an audit file that is currently being written to.
- Verification of tampering is supported only for CSV audit files with the following format:

```
"formatting" : {
    "quoteChar" : "\"",
    "delimiterChar" : ",",
    "endOfLineSymbols" : "\n"
},
```

- A tamper-evident audit configuration rotates files automatically and pairs the rotated file with the required keystore file. Files that are rotated manually cannot be verified as the required keystore information is not appended.

23.3.4. Router Audit Event Handler

The router audit event handler logs events to any external or custom endpoint, such as `system/scriptedsql` or `custom-endpoint/myhandler`. It uses target-assigned values of `_id`.

A sample configuration for a `router` event handler is provided in the `audit.json` file in the `openidm/samples/audit-jdbc/conf` directory, and described in "About the Configuration Files" in the *Samples*

Guide. This sample directs log output to a JDBC repository. The audit configuration file (`conf/audit.json`) for the sample shows the following event handler configuration:

```
{
    "class": "org.forgerock.openidm.audit.impl.RouterAuditEventHandler",
    "config": {
        "name": "router",
        "topics" : [ "access", "activity", "recon", "sync", "authentication", "config" ],
        "resourcePath" : "system/auditdb"
    }
},
```

The `resourcePath` property in the configuration indicates that logs should be directed to the `system/auditdb` endpoint. This endpoint, and the JDBC connection properties, are defined in the connector configuration file (`conf/provisioner.openicf-auditdb.json`), as follows:

```
{
    "configurationProperties" : {
        "username" : "root",
        "password" : "password",
        "driverClassName" : "com.mysql.jdbc.Driver",
        "url" : "jdbc:mysql://&{openidm.repo.host}:&{openidm.repo.port}/audit",
        "autoCommit" : true,
        "reloadScriptOnExecution" : false,
        "jdbcDriver" : "com.mysql.jdbc.Driver",
        "scriptRoots" : ["&{idm.instance.dir}/tools"],
        "createScriptFileName" : "CreateScript.groovy",
        "testScriptFileName" : "TestScript.groovy",
        "searchScriptFileName" : "SearchScript.groovy"
    },
...
```

Include the correct URL or IP address of your remote JDBC repository in the `boot.properties` file for your project.

When JSON information is sent to the router audit event handler, the value of `_id` is replaced with `eventId`.

23.3.5. Repository Audit Event Handler

The repository audit event handler sends information to a JDBC repository. Note that if you are using ForgeRock Directory Services (DS) as the repository, you cannot enable this audit event handler because audit data cannot be stored in DS.

- Log entries are stored in the following tables of a JDBC repository:

  1. `auditaccess`
  2. `auditactivity`
  3. `auditauthentication`
  4. `auditconfig`

5. `auditrecon`
6. `auditsync`

You can use the repository audit event handler to generate reports that combine information from multiple tables.

Each of these JDBC tables maps to an object in the database table configuration file (`repo.jdbc.json`). The following excerpt of that file illustrates the mappings for the `auditauthentication` table:

```
"audit/authentication" : {
    "table" : "auditauthentication",
    "objectToColumn" : {
        "_id" : "objectid",
        "transactionId" : "transactionid",
        "timestamp" : "activitydate",
        "userId" : "userid",
        "eventName" : "eventname",
        "result" : "result",
        "principal" : {"column" : "principals", "type" : "JSON_LIST"},
        "context" : {"column" : "context", "type" : "JSON_MAP"},
        "entries" : {"column" : "entries", "type" : "JSON_LIST"},
        "trackingIds" : {"column" : "trackingids", "type" : "JSON_LIST"},
    }
},
```

The tables correspond to the `topics` listed in the `audit.json` file. For example:

```
{
    "class": "org.forgerock.openidm.audit.impl.RepositoryAuditEventHandler",
    "config": {
        "name": "repo",
        "topics" : [ "access", "activity", "recon", "sync", "authentication", "config" ]
    }
},
```

23.3.6. JMS Audit Event Handler

When IDM creates auditable information, it can use a Java Message Service (JMS) Audit Event Handler. The Java Message Service (JMS) is a Java API for sending asynchronous messages between clients. The JMS Audit Event Handler can send information to message brokers, which can then forward that information to external log analysis systems.

The JMS Audit Event Handler can work with the following message brokers:

- *Apache ActiveMQ*. For a demonstration, see "*Directing Audit Information To a JMS Broker*" in the *Samples Guide*.
- *TIBCO Enterprise Message Service*, as described in this chapter.

This implementation supports the *publish/subscribe* model. For more information, see *Basic JMS API Concepts*.

As with other audit event handlers, you can configure it directly through the `conf/audit.json` file for your project or through the Admin UI.

Tip

The JMS audit event handler does not support queries. If you enable JMS, and want Audit Event query support, you must also enable a second handler that supports queries. You'll see that handler in the `audit.json` file with the `handlerForQueries` property, or in the Admin UI with the `Use For Queries` option.

The JMS audit event handler supports JMS communication, based on the following components:

- A JMS message broker, which provides clients with connectivity, along with message storage and message delivery functionality.
- JMS messages, which follow a specific format described in "JMS Message Format".
- Destinations are external to IDM and the message broker. IDM, which includes the audit service, is a producer and not a destination. IDM sends messages to a topic in a message broker. Consumers (clients) can subscribe to the message broker.
- JMS Topics differ from ForgeRock audit events, which are listed as `topics` in your project's `audit.json` file. For more information on JMS topics, see the following link on the publish/subscribe model. In contrast, ForgeRock audit event topics specify categories of events, which may include access, activity, authentication, configuration, reconciliation, and synchronization. These topics can be published via the audit handler(s).

In the following sections, you can configure the JMS audit event handler in the Admin UI, and through your project's `audit.json` file. For detailed configuration options, see "JMS Audit Event Handler Unique `config` Properties". But first, you should add several bundles to your deployment.

23.3.6.1. Adding the Dependencies for JMS Messaging

The JMS audit event handler requires ActiveMQ, and a number of dependencies. This section lists the dependencies, where they can be downloaded, and where they must be installed in the OpenIDM instance.

This sample was tested with the versions of the files mentioned in this list. If you use a different ActiveMQ version, the dependency versions might differ.

- Download the ActiveMQ binary from http://activemq.apache.org/download.html. This sample was tested with ActiveMQ 5.15.13.
- Download the ActiveMQ Client that corresponds to your ActiveMQ version from https://repository.apache.org/content/repositories/releases/org/apache/activemq/activemq-client/.
- Download the JmDNS JAR, version 3.4.1.
- Download the *bnd* tool that allows you to create a JAR with OSGi meta data. This sample was tested with **bnd** version 2.4.0, downloaded from https://repo1.maven.org/maven2/biz/aQute/bnd/bnd/.

- Download the Apache Geronimo J2EE management bundle (`geronimo-j2ee-management_1.1_spec-1.0.1.jar`) from https://repo1.maven.org/maven2/org/apache/geronimo/specs/geronimo-j2ee-management_1.1_spec/1.0.1/.
- Download the *hawtbuf* Maven-based protocol buffer compiler (hawtbuf-1.11.jar).

1. Unpack the ActiveMQ binary. For example:

```
$ tar -zxvf ~/Downloads/apache-activemq-5.15.13-bin.tar.gz
```

2. Create a temporary directory, copy the Active MQ Client and `bnd` JAR files to that directory, then change to that directory:

```
$ mkdir ~/Downloads/tmp
$ mv activemq-client-5.15.13.jar ~/Downloads/tmp/
$ mv bnd-2.4.0.jar ~/Downloads/tmp/
$ cd ~/Downloads/tmp/
```

3. Create an OSGi bundle as follows:

   a. In a text editor, create a BND file named `activemq.bnd` with the following contents:

```
version=5.15.13
Export-Package: *;version=${version}
Bundle-Name: ActiveMQ :: Client
Bundle-SymbolicName: org.apache.activemq
Bundle-Version: ${version}
```

   Your `tmp/` directory should now contain the following files:

```
$ ls
activemq-client-5.15.13.jar activemq.bnd   bnd-2.4.0.jar
```

   b. In that same directory, create the OSGi bundle archive file as follows:

```
$ java -jar bnd-2.4.0.jar \
 wrap --properties activemq.bnd \
 --output activemq-client-5.15.13-osgi.jar \
 activemq-client-5.15.13.jar
```

4. Copy the resulting `activemq-client-5.15.13-osgi.jar` file to the `openidm/bundle` directory:

```
$ cp activemq-client-5.15.13-osgi.jar /path/to/openidm/bundle/
```

5. Copy the *Apache Geronimo*, *hawtbuf*, and *JmDNS* JAR files to the `openidm/bundle` directory:

```
$ cp ~/Downloads/geronimo-j2ee-management_1.1_spec-1.0.1.jar /path/to/openidm/bundle/
$ cp ~/Downloads/hawtbuf-1.11.jar /path/to/openidm/bundle/
$ cp ~/Downloads/jmdns-3.4.1.jar /path/to/openidm/bundle
```

Your OpenIDM instance is now ready for you to configure the JMS audit event handler.

23.3.6.2. Configuring JMS at the Admin UI

To configure JMS at the Admin UI, select Configure > System Preferences > Audit. Under Event Handlers, select `JmsAuditEventHandler` and select `Add Event Handler`. You can then configure the JMS audit event handler in the pop-up window that appears. For guidance, see "JMS Configuration File".

23.3.6.3. JMS Configuration File

You can configure JMS directly in the `conf/audit.json` file, or indirectly through the Admin UI. The following code is an excerpt of the audit.json file, which depicts a sample JMS audit event handler configuration:

```
{
  "class" : "org.forgerock.audit.handlers.jms.JmsAuditEventHandler",
  "config" : {
    "name": "jms",
    "enabled" : true,
    "topics": [ "access", "activity", "config", "authentication", "sync", "recon" ],
    "deliveryMode": "NON_PERSISTENT",
    "sessionMode": "AUTO",
    "batch": {
      "batchEnabled": true,
      "capacity": 1000,
      "threadCount": 3,
      "maxBatchedEvents": 100
    },
    "jndi": {
      "contextProperties": {
        "java.naming.factory.initial" : "org.apache.activemq.jndi.ActiveMQInitialContextFactory",
        "java.naming.provider.url" : "tcp://127.0.0.1:61616?daemon=true",
        "topic.forgerock.idm.audit" : "forgerock.idm.audit"
      },
      "topicName": "forgerock.idm.audit",
      "connectionFactoryName": "ConnectionFactory"
    }
  }
}
```

As you can see from the properties, in this configuration, the JMS audit event handler is `enabled`, with `NON_PERSISTENT` delivery of audit events in batches. It is configured to use the Apache ActiveMQ Java Naming and Directory Interface (JNDI) message broker, configured on port 61616. For an example of how to configure Apache ActiveMQ, see "*Directing Audit Information To a JMS Broker*" in the *Samples Guide*.

If you substitute a different JNDI message broker, you'll have to change the `jndi contextProperties`. If you configure the JNDI message broker on a remote system, substitute the associated IP address.

To set up SSL, change the value of the `java.naming.provider.url` to:

```
ssl://127.0.0.1:61617?daemon=true&socket.enabledCipherSuites=
     SSL_RSA_WITH_RC4_128_SHA,SSL_DH_anon_WITH_3DES_EDE_CBC_SHA
```

You'll also need to set up keystores and truststores, as described in "JMS, ActiveMQ, and SSL".

23.3.6.4. JMS, ActiveMQ, and SSL

If the security of your audit data is important, you can configure SSL for JMS. Take the following steps to generate an ActiveMQ broker certificate keystore, a broker export certificate, a client keystore, and a server truststore. You can then import that client certificate into the IDM security truststore.

Note

This section is based in part on the ActiveMQ documentation on *How do I use SSL*. As of this writing, it includes the following caution: "In Linux, do not use absolute path to keystore".

But first, you should export two environment variables:

- Navigate to the directory where you unpacked the ActiveMQ binary:

```
$ cd /path/to/apache-activemq-5.15.13
```

- **ACTIVEMQ_SSL_OPTS**. Set the `ACTIVEMQ_SSL_OPTS` variable to point to the ActiveMQ broker keystore:

```
$ export \
ACTIVEMQ_SSL_OPTS=\
'-Djavax.net.ssl.keyStore=/usr/local/activemq/keystore/broker.ks -Djavax.net.ssl
.keyStorePassword=changeit'
```

- **MAVEN_OPTS** Set the `MAVEN_OPTS` variable, for the sample consumer described in "Configuring and Using a JMS Consumer Application" in the *Samples Guide*:

```
$ export \
MAVEN_OPTS=\
"-Djavax.net.ssl.keyStore=client.ks -Djavax.net.ssl
.keyStorePassword=changeit
-Djavax.net.ssl.trustStore=client.ts -Djavax.net.ssl.trustStorePassword=changeit"
```

Note that these commands use the default keystore `changeit` password. The commands which follow assume that you use the same password when creating ActiveMQ certificates.

- Create an ActiveMQ broker certificate (`broker.ks`):

```
$ keytool \
-genkey
 \
-alias broker
 \
-keyalg RSA
 \
-keystore broker.ks
```

- Export the certificate to `broker_cert`, so you can share it with clients:

```
$ keytool \
-export
 \
-alias broker
 \
-keystore broker.ks
 \
-file broker_cert
```

- Create a client keystore file (`client.ks`):

```
$ keytool \
-genkey
 \
-alias client
 \
-keyalg RSA
 \
-keystore client.ks
```

- Create a client truststore file, `client.ts`, and import the broker certificate, `broker_cert`:

```
$ keytool \
-import
 \
-alias broker
 \
-keystore client.ts
 \
-file broker_cert
```

- Export the client keystore, `client.ks`, into a client certificate file (`client.crt`):

```
$ keytool \
-export
 \
-alias client
 \
-keystore client.ks
 \
--file client.crt
```

- Now make this work with IDM. Import the client certificate file into the IDM truststore:

```
$ keytool \
-import
 \
-trustcacerts
 \
-alias client
 \
-file client.crt
 \
-keystore /path/to/openidm/security/truststore
```

With these certificate files, you can now set up SSL in the ActiveMQ configuration file, `activemq.xml`, in the `/path/to/apache-activemq-5.15.13/conf` directory.

You'll add one line to the `<transportConnectors>` code block with `<transportConnector name="ssl"`, as shown here:

```
<transportConnectors>
     <!-- DOS protection, limit concurrent connections to 1000 and frame size to 100MB -->
     <transportConnector name="openwire" uri="tcp://0.0.0.0:61616?
        maximumConnections=1000&amp;wireFormat.maxFrameSize=104857600"/>
     <transportConnector name="ssl" uri="ssl://0.0.0.0:61617?transport.enabledCipherSuites=
        SSL_RSA_WITH_RC4_128_SHA,SSL_DH_anon_WITH_3DES_EDE_CBC_SHA
        &amp;maximumConnections=1000&amp;wireFormat.maxFrameSize=104857600&transport.daemon=true"/>
     <transportConnector name="amqp" uri="amqp://0.0.0.0:5672?maximumConnections=1000&amp;
        wireFormat.maxFrameSize=104857600"/>
     <transportConnector name="stomp" uri="stomp://0.0.0.0:61613?maximumConnections=1000&amp;
        wireFormat.maxFrameSize=104857600"/>
     <transportConnector name="mqtt" uri="mqtt://0.0.0.0:1883?maximumConnections=1000&amp;
        wireFormat.maxFrameSize=104857600"/>
     <transportConnector name="ws" uri="ws://0.0.0.0:61614?maximumConnections=1000&amp;
        wireFormat.maxFrameSize=104857600"/>
</transportConnectors>
```

Make the corresponding change to your audit configuration file (`audit.json`), as described in "JMS Configuration File".

Start the ActiveMQ event broker and start IDM, as described in "Starting the ActiveMQ Broker and Running the Sample" in the *Samples Guide*.

23.3.6.5. JMS Message Format

The following JMS message reflects the authentication of the `openidm-admin` user, logging into the Admin UI from a remote location, IP address 172.16.209.49.

```
{
  "event": {
    "_id": "134ee773-c081-436b-ae61-a41e8158c712-565",
    "trackingIds": [
      "4dd1f9de-69ac-4721-b01e-666df388fb17",
      "185b9120-406e-47fe-ba8f-e95fd5e0abd8"
    ],
  "context": {
    "id": "openidm-admin",
    "ipAddress": "172.16.209.49",
    "roles": [
      "internal/role/openidm-admin",
      "internal/role/openidm-authorized"
    ],
    "component": "internal/user"
  },
  "entries": [
    {
      "info": {
        "org.forgerock.authentication.principal": "openidm-admin"
      },
      "result": "SUCCESSFUL",
      "moduleId": "JwtSession"
```

```
    }
  ],
  "principal": [
    "openidm-admin"
  ],
    "result": "SUCCESSFUL",
    "userId": "openidm-admin",
    "transactionId": "134ee773-c081-436b-ae61-a41e8158c712-562",
    "timestamp": "2016-04-15T14:57:53.114Z",
    "eventName": "authentication"
  },
  "auditTopic": "authentication"
}
```

23.3.6.6. JMS, TIBCO, and SSL

You can integrate the JMS audit event handler with the *TIBCO Enterprise Message Service*.

You'll need to use two bundles from your TIBCO installation: `tibjms.jar`, and if you're setting up a secure connection, `tibcrypt.jar`. With the following procedure, you'll process `tibjms.jar` into an OSGi bundle:

1. Download the *bnd* JAR for working with OSGi bundles, from bnd-1.50.0.jar. If you've previously set up the ActiveMQ server, as described in "Adding the Dependencies for JMS Messaging", you may have already downloaded this JAR archive.

2. In the same directory, create a file named `tibco.bnd`, and add the following lines to that file:

   ```
   version=8.3.0
   Export-Package: *;version=${version}
   Bundle-Name: TIBCO Enterprise Message Service
   Bundle-SymbolicName: com/tibco/tibjms
   Bundle-Version: ${version}
   ```

3. Add the `tibco.jar` file to the same directory.

4. Run the following command to create the bundle:

   ```
   $ java \
    -jar bnd-1.50.0.jar wrap \
    -properties tibco.bnd tibjms.jar
   ```

5. Rename the newly created `tibjms.bar` file to `tibjms-osgi.jar`, and copy it to the `/path/to/openidm/bundle` directory.

6. If you're configuring SSL, copy the `tibcrypt.jar` file from your TIBCO installation to the `/path/to/openidm/bundle` directory.

You also need to configure your project's `audit.conf` configuration file. The options are similar to those listed earlier in "JMS Configuration File", except for the following `jndi` code block:

```
"jndi": {
   "contextProperties": {
      "java.naming.factory.initial" : "com.tibco.tibjms.naming.TibjmsInitialContextFactory",
      "java.naming.provider.url" : "tibjmsnaming://localhost:7222"
   },
   "topicName": "audit",
   "connectionFactoryName": "ConnectionFactory"
}
```

If your TIBCO server is on a remote system, substitute appropriately for `localhost`. If you're configuring a secure TIBCO installation, you'll want to configure a different code block:

```
"jndi": {
   "contextProperties": {
      "java.naming.factory.initial" : "com.tibco.tibjms.naming.TibjmsInitialContextFactory",
      "java.naming.provider.url" : "ssl://localhost:7243",
      "com.tibco.tibjms.naming.security_protocol" : "ssl",
      "com.tibco.tibjms.naming.ssl_trusted_certs" : "/path/to/tibco/server/certificate/cert.pem",
      "com.tibco.tibjms.naming.ssl_enable_verify_hostname" : "false"
   },
   "topicName": "audit",
   "connectionFactoryName": "SSLConnectionFactory"
}
```

Do not add the TIBCO certificate to the IDM `truststore`. The formats are not compatible.

When this configuration work is complete, don't forget to start your TIBCO server before starting IDM. For more information, see the *TIBCO Enterprise Message Service Users's Guide*.

23.3.7. Elasticsearch Audit Event Handler

You can configure third-party audit event handlers, such as Elasticsearch, to log IDM events in file formats compatible with the Elasticsearch search server. Note that ForgeRock does not endorse or support the use of any third-party tools.

The examples in this section assume that the Elasticsearch search server is configured on the same system as your IDM instance. In a production environment, such third-party tools are more likely to be running on a remote system. If you have configured a third-party tool on a remote system, the reliability of audit data may vary, depending on the reliability of your network connection. However, you can limit the risks with appropriate buffer settings, which can mitigate issues related to your network connection, free space on your system, and related resources such as RAM. (This is not an exhaustive list.)

23.3.7.1. Installing and Configuring Elasticsearch

This appendix assumes that you are installing Elasticsearch on the same system as IDM. For Elasticsearch downloads and installation instructions, see the Elasticsearch *Getting Started* document.

You can set up Elasticsearch Shield with basic authentication to help protect your audit logs. To do so, read the following Elasticsearch document on *Getting Started with Shield*. Follow up with the following Elasticsearch document on how you can *Control Access with Basic Authentication*.

You can configure SSL for Elasticsearch Shield. For more information, see the following Elasticsearch document: *Setting Up SSL/TLS on a Cluster*.

Import the certificate that you use for Elasticsearch into the truststore, with the following command:

```
$ keytool \
 -import \
 -trustcacerts \
 -alias elasticsearch \
 -file /path/to/cacert.pem \
 -keystore /path/to/openidm/security/truststore
```

Once imported, you can activate the `useSSL` option in the `audit.json` file. If you created an Elasticsearch Shield username and password, you can also associate that information with the `username` and `password` entries in that same `audit.json` file.

23.3.7.2. Creating an Audit Index for Elasticsearch

If you want to create an audit index for Elasticsearch, you must set it up *before* starting IDM, for the audit event topics described in this section: "Audit Event Topics".

To do so, execute the REST call shown in the following audit index file. Note the properties that are `not_analyzed`. Such fields are not indexed within Elasticsearch.

The REST call in the audit index file includes the following URL:

```
http://myUsername:myPassword@localhost:9200/audit
```

That URL assumes that your Elasticsearch deployment is on the localhost system, accessible on default port 9200, configured with an `indexName` of `audit`.

It also assumes that you have configured basic authentication on Elasticsearch Shield, with a username of `myUsername` and a password of `myPassword`.

If any part of your Elasticsearch deployment is different, revise the URL accordingly.

Warning

Do not transmit usernames and passwords over an insecure connection. Enable the `useSSL` option, as described in "Configuring the Elasticsearch Audit Event Handler".

23.3.7.3. Configuring the Elasticsearch Audit Event Handler

"Configuring the Elasticsearch Audit Event Handler via the Admin UI" and "Configuring the Elasticsearch Audit Event Handler in `audit.json`" illustrate how you can configure the Elasticsearch Audit Event Handler.

If you activate the Elasticsearch audit event handler, we recommend that you enable buffering for optimal performance, by setting:

```
"enabled" : true,
```

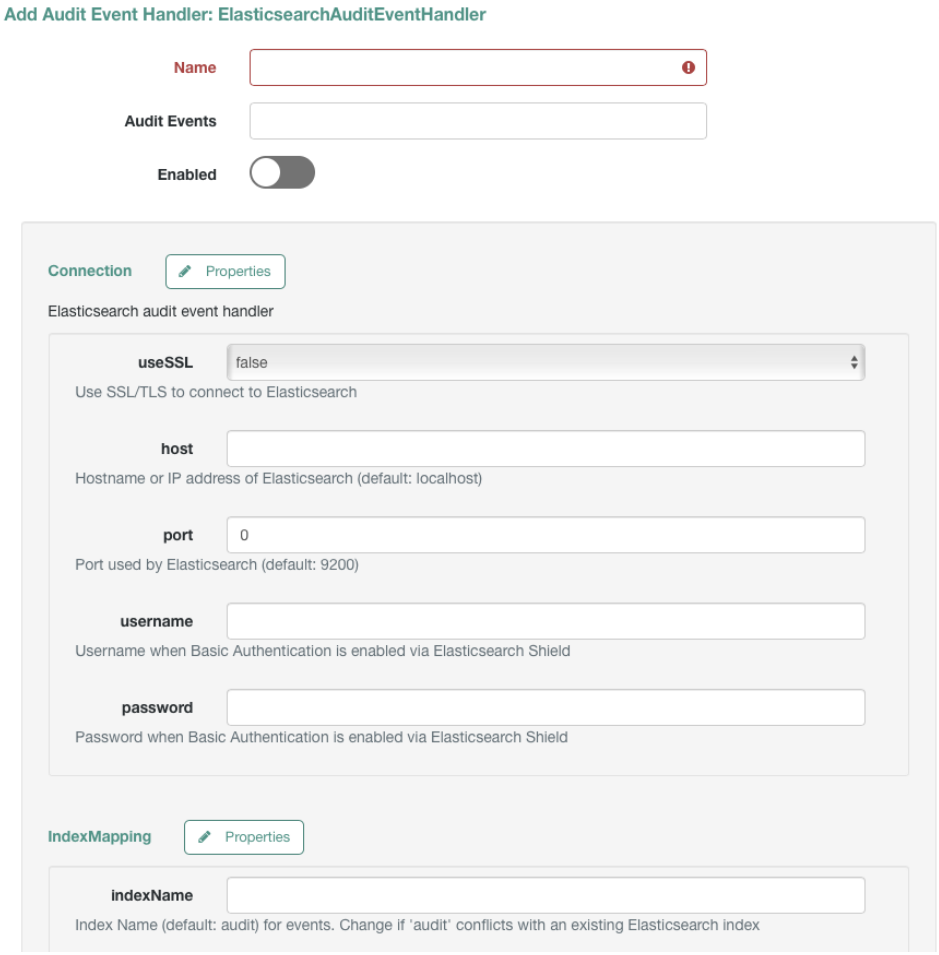
The `buffering` settings shown are not recommendations for any specific environment. If performance and audit data integrity are important in your environment, you may need to adjust these numbers.

If you choose to protect your Elasticsearch deployment with the plugin known as *Shield*, and configure the ability to *Control Access with Basic Authentication*, you can substitute your Elasticsearch Shield `admin` or `power_user` credentials for `myUsername` and `myPassword`.

If you activate the `useSSL` option, install the SSL certificate that you use for Elasticsearch into the IDM keystore. For more information, see "Accessing IDM Keys and Certificates".

23.3.7.3.1. Configuring the Elasticsearch Audit Event Handler via the Admin UI

To configure this event handler through the Admin UI, click Configure > System Preferences > Audit. Select `ElasticsearchAuditEventHandler` from the drop-down text box, click Add Event Handler, and configure it in the window that appears.



For a list of properties, see "Common Audit Event Handler Property Configuration".

23.3.7.3.2. Configuring the Elasticsearch Audit Event Handler in `audit.json`

Alternatively, you can configure the Elasticsearch audit event handler in the `audit.json` file for your project.

The following code is an excerpt from the `audit.json` file, with Elasticsearch configured as the handler for audit queries:

```
{
   "auditServiceConfig" : {
      "handlerForQueries" : "elasticsearch",
      "availableAuditEventHandlers" : [
        "org.forgerock.audit.handlers.csv.CsvAuditEventHandler",
        "org.forgerock.audit.handlers.elasticsearch.ElasticsearchAuditEventHandler",
        "org.forgerock.audit.handlers.jms.JmsAuditEventHandler",
        "org.forgerock.audit.handlers.json.JsonAuditEventHandler",
        "org.forgerock.audit.handlers.json.stdout.JsonStdoutAuditEventHandler",
        "org.forgerock.openidm.audit.impl.RepositoryAuditEventHandler",
        "org.forgerock.openidm.audit.impl.RouterAuditEventHandler",
        "org.forgerock.audit.handlers.splunk.SplunkAuditEventHandler",
        "org.forgerock.audit.handlers.syslog.SyslogAuditEventHandler"
    ],
```

You should also set up configuration for the Elasticsearch event handler. The entries shown are defaults, and can be configured. If you have set up Elasticsearch Shield, with or without SSL/TLS, as described in "Installing and Configuring Elasticsearch", you should change some of these defaults.

```
"eventHandlers" : [
    {
       "name" : "elasticsearch"
       "class" : "org.forgerock.audit.handlers.elasticsearch.ElasticsearchAuditEventHandler",
       "config" : {
          "connection" : {
             "useSSL" : false,
             "host" : "localhost",
             "port" : 9200
          },
          "indexMapping" : {
             "indexName" : "audit"
          },
          "buffering" : {
             "enabled" : false,
             "maxSize" : 20000,
             "writeInterval" : "1 second",
             "maxBatchedEvents" : 500
          },
          "topics" : [
             "access",
             "activity",
             "recon",
             "sync",
             "authentication",
             "config"
          ]
       }
    }
],
```

If you set `useSSL` to true, add the following properties to the `connection` object:

```
"username" : "myUsername",
"password" : "myPassword",
```

For more information on the other options shown in `audit.json`, see "Common Audit Event Handler Property Configuration".

23.3.7.4. Querying and Reading Elasticsearch Audit Events

By default, Elasticsearch uses pagination. As noted in the following Elasticsearch document on *Pagination*, queries are limited to the first 10 results.

For example, the following query is limited to the first 10 results:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request GET \
 "http://localhost:8080/openidm/audit/access?_queryFilter=true"
```

To override the limit of 10 results, follow the guidance shown in "Paging Query Results" for `pageSize`.

To set up a `queryFilter` that uses a "starts with" `sw` or "equals" `eq` comparison expression, you will need to set it up as a `not_analyzed` string field, as described in the following Elasticsearch document on *Term Query.*. You should also review the section on "Comparison Expressions". If you haven't already done so, you may need to modify and rerun the REST call described in "Creating an Audit Index for Elasticsearch".

The `queryFilter` output should include UUIDs as `id` values for each audit event. To read audit data for that event, include that UUID in the URL. For example, the following REST call specifies an access event, which includes data on the client:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request GET
 "http://localhost:8080/openidm/audit/access/75ca07f5-836c-4e7b-beaa-ae968325a529-622"
```

23.3.8. Syslog Audit Event Handler

The Syslog audit event handler lets you log messages to a Syslog server, based on the *Syslog Protocol*.

You can configure the Syslog audit event handler in the Admin UI, or directly through the `audit.json` file for your project. The following excerpt from this file depicts a possible Syslog configuration in `audit.json`:

```
{
    "class" : "org.forgerock.audit.handlers.syslog.SyslogAuditEventHandler",
    "config" : {
        "protocol" : "UDP",
        "host" : "172.16.206.5",
        "port" : 514,
        "connectTimeout" : 5,
        "facility" : "KERN",
        "severityFieldMappings" : [
```

```
            {
                "topic" : "recon",
                "field" : "exception",
                "valueMappings" : {
                    "SEVERE" : "EMERGENCY",
                    "INFO" : "INFORMATIONAL"
                }
            }
        ],
        "buffering" : {
            "enabled" : false
        },
        "name" : "syslog1",
        "topics" : [
            "config",
            "activity",
            "authentication",
            "access",
            "recon",
            "sync"
        ],
        "enabled" : true
    }
}
```

The `name`, `topics`, and `enabled` options in the last part of the excerpt are common to all audit event handlers. For detailed information on the remaining properties, see "Syslog Audit Event Handler Unique `config` Properties".

23.3.9. Splunk Audit Event Handler

The Splunk audit event handler logs IDM events to a Splunk system.

Important

Currently, the Splunk audit event handler can only be used to write events to Splunk. It cannot read or query audit events. You must therefore use the Splunk audit event handler in tandem with another event handler that is configured to handle queries.

Splunk lets you define the structure of the incoming data. To use the event handler with IDM, create a new data Source Type in Splunk that will be associated with the incoming IDM log data. Because the audit event handler users the HTTP endpoints in Splunk, you must also enable a Splunk HTTP Event Collector. The HTTP Event Collector provides an authorization token that allows IDM to log events to Splunk.

The following procedure assumes a Splunk instance running on the same host as IDM. Adjust the instructions for your Splunk system:

1. Create a new source type:

    a. In the Splunk UI, select Data > Source Types > New Source Type.

b. Provide a name for the source type, for example, `openidm`.

c. Under Event Breaks, specify how the incoming messages are split.

   The Splunk audit event handler supports bulk handing, so it passes multiple audit events to Splunk at a time, as a large JSON payload.

   Select Regex and enter `^{` to indicate how the bulk messages are separated.

d. Under Timestamp, click Auto to specify that Splunk should generate the timestamp, then click Save.

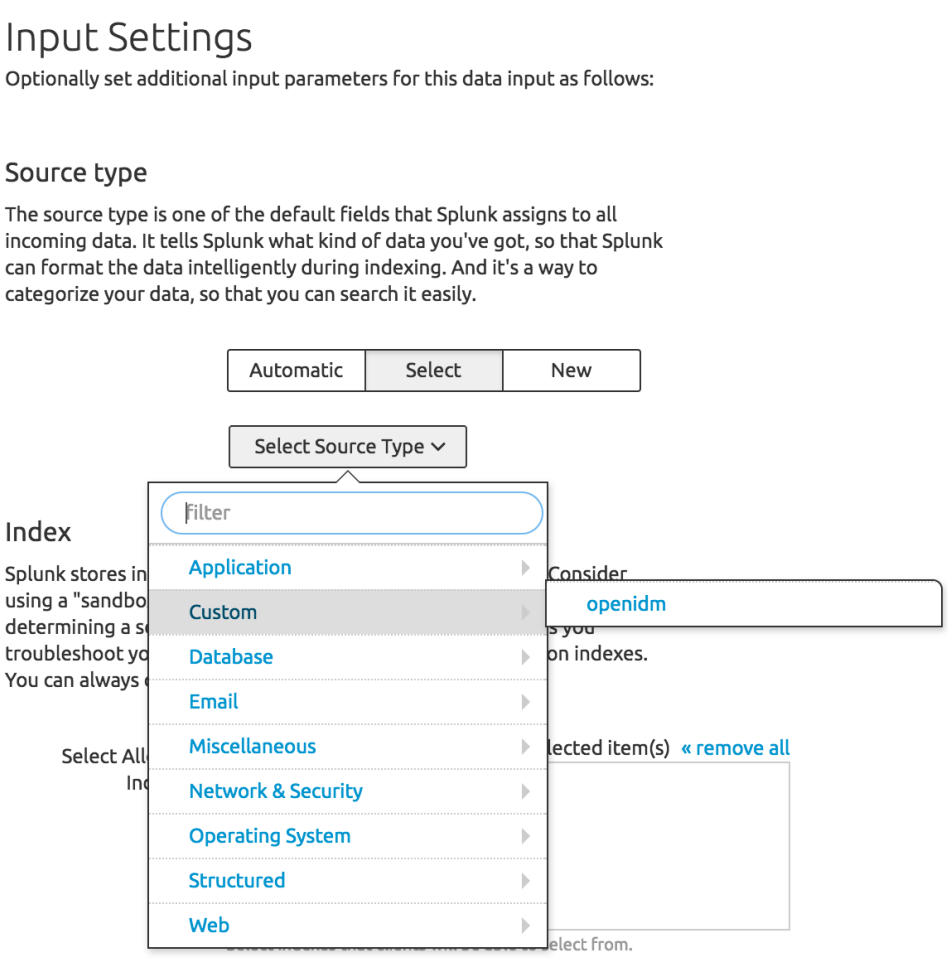
2. Create a new HTTP Event Collector.

   a. Select Data Inputs > HTTP Event Collector > New Token.

   b. Enter a Name that will be associated with this token, for example, `openidm`.

      Other fields are optional.

   c. On the Input Settings screen, click Select under Source Type, then select Custom > openidm from the Select Source Type list.



d. Click Review, then Submit.

> **Important**
>
> Splunk provides the authorization token that you must add as the value of the `authzToken` property in the Splunk audit event handler configuration.

e. Make sure that the Global Settings for HTTP Event Collectors do not conflict with the settings you have configured for this IDM HTTP Event Collector.

To add the Splunk audit event handler to your IDM configuration, update your project's `audit.json` file or select Configure > System Preferences > Audit in the Admin UI, then select SplunkAuditEventHandler and click Add Event Handler.

The following excerpt of an `audit.json` file shows a sample Splunk audit event handler configuration. Adjust the connection settings and `authzToken` to match your Splunk system.

```
{
    "class" : "org.forgerock.audit.handlers.splunk.SplunkAuditEventHandler",
    "config" : {
        "connection" : {
            "useSSL" : false,
            "host" : "localhost",
            "port" : 8088
        },
        "buffering" : {
            "maxSize" : 10000,
            "writeInterval" : "100 ms",
            "maxBatchedEvents" : 500
        },
        "authzToken" : "87E9C00F-F5E6-47CF-B62F-E415A8142355",
        "name" : "Splunk",
        "topics" : [
            "config",
            "activity",
            "authentication",
            "access",
            "recon",
            "sync"
        ],
        "enabled" : true
    }
}
```

All properties are mandatory. For a complete list of the configurable properties for this audit event handler, see "Splunk Audit Event Handler `config` Properties".

23.3.10. Reviewing Active Audit Event Handlers

To review the available audit event handlers, along with each setting shown in the `audit.json` file, use the following command to POST a request for `availableHandlers`:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request POST \
"http://localhost:8080/openidm/audit?_action=availableHandlers"
```

The output includes a full set of options for each audit event handler, which have been translated in the Admin UI. You can see "human-readable" details when you log into the Admin UI. Click Configure > System Preferences > Audit, and create or customize the event handler of your choice.

Not all audit event handlers support queries. You'll see this in the REST call output as well as in the Admin UI. In the output for `availableHandlers`, you'll see:

```
"isUsableForQueries" : false
```

In the Admin UI, when you configure the JMS audit event handler, you won't be able to enable the `Use For Queries` option.

23.4. Logging Audit Events

The audit service logs information from six event topics: access, activity, authentication, configuration, reconciliation, and synchronization.

When you start IDM, it creates audit log files in the `openidm/audit` directory. The default file-based audit event handler is the JSON handler, which creates one JSON file for each event topic.

To configure default and custom audit topics in the Admin UI, select Configure > System Preferences. Click on the Audit tab, and scroll down to Event Topics.

23.4.1. Audit Event Topics

The audit service logs the following event topics by default:

Access Events

IDM writes messages at *system boundaries*, that is REST endpoints and the invocation of scheduled tasks in this log. In short, it includes who, what, and output for every access request.

Default file: `openidm/audit/access.audit.json`

Activity Events

IDM logs operations on internal (managed) and external (system) objects to this log.

Entries in the activity log contain identifiers, both for the action that triggered the activity, and for the original caller and the relationships between related actions, on internal and external objects.

Default file: `openidm/audit/activity.audit.json`

Authentication Events

IDM logs the results of authentication operations to this log, including situations and the actions taken on each object, including when and how a user authenticated and related events. The activity log contains additional detail about each authentication action.

Default file: `openidm/audit/authentication.audit.json`

Configuration Events

IDM logs the changes to the configuration in this log. The configuration log includes the "before" and "after" settings for each configuration item, with timestamps.

Default file: `openidm/audit/config.audit.json`

Reconciliation Events

IDM logs the results of reconciliation runs to this log (including situations and the resulting actions taken). The activity log contains details about the actions, where log entries display parent activity identifiers, `recon/reconID`, links, and policy events by data store.

Default file: `openidm/audit/recon.audit.json`

Synchronization Events

IDM logs the results of automatic synchronization operations (liveSync and implicit synchronization) to this log, including situations and the actions taken on each object, by account. The activity log contains additional detail about each action.

Default file: `openidm/audit/sync.audit.json`

For detailed information about each audit event topic, see "*Audit Log Reference*".

23.5. Filtering Audit Data Per Event

The audit configuration, defined in the `audit.json` file, includes a `filter` parameter that lets you specify what should be logged, per event topic. The information that is logged can be filtered in various ways.

The following excerpt of a sample `audit.json` file shows the filter element for the activity log:

```
"eventTopics" : {
    "authentication" : { },
    "access" : { },
    "activity" : {
        "filter" : {
            "actions" : [
                "create",
                "update",
                "delete",
                "patch",
                "action"
            ]
        },
  ...
}
```

To configure audit filtering in the Admin UI, select Configure > System Preferences > Audit. Scroll down to Event Topics, and click the pencil icon next to the event that you want to filter. The four filter tabs, Filter Actions, Filter Fields, Filter Script, and Filter Triggers, correspond to the following for sections. These sections describe the filters that can be applied to each event topic:

23.5.1. Filtering Audit Data by Action

The `filter actions` list enables you to specify the actions that are logged, per event type. This filter is essentially a `fields` filter (as described in "Filtering Audit Data by Field Value") that filters log entries by the value of their `actions` field.

The following configuration specifies that the actions create, update, delete, patch, and action should be included in the log, for the activity audit event topic.

```
"eventTopics" : {
...
    "activity": {
        "filter" : {
            "actions" : [
                "create",
                "update",
                "delete",
                "patch",
                "action"
            ]
        },
        ...
    }
}
```

The list of actions that can be filtered into the log depend on the event type. The following table lists the actions that can be filtered, per event type.

Actions that can be Filtered Per Event Type

Event Type	Actions	Description
Activity and Configuration	`read`	When an object is read by using its identifier. By default, read actions are not logged. 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 `resolver/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. (Activity only.)
	`query`	When a query is performed on an object. By default, query actions are not logged. 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 `resolver/boot.properties` file:

Event Type	Actions	Description
		`openidm.audit.logFullObjects=true`
	`action`	When an action is performed on an object. (Activity only.)
Reconciliation and Synchronization	`create`	When a target object is created.
	`delete`	When a target object is deleted.
	`update`	When a target object is updated.
	`link`	When a link is created between a source object and an existing target object.
	`unlink`	When a link is removed between a source object and a target object.
	`exception`	When the synchronization situation results in an exception. For more information, see "Synchronization Situations and Actions".
	`ignore`	When the target object is ignored, that is, no action is taken.
Authentication and Access	`-`	No actions can be specified for the authentication or the access log event type.

23.5.2. Filtering Audit Data by Field Value

You can add a list of `filter fields` to the audit configuration, that lets you filter log entries by specific fields. For example, you might want to restrict the reconciliation or audit log so that only summary information is logged for each reconciliation operation. The following addition to the `audit.json` file specifies that entries are logged in the reconciliation log only if their `entryType` is `start` or `summary`.

```
"eventTopics" : {
    ...
    "activity" : {
        "filter" : {
            "actions" : [
                "create",
                "update",
                "delete",
                "patch",
                "action
            ],
            "fields" : [
                {
                    "name" : "entryType",
                    "values" : [
                        "start",
                        "summary"
                    ]
                }
            ]
        }
    }
    ...
},
...
```

To use nested properties, specify the field name as a JSON pointer. For example, to filter entries according to the value of the `authentication.id`, you would specify the field name as `authentication/id`.

23.5.3. Using a Script to Filter Audit Data

Apart from the audit filtering options described in the previous sections, you can use a JavaScript or Groovy script to specify filter what is logged. Audit filter scripts are referenced in the audit configuration file (`conf/audit.json`), and can be configured per event type. The following sample configuration references a script named `auditfilter.js`, which is used to limit what is logged in the reconciliation audit log:

```
{
    "eventTopics" : {
        ...
        "recon" : {
            "filter" : {
                "script" : {
                    "type" : "text/javascript",
                    "file" : "auditfilter.js"
                }
            }
        },
        ...
}
```

The `request` and `context` objects are available to the script. Before writing the audit entry, IDM can access the entry as a `request.content` object. For example, to set up a script to log just the summary entries for mapping managed users in an LDAP data store, you could include the following in the `auditfilter.js` script:

```
(function() {
    return request.content.entryType == 'summary' &&
    request.content.mapping == 'systemLdapAccounts_managedUser'
}());
```

The script must return `true` to include the log entry; `false` to exclude it.

23.5.4. Filtering Audit Data by Trigger

You can add a `filter triggers` list to the audit configuration, that specifies the actions that will be logged for a specific trigger. For example, the following addition to the `audit.json` file specifies that only `create` and `update` actions are logged for in the activity log, for an activity that was triggered by a `recon`.

```
"eventTopics" : {
    "activity" : {
        "filter" : {
            "actions" : [
            ...
            ],
            "triggers" : {
                "recon" : [
                    "create",
                    "update"
                ]
            }
    ...
```

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. Only the `recon` trigger is implemented. For a list of reconciliation actions that can be logged, see "Synchronization Actions".

23.6. Filtering Audit Logs by Policy

In addition to the event-based filtering described in the previous sections, you can set up policies to exclude specific information from the audit logs.

To configure audit filter policies in the Admin UI, select Configure > System Preferences > Audit and scroll down to Audit Filter Policies. The options shown in that item match the filter configuration described in this section:

By default, the `audit.json` file includes the following `filterPolicies`:

```
"filterPolicies" : {
    "value" : {
        "excludeIf" : [
            "/access/http/request/cookies/&{com.iplanet.am.cookie.name}",
            "/access/http/request/cookies/session-jwt",
            "/access/http/request/headers/&{com.sun.identity.auth.cookieName}",
            "/access/http/request/headers/&{com.iplanet.am.cookie.name}",
            "/access/http/request/headers/accept-encoding",
            "/access/http/request/headers/accept-language",
            "/access/http/request/headers/Authorization",
            "/access/http/request/headers/cache-control",
            "/access/http/request/headers/connection",
            "/access/http/request/headers/content-length",
            "/access/http/request/headers/content-type",
            "/access/http/request/headers/proxy-authorization",
            "/access/http/request/headers/X-OpenAM-Password",
            "/access/http/request/headers/X-OpenIDM-Password",
            "/access/http/request/queryParameters/access_token",
            "/access/http/request/queryParameters/IDToken1",
            "/access/http/request/queryParameters/id_token_hint",
            "/access/http/request/queryParameters/Login.Token1",
            "/access/http/request/queryParameters/redirect_uri",
            "/access/http/request/queryParameters/requester",
            "/access/http/request/queryParameters/sessionUpgradeSSOTokenId",
            "/access/http/request/queryParameters/tokenId",
```

```
            "/access/http/response/headers/Authorization",
            "/access/http/response/headers/Set-Cookie",
            "/access/http/response/headers/X-OpenIDM-Password"
        ],
        "includeIf" : [ ]
    }
}
```

- Use the `excludeIf` property to list data that the audit service should exclude from the logs. You can exclude an entire field (using the `field` property), or a field with a specific value (using the `value` property). In the default audit configuration, request and response headers, cookies, and query parameters are excluded from the access log, if their values match those shown in the previous code excerpt.

  Note

  By default, sensitive fields from other ForgeRock products are filtered out of the audit log. There are a number of configurable field names, such as `&{com.iplanet.am.cookie.name}`. These fields enable you to filter ForgeRock Access Management (Access Management) headers whose names might have been customized. The values for these headers are set in the `resolver/boot.properties` file. The default values are as follows:

  ```
  # Filtered headers in audit.json that may be customized
  com.iplanet.am.cookie.name=iPlanetDirectoryPro
  com.sun.identity.auth.cookieName=AMAuthCookie
  ```

  Adjust the properties in `resolver/boot.properties` if your Access Management deployment uses custom header names.

- Use the `includeIf` property to include specific audit data, for *custom* audit events.

  This setting has no effect on the default audit event topics - all properties are included by default for these events.

A typical use case for filtering audit data by policy is the removal of personally identifiable information (PII) from the logs. For example, you might want to hide information such as user email addresses and telephone numbers. To exclude specific fields from the audit logs, add the field to the `filterPolicies` element, as follows:

```
"filterPolicies" : {
    "value" : {...}
    "field" : {
        "excludeIf" : [
            "/eventTopic/objectURI"
        ]
    }
}
```

Consider the following entry in a sample activity log, showing a change in telephone number for user bjensen:

```
{
 "transactionId": "e14ee7fb-7eb5-47c2-bf72-adbc3a648241-7054",
 "timestamp": "2017-11-02T12:19:29.396Z",
```

```
 "eventName": "activity",
 "userId": "openidm-admin",
 "runAs": "openidm-admin",
 "operation": "PATCH",
 "before": {
  "mail": "bjensen@example.com",
  "givenName": "Barbara",
  "sn": "Jensen",
  "description": "Created By CSV",
  "userName": "bjensen",
  "password": {...},
  "telephoneNumber": "1234567",
  "accountStatus": "active",
  ...
  },
  "_rev": "00000000feb030ab",
  "_id": "9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb"
 },
 "after": {
  "mail": "bjensen@example.com",
  "givenName": "Barbara",
  "sn": "Jensen",
  "description": "Created By CSV",
  "userName": "bjensen",
  "password": {...},
  "telephoneNumber": "0828392836",
  "accountStatus": "active",
  ...
  },
  "_rev": "0000000041a73089",
  "_id": "9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb",
  "roles": [],
  "authzRoles": null,
  "reports": null,
  "manager": null
 },
 "changedFields": [],
 "revision": "0000000041a73089",
 "message": "",
 "objectId": "managed/user/9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb",
 "passwordChanged": false,
 "status": "SUCCESS",
 "_id": "e14ee7fb-7eb5-47c2-bf72-adbc3a648241-7058"
}
```


To exclude bjensen's telephone number and email address from the activity log, you would add the following filter policies:

```
"filterPolicies" : {
    "field" : {
        "excludeIf" : [
            "/activity/before/mail",
            "/activity/after/mail",
            "/activity/before/telephoneNumber",
            "/activity/after/telephoneNumber"
        ],
    }
}
```

With this configuration, a similar change in the activity log appears as follows:


```
{
 "transactionId": "e14ee7fb-7eb5-47c2-bf72-adbc3a648241-9836",
 "timestamp": "2017-11-02T12:40:43.162Z",
 "eventName": "activity",
 "userId": "openidm-admin",
 "runAs": "openidm-admin",
 "operation": "PATCH",
 "before": {
  "givenName": "Barbara",
  "sn": "Jensen",
  "description": "Created By CSV",
  "userName": "bjensen",
  "password": {...},
  "accountStatus": "active",
  "effectiveRoles": [],
  "effectiveAssignments": [],
  "preferences": {
   "updates": false,
   "marketing": false
  },
  "_rev": "0000000041a73089",
  "_id": "9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb"
 },
 "after": {
  "givenName": "Barbara",
  "sn": "Jensen",
  "description": "Created By CSV",
  "userName": "bjensen",
  "password": {...},
  "accountStatus": "active",
  "effectiveRoles": [],
  "effectiveAssignments": [],
  "preferences": {
   "updates": false,
   "marketing": false
  },
  "_rev": "00000000d6e1312d",
  "_id": "9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb",
  "roles": [],
  "authzRoles": null,
  "reports": null,
  "manager": null
 },
 "changedFields": [],
 "revision": "00000000d6e1312d",
 "message": "",
 "objectId": "managed/user/9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb",
 "passwordChanged": false,
 "status": "SUCCESS",
 "_id": "e14ee7fb-7eb5-47c2-bf72-adbc3a648241-9840"
}
```


Note

By default, the `/access/http/request/headers` and `/access/http/response/headers` fields are considered case-insensitive for filtering. All other fields are considered case-sensitive.

To specify that a value should be filtered, regardless of case, add the `caseInsensitiveFields` property to your audit configuration, including an array of fields that should be considered case-insensitive. Fields are referenced using JSON pointer syntax and the array of fields can be empty.

With the following configuration, the audit service excludes cookies named `session-jwt` and `session-JWT` from the log:

```
"caseInsensitiveFields" : [
    "http.request.cookies"
],
```

23.7. Specifying Fields to Monitor

For the activity log only, you can specify fields whose values are considered particularly important in terms of logging.

The `watchedFields` parameter, configured in the `audit.json` file, lets you define a list of properties that should be monitored for changes. When the value of one of the properties in this list changes, the change is logged in the activity log, under the column `changedFields`. This parameter gives you quick access to important changes in the log.

Properties to monitor are listed as values of the `watchedFields` parameter, separated by commas, for example:

```
"watchedFields" : [ "email", "address" ]
```

You can monitor changes to any field in this way.

To configure watched fields in the Admin UI, select Configure > System Preferences > Audit. Scroll down to Event Topics and click the pencil icon next to the `activity` event.

23.8. Specifying Password Fields to Monitor

For the activity log only, you can include a `passwordFields` parameter to specify a list of password properties. This parameter functions much like the `watchedFields` parameter in that changes to these property values are logged in the activity log, under the column `changedFields`. In addition, when a password property is changed, the boolean `passwordChanged` flag is set to `true` in the activity log. Properties that should be considered as passwords are listed as values of the `passwordFields` parameter, separated by commas. For example:

```
"passwordFields" : [ "password", "userPassword" ]
```

To configure password fields in the Admin UI, select Configure > System Preferences > Audit. Scroll down to Event Topics and click the pencil icon next to the `activity` event.

23.9. Configuring an Audit Exception Formatter

The audit service includes an *exception formatter*, configured in the following snippet of the `audit.json` file:

```
"exceptionFormatter" : {
   "type" : "text/javascript",
   "file" : "bin/defaults/script/audit/stacktraceFormatter.js"
},
```

As shown, you may find the script that defines how the exception formatter works in the `stacktraceFormatter.js` file. That file handles the formatting and display of exceptions written to the audit logger.

23.10. Adjusting Audit Write Behavior

You can buffer audit logging to minimize the writes on your systems. To do so, you can configure buffering either in the *`project-dir`*`/conf/audit.json` file, or through the Admin UI.

You can configure audit buffering through an event handler. To access an event handler in the Admin UI, click Configure > System Preferences and click on the Audit Tab. When you customize or create an event handler, you can configure the following settings:

Audit Buffering Options

Property	UI Text	Description
`enabled`	True or false	Enables / disables buffering
`autoFlush`	True or false; whether the Audit Service automatically flushes events after writing them to disk	

The following sample code illustrates where you would configure these properties in the `audit.json` file.

```
...
    "eventHandlers" : [
      {
        "config" : {
          ...
          "buffering" : {
            "autoFlush" : false,
            "enabled" : false
          }
        },
...
```

You can set up `autoFlush` when buffering is enabled. IDM then writes data to audit logs asynchronously, while `autoFlush` functionality ensures that the audit service writes data to logs on a regular basis.

If audit data is important, do activate `autoFlush`. It minimizes the risk of data loss in case of a server crash.

23.11. Purging Obsolete Audit Information

If reconciliation audit volumes grow "excessively" large, any subsequent reconciliations, as well as queries to audit tables, can become "sluggish". In a deployment with limited resources, a lack of disk space can affect system performance.

You might already have restricted what is logged in your audit logs by setting up filters, as described in "Filtering Audit Data Per Event". You can also use specific queries to purge reconciliation audit logs, or you can purge reconciliation audit entries older than a specific date, using timestamps.

IDM provides a sample purge script, `autoPurgeRecon.js`, in the `bin/defaults/script/audit` directory. This script purges reconciliation audit log entries only from the internal repository. It does not purge data from the corresponding JSON files or external repositories.

To purge reconciliation audit logs on a regular basis, set up a schedule. A sample schedule is provided in `openidm/samples/example-configurations/schedules/schedule-autoPurgeAuditRecon.json`. You can change that schedule as required, and copy the file to the `conf/` directory of your project, in order for it to take effect.

The sample purge schedule file is as follows:

```
{
   "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 information about the schedule-related properties in this file, see "Scheduling Synchronization".

Beyond scheduling, the following parameters are of interest for purging the reconciliation audit logs:

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 the following 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 entries to keep for a given mapping, including all child entries.

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.

23.11.1. Configuring Audit Log Rotation

The file-based audit event handlers enable you to rotate audit log files, either automatically, based on a set of criteria, or by using a REST call.

To configure automatic log file rotation, set the following properties in your project's `audit.json` file:

```
{
    "class" : "org.forgerock.audit.handlers.json.JsonAuditEventHandler",
    "config" : {
        "fileRotation" : {
            "rotationEnabled" : true,
            "maxFileSize" : 0,
            "rotationFilePrefix" : "",
            "rotationTimes" : [ ],
            "rotationFileSuffix" : "",
            "rotationInterval" : ""
},
```

The file rotation properties are described in "JSON Audit Event Handler `config` Properties".

If you have enabled file rotation (`"rotationEnabled" : true`), you can rotate the JSON log files manually for a specific audit event topic, over REST. The following command saves the current access log file with a date and time stamp, then starts logging to a new file with the same base name.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/audit/access?handler=json&_action=rotate"
{
  "status": "OK"
}
```

If the command is successful, you will see two `access.audit.json` files in the `openidm/audit` directory, for example:

```
access.audit.json   access.audit.json-2016.10.12-17.54.41
```

The file with the extension (`2016.10.12-17.54.41`) indicates that audit logging to this file ended on October 12, 2016, at 5:54:41 pm.

To configure log rotation in the Admin UI, click Configure > System Preferences > Audit, and edit the JSON audit event handler (or the CSV audit event handler if you are logging to CSV). You can set all the log rotation properties on this screen.

23.11.2. Configuring Audit Log File Retention

Log file retention specifies how long audit files remain on disk before they are automatically deleted.

To configure log file retention, set the following properties in your project's `audit.json` file:

```
"fileRetention" : {
    "maxNumberOfHistoryFiles" : 100,
    "maxDiskSpaceToUse" : 1000,
    "minFreeSpaceRequired" : 10
},
```

The file retention properties are described in "JSON Audit Event Handler `config` Properties".

To configure log file retention in the Admin UI, click Configure > System Preferences > Audit, and edit the JSON audit event handler (or the CSV audit event handler if you are logging to CSV). You can set all the log retention properties on this screen.

23.12. Querying Audit Logs Over REST

Regardless of where audit events are stored, they are accessible over REST on the `/audit` endpoint. The following sections describe how to query audit logs over REST.

You can also set up an aggregated analysis of audit logs over REST on the `report/audit` endpoint. For more information, see "Generating Audit Reports".

Note

Queries on the audit endpoint must use `queryFilter` syntax. Predefined queries are not supported. For more information, see "Constructing Queries".

If you get no REST output on the correct endpoint, there might be no audit data in the corresponding audit file or JDBC table.

Some of the examples in this section use client-assigned IDs (such as `bjensen` and `scarter`) when creating objects because it makes the examples easier to read. If you create objects using the Admin UI, they are created with server-assigned IDs (such as `55ef0a75-f261-47e9-a72b-f5c61c32d339`). Generally, immutable server-assigned UUIDs are used in production environments.

23.12.1. Querying the Reconciliation Audit Log

With the default audit configuration, reconciliation operations are logged in the file `/path/to/openidm/audit/recon.audit.json`, and in the repository. You can read and query the reconciliation audit logs over the REST interface, as outlined in the following examples.

To return all reconciliation operations logged in the audit log, query the `audit/recon` endpoint, as follows:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/audit/recon?_queryFilter=true"
```

The following code extract shows the reconciliation audit log after the first reconciliation operation in the `sync-with-csv` sample. The output has been truncated for legibility.

```
{
  "result": [
    {
      "_id": "49bdb7cb-79a4-429d-856d-a7154005e41a-182",
      "transactionId": "49bdb7cb-79a4-429d-856d-a7154005e41a-177",
```

```
      "timestamp": "2017-02-28T13:07:20.487Z",
      "eventName": "recon",
      "userId": "openidm-admin",
      "exception": null,
      "linkQualifier": null,
      "mapping": "systemCsvfileAccounts_managedUser",
      "message": "Reconciliation initiated by openidm-admin",
      "sourceObjectId": null,
      "targetObjectId": null,
      "reconciling": null,
      "ambiguousTargetObjectIds": null,
      "reconAction": "recon",
      "entryType": "start",
      "reconId": "49bdb7cb-79a4-429d-856d-a7154005e41a-177"
    },
    {
      "_id": "49bdb7cb-79a4-429d-856d-a7154005e41a-192",
      "transactionId": "49bdb7cb-79a4-429d-856d-a7154005e41a-177",
      "timestamp": "2017-02-28T13:07:20.934Z",
      "eventName": "recon",
      "userId": "openidm-admin",
      "action": "CREATE",
      "exception": null,
      "linkQualifier": "default",
      "mapping": "systemCsvfileAccounts_managedUser",
      "message": null,
      "situation": "ABSENT",
      "sourceObjectId": "system/csvfile/account/scarter",
      "status": "SUCCESS",
      "targetObjectId": "managed/user/scarter",
      "reconciling": "source",
      "ambiguousTargetObjectIds": "",
      "entryType": "entry",
      "reconId": "49bdb7cb-79a4-429d-856d-a7154005e41a-177"
    },
    ...
}
```


Most of the fields in the reconciliation 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 entry affected by the reconciliation.

To obtain information about a specific log entry, include its entry `_id` in the URL. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/audit/recon/414a4921-5d9d-4398-bf86-7d5312a9f5d1-146"
```

The following sample output shows the results of a read operation on a specific reconciliation audit entry. The entry shows the creation of scarter's account in the managed user repository, as the result of a reconciliation operation.

```
{
  "_id": "49bdb7cb-79a4-429d-856d-a7154005e41a-192",
  "transactionId": "49bdb7cb-79a4-429d-856d-a7154005e41a-177",
  "timestamp": "2017-02-28T13:07:20.934Z",
  "eventName": "recon",
  "userId": "openidm-admin",
  "action": "CREATE",
  "exception": null,
  "linkQualifier": "default",
  "mapping": "systemCsvfileAccounts_managedUser",
  "message": null,
  "situation": "ABSENT",
  "sourceObjectId": "system/csvfile/account/scarter",
  "status": "SUCCESS",
  "targetObjectId": "managed/user/scarter",
  "reconciling": "source",
  "ambiguousTargetObjectIds": "",
  "entryType": "entry",
  "reconId": "49bdb7cb-79a4-429d-856d-a7154005e41a-177"
}
```


To obtain information for a specific reconciliation operation, include the `reconId` in the query. You can filter the log so that the query returns only the fields you want to see, by adding the `_fields` parameter.

The following query returns the `mapping`, `timestamp`, and `entryType` fields for a specific reconciliation operation:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/openidm/audit/recon?_queryFilter=/reconId+eq+"4261227f-1d44-4042-ba7e
-1dcbc6ac96b8"&_fields=mapping,timestamp,entryType'
   {
  "result": [
    {
      "_id": "49bdb7cb-79a4-429d-856d-a7154005e41a-182",
      "mapping": "systemCsvfileAccounts_managedUser",
      "timestamp": "2017-02-28T13:07:20.487Z",
      "entryType": "start"
    },
    {
      "_id": "49bdb7cb-79a4-429d-856d-a7154005e41a-192",
      "mapping": "systemCsvfileAccounts_managedUser",
      "timestamp": "2017-02-28T13:07:20.934Z",
      "entryType": "entry"
    },
    {
      "_id": "49bdb7cb-79a4-429d-856d-a7154005e41a-191",
      "mapping": "systemCsvfileAccounts_managedUser",
      "timestamp": "2017-02-28T13:07:20.934Z",
      "entryType": "entry"
    },
    {
      "_id": "49bdb7cb-79a4-429d-856d-a7154005e41a-193",
      "mapping": "systemCsvfileAccounts_managedUser",
```

```
      "timestamp": "2017-02-28T13:07:20.943Z",
      "entryType": "summary"
    }
  ],
  ...
}
```

To query the reconciliation audit log for a particular reconciliation situation, include the `reconId` and the `situation` in the query. For example, the following query returns all ABSENT entries that were found during the specified reconciliation operation:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/openidm/audit/recon?_queryFilter=/reconId+eq+"414a4921-5d9d-4398-bf86-7d5312a9f5d1
-135"+and+situation+eq+"ABSENT"'
   {
  "result": [
    {
      "_id": "49bdb7cb-79a4-429d-856d-a7154005e41a-192",
      "situation": "ABSENT",
      "reconId": "49bdb7cb-79a4-429d-856d-a7154005e41a-177",
      "transactionId": "49bdb7cb-79a4-429d-856d-a7154005e41a-177",
      "timestamp": "2017-02-28T13:07:20.934Z",
      "eventName": "recon",
      "userId": "openidm-admin",
      "action": "CREATE",
      "exception": null,
      "linkQualifier": "default",
      "mapping": "systemCsvfileAccounts_managedUser",
      "message": null,
      "sourceObjectId": "system/csvfile/account/scarter",
      "status": "SUCCESS",
      "targetObjectId": "managed/user/scarter",
      "reconciling": "source",
      "ambiguousTargetObjectIds": "",
      "entryType": "entry"
    },
    {
      "_id": "49bdb7cb-79a4-429d-856d-a7154005e41a-191",
      "situation": "ABSENT",
      "reconId": "49bdb7cb-79a4-429d-856d-a7154005e41a-177",
      "transactionId": "49bdb7cb-79a4-429d-856d-a7154005e41a-177",
      "timestamp": "2017-02-28T13:07:20.934Z",
      "eventName": "recon",
      "userId": "openidm-admin",
      "action": "CREATE",
      "exception": null,
      "linkQualifier": "default",
      "mapping": "systemCsvfileAccounts_managedUser",
      "message": null,
      "sourceObjectId": "system/csvfile/account/bjensen",
      "status": "SUCCESS",
      "targetObjectId": "managed/user/bjensen",
      "reconciling": "source",
      "ambiguousTargetObjectIds": "",
      "entryType": "entry"
```

```
    }
  ],
  ...
}
```

23.12.2. 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 an 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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/audit/activity?_queryFilter=true"
```

The following excerpt of the activity log shows the entries that created user `scarter`, with ID `42f8a60e-2019-4110-a10d-7231c3578e2b`:

```
{
  "result": [
    {
      "_id": "49bdb7cb-79a4-429d-856d-a7154005e41a-190",
      "transactionId": "49bdb7cb-79a4-429d-856d-a7154005e41a-177",
      "timestamp": "2017-02-28T13:07:20.894Z",
      "eventName": "activity",
      "userId": "openidm-admin",
      "runAs": "openidm-admin",
      "operation": "CREATE",
      "before": null,
      "after": {
        "mail": "scarter@example.com",
        "givenName": "Steven",
        "sn": "Carter",
        "description": "Created By CSV",
        "userName": "scarter",
        "password": {
          "$crypto": {
            "type": "x-simple-encryption",
            "value": {
              "cipher": "AES/CBC/PKCS5Padding",
              "salt": "tdrE2LZ+nBAnE44QY1UrCA==",
              "data": "P/z+OXA1x35aVWMRbOHMUQ==",
              "iv": "GACI5q4qZUWZRHzIle57TQ==",
              "key": "openidm-sym-default",
              "mac": "hqLmhjv67dxcmX8L3xxgZg=="
            }
          }
        },
        "telephoneNumber": "1234567",
        "accountStatus": "active",
        "effectiveRoles": [],
        "effectiveAssignments": [],
```

```
        "_rev": "00000000dc6160c8",
        "_id": "42f8a60e-2019-4110-a10d-7231c3578e2b"
      },
      "changedFields": [],
      "revision": "00000000bad8e88e",
      "message": "create",
      "objectId": "managed/user/42f8a60e-2019-4110-a10d-7231c3578e2b",
      "passwordChanged": true,
      "status": "SUCCESS"
    },
  ...
}
```

For users who self-register through the End User UI, IDM provides more information. The following activity log excerpt depicts the information collected for user `jsanchez`. Note the following properties:

- IDM runs as user `anonymous`.
- Security questions (`kbaInfo`) are recorded with a salted hash SHA-256 algorithm.
- Marketing preferences are included.
- `termsAccepted` includes the date of the version of Terms & Conditions was accepted.
- The `message`, `context`, and `status` properties indicate that this user was created in the `SELFSERVICE` context, successfully.

```
{
    "_id" : "ddc7f35b-4b97-4586-be31-f5a2599b0764-10781",
    "transactionId" : "ddc7f35b-4b97-4586-be31-f5a2599b0764-10779",
    "timestamp" : "2017-07-26T17:14:24.137Z",
    "eventName" : "activity",
    "userId" : "anonymous",
    "runAs" : "anonymous",
    "operation" : "CREATE",
    "before" : null,
    "after" : {
      "kbaInfo" : [ {
        "answer" : {
          "$crypto" : {
            "value" : {
              "algorithm" : "SHA-256",
              "data" : "jENrBtzgIHscnOnvqSMYPTJKjZVVSN7XEfTp6VUpdXzNQsbCjmNQWpbfa1k1Zp24"
            },
            "type" : "salted-hash"
          }
        },
        "questionId" : "1"
      }, {
        "answer" : {
          "$crypto" : {
            "value" : {
              "algorithm" : "SHA-256",
              "data" : "obSQtsW3pgA4Yv4dPiISasvmrq4deoPOX4d9VRg+Bd/gGVDzu6fWPKd30Di3moEe"
            },
```

```
            "type" : "salted-hash"
          }
        },
        "questionId" : "2"
      } ],
      "userName" : "jsanchez",
      "givenName" : "Jane",
      "sn" : "Sanchez",
      "mail" : "jane.sanchez@example.com",
      "password" : {
        "$crypto" : {
          "type" : "x-simple-encryption",
          "value" : {
            "cipher" : "AES/CBC/PKCS5Padding",
            "stableId" : "openidm-sym-default",
            "salt" : "<hashValue>",
            "data" : "<encryptedValue>",
            "keySize" : 16,
            "purpose" : "idm.config.encryption",
            "iv" : "<encryptedValue>",
            "mac" : "<hashValue>"
          }
        }
      },
      "preferences" : {
        "updates" : true,
        "marketing" : false
      },
      "accountStatus" : "active",
      "effectiveRoles" : [ ],
      "effectiveAssignments" : [ ],
      "_rev" : "000000004eb36844",
      "_id" : "6e7fb8ce-4a97-42d4-90f1-b5808d51194a"
    },
    "changedFields" : [ ],
    "revision" : "000000004eb36844",
    "message" : "create",
    "context" : "SELFSERVICE",
    "objectId" : "managed/user/6e7fb8ce-4a97-42d4-90f1-b5808d51194a",
    "passwordChanged" : true,
    "status" : "SUCCESS"
  },
  ...
}
```


To return the activity information for a specific action, include the `_id` of the action in the URL, for example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/openidm/audit/activity/414a4921-5d9d-4398-bf86-7d5312a9f5d1-145'
```

Each action in the activity log has a `transactionId` that is the same as the `transactionId` that was assigned to the incoming or initiating request. So, for example, if an HTTP request invokes a script that changes a user's password, the HTTP request is assigned a `transactionId`. The action taken by the

script is assigned the same `transactionId`, which lets you track the complete set of changes resulting from a single action. You can query the activity log for all actions that resulted from a specific transaction, by including the `transactionId` in the query.

The following command returns all actions in the activity log that happened as a result of a reconciliation, with a specific `transactionId`. The results of the query are restricted to only the `objectId` and the `resourceOperation`. You can see from the output that the reconciliation with this `transactionId` resulted in two CREATEs and two UPDATEs in the managed repository.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/openidm/audit/activity?_queryFilter=/transactionId+eq+"414a4921-5d9d-4398-bf86
-7d5312a9f5d1-135"&_fields=objectId,operation'
```

The following sample output shows the result of a query that created users scarter (with ID `42f8a60e-2019-4110-a10d-7231c3578e2b`) and bjensen (with ID `9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb`).

```
{
  "result" : [ {
    "_id" : "414a4921-5d9d-4398-bf86-7d5312a9f5d1-144",
    "objectId" : "managed/user/42f8a60e-2019-4110-a10d-7231c3578e2b",
    "operation" : "CREATE"
  }, {
    "_id" : "414a4921-5d9d-4398-bf86-7d5312a9f5d1-145",
    "objectId" : "managed/user/9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb",
    "operation" : "CREATE"
  } ],
  "resultCount" : 2,
  "pagedResultsCookie" : null,
  "totalPagedResultsPolicy" : "NONE",
  "totalPagedResults" : -1,
  "remainingPagedResults" : -1
}
```

For users who register through social identity providers, the following command returns JSON-formatted output for someone who has registered socially with a LinkedIn account, based on their `_id`.

```
$ curl \
   --header "X-OpenIDM-Username: openidm-admin" \
   --header "X-OpenIDM-Password: openidm-admin" \
   --request GET \
   'http://localhost:8080/openidm/audit/activity/b164fcb7-4a45-43b0-876d-083217254962'
```

The following output illustrates the data collected from a hypothetical LinkedIn user.

```
{
  "_id" : "94001c97-c597-46fa-a6c9-f53b0ddd7ff0-1982",
  "transactionId" : "94001c97-c597-46fa-a6c9-f53b0ddd7ff0-1974",
  "timestamp" : "2018-02-05T19:55:18.427Z",
  "eventName" : "activity",
  "userId" : "anonymous",
  "runAs" : "anonymous",
```

```
  "operation" : "CREATE",
  "before" : null,
  "after" : {
    "emailAddress" : "Xie@example.com",
    "firstName" : "Xie",
    "formattedName" : "Xie Na",
    "id" : "MW9FE_KyQH",
    "lastName" : "Na",
    "location" : {
      "country" : {
        "code" : "cn"
      },
      "name" : "Beijing, China"
    },
    "_meta" : {
      "subject" : "MW9FE_KyQH",
      "scope" : [ "r_basicprofile", "r_emailaddress" ],
      "dateCollected" : "2018-02-05T19:55:18.370"
    },
    "_rev" : "00000000c29c9f46",
    "_id" : "MW9FE_KyQH"
  },
  "changedFields" : [ ],
  "revision" : "00000000c29c9f46",
  "message" : "create",
  "provider" : "linkedIn",
  "context" : "SELFSERVICE",
  "objectId" : "managed/linkedIn/MW9FE_KyQH",
  "passwordChanged" : false,
  "status" : "SUCCESS"
}
```


Note the `SELFSERVICE` context, which is included for all user self-registrations, either through the End User UI, or through a social identity provider.

23.12.3. Querying the Synchronization Audit Log

LiveSync and implicit sync operations are logged in the file `/path/to/openidm/audit/sync.audit.json` and in the repository. You can read the synchronization audit logs over the REST interface, as outlined in the following examples.

To return all operations logged in the synchronization audit log, query the `audit/sync` endpoint, as follows:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/audit/sync?_queryFilter=true"
{
  "result" : [ {
    "_id" : "53709f21-5b83-4ea0-ac35-9af39c3090cf-95",
    "transactionId" : "53709f21-5b83-4ea0-ac35-9af39c3090cf-85",
    "timestamp" : "2015-11-23T05:07:39.376Z",
    "eventName" : "sync",
    "userId" : "openidm-admin",
    "action" : "UPDATE",
    "exception" : null,
    "linkQualifier" : "default",
    "mapping" : "managedUser_systemLdapAccounts",
    "message" : null,
    "situation" : "CONFIRMED",
    "sourceObjectId" : "managed/user/128e0e85-5a07-4e72-bfc8-4d9500a027ce",
    "status" : "SUCCESS",
    "targetObjectId" : "uid=jdoe,ou=People,dc=example,dc=com"
  },
 {
...
```

Most of the fields in the synchronization audit log are self-explanatory. Each entry in the log synchronization operation is identified by a unique `_id`. Each *synchronization operation* is identified with a `transactionId`. The same base `transactionId` is assigned to the incoming or initiating request - so if a modification to a user entry triggers an implicit synchronization operation, both the sync operation and the original change operation have the same `transactionId`. You can query the sync log for all actions that resulted from a specific transaction, by including the `transactionId` in the query.

To obtain information on a specific sync audit log entry, include its entry `_id` in the URL. For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/audit/sync/53709f21-5b83-4ea0-ac35-9af39c3090cf-95"
{
  "_id" : "53709f21-5b83-4ea0-ac35-9af39c3090cf-95",
  "transactionId" : "53709f21-5b83-4ea0-ac35-9af39c3090cf-85",
  "timestamp" : "2015-11-23T05:07:39.376Z",
  "eventName" : "sync",
  "userId" : "openidm-admin",
  "action" : "UPDATE",
  "exception" : null,
  "linkQualifier" : "default",
  "mapping" : "managedUser_systemLdapAccounts",
  "message" : null,
  "situation" : "CONFIRMED",
  "sourceObjectId" : "managed/user/128e0e85-5a07-4e72-bfc8-4d9500a027ce",
  "status" : "SUCCESS",
  "targetObjectId" : "uid=jdoe,ou=People,dc=example,dc=com"
}
```

23.12.4. Querying the Authentication Audit Log

The authentication log includes details of all successful and failed authentication attempts. The output may be long. The output that follows is one excerpt from over 100 entries. To obtain the complete audit log over REST, use the following query:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/audit/authentication?_queryFilter=true"
...
    "principal" : [ "johndoe" ],
    "result" : "SUCCESSFUL",
    "userId" : "johndoe",
    "transactionId" : "cf967c5d-2b95-4cbe-9da0-e8952d726cd0-1016",
    "timestamp" : "2017-06-20T20:56:04.112Z",
    "eventName" : "LOGIN",
    "method" : "SOCIAL_PROVIDERS",
    "trackingIds" : [ "55fcec49-9631-4c00-83db-6931d10d04b8" ]
  }, {
    "_id" : "cf967c5d-2b95-4cbe-9da0-e8952d726cd0-1025",
    "provider" : "wordpress",
    "context" : {
      "component" : "managed/user",
      "provider" : "wordpress",
      "roles" : [ "internal/role/openidm-authorized" ],
      "ipAddress" : "172.16.201.36",
      "id" : "8ead23d1-4f14-4102-a130-c4093237f250",
      "moduleId" : "SOCIAL_PROVIDERS"
    },
    "entries" : [ {
      "moduleId" : "JwtSession",
      "result" : "SUCCESSFUL",
      "info" : {
        "org.forgerock.authentication.principal" : "johndoe"
      }
    } ]
,
...
```

The output depicts a successful login using Wordpress as a social identity provider. From the information shown, you can derive the following information:

- The `userId`, also known as the authentication `principal`, is `johndoe`. In the REST call that follows, you'll see how to use this information to filter authentication attempts made by that specific user.
- The login came from IP address `172.16.201.36`.
- The login used the `SOCIAL_PROVIDERS` authentication and the `JwtSession` session modules. For more information, see "Supported Authentication and Session Modules".

Login failures can also be instructive, as you'll see consecutive `moduleId` modules that correspond to the order of modules shown in your project's `authentication.json` file.

You can filter the results to return only those audit entries that you are interested in. For example, the following query returns all authentication attempts made by a specific user (`johndoe`) but displays only the security context and the result of the authentication attempt.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/openidm/audit/authentication?_queryFilter=/principal+eq+"johndoe"&_fields=context
,result'
{
  "result" : [ {
    "_id" : "cf967c5d-2b95-4cbe-9da0-e8952d726cd0-198",
    "provider" : null,
    "context" : {
      "ipAddress" : "172.16.201.36"
    },
    "entries" : [ {
      "moduleId" : "JwtSession",
      "result" : "FAILED",
      "reason" : { },
      "info" : { }
    }
,
...
  }, {
    "_id" : "cf967c5d-2b95-4cbe-9da0-e8952d726cd0-922",
    "provider" : "wordpress",
    "context" : {
      "component" : "null",
      "provider" : "wordpress",
      "roles" : [ "internal/role/openidm-authorized" ],
      "ipAddress" : "172.16.201.36",
      "id" : "e2b5bfc7-07a0-455c-a8f3-542089a8cc88",
      "moduleId" : "SOCIAL_PROVIDERS"
    },
     "entries" : [ {
      "moduleId" : "JwtSession",
      "result" : "FAILED",
      "reason" : { },
      "info" : { }
    },
 ...
    {
      "moduleId" : "SOCIAL_PROVIDERS",
      "result" : "SUCCESSFUL",
      "info" : {
        "org.forgerock.authentication.principal" : "johndoe"
      }
 ...
  }, {
    "_id" : "cf967c5d-2b95-4cbe-9da0-e8952d726cd0-1007",
    "provider" : "wordpress",
    "context" : {
      "component" : "managed/user",
      "provider" : "wordpress",
      "roles" : [ "internal/role/openidm-authorized" ],
      "ipAddress" : "172.16.201.36",
      "id" : "johndoe",
```

```
      "moduleId" : "SOCIAL_PROVIDERS"
    },
     "entries" : [ {
      "moduleId" : "JwtSession",
      "result" : "SUCCESSFUL",
      "info" : {
        "org.forgerock.authentication.principal" : "johndoe"
      }
...
```

The above excerpt illustrates a `FAILED` authentication attempt through a social identity provider, possibly based on a mistaken password. That is followed by a `SUCCESSFUL` authentication through the `SOCIAL_PROVIDERS` module, with the user included in the Managed User `component`.

23.12.5. Querying the Configuration Audit Log

This audit log lists changes made to the configuration in the audited server. You can read through the changes in the `config.extension` file in the `openidm/audit` directory.

You can also read the complete audit log over REST with the following query:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
"http://localhost:8080/openidm/audit/config?_queryFilter=true"
{
   "result" : [ {
     "_id" : "414a4921-5d9d-4398-bf86-7d5312a9f5d1-73",
     "operation" : "CREATE",
     "userId" : "openidm-admin",
     "runAs" : "openidm-admin",
     "transactionId" : "414a4921-5d9d-4398-bf86-7d5312a9f5d1-58",
     "revision" : null,
     "timestamp" : "2015-11-23T00:18:17.808Z",
     "objectId" : "ui",
     "eventName" : "CONFIG",
     "before" : "",
     "after" : "{ \"icons\":
     ...
      } ],
   "resultCount" : 3,
   "pagedResultsCookie" : null,
   "totalPagedResultsPolicy" : "NONE",
   "totalPagedResults" : -1,
   "remainingPagedResults" : -1
}
```

The output includes `before` and `after` entries, which represent the changes made to the configuration files.

23.13. Viewing Audit Events in the Admin UI

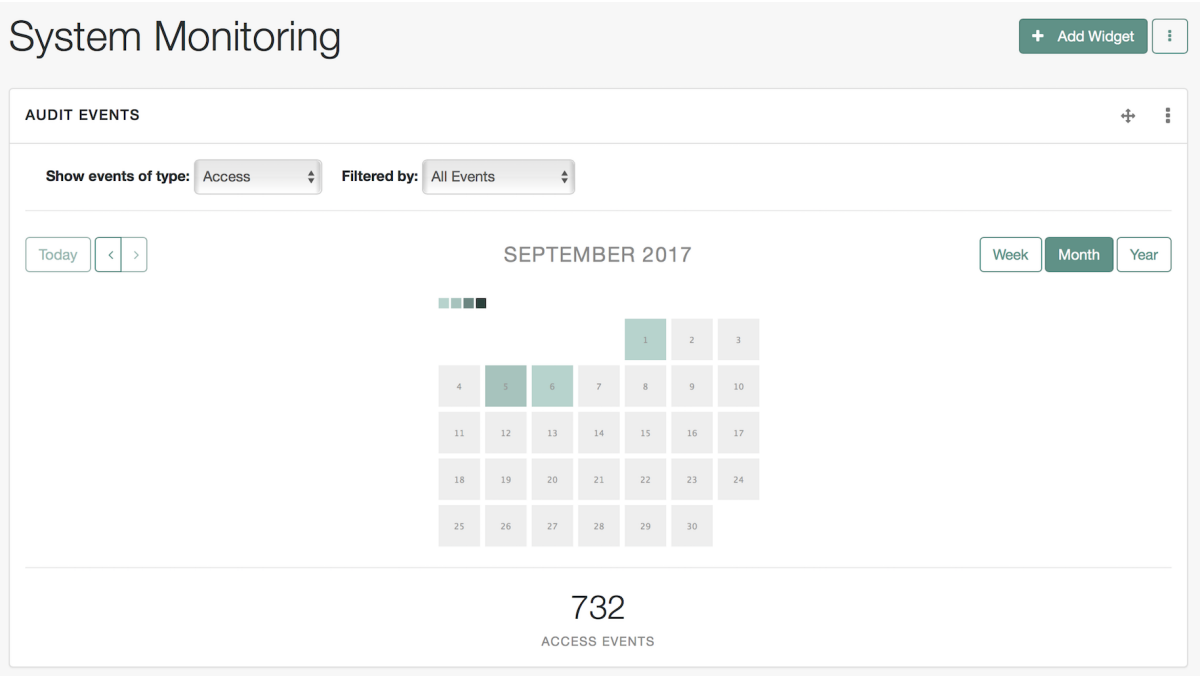
The Admin UI includes an audit widget that provides a visual display of audit events.

The audit widget is displayed on the System Monitoring dashboard by default. To show audit events:

1. Log in to the Admin UI and select Dashboards > System Monitoring.
2. On the Audit Events widget, select the type of audit event that you want to view. The event types correspond to the audit event topics, described in "Audit Event Topics".

   Depending on the event type, you filter the events further. For example, if you select Config as the event type, you can then select to view all configuration audit events, or only Creates, Reads, Updates, and so on.
3. By default, events are displayed for the current month. Use the arrow keys to scroll backwards and forwards to display the audit data for other months.

   The following image shows all access events for the month of February, 2017.



Use the move pointer to reposition the widget on the dashboard, or the vertical ellipses to delete the widget.

Chapter 24

Reporting, Monitoring, and Notifications

IDM provides a basic reporting service that generates reports on specific sets of data within a resource collection. The reporting service does not intend to replace a comprehensive data analysis platform, such as the Elastic Stack. However, this service can avoid the need for third-party data analysis tools in simple use cases.

The reporting service is accessible with a filtered query on the `openidm/report` endpoint.

The query must include an `aggregateFields` parameter. This parameter provides a comma-delimited list of name-value pairs of fields that are aggregated to generate the report. The *name* indicates the field type, and the *value* indicates the field pointer. The field type can be `TIMESTAMP` or `VALUE`. A `TIMESTAMP` field specifies a field name, a time `scale` and, optionally, a `utcOffset` in the format `+/-HHmm`. A `VALUE` field specifies a JSON pointer to any other fields to be aggregated in the report. For example:

```
TIMESTAMP=/timestamp;scale:min;utfOffset:-0700,VALUE=/response/status
```

The following example shows the full query syntax required to generate a report on a particular resource collection:

```
openidm/report/resourceCollection?_queryFilter=queryFilter&aggregateFields=TIMESTAMP=field;scale:min|hour|
day|week|month:utcOffset:offset,VALUE=field
```

24.1. Generating Audit Reports

Audit reports are intended to count similar records, usually over specified time periods. To facilitate time-based reports, audit data includes `timestamps` in ISO 8601 format (`yyyy-MM-ddTHH:mm:ss`). To aggregate the audit data for a particular time period, include these timestamps in a filtered query on the `report/audit` endpoint. You can use a UTC offset to specify different timezones.

The following example generates a report of `recon` audit events. The events are filtered to include only records with a `timestamp` value after (`gt`) October 1, 2017 and before (`lt`) October 31, 2017, both at midnight. In effect, this query generates a reconciliation report for the month of October, 2017.

The `aggregateFields` parameter determines which fields are included in the report. In the following example, the report includes the `timestamp` and `status` of each event. The `timestamp` shows the number of seconds since the Unix Epoch and the time in ISO 8601 format, with a `utcOffset` of `-0700` (which corresponds to US Pacific Daylight Time).

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
```

```
 \
--request GET \
'http://localhost:8080/openidm/report/audit/recon?_queryFilter=timestamp+gt+"2017-10
-01T00:00:00.0-0700"+and+timestamp+lt+"2017-10-31T00:00:00.0-0700"&aggregateFields=TIMESTAMP=/
timestamp;scale:min;utcOffset:-0700,VALUE=/status'
{
  "result": [
    {
      "timestamp": {
        "epochSeconds": 1509361500,
        "iso8601": "2017-10-30T11:05:00.000Z"
      },
      "status": null,
      "count": 1
    },
    {
      "timestamp": {
        "epochSeconds": 1509361440,
        "iso8601": "2017-10-30T11:04:00.000Z"
      },
      "status": null,
      "count": 1
    },
    {
      "timestamp": {
        "epochSeconds": 1509361440,
        "iso8601": "2017-10-30T11:04:00.000Z"
      },
      "status": "SUCCESS",
      "count": 4
    },
    {
      "timestamp": {
        "epochSeconds": 1509361320,
        "iso8601": "2017-10-30T11:02:00.000Z"
      },
      "status": null,
      "count": 1
    },
    {
      "timestamp": {
        "epochSeconds": 1509361320,
        "iso8601": "2017-10-30T11:02:00.000Z"
      },
      "status": "SUCCESS",
      "count": 3
    },
    {
      "timestamp": {
        "epochSeconds": 1509361500,
        "iso8601": "2017-10-30T11:05:00.000Z"
      },
      "status": "SUCCESS",
      "count": 4
    }
  ],
  "resultCount": 6,
  "pagedResultsCookie": null,
  "totalPagedResultsPolicy": "NONE",
```

```
  "totalPagedResults": -1,
  "remainingPagedResults": -1
}
```

You can further refine the audit report using an additional filter parameter, `postAggregationFilter`, to filter the aggregated audit results according to additional criteria. The `postAggregationFilter` parameter works in the same way as the `queryFilter` parameter.

The following example returns the same audit report generated previously but filters the aggregated results to display only those records whose `count` parameter is more than 2:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
'http://localhost:8080/openidm/report/audit/recon?_queryFilter=timestamp+gt+"2017-10
-01T00:00:00.0-0700"+and+timestamp+lt+"2017-10-31T00:00:00.0-0700"&aggregateFields=TIMESTAMP=/
timestamp;scale:min;utcOffset:-0700,VALUE=/status&postAggregationFilter=count+gt+2'
{
  "result": [
    {
      "timestamp": {
        "epochSeconds": 1509361440,
        "iso8601": "2017-10-30T11:04:00.000Z"
      },
      "status": "SUCCESS",
      "count": 4
    },
    {
      "timestamp": {
        "epochSeconds": 1509361320,
        "iso8601": "2017-10-30T11:02:00.000Z"
      },
      "status": "SUCCESS",
      "count": 3
    },
    {
      "timestamp": {
        "epochSeconds": 1509361500,
        "iso8601": "2017-10-30T11:05:00.000Z"
      },
      "status": "SUCCESS",
      "count": 4
    }
  ],
  "resultCount": 3,
  "pagedResultsCookie": null,
  "totalPagedResultsPolicy": "NONE",
  "totalPagedResults": -1,
  "remainingPagedResults": -1
}
```

You can sort the audit report using the `sortKeys` property. The following example runs the same query as the previous example but sorts the output according to the value of the `iso8601` field (the precise date and time of the entry):

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
'http://localhost:8080/openidm/report/audit/recon?_queryFilter=timestamp+gt+"2017-10
-01T00:00:00.0-0700"+and+timestamp+lt+"2017-10-31T00:00:00.0-0700"&aggregateFields=TIMESTAMP=/
timestamp;scale:min;utcOffset:-0700,VALUE=/status&postAggregationFilter=count+gt+2&_sortKeys=timestamp/
iso8601'
{
  "result": [
    {
      "timestamp": {
        "epochSeconds": 1509361320,
        "iso8601": "2017-10-30T11:02:00.000Z"
      },
      "status": "SUCCESS",
      "count": 3
    },
    {
      "timestamp": {
        "epochSeconds": 1509361440,
        "iso8601": "2017-10-30T11:04:00.000Z"
      },
      "status": "SUCCESS",
      "count": 4
    },
    {
      "timestamp": {
        "epochSeconds": 1509361500,
        "iso8601": "2017-10-30T11:05:00.000Z"
      },
      "status": "SUCCESS",
      "count": 4
    }
  ],
  "resultCount": 3,
  "pagedResultsCookie": null,
  "totalPagedResultsPolicy": "NONE",
  "totalPagedResults": -1,
  "remainingPagedResults": -1
}
```

Tip

The Admin UI includes an Audit Events widget that generates basic time-based reports on audit data. For more information, see "Viewing Audit Events in the Admin UI".

24.2. Generating Reports on Managed Data

To generate a report on managed data, run a filtered query on the `report/managed` endpoint. These reports enable data analysis on areas such as:

- Number of active managed users
- Number of self-registered managed users
- Number of enabled roles

The following example generates a report on the number of managed users born in the year 1999 and aggregates those users by birth month:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 'http://localhost:8080/openidm/report/managed/user?_queryFilter=/birthdate+gt+"1998-12
-31T23:59:59.999Z"+and+/birthdate+lt+"2000-01-01T00:00:00.000Z"&aggregateFields=TIMESTAMP=/
birthdate;scale:month;utcOffset:-0700'
{
  "result": [
    {
      "birthdate": {
        "epochSeconds": 933490800,
        "iso8601": "1999-08-01T00:00:00.0-0700"
      },
      "count": 8
    },
    {
      "birthdate": {
        "epochSeconds": 915174000,
        "iso8601": "1999-01-01T00:00:00.0-0700"
      },
      "count": 8
    },
    {
      "birthdate": {
        "epochSeconds": 917852400,
        "iso8601": "1999-02-01T00:00:00.0-0700"
      },
      "count": 10
    },
    {
      "birthdate": {
        "epochSeconds": 920271600,
        "iso8601": "1999-03-01T00:00:00.0-0700"
      },
      "count": 6
    },
    {
      "birthdate": {
        "epochSeconds": 928220400,
        "iso8601": "1999-06-01T00:00:00.0-0700"
      },
      "count": 10
    },
    {
      "birthdate": {
        "epochSeconds": 930812400,
        "iso8601": "1999-07-01T00:00:00.0-0700"
      },
      "count": 6
```

```
    },
    {
      "birthdate": {
        "epochSeconds": 936169200,
        "iso8601": "1999-09-01T00:00:00.0-0700"
      },
      "count": 7
    },
    {
      "birthdate": {
        "epochSeconds": 922950000,
        "iso8601": "1999-04-01T00:00:00.0-0700"
      },
      "count": 5
    },
    {
      "birthdate": {
        "epochSeconds": 925542000,
        "iso8601": "1999-05-01T00:00:00.0-0700"
      },
      "count": 3
    }
  ],
  "resultCount": 9,
  "pagedResultsCookie": null,
  "totalPagedResultsPolicy": "NONE",
  "totalPagedResults": -1,
  "remainingPagedResults": -1
}
```


The Admin UI provides a number of *count widgets* that generate reports on the following managed data:

- Number of active users (users whose account status is `active`
- Number of enabled social providers
- Number of enabled roles
- Number of configured connectors
- Number of manual user registrations

The count widgets are provided by default on the Resource Report and Business Report dashboards. Select Dashboards > Resource Report or Dashboards > Business Report to use these widgets, or add them to any other dashboard. For more information, see "Managing Dashboards".

24.3. Metrics and Monitoring

IDM includes tools for monitoring metrics related to activity in your IDM installation: a Dropwizard dashboard widget, for viewing metrics within IDM; and a Prometheus endpoint, for viewing metrics through external resources such as Prometheus and Grafana. While the same metrics are available in each tool, the right solution will depend on what you plan to use the metrics for.

IDM does not gather metrics by default. To enable metrics gathering, open `conf/metrics.json` and set the `enabled` property to `true`:

```
{
   "enabled" : true
}
```

To verify metrics are successfully enabled, run:

```
$ curl \
--header "X-OpenIDM-Username: openidm-admin"
 \
--header "X-OpenIDM-Password: openidm-admin"
 \
--request GET \
'http://localhost:8080/openidm/metrics/api?_queryFilter=true'
```

If metrics have been successfully enabled, this will return information about currently collected metrics. Otherwise, a bad request response is returned.

Metrics will only be reported once they have been triggered by activity in IDM, such as a reconciliation described in "Managing Reconciliation".

For a list of available metrics, see "*Metrics Reference*".

Note

This section discusses the installation of Prometheus and Grafana. These third-party tools are not supported by ForgeRock.

24.3.1. Dropwizard Widget

A Dropwizard widget is provided with IDM, and creates a graph of metrics based on activity in your IDM installation. This can be found by navigating to a dashboard on the admin site, selecting Add Widget, then selecting `Dropwizard Table with Graph` from the list of available widgets.

The dashboard widget is useful for lightweight, live monitoring of IDM, but does have a few limitations:

- The graphs created by the widget do not persist; they will be restarted if you reload or navigate away from the page.
- The widget only works with time-based metrics (other forms of metrics will not be listed in the widget).

24.3.2. Prometheus Endpoint

Prometheus is a third-party tool used for gathering and processing monitoring data. IDM has implemented a metrics endpoint which Prometheus can use to gather information about your IDM installation. For more information about installing and running Prometheus, see the Prometheus documentation.

24.3.2.1. Access to Prometheus

IDM includes a STATIC_USER, `prometheus`, which is configured to only have access to the `openidm/metrics/prometheus` endpoint. Additionally, the `openidm-prometheus` authorization role is available for accounts you wish to have access to this endpoint.

The STATIC_USER module is configured in the `authentication.json` file as shown here:

```
{
    "name" : "STATIC_USER",
    "properties" : {
        "queryOnResource" : "internal/user",
        "username" : "&{openidm.prometheus.username}",
        "password" : "&{openidm.prometheus.password}",
        "defaultUserRoles" : [
            "openidm-prometheus"
        ]
    },
    "enabled" : true
}
```

By default, the `prometheus` user name and password are stored in *`install-dir`*`/resolver/boot.properties`.

Note

The name of the prometheus authorization role can be changed in `boot.properties`, by altering what `openidm.prometheus.role` is set to. If you change the name of the authorization role, you *must* also change it in the `openidm.internalrole` table of your IDM repository.

24.3.2.2. Configuring Prometheus

Prometheus will need to be configured to monitor IDM, using a `prometheus.yml` configuration file. For more information on configuring Prometheus, see the Prometheus configuration documentation. An example `prometheus.yml` file would be:

```
global:
  scrape_interval: 15s
  external_labels:
    monitor: 'my_prometheus'

# https://prometheus.io/docs/operating/configuration/#scrape_config
scrape_configs:
  - job_name: 'openidm'
    scrape_interval: 15s
    scrape_timeout: 5s
    metrics_path: 'openidm/metrics/prometheus'
    scheme: http
    basic_auth:
      username: 'prometheus'
      password: 'prometheus'
    static_configs:
      - targets: ['localhost:8080']
```

This example configures Prometheus to poll the IDM endpoint every 5 seconds (`scrape_interval: 5s`), receiving metrics in a plain text format (`_fields: ['text']` and `_mimeType: ['text/plain;version=0.0.4']`). For more information about reporting formats, see the Prometheus documentation on Exposition Formats. You can validate that this configuration returns the expected results via **curl**:

```
$ curl \
--header "X-OpenIDM-Username: prometheus"
 \
--header "X-OpenIDM-Password: prometheus"
 \
--request GET \
'http://localhost:8080/openidm/metrics/prometheus?_fields=text&_mimeType=text%2Fplain%3Bversion%3D0.0.4'
```

Start Prometheus with your new `prometheus.yml` configuration file by running:

```
$ prometheus --config.file=/path/to/prometheus.yml
```

You can confirm Prometheus is correctly gathering data from IDM by navigating to the Prometheus monitoring page (by default, `http://localhost:9090`).

24.3.2.3. Configuring Grafana

Prometheus provides monitoring and processing for the information provided by IDM, but deeper analytics may be desired. In this case, you can use tools such as Grafana to create customized charts and graphs based on the information collected by Prometheus. For more information on installing and running Grafana, see the Grafana website.

Tip

The default username and password for Grafana is `admin` and `admin`.

To set up a Grafana dashboard with IDM metrics using Prometheus, your Prometheus installation needs to be added as a data source to Grafana. This can be done by selecting Configuration > Data Sources from the left navigation panel in Grafana, then selecting Add Data Source.

The options suggested in this list match the settings in the `monitoring.dashboard.json` file. With that in mind, proceed to the Add Data Source screen:

1. Give your data source a name, in this case, `ForgeRockIDM`.
2. Select Prometheus for the type.
3. Set the URL (by default, `http://localhost:9090`).
4. Set Access to proxy.
5. Enable Basic Auth.
6. Set a username and password of `prometheus` and `prometheus`.

7. Select Save & then Test Connection. If the configuration succeeds, you'll see the following message: "Data source is working."

Once Prometheus has been set up as a data source in Grafana, you can then create a dashboard with IDM metrics. You can create a dashboard in one of the following ways:

- Download the Monitoring Dashboard Samples from the ForgeRock BackStage download site. Find `monitoring.dashboard.json` in the downloaded zip file. In the Grafana administrative screen, select Home > Import and import the noted file.
- • Alternatively, select Create > Dashboard.
  - Select Graph.
  - Select Panel Title > Edit.

    From here, you can enter the metrics you wish to display (which will be available in autocomplete as you type), or you can build more complex queries using the Prometheus query language.

You can display a Grafana chart directly in IDM by creating a new dashboard in the IDM admin, and configuring the dashboard to be an Embedded URL, set to the URL of your Grafana installation (by default, `http://localhost:3000`).

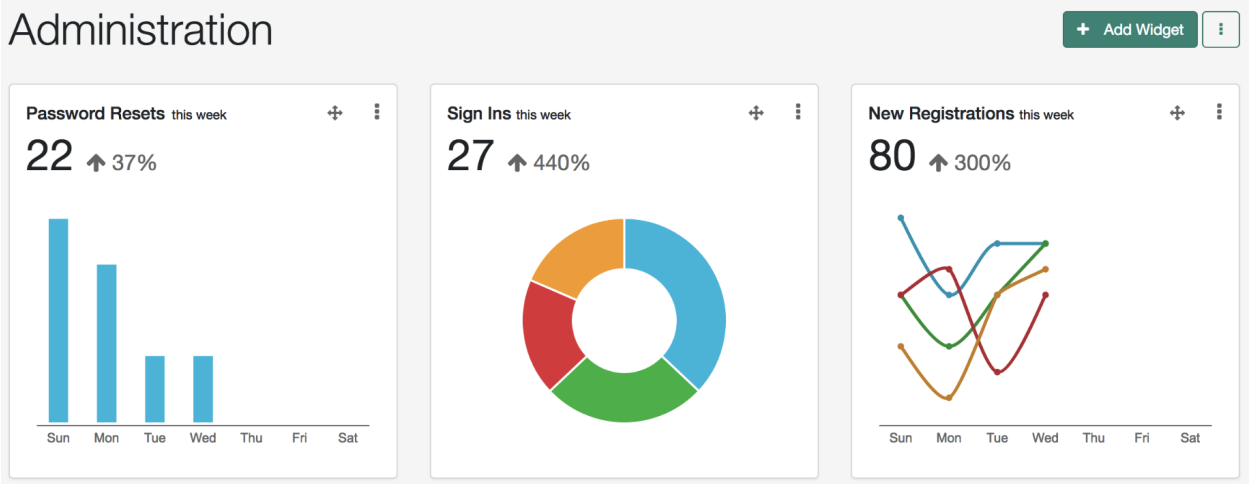
24.4. Monitoring Usage Trends

The Admin UI provides three widgets that enable you to monitor usage trends regarding new user registrations, sign-ins and password resets.

You can add these widgets to any dashboard, and configure them as required. For more information, see "Managing Dashboards".

The following image shows the usage trend widgets tracking registrations, sign-ins and password resets per week:

Usage Trend Widgets



24.5. Configuring Notifications

IDM includes a highly customizable notification service that sends messages based on changes to the routes of your choice. It includes the notifications related to the End User UI, as described in "End User UI Notifications" and more.

With the notification service, IDM uses filters to listen to incoming requests. If the filter conditions are met, IDM sends the notification as configured.

IDM notifications include several notification configuration files that you can use as templates.

24.5.1. Basic Notification Configuration

The basic service is configured in the following file in your project's `conf/` subdirectory: `notificationFactory.json`.

```
{
    "enabled" : true,
    "threadPool" : {
        "steadyPoolThreads" : 2,
        "maxPoolThreads" : 10,
        "threadKeepAlive" : 60,
        "maxQueueSize" : 20000
    }
}
```

Note

Notifications are enabled by default. You can disable *all* notifications by setting `"enabled" : false,` in `notificationFactory.json`.

These options can affect performance; for more information, see "Queued Synchronization".

User notifications require the following setting in the `user` object code block of `managed.json`:

```
},
"notifications" : {
}
```

24.5.2. Notification Configuration Files

Configuration file names have the following format: `notification-*.json`. Within these files, you'll find properties as described here:

Properties in `notification-*.json`

Property	Data Type	Description
`path`	string	For user notifications, typically `managed/user/*` or `config/*`. Defines where the filter listens on the router.
`methods`	array of strings	One or more ForgeRock REST verbs, including `create`, `read`, `update`, `delete`, `patch`, `action`, `query`. Optional. Defaults to all methods.
`condition`	string or object	Filtering on the source; may include scripts.
`target`	object	Target object; includes at least a `resource` and possibly a `_queryFilter`.
`resource`	string	Target resource, typically `managed/user`. May be the `_ref` for the target relationship, or a `_queryFilter` applied to a resource collection.
`_queryFilter`	string	Optional filtering on the target.
`notification`	object	Includes `notificationType` and `message`.
`notificationType`	object	Logging type; may be `info`, `warning`, or `error`.
`message`	string	Notification message sent to the user.

As notification configuration files follow the constructs for `router.json`, see "*Router Service Reference*" for additional `condition` constructs.

The `target.resource` and `notification.message` field values support the use of a `{{token}}` to replace contextual variables.

Notifications support the following variables for token replacement:

- `request`
- `context`

- `resourceName`
- `response`

24.5.3. End User Notification Configuration Files

You'll find notification-*.json configuration files for end users in your project's `conf/` subdirectory. Two of those files are described here:

`notification-passwordUpdate.json`

Based on the default version of this file, any time there is an `update` or a `patch` of a `managed/user/*` password, an `info` level message is sent as a notification to the user `_id`.

Here's the current version of this file:

```
{
    "enabled" : true,
    "path" : "managed/user/*",
    "methods" : [
        "update",
        "patch"
    ],
    "condition" : {
        "type" : "text/javascript",
        "source" : "(method === 'update' && content.password !== undefined) || (method === 'patch' &&
 patchOperations.filter(function(op){ return op.field === '/password' } ).length > 0)"
    },
    "target" : {
        "resource" : "managed/user/{{response/_id}}"
    },
    "notification" : {
        "notificationType": "info",
        "message": "Your password has been updated."
    }
}
```

`notification-profileUpdate.json`

Whenever there's an `update` or a `patch` of a user field other than the password, an `info` level message is sent as a notification to the user `_id`.

Here's the current version of this file:

```
{
    "enabled" : true,
    "path" : "managed/user/*",
    "methods" : [
        "update",
        "patch"
    ],
    "condition" : {
        "type" : "text/javascript",
        "source" : "(method === 'update' && content.password === undefined) || (method === 'patch' &&
 patchOperations.filter(function(op){ return op.field === '/password' } ).length == 0)"
    },
    "target" : {
        "resource" : "managed/user/{{response/_id}}"
    },
    "notification" : {
        "notificationType" : "info",
        "message" : "Your profile has been updated."
    }
}
```

If you want to specify properties to watch for each user, add a `globals` code block under `condition`. For example, the following code block reviews user profiles for changes to email addresses:

```
"condition" : {
    "type" : "text/javascript",
    "globals" : {
        "propertiesToCheck" : [
            "mail"
        ]
    },
    "file" : "propertiesModifiedFilter.js"
},
```

The `propertiesToCheck` that you specify is limited to existing user properties in the associated `managed.json` file. It depends on the `propertiesModifiedFilter.js` script that you can find in the following directory: `/path/to/openidm/bin/defaults/script/`.

24.5.4. Sample Notification Configuration Files

You'll find sample notification configuration files in the following directory: `/path/to/openidm/samples/example-configurations/conf`. If you want to use these files (or create your own), copy them to your project's `conf/` subdirectory.

`notification-newReport.json`

This file ensures that managers are notified when a new direct reporting employee is assigned to them.

`notification-termsUpdate.json`

This file ensures that all users who have accepted Terms & Conditions are notified of updates.

24.5.5. Notifications in the Repository

For a JDBC repository, IDM stores notifications in the `notificationobjects` table. A second table, `notificationobjectproperties`, serves as the index table.

For a DS repository, you'll see the following excerpt to the `genericMapping` in your project's `repo.ds.json` file:

```
"internal/notification" : {
    "dnTemplate": "ou=notification,ou=internal,dc=openidm,dc=forgerock,dc=com"
}
```

24.5.6. Limits on Notification Endpoints

While notifications are highly configurable, you can't apply them to services with their own internal routers, including internal objects. This list includes:

`workflow/taskinstance`
`workflow/processdefinition`
`workflow/processinstance`
`metrics/api`
`metrics/prometheus`
`scheduler/job`
`scheduler/trigger`
`scheduler/waitingTriggers`
`scheduler/acquiredTriggers`
`health/os`
`health/memory`
`health/recon`
`info/ping`
`info/login`
`info/version`
`info/uiconfig`
`info/features`
`internal/{object}`
`internal/{object}/{object_id}/relationship`
`managed/{object}/{object_id}/relationship`

However, you could set up a `notification-`*`someSubject`*`.json` on a top-level route such as `health`, and set up a `condition` that filters for criteria such as memory usage.

Chapter 25

Clustering, Failover, and Availability

To ensure high availability of the identity management service, you can deploy multiple IDM instances in a cluster. In a clustered environment, each instance must point to the same external repository. If the database is also clustered, IDM points to the cluster as a single system.

If one instance in a cluster shuts down or fails to check in with the cluster management service, a second instance will detect the failure. For example, if an instance named `instance1` loses connectivity 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 at that time.

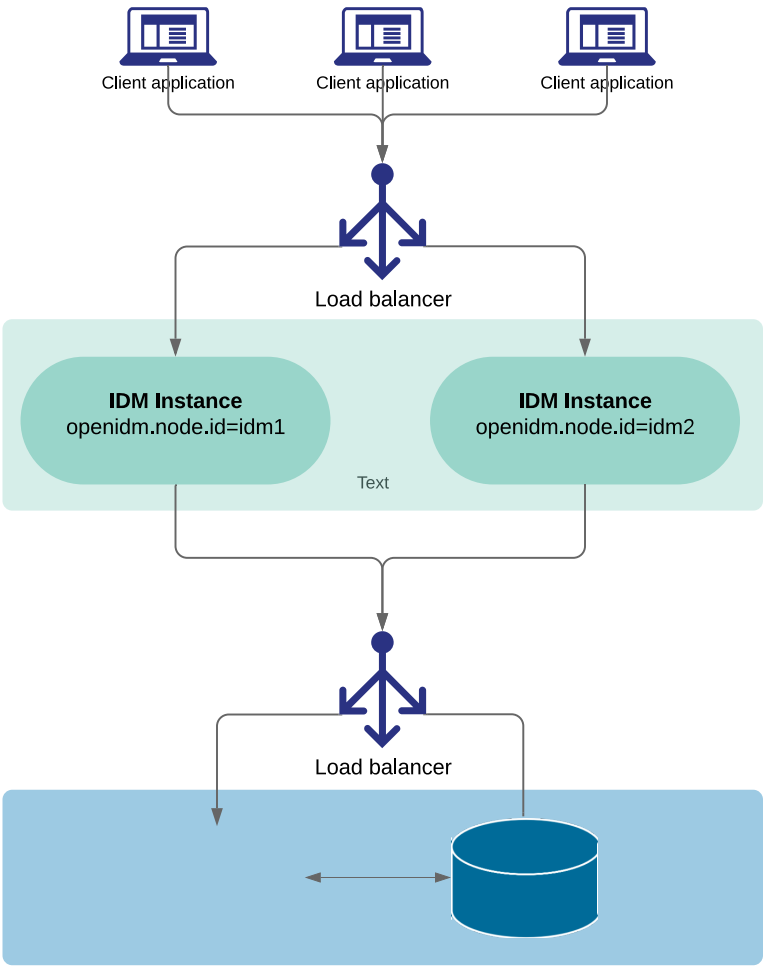
Consistency and concurrency across cluster instances is ensured using multi-version concurrency control (MVCC). MVCC provides consistency because each instance updates only the particular revision of the object that was specified in the update.

All instances in a cluster run simultaneously. When a clustered deployment is configured with a load balancer, the deployment works as an active-active high availability cluster.

IDM requires a single, consistent view of all the data it manages, including the user store, roles, schedules, and configuration. If you can guarantee this consistent view, the number and locations of IDM nodes in a cluster will be limited only by your network latency and other network factors that affect performance.

This chapter describes the changes required to configure multiple IDM instances in a single cluster. However, it does not specify how you might configure a load balancer. When configured with the scheduler service, the different instances claim jobs in a random order. For more information, see "Managing Scheduled Tasks Across a Cluster".

The following diagram depicts a relatively simple cluster configuration:



Important

A clustered deployment relies on system heartbeats to assess the cluster state. For the heartbeat mechanism to work, you *must* synchronize the system clocks of all the machines in the cluster using a time synchronization service that runs regularly. The system clocks must be within one second of each other. For information on how you can achieve this using the Network Time Protocol (NTP) daemon, see the NTP RFC.

Note that VM guests do not necessarily keep the same time as the host. You should therefore run a time synchronization service such as NTP on every VM.

25.1. Configuring an IDM Instance as Part of a Cluster

To set up a cluster of IDM systems, you'll need to make sure that each instance is shut down, configured to use the same repository, set up with unique node IDs, use the same keystore and truststore, and is configured to work with a load balancer or reverse proxy.

To configure an IDM instance as a part of a clustered deployment, follow these steps:

1. If the server is running, shut it down using the OSGi console:

   ```
   -> shutdown
   ```

2. If you have not already done so, set up a supported repository, as described in "*Selecting a Repository*" in the *Installation Guide*.

   Each instance in the cluster must be configured to use the same repository, that is, the database connection configuration file (`datasource.jdbc-default.json`) for each instance must point to the same port number and IP address for the database.

   Note

   The configuration file `datasource.jdbc-default.json` must be the same on all nodes.

   In "*Selecting a Repository*" in the *Installation Guide*, you will see a reference to a data definition language script file. Do not run that script for each instance in the cluster - run it just once to set up the tables required for IDM.

   Important

   If an instance is *not* participating in the cluster, it must *not* share a repository with nodes that are participating in the cluster. Having non-clustered nodes use the same repository as clustered nodes will result in unexpected behavior.

3. Specify a unique node ID (`openidm.node.id`) for each instance.

   You can specify the node ID in one of the following ways:

   - Set the value of `openidm.node.id` in the `resolver/boot.properties` file of the instance, for example:

     ```
     openidm.node.id = node1
     ```

   - Set the value in the `OPENIDM_OPTS` environment variable and export that variable before starting the instance. You must include the JVM memory options when you set this variable. For example:

```
$ export OPENIDM_OPTS="-Xmx1024m -Xms1024m -Dopenidm.node.id=node1"
$ ./startup.sh
Executing ./startup.sh...
Using OPENIDM_HOME:   /path/to/openidm
Using PROJECT_HOME:   /path/to/openidm
Using OPENIDM_OPTS:   -Xmx1024m -Xms1024m -Dopenidm.node.id=node1
Using LOGGING_CONFIG: -Djava.util.logging.config.file=/path/to/openidm/conf/logging.properties
Using boot properties at /path/to/openidm/resolver/boot
.properties
-> OpenIDM version "6.5.2.0"
OpenIDM ready
```

You can set any value for the `openidm.node.id`, as long as the value is unique within the cluster. The cluster manager detects unavailable instances by their node ID.

You *must* set a node ID for each instance, otherwise the instance fails to start. The default `resolver/boot.properties` file sets the node ID to `openidm.node.id=node1`.

4. Set the cluster configuration.

   The cluster configuration is defined in the `conf/cluster.json` file of each instance. By default, configuration changes are persisted in the repository so changes that you make in this file apply to all nodes in the cluster.

   The default version of the `cluster.json` file assumes that the cluster management service is enabled:

```
{
  "instanceId" : "&{openidm.node.id}",
  "instanceTimeout" : 30000,
  "instanceRecoveryTimeout" : 30000,
  "instanceCheckInInterval" : 5000,
  "instanceCheckInOffset" : 0,
  "enabled" : true
}
```

   - The `instanceId` is set to the value of each instance's `openidm.node.id` that you set in the previous step.
   - The `instanceTimeout` specifies the length of time (in milliseconds) that a member of the cluster can be "down" before the cluster manager considers that instance to be in recovery mode.

     Recovery mode indicates that the `instanceTimeout` of an instance has expired, and that another instance in the cluster has detected that event.

     The scheduler component of the second instance then moves any incomplete jobs into the queue for the cluster.
   - The `instanceRecoveryTimeout` specifies the time (in milliseconds) that an instance can be in recovery mode before it is considered to be offline.

This property sets a limit after which other members of the cluster stop trying to access an unavailable instance.

- The `instanceCheckInInterval` specifies the frequency (in milliseconds) that instances check in with the cluster manager to indicate that they are still online.
- The `instanceCheckInOffset` specifies an offset (in milliseconds) for the check-in timing, when multiple instances in a cluster are started simultaneously.

  The check-in offset prevents multiple instances from checking in simultaneously, which would strain the cluster manager resource.
- The `enabled` property specifies whether the cluster management service is enabled when you start the server. This property is set to `true` by default.

Important

Disabling the cluster manager while clustered nodes are running (by setting the `enabled` property to `false` in an instance's `cluster.json` file), has the following consequences:

- The cluster manager thread that causes instances to *check in* is not activated.
- Nodes in the cluster no longer receive cluster *events*, which are used to broadcast configuration changes when they occur over the REST interface.
- Nodes are unable to detect and attempt to recover failed instances within the cluster.
- Persisted schedules associated with failed instances can not be recovered by other nodes.

5. Optionally, configure your cluster so that each instance reads its configuration only from the files in its `conf/` directory and not from the shared repository. For more information, see "Specifying an Authoritative File-Based Configuration".
6. If your deployment uses scheduled tasks, configure persistent schedules so that jobs and tasks are launched only once across the cluster. For more information, see "Configuring Persistent Schedules".
7. Configure each node in the cluster to work with host headers. Clustering does *not* work with the default configuration of `jetty.xml` and `boot.properties`. For more information, see "Deploying Securely Behind a Load Balancer".
8. Make sure that each node in the cluster has the same keystore and truststore. You can do this in one of the following ways:

   - When the first instance has been started, copy the initialized keystore (`/path/to/openidm/security/keystore.jceks`) and truststore (`/path/to/openidm/security/truststore`) to all other instances in the cluster.

- Use a single keystore that is shared between all the nodes. The shared keystore might be on a mounted filesystem, a Hardware Security Module (HSM) or something similar. If you use this method, set the following properties in the `resolver/boot.properties` file of each instance to point to the shared keystore:

  ```
  openidm.keystore.location=path/to/keystore
  openidm.truststore.location=path/to/truststore
  ```

  For information on configuring IDM to use an HSM device, see "Configuring IDM For a Hardware Security Module (HSM) Device".

- The configuration file `secrets.json` in the `/path/to/openidm/conf` directory must be the same on all the nodes.

9. Start each instance in the cluster.

Important

The audit service logs configuration changes only on the modified instance. Although configuration changes are persisted in the repository, and thus replicated on other instances by default, those changes are not logged separately for each instance. For more information on the audit service, see "*Setting Up Audit Logging*".

Although configuration changes are persisted by default, changes to workflows and scripts, and extensions to the UI are not. Any changes that you make in these areas must be manually copied to each node in the cluster.

25.1.1. Specifying an Authoritative File-Based Configuration

Each IDM instance includes two properties in its `conf/system.properties` file that determine how configuration changes are handled:

- `openidm.fileinstall.enabled` specifies that IDM reads its configuration from the files in its `conf/` directory.

  This parameter is `true` by default because the following line is commented out:

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

  If you want the file-based configuration to be authoritative, set this property to `true` (or leave the existing line commented out) on every instance in the cluster.

  For information on changing this setting, see "Disabling Automatic Configuration Updates".

- `openidm.config.repo.enabled` specifies that IDM reads its configuration from the repository.

  This parameter is `true` by default because the following line is commented out:

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

  If you want the file-based configuration to be authoritative, set this property to `false` by removing the comment from the existing line on every instance in the cluster.

With this configuration:

- Each node in the cluster does not persist its configuration to the repository.
- Each node has its own version of the configuration in memory only.
- Any changes made to one node's file configuration must be applied manually across all nodes in the cluster for the configuration to be consistent.

  When new nodes are deployed, you must ensure that the configuration is consistent across all nodes.

25.2. 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 execute only on the node that created it.
- Persistent scheduled jobs are picked up and executed by any available node in the cluster that has been configured to execute persistent jobs.
- Jobs that are configured as persistent but *not concurrent* run on only one instance in the cluster at a time. That job will not run again at the scheduled time, on any instance in the cluster, until the current job is complete.

  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.

In clustered environments, the scheduler service obtains an `instanceID`, and check-in and timeout settings from the cluster management service (defined in the *`project-dir`*`/conf/cluster.json` file).

IDM instances in a cluster claim jobs in a random order. If one instance fails, the cluster manager automatically reassigns unstarted jobs that were claimed by that failed instance.

For example, if instance A claims a job but does not start it, and then loses connectivity, instance B can claim that job.

In contrast, if instance A claims a job, starts it, and then loses connectivity, other instances in the cluster cannot claim that job. If the failed instance does not complete the task, the next action depends on the *misfire policy*, defined in the scheduler configuration. For more information, see `misfirePolicy`.

You can override this behavior with an external load balancer.

If a liveSync operation leads to multiple changes, a single instance processes all changes related to that operation.

Because all nodes in a cluster read their configuration from a single repository, you must use an instance's `resolver/boot.properties` file to define a specific scheduler configuration for that instance. Settings in the `boot.properties` file are not persisted in the repository, so you can use this file to set different values for a property across different nodes in the cluster.

For example, if your deployment has a four-node cluster and you want only two of those nodes to execute persisted schedules, you can disable persisted schedules in the `boot.properties` files of the remaining two nodes. If you set these values directly in the `scheduler.json` file, the values are persisted to the repository and are therefore applied to all nodes in the cluster.

By default, instances in a cluster are able to execute persistent schedules. The setting in the `boot.properties` file that governs this behaviour is:

```
openidm.scheduler.execute.persistent.schedules=true
```

To prevent a specific instance from claiming pending jobs, or processing clustered schedules, set `openidm.scheduler.execute.persistent.schedules=false` in the `boot.properties` file of that instance.

Caution

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.

For more information about persistent schedules, see "Configuring Persistent Schedules".

25.3. 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.

Displaying the Nodes in the Cluster

The following REST request displays the nodes configured in the cluster, and their status.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/cluster?_queryId=query-cluster-instances"

{
  "result": [
    {
       "_id": "node1",
       "state" : "running",
       "instanceId" : "node1",
       "startup": "2017-09-16T15:37:04.757Z",
       "shutdown" : ""
    },
    {
       "_id": "node2",
       "state" : "running",
       "instanceId" : "node2",
       "startup": "2017-09-16T15:45:05.652Z",
       "shutdown" : ""
    }
  ]
}
```

Checking the State of an Individual Node

To check the status of a specific node, include its node ID in the URL, for example:

```
$  curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/cluster/node1"
{
  "_id": "node1",
  "instanceId": "node1",
  "startup": "2017-09-16T15:37:04.757Z",
  "shutdown": "",
  "state": "running"
}
```

25.4. Managing Nodes Through the Admin UI

The Admin UI provides a status widget that lets you monitor the activity and status of all nodes in a cluster.

To add the widget to a Dashboard, click Add Widget then scroll down to System Status > Cluster Node Status and click Add.

The cluster node status widget shows the current status and number of running jobs of each node.

Select Status to obtain more information on the latest startup and shutdown times of that node. Select Jobs to obtain detailed information on the tasks that the node is running.

The widget can be managed in the same way as any other dashboard widget. For more information, see "Managing Dashboards".

25.5. Clusters and Containers Managed by an Orchestrator Such as Kubernetes

Cluster nodes that are shut down in IDM may reappear. IDM therefore preserves the associated node IDs.

If you're deploying IDM with an orchestrator such as Kubernetes, you want IDM to remove the node IDs of pods that are shut down. In that case, you'll want to activate the following line in `boot.properties`:

```
openidm.cluster.remove.offline.node.state=true
```

By default, this property is *false*.

Chapter 26
Configuring Outbound Email

This chapter shows you how to configure the outbound email service, so that you can send email through IDM, either by script or through the REST API.

You can also configure the outbound email service in the Admin UI, by clicking Configure > Email Settings. The fields on that screen correspond to what is described in the following sections.

To Set Up Outbound Email

The outbound email service relies on a configuration object to identify the email account that is used to send messages. A sample configuration is provided in `samples/example-configurations/conf/external.email.json`. To set up the external email service, follow these steps. You do not have to shut down IDM:

1. If you are setting up outbound email through the UI, start configuring an outbound email server directly from the noted UI screen.

2. Copy the sample email configuration to the `conf/` directory of your project. For example:

```
$ cd /path/to/openidm
$ cp samples/example-configurations/conf/external.email.json /path/to/myproject/conf/
```

3. Edit `external.email.json` to reflect the account that is used to send messages, for example:

```
{
    "host" : "smtp.gmail.com",
    "port" : 587,
    "debug" : false,
    "auth" : {
        "enable" : true,
        "username" : "admin",
        "password" : "Passw0rd"
    },
    "from" : "admin@example.com",
    "timeout" : 300000,
    "writetimeout" : 300000,
    "connectiontimeout" : 300000,
    "starttls" : {
        "enable" : true
    },
    "ssl" : {
        "enable" : false
    },
    "smtpProperties" : [
        "mail.smtp.ssl.protocols=TLSv1.2",
        "mail.smtps.ssl.protocols=TLSv1.2"
    ],
    "threadPoolSize" : 20
}
```

IDM encrypts the password when you restart the server (or if you configure outgoing email through the Admin UI).

You can specify the following outbound email configuration properties:

`host`

The host name or IP address of the SMTP server. This can be the `localhost`, if the mail server is on the same system as IDM.

`port`

SMTP server port number, such as 25, 465, or 587.

> **Note**
>
> Many SMTP servers require the use of a secure port such as 465 or 587. Many ISPs flag email from port 25 as spam.

`debug`

When set to `true`, this option outputs diagnostic messages from the JavaMail library. Debug mode can be useful if you are having difficulty configuring the external email endpoint with your mail server.

`auth`

The authentication details for the mail account from which emails will be sent.

- `enable`—indicates whether you need login credentials to connect to the SMTP server.

  Note

  If `"enable" : false,` you can leave the entries for `"username"` and `"password"` empty:

  ```
  "enable" : false,
  "username" : "",
  "password" : ""
  ```

- `username`—the account used to connect to the SMTP server.
- `password`—the password used to connect to the SMTP server.

`starttls`

If `"enable" : true`, enables the use of the STARTTLS command (if supported by the server) to switch the connection to a TLS-protected connection before issuing any login commands. If the server does not support STARTTLS, the connection continues without the use of TLS.

`from`

(Optional) Specifies a default `From:` address, that users see when they receive emails from IDM.

`ssl`

Set `"enable" : true` to use SSL to connect, and to use the SSL port by default.

`smtpProperties`

Specifies the SSL protocols that will be enabled for SSL connections. Protocols are specified as a whitespace-separated list. The default protocol is TLSv1.2.

`threadPoolSize`

(Optional) Emails are sent in separate threads managed by a thread pool. This property sets the number of concurrent emails that can be handled at a specific time. The default thread pool size (if none is specified) is `20`.

`connectiontimeout` **(integer, optional)**

The socket connection timeout, in milliseconds. The default connection timeout (if none is specified) is `300000` milliseconds, or 5 minutes. A setting of 0 disables this timeout.

`timeout` **(integer, optional)**

The socket read timeout, in milliseconds. The default read timeout (if none is specified) is `300000` milliseconds, or 5 minutes. A setting of 0 disables this timeout.

`writetimeout` **(integer, optional)**

The socket write timeout, in milliseconds. The default write timeout (if none is specified) is `300000` milliseconds, or 5 minutes. A setting of 0 disables this timeout.

4. Start IDM if it is not running.

5. Check that the email service is enabled and active:

```
-> scr list
...
 [ 130]   org.forgerock.openidm.external.email  enabled
    [  21] [active      ] org.forgerock.openidm.external.email
...
```

26.1. 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`, to test that your configuration works. You pass the message parameters as part of the POST payload, URL encoding the content as necessary.

The following example sends a test email using the REST API:

```
$ curl \
 --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":"your_email@example.com",
   "subject":"Test",
   "body":"Test"}' \
 "http://localhost:8080/openidm/external/email?_action=send"
{
  "status": "OK",
  "message": "Email sent"
}
```

By default, a response is returned only when the SMTP relay has completed. To return a response immediately, without waiting for the SMTP relay to finish, include the parameter `waitForCompletion=false` in the REST call. Use this option only if you do not need to verify that the email was accepted by the SMTP server. For example:

```
$ curl \
 --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":"your_email@example.com",
   "subject":"Test",
   "body":"Test"}' \
 "http://localhost:8080/openidm/external/email?_action=send&waitForCompletion=false"
{
  "status": "OK",
  "message": "Email submitted"
}
```

26.2. Sending Mail From a Script

You can send email by using the resource API functions, with the `external/email` context. For more information about these functions, see "Function Reference". In the following example, `params` is an object that contains the POST parameters.

```
var params =  new Object();
params.from = "openidm@example.com";
params.to = "your_email@example.com";
params.cc = "bjensen@example.com,scarter@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 27

Accessing External REST Services

You can access remote REST services at the `openidm/external/rest` context path, 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 IDM logic. For more declarative and encapsulated interaction with remote REST services, and for synchronization or reconciliation operations, use the scripted REST implementation of the Groovy connector in the *Connector Reference*.

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.

An external REST call over REST might look something like the following:

```
$ curl \
 --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",
  "headers": { "custom-header": "custom-header-value" }
  }' \
 "http://localhost:8080/openidm/external/rest?_action=call"
{
  "headers": {
    "Accept-Ranges": [
      "bytes"
    ],
    "Content-Length": [
      "665"
    ],
    "Content-Type": [
      "text/html"
    ],
    "Date": [
      "Thu, 28 Jul 2016 09:13:38 GMT"
    ],
    "ETag": [
      "\"299-4175ff09d1140\""
    ],
    "Last-Modified": [
      "Thu, 29 Jun 2006 17:05:33 GMT"
```

```
    ],
    "Server": [
      "Apache"
    ]
  },
  "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>\r\n
            <p>\r\n   This is a minimal \"hello world\" HTML document. It
             demonstrates the\r\n   basic structure of an HTML file and anchors.\r\n
            </p>\r\n
            <p>\r\n   For more information, see the HTML Station at:
             <a href= \r\n   \"http://www.december.com/html/\">http://www.december.com/html/</a>\r\n
            </p>\r\n
            <hr>\r\n
            <address>\r\n   &copy;
            <a href=\"http://www.december.com/john/\">John December</a>
           (<a\r\n   href=\"mailto:john@december.com\">john@december.com</a>) / 2001-04-06\r\n
            </address>\r\n </body>\r\n</html>\r\n"}
```

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.

27.1. 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`, and `OPTIONS`.

`headers` (optional)

The HTTP headers to set, in a map format from string (*header-name*) to string (*header-value*). For example, `Accept-Language: en-US`.

`contentType` (optional)

The media type of the data that is sent, for example `"contentType" : "application/json"`. This parameter is applied only if no `Content-Type` header is included in the request. (If a `Content-Type` header is included, that header takes precedence over this `contentType` parameter.) If no `Content-`

`Type` is provided (in the header or with this parameter), the default content type is `application/json; charset=utf-8`.

`body` (optional)

The body or resource representation to send (for PUT and POST operations), in string format.

`base64` (boolean, optional)

Indicates that the `body` is base64-encoded, and should be decoded prior to transmission.

`forceWrap` (boolean, optional)

Indicates that the response must be wrapped in the headers/body JSON message format, even if the response was JSON and would otherwise have been passed-through unchanged.

`authenticate`

The authentication type, and the details with which to authenticate.

IDM supports the following authentication types:

- `basic` authentication with a username and password, for example:

```
"authenticate" : {
    "type": "basic",
    "user" : "john",
    "password" : "Passw0rd"
}
```

- `bearer` authentication, with 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.

27.2. Support for Non-JSON Responses

The external REST service supports any arbitrary payload (currently in stringified format). If the response is anything other than JSON, a JSON message object is returned:

- For text-compatible (non-JSON) content, IDM returns a JSON object similar to the following:

```
{
    "headers": { "Content-Type": ["..."] },
    "body": "..."
}
```

- Content that is not text-compatible (such as JPEGs) is base64-encoded in the response `body` and returned as follows:

```
{
    "headers": { "Content-Type": ["..."] },
    "body": "...",
    "base64": true
}
```

Note

If the response format is JSON, the raw JSON response is returned. If you want to inspect the response headers, set `forceWrap` to `true` in your request. This setting returns a JSON message object with `headers` and `body`, similar to the object returned for text-compatible content.

27.3. Setting the TLS Version

By default, Transport Layer Security (TLS) connections made via the external REST service use TLS version 1.2. In rare cases, you might need to specify a different TLS version, for example, if you are connecting to a legacy system that supports an old version of TLS that is not accommodated by the backward-compatibility mode of your Java client. If you need to specify that the external REST service use a different TLS version, uncomment the `openidm.external.rest.tls.version` property towards the end of your project's `resolver/boot.properties` file and set its value, for example:

```
openidm.external.rest.tls.version=TLSv1.1
```

Valid versions for this parameter include `TLSv1.1` and `TLSv1.2`.

27.4. Configuring the External REST Service

In addition to the TLS version, described in "Setting the TLS Version", you can configure several properties of the external REST service.

A sample configuration file that lists these properties (with their default values where applicable) is provided in `/path/to/openidm/samples/example-configurations/conf/external.rest.json`. To change any of the default settings, copy this file to your project's `conf` directory and edit the values. The sample file has the following configuration:

```
{
  "socketTimeout" : "10 s",
  "connectionTimeout" : "10 s",
  "reuseConnections" : true,
  "retryRequests" : true,
  "maxConnections" : 64,
  "tlsVersion": "&{openidm.external.rest.tls.version}",
  "hostnameVerifier": "&{openidm.external.rest.hostnameVerifier}",
  "proxy" : {
    "proxyUri" : "",
    "userName" : "",
    "password" : ""
  }
}
```

`socketTimeout` (string)

The TCP socket timeout, in seconds, when waiting for HTTP responses. The default timeout is 10 seconds.

`connectionTimeout` (string)

The TCP connection timeout for new HTTP connections, in seconds. The default timeout is 10 seconds.

`reuseConnections` (boolean, true or false)

Specifies whether HTTP connections should be kept alive and reused for additional requests. By default, connections will be reused if possible.

`retryRequests` (boolean, true or false)

Specifies whether requests should be retried if a failure is detected. By default requests will be retried.

`maxConnections` (integer)

The maximum number of connections that should be pooled by the HTTP client. At most `64` connections will be pooled by default.

`tlsVersion` (string)

The TLS version that should be used for connections. For more information, see "Setting the TLS Version".

`hostnameVerifier` (string)

Specifies whether the external REST service should check that the hostname to which an SSL client has connected is allowed by the certificate that is presented by the server.

The property can take the following values:

- `STRICT` - hostnames are validated
- `ALLOW_ALL` - the external REST service does not attempt to match the URL hostname to the SSL certificate Common Name, as part of its validation process

By default, this property is set in the `resolver/boot.properties` file and the value in `conf/external.rest.json` references that setting. For testing purposes, the default setting in `boot.properties` is:

```
openidm.external.rest.hostnameVerifier=ALLOW_ALL
```

If you do not set this property (by removing it from the `boot.properties` file or the `conf/external.rest.json` file), the behavior is to validate hostnames (the equivalent of setting `"hostnameVerifier": "STRICT"`). In production environments, you *should* set this property to `STRICT`.

`proxy`

Sets a proxy server *specific* to the external REST service. If you set a `proxyUri` here, the system-wide proxy settings described in "Configuring HTTP Clients" are ignored. If you want to configure a system-wide proxy, leave these `proxy` settings empty and configure the HTTP Client settings instead.

Chapter 28

Deployment Best Practices

This chapter lists points to check when implementing an identity management solution with IDM.

28.1. 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.

28.1.1. 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.

28.1.2. 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 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 IDM to manage users.

Password Management and Password Synchronization

Procedures for managing account passwords, password policies, who manages passwords, and what is required of IDM to manage passwords.

Security Policy

What security policies define for users, accounts, passwords, and access control.

Target Systems

Target systems and resources with which IDM 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 with DS or Active Directory.

28.1.3. Design

This phase focuses on solution design including on IDM 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.

28.1.4. Configure and Test

This phase configures and tests the solution prior to moving the solution into production.

Configure IDM Properties

Most deployments require customization before going into production. For example, you can modify the ports IDM uses, as described in "*Host and Port Information*".

Configure a Connector

Most deployments include a connection to one or more remote data stores. You should first define all the objects and properties for your connector configuration, as described in "Configuring Connectors".

Test Communication to Remote Data Stores

You can then test communication with each remote data store with appropriate REST calls, such as those described in: "Checking the Status of External Systems Over REST". When your tests succeed, you can have confidence in the way you configured IDM to communicate with your remote data stores.

Set Up a Mapping

You can now set up a mapping between data stores. "*Synchronizing Data Between Resources*" includes an extensive discussion of how you can customize a mapping in the `sync.json` file.

When you have completed the basic configuration, set up associated custom configuration files in a directory *outside* of the IDM installation directory (outside the `/path/to/openidm` directory tree).

28.1.5. Production

This phase deploys the solution into production until an application steady state is reached and maintenance routines and procedures can be applied.

Chapter 29

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.

29.1. Advanced Startup Configuration

A customizable startup configuration file (named `launcher.json`) lets you 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 IDM 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 IDM 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"
    },
```

Appendix A. Host and Port Information

By default, IDM listens on the following ports (specified in your `resolver/boot.properties` file):

`8080`

HTTP access to the REST API, requiring IDM 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 IDM 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.

If you have another network service that uses any of these ports, change the port numbers shown in the following excerpt of the `boot.properties` file:

```
openidm.port.http=8080
openidm.port.https=8443
openidm.port.mutualauth=8444
openidm.host=localhost

openidm.auth.clientauthonlyports=8444
```

Note

Some Social Identity providers expect specific ports in their configuration, usually ports 80 and 443. This information is noted in "*Configuring Social Identity Providers*" and in "*Social Identity Provider Configuration Details*" when it occurs.

By default, IDM uses `localhost` as its hostname. This can be changed through the `openidm.host` property in your `boot.properties` file.

The Jetty configuration (in `openidm/conf/jetty.xml`) references the host and ports that are specified in the `boot.properties` file.

Appendix B. Data Models and Objects Reference

You can customize a variety of objects that can be addressed via a URL or URI. IDM can perform a common set of functions on these objects, such as CRUDPAQ (create, read, update, delete, patch, action, and query).

Depending on how you intend to use them, different object types are appropriate.

Object Types

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.	
Audit objects	Houses audit data in the repository.	

Object Type	Intended Use	Special Functionality
Links	Defines a relation between two objects.	

B.1. Managed Objects

A *managed object* is an object that represents the identity-related data managed by IDM. Managed objects are stored in the IDM repository. All managed objects are JSON-based data structures.

B.1.1. Managed Object Schema

IDM provides a default schema for typical managed object types, such as users and roles, but does not control the structure of objects that you store in the repository. You can modify or extend the schema for the default object types, and you can set up a new managed object type for any item that can be collected in a data set.

The `_rev` property of a managed object is reserved for internal use, and is not explicitly part of its schema. This property specifies the revision of the object in the repository. 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 validation is performed by the policy service and can be configured according to the requirements of your deployment. For more information, see "*Using Policies to Validate Data*".

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. Such properties are named *virtual properties*. The value of a virtual property is computed only when that property is retrieved.

B.1.2. Data Consistency

Single-object operations are consistent within the scope of the operation performed, limited by the capabilities of the underlying data store. Bulk operations have no consistency guarantees. IDM does not expose any transactional semantics in the managed object access API.

For information on conditional header access through the REST API, see "Conditional Operations".

B.1.3. Managed Object Triggers

Triggers are user-definable functions that validate or modify object or property state.

B.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 `oldObject` and `newObject` variables are in-scope for the trigger. The `oldObject` represents a complete object, as retrieved from the data store. The trigger can elect to change `newObject` properties. If, as a result of the trigger, the values of the `oldObject` and `newObject` are identical (that is, update is reverted), the update ends prematurely, but 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.

onSync

Called when a managed object is changed, and the change triggers an implicit synchronization operation. The implicit synchronization operation is triggered by calling the sync service, which attempts to to go through all the configured managed-system mappings, defined in `sync.json`. The sync service returns either a response or an error. For both the response and the error, script that is referenced by the `onSync` hook is called.

You can use this hook to inject business logic when the sync service either fails or succeeds to synchronize all applicable mappings. For an example of how the `onSync` hook is used to revert partial successful synchronization operations, see "Synchronization Failure Compensation".

B.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. If an exception is thrown, the validation fails and the object is not stored.

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).

B.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. If an exception is thrown, the validation fails and the property is not stored.

onRetrieve

Called on all requests that return a single object: read, create, update, patch, and delete.

`onRetrieve` is called on queries only if `executeOnRetrieve` is set to `true` in the query request parameters. If `executeOnRetrieve` is not passed, or if it is `false`, the query returns previously persisted values of the requested fields. This behavior avoids performance problems when executing the script on all results of a query.

onStore

Called before an object is stored in the data store. Typically used to transform a given property before its object is stored.

B.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 check whether property values should be recalculated. 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

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

B.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.

B.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,
  "actions"   : script object,
  "onCreate"  : script object,
  "onDelete"  : script object,
  "onRead"    : script object,
  "onRetrieve": script object,
  "onStore"   : script object,
  "onSync"    : script object,
  "onUpdate"  : script object,
  "onValidate": script object,
  "postCreate": script object,
  "postDelete": script object,
  "postUpdate": script object,
  "schema"    : {
      "icon"      : string,
      "id"        : urn,
      "order"     : [ list of properties],
      "properties": { property-configuration objects },
      "$schema"   : "http://json-schema.org/draft-03/schema",
      "title"     : "User",
      "viewable"  : true
  }
}
```

name

string, required

The name of the managed object. Used to identify the managed object in URIs and identifiers.

actions

script object, optional

A custom script that initiates an action on the managed object. For more information, see "Registering Custom Scripted Actions".

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 can change the object. If an exception is thrown, the create aborts with an exception.

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.

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 can change the object. If an exception is thrown, the read aborts with an exception.

onRetrieve

script object, optional

A script object to trigger when an object is retrieved from the repository. The object that was retrieved is provided in the root scope as an `object` property. The script can 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 can change the object. If an exception is thrown, then object storage fails.

onSync

script object, optional

A script object to trigger when a change to a managed object triggers an implicit synchronization operation. The script has access to the `syncResults` object, the `request` object, the state of the object before the change (`oldObject`) and the state of the object after the change (`newObject`). The script can change the object.

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 can change the `newObject`. If an exception is thrown, the update aborts with an exception.

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.

postCreate

script object, optional

A script object to trigger after an object is created, but before any targets are synchronized.

postDelete

script object, optional

A script object to trigger after a delete of an object is complete, but before any further synchronization. The value of the deleted object is provided in the root scope as an `oldObject` property.

postUpdate

script object, optional

A script object to trigger after an update to an object is complete, but before any targets are synchronized. The value of the object before the update is provided in the root scope as an `oldObject` property. The value of the object after the update is provided in the root scope as a `newObject` property.

schema

json-schema object, optional

The schema to use to validate the structure and content of the managed object, and how the object is displayed in the UI. The schema-object format is defined by the JSON Schema specification.

The `schema` property includes the following additional elements:

icon

string, optional

The name of the Font Awesome icon that should be displayed for this object, in the UI.

id

urn, optional

The URN of the managed object, for example, `urn:jsonschema:org:forgerock:openidm:managed:api:Role`.

order

list of properties, optional

The order in which properties of this managed object are displayed in the UI.

properties

list of property configuration objects, optional

A list of property specifications. For more information, see Property Configuration Properties.

$schema

url, optional

Link to the JSON schema specification.

title

string, optional

The title of this managed object in the UI.

viewable

boolean, optional

Whether this object is visible in the UI.

Property Configuration Properties

Each managed object property, identified by its *property-name*, can have the following configurable properties:

```
"property-name" : {
  "description"     : string,
  "encryption"      : property-encryption object,
  "isPersonal"      : boolean true/false,
  "isProtected"     : boolean true/false,
  "isVirtual"       : boolean true/false,
  "items"           : {
     "id"                  : urn,
     "properties"          : property-config object,
     "resourceCollection"  : property-config object,
     "reversePropertyName" : string,
     "reverseRelationship" : boolean true/false,
     "title"               : string,
     "type"                : string,
     "validate"            : boolean true/false,
  },
  "minLength"       : positive integer,
  "onRetrieve"      : script object,
  "onStore"         : script object,
  "onValidate"      : script object,
  "pattern"         : string,
  "policies"        : policy object,
  "required"        : boolean true/false,
```

```
  "returnByDefault" : boolean true/false,
  "scope"           : string,
  "searchable"      : boolean true/false,
  "secureHash"      : property-hash object,
  "title"           : string,
  "type"            : data type,
  "usageDescription": string,
  "userEditable"    : boolean true/false,
  "viewable"        : boolean true/false,
}
```

description

string, optional

A brief description of the property.

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.

isPersonal

boolean, true/false

Designed to highlight personally identifying information. By default, `isPersonal` is set to `true` for `userName` and `postalAddress`.

isProtected

boolean, true/false

Specifies whether reauthentication is required if the value of this property changes.

isVirtual

boolean, true/false

Specifies whether the property takes a static value, or whether its value is calculated dynamically as the result of a script.

The most recently calculated value of a virtual property is persisted by default. The persistence of virtual property values allows IDM to compare the new value of the property against the last calculated value, and therefore to detect change events during synchronization.

Virtual property values are not persisted by default if you are using an explicit mapping.

items

property-configuration object, optional

For `array` type properties, defines the elements in the array. `items` can include the following sub-properties:

id

urn, optional

The URN of the property, for example, `urn:jsonschema:org:forgerock:openidm:managed:api:Role:members:items`.

properties

property configuration object, optional

A list of properties, and their configuration, that make up this items array. For example, for a relationship type property:

```
"properties" : {
    "_ref" : {
        "description" : "References a relationship from a managed object",
        "type" : "string"
    },
    "_refProperties" : {
        "description" : "Supports metadata within the relationship",
        ...
    }
}
```

resourceCollection

property configuration object, optional

The collection of resources (objects) on which this relationship is based (for example, `managed/user` objects).

reversePropertyName

string, optional

For `relationship` type properties, specifies the corresponding property name in the case of a reverse relationship. For example, a `roles` property might have a `reversePropertyName` of `members`.

reverseRelationship

boolean, true or false.

For `relationship` type properties, specifies whether the relationship exists in both directions.

title

string, optional

The title of array items, as displayed in the UI, for example `Role Members Items`.

type

string, optional

The array type, for example `relationship`.

validate

boolean, true/false

For reverse relationships, specifies whether the relationship should be validated.

minLength

positive integer, optional

The minimum number of characters that the value of this property must have.

onRetrieve

script object, optional

A script object to trigger once a property is retrieved from the repository. That property may be one of two related variables: `property` and `propertyName`. The property that was retrieved is provided in the root scope as the `propertyName` variable; its value is provided as the `property` variable. 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. That property may be one of two related variables: `property` and `propertyName`. The property that was retrieved is provided in the root scope as the `propertyName` variable; its value is provided as the `property` variable. If an exception is thrown, then object storage fails.

onValidate

script object, optional

A script object to trigger when the property requires validation. The value of the property to be validated is provided in the root scope as the `property` property. If an exception is thrown, validation fails.

pattern

string, optional

Any specific pattern to which the value of the property must adhere. For example, a property whose value is a date might require a specific date format. Patterns specified here must follow regular expression syntax.

policies

policy object, optional

Any policy validation that must be applied to the property.

required

boolean, true/false

Specifies whether or the property must be supplied when an object of this type is created.

returnByDefault

boolean, true/false

For virtual properties, specifies whether the property will be returned in the results of a query on an object of this type if it is not explicitly requested. Virtual attributes are not returned by default.

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.

searchable

boolean, true/false

Specifies whether this property can be used in a search query on the managed object. A searchable property is visible in the End User UI. False by default.

secureHash

property-hash object, optional

Specifies the configuration for hashing of the property value in the repository. If omitted or null, the property is not hashed.

title

string, required

A human-readable string, used to display the property in the UI.

type

data type, required

The data type for the property value; can be String, Array, Boolean, Integer, Number, Object, or Resource Collection.

usageDescription

string, optional

Designed to help end users understand the sensitivity of a property such as a telephone number.

userEditable

boolean, true/false

Specifies whether users can edit the property value in the UI. This property applies in the context of the End User UI, in which users are able to edit certain properties of their own accounts. False by default.

viewable

boolean, true/false

Specifies whether this property is viewable in the object's profile in the UI. True by default.

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 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 IDM cryptography service keystore used to encrypt the property.

Property Hash Object

```
{
    "algorithm" : "string",
    "type" : "string"
}
```

algorithm

string, required

The algorithm that should be used to hash the value. For a list of supported hash algorithms, see "Encoding Attribute Values by Using Salted Hash Algorithms".

type

string, optional

The type of hashing. Currently only salted hash is supported. If this property is omitted or null, the default `"salted-hash"` is used.

B.1.6. Custom Managed Objects

Managed objects are inherently fully user definable and customizable. Like all 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 *managed objects* comes from the intention that IDM stores and manages these objects, as opposed to system objects that are present in external systems.

IDM 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.

B.1.6.1. Setting Up a Managed Object Type

To set up a managed object, you declare the object in your project's `conf/managed.json` file. The following example adds a simple `foobar` object declaration after the user object type.

```
{
    "objects": [
        {
            "name": "user"
        },
        {
            "name": "foobar"
        }
    ]
}
```

B.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 "*Synchronizing Data Between Resources*".

B.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 IDM 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 "*Scripting Reference*".

IDM supports concurrency through a multi version concurrency control (MVCC) mechanism. Each time an object changes, IDM 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.

B.1.6.3.1. Creating Objects

The following script example creates an object type.

```
openidm.create("managed/foobar", "myidentifier", mymap)
```

B.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, IDM rejects the update, and you must either retry or inspect the concurrent modification.

B.1.6.3.3. Patching Objects

You can partially update a managed or system object using the patch method, which changes only the specified properties of the object.

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. Alternatively, you can omit the "If-Match: *" header.

For managed objects, the API supports patch by query, so the caller does not need to know the identifier of the object to change.

```
$ curl \
 --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"
  }]' \
 "http://localhost:8080/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 "Querying Object Sets".

B.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, IDM rejects deletion, and you must either retry or inspect the concurrent modification.

B.1.6.3.5. Reading Objects

The following script example reads an object type.

```
val = openidm.read("managed/foobar/myidentifier")
```

B.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 "Defining and Calling Queries".

B.1.7. Accessing Managed Objects Through the REST API

IDM 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 "*REST API Reference*".

IDM requires authentication to access the REST API. The authentication configuration is provided in your project's `conf/authentication.json` file. The default authorization filter script is `openidm/bin/defaults/script/router-authz.js`. For more information, see "The Authentication Model".

B.2. Configuration Objects

IDM provides an extensible configuration to allow you to leverage regular configuration mechanisms.

Unlike native the IDM configuration, which is interpreted automatically and can start new services, IDM stores custom configuration objects and makes them available to your code through the API.

For an introduction to the standard configuration objects, see "*Configuring the Server*".

B.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. 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 programmatically and manually, configuration objects are expected to change slowly, through 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.

B.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 IDM configuration names.

B.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`.

IDM detects and automatically picks up changes to the file.

IDM also applies changes made through APIs to the file.

By default, IDM stores configuration objects in the repository. The file view is an added convenience aimed to help you in the development phase of your project.

B.2.4. Configuration Objects File and REST Payload Formats

By default, IDM maps configuration objects to JSON representations.

IDM represents objects internally in plain, native types like maps, lists, strings, numbers, booleans, null. The object model is restricted to simple types so that mapping objects to external representations is easy.

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"
}
```

B.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`.

IDM supports REST mappings for create, read, update, delete, patch, and query of configuration objects.

B.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.

IDM supports concurrency through a multi version concurrency control mechanism. Each time an object changes, IDM 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.

B.2.7. Creating Objects

The following script example creates an object type.

```
openidm.create("config/custom", "myconfig", mymap)
```

B.2.8. Updating Objects

The following script example updates a custom configuration object type.

```
openidm.update("config/custom/myconfig", mymap)
```

B.2.9. Deleting Objects

The following script example deletes a custom configuration object type.

```
openidm.delete("config/custom/myconfig")
```

B.2.10. Reading Objects

The following script example reads an object type.

```
val = openidm.read("config/custom/myconfig")
```

B.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 ICF framework, which allows any connector object to be represented as a system object.

B.4. Audit Objects

Audit objects house audit data selected for local storage in repository. For details, see "*Setting Up Audit Logging*".

B.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 C. Synchronization Reference

The synchronization engine is one of the core IDM services. 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, ... ]
}
```

C.1. Object-Mapping Objects

An object-mapping object specifies the configuration for a mapping of source objects to target objects. The `name`, `source`, and `target` properties are mandatory. Other properties are optional or implicit (that is, they have a default value if not set).

```
{
  "correlationQuery"  : script object,
  "correlationScript" : script object,
  "enableSync"        : boolean,
  "linkQualifiers"    : [ list of strings ] or script object
  "links"             : string,
  "name"              : string,
  "onCreate"          : script object,
  "onDelete"          : script object,
  "onLink"            : script object,
  "onUnlink"          : script object,
  "onUpdate"          : script object,
  "policies"          : [ policy object, ... ],
  "properties"        : [ property object, ... ],
  "result"            : script object,
  "runTargetPhase"    : boolean,
  "source"            : string,
  "sourceCondition"   : script object or queryFilter string,
  "target"            : string,
  "taskThreads"       : integer,
  "validSource"       : script object,
  "validTarget"       : script object
}
```

Mapping Object Properties

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 correlation queries, see "Correlating Source Objects With Existing Target Objects". The source object is provided in the `source` property in the script scope.

correlationScript

script object, optional

A script that goes beyond a `correlationQuery` of a target system. Used when you need another method to determine which records in the target system relate to the given source record. The syntax depends on the target of the correlation. For information about defining correlation scripts, see "Writing Correlation Scripts".

enableSync

boolean, true or false

Specifies whether automatic synchronization (liveSync and implicit synchronization) should be enabled for a specific mapping. For more information, see "Disabling Automatic Synchronization Operations".

Default : `true`

linkQualifiers

list of strings or script object, optional

Enables mapping of a single source object to multiple target objects.

Example: `"linkQualifiers" : [ "employee", "customer" ]` or

```
"linkQualifiers" : {
        "type" : "text/javascript",
        "globals" : { },
        "source" : "if (returnAll) {
                      ['contractor', 'employee', 'customer', 'manager']
                    } else {
                      if(object.type === 'employee') {
                        ['employee', 'customer', 'manager']
                      } else {
                        ['contractor', 'customer']
                      }
                    }"
      }
```

If a script object, the script must return a list of strings.

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"`.

name

string, required

Uniquely names the object mapping. Used in the link object identifier.

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, the projected target object in the `target` property, and the link situation that led to the create operation in the `situation` property. Properties on the target object can be modified by the script. If a property value is not set by the script, IDM falls back on the default property mapping configuration. If the script throws an exception, the target object creation is aborted.

onDelete

script object, optional

A script to execute when a target object is to be deleted, after property mappings have been applied. In the root scope, the source object is provided in the `source` property, the target object in the `target` property, and the link situation that led to the delete operation in the `situation` property. If the script throws an exception, the target object deletion 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, and the projected target object in the `target` property.

Note that, although an `onLink` script has access to a copy of the target object, changes made to that copy will not be saved to the target system automatically. If you want to persist changes made to target objects by an `onLink` script, you must explicitly include a call to the action that should be taken on the target object (for example `openidm.create`, `openidm.update` or `openidm.delete`) within the script.

In the following example, when an LDAP target object is linked, the `"description"` attribute of that object is updated with the value `"Active Account"`. A call to `openidm.update` is made within the `onLink` script, to set the value.

```
"onLink" : {
    "type" : "text/javascript",
    "source" : "target.description = 'Active Account';
                openidm.update('system/ldap/account/' + target._id, null, target);"
}
```

If the script throws an exception, 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, and the target object in the `target` property.

Note that, although an `onUnlink` script has access to a copy of the target object, changes made to that copy will not be saved to the target system automatically. If you want to persist changes made to target objects by an `onUnlink` script, you must explicitly include a call to the action that should be taken on the target object (for example `openidm.create`, `openidm.update` or `openidm.delete`) within the script.

In the following example, when an LDAP target object is unlinked, the `description` attribute of that object is updated with the value `Inactive Account`. A call to `openidm.update` is made within the `onUnlink` script, to set the value.

```
"onUnlink" : {
    "type" : "text/javascript",
    "source" : "target.description = 'Inactive Account';
                openidm.update('system/ldap/account/' + target._id, null, target);"
}
```

If the script throws an exception, target object unlinking 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, the projected target object in the `target` property, and the link situation that led to the update operation in the `situation` property. Any changes that the script makes to the target object will be persisted when the object is finally saved to the target resource. If the script throws an exception, the target object update is aborted.

policies

array of policy objects, optional

Specifies a set of link conditions and associated actions to take in response.

properties

array of property-mapping objects, optional

Specifies mappings between source object properties and target object properties, with optional transformation scripts. See Property Object Properties.

result

script object, optional

A script for each mapping event, executed only after a successful reconciliation.

The variables available to a `result` script are as follows:

- `source` - provides statistics about the source phase of the reconciliation
- `target` - provides statistics about the target phase of the reconciliation
- `global` - provides statistics about the entire reconciliation operation

runTargetPhase

boolean, true or false

Specifies whether reconciliation operations should run both the source and target phase. To avoid queries on the target resource, set to `false`.

Default : `true`

source

string, required

Specifies the path of the source object set. Example: `"managed/user"`.

sourceCondition

script object or `queryFilter` string, optional

A script or query filter that determines if a source object should be included in the mapping. If no `sourceCondition` element (or `validSource` script) is specified, all source objects are included in the mapping.

target

string, required

Specifies the path of the target object set. Example: `"system/ldap/account"`.

taskThreads

integer, optional

Sets the number of threads dedicated to the same reconciliation run.

Default : `10`

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.

C.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 `""`, 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`.

C.1.2. Policy Objects

A policy object specifies a link condition and the associated actions to take in response.

```
{
  "condition"  : optional, script object,
  "situation"  : string,
  "action"     : string or script object
  "postAction" : optional, script object
}
```

Policy Object Properties

condition

script object or queryFilter condition, optional

Applies a policy, based on the link type, for example `"condition" : "/linkQualifier eq \"user\""`.

A queryFilter condition can be expressed in two ways—as a string (`"condition" : "/linkQualifier eq \"user\""`) or a map, for example:

```
"condition" : {
    "type" : "queryFilter",
    "filter" : "/linkQualifier eq \"user\""
}
```

It is generally preferable to express a queryFilter condition as a map.

A `condition` script has the following variables available in its scope: `object`, and `linkQualifier`.

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.

The `action` script has the following variables available in its scope: `source`, `target`, `sourceAction`, `linkQualifier`, and `recon`.

postAction

script object, optional

Specifies the action to perform after the previously specified action has completed.

The `postAction` script has the following variables available in its scope: `source`, `target`, `action`, `sourceAction`, `linkQualifier`, and `reconID`. `sourceAction` is `true` if the action was performed during the source reconciliation phase, and `false` if the action was performed during the target reconciliation phase. For more information, see "How Synchronization Situations Are Assessed".

Note

No `postAction` script is triggered if the `action` is either `IGNORE` or `ASYNC`.

C.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.

C.2. Links

To maintain links between source and target objects in mappings, IDM 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 the 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.

C.3. Queries

IDM 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.

C.4. Reconciliation

IDM 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 "Optimizing Reconciliation Performance".

C.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/csvfile/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 D. 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. IDM provides a RESTful API for accessing managed objects, system objects, workflows, and some elements of the system configuration.

The following section describes the ForgeRock Common REST API. See "Common REST and IDM" for information specific to the IDM implementation of Common REST.

D.1. About ForgeRock Common REST

ForgeRock® Common REST is a common REST API framework. It works across the ForgeRock platform to provide common ways to access web resources and collections of resources. Adapt the examples in this section to your resources and deployment.

Note

This section describes the full Common REST framework. Some platform component products do not implement all Common REST behaviors exactly as described in this section. For details, refer to the product-specific examples and reference information in other sections of this documentation set.

D.1.1. Common REST Resources

Servers generally return JSON-format resources, though resource formats can depend on the implementation.

Resources in collections can be found by their unique identifiers (IDs). IDs are exposed in the resource URIs. For example, if a server has a user collection under `/users`, then you can access a user at `/users/user-id`. The ID is also the value of the `_id` field of the resource.

Resources are versioned using revision numbers. A revision is specified in the resource's `_rev` field. Revisions make it possible to figure out whether to apply changes without resource locking and without distributed transactions.

D.1.2. Common REST Verbs

The Common REST APIs use the following verbs, sometimes referred to collectively as CRUDPAQ. For details and HTTP-based examples of each, follow the links to the sections for each verb.

Create

Add a new resource.

This verb maps to HTTP PUT or HTTP POST.

For details, see "Create".

Read

Retrieve a single resource.

This verb maps to HTTP GET.

For details, see "Read".

Update

Replace an existing resource.

This verb maps to HTTP PUT.

For details, see "Update".

Delete

Remove an existing resource.

This verb maps to HTTP DELETE.

For details, see "Delete".

Patch

Modify part of an existing resource.

This verb maps to HTTP PATCH.

For details, see "Patch".

Action

Perform a predefined action.

This verb maps to HTTP POST.

For details, see "Action".

Query

Search a collection of resources.

This verb maps to HTTP GET.

For details, see "Query".

D.1.3. Common REST Parameters

Common REST reserved query string parameter names start with an underscore, `_`.

Reserved query string parameters include, but are not limited to, the following names:

```
_action
_api
_crestapi
_fields
_mimeType
_pageSize
_pagedResultsCookie
_pagedResultsOffset
_prettyPrint
_queryExpression
_queryFilter
_queryId
_sortKeys
_totalPagedResultsPolicy
```

Note

Some parameter values are not safe for URLs, so URL-encode parameter values as necessary.

Continue reading for details about how to use each parameter.

D.1.4. Common REST Extension Points

The *action* verb is the main vehicle for extensions. For example, to create a new user with HTTP POST rather than HTTP PUT, you might use `/users?_action=create`. A server can define additional actions. For example, `/tasks/1?_action=cancel`.

A server can define *stored queries* to call by ID. For example, `/groups?_queryId=hasDeletedMembers`. Stored queries can call for additional parameters. The parameters are also passed in the query string. Which parameters are valid depends on the stored query.

D.1.5. Common REST API Documentation

Common REST APIs often depend at least in part on runtime configuration. Many Common REST endpoints therefore serve *API descriptors* at runtime. An API descriptor documents the actual API as it is configured.

Use the following query string parameters to retrieve API descriptors:

`_api`

Serves an API descriptor that complies with the OpenAPI specification.

This API descriptor represents the API accessible over HTTP. It is suitable for use with popular tools such as Swagger UI.

`_crestapi`

Serves a native Common REST API descriptor.

This API descriptor provides a compact representation that is not dependent on the transport protocol. It requires a client that understands Common REST, as it omits many Common REST defaults.

Note

Consider limiting access to API descriptors in production environments in order to avoid unnecessary traffic.

To provide documentation in production environments, see "To Publish OpenAPI Documentation" instead.

To Publish OpenAPI Documentation

In production systems, developers expect stable, well-documented APIs. Rather than retrieving API descriptors at runtime through Common REST, prepare final versions, and publish them alongside the software in production.

Use the OpenAPI-compliant descriptors to provide API reference documentation for your developers as described in the following steps:

1. Configure the software to produce production-ready APIs.

   In other words, the software should be configured as in production so that the APIs are identical to what developers see in production.

2. Retrieve the OpenAPI-compliant descriptor.

The following command saves the descriptor to a file, `myapi.json`:

```
$ curl -o myapi.json endpoint?_api
```

3. (Optional) If necessary, edit the descriptor.

   For example, you might want to add security definitions to describe how the API is protected.

   If you make any changes, then also consider using a source control system to manage your versions of the API descriptor.

4. Publish the descriptor using a tool such as Swagger UI.

   You can customize Swagger UI for your organization as described in the documentation for the tool.

D.1.6. Create

There are two ways to create a resource, either with an HTTP POST or with an HTTP PUT.

To create a resource using POST, perform an HTTP POST with the query string parameter `_action=create` and the JSON resource as a payload. Accept a JSON response. The server creates the identifier if not specified:

```
POST /users?_action=create HTTP/1.1
Host: example.com
Accept: application/json
Content-Length: ...
Content-Type: application/json
{ JSON resource }
```

To create a resource using PUT, perform an HTTP PUT including the case-sensitive identifier for the resource in the URL path, and the JSON resource as a payload. Use the `If-None-Match: *` header. Accept a JSON response:

```
PUT /users/some-id HTTP/1.1
Host: example.com
Accept: application/json
Content-Length: ...
Content-Type: application/json
If-None-Match: *
{ JSON resource }
```

The `_id` and content of the resource depend on the server implementation. The server is not required to use the `_id` that the client provides. The server response to the create request indicates the resource location as the value of the `Location` header.

If you include the `If-None-Match` header, its value must be `*`. In this case, the request creates the object if it does not exist, and fails if the object does exist. If you include the `If-None-Match` header with any value other than `*`, the server returns an HTTP 400 Bad Request error. For example, creating an object with `If-None-Match: revision` returns a bad request error. If you do not include `If-None-Match: *`, the request creates the object if it does not exist, and *updates* the object if it does exist.

Parameters

You can use the following parameters:

`_prettyPrint=true`

Format the body of the response.

`_fields=field[,field...]`

Return only the specified fields in the body of the response.

The `field` values are JSON pointers. For example if the resource is `{"parent":{"child":"value"}}`, `parent/child` refers to the `"child":"value"`.

If the `field` is left blank, the server returns all default values.

D.1.7. Read

To retrieve a single resource, perform an HTTP GET on the resource by its case-sensitive identifier (`_id`) and accept a JSON response:

```
GET /users/some-id HTTP/1.1
Host: example.com
Accept: application/json
```

Parameters

You can use the following parameters:

`_prettyPrint=true`

Format the body of the response.

`_fields=field[,field...]`

Return only the specified fields in the body of the response.

The `field` values are JSON pointers. For example if the resource is `{"parent":{"child":"value"}}`, `parent/child` refers to the `"child":"value"`.

If the `field` is left blank, the server returns all default values.

`_mimeType=`*`mime-type`*

Some resources have fields whose values are multi-media resources such as a profile photo for example.

By specifying both a single *field* and also the *mime-type* for the response content, you can read a single field value that is a multi-media resource.

In this case, the content type of the field value returned matches the *mime-type* that you specify, and the body of the response is the multi-media resource.

The `Accept` header is not used in this case. For example, `Accept: image/png` does not work. Use the `_mimeType` query string parameter instead.

D.1.8. Update

To update a resource, perform an HTTP PUT including the case-sensitive identifier (`_id`) as the final element of the path to the resource, and the JSON resource as the payload. Use the `If-Match: _rev` header to check that you are actually updating the version you modified. Use `If-Match: *` if the version does not matter. Accept a JSON response:

```
PUT /users/some-id HTTP/1.1
Host: example.com
Accept: application/json
Content-Length: ...
Content-Type: application/json
If-Match: _rev
{ JSON resource }
```

When updating a resource, include all the attributes to be retained. Omitting an attribute in the resource amounts to deleting the attribute unless it is not under the control of your application. Attributes not under the control of your application include private and read-only attributes. In addition, virtual attributes and relationship references might not be under the control of your application.

Parameters

You can use the following parameters:

`_prettyPrint=true`

Format the body of the response.

`_fields=`*`field`*`[,`*`field`*`...]`

Return only the specified fields in the body of the response.

The `field` values are JSON pointers. For example if the resource is `{"parent":{"child":"value"}}`, `parent/child` refers to the `"child":"value"`.

If the `field` is left blank, the server returns all default values.

D.1.9. Delete

To delete a single resource, perform an HTTP DELETE by its case-sensitive identifier (`_id`) and accept a JSON response:

```
DELETE /users/some-id HTTP/1.1
Host: example.com
Accept: application/json
```

Parameters

You can use the following parameters:

`_prettyPrint=true`

Format the body of the response.

`_fields=field[,field...]`

Return only the specified fields in the body of the response.

The `field` values are JSON pointers. For example if the resource is `{"parent":{"child":"value"}}`, `parent/child` refers to the `"child":"value"`.

If the `field` is left blank, the server returns all default values.

D.1.10. Patch

To patch a resource, send an HTTP PATCH request with the following parameters:

- `operation`
- `field`
- `value`
- `from` (optional with copy and move operations)

You can include these parameters in the payload for a PATCH request, or in a JSON PATCH file. If successful, you'll see a JSON response similar to:

```
PATCH /users/some-id HTTP/1.1
Host: example.com
Accept: application/json
Content-Length: ...
Content-Type: application/json
If-Match: _rev
{ JSON array of patch operations }
```

PATCH operations apply to three types of targets:

- **single-valued**, such as an object, string, boolean, or number.
- **list semantics array**, where the elements are ordered, and duplicates are allowed.
- **set semantics array**, where the elements are not ordered, and duplicates are not allowed.

ForgeRock PATCH supports several different `operations`. The following sections show each of these operations, along with options for the `field` and `value`:

D.1.10.1. Patch Operation: Add

The `add` operation ensures that the target field contains the value provided, creating parent fields as necessary.

If the target field is single-valued, then the value you include in the PATCH replaces the value of the target. Examples of a single-valued field include: object, string, boolean, or number.

An `add` operation has different results on two standard types of arrays:

- **List semantic arrays**: you can run any of these `add` operations on that type of array:
  - If you `add` an array of values, the PATCH operation appends it to the existing list of values.
  - If you `add` a single value, specify an ordinal element in the target array, or use the `{-}` special index to add that value to the end of the list.
- **Set semantic arrays**: The list of values included in a patch are merged with the existing set of values. Any duplicates within the array are removed.

As an example, start with the following list semantic array resource:

```
{
    "fruits" : [ "orange", "apple" ]
}
```

The following add operation includes the pineapple to the end of the list of fruits, as indicated by the `-` at the end of the `fruits` array.

```
{
    "operation" : "add",
    "field" : "/fruits/-",
    "value" : "pineapple"
}
```

The following is the resulting resource:

```
{
    "fruits" : [ "orange", "apple", "pineapple" ]
}
```

D.1.10.2. Patch Operation: Copy

The copy operation takes one or more existing values from the source field. It then adds those same values on the target field. Once the values are known, it is equivalent to performing an `add` operation on the target field.

The following `copy` operation takes the value from a field named `mail`, and then runs a `replace` operation on the target field, `another_mail`.

```
[
  {
     "operation":"copy",
     "from":"mail",
     "field":"another_mail"
  }
]
```

If the source field value and the target field value are configured as arrays, the result depends on whether the array has list semantics or set semantics, as described in "Patch Operation: Add".

D.1.10.3. Patch Operation: Increment

The `increment` operation changes the value or values of the target field by the amount you specify. The value that you include must be one number, and may be positive or negative. The value of the target field must accept numbers. The following `increment` operation adds `1000` to the target value of `/user/payment`.

```
[
  {
    "operation" : "increment",
    "field" : "/user/payment",
    "value" : "1000"
  }
]
```

Since the `value` of the `increment` is a single number, arrays do not apply.

D.1.10.4. Patch Operation: Move

The move operation removes existing values on the source field. It then adds those same values on the target field. It is equivalent to performing a `remove` operation on the source, followed by an `add` operation with the same values, on the target.

The following `move` operation is equivalent to a `remove` operation on the source field, `surname`, followed by a `replace` operation on the target field value, `lastName`. If the target field does not exist, it is created.

```
[
  {
     "operation":"move",
     "from":"surname",
     "field":"lastName"
  }
]
```

To apply a `move` operation on an array, you need a compatible single-value, list semantic array, or set semantic array on both the source and the target. For details, see the criteria described in "Patch Operation: Add".

D.1.10.5. Patch Operation: Remove

The `remove` operation ensures that the target field no longer contains the value provided. If the remove operation does not include a value, the operation removes the field. The following `remove` deletes the value of the `phoneNumber`, along with the field.

```
[
  {
    "operation" : "remove",
    "field" : "phoneNumber"
  }
]
```

If the object has more than one `phoneNumber`, those values are stored as an array.

A `remove` operation has different results on two standard types of arrays:

- **List semantic arrays**: A `remove` operation deletes the specified element in the array. For example, the following operation removes the first phone number, based on its array index (zero-based):

  ```
  [
     {
        "operation" : "remove",
        "field" : "/phoneNumber/0"
     }
  ]
  ```

- **Set semantic arrays**: The list of values included in a patch are removed from the existing array.

D.1.10.6. Patch Operation: Replace

The `replace` operation removes any existing value(s) of the targeted field, and replaces them with the provided value(s). It is essentially equivalent to a `remove` followed by a `add` operation. If the arrays are used, the criteria is based on "Patch Operation: Add". However, indexed updates are not allowed, even when the target is an array.

The following `replace` operation removes the existing `telephoneNumber` value for the user, and then adds the new value of `+1 408 555 9999`.

```
[
  {
    "operation" : "replace",
    "field" : "/telephoneNumber",
    "value" : "+1 408 555 9999"
  }
]
```

A PATCH replace operation on a list semantic array works in the same fashion as a PATCH remove operation. The following example demonstrates how the effect of both operations. Start with the following resource:

```
{
    "fruits" : [ "apple", "orange", "kiwi", "lime" ],
}
```

Apply the following operations on that resource:

```
[
  {
    "operation" : "remove",
    "field" : "/fruits/0",
    "value" : ""
  },
  {
    "operation" : "replace",
    "field" : "/fruits/1",
    "value" : "pineapple"
  }
]
```

The PATCH operations are applied sequentially. The `remove` operation removes the first member of that resource, based on its array index, (`fruits/0`), with the following result:

```
[
  {
    "fruits" : [ "orange", "kiwi", "lime" ],
  }
]
```

The second PATCH operation, a `replace`, is applied on the second member (`fruits/1`) of the intermediate resource, with the following result:

```
[
  {
    "fruits" : [ "orange", "pineapple", "lime" ],
  }
]
```

D.1.10.7. Patch Operation: Transform

The `transform` operation changes the value of a field based on a script or some other data transformation command. The following `transform` operation takes the value from the field named `/objects`, and applies the `something.js` script as shown:

```
[
  {
    "operation" : "transform",
    "field" : "/objects",
    "value" : {
      "script" : {
        "type" : "text/javascript",
        "file" : "something.js"
      }
    }
  }
]
```

D.1.10.8. Patch Operation Limitations

Some HTTP client libraries do not support the HTTP PATCH operation. Make sure that the library you use supports HTTP PATCH before using this REST operation.

For example, the Java Development Kit HTTP client does not support PATCH as a valid HTTP method. Instead, the method `HttpURLConnection.setRequestMethod("PATCH")` throws `ProtocolException`.

Parameters

You can use the following parameters. Other parameters might depend on the specific action implementation:

`_prettyPrint=true`

Format the body of the response.

`_fields=field[,field...]`

Return only the specified fields in the body of the response.

The `field` values are JSON pointers. For example if the resource is `{"parent":{"child":"value"}}`, `parent/child` refers to the `"child":"value"`.

If the `field` is left blank, the server returns all default values.

D.1.11. Action

Actions are a means of extending Common REST APIs and are defined by the resource provider, so the actions you can use depend on the implementation.

The standard action indicated by `_action=create` is described in "Create".

Parameters

You can use the following parameters. Other parameters might depend on the specific action implementation:

`_prettyPrint=true`

Format the body of the response.

`_fields=field[,field...]`

Return only the specified fields in the body of the response.

The `field` values are JSON pointers. For example if the resource is `{"parent":{"child":"value"}}`, `parent/child` refers to the `"child":"value"`.

If the `field` is left blank, the server returns all default values.

D.1.12. Query

To query a resource collection (or resource container if you prefer to think of it that way), perform an HTTP GET and accept a JSON response, including at least a `_queryExpression`, `_queryFilter`, or `_queryId` parameter. These parameters cannot be used together:

```
GET /users?_queryFilter=true HTTP/1.1
Host: example.com
Accept: application/json
```

The server returns the result as a JSON object including a "results" array and other fields related to the query string parameters that you specify.

Parameters

You can use the following parameters:

`_queryFilter=filter-expression`

Query filters request that the server return entries that match the filter expression. You must URL-escape the filter expression.

The string representation is summarized as follows. Continue reading for additional explanation:

```
Expr           = OrExpr
OrExpr         = AndExpr ( 'or' AndExpr ) *
AndExpr        = NotExpr ( 'and' NotExpr ) *
NotExpr        = '!' PrimaryExpr | PrimaryExpr
PrimaryExpr    = '(' Expr ')' | ComparisonExpr | PresenceExpr | LiteralExpr
ComparisonExpr = Pointer OpName JsonValue
PresenceExpr   = Pointer 'pr'
LiteralExpr    = 'true' | 'false'
Pointer        = JSON pointer
OpName         = 'eq' |  # equal to
                 'co' |  # contains
                 'sw' |  # starts with
                 'lt' |  # less than
                 'le' |  # less than or equal to
                 'gt' |  # greater than
                 'ge' |  # greater than or equal to
                 STRING  # extended operator
JsonValue      = NUMBER | BOOLEAN | '"' UTF8STRING '"'
STRING         = ASCII string not containing white-space
UTF8STRING     = UTF-8 string possibly containing white-space
```

JsonValue components of filter expressions follow RFC 7159: *The JavaScript Object Notation (JSON) Data Interchange Format*. In particular, as described in section 7 of the RFC, the escape character in strings is the backslash character. For example, to match the identifier `test\`, use `_id eq 'test\\'`. In the JSON resource, the `\` is escaped the same way: `"_id":"test\\"`.

When using a query filter in a URL, be aware that the filter expression is part of a query string parameter. A query string parameter must be URL encoded as described in RFC 3986: *Uniform Resource Identifier (URI): Generic Syntax* For example, white space, double quotes (`"`), parentheses, and exclamation characters need URL encoding in HTTP query strings. The following rules apply to URL query components:

```
query       = *( pchar / "/" / "?" )
pchar       = unreserved / pct-encoded / sub-delims / ":" / "@"
unreserved  = ALPHA / DIGIT / "-" / "." / "_" / "~"
pct-encoded = "%" HEXDIG HEXDIG
sub-delims  = "!" / "$" / "&" / "'" / "(" / ")"
                  / "*" / "+" / "," / ";" / "="
```

`ALPHA`, `DIGIT`, and `HEXDIG` are core rules of RFC 5234: *Augmented BNF for Syntax Specifications*:

```
ALPHA       =  %x41-5A / %x61-7A   ; A-Z / a-z
DIGIT       =  %x30-39             ; 0-9
HEXDIG      =  DIGIT / "A" / "B" / "C" / "D" / "E" / "F"
```

As a result, a backslash escape character in a *JsonValue* component is percent-encoded in the URL query string parameter as `%5C`. To encode the query filter expression `_id eq 'test\\'`, use `_id+eq+'test%5C%5C'`, for example.

A simple filter expression can represent a comparison, presence, or a literal value.

For comparison expressions use *json-pointer comparator json-value*, where the *comparator* is one of the following:

`eq` (equals)
`co` (contains)
`sw` (starts with)
`lt` (less than)
`le` (less than or equal to)
`gt` (greater than)
`ge` (greater than or equal to)

For presence, use *json-pointer pr* to match resources where:

- The JSON pointer is present.
- The value it points to is not `null`.

Literal values include true (match anything) and false (match nothing).

Complex expressions employ `and`, `or`, and `!` (not), with parentheses, `(expression)`, to group expressions.

`_queryId=identifier`

Specify a query by its identifier.

Specific queries can take their own query string parameter arguments, which depend on the implementation.

`_pagedResultsCookie=string`

The string is an opaque cookie used by the server to keep track of the position in the search results. The server returns the cookie in the JSON response as the value of `pagedResultsCookie`.

In the request `_pageSize` must also be set and non-zero. You receive the cookie value from the provider on the first request, and 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.

The `_pagedResultsCookie` parameter is supported when used with the `_queryFilter` parameter. The `_pagedResultsCookie` parameter is not guaranteed to work when used with the `_queryExpression` and `_queryId` parameters.

The `_pagedResultsCookie` and `_pagedResultsOffset` parameters are mutually exclusive, and not to be used together.

`_pagedResultsOffset=integer`

When `_pageSize` is non-zero, use this as an index in the result set indicating the first page to return.

The `_pagedResultsCookie` and `_pagedResultsOffset` parameters are mutually exclusive, and not to be used together.

`_pageSize=integer`

Return query results in pages of this size. After the initial request, use `_pagedResultsCookie` or `_pageResultsOffset` to page through the results.

`_totalPagedResultsPolicy=string`

When a `_pageSize` is specified, and non-zero, the server calculates the "totalPagedResults", in accordance with the `totalPagedResultsPolicy`, and provides the value as part of the response. The "totalPagedResults" is either an estimate of the total number of paged results (`_totalPagedResultsPolicy=ESTIMATE`), or the exact total result count (`_totalPagedResultsPolicy=EXACT`). If no count policy is specified in the query, or if `_totalPagedResultsPolicy=NONE`, result counting is disabled, and the server returns value of -1 for "totalPagedResults".

`_sortKeys=[+-]field[,[+-]field...]`

Sort the resources returned based on the specified field(s), either in `+` (ascending, default) order, or in `-` (descending) order.

Because ascending order is the default, including the `+` character in the query is unnecessary. If you do include the `+`, it must be URL-encoded as `%2B`, for example:

```
http://localhost:8080/api/users?_prettyPrint=true&_queryFilter=true&_sortKeys=%2Bname/givenName
```

The `_sortKeys` parameter is not supported for predefined queries (`_queryId`).

`_prettyPrint=true`

Format the body of the response.

`_fields=field[,field...]`

Return only the specified fields in each element of the "results" array in the response.

The `field` values are JSON pointers. For example if the resource is `{"parent":{"child":"value"}}`, `parent/child` refers to the `"child":"value"`.

If the `field` is left blank, the server returns all default values.

D.1.13. HTTP Status Codes

When working with a Common REST API over HTTP, client applications should expect at least the following HTTP status codes. Not all servers necessarily return all status codes identified here:

200 OK

The request was successful and a resource returned, depending on the request.

201 Created

The request succeeded and the resource was created.

204 No Content

The action request succeeded, and there was no content to return.

304 Not Modified

The read request included an `If-None-Match` header, and the value of the header matched the revision value of the resource.

400 Bad Request

The request was malformed.

401 Unauthorized

The request requires user authentication.

403 Forbidden

Access was forbidden during an operation on a resource.

404 Not Found

The specified resource could not be found, perhaps because it does not exist.

405 Method Not Allowed

The HTTP method is not allowed for the requested resource.

406 Not Acceptable

The request contains parameters that are not acceptable, such as a resource or protocol version that is not available.

409 Conflict

The request would have resulted in a conflict with the current state of the resource.

410 Gone

The requested resource is no longer available, and will not become available again. This can happen when resources expire for example.

412 Precondition Failed

The resource's current version does not match the version provided.

415 Unsupported Media Type

The request is in a format not supported by the requested resource for the requested method.

428 Precondition Required

The resource requires a version, but no version was supplied in the request.

500 Internal Server Error

The server encountered an unexpected condition that prevented it from fulfilling the request.

501 Not Implemented

The resource does not support the functionality required to fulfill the request.

503 Service Unavailable

The requested resource was temporarily unavailable. The service may have been disabled, for example.

D.2. Common REST and IDM

IDM implements the Common REST API as described in the previous section, with the exception of the following elements:

- The PATCH `transform` action is supported only on the `config` endpoint. Note that this is an optional action and not implemented everywhere across the ForgeRock Identity Platform.
- Common REST supports PATCH operations by list element index, as shown in the example in "Patch Operation: Remove". IDM does not support PATCH by list element index. So, for PATCH ADD operations, you cannot use an ordinal when adding items to a list. You can add an item using the special hyphen index, which designates that the element should be added to the end of the list.
- If `_fields` is left blank (null), the server returns all default values. In IDM, this excludes relationships and virtual fields. To include these fields in the output, add `"returnByDefault" : true` in the applicable schema.

  IDM also implements wild-card (`*`) handling with the `_fields` parameter. So, a value of `_fields=*_ref` will return all relationship fields associated with an object. A value of `_fields=*_ref/*` will return all the fields within each relationship.
- IDM does not implement the `ESTIMATE` total paged results policy. The `totalPagedResults` is either the exact total result count (`_totalPagedResultsPolicy=EXACT`) or result counting is disabled (`_totalPagedResultsPolicy=NONE`). For more information, see "Paging Query Results".

D.3. URI Scheme

The URI scheme for accessing a managed object follows this convention, assuming the IDM 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 "Understanding the Access Configuration Script (`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 directory might be:

```
/openidm/system/ldap/account/07b46858-56eb-457c-b935-cfe6ddf769c7
```

Important

For LDAP resources, you should *not* map the LDAP `dn` to the IDM `uidAttribute` (`_id`). The attribute that is used for the `_id` should be immutable. You should therefore map the LDAP `entryUUID` operational attribute to the IDM `_id`, as shown in the following excerpt of the provisioner configuration file:

```
...
"uidAttribute" : "entryUUID",
...
```

D.4. 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.

D.5. Content Negotiation

The REST API fully supports negotiation of content representation through the `Accept` HTTP header. Currently, the supported content type is JSON. When you send a JSON payload, you must 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 the REST call does not send a JSON payload.

D.6. Conditional Operations

The REST API 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 IDM's optimistic concurrency control system. Clients should make requests conditional in order to prevent inadvertent modification of the wrong version of an object. For *managed objects*, if no conditional header is specified, a default of `If-Match: *` is applied.

REST API Conditional Operations

HTTP Header	Operation	Description
`If-Match: <rev>`	PUT	Update the object if the <rev> matches the revision level of the object.
`If-Match: *`	PUT	Update the object regardless of revision level
`If-None-Match: <rev>`		Bad request
`If-None-Match: *`	PUT	Create; fails if the object already exists
When the conditional operations `If-Match`, `If-None-Match` are not used	PUT	Upsert; attempts a create, and then an update; if both attempts fail, return an error

D.7. REST Endpoints and Sample Commands

This section describes the REST endpoints and provides a number of sample commands that show the interaction with the REST interface.

D.7.1. Managing the Server Configuration Over REST

IDM 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

URI	HTTP Operation	Description
/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/selfservice/*function*	GET	Returns the configuration of the specified self-service feature, `registration`, `reset`, or `username`
/openidm/config/router	PUT	Changes the router configuration. Modifications are provided with the `--data` option, in JSON format.
/openidm/config/*object*	PATCH	Changes one or more fields of the specified configuration object. Modifications are provided as a JSON array of patch operations.
/openidm/config/*object*	DELETE	Deletes the specified configuration object.
/openidm/config/*object*?_queryFilter=*query*	GET	Queries the specified configuration object. You can use a filtered query (`_queryFilter`) or one of two predefined queries (`_queryId=query-all-ids` or `_queryId=query-all`). You cannot create custom predefined queries to query the configuration.

IDM supports REST operations to create, read, update, query, and delete configuration objects.

For command-line examples of managing the configuration over REST, see "Configuring the Server 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 a deployment using the `sync-with-csv` sample.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/openidm/config/sync"
{
  "_id": "sync",
  "mappings": [
    {
      "name": "systemCsvfileAccounts_managedUser",
      "source": "system/csvfile/account",
      "target": "managed/user",
      "correlationQuery": {
        "type": "text/javascript",
        "source": "var query = {'_queryId' : 'for-userName', 'uid' : source.name};query;"
      },
      "properties": [
```

```
        {
          "source": "email",
          "target": "mail"
        },
        {
          "source": "firstname",
          "target": "givenName"
        },
        {
          "source": "lastname",
          "target": "sn"
        },
        {
          "source": "description",
          "target": "description"
        },
        {
          "source": "_id",
          "target": "_id"
        },
        {
          "source": "name",
          "target": "userName"
        },
        {
          "default": "Passw0rd",
          "target": "password"
        },
        {
          "source": "mobileTelephoneNumber",
          "target": "telephoneNumber"
        },
        {
          "source": "roles",
          "transform": {
            "type": "text/javascript",
            "source": "var _ = require('lib/lodash'); _.map(source.split(','), function(role)
            { return {'_ref': 'internal/role/' + role} });"
          },
          "target": "authzRoles"
        }
      ],

...
```

D.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 the IDs of all the managed users in the repository

URI	HTTP Operation	Description
/openidm/managed/user?_queryId=query-all	GET	List all info for the managed users in the repository
/openidm/managed/user?_queryFilter=*filter*	GET	Query the managed user object with the defined filter.
/openidm/managed/user/*_id*	GET	Retrieve the JSON representation of a specific user
/openidm/managed/user/*_id*	PUT	Create a new user
/openidm/managed/user/*_id*	PUT	Update a user entry (replaces the entire entry)
/openidm/managed/user?_action=create	POST	Create a new user
/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/*_id*	PATCH	Update specified fields of a user entry
/openidm/managed/user/*_id*	DELETE	Delete a user entry

For a number of sample commands that show how to manage users over REST, see "Working with Managed Users".

D.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. IDM 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. `_action=createFullConfig` generates a complete connector configuration, using the configuration properties from the `createCoreConfig` action, and retrieving

URI	HTTP Operation	Description
		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*	PATCH	Updates the specified fields of a system 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."
}
```

A `POST` request with a `patch` action is not currently supported on system objects. To patch a system object, you must send a `PATCH` request.

Returning a list of the available connector configurations

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/system?_action=availableConnectors"
```

Returning a list of remote systems, and their status

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/system?_action=test"
[
  {
    "ok": true,
    "displayName": "LDAP Connector",
    "connectorRef": {
      "bundleVersion": "[1.5.19.0,1.6.0.0)",
      "bundleName": "org.forgerock.openicf.connectors.ldap-connector",
      "connectorName": "org.identityconnectors.ldap.LdapConnector"
    },
    "objectTypes": [
      "__ALL__",
      "group",
      "account"
    ],
    "config": "config/provisioner.openicf/ldap",
    "enabled": true,
    "name": "ldap"
  }
]
```

Two options for running a liveSync operation on a specified system object

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/system?_action=liveSync&source=system/ldap/account"
{
  "connectorData": {
    "nativeType": "integer",
    "syncToken": 0
  },
  "_rev": "00000000a92657c7",
  "_id": "SYSTEMLDAPACCOUNT"
}
```

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/system/ldap/account?_action=liveSync"
{
  "connectorData": {
    "nativeType": "integer",
    "syncToken": 0
  },
  "_rev": "00000000a92657c7",
  "_id": "SYSTEMLDAPACCOUNT"
}
```

Running a script on a system object

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/system/ldap/account?_action=script&_scriptId=addUser"
```

Authenticating to a system object

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
     "username" : "bjensen",
     "password" : "Passw0rd"
     }' \
 "http://localhost:8080/openidm/system/ldap/account?_action=authenticate"
{
  "_id": "fc252fd9-b982-3ed6-b42a-c76d2546312c"
}
```

Creating a new system object

```
$ curl \
 --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 IDM REST"}' \
 --request POST \
 "http://localhost:8080/openidm/system/ldap/account?_action=create"
{
    "telephoneNumber":null,
    "description":"Created by IDM 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"
}
```

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 \
 --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 \
 "http://localhost:8080/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 IDM REST",
  "givenName":"James",
  "uid":"jimmysmith",
  "_id":"07b46858-56eb-457c-b935-cfe6ddf769c7"
}
```

List the IDs associated with a specific system object

```
$ curl \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --request GET \
 "http://localhost:8080/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"
        }
  ]
}
```

D.7.4. Managing Workflows Over REST

Workflow objects are exposed under the `/openidm/workflow` context path. IDM 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/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/processinstance?_queryId=query-all-ids	GET	Lists the available running workflows, by their ID
/openidm/workflow/processinstance/*id*	GET	Provides detailed information of a running process instance
/openidm/workflow/processinstance?_queryId=filtered-query&*filter*	GET	Returns a list of workflows, based on the specified query filter. The parameters on which this list can be filtered include: `businessKey`, `deleteReason`, `durationInMillis`, `endActivityId`, `endTime`, `processDefinitionId`, `processInstanceId`, `processVariables`, `queryVariables`, `startActivityId`, `startTime`, `startUserId`, `superProcessInstanceId`, `tenantId`, `processDefinitionResourceName`
/openidm/workflow/processinstance/history?_queryId=query-all-ids	GET	Lists running and completed workflows, by their ID
/openidm/workflow/processinstance/history?_queryId=filtered-query&*filter*	GET	Returns a list of running or completed workflows, based on the specified query filter. The parameters on which this list can be filtered include: `businessKey`, `deleteReason`, `durationInMillis`, `endActivityId`, `endTime`, `processDefinitionId`, `processInstanceId`, `processVariables`, `queryVariables`, `startActivityId`, `startTime`, `startUserId`, `superProcessInstanceId`, `tenantId`, `processDefinitionResourceName`,
/openidm/workflow/processinstance?_action=create	POST	Start a new workflow. Parameters are included in the request body.
/openidm/workflow/processinstance/*id*	DELETE	Stops a process instance
/openidm/workflow/taskinstance?_queryId=query-all-ids	GET	Lists all active tasks

URI	HTTP Operation	Description
/openidm/workflow/taskinstance?_queryId=filtered-query&*filter*	GET	Lists the tasks according to the specified filter. The parameters on which this list can be filtered include: `taskId`, `activityInstanceVariables`, `cachedElContext`, `category`, `createTime`, `delegationState`, `delegationStateString`, `deleted` (boolean), `description`, `dueDate`, `eventName`, `executionId`, `name`, `owner`, `parentTaskId`, `priority`, `processDefinitionId`, `processInstanceId`, `processVariables`, `queryVariables`, `suspended` (boolean), `suspensionState`, `taskDefinitionKey`, `taskLocalVariables`, `tenantId`, `assignee`

/openidm/workflow/taskinstance/*id*	PUT	Update task data. Only the following attributes of a task can be updated:
		
		`assignee`
		`description`
		`name`
		`owner`
		Changes to any other attribute are silently discarded.

/openidm/workflow/taskinstance/*id*?_action=*action*	POST	Perform the specified action on that task. Parameters are included in the request body. Supported actions include `claim`, and `complete`
/openidm/workflow/taskinstance/history?_queryId=query-all-ids	GET	Lists the running and completed tasks, by their ID
/openidm/workflow/taskinstance/history?_queryId=filtered-query&*filter*	GET	Returns a list of running or completed tasks, based on the specified query filter. The parameters on which this list can be filtered include: `taskId`, `assignee`, `category`, `claimTime`, `deleteReason`, `description`, `dueDate`, `durationInMillis`, `endTime`, `executionId`, `formKey`, `name`, `owner`, `parentTaskId`, `priority`, `processDefinitionId`, `processInstanceId`, `processVariables`, `queryVariables`, `startTime`, `taskDefinitionKey`, `taskLocalVariables`, `tenantId`, `time`, `workTimeInMillis`

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 \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request GET \
 "http://localhost:8080/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 \
 --header "Content-Type: application/json" \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 --data '{
      "_key":"contractorOnboarding",
      "foo":"bar"
  }' \
 "http://localhost:8080/openidm/workflow/processinstance?_action=create"
```

D.7.5. Managing Schedules Over REST

The scheduler service lets you manage and monitor scheduled jobs. For more information about the scheduler service, see "*Scheduling Tasks and Events*".

You can access the scheduler service over REST, as indicated in the following table:

URI	HTTP Operation	Description
/openidm/scheduler?_action=validateQuartzCronExpression	POST	Validates a cron expression.
/openidm/scheduler/job/*id*	PUT	Creates or updates a schedule with the specified ID.
/openidm/scheduler/job/*id*	GET	Obtains the details of the specified schedule.
/openidm/scheduler/job/*id*	DELETE	Deletes the specified schedule.

URI	HTTP Operation	Description
/openidm/scheduler/job?_action=create	POST	Creates a schedule with a system-generated ID.
/openidm/scheduler/job?_queryFilter=*query*	GET	Queries the existing defined schedules.
/openidm/scheduler/job?_action=listCurrentlyExecutingJobs	POST	Returns a list of the jobs that are currently running.
/openidm/scheduler/job?_action=pauseJobs	POST	Suspends all scheduled jobs.
/openidm/scheduler/job?_action=resumeJobs	POST	Resumes all suspended scheduled jobs.
/openidm/scheduler/trigger?_queryFilter=*query*	GET	Queries the existing triggers.
/openidm/scheduler/trigger/*id*	GET	Obtains the details of the specified trigger.
/openidm/scheduler/acquiredTriggers	GET	Returns an array of the triggers that have been acquired, per node.
/openidm/scheduler/waitingTriggers	GET	Returns an array of the triggers that have not yet been acquired.

D.7.6. Managing Scanned Tasks Over REST

The task scanning mechanism lets you perform a batch scan for a specified date, on a scheduled interval, and then to execute a task when this date is reached. For more information about scanned tasks, see "Scanning Data to Trigger Tasks".

IDM 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.

D.7.7. Accessing Log Entries Over REST

You can interact with the audit logs over REST, as shown in the following table. Queries on the audit endpoint must use `queryFilter` syntax. Predefined queries (invoked with the `_queryId` parameter) are not supported.

URI	HTTP Operation	Description
/openidm/audit/recon?_queryFilter=true	GET	Displays the reconciliation audit log

URI	HTTP Operation	Description
/openidm/audit/recon/*id*	GET	Reads a specific reconciliation audit log entry
/openidm/audit/recon/*id*	PUT	Creates a reconciliation audit log entry
/openidm/audit/recon?_queryFilter=/reconId+eq+"*reconId*"	GET	Queries the audit log for a particular reconciliation operation
/openidm/audit/recon?_queryFilter=/reconId+eq+"*reconId*"+and+situation+eq+"*situation*"	GET	Queries the reconciliation audit log for a specific reconciliation situation
/openidm/audit/sync?_queryFilter=true	GET	Displays the synchronization audit log
/openidm/audit/sync/*id*	GET	Reads a specific synchronization audit log entry
/openidm/audit/sync/*id*	PUT	Creates a synchronization audit log entry
/openidm/audit/activity?_queryFilter=true	GET	Displays the activity log
/openidm/audit/activity/*id*	GET	Returns activity information for a specific action
/openidm/audit/activity/*id*	PUT	Creates an activity audit log entry
/openidm/audit/activity?_queryFilter=transactionId=*id*	GET	Queries the activity log for all actions resulting from a specific transaction
/openidm/audit/access?_queryFilter=true	GET	Displays the full list of auditable actions.
/openidm/audit/access/*id*	GET	Displays information on the specific audit item
/openidm/audit/access/*id*	PUT	Creates an access audit log entry
/openidm/audit/authentication?_queryFilter=true	GET	Displays a complete list of authentication attempts, successful and unsuccessful
/openidm/audit/authentication?_queryFilter=/principal+eq+"*principal*"	GET	Displays the authentication attempts by a specified user
/openidm/audit?_action=availableHandlers	POST	Returns a list of audit event handlers
openidm/audit/config?_queryFilter=true	GET	Lists changes made to the configuration

D.7.8. 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 reconciliation runs, including those in progress. Inspect the `state` property to see the replication status.

URI	HTTP Operation	Description
/openidm/recon?_action=recon&mapping=*mapping-name*	POST	Launches a reconciliation run with the specified mapping
/openidm/recon?_action=reconById&mapping=*mapping-name*&id=*id*	POST	Restricts the reconciliation run to the specified ID
/openidm/recon/*id*?_action=cancel	POST	Cancels the specified reconciliation run

The following example runs a reconciliation action, with the mapping `systemHrdb_managedUser`, defined in the `sync.json` file.

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --request POST \
 "http://localhost:8080/openidm/recon?_action=recon&mapping=systemHrdb_managedUser"
```

D.7.9. Managing the Synchronization Service Over REST

You can interact with the synchronization service over REST, as shown in the following table:

URI	HTTP Operation	Description
/openidm/sync?_action=getLinkedResources&resourceName=*resource*	POST	Provides a list of linked resources for the specified resource
/openidm/sync/queue?_queryFilter=*filter*	GET	List the queued synchronization events, based on the specified filter. For more information, see "Managing the Synchronization Queue".
/openidm/sync/queue/*eventID*	DELETE	Delete a queued synchronization event, based on its ID.

For example:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 "http://localhost:8080/openidm/sync?_action=getLinkedResources&resourceName=managed/user/42f8a60e-2019
-4110-a10d-7231c3578e2b"

[
  {
    "resourceName": "system/ldap/account/03496258-1c5e-40a0-8744-badc2500f262",
    "content": {
      "uid": "joe.smith1",
      "mail": "joe.smith@example.com",
      "sn": "Smith",
```

```
      "givenName": "Joe",
      "employeeType": [],
      "dn": "uid=joe.smith1,ou=People,dc=example,dc=com",
      "ldapGroups": [],
      "cn": "Joe Smith",
      "kbaInfo": [],
      "aliasList": [],
      "objectClass": [
        "top",
        "inetOrgPerson",
        "organizationalPerson",
        "person"
      ],
      "_id": "03496258-1c5e-40a0-8744-badc2500f262"
    },
    "linkQualifier": "default",
    "linkType": "systemLdapAccounts_managedUser"
  }
]
```

D.7.10. Managing Scripts Over REST

You can interact with the script service over REST, as shown in the following table:

URI	HTTP Operation	Description
/openidm/script?_action=compile	POST	Compiles a script, to validate that it can be executed. Note that this action compiles a script, but does not execute it. The action is used primarily by the UI, to validate scripts that are entered in the UI. A successful compilation returns `true`. An unsuccessful compilation returns the reason for the failure.
/openidm/script?_action=eval	POST	Executes a script and returns the result, if any

The following example compiles, but does not execute, the script provided in the JSON payload:

```
$ curl \
 --header "X-OpenIDM-Username: openidm-admin" \
 --header "X-OpenIDM-Password: openidm-admin" \
 --header "Content-Type: application/json" \
 --request POST \
 --data '{
   "type":"text/javascript",
   "source":"source.mail ? source.mail.toLowerCase() : null"
 }' \
 "http://localhost:8080/openidm/script?_action=compile"
True
```

The following example executes the script referenced in the `file` parameter, with the provided input:

```
$ curl \
 --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
     }
   }
 }' \
 "http://localhost:8080/openidm/script?_action=eval"
"Must choose to either purge by expired or number of recons to keep"
```

D.7.11. 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

For examples of queries on the `repo/` endpoint, see "Interacting With the Repository Over REST".

D.7.12. Managing Internal Objects Over REST

You can manage the following internal objects over REST:

URI	HTTP Operation	Description
/openidm/internal/role?_queryFilter=true	GET	Lists all internal roles
/openidm/internal/user?_queryId=query-all-ids	GET	Lists internal users
/openidm/internal/user/*username*	PUT	Allows you to add a new internal user, or change the password of an existing internal user
/openidm/internal/user/*username*	PATCH	Allows you to add or remove roles of an internal user
/openidm/internal/role?_queryId=query-all-ids	GET	Lists internal roles

URI	HTTP Operation	Description
/openidm/internal/role/*role-id*?_fields*,authzMembers	GET	Lists internal and managed users with the specified internal role

D.7.13. Managing Privileges Over REST

Privileges are a part of internal roles, and can be created or modified using the REST calls specified in "Managing Internal Objects Over REST". Additionally, `openidm/privilege` can be used for getting information about privileges on a resource as they apply to the authenticated user.

URI	HTTP Operation	Description
/openidm/privilege?_action=listPrivileges	POST	Lists an array of privilege paths for the authenticated user, with additional detail required by the Admin UI
/openidm/privilege/*resource*	GET	Lists the privileges for the logged in user associated with the given resource path.
/openidm/privilege/*resource*/*guid*	GET	Lists the privileges for the logged in user associated with the specified object.

D.7.14. Managing Updates Over REST

You can interact with the updates engine over REST, as shown in the following table.

URI	HTTP Operation	Description
/openidm/maintenance/update?_action=available	POST	Lists update archives in the *`project-dir`*`/openidm/bin/update/` directory
/openidm/maintenance/update?_action=preview&archive=*patch*.zip	POST	Lists file states of the current installation, relative to the *patch*.zip archive, using checksums
openidm/maintenance/update?_action=listMigrations&archive=*patch*.zip	POST	Gets a list of repository migrations for a given update type
/openidm/maintenance/update?_action=getLicense&archive=*patch*.zip	POST	Retrieves the license from the *patch*.zip archive
/openidm/maintenance/update?_action=listRepoUpdates&archive=*patch*.zip	POST	Get a list of repository update archives; use the *path* in the output for the endpoint with repo files
/openidm/maintenance/update/archives/*patch*.zip/*path*?_field=contents&_mimeType=text/plain	POST	Get files for the specific repository update, defined in the *path*.

URI	HTTP Operation	Description
/openidm/maintenance?_action=enable	POST	Activates maintenance mode; you should first run the commands in "Pausing Scheduled Jobs".
/openidm/maintenance?_action=disable	POST	Disables maintenance mode; you can then re-enable scheduled tasks as noted in "Resuming All Scheduled Jobs".
/openidm/maintenance?_action=status	POST	Returns current maintenance mode information
/openidm/maintenance/update?_action=update&archive=*patch*.zip	POST	Start an update with the *patch*.zip archive
/openidm/maintenance/update?_action=installed	POST	Retrieve a summary of all installed updates
/openidm/maintenance/update?_action=restart	POST	Restart IDM
/openidm/maintenance/update?_action=lastUpdateId	POST	Returns the `_id` value of the last successful update
/openidm/maintenance/update?_action=markComplete&updateId=*id_string*	POST	For an update with `PENDING_REPO_UPDATES` for one or more repositories, mark as complete. Replace *id_string* with the value of `_id` for the update archive.
/openidm/maintenance/update/log/*_id*	GET	Get information about an update, by *_id* (status, dates, file action taken)
/openidm/maintenance/update/log/?_queryFilter=true	GET	Get information about all past updates, by repository

Update Status Message

Status	Description
IN_PROGRESS	Update has started, not yet complete
PENDING_REPO_UPDATES	Update is complete, updates to the repository are pending
COMPLETE	Update is complete
FAILED	Update failed, not yet reverted

D.7.15. Uploading Files Over REST

IDM supports a generic file upload service at the `file` endpoint. Files are uploaded either to the filesystem or to the repository. For information about configuring this service, and for command-line examples, see "Uploading Files to the Server".

IDM provides REST access to the file upload service, as listed in the following table:

URI	HTTP Operation	Description
/openidm/file/*handler*/	PUT	Uploads a file to the specified file *handler*. The file handler is either the repository or the filesystem and the context path is configured in the `conf/file-handler.json` file.
/openidm/file/*handler*/*filename*	GET	Returns the file content in a base 64-encoded string within the returned JSON object.
/openidm/file/*handler*/*filename*?_fields=content&_mimeType=*mimeType*"	GET	Returns the file content with the specified MIME type
/openidm/file/*handler*/*filenamemimeType*"	DELETE	Deletes an uploaded file

D.7.16. Accessing Server Information and Health Over REST

You can access information about the current state of the IDM instance through the `info` and `health` REST calls, as shown in the following table. For more information, see "Monitoring Server Health".

URI	HTTP Operation	Description
/openidm/info/features?_queryFilter=true	GET	Queries the available features in the server configuration.
/openidm/info/login	GET	Provides authentication and authorization details for the current user.
/openidm/info/ping	GET	Lists the current server state. Possible states are `STARTING`, `ACTIVE_READY`, `ACTIVE_NOT_READY`, and `STOPPING`.
/openidm/info/uiconfig	GET	Provides the UI configuration of this IDM instance. The language parameter returned is the user's preferred language, based on the `Accept-Language` header included in the request. If `Accept-Language` is not specified in the request, it returns the language set in `conf/ui-configuration.json`.
/openidm/info/version	GET	Provides the software version of this IDM instance.
/openidm/health/os	GET	Provides information about the server the IDM instance is running on.
/openidm/health/memory	GET	Provides information about JVM memory usage.
/openidm/health/recon	GET	Provides reconciliation thread pool statistics.

D.7.17. Managing Social Identity Providers Over REST

You can manage social identity providers over REST, as shown in the following table. For more information, see "*Configuring Social Identity Providers*".

URI	HTTP Operation	Description
/openidm/identityProviders	GET	Returns JSON details for all configured social identity providers
/openidm/authentication	GET	Returns JSON details for all configured social identity providers, if the `SOCIAL_PROVIDERS` module is enabled
/openidm/managed/*social identity provider*	multiple	Supports access to social identity provider information
/openidm/managed/user/*social identity provider*	GET	Supports a list of users associated with a specific social identity provider
/openidm/managed/user/*User UUID*/idps	multiple	Supports management of social identity providers by UUID

Appendix E. Scripting Reference

This appendix lists the functions supported by the script engine, the locations in which scripts can be triggered, and the variables available to scripts. For more information about scripting in IDM, see "*Extending IDM Functionality By Using Scripts*".

E.1. Function Reference

Functions (access to managed objects, system objects, and configuration objects) within IDM are accessible to scripts via the `openidm` object, which is included in the top-level scope provided to each script.

The following sections describe the functions supported by the script engine:

E.1.1. openidm.create(resourceName, newResourceId, content, params, fields)

This function creates a new resource object.

Parameters

resourceName

string

The container in which the object will be created, for example, `managed/user`.

newResourceId

string

The identifier of the object to be created, if the client is supplying the ID. If the server should generate the ID, pass null here.

content

JSON object

The content of the object to be created.

params

JSON object (optional)

Additional parameters that are passed to the create request.

fields

JSON array (optional)

An array of the fields that should be returned in the result. The list of fields can include wild cards, such as `*` or `*_ref`. If no fields are specified, the entire new object is returned.

Returns

The created resource object.

Throws

An exception is thrown if the object could not be created.

Example

```
openidm.create("managed/user", ID, JSON object);
```

E.1.2. openidm.patch(resourceName, rev, value, params, fields)

This function performs a partial modification of a managed or system object. Unlike the `update` function, only the modified attributes are provided, not the entire object.

Parameters

resourceName

string

The full path to the object being updated, including the ID.

rev

string

The revision of the object to be updated. Use `null` if the object is not subject to revision control, or if you want to skip the revision check and update the object, regardless of the revision.

value

An array of one or more JSON object

The value of the modifications to be applied to the object. The patch set includes the operation type, the field to be changed, and the new values. A PATCH request can `add`, `remove`, `replace`, or `increment` an attribute value.

A `remove` operation removes a property if the value of that property equals the specified value, or if no value is specified in the request. The following example `value` removes the `marital_status` property from the object, *if* the value of that property is `single`:

```
[
   {
      "operation":"remove",
      "field":"marital_status",
      "value":"single"
   }
]
```

For fields whose value is an array, it's not necessary to know the position of the value in the array, as long as you specify the full object. If the full object is found in the array, that value is removed. The following example removes the `openidm-authorized` role from a user's `authzRoles`:

```
{
    "operation":"remove",
    "field":"/authzRoles",
    "value": {
      "_ref": "internal/role/openidm-authorized",
      "_refResourceCollection": "internal/role",
      "_refResourceId": "openidm-authorized",
      "_refProperties": {
          "_id": "ID",
          "_rev": "rev"
      }
    }
}
```

If an invalid value is specified (that is a value that does not exist for that property in the current object) the patch request is silently ignored.

A `replace` operation replaces an existing value, or adds a value if no value exists.

params

JSON object (optional)

Additional parameters that are passed to the patch request.

fields

JSON array (optional)

An array of the fields that should be returned in the result. The list of fields can include wild cards, such as `*` or `*_ref`. If no fields are specified, the entire new object is returned.

Returns

The modified resource object.

Throws

An exception is thrown if the object could not be updated.

Examples

Patching an object to add a value to an array:

```
openidm.patch("managed/role/" + role._id, null,
[{"operation":"add", "field":"/members/-", "value": {"_ref":"managed/user/" + user._id} }]);
```

Patching an object to remove an existing property:

```
openidm.patch("managed/user/" + user._id, null,
 [{"operation":"remove", "field":"marital_status", "value":"single"}]);
```

Patching an object to replace a field value:

```
openidm.patch("managed/user/" + user._id, null,
  [{"operation":"replace", "field":"/password", "value":"Passw0rd"}]);
```

Patching an object to increment an integer value:

```
openidm.patch("managed/user/" + user._id, null,
  [{"operation":"increment","field":"/age","value":1}]);
```

E.1.3. openidm.read(resourceName, params, fields)

This function reads and returns a resource object.

Parameters

resourceName

string

The full path to the object to be read, including the ID.

params

JSON object (optional)

The parameters that are passed to the read request. Generally, no additional parameters are passed to a read request, but this might differ, depending on the request. If you need to specify a list of `fields` as a third parameter, and you have no additional `params` to pass, you must pass `null` here. Otherwise, you simply omit both parameters.

fields

JSON array (optional)

An array of the fields that should be returned in the result. The list of fields can include wild cards, such as `*` or `*_ref`. If no fields are specified, the entire object is returned.

Returns

The resource object, or `null` if not found.

Example

```
openidm.read("managed/user/"+userId, null, ["*", "manager"])
```

E.1.4. openidm.update(resourceName, rev, value, params, fields)

This function updates an entire resource object.

Parameters

id

string

The complete path to the object to be updated, including its ID.

rev

string

The revision of the object to be updated. Use `null` if the object is not subject to revision control, or if you want to skip the revision check and update the object, regardless of the revision.

value

object

The complete replacement object.

params

JSON object (optional)

The parameters that are passed to the update request.

fields

JSON array (optional)

An array of the fields that should be returned in the result. The list of fields can include wild cards, such as `*` or `*_ref`. If no fields are specified, the entire object is returned.

Returns

The modified resource object.

Throws

An exception is thrown if the object could not be updated.

Example

In this example, the managed user entry is read (with an `openidm.read`, the user entry that has been read is updated with a new description, and the entire updated object is replaced with the new value.

```
var user_read = openidm.read('managed/user/' + source._id);
user_read['description'] = 'The entry has been updated';
openidm.update('managed/user/' + source._id, null, user_read);
```

E.1.5. openidm.delete(resourceName, rev, params, fields)

This function deletes a resource object.

Parameters

resourceName

string

The complete path to the to be deleted, including its ID.

rev

string

The revision of the object to be deleted. Use `null` if the object is not subject to revision control, or if you want to skip the revision check and delete the object, regardless of the revision.

params

JSON object (optional)

The parameters that are passed to the delete request.

fields

JSON array (optional)

An array of the fields that should be returned in the result. The list of fields can include wild cards, such as `*` or `*_ref`. If no fields are specified, the entire object is returned.

Returns

Returns the deleted object if successful.

Throws

An exception is thrown if the object could not be deleted.

Example

```
openidm.delete('managed/user/'+ user._id, user._rev)
```

E.1.6. openidm.query(resourceName, params, fields)

This function performs a query on the specified resource object. For more information, see "Constructing Queries".

Parameters

resourceName

string

The resource object on which the query should be performed, for example, `"managed/user"`, or `"system/ldap/account"`.

params

JSON object

The parameters that are passed to the query, `_queryFilter`, `_queryId`, or `_queryExpression`. Additional parameters passed to the query will differ, depending on the query.

Certain common parameters can be passed to the query to restrict the query results. The following sample query passes paging parameters and sort keys to the query.

```
reconAudit = openidm.query("audit/recon", {
    "_queryFilter": queryFilter,
    "_pageSize": limit,
    "_pagedResultsOffset": offset,
    "_pagedResultsCookie": string,
    "_sortKeys": "-timestamp"
});
```

For more information about `_queryFilter` syntax, see "Common Filter Expressions". For more information about paging, see "Paging Query Results".

fields

list

A list of the fields that should be returned in the result. The list of fields can include wild cards, such as `*` or `*_ref`. The following example returns only the `userName` and `_id` fields:

```
openidm.query("managed/user", { "_queryFilter": "/userName sw \"user.1\""}, ["userName", "_id"])
```

This parameter is particularly useful in enabling you to return the response from a query without including intermediary code to massage it into the right format.

Fields are specified as JSON pointers.

Returns

The result of the query. A query result includes the following parameters:

query-time-ms

(For JDBC repositories only) the time, in milliseconds, that IDM took to process the query.

result

The list of entries retrieved by the query. The result includes the 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 all managed users in the repository.

```
{
  "result": [
    {
      "_id": "9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb",
      "_rev": "00000000a059dc9f",
      "userName": "bjensen",
      "mail": "bjensen@example.com"
    },
    {
      "_id": "42f8a60e-2019-4110-a10d-7231c3578e2b",
      "_rev": "00000000d84ade1c",
      "userName": "scarter",
      "mail": "scarter@example.com"
    }
  ],
  "resultCount": 2,
  "pagedResultsCookie": null,
  "totalPagedResultsPolicy": "NONE",
  "totalPagedResults": -1,
  "remainingPagedResults": -1
}
```

Throws

An exception is thrown if the given query could not be processed.

Examples

The following sample query uses a `_queryFilter` to query the managed user repository.

```
openidm.query("managed/user",
        {'_queryFilter': userIdPropertyName + ' eq "' + security.authenticationId  + '"'});
```

The following sample query references the `for-userName` query, defined in the repository configuration, to query the managed user repository.

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

E.1.7. openidm.action(resource, actionName, content, params, fields)

This function performs an action on the specified resource object. The `resource` and `actionName` are required. All other parameters are optional.

Parameters

resource

string

The resource that the function acts upon, for example, `managed/user`.

actionName

string

The action to execute. Actions are used to represent functionality that is not covered by the standard methods for a resource (create, read, update, delete, patch, or query). In general, you should not use the `openidm.action` function for create, read, update, patch, delete or query operations. Instead, use the corresponding function specific to the operation (for example, `openidm.create`).

These operation-specific functions let you benefit from the well-defined REST API, which follows the same pattern as all other standard resources in the system. Using the REST API enhances usability for your own API and enforces the established patterns described in "*REST API Reference*".

IDM-defined resources support a fixed set of actions. For user-defined resources (scriptable endpoints) you can implement whatever actions you require.

Supported Actions Per Resource

The following list outlines the supported actions for each resource or endpoint. The actions listed here are also supported over the REST interface, and are described in detail in "*REST API Reference*".

Actions supported on the `authentication` endpoint (`authentication/*`)

reauthenticate

Actions supported on the configuration resource (`config/`)

No action parameter applies.

Actions supported on custom endpoints

Custom endpoints enable you to run arbitrary scripts through the REST URI, and are routed at `endpoint/name`, where name generally describes the purpose of the endpoint. For more information on custom endpoints, see "Creating Custom Endpoints to Launch Scripts". You can implement whatever actions you require on a custom endpoint. IDM uses custom endpoints in its workflow implementation. Those endpoints, and their actions are as follows:

`endpoint/getprocessforuser` - `create, complete`
`endpoint/gettasksview` - `create, complete`

Actions supported on the `external` endpoint

- `external/email` - `send`, for example:

```
{
    emailParams = {
        "from" : 'admin@example.com',
        "to" : user.mail,
        "subject" : 'Password expiry notification',
        "type" : 'text/plain',
        "body" : 'Your password will expire soon. Please change it!'
    }
    openidm.action("external/email", "send",  emailParams);
}
```

- `external/rest` - `call`, for example:

```
openidm.action("external/rest", "call", params);
```

Actions supported on the `info` endpoint (`info/*`)

No action parameter applies.

Actions supported on managed resources (`managed/*`)

patch, triggerSyncCheck

Actions supported on the policy resource (`policy`)

validateObject, validateProperty

For example:

```
openidm.action("policy/" + fullResourcePath, "validateObject", request.content, { "external" : "true" });
```

Actions supported on the reconciliation resource (`recon`)

recon, reconById, cancel

For example:

```
openidm.action("recon", "cancel", content, params);
```

Actions supported on the repository (`repo`)

command

For example:

```
var r, command = {
    "commandId": "purge-by-recon-number-of",
    "numberOf": numOfRecons,
    "includeMapping" : includeMapping,
    "excludeMapping" : excludeMapping
};
r = openidm.action("repo/audit/recon", "command", {}, command);
```

Actions supported on the script resource (`script`)

eval

For example:

```
openidm.action("script", "eval", getConfig(scriptConfig), {});
```

Actions supported on the synchronization resource (`sync`)

getLinkedResources, notifyCreate, notifyDelete, notifyUpdate, performAction

For example:

```
openidm.action('sync', 'performAction', content, params)
```

Actions supported on system resources (`system/*`)

availableConnectors, createCoreConfig, createFullConfig, test, testConfig, liveSync, authenticate, script

For example:

```
openidm.action("system/ldap/account", "authenticate",
{"username" : "bjensen", "password" : "Passw0rd"});
```

Actions supported on the task scanner resource (`taskscanner`)

execute, cancel

Actions supported on the workflow resource (`workflow/*`)

On `workflow/processdefinition` create, complete

On `workflow/processinstance` create, complete

For example:

```
var params = {
"_key":"contractorOnboarding"
};
openidm.action('workflow/processinstance', 'create', params);
```

On `workflow/taskinstance` claim, create, complete

For example:

```
var params = {
"userId":"manager1"
};
openidm.action('workflow/taskinstance/15', 'claim', params);
```

content

object

Content given to the action for processing.

params

object (optional)

Additional parameters passed to the script. The `params` object must be a set of simple key:value pairs, and cannot include complex values. The parameters must map directly to URL variables, which take the form `name1=val1&name2=val2&...`.

fields

JSON array (optional)

An array of the fields that should be returned in the result. The list of fields can include wild cards, such as `*` or `*_ref`. If no fields are specified, the entire object is returned.

Returns

The result of the action may be `null`.

Throws

If the action cannot be executed, an exception is thrown.

E.1.8. 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/CBC/PKCS5Padding`.

alias

string

The key alias in the keystore, such as `openidm-sym-default` (deprecated) or a purpose defined in the `secrets.json` file, such as `idm.password.encryption`.

Returns

The value, encrypted with the specified cipher and key.

Throws

An exception is thrown if the object could not be encrypted.

E.1.9. openidm.decrypt(value)

This function decrypts a value.

Parameters

value

object

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. An error is thrown if the value is passed in as a string - it must be passed in an object.

E.1.10. openidm.isEncrypted(object)

This function determines if a value is encrypted.

Parameters

object to check

any

The object whose value should be checked to determine if it is encrypted.

Returns

Boolean, `true` if the value is encrypted, and `false` if it is not encrypted.

Throws

An exception is thrown if the server is unable to detect whether the value is encrypted, for any reason.

E.1.11. openidm.hash(value, algorithm)

This function calculates a value using a salted hash algorithm.

Parameters

value

any

The value to be hashed.

algorithm

string (optional)

The algorithm with which to hash the value. Example: `SHA-512`. If no algorithm is provided, a `null` value must be passed, and the algorithm defaults to SHA-256. For a list of supported hash algorithms, see "Encoding Attribute Values by Using Salted Hash Algorithms".

Returns

The value, calculated with the specified hash algorithm.

Throws

An exception is thrown if the object could not be hashed for any reason.

E.1.12. openidm.isHashed(value)

This function detects whether a value has been calculated with a salted hash algorithm.

Parameters

value

any

The value to be reviewed.

Returns

Boolean, `true` if the value is hashed, and `false` otherwise.

Throws

An exception is thrown if the server is unable to detect whether the value is hashed, for any reason.

E.1.13. openidm.matches(string, value)

This function detects whether a string, when hashed, matches an existing hashed value.

Parameters

string

any

A string to be hashed.

value

any

A hashed value to compare to the string.

Returns

Boolean, `true` if the hash of the string matches the hashed value, and `false` otherwise.

Throws

An exception is thrown if the string could not be hashed.

E.1.14. Logging Functions

IDM also provides a `logger` object to access the Simple Logging Facade for Java (SLF4J) facilities. The following code shows an example of the `logger` object.

```
logger.info("Parameters passed in: {} {} {}", param1, param2, param3);
```

To set the log level for JavaScript scripts, add the following property to your project's `conf/logging.properties` file:

```
org.forgerock.openidm.script.javascript.JavaScript.level
```

The level can be one of `SEVERE` (highest value), `WARNING, INFO, CONFIG, FINE, FINER`, or `FINEST` (lowest value). For example:

```
org.forgerock.openidm.script.javascript.JavaScript.level=WARNING
```

In addition, JavaScript has a useful logging function named `console.log()`. This function provides an easy way to dump data to the IDM standard output (usually the same output as the OSGi console). The function works well with the JavaScript built-in function `JSON.stringify` and provides fine-grained details about any given object. For example, the following line will print a formatted JSON structure that represents the HTTP request details to STDOUT.

```
console.log(JSON.stringify(context.http, null, 4));
```

Note

These logging functions apply only to JavaScript scripts. To use the logging functions in Groovy scripts, the following lines must be added to the Groovy scripts:

```
import org.slf4j.*;
logger = LoggerFactory.getLogger('logger');
```

The following sections describe the logging functions available to the script engine.

E.1.14.1. 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.

E.1.14.2. 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.

E.1.14.3. 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.

E.1.14.4. 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.

E.1.14.5. 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.

E.2. Places to Trigger Scripts

Scripts can be triggered in different places, and by different events. The following list indicates the configuration files in which scripts can be referenced, the events upon which the scripts can be triggered and the actual scripts that can be triggered on each of these files.

Scripts called in the mapping (`conf/sync.json`) file

Triggered by situation

onCreate, onUpdate, onDelete, onLink, onUnlink

Object filter

validSource, validTarget

Triggered when correlating objects

correlationQuery, correlationScript

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.

Scripts inside policies

condition

Within a synchronization policy, you can use a `condition` script to apply different policies based on the link type, for example:

```
"condition" : {
    "type" : "text/javascript",
    "source" : "linkQualifier == \"user\""
}
```

Scripts called in the managed object configuration (`conf/managed.json`) file

onCreate, onRead, onUpdate, onDelete, onValidate, onRetrieve, onStore, onSync, 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.

Scripts called in the router configuration (`conf/router.json`) file

onRequest, onResponse, onFailure

`router.json` supports multiple scripts per hook.

E.3. Variables Available to Scripts

The variables available to a script depend on several factors:

- The trigger that launches the script
- The configuration file in which that trigger is defined
- The object type:
  - For a managed object (defined in `managed.json`), the object type is either a managed object configuration object, or a managed object property.
  - For a synchronization object (defined in `sync.json`), the object can be an object-mapping object (see "Object-Mapping Objects"), a property object (see "Property Objects"), or a policy object (see "Policy Objects").

The following tables list the variables available to scripts, based on the configuration file in which the trigger is defined.

E.3.1. Script Triggers Defined in `managed.json`

For information about how managed objects in `managed.json` are handled and what script triggers are available, see "Managed Objects".

Managed Object Configuration Object	
Trigger	**Variable**
`onCreate`, `postCreate`	• **object**: The content of the object being created. • **newObject**: The object after the create operation is complete. • **context**: Information related to the current request, such as client, end user, and routing. • **resourceName**: The resource path of the object of the query. For example, if you create a managed user with ID `42f8a60e-2019-4110-a10d-7231c3578e2b`, resourceName returns `managed/user/42f8a60e-2019-4110-a10d-7231c3578e2b`. • **request**: Information related to the request, such as headers, credentials, and the desired action. Also includes the endpoint, and payload to be processed.
`onUpdate`, `postUpdate` *Returns JSON object*	• **object**: The content of the object being updated. • **oldObject**: The state of the object, before the update. • **newObject**: Changes to be applied to the object. May continue with the `onUpdate` trigger. • **context**: Information related to the current request, such as client, end user, and routing. • **resourceName**: The resource path of the object the query. • **request**: Information related to the request, such as headers, credentials, and the desired action. Also includes the endpoint, and payload to be processed.
`onDelete`, `onRetrieve`, `onRead` *Returns a JSON object.*	• **object**: The content of the object. • **context**: Information related to the current request, such as client, end user, and routing. • **resourceName**: The resource path of the object the query. • **request**: Information related to the request, such as headers, credentials, and the desired action. Also includes the endpoint, and payload to be processed.
`postDelete` *Returns a JSON object.*	• **oldObject**: Represents the deleted object. • **context**: Information related to the current request, such as client, end user, and routing.

Managed Object Configuration Object	
Trigger	**Variable**
	• **resourceName**: The resource path of the object the query is performed upon • **request**: Information related to the request, such as headers, credentials, and the desired action. Also includes the endpoint, and payload to be processed.

`onSync`
Returns JSON object
	• **oldObject**: Represents the object prior to sync. If sync has not been run before, the value will be `null`.
	• **newObject**: Represents the object after sync is completed.
	• **context**: Information related to the current request, such as client, end user, and routing.
	• **request**: Information related to the request, such as headers, credentials, and the desired action. Also includes the endpoint, and payload to be processed.
	• **resourceName**: An object representing the resource path the query is performed upon.
	• **syncResults**: A map containing the results and details of the sync, including:
	  • **success** (boolean): Success or failure of the sync operation.
	  • **action**: Returns the name of the action performed as a string.
	  • **syncDetails**: The mappings attempted during synchronization.

`onStore`, `onValidate` *Returns JSON object*	• **object**: Represents the object being stored or validated • **value**: The content to be stored or validated for the object • **context**: Information related to the current request, such as client, end user, and routing. • **resourceName**: The resource path of the object the query is performed upon • **request**: Information related to the request, such as headers, credentials, and the desired action. Also includes the endpoint, and payload to be processed.

property object	
Trigger	**Variable**
`onRetrieve`, `onStore` *Returns JSON object*	• **object**: Represents the object being operated upon • **property**: The value of the property being retrieved or stored

property object	
Trigger	**Variable**
	• **propertyName**: The name of the property being retrieved or stored • **context**: Information related to the current request, such as client, end user, and routing. • **resourceName**: The resource path of the object the query is performed upon • **request**: Information related to the request, such as headers, credentials, and the desired action. Also includes the endpoint, and payload to be processed.
`onValidate` *Returns JSON object*	• **property**: The value of the property being validated • **context**: Information related to the current request, such as client, end user, and routing. • **resourceName**: The resource path of the object the query is performed upon • **request**: Information related to the request, such as headers, credentials, and the desired action. Also includes the endpoint, and payload to be processed.

E.3.2. Script Triggers Defined in `sync.json`

For information about how managed objects in `sync.json` are handled and what script triggers are available, see "Object-Mapping Objects".

object-mapping object	
Trigger	**Variable**
`correlationQuery`, `correlationScript` *Returns JSON object*	• **source**: Represents the source object • **linkQualifier**: The link qualifier associated with the current sync
`linkQualifier` *Returns JSON object*	• **mapping**: The name of the current mapping. • **object**: The value of the source object. During a DELETE event, that source object may not exist, and may be null. • **oldValue**: The former value of the deleted source object, if any. If the source object is new, oldValue will be null. When there are deleted objects, oldValue is populated only if the source is a managed object. • **returnAll** (boolean): Link qualifier scripts must return every valid link qualifier when returnAll is true, independent of the source object. If returnAll is true, the script must not attempt to use the object variable,

object-mapping object	
Trigger	**Variable**
	because it will be null. It's best practice to configure scripts to start with a check for the value of returnAll. • **context**: Information related to the current request, such as source and target.
`onCreate` *Returns JSON object*	• **source**: Represents the source object • **target**: Represents the target object • **situation**: The situation associated with the current sync operation • **linkQualifier**: The link qualifier associated with the current sync operation • **context**: Information related to the current sync operation. • **sourceId**: The object ID for the source object • **targetId**: The object ID for the target object • **mappingConfig**: A configuration object representing the mapping being processed
`onDelete`, `onUpdate` *Returns JSON object*	• **source**: Represents the source object • **target**: Represents the target object • **oldTarget**: Represents the target object prior to the DELETE or UPDATE action • **situation**: The situation associated with the current sync operation • **linkQualifier**: The link qualifier associated with the current sync • **context**: Information related to the current sync operation. • **sourceId**: The object ID for the source object • **targetId**: The object ID for the target object • **mappingConfig**: A configuration object representing the mapping being processed
`onLink`, `onUnlink` *Returns JSON object*	• **source**: Represents the source object • **target**: Represents the target object • **linkQualifier**: The link qualifier associated with the current sync operation • **context**: Information related to the current sync operation. • **sourceId**: The object ID for the source object

object-mapping object	
Trigger	**Variable**
	• **targetId**: The object ID for the target object • **mappingConfig**: A configuration object representing the mapping being processed
`result` *Returns JSON object of reconciliation results*	• **source**: Provides statistics about the source phase of the reconciliation • **target**: Provides statistics about the target phase of the reconciliation • **context**: Information related to the current operation, such as source and target. • **global**: Provides statistics about the entire reconciliation operation
`validSource` *Returns boolean*	• **source**: Represents the source object • **linkQualifier**: The link qualifier associated with the current sync operation
`validTarget` *Returns boolean*	• **target**: Represents the target object • **linkQualifier**: The link qualifier associated with the current sync operation

property object	
Trigger	**Variable**
`condition` *Returns boolean*	• **object**: The current object being mapped. • **context**: Information related to the current operation, such as source and target. • **linkQualifier**: The link qualifier associated with the current sync operation. • **target**: Represents the target object. • **oldTarget**: Represents the target object prior to any changes. • **oldSource**: Available during UPDATE and DELETE operations performed through implicit sync. With implicit synchronization, the synchronization operation is triggered by a specific change to the source object. As such, implicit sync can populate the old value within the `oldSource` variable and pass it on to the sync engine. During reconciliation operations `oldSource` will be undefined. A reconciliation operation cannot populate the value of the `oldSource` variable as it has no awareness of the specific change to the source object. Reconciliation simply synchronizes the static source object to the target.
`transform`	• **source**: Represents the source object

property object	
Trigger	**Variable**
Returns JSON object	• **linkQualifier**: The link qualifier associated with the current sync operation

policy object	
Trigger	**Variable**

`action`
 	
Returns string OR json object
	• **source**: Represents the source object.
	• **target**: Represents the target object.
	• **sourceAction** (boolean): Indicates whether the action is being processed during the source or target synchronization phase (true if performed during a source synchronization, false if performed during a target synchronization).
	• **linkQualifier**: The link qualifier used for this operation (`default` if no other link qualifier is specified).
	• **recon**: Represents the reconciliation operation.
	• The `recon.actionParam` object contains information about the current reconciliation operation and includes the following variables:
	  • `reconId`: The ID of the reconciliation operation
	  • `mapping`: The mapping for which the reconciliation was performed, for example, `systemLdapAccounts_managedUser`.
	  • `situation`: The situation encountered, for example, AMBIGUOUS.
	  • `action`: The default action that would be used for this situation, if not for this script. The script being executed replaces the default action (and is used instead of any other named action).
	  • `sourceId`: The `_id` value of the source record.
	  • `linkQualifier`: The link qualifier used for that mapping, (`default` if no other link qualifier is specified).
	  • `ambiguousTargetIds`: An array of the target object IDs that were found in an AMBIGUOUS situation during correlation.
	  • `_action`: The synchronization action (only `performAction` is supported).

`postAction` *Returns JSON object*	• **source**: Represents the source object. • **target**: Represents the target object. • **action**: The sync action that was performed. • **sourceAction** (boolean): Indicates whether the action is being processed during the source or target synchronization phase (true if

policy object	
Trigger	**Variable**
	performed during a source synchronization, false if performed during a target synchronization). • **linkQualifier**: The link qualifier used for this operation (`default` if no other link qualifier is specified). • **reconId**: Represents the ID of the reconciliation. • **situation**: Represents the situation for this policy. • **context**: Information related to the current operation, such as source and target.

E.3.3. Script Triggers Defined in `router.json`

Trigger	Variable
onFailure	exception
onRequest	request
onResponse	response

E.3.4. Variables Available to Scripts in Custom Endpoints

All custom endpoint scripts have a `request` variable in their scope, which is a JSON object containing all information about the request. The parameters found in this object vary depending on the request method. The request may include headers, credentials, and the desired action. The request normally also includes the endpoint as well as the payload to be processed.

For more details about writing custom endpoint scripts, see "Writing Custom Endpoint Scripts".

Variable	Variable Parameters
`request`	• **method**: The type of request, such as `query`, `create`, or `delete`. • **resourceName**: The name of the resource associated with the request. • **revision**: The revision number of the requested object. • **parameters**: JSON object mapping any additional parameters sent in the request. • **content**: The contents of the requested object. • **context**: Information related to the current request, such as client, end user, and routing. **Only available in `query` requests**

Variable	Variable Parameters
	• **pagedResultsCookie**: Represents the cookie used for `queryFilter` operations to track the results of a filtered query. • **pagedResultsOffset**: Specifies how many records to skip before returning a set of results. • **pageSize**: Specifies how many results to return per page. • **queryExpression**: A string containing a native query used to query a data source directly. • **queryId**: A string using the id of a predefined query object to return a specific set of results from a queried object. • **queryFilter**: A string with a common expression used to filter the results of a queried object. **Only available in `create` requests** • **newResourceId**: The ID of the new object. Only available in `create` requests

E.3.5. Variables Available to Role Assignment Scripts

The optional `onAssignment` and `onUnassignment` event scripts specify what should happen to attributes that are affected by role assignments when those assignments are applied to a user, or removed from a user. For more information on role assignments, see "Creating an Assignment".

These scripts have access to the following variables:

`sourceObject`
`targetObject`
`existingTargetObject`
`linkQualifier`

The standard assignment scripts, `replaceTarget.js`, `mergeWithTarget.js`, `removeFromTarget.js`, and `noOp.js` have access to all the variables in the previous list, as well as the following:

`attributeName`
`attributeValue`
`attributesInfo`

Note

Role assignment scripts must always return `targetObject`, otherwise other scripts and code that occur downstream of your script will not work as expected.

E.3.6. The `augmentSecurityContext` Trigger

The `augmentSecurityContext` trigger, defined in `authentication.json`, can reference a script that is executed after successful authentication. Such scripts can populate the security context of the authenticated user. If the authenticated user is not found in the resource specified by `queryOnResource`, the `augmentSecurityContext` can provide the required authorization map.

Such scripts have access to the following bindings:

- `security` - includes the `authenticationId` and the `authorization` key, which includes the `moduleId`.

  The main purpose of an `augmentSecurityContext` script is to modify the `authorization` map that is part of this `security` binding. The authentication module determines the value of the `authenticationId`, and IDM attempts to populate the `authorization` map with the details that it finds, related to that `authenticationId` value. These details include the following:

  - `security.authorization.component` - the resource that contains the account (this will always will be the same as the value of `queryOnResource` by default).
  - `security.authorization.id` - the internal `_id` value that is associated with the account.
  - `security.authorization.roles` - any roles that were determined, either from reading the `userRoles` property of the account or from calculation.
  - `security.authorization.moduleId` - the authentication module responsible for performing the original authentication.

  You can use the `augmentSecurityContext` script to change any of these `authorization` values. The script can also add new values to the `authorization` map, which will be available for the lifetime of the session.

- `properties` - corresponds to the `properties` map of the related authentication module
- `httpRequest` - a reference to the `Request` object that was responsible for handling the incoming HTTP request.

  This binding is useful to the augment script because it has access to all of the raw details from the HTTP request, such as the headers. The following code snippet shows how you can access a header using the `httpRequest` binding. This example accesses the `authToken` request header:

  ```
  httpRequest.getHeaders().getFirst('authToken').toString()
  ```

E.3.7. The `identityServer` Variable

IDM provides an additional variable, named `identityServer`, to scripts. You can use this variable in several ways. The `ScriptRegistryService`, described in "Validating Scripts Over REST", binds this variable to:

- `getProperty`

  Retrieves property information from system configuration files. Takes up to three parameters:

  - The name of the property you are requesting.
  - *(Optional)* The default result to return if the property wasn't set.
  - *(Optional)* Boolean to determine whether or not to use property substitution when getting the property. For more information about property substitution, see "Using Property Value Substitution".

  Returns the first property found following the same order of precedence IDM uses to check for properties: environment variables, `system.properties`, `boot.properties`, then other configuration files. For more information, see "*Configuring the Server*".

  For example, you can retrieve the value of the `openidm.config.crypto.alias` property with the following code: `alias = identityServer.getProperty("openidm.config.crypto.alias", "true", true);`

- `getInstallLocation`

  Retrieves the IDM installation path, such as `/path/to/openidm`. May be superseded by an absolute path.

- `getProjectLocation`

  Retrieves the directory used when you started IDM. That directory includes configuration and script files for your project.

  For more information on the project location, see "Specifying the Startup Configuration".

- `getWorkingLocation`

  Retrieves the directory associated with database cache and audit logs. You can find `db/` and `audit/` subdirectories there.

  For more information on the working location, see "Specifying the Startup Configuration".

Appendix F. Router Service Reference

The router service provides the uniform interface to all IDM objects: managed objects, system objects, configuration objects, and so on.

F.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.

F.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.

F.1.1.1. Pattern Matching in the `router.json` File

Pattern matching can minimize overhead in the router service. For example, the default `router.json` file includes instances of the `pattern` filter object, which limits script requests to specified methods and endpoints.

Based on the following code snippet, the router service would trigger the `policyFilter.js` script for `CREATE` and `UPDATE` calls to managed, system, and internal objects:

```
{
    "pattern" : "^(managed|system|internal)($|(/.+))",
    "onRequest" : {
        "type" : "text/javascript",
        "source" : "require('policyFilter').runFilter()"
    },
    "methods" : [
        "create",
        "update"
    ]
},
```

Without this `pattern`, IDM would apply the policy filter to additional objects such as the audit service, which may affect performance.

F.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",
                "source" : "require('router-authz').testAccess()"
            }
        },
        {
            "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
```

F.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 "Function Reference").

Provides access to IDM resources.

request

resource-request object

The resource-request context, which has one or more parent contexts. Provided in the scope of all scripts. For more information about the request context, see "Understanding the Request Context Chain".

response

resource-response object

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.

F.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"
            }
        }
    ]
}
```

F.3. Understanding the Request Context Chain

The context chain of any request is established as follows:

1. The request starts with a *root context*, associated with a specific context ID.
2. The root context is wrapped in the *security context* that includes the authentication and authorization detail for the request.
3. The security context is further wrapped by the *HTTP context*, with the target URI. The HTTP context is associated with the normal parameters of the request, including a user agent, authorization token, and method.
4. The HTTP context is wrapped by one or more server/router context(s), with an endpoint URI. The request can have several layers of server and router contexts.

Appendix G. Embedded Jetty Configuration

IDM includes an embedded Jetty web server.

To configure the embedded Jetty server, edit `openidm/conf/jetty.xml`. IDM 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 your `resolver/boot.properties` file.

G.1. Using IDM Configuration Properties in the Jetty Configuration

IDM exposes a `Param` class that you can use in `jetty.xml` to include IDM-specific configuration. The `Param` class exposes Bean properties for common Jetty settings and generic property access for other, arbitrary settings.

G.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; they map either to the `boot.properties` in the `openidm/resolver/` subdirectory, or the `secrets.json` file in your project's `conf/` subdirectory.

port

Maps to `openidm.port.http`

port

Maps to `openidm.port.https`

port

Maps to `openidm.port.mutualauth`

keystoreType

Maps to `mainKeyStore storeType`

keystoreProvider

Maps to `mainKeyStore providerName`

keystoreLocation

Maps to `mainKeyStore file`

keystorePassword

Maps to `mainKeyStore storePassword`

truststoreLocation

Maps to `mainTrustStore file`

truststorePassword

Maps to `mainTrustStore storePassword`

G.1.2. Accessing Generic Properties

```
<Call class="org.forgerock.openidm.jetty.Param" name="getProperty">
  <Arg>org.forgerock.openidm.some.sample.property</Arg>
</Call>
```

G.2. Jetty Default Settings

By default the embedded Jetty server uses the following settings.

- The HTTP, SSL, and Mutual Authentication ports defined in IDM
- The same keystore and truststore settings as IDM
- 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.

G.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 IDM. For example, you might want to use a servlet filter to protect access to IDM 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:&{openidm.port.https}",
       "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 when the filter is invoked. IDM 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 IDM. Currently only `augmentSecurityContext` is supported. A script that is defined in `augmentSecurityContext` is executed after a successful authentication request. The script helps to populate the expected security context. 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 `["/*"]`.

`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.

G.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, use a command such as the following:

```
nmap --script ssl-enum-ciphers -p 8443 localhost
```

You can modify the list of enabled protocols in the `jetty.xml` file in the `conf/` subdirectory for your project. Based on the following excerpt, `SSLv3` and `TLSv1` are excluded from the list of enabled protocols:

```
...
    <Array id="excludedProtocols" type="java.lang.String">
       <Item>SSLv3</Item>
       <Item>TLSv1</Item>
    </Array>
...
```

Note

As noted in the following *Security Advisory*, "SSL 3.0 [RFC6101] is an obsolete and insecure protocol."

Support for the `TLSv1.0` protocol has been removed. For more information, see the following PDF: *Migrating from SSL and Early TLS* from the *PCI Security Standards Council*.

You can exclude other protocols from the `Enabled` list, by adding them to the `"ExcludeProtocols"` XML block. For example, if you included the following line in that XML block, your instance of Jetty would also exclude TLSv1.1:

```
<Item>TLSv1.1</Item>
```

G.5. Adjusting Jetty Thread Settings

To change the Jetty thread pool settings, add the following excerpt to your project's `conf/config.properties` file:

```
# Jetty maxThreads (default 200)
org.ops4j.pax.web.server.maxThreads=${org.ops4j.pax.web.server.maxThreads}
# Jetty minThreads (default 8)
org.ops4j.pax.web.server.minThreads=${org.ops4j.pax.web.server.minThreads}
# Jetty idle-thread timeout milliseconds (default 60000)
org.ops4j.pax.web.server.idleTimeout=${org.ops4j.pax.web.server.idleTimeout}
```

To override these defaults, set a corresponding `OPENIDM_OPTS` variable when you start IDM. For example:

```
$ export OPENIDM_OPTS="-Xmx1024m -Xms1024m -Dorg.ops4j.pax.web.server.maxThreads=768"
$ ./startup.sh
Executing ./startup.sh...
Using OPENIDM_HOME:   /path/to/openidm
Using PROJECT_HOME:   /path/to/openidm
Using OPENIDM_OPTS:   -Xmx1024m -Xms1024m -Dorg.ops4j.pax.web.server.maxThreads=768
Using LOGGING_CONFIG: -Djava.util.logging.config.file=/path/to/openidm/conf/logging
.properties
-> OpenIDM version "6.5.2.0" (revision: unknown)
OpenIDM ready
```

Important

You cannot use property substitution to set these properties.

You cannot adjust Jetty's thread settings in the `conf/jetty.xml` file. If you uncomment the excerpt of `jetty.xml` that starts with `<!--<Arg name="threadpool">...`, you'll see errors in the IDM log.

Appendix H. Authentication and Session Module Configuration Details

This appendix includes configuration details for the supported authentication modules described in "Supported Authentication and Session Modules".

Authentication modules, as configured in the `authentication.json` file, include a number of properties.

Session Module

Authentication Property	Property as Listed in the Admin UI	Description
`keyAlias`	(not shown)	Used by the Jetty Web server to service SSL requests.
`maxTokenLifeMinutes`	Max Token Life (in seconds)	Maximum time before a session is cancelled. Note the different units for the property and the UI.
`tokenIdleTimeMinutes`	Token Idle Time (in seconds)	Maximum time before an idle session is cancelled. Note the different units for the property and the UI.
`sessionOnly`	Session Only	Whether the session continues after browser restarts.

Static User Module

Authentication Property	Property as Listed in the Admin UI	Description
`enabled`	Module Enabled	Does IDM use the module
`queryOnResource`	Query on Resource	Endpoint hard coded to user `anonymous`
`username`	Static User Name	Default for the static user, `anonymous`
`password`	Static User Password	Default for the static user, `anonymous`
`defaultUserRoles`	Static User Role	Normally set to `openidm-reg` for self-registration

The following table applies to several authentication modules:

`Managed User`
`Internal User`
`Client Cert`
`Passthrough`
`IWA`

The IWA module includes several Kerberos-related properties listed at the end of the table.

Common Module Properties

Authentication Property	Property as Listed in the Admin UI	Description
`enabled`	Module Enabled	Does IDM use the module
`queryOnResource`	Query on Resource	Endpoint to query
`queryId`	Use Query ID	A defined `queryId` searches against the `queryOnResource` endpoint. An undefined `queryId` against `queryOnResource` with `action=reauthenticate`
`defaultUserRoles`	Default User Roles	Normally blank for managed users
`authenticationId`	Authentication ID	Defines how account credentials are derived from a `queryOnResource` endpoint
`userCredential`	User Credential	Defines how account credentials are derived from a `queryOnResource` endpoint; if required, typically `password` or `userPassword`
`userRoles`	User Roles	Defines how account roles are derived from a `queryOnResource` endpoint
`groupMembership`	Group Membership	Provides more information for calculated roles
`groupRoleMapping`	Group Role Mapping	Provides more information for calculated roles
`groupComparisonMethod`	Group Comparison Method	Provides more information for calculated roles

Authentication Property	Property as Listed in the Admin UI	Description
`managedUserLink`	Managed User Link	For pass-through authentication, this property specifies the mapping from the system resource to the IDM managed user. For example, if the user authenticates using their account in an LDAP directory, the `managedUserLink` might be `systemLdapAccounts_managedUser`
`augmentSecurityContext`	Augment Security Context	Includes a script that is executed only after a successful authentication request. For more information on this property, see "Authenticating as a Different User".
`servicePrincipal`	Kerberos Service Principal	(IWA only) For more information, see "Configuring IWA Authentication"
`keytabFileName`	Keytab File Name	(IWA only) For more information, see "Configuring IWA Authentication"
`kerberosRealm`	Kerberos Realm	(IWA only) For more information, see "Configuring IWA Authentication"
`kerberosServerName`	Kerberos Server Name	(IWA only) For more information, see "Configuring IWA Authentication"

Appendix I. Social Identity Provider Configuration Details

This appendix includes a list of configuration details for each supported social identity provider.

All social identity providers in IDM include badge and button information in the UI and the associated configuration file. For more information, see "Social Identity Provider Button and Badge Properties".

I.1. Google Social Identity Provider Configuration Details

You can set up the Google social identity provider either through the Admin UI or in the `identityProvider-google.json` file in your project's `conf/` subdirectory. The following table includes the information shown in the Admin UI Google Provider pop-up window, along with associated information in the `identityProvider-google.json` file.

IDM generates the `identityProvider-google.json` file only when you configure and enable the Google social identity provider in the Admin UI.

Google Social Identity Provider Configuration Properties

Property (UI)	Property (JSON file)	Description
Client ID	`clientId`	The client identifier for your Google Identity Platform project
Client Secret	`clientSecret`	Used with the Client ID to access the configured Google API
Scope	`scope`	An array of strings that allows access to user data; see Google's documentation on *Authorization Scopes*

Property (UI)	Property (JSON file)	Description
Authorization Endpoint	`authorizationEndpoint`	Per *RFC 6749*, "used to interact with the resource owner and obtain an authorization grant". For Google's implementation, see *Forming the URL*.
Token Endpoint	`tokenEndpoint`	Endpoint that receives a one-time authorization grant, and returns an access and ID token
User Info Endpoint	`userInfoEndpoint`	Endpoint that receives an access token, and returns information about the user
Well-Known Endpoint	`wellKnownEndpoint`	Access URL for Google's *Discovery Document*
Not in the Admin UI	`name`	Name of the social identity provider
Not in the Admin UI	`type`	Authentication module
Not in the Admin UI	`authenticationId`	Authentication identifier, as returned from the User Info Endpoint for each social identity provider
Not in the Admin UI	`propertyMap`	Mapping between Google and IDM

For information on social identity provider buttons and badges, see "Social Identity Provider Button and Badge Properties".

I.2. LinkedIn Social Identity Provider Configuration Details

You can set up the LinkedIn social identity provider either through the Admin UI or in the `identityProvider-linkedIn.json` file in your project's `conf/` subdirectory. The following table includes the information shown in the Admin UI LinkedIn Provider pop-up window, along with associated information in the `identityProvider-linkedIn.json` file.

IDM generates the `identityProvider-linkedIn.json` file only when you configure and enable the LinkedIn social identity provider in the Admin UI.

LinkedIn Social Identity Provider Configuration Properties

Property (UI)	Property (JSON file)	Description
Client ID	`clientId`	The client identifier for your LinkedIn Application
Client Secret	`clientSecret`	Used with the Client ID to access the applicable LinkedIn API
Scope	`scope`	An array of strings that allows access to user data; see LinkedIn's documentation on *Basic Profile Fields*.
Authorization Endpoint	`authorizationEndpoint`	Per *RFC 6749*, "used to interact with the resource owner and obtain an authorization grant". For LinkedIn's implementation, see their documentation on *Authenticating with OAuth 2.0*.
Token Endpoint	`tokenEndpoint`	Endpoint that receives a one-time authorization code, and returns an access token. For LinkedIn's

Property (UI)	Property (JSON file)	Description
		implementation, see their documentation on *Authenticating with OAuth 2.0*.
User Info Endpoint	`userInfoEndpoint`	Endpoint that transmits scope-related fields through LinkedIn's API. The default endpoint includes the noted field properties in parentheses, as defined in LinkedIn's documentation on *Basic Profile Fields*.
Well-Known Endpoint	`wellKnownEndpoint`	Not used for LinkedIn
Not in the Admin UI	`name`	Name of the social identity provider
Not in the Admin UI	`type`	Authentication module
Not in the Admin UI	`authenticationId`	Authentication identifier, as returned from the User Info Endpoint for each social identity provider
Not in the Admin UI	`propertyMap`	Mapping between LinkedIn and IDM

For information on social identity provider buttons and badges, see "Social Identity Provider Button and Badge Properties".

I.3. Facebook Social Identity Provider Configuration Details

You can set up the Facebook social identity provider either through the Admin UI or in the `identityProvider-facebook.json` file in your project's `conf/` subdirectory. The following table includes the information shown in the Admin UI Facebook Provider pop-up window, along with associated information in the `identityProvider-facebook.json` file.

IDM generates the `identityProvider-facebook.json` file only when you configure and enable the Facebook social identity provider in the Admin UI. Alternatively, you can create that file manually.

Facebook Social Identity Provider Configuration Properties

Property (UI)	Property (JSON file)	Description
App ID	`clientId`	The client identifier for your Facebook App
App Secret	`clientSecret`	Used with the App ID to access the applicable Facebook API
Scope	`scope`	An array of strings that allows access to user data; see Facebook's *Permissions Reference* Documentation.
Authorization Endpoint	`authorizationEndpoint`	For Facebook's implementation, see their documentation on how they *Manually Build a Login Flow*.
Token Endpoint	`tokenEndpoint`	Endpoint that receives a one-time authorization code, and returns an access token. For Facebook's implementation, see their documentation on how they *Manually Build a Login Flow*.

Property (UI)	Property (JSON file)	Description
User Info Endpoint	`userInfoEndpoint`	Endpoint that transmits scope-related fields through Facebook's API. The default endpoint includes the noted field properties as a list, as defined in Facebook's *Permissions Reference*.
Not in the Admin UI	`name`	Name of the Social ID provider
Not in the Admin UI	`type`	Authentication module
Not in the Admin UI	`authenticationId`	Authentication identifier, as returned from the User Info Endpoint for each social identity provider
Not in the Admin UI	`propertyMap`	Mapping between Facebook and IDM

For information on social identity provider buttons and badges, see "Social Identity Provider Button and Badge Properties".

I.4. Amazon Social Identity Provider Configuration Details

You can set up the Amazon social identity provider either through the Admin UI or in the `identityProvider-amazon.json` file in your project's `conf/` subdirectory. The following table includes the information shown in the Admin UI Amazon Provider pop-up window, along with associated information in the `identityProvider-amazon.json` file.

IDM generates the `identityProvider-amazon.json` file only when you configure and enable the Amazon social identity provider in the Admin UI. Alternatively, you can create that file manually.

Amazon Social Identity Provider Configuration Properties

Property (UI)	Property (JSON file)	Description
Client ID	`clientId`	The client identifier for your Amazon App
Client Secret	`clientSecret`	Used with the Client ID to access the applicable Amazon API
Scope	`scope`	An array of strings that allows access to user data; see Amazon's *Customer Profile* Documentation.
Authorization Endpoint	`authorizationEndpoint`	Typically `https://www.amazon.com/ap/oa`.
Token Endpoint	`tokenEndpoint`	Endpoint that receives a one-time authorization code, and returns an access token; typically `https://api.amazon.com/auth/o2/token`
User Info Endpoint	`userInfoEndpoint`	Endpoint that transmits scope-related fields; typically `https://api.amazon.com/user/profile`
Not in the Admin UI	`name`	Name of the social identity provider
Not in the Admin UI	`type`	Authentication module

Property (UI)	Property (JSON file)	Description
Not in the Admin UI	`authenticationId`	Authentication identifier, as returned from the User Info Endpoint for each social identity provider
Not in the Admin UI	`propertyMap`	Mapping between Amazon and IDM

For information on social identity provider buttons and badges, see "Social Identity Provider Button and Badge Properties".

I.5. Microsoft Social Identity Provider Configuration Details

You can set up the Microsoft social identity provider either through the Admin UI or in the `identityProvider-microsoft.json` file in your project's `conf/` subdirectory. The following table includes the information shown in the Admin UI Microsoft Provider pop-up window, along with associated information in the `identityProvider-microsoft.json` file.

IDM generates the `identityProvider-microsoft.json` file only when you configure and enable the Microsoft social identity provider in the Admin UI. Alternatively, you can create that file manually.

Microsoft Social Identity Provider Configuration Properties

Property (UI)	Property (JSON file)	Description
Application ID	`clientId`	The client identifier for your Microsoft App
Application Secret	`clientSecret`	Used with the Application ID; shown as application password
Scope	`scope`	OAuth 2 scopes; for more information, see *Microsoft Graph Permission Scopes*.
Authorization Endpoint	`authorizationEndpoint`	Typically `https://login.microsoftonline.com/common/oauth2/v2.0/authorize`
Token Endpoint	`tokenEndpoint`	Endpoint that receives a one-time authorization code and returns an access token; typically `https://login.microsoftonline.com/common/oauth2/v2.0/token`
User Info Endpoint	`userInfoEndpoint`	Endpoint that transmits scope-related fields; typically `https://graph.microsoft.com/v1.0/me`
Not in the Admin UI	`name`	Name of the social identity provider
Not in the Admin UI	`type`	Authentication module
Not in the Admin UI	`authenticationId`	Authentication identifier, as returned from the User Info Endpoint for each social identity provider
Not in the Admin UI	`propertyMap`	Mapping between Microsoft and IDM

For information on social identity provider buttons and badges, see "Social Identity Provider Button and Badge Properties".

I.6. WordPress Social Identity Provider Configuration Details

You can set up the WordPress social identity provider either through the Admin UI or in the `identityProvider-wordpress.json` file in your project's `conf/` subdirectory. The following table includes the information shown in the Admin UI WordPress Provider pop-up window, along with associated information in the `identityProvider-wordpress.json` file.

IDM generates the `identityProvider-wordpress.json` file only when you configure and enable the WordPress social identity provider in the Admin UI. Alternatively, you can create that file manually.

WordPress Social Identity Provider Configuration Properties

Property (UI)	Property (JSON file)	Description
Client ID	`clientId`	The client identifier for your WordPress App
Client Secret	`clientSecret`	Used with the Client ID to access the applicable WordPress API
Scope	`scope`	An array of strings that allows access to user data; see WordPress's *OAuth2 Authentication* Documentation.
Authorization Endpoint	`authorizationEndpoint`	Typically `https://public-api.wordpress.com/oauth2/authorize`; known as a WordPress *Authorize URL*.
Token Endpoint	`tokenEndpoint`	Endpoint that receives a one-time authorization code, and returns an access token; typically `https://public-api.wordpress.com/oauth2/token`; known as a WordPress *Request Token URL*.
User Info Endpoint	`userInfoEndpoint`	Endpoint that transmits scope-related fields; typically `https://public-api.wordpress.com/rest/v1.1/me/`
Not in the Admin UI	`name`	Name of the social identity provider
Not in the Admin UI	`type`	Authentication module
Not in the Admin UI	`authenticationId`	Authentication identifier, as returned from the User Info Endpoint for each social identity provider
Not in the Admin UI	`propertyMap`	Mapping between WordPress and IDM

For information on social identity provider buttons and badges, see "Social Identity Provider Button and Badge Properties".

I.7. WeChat Social Identity Provider Configuration Details

You can set up the WeChat social identity provider either through the Admin UI or in the `identityProviders.json` file in your project's `conf/` subdirectory. The following table includes the information shown in the Admin UI WeChat Provider pop-up window, along with associated information from the `identityProviders.json` file.

IDM generates the `identityProvider-wechat.json` file only when you configure and enable the WeChat social identity provider in the Admin UI. Alternatively, you can create that file manually.

Note

WeChat supports URLs on one of the following ports: 80 or 443. For more information on how to configure IDM to use these ports, see "*Host and Port Information*".

WeChat Social Identity Provider Configuration Properties

Property (UI)	Property (JSON file)	Description
Client ID	`clientId`	The client identifier for your WeChat App
Client Secret	`clientSecret`	Used with the Client ID to access the applicable WeChat API
Scope	`scope`	An array of strings that allows access to user data
Authorization Endpoint	`authorizationEndpoint`	Typically `https://open.weixin.qq.com/connect/qrconnect`.
Token Endpoint	`tokenEndpoint`	Endpoint that receives a one-time authorization code, and returns an access token; typically `https://api.wechat.com/sns/oauth2/access_token`
Refresh Token Endpoint	`refreshTokenEndpoint`	Endpoint that receives a one-time authorization code, and returns a refresh token; typically `https://api.wechat.com/sns/oauth2/refresh_token`
User Info Endpoint	`userInfoEndpoint`	Endpoint that transmits scope-related fields; typically `https://api.wechat.com/user/profile`
Not in the Admin UI	`provider`	Name of the social identity provider
Not in the Admin UI	`configClass`	Configuration class for the authentication module
Not in the Admin UI	`basicAuth`	Whether to use basic authentication
Not in the Admin UI	`propertyMap`	Mapping between WeChat and IDM

For information on social identity provider buttons and badges, see "Social Identity Provider Button and Badge Properties".

I.8. Instagram Social Identity Provider Configuration Details

You can set up the Instagram social identity provider either through the Admin UI or in the `identityProvider-instagram.json` file in your project's `conf/` subdirectory. The following table includes the information shown in the Admin UI Instagram Provider pop-up window, along with associated information in the `identityProvider-instagram.json` file.

IDM generates the `identityProvider-instagram.json` file only when you configure and enable the Amazon social identity provider in the Admin UI. Alternatively, you can create that file manually.

Instagram Social Identity Provider Configuration Properties

Property (UI)	Property (JSON file)	Description
Client ID	`clientId`	The client identifier for your Instagram App
Client Secret	`clientSecret`	Used with the Client ID to access the applicable Instagram API
Scope	`scope`	An array of strings that allows access to user data
Authorization Endpoint	`authorizationEndpoint`	Typically `https://api.instagram.com/oauth/authorize/`; known as an Instagram *Authorize URL*
Token Endpoint	`tokenEndpoint`	Endpoint that receives a one-time authorization code, and returns an access token; typically `https://api.instagram.com/oauth/access_token`
User Info Endpoint	`userInfoEndpoint`	Endpoint that transmits scope-related fields; typically `https://api.instagram.com/v1/users/self/`
Not in the Admin UI	`provider`	Name of the social identity provider
Not in the Admin UI	`configClass`	Configuration class for the authentication module
Not in the Admin UI	`basicAuth`	Whether to use basic authentication
Not in the Admin UI	`propertyMap`	Mapping between Instagram and IDM

For information on social identity provider buttons and badges, see "Social Identity Provider Button and Badge Properties".

I.9. Vkontakte Social Identity Provider Configuration Details

You can set up the Vkontakte social identity provider either through the Admin UI or in the `identityProvider-vkontakte.json` file in your project's `conf/` subdirectory. The following table includes the information shown in the Admin UI Vkontakte Provider pop-up window, along with associated information in the `identityProvider-vkontakte.json` file.

IDM generates the `identityProvider-vkontakte.json` file only when you configure and enable the Vkontakte social identity provider in the Admin UI. Alternatively, you can create that file manually.

Vkontakte Social Identity Provider Configuration Properties

Property (UI)	Property (JSON file)	Description
Application ID	`clientId`	The client identifier for your Vkontakte App
Secure Key	`clientSecret`	Used with the Client ID to access the applicable Vkontakte API
Scope	`scope`	An array of strings that allows access to user data.
Authorization Endpoint	`authorizationEndpoint`	Typically `https://oauth.vk.com/authorize`.

Property (UI)	Property (JSON file)	Description
Token Endpoint	`tokenEndpoint`	Endpoint that receives a one-time authorization code, and returns an access token; typically `"https://oauth.vk.com/access_token`
User Info Endpoint	`userInfoEndpoint`	Endpoint that transmits scope-related fields; typically `https://api.vk.com/method/users.get`
API Version	`apiVersion`	Version of the applicable VKontakte API, available from *VK Developers Documentation, API Versions* section. The default VKontakte API version used for IDM 6.5 is 5.73.
Not in the Admin UI	`provider`	Name of the social identity provider
Not in the Admin UI	`configClass`	Configuration class for the authentication module
Not in the Admin UI	`basicAuth`	Whether to use basic authentication
Not in the Admin UI	`authenticationIdKey`	The user identity property, such as `id`
Not in the Admin UI	`propertyMap`	Mapping between Vkontakte and IDM

For information on social identity provider buttons and badges, see "Social Identity Provider Button and Badge Properties".

I.10. Salesforce Social Identity Provider Configuration Details

You can set up the Salesforce social identity provider either through the Admin UI or in the `identityProvider-salesforce.json` file in your project's `conf/` subdirectory. The following table includes the information shown in the Admin UI Salesforce Provider pop-up window, along with associated information in the `identityProvider-salesforce.json` file.

IDM generates the `identityProvider-salesforce.json` file only when you configure and enable the Salesforce social identity provider in the Admin UI. Alternatively, you can create that file manually.

Salesforce Social Identity Provider Configuration Properties

Property (UI)	Property (JSON file)	Description
Client ID	`clientId`	The client identifier for your Salesforce App
Client Secret	`clientSecret`	Used with the Client ID to access the applicable Salesforce API
Scope	`scope`	An array of strings that allows access to user data
Authorization Endpoint	`authorizationEndpoint`	A typical URL: `https://login.salesforce.com/services/oauth2/authorize`.
Token Endpoint	`tokenEndpoint`	Endpoint that receives a one-time authorization code, and returns an access token; such as `https://login.salesforce.com/services/oauth2/token`

Property (UI)	Property (JSON file)	Description
User Info Endpoint	`userInfoEndpoint`	Endpoint that transmits scope-related fields; a typical URL: `https://login.salesforce.com/services/oauth2/userinfo`
Not in the Admin UI	`provider`	Name of the social identity provider
Not in the Admin UI	`configClass`	Configuration class for the authentication module
Not in the Admin UI	`basicAuth`	Whether to use basic authentication
Not in the Admin UI	`propertyMap`	Mapping between Salesforce and IDM

I.11. Yahoo Social Identity Provider Configuration Details

You can set up the Yahoo social identity provider either through the Admin UI or in the `identityProvider-yahoo.json` file in your project's `conf/` subdirectory. The following table includes the information shown in the Admin UI Yahoo Provider pop-up window, along with associated information in the `identityProvider-yahoo.json` file.

IDM generates the `identityProvider-yahoo.json` file only when you configure and enable the Yahoo social identity provider in the Admin UI. Alternatively, you can create that file manually.

Note

Yahoo supports URLs using only HTTPS, only on port 443. For more information on how to configure IDM to use these ports, see "*Host and Port Information*".

Yahoo Social Identity Provider Configuration Properties

Property (UI)	Property (JSON file)	Description
Client ID	`clientId`	The client identifier for your Yahoo App
Client Secret	`clientSecret`	Used with the Client ID to access the applicable Yahoo API
Scope	`scope`	An array of strings that allows access to user data
Authorization Endpoint	`authorizationEndpoint`	Typically `https://api.login.yahoo.com/oauth2/request_auth`; known as a Yahoo *Authorize URL*
Token Endpoint	`tokenEndpoint`	Endpoint that receives a one-time authorization code, and returns an access token; typically `https://api.login.yahoo.com/oauth2/get_token`
Well-Known Endpoint	`wellKnownEndpoint`	Access for other URIs; typically `https://login.yahoo.com/.well-known/openid-configuration`
Not in the Admin UI	`provider`	Name of the social identity provider
Not in the Admin UI	`configClass`	Configuration class for the authentication module
Not in the Admin UI	`basicAuth`	Whether to use basic authentication

Property (UI)	Property (JSON file)	Description
Not in the Admin UI	`propertyMap`	Mapping between Yahoo and IDM

For information on social identity provider buttons and badges, see "Social Identity Provider Button and Badge Properties".

I.12. Twitter Social Identity Provider Configuration Details

You can set up the Twitter social identity provider either through the Admin UI or in the `identityProvider-twitter.json` file in your project's `conf/` subdirectory. The following table includes the information shown in the Admin UI Twitter Provider pop-up window, along with associated information in the `identityProvider-twitter.json` file.

IDM generates the `identityProvider-twitter.json` file only when you configure and enable the Twitter social identity provider in the Admin UI. Alternatively, you can create that file manually.

Twitter Social Identity Provider Configuration Properties

Property (UI)	Property (JSON file)	Description
Consumer Key	`clientId`	The client identifier for your Twitter App
Consumer Secret	`clientSecret`	Used with the Client ID to access the applicable Twitter API
Authorization Endpoint	`authorizationEndpoint`	Typically `https://api.twitter.com/oauth/authenticate`; known as a Twitter *Authorize URL*
Access Token Endpoint	`tokenEndpoint`	Endpoint that receives a one-time authorization code, and returns an access token; typically `https://api.twitter.com/oauth/access_token`
User Info Endpoint	`userInfoEndpoint`	Access for other URIs; typically `https://api.twitter.com/1.1/account/verify_credentials.json`
Request Token Endpoint	`requestTokenEndpoint`	Endpoint that receives a one-time authorization code, and returns an access token; typically `https://api.twitter.com/oauth/request_token`
Not in the Admin UI	`provider`	Name of the social identity provider
Not in the Admin UI	`authenticationIdKey`	The user identity property, such as `_id`
Not in the Admin UI	`configClass`	Configuration class for the authentication module
Not in the Admin UI	`basicAuth`	Whether to use basic authentication
Not in the Admin UI	`propertyMap`	Mapping between Twitter and IDM

For information on social identity provider buttons and badges, see "Social Identity Provider Button and Badge Properties".

I.13. Custom Social Identity Provider Configuration Details

When you set up a custom social identity provider, starting with "Preparing IDM", you'll see configuration details in the `identityProviders.json` file, in your project's `conf/` subdirectory. The following table includes the information shown in the relevant Admin UI pop-up window.

IDM generates the `identityProvider-custom.json` file only when you configure and enable the custom social identity provider in the Admin UI. Alternatively, you can create that file manually.

Custom Social Identity Provider Configuration Properties

Property (UI)	Property (JSON file)	Description
Client ID	`clientId`	The client identifier for your social identity provider
Client Secret	`clientSecret`	Used with the Client ID
Scope	`scope`	An array of strings that allows access to user data; varies by provider.
Authorization Endpoint	`authorizationEndpoint`	Every social identity provider should have an authorization endpoint to authenticate end users.
Token Endpoint	`tokenEndpoint`	Endpoint that receives a one-time authorization code, and returns an access token.
User Info Endpoint	`userInfoEndpoint`	Endpoint that transmits scope-related fields.
Not in the Admin UI	`name`	Name of the social identity provider
Not in the Admin UI	`type`	Authentication module
Not in the Admin UI	`authenticationId`	Authentication identifier, as returned from the User Info Endpoint for each social identity provider
Not in the Admin UI	`propertyMap`	Mapping between the social identity provider and IDM

For information on social identity provider buttons and badges, see "Social Identity Provider Button and Badge Properties".

I.14. Social Identity Provider Button and Badge Properties

IDM allows you to configure buttons and badges for each social identity provider, either through the UI or via the associated `identityProvider-`*`name`*`.json` configuration file.

A badge is a circular icon associated with a social identity provider. It appears in the Admin UI under Configure > Social ID Providers, and in the End User UI under My Account > Sign-in & Security > Social Sign-in. You can modify the badge options as described in the following table.

A button is a rectangular icon associated with a social identity provider. It appears in the IDM login screens. It also appears when you select `Register` from the End User UI login screen.

If you have configured up to three social identity providers, IDM includes long rectangular buttons, with words like *Register with Provider*.

If you've configured four or more social identity providers, IDM includes smaller rectangular buttons with icons.

If you've configured seven or more social identity providers, you may have to scroll horizontally to log in or register with the provider of your choice.

Properties for Social Identity Provider Buttons and Badges

Property (UI)	Property (JSON file)	Description
Badge background color	`iconBackground`	Color for the social identity provider icon
Badge icon classname	`iconClass`	Name of the icon class; may be a Font Awesome name like `fa-google`
Badge font color	`iconFontColor`	Color for the social identity provider icon font
Button image path	Looks in `openidm/ui/admin/extension` and then `openidm/ui/admin/default` for an image file; takes precedence over the *Button icon classname*	Unknown
Button icon classname	`buttonClass`	Name for the social identity provider class; may be a Font Awesome name like `fa-yahoo`
Button styles	`buttonCustomStyle`	Custom styles, such as `background-color: #7B0099; border-color: #7B0099; color:white;`
Button hover styles	`buttonCustomStyleHover`	Custom styles for the hover state of a button, such as `background-color: #7B0099; border-color: #7B0099; color:white;`

Appendix J. Audit Log Reference

This appendix lists the configuration parameters for the audit event handlers.

J.1. Audit Log Schema

The following tables depict the schema for the six audit event topics. For the JSON audit event handler, each audit topic is logged to a distinct JSON file, with the topic in the filename. Files are created in the `openidm/audit` directory by default:

- `access.audit.json`: see "Access Event Topic Properties"
- `activity.audit.json`: see "Activity Event Topic Properties"
- `authentication.audit.json`: see "Authentication Event Topic Properties"
- `config.audit.json`: see "Configuration Event Topic Properties"
- `recon.audit.json`: see "Reconciliation Event Topic Properties"
- `sync.audit.json`: see "Synchronization Event Topic Properties"

You can parse the files in the `openidm/audit` directory using a JSON processor, such as `jq`. For example:

```
$ tail -f authentication.audit.json | jq .
{
  "context": {
    "component": "internal/user",
    "roles": [
      "internal/role/openidm-admin",
      "internal/role/openidm-authorized"
    ],
    "ipAddress": "0:0:0:0:0:0:0:1",
    "id": "openidm-admin",
    "moduleId": "INTERNAL_USER"
  },
  "entries": [
    {
      "moduleId": "JwtSession",
      "result": "SUCCESSFUL",
      "info": {
        "org.forgerock.authentication.principal": "openidm-admin"
      }
    }
  ],
  "principal": [
    "openidm-admin"
  ]
,
...
```

The JSON properties that correspond to each audit topic are described in the following tables:

J.1.1. Audit Event Topics

Reconciliation Event Topic Properties

Event Property	Description
`_id`	UUID for the message object, such as `"0419d364-1b3d-4e4f-b769-555c3ca098b0"`
`transactionId`	The UUID of the transaction; you may see the same ID in different audit event topics.
`timestamp`	The time that the message was logged, in UTC format; for example `"2015-05-18T08:48:00.160Z"`
`eventName`	The name of the audit event: `recon` for this log
`userId`	User ID
`trackingIds`	A unique value for an object being tracked
`action`	Reconciliation action, depicted as a CREST action. For more information, see "Synchronization Actions"
`exception`	The stack trace of the exception
`linkQualifier`	The link qualifier applied to the action; For more information, see "Mapping a Single Source Object to Multiple Target Objects"

Event Property	Description
`mapping`	The name of the mapping used for the synchronization operation, defined in `conf/sync.json`.
`message`	Description of the synchronization action
`messageDetail`	Details from the synchronization run, shown as CREST output
`situation`	The synchronization situation described in "How Synchronization Situations Are Assessed"
`sourceObjectId`	The object ID on the source system, such as `managed/user/9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb`
`status`	Reconciliation result status, such as SUCCESS or FAILURE
`targetObjectId`	The object ID on the target system, such as `system/csvfile/account/bjensen`
`reconciling`	What is currently being reconciled, `source` for the first phase, `target` for the second phase.
`ambiguousTargetObjectIds`	When the `situation` is AMBIGUOUS or UNQUALIFIED, and IDM cannot distinguish between more than one target object, the object IDs are logged, to help figure out what was ambiguous.
`reconAction`	The reconciliation action, typically `recon` or `null`
`entryType`	The type of reconciliation log entry, such as `start`, `entry`, or `summary`.
`reconId`	UUID for the reconciliation operation

Synchronization Event Topic Properties

Event Property	Description
`_id`	UUID for the message object, such as `"0419d364-1b3d-4e4f-b769-555c3ca098b0"`
`transactionId`	The UUID of the transaction; you may see the same ID in different audit event topics.
`timestamp`	The time that the message was logged, in UTC format; for example `"2015-05-18T08:48:00.160Z"`
`eventName`	The name of the audit event: `sync` for this log
`userId`	User ID
`trackingIds`	A unique value for an object being tracked
`action`	Synchronization action, depicted as a CREST action. For more information, see "Synchronization Actions"
`exception`	The stack trace of the exception
`linkQualifier`	The link qualifier applied to the action; For more information, see "Mapping a Single Source Object to Multiple Target Objects"

Event Property	Description
`mapping`	The name of the mapping used for the synchronization operation, defined in `conf/sync.json`.
`message`	Description of the synchronization action
`messageDetail`	Details from the reconciliation run, shown as CREST output
`situation`	The synchronization situation described in "How Synchronization Situations Are Assessed"
`sourceObjectId`	The object ID on the source system, such as `managed/user/9dce06d4-2fc1-4830-a92b-bd35c2f6bcbb`
`status`	Reconciliation result status, such as SUCCESS or FAILURE
`targetObjectId`	The object ID on the target system, such as `uid=jdoe,ou=People,dc=example,dc=com`

J.1.2. Commons Audit Event Topics

Access Event Topic Properties

Event Property	Description
`_id`	UUID for the message object, such as `"0419d364-1b3d-4e4f-b769-555c3ca098b0"`
`timestamp`	The time that OpenIDM logged the message, in UTC format; for example `"2015-05-18T08:48:00.160Z"`
`eventName`	The name of the audit event: `access` for this log
`transactionId`	The UUID of the transaction; you may see the same transaction for the same event in different audit event topics
`userId`	User ID
`trackingId`	A unique value for the object being tracked
`server.ip`	IP address of the OpenIDM server
`server.port`	Port number used by the OpenIDM server
`client.ip`	Client IP address
`client.port`	Client port number
`request.protocol`	Protocol for request, typically CREST
`request.operation`	The CREST operation taken on the object, for example, UPDATE, DELETE, or ACTION
`request.detail`	Typically details for an ACTION request
`http.request.secure`	Boolean for request security
`http.request.method`	HTTP method requested by the client
`http.request.path`	Path of the HTTP request

Event Property	Description
`http.request.queryParameters`	Parameters sent in the HTTP request, such as a key/value pair
`http.request.headers`	HTTP headers for the request (optional)
`http.request.cookies`	HTTP cookies for the request (optional)
`http.response.headers`	HTTP response headers (optional)
`response.status`	Normally, SUCCESSFUL, FAILED, or null
`response.statusCode`	SUCCESS in `response.status` leads to a null `response.statusCode`; FAILURE leads to a 400-level error
`response.detail`	Message associated with `response.statusCode`, such as Not Found or Internal Server Error
`response.elapsedTime`	Time to execute the access event
`response.elapsedTimeUnits`	Units for response time
`roles`	OpenIDM roles associated with the request

Activity Event Topic Properties

Event Property	Description
`_id`	UUID for the message object, such as `"0419d364-1b3d-4e4f-b769-555c3ca098b0"`
`timestamp`	The time that OpenIDM logged the message, in UTC format; for example `"2015-05-18T08:48:00.160Z"`
`eventName`	The name of the audit event: `activity` for this log
`transactionId`	The UUID of the transaction; you may see the same transaction for the same event in different audit event topics.
`userId`	User ID
`trackingId`	A unique value for the object being tracked
`runAs`	User to run the activity as; may be used in delegated administration
`objectId`	Object identifier, such as `/managed/user/42f8a60e-2019-4110-a10d-7231c3578e2b`
`operation`	The CREST operation taken on the object, for example, UPDATE, DELETE, or ACTION
`before`	JSON representation of the object prior to the activity
`after`	JSON representation of the object after the activity
`changedFields`	Fields that were changed, based on "Specifying Fields to Monitor"
`revision`	Object revision number
`status`	Result, such as SUCCESS
`message`	Human readable text about the action

Event Property	Description
passwordChanged	True/False entry on changes to the password
context	Flag for self-service logins, such as SELFSERVICE
provider	Name of the self-service provider, normally a social identity provider

Authentication Event Topic Properties

Event Property	Description
_id	UUID for the message object, such as "0419d364-1b3d-4e4f-b769-555c3ca098b0"
timestamp	The time that OpenIDM logged the message, in UTC format; for example "2015-05-18T08:48:00.160Z"
eventName	The name of the audit event: authentication for this log
transactionId	The UUID of the transaction; you may see the same transaction for the same event in different audit event topics.
userId	User ID
trackingId	A unique value for the object being tracked
result	The result of the transaction, either "SUCCESSFUL", or "FAILED"
principal	An array of the accounts used to authenticate, such as ["openidm-admin"]
context	The complete security context of the authentication operation, including the authenticating ID, targeted endpoint, authentication module, any roles applied, and the IP address from which the authentication request was made.
entries	The JSON representation of the authentication session
method	The authentication module, such as JwtSession, MANAGED_USER and SOCIAL_PROVIDERS
provider	The social identity provider name

Configuration Event Topic Properties

Event Property	Description
_id	UUID for the message object, such as "0419d364-1b3d-4e4f-b769-555c3ca098b0"
timestamp	The time that OpenIDM logged the message, in UTC format; for example "2015-05-18T08:48:00.160Z"
eventName	The name of the audit event: config for this log
transactionId	The UUID of the transaction; you may see the same transaction for the same event in different audit event topics.
userId	User ID

Event Property	Description
`trackingId`	A unique value for the object being tracked
`runAs`	User to run the activity as; may be used in delegated administration
`objectId`	Object identifier, such as `ui`
`operation`	The CREST operation taken on the object, for example, UPDATE, DELETE, or ACTION
`before`	JSON representation of the object prior to the activity
`after`	JSON representation of the object after to the activity
`changedFields`	Fields that were changed, based on "Specifying Fields to Monitor"
`revision`	Object revision number

J.2. Audit Event Handler Configuration

To configure an audit event handler, set the `config` properties for that handler in your project's `conf/audit.json` file.

To configure these properties from the Admin UI, click Configure > System Preferences > Audit, and click the edit icon associated with your event handler.

The tables shown in this section reflect the order in which properties are shown in the Admin UI. That order differs when you review the properties in your project's `audit.json` file.

Common Audit Event Handler Property Configuration

UI Label / Text	`audit.json` File Label	Description
Name	`name`	`config` sub-property. The name of the audit event handler
Audit Events	`topics`	`config` sub-property; the list of audit topics that are logged by this audit event handler, for example, `access`, `activity`, and `config`
Use for Queries	`handlerForQueries`	Specifies whether this audit event handler manages the queries on audit logs
Enabled	`enabled`	`config` sub-property; specifies whether the audit event handler is enabled. An audit event handler can be configured, but disabled, in which case it will not log events.
n/a	`config`	The JSON object used to configure the handler; includes several sub-properties
Shown only in `audit.json`	`class`	The class name in the Java file(s) used to build the handler

The following table lists the configurable properties specific to the JSON audit event handler:

JSON Audit Event Handler `config` Properties

Property	Description
`fileRotation`	Groups the file rotation configuration parameters.
`rotationEnabled`	Specifies whether file rotation is enabled. Boolean, true or false.
`maxFileSize`	The maximum size of an audit file, in bytes, before rotation is triggered.
`rotationFilePrefix`	The prefix to add to the start of an audit file name when it is rotated.
`rotationTimes`	Specifies a list of times at which file rotation should be triggered. The times must be provided as durations, offset from midnight. For example, a list of `10 minutes, 20 minutes, 30 minutes` will cause files to rotate at 10, 20 and 30 minutes after midnight.
`rotationFileSuffix`	The suffix appended to rotated audit file names. This suffix should take the form of a timestamp, in simple date format. The default suffix format, if none is specified, is `-yyyy.MM.dd-HH.mm.ss`.
`rotationInterval`	The interval to trigger a file rotation, expressed as a duration. For example, `5 seconds`, `5 minutes`, `5 hours`. A value of `0` or `disabled` disables time-based file rotation. Note that you can specify a list of `rotationTimes` and a `rotationInterval`. The audit event handler checks all rotation and retention policies on a periodic basis, and assesses whether each policy should be triggered at the current time, for a particular audit file. The first policy to meet the criteria is triggered.
`fileRetention`	Groups the file retention configuration parameters. The retention policy specifies how long audit files remain on disk before they are automatically deleted.
`maxNumberOfHistoryFiles`	The maximum number of historical audit files that can be stored. If the total number of audit files exceed this maximum, older files are deleted. A value of `-1` disables purging of old log files.
`maxDiskSpaceToUse`	The maximum disk space, in bytes, that can be used for audit files. If the total space occupied by the audit files exceed this maximum, older files are deleted. A negative or zero value indicates that this policy is disabled, that is, that unlimited disk space can be used for historical audit files.
`minFreeSpaceRequired`	The minimum free disk space, in bytes, required on the system that houses the audit files. If the free space drops below this minimum, older files are deleted. A negative or zero value indicates that this policy is disabled, that is, that no minimum space requirements apply.
`rotationRetentionCheckInterval`	Interval for periodically checking file rotation and retention policies. The interval must be a duration, for example, `5 seconds`, `5 minutes`, or `5 hours`.
`logDirectory`	Directory with JSON audit files
`elasticsearchCompatible`	Enable ElasticSearch JSON format compatibility. Boolean, true or false. Set this property to `true`, for example, if you are using Logstash to feed into ElasticSearch. When `elasticsearchCompatible` is `true`, the handler renames the `_id` field to `_eventId` because `_id` is reserved by ElasticSearch. The rename is reversed after JSON serialization, so that

Property	Description
	other handlers will see the original field name. For more information, see the ElasticSearch documentation.
`buffering`	Configuration for event buffering
`maxSize`	The maximum number of events that can be buffered (default/minimum: 100000)
`writeInterval`	The delay after which the file-writer thread is scheduled to run after encountering an empty event buffer (units of 'ms' are recommended). Default: 100 ms.

The following table lists the configurable properties specific to the CSV audit event handler:

CSV Audit Event Handler `config` Properties

UI Label / Text	`audit.json` File Label	Description
File Rotation	`fileRotation`	Groups the file rotation configuration parameters.
rotationEnabled	`rotationEnabled`	Specifies whether file rotation is enabled. Boolean, true or false.
maxFileSize	`maxFileSize`	The maximum size of an audit file, in bytes, before rotation is triggered.
rotationFilePrefix	`rotationFilePrefix`	The prefix to add to the start of an audit file name when it is rotated.
Rotation Times	`rotationTimes`	Specifies a list of times at which file rotation should be triggered. The times must be provided as durations, offset from midnight. For example, a list of `10 minutes, 20 minutes, 30 minutes` will cause files to rotate at 10, 20 and 30 minutes after midnight.
File Rotation Suffix	`rotationFileSuffix`	The suffix appended to rotated audit file names. This suffix should take the form of a timestamp, in simple date format. The default suffix format, if none is specified, is `-yyyy.MM.dd-HH.mm.ss`.
Rotation Interval	`rotationInterval`	The interval to trigger a file rotation, expressed as a duration. For example, `5 seconds`, `5 minutes`, `5 hours`. A value of `0` or `disabled` disables time-based file rotation. Note that you can specify a list of `rotationTimes` and a `rotationInterval`. The audit event handler checks all rotation and retention policies on a periodic basis, and assesses whether each policy should be triggered at the current time, for a particular audit file. The first policy to meet the criteria is triggered.
File Retention	`fileRetention`	Groups the file retention configuration parameters. The retention policy specifies how long audit files remain on disk before they are automatically deleted.

UI Label / Text	`audit.json` File Label	Description
Maximum Number of Historical Files	`maxNumberOfHistoryFiles`	The maximum number of historical audit files that can be stored. If the total number of audit files exceed this maximum, older files are deleted. A value of `-1` disables purging of old log files.
Maximum Disk Space	`maxDiskSpaceToUse`	The maximum disk space, in bytes, that can be used for audit files. If the total space occupied by the audit files exceed this maximum, older files are deleted. A negative or zero value indicates that this policy is disabled, that is, that unlimited disk space can be used for historical audit files.
Minimum Free Space Required	`minFreeSpaceRequired`	The minimum free disk space, in bytes, required on the system that houses the audit files. If the free space drops below this minimum, older files are deleted. A negative or zero value indicates that this policy is disabled, that is, that no minimum space requirements apply.
rotationRetentionCheckInter	`rotationRetentionCheckInterval`	Interval for periodically checking file rotation and retention policies. The interval must be a duration, for example, `5 seconds`, `5 minutes`, or `5 hours`.
Log Directory	`logDirectory`	Directory with CSV audit files
CSV Output Formatting	`formatting`	
quoteChar	`quoteChar`	Formatting: Character used around a CSV field
delimiterChar	`delimiterChar`	Formatting: Character between CSV fields
End of Line Symbols	`endOfLineSymbols`	Formatting: end of line symbol, such as `\n` or `\r`
Security: CSV Tamper Evident Configuration	`security`	Uses keystore-based signatures
Enabled	`enabled`	CSV Tamper Evident Configuration: true or false
Filename	`filename`	CSV Tamper Evident Configuration: Path to the Java keystore
Password	`password`	CSV Tamper Evident Configuration: Password for the Java keystore
Keystore Handler	`keystoreHandlerName`	CSV Tamper Evident Configuration: Keystore name. The value of this property must be `openidm`. This is the name that the audit service provides to the ForgeRock Common Audit Framework for the configured IDM keystore.
Signature Interval	`signatureInterval`	CSV Tamper Evident Configuration: Signature generation interval. Default = 1 hour. Units described in "Minimum Admin UI CSV Audit Handler Configuration Requirements".
Buffering	`buffering`	Configuration for optional event buffering
enabled	`enabled`	Buffering: true or false

UI Label / Text	audit.json File Label	Description
autoFlush	autoFlush	Buffering: avoids flushing after each event

Except for the common properties shown in "Common Audit Event Handler Property Configuration", the Repository and Router audit event handlers share one unique property: resourcePath:

```
{
     "class" : "org.forgerock.openidm.audit.impl.RouterAuditEventHandler",
     "config" : {
         "name" : "router",
         "topics" : [ "access", "activity", "recon", "sync", "authentication", "config" ],
         "resourcePath" : "system/auditdb"
     }
  },
```

Repository / Router Audit Event Handler Unique config Properties

UI Label / Text	audit.json File Label	Description
resourcePath	resourcePath	Path to the repository resource

Note

Take care when reading JMS properties in the audit.json file. They include the standard ForgeRock audit event topics, along with JMS-unique topics:

JMS Audit Event Handler Unique config Properties

UI Label / Text	audit.json File Label	Description
Delivery Mode	deliveryMode	Required property, for messages from a JMS provider; may be PERSISTENT or NON_PERSISTENT
Session Mode	sessionMode	Acknowledgement mode, in sessions without transactions. May be AUTO, CLIENT, or DUPS_OK.
Batch Configuration Settings	batchConfiguration	Options when batch messaging is enabled
Batch Enabled	batchEnabled	Boolean for batch delivery of audit events
Capacity	capacity	Maximum event count in the batch queue; additional events are dropped
Thread Count	threadCount	Number of concurrent threads that pull events from the batch queue
Maximum Batched Events	maxBatchedEvents	Maximum number of events per batch
Insert Timeout (Seconds)	insertTimeoutSec	Waiting period (seconds) for available capacity, when a new event enters the queue
Polling Timeout (Seconds)	pollTimeoutSec	Worker thread waiting period (seconds) for the next event, before going idle

UI Label / Text	audit.json File Label	Description
Shutdown Timeout (Seconds)	shutdownTimeoutSec	Application waiting period (seconds) for worker thread termination
JNDI Configuration	jndiConfiguration	Java Naming and Directory Interface (JNDI) Configuration Settings
JNDI Context Properties	contextProperties	Settings to populate the JNDI initial context with
JNDI Context Factory	java.naming.factory.initial	Initial JNDI context factory, such as com.tibco.tibjms.naming.TibjmsInitialContextFactory
JNDI Provider URL	java.naming.provider.url	Depends on provider; options include tcp://localhost:61616 and tibjmsnaming://192.168.1.133:7222
JNDI Topic	topic.forgerock.idm.audit	Relevant JNDI topic; default=forgerock.idm.audit
JNDI Topic Name	topicName	JNDI lookup name for the JMS topic
Connection Factory	connectionFactoryName	JNDI lookup name for the JMS connection factory

Note

To use the JMS resources provided by your application server, leave the JNDI Context Properties settings empty. Values for topicName and connectionFactoryName will then depend on the configuration of your application server.

The ForgeRock Syslog audit event handler is based on a widely-used logging protocol. When you configure the Syslog audit event handler, you will see many of the following properties in the UI and in your project's audit.json file.

Syslog Audit Event Handler Unique config Properties

UI Label / Text	audit.json File Label	Description
protocol	protocol	Transport protocol for Syslog messages; may be TCP or UDP
host	host	Host name or IP address of the receiving Syslog server
port	port	The TCP/IP port number of the receiving Syslog server
connectTimeout	connectTimeout	Timeout for connecting to the Syslog server (seconds)
facility	facility	Options shown in the Admin UI, KERN, USER, MAIL, DAEMON, AUTH, SYSLOG, LPR, NEWS, UUCP, CRON, AUTPRIV, FTP, NTP, LOGAUDIT, LOGALERT, CLOCKD, LOCAL0, LOCAL1, LOCAL2, LOCAL3, LOCAL4, LOCAL5, LOCAL6, LOCAL7 correspond directly to facility values shown in RFC 5424, *The Syslog Protocol*.

UI Label / Text	`audit.json` File Label	Description
SeverityFieldMappings	`severityFieldMappings`	Sets the correspondence between audit event fields and Syslog severity values
topic	`topic`	Severity Field Mappings: the audit event topic to which the mapping applies
field	`field`	Severity Field Mappings: the audit event field to which the mapping applies; taken from the JSON schema for the audit event content
Value Mappings	`valueMappings`	Severity Field Mappings: The map of audit event values to Syslog severities. Syslog severities may be: EMERGENCY, ALERT, CRITICAL, ERROR, WARNING, NOTICE, INFORMATIONAL, or DEBUG, in descending order of importance
Buffering	`buffering`	Disabled by default; all messages written immediately to the log

The Elasticsearch audit event handler is relatively complex, with `config` subcategories for `connection`, `indexMapping`, `buffering`, and `topics`.

Elasticsearch Audit Event Handler Unique `config` Properties

UI Label / Text	`audit.json` File Label	Description
Connection	`connection`	Elasticsearch audit event handler
useSSL	`useSSL`	Connection: Use SSL/TLS to connect to Elasticsearch
host	`host`	Connection: Hostname or IP address of Elasticsearch (default: localhost)
port	`port`	Connection: Port used by Elasticsearch (default: 9200)
username	`username`	Connection: Username when Basic Authentication is enabled via Elasticsearch Shield
password	`password`	Connection: Password when Basic Authentication is enabled via Elasticsearch Shield
Index Mapping	`indexMapping`	Defines how an audit event and its fields are stored and indexed
indexName	`indexName`	Index Mapping: Index Name (default=audit). Change if 'audit' conflicts with an existing Elasticsearch index
Buffering	`buffering`	Configuration for buffering events and batch writes (increases write-throughput)
enabled	`enabled`	Buffering: recommended
maxSize	`maxSize`	Buffering: Fixed maximum number of events that can be buffered (default: 10000)

UI Label / Text	`audit.json` File Label	Description
Write Interval	`writeInterval`	The delay after which the file-writer thread is scheduled to run after encountering an empty event buffer (units of 'ms' are recommended). Default: 100 ms.
maxBatchedEvents	`maxBatchedEvents`	Buffering: Maximum number of events per batch-write to Elasticsearch for each Write Interval (default: 500)

The following table lists the configurable properties specific to the Splunk audit event handler:

Splunk Audit Event Handler `config` Properties

Property	Description
`useSSL`	Specifies whether IDM should connect to the Splunk instance over SSL. Boolean, true or false.
`host`	The hostname or IP address of the Splunk instance. If no hostname is specified, `localhost` is assumed.
`port`	The dedicated Splunk port for HTTP input. Default: 8088.
`buffering`	Configuration for event buffering
`maxSize`	The maximum number of events that can be buffered. Default/minimum: 10000.
`writeInterval`	The delay after which the file-writer thread is scheduled to run after encountering an empty event buffer (units of 'ms' or 's' are recommended). Default: 100 ms.
`maxBatchedEvents`	The maximum number of events per batch-write to Splunk for each Write Interval. Default: 500.
`authzToken`	The authorization token associated with the Splunk configured HTTP event collector.

Appendix K. Metrics Reference

Below is a list of available metrics provided by IDM. There are currently two types of metrics:

- Timers provide a histogram of the duration of an event, along with a measure of the rate of occurrences. Timers are available to be monitored using both the Dropwizard dashboard widget and the IDM Prometheus endpoint. Durations in timers are measured in milliseconds, while rates are reported in number of calls per second. Below is an example timer metric:

```
{
  "_id": "sync.source.perform-action",
  "count": 2,
  "max": 371.53391,
  "mean": 370.1752705,
  "min": 368.816631,
  "p50": 371.53391,
  "p75": 371.53391,
  "p95": 371.53391,
  "p98": 371.53391,
  "p99": 371.53391,
  "p999": 371.53391,
  "stddev": 1.3586395,
  "m15_rate": 0.393388581528647,
  "m1_rate": 0.311520313228562,
  "m5_rate": 0.3804917698002856,
  "mean_rate": 0.08572717156016606,
  "duration_units": "milliseconds",
  "rate_units": "calls/second",
  "total": 740.350541,
  "_type": "timer"
}
```

- Summaries are similar to Timers in that they measure a distribution of events, but for recording values that aren't units of time, such as user login counts. Summaries are not available to be

graphed in the Dropwizard dashboard widget, but are available through the Prometheus endpoint and by querying the `openidm/metrics/api` endpoint directly. Below is an example summary metric:

```
{
  "_id": "audit.recon",
  "m15_rate": 0.786777163057294,
  "m1_rate": 0.623040626457124,
  "m5_rate": 0.7609835396005712,
  "mean_rate": 0.16977218861919927,
  "units": "events/second",
  "total": 4,
  "count": 4,
  "_type": "summary"
}
```

For more information about monitoring IDM metrics, see "Metrics and Monitoring".

All metrics are currently available through both `openidm/metrics/api` and `openidm/metrics/prometheus` endpoints, but the names for these metrics can vary depending on the endpoint used.

K.1. API Metrics available in IDM

Metrics accessed through the API endpoint (such as those consumed by the Dropwizard dashboard widget) use dot notation for their metric names, for example, `recon.target-phase`. The following table lists the API metrics currently available in IDM:

API Metrics available in IDM

API Metric Name	Type	Description
`audit.<audit-topic>`	Summary	Count of all audit events generated of a given topic type.
`user.login.<user-type>`	Summary	Count of all successful logins by user type.
`user.login.<user-type>.<provider>`	Summary	Count of all successful logins by user type and provider.
`selfservice.user .registration.<registration-type>`	Summary	Count of all successful user self-service registrations by registration type.
`selfservice.user .registration.<registration-type> .<provider>`	Summary	Count of all successful user self-service registrations by registration type and provider.
`selfservice.user.password.reset`	Summary	Count of all successful user self-service password resets.
`script.<script-name>.<request-type>`	Timer	Rate of calls to a script and time taken to complete.
`repo.jdbc.relationship.execute`	Timer	Rate of relationship graph query execution times.

API Metric Name	Type	Description
`repo.jdbc.relationship.process`	Timer	Rate of relationship graph query result processing times.
`repo.<repo-type>get-connection`	Timer	Rate of retrievals of a repository connection.
`repo.raw._queryId.<queryId>`	Timer	Rate of executions of a query with queryId at a repository level, and time taken to perform this operation.
`repo.raw._queryExpression`	Timer	Rate of executions of a query with queryExpression at a repository level, and time taken to perform this operation.
`repo.<repo-type>.<operation>.<resource-mapping>`	Timer	Rate of initiations of a CRUDPAQ operation to a repository datasource.
`repo.<repo-type>.<operation>.relationship`	Timer	Rate of CRUDPAQ operations to a repository datasource for a generic/ explicit/relationship mapped table.
`repo.<repo-type>.<operation> .<action_name>.<command>.<resource-mapping>`	Timer	Rate of actions to a repository datasource for a generic/explicit mapped table.
`icf.<system-identifier>.<objectClass> .query._queryId.<queryId>`	Timer	Rate of ICF query executions with queryId, and time taken to perform this operation.
`icf.<system-identifier>.<objectClass> .query._queryExpression`	Timer	Rate of ICF query executions with queryExpression, and time taken to perform this operation.
`icf.<system-identifier>.<objectClass> .query._queryFilter`	Timer	Rate of ICF query executions with queryFilter, and time taken to perform this operation.
`icf.<system-identifier>.<objectClass> .query._UNKNOWN`	Timer	Rate of ICF query executions when the query type is UNKNOWN, and time taken to perform this operation.
`router.<path-name>`.action.<*action-type*>	Timer	Rate of actions over the router, and time taken to perform this operation.
`router.<path-name>`.create	Timer	Rate of creates over the router, and time taken to perform this operation.
`router.<path-name>`.delete	Timer	Rate of deletes over the router, and time taken to perform this operation.
`router.<path-name>`.patch	Timer	Rate of patches over the router, and time taken to perform this operation.
`router.<path-name>`.query.queryExpression	Timer	Rate of queries with queryExpression completed over the router, and time taken to perform this operation.

API Metric Name	Type	Description
`router.<path-name>`.query.queryFilter	Timer	Rate of queries with queryFilter completed over the router, and time taken to perform this operation.
`router.<path-name>`.read	Timer	Rate of reads over the router, and time taken to perform this operation.
`router.<path-name>`.update	Timer	Rate of updates over the router, and time taken to perform this operation.
`managed.<managed-object>.<operation>`	Timer	Rate of operations on a managed object.
`managed.<managed-object>.script.<script-name>`	Timer	Rate of executions of a script on a managed object.
`managed.<managed-object>.relationship.fetch-relationship-fields`	Timer	Rate of fetches of relationship fields of a managed object.
`managed.<managed-object>.relationship.validate-relationship-fields`	Timer	Rate of validations of relationship fields of a managed object.
`managed.<managed-object>.relationship.getRelationshipValueForResource`	Timer	Rate of queries to get relationship values for a resource on a managed object.
`managed.relationship.validate.read-relationship-endpoint-edges`	Timer	Rate of reads on relationship endpoint edges for validation.
`recon`	Timer	Rate of executions of a full reconciliation, and time taken to perform this operation.
`recon.target-phase`	Timer	Rate of executions of the target phase of a reconciliation, and time taken to perform this operation.
`recon.source-phase`	Timer	Rate of executions of the source phase of a reconciliation, and time taken to perform this operation.
`recon.source-phase.page`	Timer	Rate of pagination executions of the source phase of a reconciliation, and time taken to perform this operation.
`recon.id-queries-phase`	Timer	Rate of executions of the id query phase of a reconciliation, and time taken to perform this operation.
`sync.raw-read-object`	Timer	Rate of reads of an object.
`sync.source.correlate-target`	Timer	Rate of correlations between a target and a given source, and time taken to perform this operation.
`sync.source.assess-situation`	Timer	Rate of assessments of a synchronization situation.
`sync.source.determine-action`	Timer	Rate of determinations done on a synchronization action based on its current situation.

API Metric Name	Type	Description
`sync.source.perform-action`	Timer	Rate of completions of an action performed on a synchronization operation.
`sync.objectmapping.<mapping-name>`	Timer	Rate of configurations applied to a mapping.
`sync.create-object`	Timer	Rate of requests to create an object on the target, and the time taken to perform this operation.
`sync.delete-target`	Timer	Rate of requests to delete an object on the target, and the time taken to perform this operation.
`sync.update-target`	Timer	Rate of requests to update an object on the target, and the time taken to perform this operation.
`sync.target.assess-situation`	Timer	Rate of assessments of a target situation.
`sync.target.determine-action`	Timer	Rate of determinations done on a target action based on its current situation.
`sync.target.perform-action`	Timer	Rate of completions of an action performed on a target sync operation.
`sync.queue.mapping-name.action.acquire`	Timer	Rate of acquisition of queued synchronization events from the queue.
`sync.queue.mapping-name.action.release`	Timer	Rate at which queued synchronization events are released.
`sync.queue.mapping-name.action.submit`	Timer	Rate of insertion of synchronization events into the queue.
`sync.queue.mapping-name.action.discard`	Timer	Rate of deletion of synchronization events from the queue.
`sync.queue.mapping-name.action.precondition-failed`	Summary	Number of queued synchronization events that were acquired by another node in the cluster.
`sync.queue.mapping-name.action.execution`	Timer	Rate at which queued synchronization operations are executed.
`sync.queue.mapping-name.action.failed`	Summary	Number of queued synchronization operations that failed.
`sync.queue.mapping-name.action.rejected-executions`	Summary	Number of queued synchronization events that were rejected because the backing thread-pool queue was at full capacity and the thread-pool had already allocated its maximum configured number of threads.
`sync.queue.mapping-name.poll-pending-events`	Timer	The latency involved in polling for synchronization events.

API Metric Name	Type	Description
`filter.filter-type.action.script-name`	Timer	Rate at which filter scripts are executed, per action. Monitors scripted filters and delegated admin.

K.2. Prometheus Metrics available in IDM

Metrics accessed through the Prometheus endpoint are prepended with `idm_` and use underscores between words, for example `idm_recon_target_phase_seconds`. The following table lists the Prometheus metrics currently available in IDM:

Prometheus Metrics available in IDM

Prometheus Metric Name	Type	Description
`idm_audit{audit_topic=<audit-topic>}`	Summary	Count of all audit events generated of a given topic type.
`idm_user_login{user_type=<user-type>}`	Summary	Count of all successful logins by user type.
`idm_user_login_total{provider=<provider>,user_type=<user-type>}`	Summary	Count of all successful logins by user type and provider.
`idm_selfservice_user_registration{reg_type=<registration-type>}`	Summary	Count of all successful user self-service registrations by registration type.
`idm_selfservice_user_registration{provider=<registration-type>,reg_type=<provider>}`	Summary	Count of all successful user self-service registrations by registration type and provider.
`idm_selfservice_user_password_reset`	Summary	Count of all successful user self-service password resets.
`idm_script_<script-name>_<request-type>`	Timer	Rate of calls to a script and time taken to complete.
`idm_repo_jdbc_relationship_execute_seconds`	Timer	Rate of relationship graph query execution times.
`idm_repo_jdbc_relationship_process_seconds`	Timer	Rate of relationship graph query result processing times.
`idm_repo_get_connection_seconds{repo_type=<repo-type>}`	Timer	Rate of retrievals of a repository connection.
`idm_repo_raw__queryid_credential_<queryId>_seconds`	Timer	Rate of executions of a query with queryId at a repository level, and time taken to perform this operation.
`idm_repo_raw__queryexpression_seconds`	Timer	Rate of executions of a query with queryExpression at a repository level, and time taken to perform this operation.

Prometheus Metric Name	Type	Description
idm_repo_seconds{operation=<*operation*>,repo_type=<*repo-type*>,resource_mapping=<*resource-mapping*>}	Timer	Rate of initiations of a CRUDPAQ operation to a repository datasource.
idm_repo_relationship_seconds{operation=<*operation*>,repo_type=<*repo-type*>}	Timer	Rate of CRUDPAQ operations to a repository datasource for a generic/explicit/relationship mapped table.
idm_repo_seconds{action_name=<*action-name*>,command=<*command*>,operation=<*operation*>,repo_type=<*repo-type*>,resource_mapping=<*resource-mapping*>}	Timer	Rate of actions to a repository datasource for a generic/explicit mapped table.
idm_icf_<*system-identifier*>_<*objectClass*>_query__queryId_<*queryId*>_seconds	Timer	Rate of ICF query executions with queryId, and time taken to perform this operation.
idm_icf_<*system-identifier*>_<*objectClass*>_query__queryExpression_seconds	Timer	Rate of ICF query executions with queryExpression, and time taken to perform this operation.
idm_icf_<*system-identifier*>_<*objectClass*>_query__queryFilter_seconds	Timer	Rate of ICF query executions with queryFilter, and time taken to perform this operation.
idm_icf_<*system-identifier*>_<*objectClass*>_query__UNKNOWN_seconds	Timer	Rate of ICF query executions when the query type is UNKNOWN, and time taken to perform this operation.
idm_router_<*path-name*>_action_<*action-type*>_seconds	Timer	Rate of actions over the router, and time taken to perform this operation.
idm_router_<*path-name*>_create_seconds	Timer	Rate of creates over the router, and time taken to perform this operation.
idm_router_<*path-name*>_delete_seconds	Timer	Rate of deletes over the router, and time taken to perform this operation.
idm_router_<*path-name*>_patch_seconds	Timer	Rate of patches over the router, and time taken to perform this operation.
idm_router_<*path-name*>_query_queryExpression_seconds	Timer	Rate of queries with queryExpression completed over the router, and time taken to perform this operation.
idm_router_<*path-name*>_query_queryFilter_seconds	Timer	Rate of queries with queryFilter completed over the router, and time taken to perform this operation.
idm_router_<*path-name*>_read_seconds	Timer	Rate of reads over the router, and time taken to perform this operation.
idm_router_<*path-name*>_update_seconds	Timer	Rate of updates over the router, and time taken to perform this operation.
idm_managed_seconds{managed_object=<*managed-object*>,operation=<*operation*>}	Timer	Rate of operations on a managed object.

Prometheus Metric Name	Type	Description
idm_managed_<*managed-object*>_script_<*script-name*>_seconds	Timer	Rate of executions of a script on a managed object.
idm_managed_<*managed-object*>_relationship_fetch_relationship_fields_seconds	Timer	Rate of fetches of relationship fields of a managed object.
idm_managed_<*managed-object*>_relationship_validate_relationship_fields_seconds	Timer	Rate of validations of relationship fields of a managed object.
idm_managed_<*managed-object*>_relationship_get_relationship_value_for_resource_seconds	Timer	Rate of queries to get relationship values for a resource on a managed object.
idm_managed_relationship_validate_read_relationship_endpoint_edges_seconds	Timer	Rate of reads on relationship endpoint edges for validation.
idm_recon_seconds	Timer	Rate of executions of a full reconciliation, and time taken to perform this operation.
idm_recon_target_phase_seconds	Timer	Rate of executions of the target phase of a reconciliation, and time taken to perform this operation.
idm_recon_source_phase_seconds	Timer	Rate of executions of the source phase of a reconciliation, and time taken to perform this operation.
idm_recon_source_phase_page_seconds	Timer	Rate of pagination executions of the source phase of a reconciliation, and time taken to perform this operation.
idm_recon_id_queries_phase_seconds	Timer	Rate of executions of the id query phase of a reconciliation, and time taken to perform this operation.
idm_sync_raw_read_object_seconds	Timer	Rate of reads of an object.
idm_sync_source_correlate_target_seconds	Timer	Rate of correlations between a target and a given source, and time taken to perform this operation.
idm_sync_source_assess_situation_seconds	Timer	Rate of assessments of a synchronization situation.
idm_sync_source_determine_action_seconds	Timer	Rate of determinations done on a synchronization action based on its current situation.
idm_sync_source_perform_action_seconds	Timer	Rate of completions of an action performed on a synchronization operation.
idm_sync_objectmapping_seconds{mapping_name=<*mapping-name*>}	Timer	Rate of configurations applied to a mapping.
idm_sync_create_object_seconds	Timer	Rate of requests to create an object on the target, and the time taken to perform this operation.

Prometheus Metric Name	Type	Description
`idm_sync_delete_target_seconds`	Timer	Rate of requests to delete an object on the target, and the time taken to perform this operation.
`idm_sync_update_target_seconds`	Timer	Rate of requests to update an object on the target, and the time taken to perform this operation.
`idm_sync_target_assess_situation_seconds`	Timer	Rate of assessments of a target situation.
`idm_sync_target_determine_action_seconds`	Timer	Rate of determinations done on a target action based on its current situation.
`idm_sync_target_perform_action_seconds`	Timer	Rate of completions of an action performed on a target sync operation.
`idm_sync_queue_acquire{mapping_name=`*`mapping-name`*`, action=`*`action`*`}`	Timer	Rate of acquisition of queued synchronization events from the queue.
`idm_sync_queue_release{mapping_name=`*`mapping-name`*`, action=`*`action`*`}`	Timer	Rate at which queued synchronization events are released.
`idm_sync_queue_submit{mapping_name=`*`mapping-name`*`, action=`*`action`*`}`	Timer	Rate of insertion of synchronization events into the queue.
`idm_sync_queue_discard{mapping_name=`*`mapping-name`*`, action=`*`action`*`}`	Timer	Rate of deletion of synchronization events from the queue.
`idm_sync_queue_precondition_failed{mapping_name=`*`mapping-name`*`, action=`*`action`*`}`	Summary	Number of queued synchronization events that were acquired by another node in the cluster.
`idm_sync_queue_execution{mapping_name=`*`mapping-name`*`, action=`*`action`*`}`	Timer	Rate at which queued synchronization operations are executed.
`idm_sync_queue_failed{mapping_name=`*`mapping-name`*`, action=`*`action`*`}`	Summary	Number of queued synchronization operations that failed.
`idm_sync_queue_rejected_executions{mapping_name=`*`mapping-name`*`, action=`*`action`*`}`	Summary	Number of queued synchronization events that were rejected because the backing thread-pool queue was at full capacity and the thread-pool had already allocated its maximum configured number of threads.
`idm_sync_queue_poll_pending_events{mapping_name=`*`mapping-name`*`}`	Timer	The latency involved in polling for synchronization events.
idm_filter_seconds{action=<*action*>,filter_type=<*filter-type*>,script_name=<*script-name*>}	Timer	Rate at which filter scripts are executed, per action. Monitors scripted filters and delegated admin.

Appendix L. IDM Property Files

This appendix lists the `*.properties` files used to configure IDM. Unless otherwise noted, you'll find these files in your project's `conf/` subdirectory. It does not include the `*.properties` files associated with ICF connectors.

You'll find a discussion of properties that affect the configuration throughout ForgeRock Identity Management documentation.

L.1. `boot.properties`

The `boot.properties` file is the property resolver file used for property substitution. As such, you'll find this file in the `/path/to/openidm/resolver` directory. Generally, it allows you to set variables that are used in other configuration files, including "`config.properties`" and "`system.properties`".

L.2. `config.properties`

The `config.properties` file is used for two purposes:

- To set OSGi bundle properties.
- To set Apache Felix properties, and plugin bundles related to the Felix web console.

For more information about each item in `config.properties`, see the following documentation: *Apache Felix Framework Configuration Properties*.

L.3. `logging.properties`

The `logging.properties` file configures the operation of the JDK logging facility for IDM. For more information, see "*Configuring Server Logs*".

L.4. `system.properties`

The `system.properties` file is used to bootstrap java system properties such as:

- Jetty log settings, based on the Jetty container bundled with IDM. IDM bundles Jetty version 9.2.
- Authoritative file-based configuration, as described in "Specifying an Authoritative File-Based Configuration".
- Quartz updates, as described in *Quartz Best Practices* documentation.

  `org.terracotta.quartz`
- A common transaction ID, as described in "Configuring the Audit Service".

IDM Glossary

correlation query	A correlation query specifies an expression that matches existing entries in a source repository to one or more entries on a target repository. While a correlation query may be built with a script, it is *not* a correlation script. As noted in "Correlating Source Objects With Existing Target Objects", you can set up a query definition, such as `_queryId`, `_queryFilter`, or `_queryExpression`, possibly with the help of a `linkQualifier`.
correlation script	A correlation script matches existing entries in a source repository, and returns the IDs of one or more matching entries on a target repository. While it skips the intermediate step associated with a `correlation query`, a correlation script can be relatively complex, based on the operations of the script.
entitlement	An entitlement is a collection of attributes that can be added to a user entry via roles. As such, it is a specialized type of `assignment`. A user or device with an entitlement gets access rights to specified resources. An entitlement is a property of a managed object.
JCE	Java Cryptographic Extension, which is part of the Java Cryptography Architecture, provides a framework for encryption, key generation, and digital signatures.
JSON	JavaScript Object Notation, a lightweight data interchange format based on a subset of JavaScript syntax. For more information, see the JSON site.

JSON Pointer	A JSON Pointer defines a string syntax for identifying a specific value within a JSON document. For information about JSON Pointer syntax, see the JSON Pointer RFC.
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 IDM, the JWT is associated with the `JWT_SESSION` authentication module.
managed object	An object that represents the identity-related data managed by IDM. Managed objects are configurable, JSON-based data structures that IDM 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 more information, see What is OSGi? Currently, only the Apache Felix container is supported.
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.
role	IDM distinguishes between two distinct role types - provisioning roles and authorization roles. For more information, see "*Working With Managed Roles*".
source object	In the context of reconciliation, a source object is a data object on the source system, that IDM scans before attempting to find a corresponding object on the target system. Depending on the defined mapping, IDM 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 IDM for the period during which IDM 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 IDM scans after locating its corresponding object on the source system. Depending on the defined mapping, IDM then adjusts the target object to match the corresponding source object.