PingDataGovernance™

Release 7.2

Server Administration Guide

Notice

PingDataGovernance™ Product Documentation

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Support

https://support.pingidentity.com/

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Chapter 1

Introduction

Topics:

The PingDataGovernance Server provides solutions to manage and monitor sensitive user data and account resources, helping enterprises avoid data breaches and meet regulatory standards.

Server overview

Giving applications unrestricted access to sensitive or regulated user data can lead to privacy violations, increased risk of breach, and lost customer trust. Most applications only require a subset of that data. PingDataGovernance Server provides policy-based protection for identity data, while ensuring end-user privacy and regulatory standards.

PingDataGovernance Server provides a single view of the customer by mapping account attributes from multiple back-end PingDirectory Server to SCIM Resource Types defined in the PingDataGovernance Server. Restricted access to consumer information is enforced through policy rules.

Server features

The PingDataGovernance Server provides the following features to securely manage account resources:

- **Support for multiple back-end servers**.The PingDataGovernance Server supports multiple directory servers, with native support for the PingDirectory Server and extension points for others. PingDirectory Servers serve as user stores to provide the resources that can be requested by clients. Clients can be written one time for access to the PingDataGovernance Server and receive data from any type of infrastructure back end.
- **Support for Open Banking**. The PingDataGovernance Server supports a subset of Open Banking APIs. A working Open Banking solution requires a PingDataGovernance Server, a PingDirectory Server, and a PingFederate instance. These products working together provide an implementation for an Open Banking Account Servicing Payment Service Provider (ASPSP), which is the role played by a bank or other entity providing payment accounts.
- **Support for General Data Protection Regulation (GDPR)**. GDPR 2016/679 is a European Union (EU) regulation on data protection and privacy for all individuals within the EU, and businesses outside of the EU that handle EU individual's data. The GDPR aims primarily to give control to citizens and residents over their personal data through the use and management of consents. PingDataGovernance Server can be used with the PingDirectoryProxy Server's Consent Service to meet the security, tracking, and auditing requirements of GDPR. See the *PingDirectory Server Consent Guide* for details about configuring the Consent Service.
- **Access to resources based on policy**. The PingDataGovernance Server ensures that data is provided to authorized clients through the use of defined policies. Policies can be based on industry rules, corporate policy, or consent granted by customers.
- **Application developer resources**.These enable client application developers to work with the PingDataGovernance Server APIs to design applications that can access identity attributes. For configuration examples, see the Ping Identity API site at *http://www.pingidentity.com/content/developer/en/explore.html*.

Deployment considerations

The PingDataGovernance Server accepts client requests to access user data. Clients are granted authorization through an identity provider and receive access through the PingDataGovernance Server SCIM endpoint. The PingDataGovernance Server validates an OAuth2 access token request and checks policy rules before allowing access to identity attributes.

Planning a PingDataGovernance Server deployment starts with defining what data can be accessed and updated from back-end PingDirectory Server user stores. User Stores have a schema defined to surface select identity attributes. SCIM Resource Types are then defined to enable access to attributes, and provide a unified view of identity data found in multiple PingDirectory Servers through Store Adapter Mappings.

Policies determine if a client can access requested attributes, based on the information provided with the request. Obligations within the policy can define conditions for access. Policies then determine the operations that can be performed on requested attributes.

Configuration overview

The PingDataGovernance Server configuration defines all server services, policies, applications, resources, and the mapping of data from one or more back-end PingDirectory Servers. Configuration can be done from the command line with the dsconfig tool or through the Administrative Console interface. All settings have associated help text in the interface and in the linked Configuration Guide. The Configuration Guide contains details and relationship specifics for all configuration objects and is available from the Administrative Console interface or from the `<server-root>/docs/index.html` page.

SCIM

The SCIM protocol is an application-level REST protocol for provisioning and managing identity data. The SCIM Schema provides a schema and extension for representing account information. Only those attributes defined in the SCIM Resource Type can be accessed through the PingDataGovernance Server. Any changes to these settings are saved to all PingDataGovernance Server in a topology.

- **SCIM Resource Types** – Defines attribute mapping from a SCIM schema to native attributes found in PingDirectory Server entries. A pass-through SCIM Resource Type can also be created to allow the addition of new attributes that are not mapped to any in a PingDirectory Server. The SCIM schema defines the attributes that comprise a SCIM Resource Type. The SCIM Resource Type determines the attributes that can be accessed by a client application.
- **SCIM Schemas** – Specifies the SCIM 2.0 schemas for data that can be accessed from back-end PingDirectory Server. Schemas provide the basis for creating SCIM Resource Types.

Data sources

Data sources are the servers that house the attributes governed by the PingDataGovernance Server.

- **External Servers** – Lists the LDAP PingDirectory Server instances that are configured with the PingDataGovernance Server.
- **LDAP Health Checks** – Checks the status of external LDAP servers on a regular basis, and examines failures to determine if the server has become unavailable. This is an advanced setting.
- **Load Balancing Algorithms** – Used to determine the appropriate LDAP external server to use to process a request. They may be used to provide improved availability and performance by distributing the workload across multiple back-end servers. This is an advanced setting.
- **Store Adapters** – Provides a PingDirectory Server interface to the PingDataGovernance Server. Changes or additions to Store Adapters are saved to all PingDataGovernance Servers in a topology. Third-party store adapters can be created with the Server SDK.

Policies

Policies define the rules for accessing attributes through the PingDataGovernance Server. Any changes to these settings are saved to all PingDataGovernance Server in a topology.

- **Access Token Validators** – Validates an access token used to access protected resources (OAuth2 scopes). Validators are used to decode tokens and return token metadata. The PingDataGovernance Server's local access token validator can be used, or a third-party token validator can be defined using the Server SDK.
- **Policy Information Providers** – Retrieves policy rules from a Policy Information Point (PIP) for policy evaluation. This is an advanced setting.
- **Policies** – Specifies the rules for how requested resources can be shared with client applications. The PingDataGovernance Server provides default policies that can be used or modified.
- **Policy Service** – Contains the properties that affect the overall operation of the PingDataGovernance Server Policy Decision Point (PDP).

System

System settings define communication, connection, and the criteria for triggering alarms regarding the server's resources. Changes to these setting can be saved to the local server or saved to a group of servers. Most are not mirrored across a topology, unless otherwise stated. See *General server configuration* on page 53 for more information.

- **Connection Handlers** – Defines the settings for handling all interaction with the clients, including accepting connections, reading requests, and sending responses.
- **Global Configuration** – Specifies the SMTP server, password policies, and LDAP request criteria configured for this server.
- **Key Manager Providers** – Manages the key material used to authenticate to another server. This is an advanced setting.
- **Key Pairs** – Defines the key pair that can be used to provide credentials for digital signatures. An existing key pair can be imported or a new one can be generated by the server. This configuration object is mirrored across a topology.
- **Locations** – Lists the locations in which servers that are accessed by the PingDataGovernance Server reside.
- **Trust Manager Providers** – Determine whether to trust certificates presented to the server. This is an advanced setting.
- **Trusted Certificates** – Specifies a trusted public key that can be used to verify credentials for digital signatures and public-key encryption. This configuration object is mirrored across a topology.

Web services and applications

These settings define the HTTP connection criteria for application access to the PingDataGovernance Server. Changes to these setting can be saved to the local server or saved to a group of servers. They are not mirrored across a topology. See *General server configuration* on page 53 for more information.

- **HTTP Configuration** – Defines configuration for the PingDataGovernance Server HTTP Service. This is an advance setting and cannot be changed other than to include stack traces in error pages.
- **HTTP Servlet Cross Origin Policies** – Defines the configuration for handling Cross- Origin HTTP requests using the Cross Origin Resource Sharing (CORS) protocol. An instance of HTTP Servlet Cross Origin Policy can be associated with multiple HTTP Servlet Extensions.
- **HTTP Servlet Extensions** – Defines classes and initialization parameters used by a servlet invoked by an HTTP connection handler.
- **Web Application Extensions** – Specifies the configuration settings for the Administrative Console and any other web applications that are configured to work with the PingDataGovernance Server.

LDAP administration and monitoring

These are all advanced settings to manage the local server's accounts, account requirements and security settings, and back-end configuration. Changes to these setting can be saved to the local server or saved to a group of servers. They are not mirrored across a topology. See *General server configuration* on page 53 for more information.

Logging, monitoring, and notifications

These settings define the notification criteria for system alerts, and the logging criteria for actions within the PingDataGovernance Server. Changes to these setting can be saved to the local server or saved to a group of servers. They are not mirrored across a topology. See *General server configuration* on page 53 for more information.

- **Alarm Manager** – Defines the severity of alarms to be raised.
- **Alert Handlers** – Specifies the Alert Handlers used to notify administrators of problems or events that occur in the PingDataGovernance Server.
- **Gauges** – Specifies server performance thresholds and circumstances that merit the raising of an alarm.
- **Gauge Data Sources** – Defines the source of gauge data obtained from the server, including available memory and disk space.

- **LDAP SDK Debug Logger** – Records debug messages generated by the LDAP SDK for Java. This is an advanced setting.
- **Log File Rotation Listeners** – Defines an action for the server to take before a log file is rotated out of service, such as copying the file to a new location. This is an advanced setting.
- **Log Publishers** – Defines the distribution of log messages from different loggers to a destination.
- **Log Retention Policies** – Defines how long logs should be kept.
- **Log Rotation Policies** – Specifies when log files should be rotated.
- **Monitor Providers** – Provides information about the state of the server or server components.

Chapter 2

Installation

Topics:

The PingDataGovernance Server installation requires few prerequisites, and can be deployed on virtualized and/or commodity hardware.

Installation prerequisites

The following are required before installing the PingDataGovernance Server:

- Java 8
- Minimum of 2 GB RAM
- PingDirectory Server 6.0, or later

Note: It is highly recommended that a Network Time Protocol (NTP) system be in place so that multi-server environments are synchronized and timestamps are accurate.

Set the file descriptor limit

The server allows for an unlimited number of connections by default, but is restricted by the file descriptor limit on the operating system. The file descriptor limit on the operating system can be increased with the following procedure.

Note: If the operating system relies on `systemd`, refer to the Linux operating system documentation for instructions on setting the file descriptor limit.

1. Display the current hard limit of the system. The hard limit is the maximum server limit that can be set without tuning the kernel parameters in the proc filesystem.

```
ulimit -aH
```

2. Edit the `/etc/sysctl.conf` file. If the `fs.file-max` property is defined in the file, make sure its value is set to at least 65535. If the line does not exist, add the following to the end of the file:

```
fs.file-max = 65535
```

3. Edit the `/etc/security/limits.conf` file. If the file has lines that set the soft and hard limits for the number of file descriptors, make sure the values are set to `65535`. If the lines are not present, add the following lines to the end of the file (before `#End of file`). Insert a tab between the columns.

```
* soft nofile 65535
* hard nofile 65535
```

4. Reboot the server, and then use the `ulimit` command to verify that the file descriptor limit is set to `65535` with the following command:

```
ulimit -n
```

After the operating system limit is set, the number of file descriptors that the server will use can be configured by either using a `NUM_FILE_DESCRIPTORS` environment variable, or by creating a `config/num-file-descriptors` file with a single line such as `NUM_FILE_ DESCRIPTORS=12345`. If these are not set, the default of 65535 is used. This is strictly optional if wanting to ensure that the server shuts down safely before reaching the file descriptor limit.

Note: For Red Hat 7 or later, modify the `20-nproc.conf` file to set both the open files and max user processes limits:

```
/etc/security/limits.d/20-nproc.conf

Add or edit the following lines if they do not already exist:
*       soft      nproc       65536
*       soft      nofile      65536
*       hard      nproc       65536
```

```
*       hard      nofile      65536
root    soft      nproc       unlimited
```

Set the maximum user processes

Red Hat Enterprise Linux Server/CentOS 6.x sets the default maximum number of user processes to 1024, which is lower than the setting on older distributions. This may cause JVM memory errors when running multiple servers on a machine because each Linux thread is counted as a user process.

At startup, the PingDataGovernance Server attempts to raise this limit to 16,383 if the value reported by `ulimit` is less. If the value cannot be set, an error message is displayed. Explicitly set the limit in `/etc/security/limit.conf`. For example:

```
*    soft    nproc   100000
*    hard    nproc   100000
```

The 16,383 value can also be set in the `NUM_USER_PROCESSES` environment variable, or by setting the same variable in `config/num-user-processes`.

Disable filesystem swapping

It is recommended that any performance tuning services like `tuned` be disabled. As root, change the current value in the operating system and by adding a line `vm.swappiness = 0` to `/etc/sysctl.conf` to ensure that the correct setting is applied when the system restarts.

If performance tuning is required, `vm.swappiness` can be set by cloning the existing performance profile then adding `vm.swappiness = 0` to the new profile's `tuned.conf` file in `/usr/lib/tuned/profile- name/tuned.conf`. The updated profile is then selected by running `tuned-adm profile customized_profile`.

Install the dstat utility on SuSE Linux

The `dstat` utility is used by the `collect-support-data` tool to gather support data. It can be obtained from the OpenSuSE project website. Perform the following steps to install the `dstat` utility:

1. Log in to the server as root.
2. Add the appropriate repository using the zypper tool.
3. Install the `dstat` utility:

```
$ zypper install dstat
```

Manage system entropy

Entropy is used to calculate random data that is used by the system in cryptographic operations. Some environments with low entropy may have intermittent performance issues with SSL-based communication. This is more typical on virtual machines, but can occur in physical instances as well. Monitor the `kernel.random.entropy_avail` in `sysctl` value for best results.

If necessary, update `$JAVA_HOME/jre/lib/security/java.security` to use `file:/dev/./urandom` for the `securerandom.source` property.

Set Filesystem Event Monitoring (inotify)

An event monitoring tool such as inotify can be configured for notifying processes about filesystem events (including file creation, deletion, and updates). The Linux system puts a limit on the number of inotify watches each user can receive. To increase the limit, edit `etc/sysctl.conf` to add a line:

```
fs.inotify.max_user_watches = 524288
```

Run the command:

```
$ sudo sysctl -w fs.inotify.max_user_watches=524288
```

Tune IO Scheduler

Using the correct IO scheduler can increase performance and reduce the possibility of database timeouts when the system is under extreme write load. For file systems running on an SSD, or in a virtualized environment, the `noop` scheduler is recommended. For all other systems, the `deadline` scheduler is recommended. To determine which scheduler is configured on your system, run this command:

```
$ cat /sys/block/<block-device>/queue/scheduler
```

For example:

```
$ cat /sys/block/sda/queue/scheduler
```

Changing the scheduler on a running system can be done with the following command:

```
$ echo 'deadline' > /sys/block/sda/queue/scheduler
```

The change will take effect after the system is restarted. The procedure for configuring a scheduler to use at startup depends on the version of Linux. See the Linux documentation for your specific version for the correct way to configure this setting.

Enable the server to listen on privileged ports

Linux systems provide 'capabilities' used to grant specific commands the ability to do things that are normally only allowed for a root account. Instead of granting the ability to a specific user, capabilities are granted to a specific command. It may be convenient to enable the server to listen on privileged ports while running as a non-root user.

The `setcap` command is used to assign capabilities to an application. The `cap_net_bind_service` capability enables a service to bind a socket to privileged ports (port numbers less than 1024). If Java is installed in `/ds/java` (and the Java command to run the server is `/ds/java/bin/java`), the Java binary can be granted the `cap_net_bind_service` capability with the following command:

```
$ sudo setcap cap_net_bind_service=+eip /ds/java/bin/java
```

The java binary needs an additional shared library (`libjli.so`) as part of the Java installation. More strict limitations are imposed on where the operating system will look for shared libraries to load for commands that have capabilities assigned. So it is also necessary to tell the operating system where to look for this library. This can be done by creating the file `/etc/ld.so.conf.d/libjli.conf` with the path to the directory that contains the `libjli.so` file. For example, if the Java installation is in `/ds/java`, the contents of that file should be:

```
/ds/java/lib/amd64/jli
```

Run the following command for the change to take effect:

```
$ sudo ldconfig -v
```

Install the JDK

The PingDataGovernance Server requires the Java 64-bit JDK. Even if Java is already installed, create a separate Java installation for use by PPingDataGovernance Server to ensure that updates to the system-wide Java installation do not inadvertently impact the PingDataGovernance Server.

Supported Platforms

The following platforms and versions are supported for this release.

Operating systems	Virtualization platforms	Java versions
• RedHat 6.6 • RedHat 6.8 • RedHat 6.9 • RedHat 7.4 • RedHat 7.5 • CentOS 6.8 • CentOS 6.9 • CentOS 7.4 • CentOS 7.5 • SUSE Enterprise 11 SP4 • SUSE Enterprise 12 SP3 • Ubuntu 16.04 LTS • Ubuntu 18.04 LTS • Amazon Linux • Windows Server 2012 R2 • Windows Server 2016	• VMWare vSphere & ESX 6.0 • KVM • Amazon EC2 • Microsoft Azure (Supported by Professional Services)	• OpenJDK 8.x 64-bit • OpenJDK 11.x 64-bit • Oracle JDK 8.x 64-bit • Oracle JDK 11.x 64-bit

Encryption keys

Encryption is configured during server installation. All PingDataGovernance Server instances must use the same set of definitions. Encryption setting definitions are managed using the `encryption-settings` tool.

If new encryption settings must be defined after initial setup, the new definition must be exported using the `encryption-settings` tool and imported on all PingDataGovernance Server instances. Only after the new definition is imported on all servers can the new definition be used for subsequent encryption operations.

User store overview

During the PingDataGovernance Server installation, at least one PingDirectory Server is defined to serve as a user store. The user store is a repository of user data, such as names, email addresses, and preferences, as well as user-specific metadata needed by the PingDataGovernance Server. For example, some user data may be stored in an LDAP directory server while other attributes may be stored in a relational database. SCIM Resource Types are defined to enable access to a user store's resources.

Ping license keys

License keys are required to install all Ping products. Obtain licenses through Salesforce or from https://www.pingidentity.com/en/account/request-license-key.html.

- A license is always required for setting up a new single server instance and can be used site-wide for all servers in an environment. When cloning a server instance with a valid license, no new license is needed.
- A new license must be obtained when updating a server to a new major version, for example from 6.2 to 7.0. Licenses with no expiration date are valid until the server is upgraded to the next major version. A prompt for a new license is displayed during the update process.
- A license may expire on particular date. If a license does expire, obtain a new license and install it using dsconfig or the Admin Console. The server will provide a notification as the expiration date approaches. License details are available using the server's `status` tool.

When installing the server, specify the license key file in one of the following ways:

- Copy the license key file to the server root directory before running setup. The interactive `setup` tool will discover the file and not require input. If the file is not in the server root, the `setup` tool will prompt for its location.
- If the license key is not in the server root directory, specify the --licenseKeyFile option for non-interactive setup, and the path to the file.

Install the PingDirectory Server

The PingDataGovernance Server requires at least one installed PingDirectory Server. The PingDataGovernance Server can be configured with multiple user stores.

Note: All sensitive data in the user store can be encrypted. When using the PingDirectory Server as the user store, server-level encryption can be enabled as described in the "Encrypting Sensitive Data" section in the *PingDirectory Server Administration Guide*.

The following information is needed during the installation:

- Server hostname
- LDAPS port
- Root DN and password
- Base DN
- l Location of user entries

All configuration settings can be later modified through the `dsconfig` tool.

1. Download the PingDirectory Server zip distribution, `PingDirectory-<version>.zip`.
2. Unzip the file in any location.

```
$ unzip PingDirectory-<version>.zip
```

3. Change to the top level PingDirectory folder.

```
$ cd PingDirectory
```

4. Run the `setup` command.

```
$ ./setup
```

5. Enter yes to agree to the license terms.
6. Enter the fully qualified host name or IP address of the local host, or press Enter to accept the default.

7. Create the initial root user DN for the PingDirectory Server, or accept the default, (cn=Directory Manager). This account has full access privileges.
8. Enter a password for this account, and confirm it.
9. To enable the Platform APIs over HTTPS, enter yes. These are the product's configuration APIs.
10. Enter the port to accept connections from HTTPS clients, or press Enter to accept the default. The default may be different depending on the account privileges of the user installing.
11. Enter the port to accept connections from LDAP clients, or press Enter to accept the default.
12. Type yes to enable LDAPS, or press Enter to accept the default (no). If enabling LDAPS, enter the port to accept connections, or press Enter to accept the default LDAPS port.
13. Type yes to enable StartTLS for encrypted communication, or press Enter to accept the default (no).
14. Select the certificate option for the server and provide the certificate location.
15. Choose the desired encryption for the directory data, backups, and log files from the choices provided:
    - Encrypt data with a key generated from an interactively provided passphrase. Using a passphrase (obtained interactively or read from a file) is the recommended approach for new deployments, and you should use the same encryption passphrase when setting up each server in the topology.
    - Encrypt data with a key generated from a passphrase read from a file.
    - Encrypt data with a randomly generated key. This option is primarily intended for testing purposes, especially when only testing with a single instance, or if you intend to import the resulting encryption settings definition into other instances in the topology.
    - Encrypt data with an imported encryption settings definition. This option is recommended if you are adding a new instance to an existing topology that has older server instances with data encryption enabled.
    - Do not encrypt server data.
16. Specify the base DN for the PingDirectory Server repository, for example dc=company,dc=com.
17. Select an option to populate the database.
18. If this machine is dedicated to the PingDirectory Server, tune the JVM memory allocation to use the maximum amount of memory the Aggressive option). This ensures that communication with the PingDirectory Server is given the maximum amount of memory. Choose the best memory option for the system and press Enter.
19. Enter yes to configure the server on startup and load the back end into memory before accepting connections, or press Enter to accept the default (no).
20. To start the server after the configuration, press Enter for (yes).
21. Review the Setup Summary, and enter an option to accept the configuration, redo it, or cancel.

PingDataGovernance Server installation tools

The PingDataGovernance Server provides a number of tools to install and configure the system.

- The `setup` tool performs the initial tasks needed to start the PingDataGovernance Server, including configuring JVM runtime settings and assigning listener ports for the PingDataGovernance Server's REST services and applications.
- The `create-initial-config` tool continues after setup and configures connectivity between the user store and the PingDataGovernance Server. During the process, the `prepare-external-store` tool prepares each PingDirectory Server to serve as a user store by the PingDataGovernance Server. Configuration can be written to a file to use for additional installations.
- After the initial configuration is finished, you can use the `dsconfig` tool and the Administrative Console for more granular configuration.

Install the PingDataGovernance Server

To expedite the setup process, be prepared to enter the following information:

- An administrative account for the PingDataGovernance Server.
- An available port for the PingDataGovernance Server to accept HTTPS connections from REST API clients.
- An available port for the Administrative Console's communication.
- An available port to accept LDAP client connections.
- Information related to the server's connection security, including the location of a keystore containing the server certificate, the nickname of that server certificate, and the location of a truststore.

1. Download the latest zip distribution of the PingDataGovernance Server software.
2. Unzip the file in any location.

```
$ unzip PingDataGovernance-<version>.zip
```

3. Change to the top level PingDataGovernance folder.
4. Run the `setup` command.

```
$ ./setup
```

5. Type yes to accept the terms of this license agreement.
6. The `setup` tool enables cloning a configuration by adding to an existing PingDataGovernance Server topology. For an initial installation, press Enter to accept the default (no). When adding additional PingDataGovernance Server instances, an existing peer can be chosen to mirror configuration.
7. Enter the fully qualified host name or IP address of the machine that hosts the PingDataGovernance Server, or press `Enter` to accept the default (local hostname).
8. Create the initial root user DN for the PingDataGovernance Server. This account has full access privileges. To accept the default (`cn=Directory Manager`), press `Enter`.
9. Enter and confirm a password for this account.
10. Define a port for PingDataGovernance Server REST APIs and the Administrative Console to accept HTTPS connections, or press `Enter` to accept the default.
11. Enter the port to accept LDAP client connections, or press Enter to accept the default.
12. To enable LDAPS connections press `Enter` and enter a port, or type `no`.
13. To enable StartTLS connections over regular LDAP connection press `Enter`, or type `no`.
14. Enter the certificate option for this server. If needed, the server will generate self-signed certificates that should be replaced before the server is put into production.
15. Choose the desired encryption for the directory data, backups, and log files from the choices provided:
    - Encrypt data with a key generated from an interactively provided passphrase. Using a passphrase (obtained interactively or read from a file) is the recommended approach for new deployments, and you should use the same encryption passphrase when setting up each server in the topology.
    - Encrypt data with a key generated from a passphrase read from a file.
    - Encrypt data with a randomly generated key. This option is primarily intended for testing purposes, especially when only testing with a single instance, or if you intend to import the resulting encryption settings definition into other instances in the topology.
    - Encrypt data with an imported encryption settings definition. This option is recommended if you are adding a new instance to an existing topology that has older server instances with data encryption enabled.
    - Do not encrypt server data.
16. If this machine is dedicated to the PingDataGovernance Server, tune the JVM memory to use the maximum amount of memory (the Aggressive option). If this system supports other applications, choose an appropriate option.
17. Enter a location name for this server. The location is used for failover purposes if this server belongs to a server group.
18. Enter an instance name for this PingDataGovernance Server, or press `Enter` to accept the default (<location> Server 1). The name must be unique in a topology and cannot be changed after it is configured.
19. Press `Enter` (yes) to start the server when the configuration is applied.

20. Review the configuration options and press `Enter` to accept the default (set up the server).

The installation will continue with the `create-initial-config` tool.

Configure the PingDataGovernance Server

The next set of steps in the setup process rely on the `create-initial-config` tool. The `setup` tool will continue with the `create-initial-config` tool to configure the PingDataGovernance Server. Having the following in place will expedite the configuration:

- At least one PingDirectory Server installed. Have the host name and communication port available.
- Any additional PingDirectory Servers that act as user stores. Only Ping PingDirectory Servers can be configured with this tool. Other user stores must be configured outside of this process. Have the host names and communication ports available.
- Locations for this and any other PingDataGovernance Servers for failover.

Note: The `create-initial-config` tool can install starter schemas that enable having a base schema for the product to use after installation and/or using reference applications. The schemas are `user` and `user-and-ref-apps`. If neither schema is installed, a custom schema and mapping SCIM resource type or a Pass-through SCIM resource type can be configured later.

After the initial setup and configuration, run the `dsconfig` tool later to make configuration adjustments. Perform the following steps to configure the PingDataGovernance Server:

1. Press `Enter` (yes) to continue with `create-initial-config`. If for some reason the initial configuration cannot be completed in one session, manually restart `create-initial-config` later.
2. Define the account used by the PingDataGovernance Server to communicate with an external User Store, or press Enter to accept the default (cn=Governance User, cn=Root DNs, cn=config).
3. Enter and confirm the account password.
4. Specify the type of security that the PingDataGovernance Server uses when communicating with all external store instances, or press `Enter` to accept the default (SSL).
5. Enter the host:port configured for the first PingDirectory Server. The connection is verified.
6. Select the location name for the PingDirectory Server (or user store server), or enter another location if not listed in the menu.
7. Confirm that the identified host should be prepared. If additional servers will be added as backups, select the Yes, and all subsequent servers option. This enables the identification of another server later in the configuration. The `prepare-external-store` tool can also be used to perform these tasks at a later time.
8. Enter the account and password needed to create the root user cn=Governance User ,cn=Root DNs, cn=config account on the PingDirectory Server. This is the root account created in the initial setup, such as the default (cn=Directory Manager). The PingDataGovernance Server sets up the DN and tests that it can access the account. This is also the account used to log into the Administrative Console.
9. To configure the initial user store, press `Enter` for (yes). The user store will be configured with a default Store Adapter and SCIM Resource Type, which will enable mapping of resources in the user store.
10. If there are additional PingDirectory Server locations, enter their host:port. If there are no additional servers to add, press `Enter` to continue.
11. Choose one of the predefined schemas (the standard user schema and optionally the reference application schema), or no schema. The instructions for configuration in this guide use the standard user schema.
12. Specify the base DN for locating user entries, such as ou=people, dc=example, dc=com and press `Enter`.
13. Review the configuration summary, and press `Enter` to accept the default (w) to write the configuration to a `dsconfig` batch file. The configuration is written to `<serverroot>/resource/governance-cfg.dsconfig`. Certificate files are written to `externalserver-certs.zip`.
14. Press `Enter` (yes) to confirm that the configuration should be applied to this PingDataGovernance Server and written to the `governance-cfg.dsconfig` file.

This completes the initial configuration for the PingDataGovernance Server. Run the `bin/status` tool to confirm that the PingDataGovernance Server is up and running.

Log in to the Administrative Console

After the server is installed, access the Administrative Console, https://<*host*>/console/login, to verify the configuration and manage the server. To log into the Administrative Console, use the initial root user DN specified during setup (by default `cn=Directory Manager`).

The `dsconfig` command or the Administrative Console can be used to create additional root DN users in `cn=Root DNs, cn=config`. These new users require the fully qualified DN as the login name, such as `cn=new-admin, cn=Root DNs, cn=config`. To use a simple user name (with out the `cn=` prefix) for logging into the Administrative Console, the root DN user must have the alternate-bind-dn attribute configured with an alternate name, such as "admin." If the Administrative Console needs to run in an external container, such as Tomcat, a separate package (`<server-root>/resource/admin-console.zip`) can be installed according to that container's documentation.

Install an additional PingDataGovernance Server in a topology

A PingDataGovernance Server instance can be cloned to serve as an additional server in a topology. Adding a server to an existing topology copies the original PingDataGovernance Server's local configuration and links the two configurations. The configuration of PPingDataGovernance Server's cluster items and the topology settings are automatically mirrored across servers in a topology. See *Topology configuration* on page 97 for more information.

Note: When setting up a new PingDataGovernance Server from an existing peer, the existing HTTP(S) connection handlers are not cloned. These connection handlers are created from scratch using default values of the new server and any specified port values.

1. Unpack the zip distribution in a folder different from the peer PingDataGovernance Server.
2. Run the `./setup` command in the <*server-root*> directory of the new server.
3. Accept the licensing agreement.
4. Enter yes to add this server to an existing PingDataGovernance Server topology.
5. Enter the host name of the peer PingDataGovernance Server from which the configuration will be copied.
6. Enter the port of the peer PingDataGovernance Server.
7. Choose the security communication to use to connect to the peer PingDataGovernance Server.
8. Enter the manager account DN and password for the peer PingDataGovernance Server. The connection is verified.
9. Enter the fully-qualified host name or IP address of the local host (the new server).
10. Enter the HTTPS client connection port for the PingDataGovernance Server, or press Enter to accept the default.
11. Select the option to install the Administrative Console application, if desired.
12. Enter the HTTPS connection port for the Administrative Console application, or press Enter to accept the default.
13. Enter the port on which the new PingDataGovernance Server will accept connections from LDAP clients, or press `Enter` to accept the default.
14. Choose a certificate option for this PingDataGovernance Server.
15. Choose the amount of memory to allocate to the JVM.
16. Choose the location for this server. The location of the peer is listed as an option, or a new location can be defined. Regardless, the new server will have its topology and cluster settings mirrored with its peer.
17. Enter a name for this server. The name cannot be changed after installation.
18. Press `Enter` to start the server after configuration.
19. Review the information for the configuration, and press `Enter` to set up the server with these parameters.
20. To write this configuration to a file, press `Enter` to accept the default (yes).

Server folders and files

After the distribution file is unzipped, the following folders and command line utilities are available:

Table 1:

Directories/Files/Tools	Description
ldif	Stores any LDIF files that have been created or imported.
import-tmp	Stores temporary imported items.
classes	Stores any external classes for server extensions.
bak	Stores the physical backup files used with the backup command-line tool.
update.bat, and update	The update tool for UNIX/Linux systems and Windows systems. (Update is not supported for version 6.0)
uninstall.bat, and uninstall	The uninstall tool for UNIX/Linux systems and Windows systems.
vendor_logo.png	The image file for the Ping Identity logo.
setup.bat, and setup	The setup tool for UNIX/Linux systems and Windows systems.
revert-update.bat, and revertupdate	The revert-update tool for UNIX/Linux systems and Windows systems.
README	README file that describes the steps to set up and start the server.
License.txt	Licensing agreement for the product.
legal-notices	Legal notices for dependent software used with the product.
docs	Provides the release notes, *Configuration Reference Guide* (HTML), API Reference, and all other product documentation.
metrics	Stores the metrics that can be gathered for this server and surfaced in the PingDataMetrics Server.
bin	Stores UNIX/Linux-based command-line tools.
bat	Stores Windows-based command-line tools.
webapps	Stores the Administrative Console .war file, the Authentication interface reference application's war file and source, and third-party licenses.
lib	Stores any scripts, jar files, and library files needed for the server and its extensions.
collector	Used by the server to make monitored statistics available to the PingDataMetrics Server.
locks	Stores any lock files in the back ends.
tmp	Stores temporary files.
resource	Stores the MIB files for SNMP and can include ldif files, make-ldif templates, schema files, dsconfig batch files, and other items for configuring or managing the server.

Directories/Files/Tools	Description
config	Stores the configuration files for the back ends (admin, config) as well as the directories for messages, schema, tools, and updates
logs	Stores log files.

Plan a scripted installation

An interactive installation of an PingDataGovernance Server uses the `setup` and `create-initial-config` tools. This is the recommended installation method and should be used when possible. A scripted installation can be performed, for scenarios that require a custom configuration or automated deployment. The resulting `governance-cfg.dsconfig` batch file, created with the `create-initial-config` tool, can then be used as a basis for scripted installations.

The following is performed by the `create-initial-config` tool during an interactive installation:

External store preparation

- For each PingDirectory Server, the `prepare-external-store` tool is run. This updates the PingDirectory Server's schema, creates a privileged service account for use by the PingDataGovernance Server with the DN cn=Governance User,cn=Root DNs,cn=config, and creates an administrative account.
- If the user store is comprised of LDAP directory servers, the prepare-external-store tool is run for every server that comprises the user store. This updates the server's schema, and creates a privileged service account for use by the PingDataGovernance Server with the DN cn=Governance User,cn=Root DNs,cn=config.

Server configuration with `dsconfig`

The `create-initial-config` command has a --dry-run option that can be used to generate the `governance-cfg.dsconfig` file in non-interactive, or interactive mode, without applying the configuration to the local server.

Note: The PingDirectory Server ACIs may need to be configured to grant access to elements of data, or specific LDAP controls using ACIs, depending on which PingDataGovernance Server services are used. See `resource/starter-schemas/README.txt` for sample ACIs.

Installation process

The following is a sample of the commands that should be included in a scripted installation:

1. Set up and configure one or more PingDirectory Servers. See *Install the PingDirectory Server* on page 18.
2. Run the PingDataGovernance Server `setup` command on the server that will host the PingDataGovernance Server.

```
$ ./setup --cli --no-prompt --acceptLicense --maxHeapSize 2g \
  --ldapPort 2389 --ldapsPort 2636 --httpsPort 8443 \
  --location Austin --instanceName server1 \
  --rootUserPassword <password> \
  --useJavaTrustStore <path>/keystores/truststore.jks \
  --useJavaKeystore <path>/keystores/server1keystore.jks \
  --trustStorePasswordFile <path>/keystores/truststore.txt \
  --keystorePasswordFile <path>/keystores/keystore.txt \
  --certNickname server-cert
```

The --trustStorePasswordFile option is only required if this server is expected to update the truststore with certificates of other servers in the topology.

The password for the private key associated with the certificate (server-cert) should be the same as the keystore password.

3. Run `prepare-external-store` for each user store.

```
$ ./prepare-external-store --no-prompt \
  --hostname ds1.example.com \
  --port 1636 --useSSL --trustStorePath <path>/keystores/truststore.jks
\
  --userStoreBaseDN "ou=people,dc=example,dc=com" \
  --governanceBindPassword <password> \
  --bindDN "cn=directory manager" \
  --bindPassword <password>
```

4. Run the `create-initial-config` tool.

```
$ ./create-initial-config --no-prompt \
  --port 2636 --useSSL --trustStorePath <path>/keystores/truststore.jks
\
  --bindDN "cn=Directory Manager" \
  --bindPassword <password> \
  --governanceBindPassword <password> \
  --externalServerConnectionSecurity useSSL \
  --userStoreBaseDN "o=people,dc=example,dc=com" \
  --userStore ds1.example.com:1636:Austin
```

To Start the Directory Server

Use bin/start-server to start the server.

```
$ bin/start-server
```

To Stop the Server

- Use the bin/stop-server tool to shut down the server.

```
$ bin/stop-server
```

Run the Server as a Microsoft Windows Service

The server can run as a Windows service on Windows Server 2012 R2 and Windows Server 2016. This enables log out of a machine without the server being stopped.

Updating Servers in a Topology

An update to the current release includes significant changes, and the introduction of a topology registry, which will store information previously stored in the admin backend (server instances, instance and secret keys, server groups, and administrator user accounts). For the admin backend to be migrated, the `update` tool must be provided LDAP authentication options to the peer servers of the server being updated.

The LDAP connection security option requested (either plain, TLS, StartTLS, or SASL) must be configured on every server in the topology. The LDAP credentials must be present on every server in the topology, and must have permissions to read from the admin backend and the config backend of every server in the topology. For example, a root DN user with the `inherit-default-privileges` set to true (such as the `cn=Directory Manager` user) that exists on every server can be used.

After enabling or fixing the configuration of the LDAP connection handler(s) to support the desired connection security mechanism on each server, run the following `dsframework` command on the server being updated so that its admin backend has the most up-to-date information:

```
$ bin/dsframework set-server-properties \
  --serverID serverID \
  --set ldapport:port \
  --set ldapsport:port \
  --set startTLSEnabled:true
```

The `update` tool will verify that the following conditions are satisfied on every server in the topology before allowing the update:

- When the first server is being updated, all other servers in the topology must be online. When updating additional servers, all topology information will be obtained from one of the servers that has already been updated. The `update` tool will connect to the peer servers of the server being updated to obtain the necessary information to populate the topology registry. The provided LDAP credentials must have read permissions to the config and admin backends of the peer servers.
- The instance name is set on every server, and is unique across all servers in the topology. The instance name is a server's identifier in the topology. After all servers in the topology have been updated, each server will be uniquely identified by its instance name. Once set, the name cannot be changed. If needed, the following command can be used to set the instance name of a server prior to the update:

  ```
  $ bin/dsconfig set-global-configuration-prop \
    --set instance-name:uniqueName
  ```
- The cluster-wide configuration is synchronized on all servers in the topology. Older versions have some topology configuration under `cn=cluster,cn=config` (JSON attribute and field constraints). These items did not support mirrored cluster-wide configuration data. An update should avoid custom configuration changes on a server being overwritten with the configuration on the mirrored subtree master. To synchronize the cluster-wide configuration data across all servers in the topology, run the `config-diff` tool on each pair of servers to determine the differences, and use `dsconfig` to update each instance using the `config-diff` output. For example:

  ```
  $ bin/config-diff --sourceHost hostName \
    --sourcePort port \
    --sourceBindDN bindDN \
    --sourceBindPassword password \
    --targetHost hostName \
    --targetPort port \
    --targetBindDN bindDN \
    --targetBindPassword password
  ```

If any of these conditions are not satisfied, the `update` tool will list all of the errors encountered for each server, and provide instructions on how to fix them.

Uninstall the PingDataGovernance Server

The PingDataGovernance Server provides an `uninstall` tool to remove the components from the system. If this instance is a member of a topology of PingDataGovernance Servers, the `uninstall` tool will remove it from the topology.

Note: If a PingDataGovernance Server is a member of a topology, and the `uninstall` tool is not used to remove it (it was shut down and deleted manually), it will not be removed from the topology registry. In this scenario, use the `bin/remove-defunct-server` tool to remove the instance from the topology.

To uninstall the PingDataGovernance Server:

1. From the server root directory, run the `uninstall` command.

```
$ ./uninstall
```

2. Select the option to remove all components or select the components to be removed.
3. To remove selected components, enter `yes` when prompted.

```
Remove Server Libraries and Administrative Tools? (yes / no) [yes]: yes
Remove Log Files? (yes / no) [yes]: no
Remove Configuration and Schema Files? (yes / no) [yes]: yes
Remove Backup Files Contained in bak Directory? (yes / no) [yes]: no
Remove LDIF Export Files Contained in ldif Directory? (yes / no) [yes]: no
The files will be permanently deleted, are you sure you want to continue?
 (yes / no)
[yes]:
```

4. Manually delete any remaining files or directories.

Reverting an Update

Once the PingDataGovernance Server has been updated, you can revert to the last version (one level back) using the `revert-update` tool. The `revert-update` tool accesses a log of file actions taken by the updater to put the filesystem back to its prior state. If you have run multiple updates, you can run the `revert-update` tool multiple times to revert to each prior update sequentially. You can only revert back one level. For example, if you have run the update twice since first installing the PingDataGovernance Server, you can run the `revert-update` command to revert to its previous state, then run the `revert-update` command again to return to its original state.

Reverting from Version 7.x to a Version Prior to 7.0

Reverting from version 7.0 or later to a pre-7.0 version can be done using the `revert-update` command with some extra steps. This is also the case when updating or reverting from a pre-6.2.0.2 version to 6.2.0.2 or later. These steps are listed when the `update` and `revert-update` tool are run as well. You may need to perform one or more of the following tasks, depending on your installation and configuration:

- When updating or reverting from 6.2.0.2 or later to a pre-6.2.0.2 version, indexes may need to be rebuilt. Older versions of the server use an incompatible format for Local DB Composite Indexes. To update a server with composite indexes in the previous format, delete these indexes and re-run the update. After the update is complete, recreate the indexes and use the `rebuild-index` tool to rebuild the indexes. The command for recreating an index will be in the "Undo" portion of the `logs/config-audit.log` file. If you wish to later revert to an older version, delete and recreate those composite indexes again after the revert has completed.
- When updating to 7.x for the first time, instance names will need to be set for each server in the topology if they were not previously set. This is done with the following `dsconfig` command:

```
$ bin/dsconfig --bindDN "cn=Directory Manager" \
  --bindPassword secret \
  --no-prompt set-global-configuration-prop \
  --set instance-name:<name>
```

- Topology information such as server instances, instance and secret keys, server groups, and administrator users have moved to the topology portion of the configuration from the `admin` backend. As long as new servers are not added to the topology after this update, the `revert-update` command can be used to return to the previous version. However, if new servers are added, then the restored `admin` backend of this server will not contain information about the new servers, and the local server will not be able to communicate with any other servers in the topology. New servers should not be added to the topology if reverting this update is a possibility.
- If new servers were added to the topology after the update, the new servers must be temporarily removed from the topology until all servers have been reverted to the previous version.
- When a server is reverted to a pre-7.x version, any servers in the topology using the topology portion of the configuration (rather than the `admin` backend) will need to know that the reverted server was downgraded to the

`admin` backend. This is done by running the following `dsconfig` command on one of the servers that has not been reverted:

```
$ bin/dsconfig set-server-instance-prop \
  --instance-name <Reverted server instance name> \
  --set server-version:<Version to which server is reverted>
```

- If the topology does not have a master server when this command is run, it will not succeed. In this case, one of the remaining updated servers in the topology must be made master with the following command. This will enable the chosen instance to run the first command successfully.

```
$ bin/dsconfig set-global-configuration-prop \
  --set force-as-master-for-mirrored-data:true
```

- The 7.x server version includes database changes that are not compatible with previous server versions (6.x or older). If you wish to later revert to an older version, the data must be exported to LDIF before performing the reversion. Re-import the data after the revert process has completed. In addition, the `changelogDb/` and `db/changelog/` directories in the reverted server root must be deleted after the revert has completed.

When starting up the server for the first time after a revert has been run, and the necessary extra steps have been completed, the server will display warnings about "offline configuration changes," but they are not critical and will not appear on subsequent start ups.

To Revert to the Most Recent Server Version

Use `revert-update` in the server root directory revert back to the most recent version of the server.

```
$ PingDataGovernance-old/revert-update
```

Chapter 3

Data access and mapping

Topics:

PingDirectory Servers provide the resources that can be accessed by clients. Attributes can be mapped from multiple PingDirectory Servers to create a unified identity in a SCIM Resource Type. The SCIM Resource Type is the component that makes resources available to clients.

Data components

When a PingDirectory Server is configured, a store adapter is installed to read and return native SCIM objects. Custom store adapters can be created for non-LDAP PingDirectory Servers with the Ping Identity Server SDK. See *Server SDK extensions* on page 84 for information. The attributes surfaced for each back-end store are mapped in SCIM Resource Types to enable a unified view of a user profile, and to make them available to clients. The PingDataGovernance Server provides full read/write access through the SCIM Resource Type (`/scim/v2/Me`). The access to these resources is subject to policy rules and restrictions.

Store adapter mappings

A SCIM Resource Type enables attribute mappings between the native store adapter schema and the SCIM schema. The store adapter mapping can contain additional information as to whether the native attribute is readable, writable, searchable, or authoritative. One must be authoritative. A SCIM Resource Type can map attributes from multiple PingDirectory Servers and determine which attributes are the authoritative resource for a user profile. See *SCIM resource properties* for details about policy evaluation.

Directory servers

The user stores provide data resources. One or more PingDirectory Servers, PingDirectoryProxy Servers, or third-party directory servers can serve as a user store. SCIM Resource Type mappings can be used to aggregate attributes from multiple PingDirectory Servers into a unified view.

When a store adapter is added to the PingDataGovernance Server's server configuration, a correlation attribute must be defined for SCIM Resource Types that are backed by multiple store adapters. The correlation attribute defines an attribute for each store adapter that is used to uniquely identify the same end user data across different store adapters. For example, if every PingDirectory Server stores a user's email address, and an email address can always be considered a primary key (that is, it is always unique per use), then each store adapter's email address attribute can be set as its correlation attribute.

Note: The PingDirectory Server ACIs may need to be configured to grant access to elements of data, or specific LDAP controls using ACIs, depending on which PingDataGovernance Server services are used. See `resource/starter-schemas/README.txt` for sample ACIs.

Primary and secondary store adapters

Store adapters contain the configuration that the PingDataGovernance Server uses to interact directly with external PingDirectory Servers. Every PingDirectory Server providing a distinct set of user data must have a store adapter entry in the configuration.

If the PingDataGovernance Server is used to aggregate user attributes from multiple PingDirectory Servers, secondary store adapters can be configured. "Primary store adapter" and "Secondary store adapter" designate how a SCIM Resource Type prioritizes user data lookups to multiple store adapters. The primary store adapter is always checked first when processing a request for a user resource, and then any secondary store adapters are checked. A user account effectively does not exist if a record does not exist for it on the primary store adapter. The primary store adapter should be used to store a user's core attributes, while a secondary store adapter can store additional attributes.

Defining correlation attributes

When handling a request for a particular user, the PingDataGovernance Server needs a way to correlate an entry in the primary store adapter with any related entries in secondary store adapters. This is done by correlating the value of an attribute shared across the store adapters using the secondary store adapter's primary-correlation-attribute and secondary-correlation-attribute properties. The correlation attribute should have a value that is unique for each user.

Note: When creating SCIM resources backed by secondary store adapters, the server automatically sets the secondary correlation attribute value if it does not already have a value from the resource create request.

For example, user entries can be correlated across store adapters by email address:

```
$ dsconfig create-secondary-store-adapter \
  --type-name Users \
  --adapter-name MarketingData \
  --set store-adapter:DemographicsStoreAdapter \
  --set primary-correlation-attribute:mail \
  --set secondary-correlation-attribute:emailAddress
```

Sample configuration

An environment may have two LDAP PingDirectory Servers with distinct sets of data. Set A may have user credentials and profile attributes, and is configured with the primary store adapter. Set B may have demographic data about these users, and is configured with the secondary store adapter. The following can be configured for this scenario:

1. Configure each server in Set A.

```
$ bin/dsconfig create-external-server \
  --server-name profile-server \
  --type ping-identity-ds \
  ...
```

2. Configure each server in Set B.

```
$ dsconfig create-external-server \
  --server-name demographics-server \
  --type ping-identity-ds \
  ...
```

3. Create LDAP load balancing algorithms.

```
$ dsconfig create-load-balancing-algorithm \
  --algorithm-name "Profile Store LBA" \
  --type failover \
  --set enabled:true \
  --set backend-server:profile-server
```

```
$ dsconfig create-load-balancing-algorithm \
  --algorithm-name "Demographics Store LBA" \
  --type failover \
  --set enabled:true \
  --set backend-server:demographics-server
```

4. Create store adapters.

```
$ dsconfig --adapter-name ProfileStoreAdapter \
  --type ldap \
  --set enabled:true \
  --set "load-balancing-algorithm:Profile Store LBA"
  ...
```

```
$ dsconfig --adapter-name ProfileStoreAdapter \
  --type ldap \
```

```
  --set enabled:true \
  --set "load-balancing-algorithm:Demographics Store LBA"
  ...
```

5. Designate the primary store adapter.

```
$ dsconfig create-scim-resource-type \
  --type-name Users \
  --type mapping \
  --set enabled:true \
  --set endpoint:Users \
  --set primary-store-adapter:ProfileStoreAdapter \
  --set core-schema:urn:example:schemas:Profile:1.0 \
  --set optional-schema-extension:urn:example:schemas:Demographics:1.0
```

6. Designate the secondary store adapter and correlation attributes.

```
$ dsconfig create-secondary-store-adapter \
  --type-name Users \
  --adapter-name MarketingData \
  --set store-adapter:DemographicsStoreAdapter \
  --set primary-correlation-attribute:mail \
  --set secondary-correlation-attribute:emailAddress
```

SCIM schemas

Each SCIM Resource Type maps to one core SCIM schema and optional extension schemas. SCIM schemas are used to define the resources that can be retrieved from a back-end PingDirectory Server. Each SCIM Resource Type represents one type of resource, such as "user" or "account," and the schema defines the attributes of that resource.

Store adapter mappings

The PingDataGovernance Server uses store adapter mappings to determine which store adapter handles which attribute from the SCIM schema. For cases in which an attribute can be found on multiple store adapters, one store adapter mapping should be created for each combination of attribute and store adapter. One of these mappings must have the shared attribute set as authoritative. This designates the store adapter that will be the authoritative source when multiple possible values are found across a set of store adapters.

In the following example, the SCIM attribute urn:pingidentity:schemas:sample:profile:1.0:topicPreferences is mapped to the LDAP attribute ubidXTopicPreferenceJSON from the Marketing PingDirectory Server adapter:

```
$ bin/dsconfig create-store-adapter-mapping \
  --type-name Users \
  --mapping-name topicPreferences \
  --set secondary-store-adapter:DemographicsStoreAdapter \
  --set scim-resource-type-
attribute:urn:example:schemas:Demographics:1.0:topicPreferences
 \
  --set store-adapter-attribute:ubidXTopicPreferenceJSON \
  --set authoritative:true
```

SCIM attribute search considerations

To provide paging and sorting, the PingDataGovernance Server holds an entire search result set in memory while it processes a SCIM search request. This is true for searches that do not request paging or sorting. The SCIM Resource Type lookthrough-limit property sets an upper bound for searches, so that clients do not exhaust the server resources. If the number of search results for a given request exceeds this value, an error is returned to the client indicating that the search matched too many results. A request that causes an unindexed search is also restricted to the size limit of the lookthrough-limit setting.

The PingDataGovernance Server attempts to find a single store adapter that can process the provided search filter. The primary store adapter is checked first to see if it can process the search filter. If it cannot, the secondary store adapters are consulted in no particular order. The first store adapter capable of processing the search filter is chosen. The store adapter must be able to return a superset of possible matches for the filter. The attributes in the search filter must correspond to at least one searchable native attribute in the store adapter. If the SCIM Resource Type is a Mapping SCIM Resource Type, the store adapter mapping for the search filter attribute must be marked as searchable.

If no store adapters can process the search, the PingDataGovernance Server returns an error. For each candidate search result from a store adapter, the PingDataGovernance Server assembles a complete SCIM resource by retrieving the native resource for every other store adapter using the store adapter correlation attributes (set when secondary store adapters are defined) and merging them together. Each resulting candidate SCIM resource is checked to see if it matches the provided search filter and is discarded if it does not match.

Maintain username uniqueness

The PingDataGovernance Server's default schema configuration uses "uid" as the RDN attribute of user DNs, which ensures that all uid values are unique for that branch of the DIT. In the default configuration, uid is recognized as a user's username. The PingDataGovernance Server store adapter mapping for the userName attribute of the default starter schema relies on this.

It may be the case that the attribute used for the username is also an RDN attribute in the PingDirectory Server. If every entry resides on the same branch, these attribute values will always be unique. Any configuration changes that do not maintain this structure must ensure that usernames are unique. The PingDirectory Server provides the attribute uniqueness plugin that can be used if configuration changes are required. See the *PingDirectory Server Administration Guide*.

Define SCIM resource types

SCIM Resource Types provide a unified view of resources between the PingDataGovernance Server and one or more underlying PingDirectory Servers, and correspond to the SCIM 2.0 SCIM Resource Type. SCIM Resource Types determine what resources can be accessed from a PingDirectory Server. Each SCIM Resource Type represents one resource, such as "user" or "account" and the schema defines the attributes of that resource.

Note: When mapping attributes, PingDirectory Server attributes and SCIM Resource Type attributes must be of compatible types. For example, an attribute with an integer value must be mapped to another attribute with an integer value. An attribute with a string value can only be mapped to attributes with boolean, integer, or date-time if it can be parsed.

There are two SCIM resource types: Pass-through SCIM and Mapping SCIM. A Mapping SCIM resource type relies on a SCIM schema, which is installed with the configuration of a user store on a PingDirectory Server.

Pass-through SCIM resource type

This type of SCIM Resource Type simply exposes the primary store adapter’s data as core attributes, while secondary store adapter’s data are exposed as schema extensions. No schema needs to be defined at the SCIM Resource Type and all schema enforcement is at the responsibility of the store adapters. Since no schema is defined at the SCIM

Resource Type, attribute mappings are not defined. If the configured store adapter exposes a schema, it will be enforced as the core or extension schemas for the SCIM Resource Type.

Mapping SCIM resource type

Attributes associated with a SCIM Resource Type are configured by specifying at least one core schema and one or more schema extensions. The core schema defines attributes that can appear at the root level of the SCIM resource exposed by the SCIM Resource Type. Schema extensions define attributes that are namespaced by the schema's URI. Schema extensions can be optional or required. When processing client requests, the SCIM resource from the client is first checked against the schemas defined for the SCIM Resource Type (core or extension). The request is then mapped to a store adapter object, using the store adapter mappings, and then processed.

Create a SCIM resource type

After user stores and store adapters are in place, SCIM Resource Types can be defined to provide a unified view of identity data found in multiple PingDirectory Servers. The SCIM Resource Type determines the attributes that can be accessed by a client.

The following is a sample command for creating a mapping SCIM Resource Type:

```
$ bin/dsconfig create-scim-resource-type \
  --type-name Users \
  --type mapping \
  --set "description:Users Resource Type" \
  --set enabled:true \
  --set endpoint:/Users \
  --set primary-store-adapter:UserStoreAdapter \
  --set core-schema:urn:pingidentity:schemas:User:1.0 \
  --set required-schema-
extension:urn:pingidentity:schemas:sample:profile:1.0
```

SCIM Resource Types can also be configured in the Administrative Console through **SCIM** -> **SCIM Resource Types**.

Create a Mapping SCIM resource type

The following information is used to configure a Mapping SCIM Resource Type:

- A name for this SCIM Resource Type.
- An optional description for the SCIM Resource Type.
- The SCIM Resource Type's endpoint HTTP address, which will be relative to the `/scim/v2` base URL.
- A primary store adapter to persist the data for this SCIM Resource Type.
- The primary store adapter attribute to use as the value for the SCIM object ID. The object ID is a unique, immutable identifier for fetch, update, and delete operations on an object. The entryUUID attribute is the default for an LDAP store adapter.
- A look-through limit for the maximum number of resources that the SCIM Resource Type should scan when processing a search request. This prevents a client from taking too many of the server's resources for a single search.
- The core schema for the primary store adapter and any extension schemas.

Create a Pass Through SCIM Resource Type

The following information is used to configure a Pass Through SCIM Resource Type:

- A name for this SCIM Resource Type.
- An optional description for the SCIM Resource Type.
- The SCIM Resource Type's endpoint HTTP address, which will be relative to the `/scim/v2` base URL.
- A primary store adapter to persist the data for this SCIM Resource Type.

- The primary store adapter attribute to use as the value for the SCIM object ID. The object ID is a unique, immutable identifier for fetch, update, and delete operations on an object. The entryUUID attribute is the default for an LDAP store adapter.
- A look-through limit for the maximum number of resources that the SCIM Resource Type should scan when processing a search request. This prevents a client from taking too many of the server's resources for a single search.

Edit attribute and sub-attribute properties

Attribute properties in the schema can be configured to change the actions that can be performed, and when an attribute is returned to a requesting client. If the attribute contains sub-attributes, those can be configured as well.

```
$ bin/dsconfig set-scim-attribute-prop \
  --schema-name urn:pingidentity:schemas:User:1.0 \
  --attribute-name displayName \
  --set "description:User's name."
  --set required:true \
  --set case-exact:true \
  --set mutability:read-only
```

This can be configured in the Administrative Console by editing a schema in SCIM -> SCIM Schemas. Select a schema and edit any of the attributes listed. The following can be configured for an attribute or sub-attribute:

- An optional description of the attribute.
- The attribute type, which can be:
  - string - A sequence of zero or more Unicode characters encoded using UTF-8.
  - boolean - The literal true or false.
  - datetime - A date and time encoded as a valid xsd:dateTime (for example, 2008-01-23T04:56:22Z).
  - decimal - A real number with at least one digit to the left and right of the period.
  - integer - A decimal number with no fractional digits.
  - binary - Arbitrary binary data.
  - reference - A URI for a resource. A resource can be a SCIM resource, an external link to a resource (such as a photo), or an identifier such as a URN. The reference-type property must be specified for these attributes.
  - complex - A singular or multi-valued attribute whose value is a composition of one or more sub-attributes.
- Specify if the attribute is required.
- Specify if the attribute is case-sensitive.
- Specify if the attribute can have multiple values.
- Specify suggested canonical values that can be used (such as work and home).
- The circumstances under which the values of the attribute can be written (mutability). Values include:
  - read-only - The attribute cannot be modified.
  - read-write - The attribute can be updated and read.
  - immutable - The attribute may have its initial value set, but cannot be modified after.
  - write-only - The attribute can be updated but cannot be read.
- The circumstances under which the values of the attribute are returned in response to a request. Values include:
  - by-default - The attribute is returned by default in all SCIM responses where attribute values are returned.
  - upon-request - The attribute is returned in response to any PUT, POST, or PATCH operations if the attribute was specified by the client (for example, the attribute was modified).
  - always - The attribute is always returned.
  - never - The attribute is never returned.
- The SCIM Resource Types that can be referenced. This property is applicable only for attributes that are of type reference. Valid values are a defined SCIM Resource Type, external indicating the resource is an external resource

(such as a photo), or uri indicating that the reference is to a service endpoint or an identifier (such as a schema urn).

- If the attribute is complex and has sub-attributes, they can be edited as well with these values.

Edit store adapter mappings

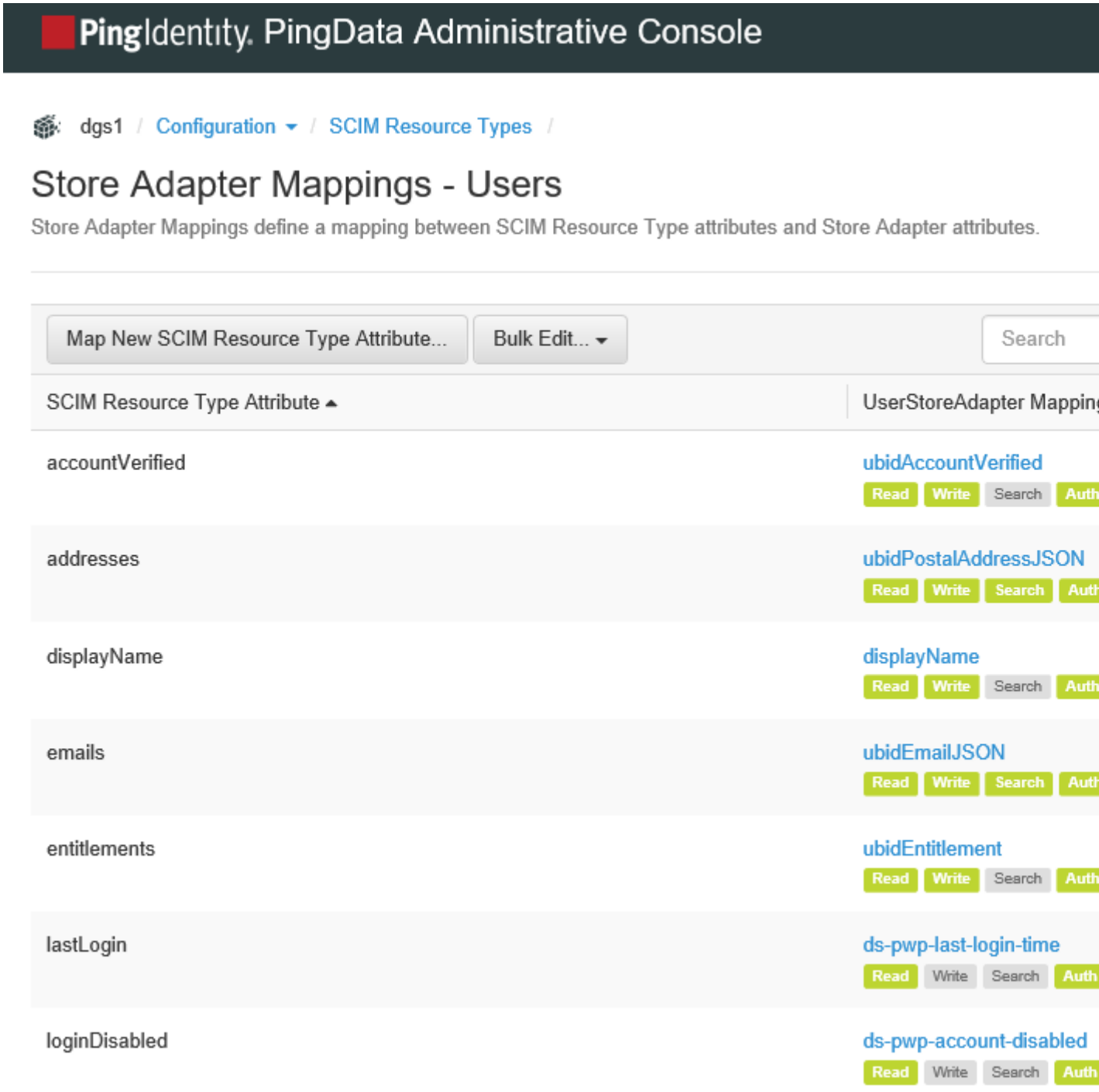
Store adapters are designed to surface the schema of a back-end Directory Server. Store adapter mappings map SCIM Resource Type attributes and store adapter attributes. When the PingDataGovernance Server is installed with a Ping PingDirectory Server, the schema attributes are automatically mapped to a User SCIM Schema Resource Type.

Note: If the SCIM Resource Type attribute name changes, make sure that scopes and OpenID Connect Claims are updated to reflect the change.

The following is a sample command for editing a store adapter attribute mapping:

```
$ bin/dsconfig set-store-adapter-mapping-prop \
  --type-name Users \
  --mapping-name communicationOpts \
  --set store-adapter-attribute:ubidXCommunicationOptJSON \
  --set writable:false \
  --set searchable:true \
  --reset authoritative
```

Store adapter mappings can also be configured in the Administrative Console through **SCIM** -> **SCIM Resource Types**. Click **Actions** -> **Edit Store Adapter Mappings** for a SCIM Resource Type. The following is displayed:



Individual attributes can be changed, or all can be edited by clicking **Bulk Edit**. For each attribute, the following can be configured:

- The store adapter attribute that is mapped to the SCIM Resource Type attribute.
- Readable – The SCIM Resource Type can read this attribute.
- Writable – The SCIM Resource Type can write to this attribute.
- Searchable – This specifies whether the attribute is efficiently searchable in the underlying PingDirectory Server. Indexed PingDirectory Server attributes determine what attributes (from the SCIM Resource Type Schema) can be used in a SCIM filter when performing a query. If an attribute is not indexed in the PingDirectory Server, it should not be marked as Searchable here.

- Authoritative – If there are multiple mappings for this attribute (from multiple PingDirectory Servers), one must be marked Authoritative.

Complex attribute mappings

For searches involving sub-attributes of SCIM attributes that are mapped to LDAP JSON attributes in the PingDirectory Server, the sub-attribute field names in the search filter are treated case-sensitively because the PingDirectory Server treats them this way. This is a departure from the SCIM 2.0 specification, where attribute names in search filters are caseinsensitive.

For example, the SCIM attribute name has the sub-attribute familyName. The SCIM attribute name is mapped to the LDAP JSON attribute scimName. The search filter NAME.FAMILYNAME eq "Zweig" will not return a search result for an entry containing the specified value Zweig in the familyName sub-attribute. A search result for this entry is returned if the filter is specified instead as NAME.familyName. This is because the top-level attribute can be matched case-insensitively but the sub-attribute can only be matched case-sensitively.

Client-specific SCIM attributes

Some environments may find it useful to designate a namespaced, schema-less portion of a SCIM user resource, in which a client can store its data. For example, a resource type could be configured such that an application may write any previously undefined attributes that are prefixed with urn:customApp1.

To enable this, the data store schema must first have a single-valued JSON attribute defined to hold application-specific attributes. For example, for an LDAP attribute called customApp:

```
customApp: { "urn:customApp1":{ "wine":["Napa Cabs","French Burgundy","Lodi
 Zinfandel"],
"age":"2000-2010" } }
```

This value should appear in the SCIM resource as follows:

```
'urn:customApp1' : {
'wine' : [ 'Napa Cabs', 'French Burgundy', 'Lodi Zinfandel' ],
'age' : '2000-2010'
}
```

The following is a command line sample of the steps needed to configure this type of functionality in the PingDataGovernance Server, or this process can be done in the Administrative Console.

1. Create a store adapter mapping from "*" (SCIM) to "customApp" (LDAP). Using a wildcard SCIM attribute, client-specific SCIM attributes do not need to be defined in advance. To map only attributes from a single SCIM schema to an LDAP attribute, use a schema-specific SCIM wildcard such as urn:myExtensionSchema:*.

   ```
   $ bin/dsconfig create-store-adapter-mapping \
     --type-name "Users" \
     --mapping-name "customAppWildcard" \
     --set "scim-resource-type-attribute:*" \
     --set store-adapter-attribute:customApp
   ```

2. Set the SCIM Resource Type's schema-checking-option property to allow-undefined-attributes.

   ```
   $ bin/dsconfig set-scim-resource-type-prop \
     --type-name "Users" \
     --add schema-checking-option:allow-undefined-attributes
   ```

3. Define a wildcard scope that uses the client-specific namespace urn:customApp1 as a prefix. Because the mapping is a wildcard, this prevents the client from reading or writing any user attribute, and client-specific attributes do not need to be defined in advance.

```
$ bin/dsconfig create-oauth2-scope \
  --scope-name Wildcard-Scope \
  --type authenticated-identity \
  --set "consent-prompt-text:Save application data to your account!" \
  --set "resource-attribute:urn:customApp1:*" \
  --set resource-operation:modify \
  --set resource-operation:retrieve
```

4. Create the client and assign the wildcard scope to it.

```
$ bin/dsconfig create-oauth2-client \
  --client-name "App1" \
  --set client-id:<App-ID> \
  --set client-secret:<secret> \
  --set grant-type:authorization-code \
  --set grant-type:implicit \
  --set scope:openid \
  --set scope:email \
  --set scope:Wildcard-Scope \
  --set redirect-url:https://company.com:<port>/client/
```

Access data

The SCIM endpoint provides full operations on user profile data through the SCIM protocol. The endpoint's URL context path is `/scim/v2/{name}`. Each SCIM resource, specified in the SCIM Schema, is exposed as an endpoint. For example, the URL path `/scim/v2/Users` would be used to access the Users SCIM resource. Access to resources is determined by the XACML policies that are configured for the PingDataGovernance Server. If a request to the PingDataGovernance Server is delivering partial results, it may be due to policy settings. See *SCIM resource properties*.

The PingDataGovernance Server SCIM endpoint enables applications to perform actions on an end user's resources, if XACML policies permit. The following are important to consider when using the SCIM endpoint:

`/Me`. SCIM supports a special endpoint to retrieve attributes of the currently authenticated user without knowing the SCIM ID. Retrieve attributes of the currently authenticated user with the following:

```
/scim/v2/Me
```

Chapter 4

Token access

Topics:

Each client request is processed by policies, which determine whether requested scopes can be granted. The PingDataGovernance Server validates the access tokens included with the client request to ensure that only authorized resources are accessed.

PingDataGovernance Server endpoint for OAuth2 clients

The Data Governance Server provides a SCIM REST endpoint for client access. The following list presents a summary of the endpoints that may be called by a client application requesting user profile data. See `<server-root>/docs/restapi/index.html` for details.

Table 2: Data Governance Server endpoint for clients

Endpoint	Description
/scim	
`/scim/v2/<name>`	This is the SCIM 2.0 protocol endpoint used to retrieve a specified SCIM Resource Type, where *<name>* is the SCIM Resource Type being accessed. This endpoint supports all SCIM operations and implements its access control through the XACML policies. A request to this endpoint requires a scope that includes a resourceOperations value that represents the desired action.

Access token validation

Access Token Validators validate tokens submitted by client applications requesting access to protected resources. Any number of validators can be configured for the PingDataGovernance Server. Two types of access token validators are available. One for PingFederate tokens and another for JWT. Server SDK extensions can be installed to enable the PingDataGovernance Server to accept access tokens issued by other identity providers.

A third-party Access Token Validator is responsible for decoding an incoming access token and returning token metadata that is similar in content to that specified by RFC 7662. Metadata includes whether the token is valid and what scopes are granted to the token. This information is passed to the PingDataGovernance Server policy engine, which is responsible for determining whether the token should be accepted and if it is sufficient to allow the incoming request to be processed.

When an access token is presented with a resource request, the PingDataGovernance Server cycles through each configured Access Token Validator until it finds one that can decode the token.

PingFederate Access Token Validator

Before configuring a PingFederate Access Token Validator on the PingDataGovernance Server, complete the following tasks on the PingFederate instance:

1. Create a client on the PingFederate instance that represents the PingDataGovernance Server as a resource server.
2. Set the Allowed Grant Types for this client to include the Access Token Validation grant type.
3. Record the PingDataGovernance Server client ID and client secret for use when configuring the access token validator on the PingDataGovernance Server.

To configure an instance of the PingFederate Access Token Validator on the PingDataGovernance Server, have the following information:

- The base URL of the PingFederate instance (such as https://myPingFedInstance.example.com:9031).
- The client ID and client secret for the validator to use when validating the token with PingFederate.

Trust and key managers may also need to be configured for communication with the PingFederate server over SSL. See *Public and private key store configuration* on page 91.

If the access token validator will support tokens obtained through OAuth2 grant types other than Client Credentials, the token owner must be mapped to a user defined within the PingDataGovernance Server's user store. This is done by creating one or more Token Resource Lookup Methods for the access token validator. Each Token Resource Lookup Method references a SCIM Resource Type and SCIM filter that are used by the PingDataGovernance Server to look up the local user that owns the access token. The SCIM filter is used to associate a token property (such as the externalId or sub claim) to a SCIM user with matching attribute(s). See the *Configuration Reference Guide* or the `dsconfig` tool help.

JWT token validation

The JWT Access Token Handler enables self introspection of an access token. The JWT token can be encrypted or plain text.

The PingDataGovernance Server supports creating a key pair using RSA algorithms (Key Pairs). The public key needs to be exported from the PingDataGovernance Server and added to an instance of PingFederate or another client's Access Token Manager and configured to use this public key to encrypt the access token.

To verify signatures, the validator needs the public key(s) of the entity that is issuing access tokens. Those public keys can either be imported (as Trusted Certificates) or obtained from the JWKS endpoint of the access token issuer. Multiple keys are supported.

A mapping mechanism for sub and client_id is also available, if PingFederate or other client's Access Token Manager is configured to provide this information in non-standard claims. All JWT or custom claims should be made available in the request context for tokens.

Chapter 5

Configure policies

Topics:

Policies are the rules that determine what resources may be accessed by client applications. Policies include the criteria by which access decisions are made using targets, rules, conditions, obligations, and a rule combining algorithm. Default policies are available, or custom policies can be written.

Policy overview

Policies determine the scopes that can be accessed by requesting clients through the use of an access token, and the operations on attributes within the scope that are allowed. Policy creation must balance the privacy requirements of the organization with the resource access requirements of the clients. Policies are based on the eXtensible access control markup language (XACML) as specified in the *OASIS Committee Specification 01, eXtensible access control markup language (XACML) Version 3.0*. The targets, rules, conditions, and rule combining algorithms are expressed using JEXL. The native language features of JEXL duplicate a large subset of functions defined by XACML and provide a more concise mechanism for defining policy conditionals. See *#unique_51* for details about policy components.

Policies are evaluated by the PingDataGovernance Server in response to the following requests made by clients:

- All SCIM requests:
  - Search request
  - Get request
  - Update request
  - Create request
  - Delete request
- A request to the PDP endpoint

To create policies that will work as expected, or to create clients that can access data correctly, review the parameters and attributes that will be included in the policy.

Requesting operations through SCIM

The PingDataGovernance Server uses policies to determine whether a request for resources should be granted given the scopes defined in the access token. Obligations can be used to define conditions for limiting access to certain attributes. The requested attributes are returned to the client, and any permitted operation (such as adding or modifying an address) is performed.

Advice

When a policy is applied to a request or response, the policy result may include one or more advices. An advice is a directive that instructs the policy enforcement point (the PingDataGovernance Server) to perform additional processing in conjunction with an authorization decision. Advices allow PingDataGovernance Server to do more than simply allow or deny access to an API resource. For example, an advice may cause a specific set of fields to be removed from a response.

An advice can be added directly to a single policy or rule, or it can be defined in the Toolbox and used with multiple policies or rules. Advices have the following significant properties:

Advice property	Description
Name	A name for this advice
Obligatory	If true, fulfilling the advice is required as a condition of authorizing the request. If PingDataGovernance Server is unable to fulfill an obligatory advice, the operation will fail and an error is returned to the client application. If a non-obligatory advice cannot be fulfilled, an error is logged but the client's requested operation will continue.
Code	Identifies the advice type. This must correspond to an advice ID defined in the PingDataGovernance Server configuration.

Advice property	Description
Aplies To	Determines which policy decisions (such as Permit or Deny) will cause the advice to be included with the policy result.
Payload	A set of parameters governing what the advice will do when it is applied. The payload value varies depending on the advice type.

PingDataGovernance Server supports the following advice types. Custom advice types can be created using the Server SDK.

Add Filter Advice

The Add filter Advice (advice ID `add-filter`) is applicable to SCIM requests, and can be used to add administrator-required filters to SCIM search queries. This advice provides a way to put restrictions on the resources that may be returned to an application that is generally allowed to use SCIM search requests. The filters specified by this advice will be added with any filter that is included in the SCIM request.

The payload for this advice is a string representing a valid SCIM filter. This filter may contain multiple clauses separated by `AND` or `OR`. If multiple instances of Add Filter Advice are returned from policy, they are added together (`AND`) to form a single filter that will be passed with the SCIM request. If the original SCIM request body also included a filter, that filter is added with the filter generated from policy to form the final filter value.

Allow Attributes Advice

The Allow Attributes Advice (advice ID `allow-attributes`) is applicable to all requests, and specifies the attributes that can be modified or created by a JSON request body for `POST`, `PUT`, or `PATCH`.

The payload for this advice is a JSON array of strings. Each string is interpreted as the name of a resource attribute that the client is allowed to modify, create, or delete. If the client request contains changes for any attribute not named by this advice, the request is denied with a 403 Forbidden response. If multiple instances of Allow Attributes Advice are returned from policy, they are combined such that the union of all attributes named are allowed. The wild card string "*", if present in the array, indicates that any attributes can be modified by the request, and will override any other paths present in the policy result.

Denied Reason Advice

The Denied Reason Advice (advice ID `denied-reason`) is applicable to all requests, and allows a policy writer to provide an error message containing the reason that a request was denied.

The payload for this advice is a JSON object string with three fields. The `status` field is optional and contains the HTTP status code that should be returned to the client. If not present, the default status is 403 Forbidden. The `message` field contains a short error message that is returned to the client. The optional `detail` field may contain more detailed error information. The following example could be returned for a request made with insufficient scope:

```
{"status":403, "message":"insufficient_scope",
"detail":"Requested operation not allowed by the granted OAuth scopes."}
```

Exclude Attributes Advice

The Exclude Attributes Advice (advice ID `exclude-attributes`) is applicable to all requests, and specifies attributes that must be excluded from a JSON response.

The payload for this advice is a JSON array of strings. Each string is interpreted as a SCIM (JSON) path into the response body of the request being authorized. Portions of the response selected by each SCIM path are removed

from the response before it is returned to the client. For example, the following would instruct PingDataGovernance Server to remove the attributes `secret` and `data.private`:

```
["secret","data.private"]
```

Filter Response Advice

The Filter Response Advice (advice ID `filter-response`) is applicable to SCIM requests, and directs PingDataGovernance Server to recursively invoke policy over each item of a JSON array that is contained within an API response. This advice enables policies, when presented with a request to permit or deny a multi-valued response body, to require that a separate policy request be made to determine whether the client is permitted access to each individual resource that is returned in a JSON array.

The payload for this advice is a JSON object with the following fields:

Field	Required	Description
`Path`	Yes	The path to a JSON array within the API's response body. The advice implementation will iterate over the nodes in this array, making a policy request for each node.
`Action`	No	The value to pass as the "action" parameter on subsequent policy requests. If not specified, the action from the parent policy request is used.
`Service`	No	The value to pass as the "action" parameter on subsequent policy requests. If not specified, the action from the parent policy request is used.
`ResourceType`	No	The value to pass as the "service" parameter on subsequent policy requests. If not specified, the service value from the parent policy request is used.

On each recursive policy request, if policy returns a DENY decision, then that specific array node is removed from the response. If the policy request returns a PERMIT decision with additional advice, then that advice will be fulfilled in the context of the recursive request. For example, this would allow policy to decide for each array item whether to exclude or obfuscate particular attributes.

For a response containing complex data including arrays of arrays, this advice type can be used to recursively descend through the JSON content of the response. The advice may enforce a maximum depth for recursive usage. There may also be performance ramifications as the total number of policy requests increases.

Include Attributes Advice

The Include Attributes Advice (advice ID `include-attributes`) is applicable to all requests, and limits the attributes that may be returned in a JSON response.

The payload for this advice is a JSON array of strings. Each string is interpreted as a SCIM (JSON) path into the response body of the request being authorized. Only the portions of the response selected by one of these SCIM paths are included in the response. If multiple instances of Include Attributes Advice are returned from policy, they are combined so all attributes selected are in the response. The wild card string "*", if present in the array, indicates that all attributes may be included in the response, and will override any other paths present in the policy result.

Prohibit Attributes Advice

The Prohibit Attributes Advice (advice ID `prohibit-attributes`) is applicable to all requests, and specifies attributes that may not be modified or created by a JSON request body for POST, PUT, or PATCH actions.

The payload for this advice is a JSON array of strings. Each string is interpreted as the name of a resource attribute that the client is not allowed to modify, create, or delete. If the client request contains changes for any attribute specified by this advice, the request will be denied with a 403 Forbidden response.

Policies and request processing

Client requests to PingDataGovernance Server are made through either the SCIM or API Gateway endpoint. Resource requests are evaluated and either granted or denied based on configured policy rules and advice.

SCIM resource type policy evaluation

Each request to the SCIM endpoint explicitly specifies what action is being requested and on what resources. As a REST interface, SCIM uses the HTTP method, query parameters, method body, and URI path to specify request parameters.

All SCIM requests target a specific SCIM Resource Type. For example, a search targeted to `/scim/v2/Users` is executed against the Users SCIM endpoint. An update targeted to `/scim/v2/ConsumerUsers/9f8a23-5f7ec932-55c4-347e-b757-ce74258ea9e6` is executed against a user with ID 9f8a23-5f7ec932-55c4-347e-b757-ce74258ea9e6 in the Users SCIM Resource Type.

SCIM search request

A SCIM search request consists of a search filter and an optional specification of which attributes to return from each record that satisfies the filter definition. The SCIM Resource Type against which the search is to be conducted is derived from the relative URL path, such as `/scim/v2/Users`.

The policy request generated from a SCIM search request contains the following attributes.

Table 3: SCIM search request attributes

Attribute ID/Content	Attribute Category	Attribute Value
subject_id	access_subject	Name of the requesting client, if it can be retrieved from the OAuth2 access token
action_id	action	search
resource_id	resource	Relative URL of the SCIM endpoint, such as Users
<JSON Content>	access_token	Access token properties
<JSON Content>	applicable_scope	Applicable scope objects

After the search is run against the SCIM Resource Type, it generates policy requests for each record returned in the results to determine whether the requesting client has permission to receive the record's attributes. Each resource and attribute of each record is evaluated independently through a separate policy request to determine if it can be returned. Any resources or individual resource attributes that are denied by policy are omitted from the response. These subsequent policy requests are identical to a SCIM GET request.

Note: The number of search results that can be returned is limited by the SCIM Resource Type's lookthroughLimit property, due to the potential cost of checking each response against policy.

SCIM GET request

The following is contained in the authorization request generated for a SCIM GET request for a known resource.

Table 4: SCIM GET request attributes

Attribute ID/Content	Attribute Category	Value
subject_id	access_subject	Name of the requesting client, if it can be retrieved from the OAuth2 access token
action_id	action	retrieve
resource_id	resource	Relative URL of the resource or sub resource to retrieve, such as Users/12345 or /Users/12345/consents
<JSON Content>	resource	SCIM object representation of the requested resource
<JSON Content>	access_token	Access token properties
<JSON Content>	applicable_scope	Applicable scope objects

The SCIM endpoint will perform the following actions based on the result of the XACML policy authorization request:

- If the result is deny – The resource is not returned to the client and an error is returned.
- If the result is permit – The initial attribute set to be returned to the client is determined. Since multiple policies and/or rules may be consulted to make the permit decision, it's possible that multiple obligations will be returned with the result. See *#unique_51*. Include and exclude obligations are processed as follows:
  - All attributes specified in an exclude obligation are removed from the attribute set.
  - If there are include obligations, all attributes that are not specified by an include obligation are removed from the attribute set.
  - If no attributes remain in the attribute set, a 200 success response code is returned but with an empty resource object.

These rules for each result type are used for all resources returned from the SCIM endpoint.

SCIM POST request

The following is contained in the authorization request generated for a SCIM POST request.

Table 5: SCIM POST request attributes

Attribute ID/Content	Attribute Category	Value
subject_id	access_subject	The client name
action_id	action	create
resource_id	resource	Relative URL of the SCIM Resource Type to be created, such as Users or of the SCIM sub resource to be created, such as /Users/12345/consents
<JSON Content>	scim_resource	SCIM request body of the resource or sub resource to be created
<JSON Content>	access_token	Access token properties
<JSON Content>	applicable_scope	Applicable scope objects

If the POST operation is permitted, the new resource is created and the new object is returned to the client. After the POST is complete, a second policy request is issued to determine which attributes of the updated record the client can receive in the response.

SCIM PATCH and PUT requests

PUT requests are internally converted into a PATCH operation, which is why they are handled the same way by policy. The following is contained in the authorization request generated for a SCIM PATCH or PUT request for a known resource.

Table 6: SCIM PATCH request attributes

Attribute ID/Content	Attribute Category	Value
subject_id	access_subject	The client name
action_id	action	modify
resource_id	resource	Relative URL of the resource or sub resource to be modified, such as Users/12345 or /Users/12345/account
<JSON Content>	scim_request	The normalized SCIM PATCH request body
<JSON Content>	access_token	Access token properties
<JSON Content>	applicable_scope	Applicable scope objects

If the PATCH or PUT operation is permitted, the resource is updated and returned to the client. The updated resource is then subject to the same read criteria in a GET request.

SCIM DELETE request

The following is contained in the authorization request generated for a SCIM DELETE request for a known resource.

Table 7: SCIM DELETE request attributes

Attribute ID/Content	Attribute Category	Value
subject_id	access_subject	The client application name
action_id	action	delete
resource_id	resource	Relative URL of the resource or subresource to be deleted, such as Users/12345 or /Users/12345/account
<JSON Content>	access_token	Access token properties
<JSON Content>	applicable_scope	Applicable scope objects

Configure the Policy Service

Policies are managed by the Policy Service. The default conditions of the Policy Service can be viewed and changed with the `dsconfig` tool, or through the Management Console **Authorization and Policies** -> **Policy Service**.

The combining-algorithm determines how decisions are made if multiple policies or policy sets are applied to a request for resources. The default for the Policy Service is deny-overrides, which specifies that a "deny" decision from a policy should take priority over a "permit" decision. The PingDataGovernance Server also supports permit-overrides, deny-unless-permit, and permit-unless-deny. See the *OASIS Committee Specification 01, eXtensible access control markup language (XACML) Version 3.0. August 2010* for details about each combining algorithm.

Add any custom logged policy request attributes, which enables additional request attributes to be included in the output of a Trace Log Publisher during policy evaluations. The URN of the XACML category ID and Attribute ID are required, in addition to the logger key.

Troubleshoot policies with traces

Policy decisions are frequently the result of a complex series of logical steps. Identifying the reason why a particular request is getting an unexpected result can be difficult. The PingDataGovernance Server can generate a trace of any policy decision, and log traces with in the File Based Trace Log Publisher with `dsconfig` or through the Administrative Console.

Note: Policy traces are logged in the File Based Trace Log Publisher. See *Logs and log publishers* on page 78.

A Policy Decision Trace is an XML document that is formatted like the XACML policies. It demonstrates the sequence of steps taken by the policy engine to come to a decision for a specific request. The elements of the trace parallel the policies, policy targets, and policy rules that are evaluated. The following are included:

- The first line of the log entry identifies the message type as POLICY-DECISION-TRACE.
- The parameters of the policy request being traced are listed, including the application, action, and resources.
- Following this is the trace itself, which is included in the <DecisionTrace> XML element.

The trace also includes entries for each policy, rule, and target evaluated during the decision process. Each entry contains a result XML attribute, which specifies the result of evaluating the corresponding policy element.

Chapter 6

General server configuration

Topics:

The PingDataGovernance Server's non-user data consists of data in the server configuration. Generally, data in the server configuration define an individual PingDataGovernance Server instance, and can include its place in a server topology. Multiple server instances can be grouped in two ways to share or mirror configuration settings:

- Server groups – Servers that are added to a server group in the global configuration can share configuration changes across the group, or not.
- Cluster – A topology management setting that enables a set of servers to be grouped by a functional purpose, and any change to one is mirrored to all. A master server verifies any configuration change before it is propagated to other servers in the group.

Note: All configuration objects and settings are described in the HTML Configuration Reference, which can be accessed from the Administrative Console or from the `<serverroot>/ docs/ index.html page`. Information in this chapter highlights configuration of interest to a PingDataGovernance Server installation. For complete configuration options and details, see the Configuration Reference.

There are tools and settings that are common across all Ping servers. These enable monitoring and managing the server, configuring and sending alerts and alarms, and managing the server's communication with clients. These configuration objects can be changed at the local server, with the option to apply changes to servers in a group.

Available configuration tools

There are several tools that can be used for server administration and maintenance in the `/bin` directory. The following is a sample of the command-line configuration tools:

Table 8: Command line tools

Tool	Description
backup	Run full or incremental backups on one or more PingDataGovernance Servers. This utility also supports the use of a properties file to pass predefined command-line arguments.
base64	Encode raw data using the base64 algorithm or decode base64-encoded data back to its raw representation.
collect-support-data	Collect and package system information useful in troubleshooting problems. The information is packaged as a ZIP archive that can be sent to a technical support representative.
config-diff	Generate a summary of the configuration changes in a local or remote server instance. The tool can be used to compare configuration settings when troubleshooting issues, or when verifying configuration settings on new servers.
create-initial-config	Create an initial PingDataGovernance Server configuration.
create-rc-script	Create a Run Control (RC) script that can be used to start, stop, and restart the PingDataGovernance Server on Unix-based systems.
dsconfig	View and edit the PingDataGovernance Server configuration.
dsframework	Manage administrative server groups or the global administrative user accounts that are used to configure servers within server groups.
dsjavaproperties	Configure the JVM arguments used to run the PingDataGovernance Server and its associated tools. Before launching the command, edit the properties file located in `config/java.properties` to specify the desired JVM arguments and the *JAVA_HOME* environment variable.
encryption-settings	Manage the server encryption settings database.
ldapdelete	Perform an LDAP delete operation.
ldapcompare	Perform an LDAP compare operation.
ldapmodify	Perform LDAP modify, add, and modify DN operations in the PingDataGovernance Server.
ldappasswordmodify	Perform LDAP password modify operations in the PingDataGovernance Server.
ldapsearch	Perform LDAP search operations in the PingDataGovernance Server.
ldif-diff	Compare the contents of two LDIF files, the output being an LDIF file needed to bring the source file in sync with the target.
ldifmodify	Apply a set of modify, add, and delete operations against data in an LDIF file.
list-backends	List the back ends and base DNs configured in the PingDataGovernance Server.

Tool	Description
manage-extension	Install or update extension bundles. An extension bundle is a package of extension (s) that utilize the Server SDK to extend the functionality of the PingDataGovernance Server. Any added extensions require a server re-start.
oauth2-request	Performs OAuth2 requests on the PingDataGovernance Server. This tool can be used to test OAuth2 functions of the PingDataGovernance Server, and to manage OAuth2 tokens on behalf of registered applications.
prepare-external-store	Prepares the external PingDirectory Servers for the PingDataGovernance Server. This is run as part of the `create-initial-config` tool during installation. This tool creates the PingDataGovernance Server user account, sets the correct password, and configures the account with required privileges. It will also install the necessary schema required by the PingDataGovernance Server.
remove-defunct-server	Removes a permanently unavailable PingDataGovernance Server after it has been removed from its topology by the `uninstall` tool.
restore	Restore a backup of the PingDataGovernance Server.
review-license	Review and/or accept the product license.
server-state	View information about the current state of the PingDataGovernance Server processes.
start-server	Start the PingDataGovernance Server.
status	Display basic server information.
stop-server	Stop or restart the PingDataGovernance Server.
sum-file-sizes	Calculate the sum of the sizes for a set of files.

Use the dsconfig tool

The dsconfig tool is used to view or edit the PingDataGovernance Server configuration, and is parallel in functionality with the Administrative Console. This utility can be run in interactive mode, non-interactive mode, and batch mode. Interactive mode provides an intuitive, menu-driven interface for accessing and configuring the server.

To start `dsconfig` in interactive mode, enter the following command:

```
$ bin/dsconfig
```

The `dsconfig` tool provides a batching mechanism that reads multiple `dsconfig` invocations from a file and executes them sequentially. The batch file advantage is that it minimizes LDAP connections and JVM invocations required with scripting each call. To use batch mode to read and execute a series of commands in a batch file, enter the following command:

```
$ dsconfig --bindDN uid=admin,dc=company,dc=com \
--bindPassword password \
--no-prompt \
--batch-file </path/to/config-batch.txt>
```

The `logs/config-audit.log` file can be used to review the configuration changes made to the PingDataGovernance Server and use them in the batch file.

Administrative accounts

Users that authenticate to the Config API or the Administrative Console are stored in cn=Root DNs,cn=config. These users must exist on all instances of the PingDataGovernance Server to manage a Topology of servers. The `setup` tool automatically copies one administrative account when performing an installation from a peer, but if changed, the accounts must be synchronized. Accounts can be added or changed with the `dsconfig` tool.

Change the administrative password

Root users are governed by the Root Password Policy and by default, their passwords never expire. However, if a root user's password must be changed, use the `ldappasswordmodify` tool.

1. Open a text editor and create a text file containing the new password. In this example, name the file rootuser.txt.

```
$ echo password > rootuser.txt
```

2. Use `ldappasswordmodify` to change the root user's password.

```
$ bin/ldappasswordmodify --port 1389 --bindDN "cn=Directory Manager" \
   --bindPassword secret --newPasswordFile rootuser.txt
```

3. Remove the text file.

```
$ rm rootuser.txt
```

Use the Configuration API

Ping servers provide a Configuration API, which may be useful in situations where using LDAP to update the server configuration is not possible. The API is consistent with the System for Cross-domain Identity Management (SCIM) 2.0 protocol and uses JSON as a text exchange format, so all request headers should allow the application/json content type.

The server includes a servlet extension that provides read and write access to the server's configuration over HTTP. The extension is enabled by default for new installations, and can be enabled for existing deployments by simply adding the extension to one of the server's HTTP Connection Handlers, as follows:

```
$ bin/dsconfig set-connection-handler-prop \
  --handler-name "HTTPS Connection Handler" \
  --add http-servlet-extension:Configuration
```

The API is made available on the HTTPS Connection handler's host:port in the `/config` context. Due to the potentially sensitive nature of the server's configuration, the HTTPS Connection Handler should be used, for hosting the Configuration extension.

Authentication and authorization

Clients must use HTTP Basic authentication to authenticate to the Configuration API. If the username value is not a DN, then it will be resolved to a DN value using the identity mapper associated with the Configuration servlet. By default, the Configuration API uses an identity mapper that allows an entry's UID value to be used as a username. To

customize this behavior, either customize the default identity mapper, or specify a different identity mapper using the Configuration servlet's identity-mapper property. For example:

```
$ bin/dsconfig set-http-servlet-extension-prop \
  --extension-name Configuration \
  --set "identity-mapper:Alternative Identity Mapper"
```

To access configuration information, users must have the appropriate privileges:

- To access the cn=config back end, users must have the bypass-acl privilege or be allowed access to the configuration using an ACI.
- To read configuration information, users must have the config-read privilege.
- To update the configuration, users must have the config-write privilege.

Relationship between the Configuration API and the dsconfig tool

The Configuration API is designed to mirror the `dsconfig` tool, using the same names for properties and object types. Property names are presented as hyphen case in dsconfig and as camel-case attributes in the API. In API requests that specify property names, case is not important. Therefore, baseDN is the same as baseDn. Object types are represented in hyphen case. API paths mirror what is in `dsconfig`. For example, the `dsconfig list-connectionhandlers` command is analogous to the API's `/config/connection-handlers` path. Object types that appear in the schema URNs adhere to a type:subtype syntax. For example, a Local DB back end's schema URN is `urn:pingidentity:schemas:configuration:2.0:backend:local-db`. Like the `dsconfig` tool, all configuration updates made through the API are recorded in `logs/config-audit.log`.

The API includes the filter, sort, and pagination query parameters described by the SCIM specification. Specific attributes may be requested using the attributes query parameter, whose value must be a comma-delimited list of properties to be returned, for example attributes=baseDN,description. Likewise, attributes may be excluded from responses by specifying the excludedAttributes parameter. See *Sorting and filtering configuration objects* on page 65 for more information on query parameters.

Operations supported by the API are those typically found in REST APIs:

Table 9:

HTTP Method	Description	Related dsconfig Example
GET	Lists the attributes of an object when used with a path representing an object, such as `/config/globalconfiguration` or `/config/backends/userRoot`. Can also list objects when used with a path representing a parent relation, such as `/config/backends`.	get-backend-prop list-backends get-globalconfigurationprop
POST	Creates a new instance of an object when used with a relation parent path, such as `config/backends`.	create-backend
PUT	Replaces the existing attributes of an object. A PUT operation is similar to a PATCH operation, except that the PATCH is determined by determining the difference between an existing target object and a supplied source object. Only those attributes in the source object are modified in the target object. The target object is specified using a path, such as `/config/backends/userRoot`.	set-backend-prop set-globalconfigurationprop

HTTP Method	Description	Related dsconfig Example
PATCH	Updates the attributes of an existing object when used with a path representing an object, such as `/config/backends/userRoot`. See *PATCH example*.	set-backend-prop set-globalconfigurationprop
DELETE	Deletes an existing object when used with a path representing an object, such as `/config/backends/userRoot`.	delete-backend

The OPTIONS method can also be used to determine the operations permitted for a particular path.

Object names, such as userRoot in the Description column, must be URL-encoded in the path segment of a URL. For example, %20 must be used in place of spaces, and %25 is used in place of the percent (%) character. So the URL for accessing the HTTP Connection Handler object is:

```
/config/connection-handlers/http%20connection%20handler
```

GET example

The following is a sample GET request for information about the userRoot back end:

```
GET /config/backends/userRoot
Host: example.com:5033
Accept: application/scim+json
```

The response:

```
{
 "schemas": [
 "urn:pingidentity:schemas:configuration:2.0:backend:local-db"
 ],
 "id": "userRoot",
 "meta": {
 "resourceType": "Local DB Backend",
 "location": "http://localhost:5033/config/backends/userRoot"
 },
 "backendID": "userRoot2",
 "backgroundPrime": "false",
 "backupFilePermissions": "700",
 "baseDN": [
 "dc=example2,dc=com"
 ],
 "checkpointOnCloseCount": "2",
 "cleanerThreadWaitTime": "120000",
 "compressEntries": "false",
 "continuePrimeAfterCacheFull": "false",
 "dbBackgroundSyncInterval": "1 s",
 "dbCachePercent": "10",
 "dbCacheSize": "0 b",
 "dbCheckpointerBytesInterval": "20 mb",
 "dbCheckpointerHighPriority": "false",
 "dbCheckpointerWakeupInterval": "1 m",
 "dbCleanOnExplicitGC": "false",
 "dbCleanerMinUtilization": "75",
 "dbCompactKeyPrefixes": "true",
 "dbDirectory": "db",
 "dbDirectoryPermissions": "700",
```

```
    "dbEvictorCriticalPercentage": "0",
    "dbEvictorLruOnly": "false",
    "dbEvictorNodesPerScan": "10",
    "dbFileCacheSize": "1000",
    "dbImportCachePercent": "60",
    "dbLogFileMax": "50 mb",
    "dbLoggingFileHandlerOn": "true",
    "dbLoggingLevel": "CONFIG",
    "dbNumCleanerThreads": "0",
    "dbNumLockTables": "0",
    "dbRunCleaner": "true",
    "dbTxnNoSync": "false",
    "dbTxnWriteNoSync": "true",
    "dbUseThreadLocalHandles": "true",
    "deadlockRetryLimit": "10",
    "defaultCacheMode": "cache-keys-and-values",
    "defaultTxnMaxLockTimeout": "10 s",
    "defaultTxnMinLockTimeout": "10 s",
    "enabled": "false",
    "explodedIndexEntryThreshold": "4000",
    "exportThreadCount": "0",
    "externalTxnDefaultBackendLockBehavior": "acquire-before-retries",
    "externalTxnDefaultMaxLockTimeout": "100 ms",
    "externalTxnDefaultMinLockTimeout": "100 ms",
    "externalTxnDefaultRetryAttempts": "2",
    "hashEntries": "false",
    "id2childrenIndexEntryLimit": "66",
    "importTempDirectory": "import-tmp",
    "importThreadCount": "16",
    "indexEntryLimit": "4000",
    "isPrivateBackend": "false",
    "javaClass": "com.unboundid.directory.server.backends.jeb.BackendImpl",
    "jeProperty": [
    "je.cleaner.adjustUtilization=false",
    "je.nodeMaxEntries=32"
    ],
    "numRecentChanges": "50000",
    "offlineProcessDatabaseOpenTimeout": "1 h",
    "primeAllIndexes": "true",
    "primeMethod": [
    "none"
     ],
     "primeThreadCount": "2",
     "primeTimeLimit": "0 ms",
     "processFiltersWithUndefinedAttributeTypes": "false",
     "returnUnavailableForUntrustedIndex": "true",
     "returnUnavailableWhenDisabled": "true",
     "setDegradedAlertForUntrustedIndex": "true",
     "setDegradedAlertWhenDisabled": "true",
     "subtreeDeleteBatchSize": "5000",
     "subtreeDeleteSizeLimit": "5000",
     "uncachedId2entryCacheMode": "cache-keys-only",
     "writabilityMode": "enabled"
    }
```


GET list example

The following is a sample GET request for all local back ends:

```
GET /config/backends
Host: example.com:5033
Accept: application/scim+json
```

The response (which has been shortened):


```
{
  "schemas": [
    "urn:ietf:params:scim:api:messages:2.0:ListResponse"
   ],
   "totalResults": 24,
   "Resources": [
    {
    "schemas": [
    "urn:pingidentity:schemas:configuration:2.0:backend:ldif"
    ],
    "id": "adminRoot",
    "meta": {
    "resourceType": "LDIF Backend",
    "location": "http://localhost:5033/config/backends/adminRoot"
    },
    "backendID": "adminRoot",
    "backupFilePermissions": "700",
    "baseDN": [
    "cn=admin data"
    ],
    "enabled": "true",
    "isPrivateBackend": "true",
    "javaClass": "com.unboundid.directory.server.backends.LDIFBackend",
    "ldifFile": "config/admin-backend.ldif",
    "returnUnavailableWhenDisabled": "true",
    "setDegradedAlertWhenDisabled": "false",
    "writabilityMode": "enabled"
    },
    {
    "schemas": [
    "urn:pingidentity:schemas:configuration:2.0:backend:trust-store"
    ],
    "id": "ads-truststore",
    "meta": {
    "resourceType": "Trust Store Backend",
    "location": "http://localhost:5033/config/backends/ads-truststore"
    },
    "backendID": "ads-truststore",
    "backupFilePermissions": "700",
    "baseDN": [
    "cn=ads-truststore"
    ],
    "enabled": "true",
    "javaClass":
 "com.unboundid.directory.server.backends.TrustStoreBackend",
    "returnUnavailableWhenDisabled": "true",
    "setDegradedAlertWhenDisabled": "true",
    "trustStoreFile": "config/server.keystore",
    "trustStorePin": "********",
    "trustStoreType": "JKS",
    "writabilityMode": "enabled"
    },
    {
    "schemas": [
    "urn:pingidentity:schemas:configuration:2.0:backend:alarm"
    ],
    "id": "alarms",
    "meta": {
    "resourceType": "Alarm Backend",
    "location": "http://localhost:5033/config/backends/alarms"
```

```
    },
    ...
```

PATCH example

Configuration can be modified using the HTTP PATCH method. The PATCH request body is a JSON object formatted according to the SCIM patch request. The Configuration API, supports a subset of possible values for the path attribute, used to indicate the configuration attribute to modify.

The configuration object's attributes can be modified in the following ways. These operations are analogous to the `dsconfig modify-[object]` options.

- An operation to set the single-valued description attribute to a new value:

  ```
  {
    "op" : "replace",
    "path" : "description",
    "value" : "A new backend."
  }
  ```

  is analogous to:

  ```
  $ dsconfig set-backend-prop --backend-name userRoot \
    --set "description:A new backend"
  ```

- An operation to add a new value to the multi-valued jeProperty attribute:

  ```
  {
    "op" : "add",
    "path" : "jeProperty",
    "value" : "je.env.backgroundReadLimit=0"
  }
  ```

  is analogous to:

  ```
  $ dsconfig set-backend-prop --backend-name userRoot \
    --add je-property:je.env.backgroundReadLimit=0
  ```

- An operation to remove a value from a multi-valued property. In this case, path specifies a SCIM filter identifying the value to remove:

  ```
  {
    "op" : "remove",
    "path" : "[jeProperty eq \"je.cleaner.adjustUtilization=false\"]"
  }
  ```

  is analogous to:

  ```
  $ dsconfig set-backend-prop --backend-name userRoot \
    --remove je-property:je.cleaner.adjustUtilization=false
  ```

- A second operation to remove a value from a multi-valued property, where the path specifies both an attribute to modify, and a SCIM filter whose attribute is value:

  ```
  {
  ```

```
  "op" : "remove",
  "path" : "jeProperty[value eq \"je.nodeMaxEntries=32\"]"
}
```

is analogous to:

```
$ dsconfig set-backend-prop --backend-name userRoot \
  --remove je-property:je.nodeMaxEntries=32
```

- An option to remove one or more values of a multi-valued attribute. This has the effect of restoring the attribute's value to its default value:

```
{
  "op" : "remove",
  "path" : "id2childrenIndexEntryLimit"
}
```

is analogous to:

```
$ dsconfig set-backend-prop --backend-name userRoot \
  --reset id2childrenIndexEntryLimit
```

The following is the full example request. The API responds with the entire modified configuration object, which may include a SCIM extension attribute urn:pingidentity:schemas:configuration:messages containing additional instructions:

Example request:

```
PATCH /config/backends/userRoot
Host: example.com:5033
Accept: application/scim+json
{
"schemas" : [ "urn:ietf:params:scim:api:messages:2.0:PatchOp" ],
"Operations" : [ {
"op" : "replace",
"path" : "description",
"value" : "A new backend."
}, {
"op" : "add",
"path" : "jeProperty",
"value" : "je.env.backgroundReadLimit=0"
}, {
"op" : "remove",
"path" : "[jeProperty eq \"je.cleaner.adjustUtilization=false\"]"
}, {
"op" : "remove",
"path" : "jeProperty[value eq \"je.nodeMaxEntries=32\"]"
}, {
"op" : "remove",
"path" : "id2childrenIndexEntryLimit"
} ]
}
```

Example response:

```
{
"schemas": [
```

```
    "urn:pingidentity:schemas:configuration:2.0:backend:local-db"
    ],
    "id": "userRoot2",
    "meta": {
    "resourceType": "Local DB Backend",
    "location": "http://example.com:5033/config/backends/userRoot2"
    },
    "backendID": "userRoot2",
    "backgroundPrime": "false",
    "backupFilePermissions": "700",
    "baseDN": [
    "dc=example2,dc=com"
    ],
    "checkpointOnCloseCount": "2",
    "cleanerThreadWaitTime": "120000",
    "compressEntries": "false",
    "continuePrimeAfterCacheFull": "false",
    "dbBackgroundSyncInterval": "1 s",
    "dbCachePercent": "10",
    "dbCacheSize": "0 b",
    "dbCheckpointerBytesInterval": "20 mb",
    "dbCheckpointerHighPriority": "false",
    "dbCheckpointerWakeupInterval": "1 m",
    "dbCleanOnExplicitGC": "false",
    "dbCleanerMinUtilization": "75",
    "dbCompactKeyPrefixes": "true",
    "dbDirectory": "db",
    "dbDirectoryPermissions": "700",
    "dbEvictorCriticalPercentage": "0",
    "dbEvictorLruOnly": "false",
    "dbEvictorNodesPerScan": "10",
    "dbFileCacheSize": "1000",
    "dbImportCachePercent": "60",
    "dbLogFileMax": "50 mb",
    "dbLoggingFileHandlerOn": "true",
    "dbLoggingLevel": "CONFIG",
    "dbNumCleanerThreads": "0",
    "dbNumLockTables": "0",
    "dbRunCleaner": "true",
    "dbTxnNoSync": "false",
    "dbTxnWriteNoSync": "true",
    "dbUseThreadLocalHandles": "true",
    "deadlockRetryLimit": "10",
    "defaultCacheMode": "cache-keys-and-values",
    "defaultTxnMaxLockTimeout": "10 s",
    "defaultTxnMinLockTimeout": "10 s",
    "description": "123",
    "enabled": "false",
    "explodedIndexEntryThreshold": "4000",
    "exportThreadCount": "0",
    "externalTxnDefaultBackendLockBehavior": "acquire-before-retries",
    "externalTxnDefaultMaxLockTimeout": "100 ms",
    "externalTxnDefaultMinLockTimeout": "100 ms",
    "externalTxnDefaultRetryAttempts": "2",
    "hashEntries": "false",
    "importTempDirectory": "import-tmp",
    "importThreadCount": "16",
    "indexEntryLimit": "4000",
    "isPrivateBackend": "false",
    "javaClass": "com.unboundid.directory.server.backends.jeb.BackendImpl",
    "jeProperty": [
    "\"je.env.backgroundReadLimit=0\""
    ],
    "numRecentChanges": "50000",
```

```
    "offlineProcessDatabaseOpenTimeout": "1 h",
    "primeAllIndexes": "true",
    "primeMethod": [
    "none"
    ],
    "primeThreadCount": "2",
    "primeTimeLimit": "0 ms",
    "processFiltersWithUndefinedAttributeTypes": "false",
    "returnUnavailableForUntrustedIndex": "true",
    "returnUnavailableWhenDisabled": "true",
    "setDegradedAlertForUntrustedIndex": "true",
    "setDegradedAlertWhenDisabled": "true",
    "subtreeDeleteBatchSize": "5000",
    "subtreeDeleteSizeLimit": "5000",
    "uncachedId2entryCacheMode": "cache-keys-only",
    "writabilityMode": "enabled",
    "urn:pingidentity:schemas:configuration:messages:2.0": {
    "requiredActions": [
    {
    "property": "jeProperty",
    "type": "componentRestart",
    "synopsis": "In order for this modification to take effect,
    the component must be restarted, either by disabling and
    re-enabling it, or by restarting the server"
    },
    {
    "property": "id2childrenIndexEntryLimit",
    "type": "other",
    "synopsis": "If this limit is increased, then the contents
    of the backend must be exported to LDIF and re-imported to
    allow the new limit to be used for any id2children keys
    that had already hit the previous limit."
    }
    ]
    }
    }
```

API paths

The Configuration API is available under the `/config` path. A full listing of root sub-paths can be obtained from the `/config/ResourceTypes` endpoint:

```
GET /config/ResourceTypes
Host: example.com:5033
Accept: application/scim+json
```

Sample response (abbreviated):

```
    {
    "schemas": [
    "urn:ietf:params:scim:api:messages:2.0:ListResponse"
    ],
    "totalResults": 520,
    "Resources": [
    {
    "schemas": [
    "urn:ietf:params:scim:schemas:core:2.0:ResourceType"
    ],
    "id": "dsee-compat-access-control-handler",
    "name": "DSEE Compat Access Control Handler",
```

```
    "description": "The DSEE Compat Access Control
    Handler provides an implementation that uses syntax
    compatible with the Sun Java System Directory Server
    Enterprise Edition access control handler.",
    "endpoint": "/access-control-handler",
    "meta": {
    "resourceType": "ResourceType",
    "location": "http://example.com:5033/config/ResourceTypes/dsee-compat-
accesscontrol-
    handler"
    }
    },
    {
    "schemas": [
    "urn:ietf:params:scim:schemas:core:2.0:ResourceType"
    ],
    "id": "access-control-handler",
    "name": "Access Control Handler",
    "description": "Access Control Handlers manage the
    application-wide access control. The server's access
    control handler is defined through an extensible
    interface, so that alternate implementations can be created.
    Only one access control handler may be active in the server
    at any given time.",
    "endpoint": "/access-control-handler",
    "meta": {
    "resourceType": "ResourceType",
    "location": "http://example.com:5033/config/ResourceTypes/access-
control-handler"
    }
    },
    {
    ...
```

The response's endpoint elements enumerate all available sub-paths. The path `/config/access-control-handler` in the example can be used to get a list of existing access control handlers, and create new ones. A path containing an object name like `/config/backends/{backendName}`, where {backendName} corresponds to an existing backend (such as userRoot) can be used to obtain an object's properties, update the properties, or delete the object.

Some paths reflect hierarchical relationships between objects. For example, properties of a local DB VLV index for the userRoot backend are available using a path like `/config/backends/userRoot/local-db-indexes/uid`. Some paths represent singleton objects, which have properties but cannot be deleted nor created. These paths can be differentiated from others by their singular, rather than plural, relation name (for example global-configuration).

Sorting and filtering configuration objects

The Configuration API supports SCIM parameters for filter, sorting, and pagination. Search operations can specify a SCIM filter used to narrow the number of elements returned. See the SCIM specification for the full set of operations for SCIM filters. Clients may also specify sort parameters, or paging parameters. As previously mentioned, clients may specify attributes to include or exclude in both get and list operations.

Table 10: GET parameters for sorting and filtering

GET Parameter	Description
filter	Values can be simple SCIM filters such as id eq "userRoot" or compound filters like meta.resourceType eq "Local DB Backend" and baseDn co "dc=exmple,dc=com".

GET Parameter	Description
sortBy	Specifies a property value by which to sort.
sortOrder	Specifies either ascending or descending alphabetical order.
startIndex	1-based index of the first result to return.
count	Indicates the number of results per page.

Update Properties

with HTTP PATCH. With PUT, the server computes the differences between the object in the request with the current version in the server, and performs modifications where necessary. The server will never remove attributes that are not specified in the request. The API responds with the entire modified object.

Request:

```
PUT /config/backends/userRoot
Host: example.com:5033
Accept: application/scim+json
{
 "description" : "A new description."
}
```

Response:


```
    {
    "schemas": [
    "urn:pingidentity:schemas:configuration:2.0:backend:local-db"
    ],
    "id": "userRoot",
    "meta": {
    "resourceType": "Local DB Backend",
    "location": "http://example.com:5033/config/backends/userRoot"
    },
    "backendID": "userRoot",
    "backgroundPrime": "false",
    "backupFilePermissions": "700",
    "baseDN": [
    "dc=example,dc=com"
    ],
    "checkpointOnCloseCount": "2",
    "cleanerThreadWaitTime": "120000",
    "compressEntries": "false",
    "continuePrimeAfterCacheFull": "false",
    "dbBackgroundSyncInterval": "1 s",
    "dbCachePercent": "25",
    "dbCacheSize": "0 b",
    "dbCheckpointerBytesInterval": "20 mb",
    "dbCheckpointerHighPriority": "false",
    "dbCheckpointerWakeupInterval": "30 s",
    "dbCleanOnExplicitGC": "false",
    "dbCleanerMinUtilization": "75",
    "dbCompactKeyPrefixes": "true",
    "dbDirectory": "db",
    "dbDirectoryPermissions": "700",
    "dbEvictorCriticalPercentage": "5",
    "dbEvictorLruOnly": "false",
    "dbEvictorNodesPerScan": "10",
    "dbFileCacheSize": "1000",
```

```
    "dbImportCachePercent": "60",
    "dbLogFileMax": "50 mb",
    "dbLoggingFileHandlerOn": "true",
    "dbLoggingLevel": "CONFIG",
    "dbNumCleanerThreads": "1",
    "dbNumLockTables": "0",
    "dbRunCleaner": "true",
    "dbTxnNoSync": "false",
    "dbTxnWriteNoSync": "true",
    "dbUseThreadLocalHandles": "true",
    "deadlockRetryLimit": "10",
    "defaultCacheMode": "cache-keys-and-values",
    "defaultTxnMaxLockTimeout": "10 s",
    "defaultTxnMinLockTimeout": "10 s",
    "description": "abc",
    "enabled": "true",
    "explodedIndexEntryThreshold": "4000",
    "exportThreadCount": "0",
    "externalTxnDefaultBackendLockBehavior": "acquire-before-retries",
    "externalTxnDefaultMaxLockTimeout": "100 ms",
    "externalTxnDefaultMinLockTimeout": "100 ms",
    "externalTxnDefaultRetryAttempts": "2",
    "hashEntries": "true",
    "importTempDirectory": "import-tmp",
    "importThreadCount": "16",
    "indexEntryLimit": "4000",
    "isPrivateBackend": "false",
    "javaClass": "com.unboundid.directory.server.backends.jeb.BackendImpl",
    "numRecentChanges": "50000",
    "offlineProcessDatabaseOpenTimeout": "1 h",
    "primeAllIndexes": "true",
    "primeMethod": [
    "none"
    ],
    "primeThreadCount": "2",
    "primeTimeLimit": "0 ms",
    "processFiltersWithUndefinedAttributeTypes": "false",
    "returnUnavailableForUntrustedIndex": "true",
    "returnUnavailableWhenDisabled": "true",
    "setDegradedAlertForUntrustedIndex": "true",
    "setDegradedAlertWhenDisabled": "true",
    "subtreeDeleteBatchSize": "5000",
    "subtreeDeleteSizeLimit": "100000",
    "uncachedId2entryCacheMode": "cache-keys-only",
    "writabilityMode": "enabled"
    }
```


Administrative actions

Updating a property may require an administrative action before the change can take effect. If so, the server will return 200 Success, and any actions are returned in the `urn:pingidentity:schemas:configuration:messages:2.0` section of the JSON response that represents the entire object that was created or modified.

For example, changing the jeProperty of a backend will result in the following:


```
            "urn:pingidentity:schemas:configuration:messages:2.0": {
            "requiredActions": [
            {
            "property": "baseContextPath",
            "type": "componentRestart",
```

```
            "synopsis": "In order for this modification to
            take effect, the component must be restarted,
            either by disabling and re-enabling it, or by
            restarting the server"
            },
            {
            "property": "id2childrenIndexEntryLimit",
            "type": "other",
            "synopsis": "If this limit is increased, then the
            contents of the backend must be exported to LDIF
            and re-imported to allow the new limit to be used
            for any id2children keys that had already hit the
            previous limit."
            }
            ]
            } ...
```

Updating servers and server groups

Servers can be configured as part of a server group, so that configuration changes that are applied to a single server, are then applied to all servers in a group. When managing a server that is a member of a server group, creating or updating objects using the Configuration API requires the applyChangeTo query parameter. The behavior and acceptable values for this parameter are identical to the dsconfig parameter of the same name. A value of singleServer or serverGroup can be specified. For example:

```
https://example.com:5033/config/Backends/userRoot?applyChangeTo=singleServer
```

Note: This does not apply to mirrored subtree objects, which include Topology and Cluster level objects. Changes made to mirrored objects are applied to all objects in the subtree.

Configuration API responses

Clients of the API should examine the HTTP response code to determine the success or failure of a request. The following are response codes and their meanings:

Table 11:

Response Code	Description	Response Body
200 Success	The requested operation succeeded, with the response body being the configuration object that was created or modified. If further actions are required, they are included in the `urn:pingidentity:schemas:configuration:messages:2.0` object.	List of objects, or object properties, administrative actions.
204 No Content	The requested operation succeeded and no further information has been provided, such as in the case of a DELETE operation.	None.
400 Bad Request	The request contents are incorrectly formatted or a request is made for an invalid API version.	Error summary and optional message.
401 Unauthorized	User authentication is required. Some user agents such as browsers may respond by prompting for credentials. If the request had specified credentials in an Authorization header, they are invalid.	None.

Response Code	Description	Response Body
403 Forbidden	The requested operation is forbidden either because the user does not have sufficient privileges or some other constraint such as an object is editonly and cannot be deleted.	None.
404 Not Found	The requested path does not refer to an existing object or object relation.	Error summary and optional message.
409 Conflict	The requested operation could not be performed due to the current state of the configuration. For example, an attempt was made to create an object that already exists or an attempt was made to delete an object that is referred to by another object.	Error summary and optional message.
415 Unsupported Media Type	The request is such that the Accept header does not indicate that JSON is an acceptable format for a response.	None.
500 Server Error	The server encountered an unexpected error. Please report server errors to customer support.	Error summary and optional message.

An application that uses the Configuration API should limit dependencies on particular text appearing in error message content. These messages may change, and their presence may depend on server configuration. Use the HTTP return code and the context of the request to create a client error message. The following is an example encoded error message:

```
{
  "schemas": [
  "urn:ietf:params:scim:api:messages:2.0:Error"
   ],
   "status": 404,
   "scimType": null,
   "detail": "The Local DB Index does not exist."
}
```

Configuring HTTP connection handlers

The server relies on the HTTP connection handler, which relies on one or more servlet extensions. Servlet extensions are responsible for obtaining Java servlets and registering them to be invoked using one or more context paths. For custom servlet extensions created using the Server SDK, the process varies based on using a Java-based or Groovy-scripted extension. See the Server SDK documentation for details.

HTTP connection handlers are responsible for managing the communication with HTTP clients and invoking servlets to process requests from those clients. They can also be used to host web applications on the server. Each HTTP connection handler must be configured with one or more HTTP servlet extensions and zero or more HTTP operation log publishers.

If the HTTP Connection Handler cannot be started (for example, if its associated HTTP Servlet Extension fails to initialize), this does not prevent the entire server from starting. The server's start tool posts any errors to the error log.

The configuration properties available for use with an HTTP connection handler include:

- listen-address – Specifies the address on which the connection handler will listen for requests from clients. If not specified, then requests will be accepted on all addresses bound to the system.
- listen-port – Specifies the port on which the connection handler will listen for requests from clients. Required.

- use-ssl – Indicates whether the connection handler will use SSL/TLS to secure communications with clients (whether it uses HTTPS rather than HTTP). If SSL is enabled, then key-manager-provider and trust-manager-provider values must also be specified.
- http-servlet-extension – Specifies the set of servlet extensions that will be enabled for use with the connection handler. You can have multiple HTTP connection handlers (listening on different address/port combinations) with identical or different sets of servlet extensions. At least one servlet extension must be configured.
- http-operation-log-publisher – Specifies the set of HTTP operation log publishers that should be used with the connection handler. By default, no HTTP operation log publishers will be used.
- ssl-cert-nickname – In scenarios where the multiple public-private key pairs are in a JKS keystore, the LDAPConnectionHandler allows choosing a specific certificate alias through the ssl-cert-nickname property. The HTTPConnectionHandler for HTTPS connections should have the same option for parity.
- key-manager-provider – Specifies the key manager provider that will be used to obtain the certificate presented to clients if SSL is enabled.
- trust-manager-provider – Specifies the trust manager provider that will be used to determine whether to accept any client certificates presented to the server.
- num-request-handlers – Specifies the number of threads that should be used to process requests from HTTP clients. These threads are separate from the worker threads used to process other kinds of requests. The default value of zero means the number of threads will be automatically selected based on the number of CPUs available to the JVM.
- web-application-extension– Specifies the web applications to be hosted by the server.

For information about other connection handlers, see the *PingDataGovernance Server Configuration Reference Guide*.

To Configure an HTTP Connection Handler

An HTTP connection handler has two dependent configuration objects: one or more HTTP servlet extensions and optionally, an HTTP log publisher. The HTTP servlet extension and log publisher must be configured prior to configuring the HTTP connection handler. The log publisher is optional but in most cases, you want to configure one or more logs to troubleshoot any issues with your HTTP connection.

1. The first step is to configure your HTTP servlet extensions. The following example uses the ExampleHTTPServletExtension in the Server SDK.

```
$ bin/dsconfig create-http-servlet-extension \
  --extension-name "Hello World Servlet" \
  --type third-party \
  --set "extension-
class:com.unboundid.directory.sdk.examples.ExampleHTTPServletExtension" \
  --set "extension-argument:path=/" \
  --set "extension-argument:name=example-servlet"
```

2. Next, configure one or more HTTP log publishers. The following example configures two log publishers: one for common access; the other, detailed access. Both log publishers use the default configuration settings for log rotation and retention.

```
$ bin/dsconfig create-log-publisher \
  --publisher-name "HTTP Common Access Logger" \
  --type common-log-file-http-operation \
  --set enabled:true \
  --set log-file:logs/http-common-access \
  --set "rotation-policy:24 Hours Time Limit Rotation Policy" \
  --set "rotation-policy:Size Limit Rotation Policy" \
  --set "retention-policy:File Count Retention Policy" \
  --set "retention-policy:Free Disk Space Retention Policy"

$ bin/dsconfig create-log-publisher \
  --publisher-name "HTTP Detailed Access Logger" \
  --type detailed-http-operation \
  --set enabled:true \
```

```
  --set log-file:logs/http-detailed-access \
  --set "rotation-policy:24 Hours Time Limit Rotation Policy" \
  --set "rotation-policy:Size Limit Rotation Policy" \
  --set "retention-policy:File Count Retention Policy" \
  --set "retention-policy:Free Disk Space Retention Policy"
```

3. Configure the HTTP connection handler by specifying the HTTP servlet extension and log publishers. Note that some configuration properties can be later updated on the fly while others, like `listen-port`, require that the HTTP Connection Handler be disabled, then re-enabled for the change to take effect.

```
$ bin/dsconfig create-connection-handler \
  --handler-name "Hello World HTTP Connection Handler" \
  --type http \
  --set enabled:true \
  --set listen-port:8443 \
  --set use-ssl:true \
  --set "http-servlet-extension:Hello World Servlet" \
  --set "http-operation-log-publisher:HTTP Common Access Logger" \
  --set "http-operation-log-publisher:HTTP Detailed Access Logger" \
  --set "key-manager-provider:JKS" \
  --set "trust-manager-provider:JKS"
```

4. By default, the HTTP connection handler has an advanced monitor entry property, `keep-stats`, that is set to TRUE by default. You can monitor the connection handler using the `ldapsearch` tool.

```
$ bin/ldapsearch --baseDN "cn=monitor" \
  "(objectClass=ds-http-connection-handler-statistics-monitor-entry)"
```

HTTP Correlation IDs

A typical request to a software system is handled by multiple subsystems, many of which may be distinct servers residing on distinct hosts and locations. Tracing the request flow on distributed systems can be challenging, as log messages are scattered across various systems and intermingled with messages for other requests. To make this easier, a correlation ID can be assigned to a request, which is then added to every associated operation as the request flows through the larger system. The correlation ID allows related log messages to be easily located and grouped. The server supports correlation IDs for all HTTP requests received through its HTTP(S) Connection Handler.

When an HTTP request is received, it is automatically assigned a correlation ID. This ID can be used to correlate HTTP responses with messages recorded to the HTTP Detailed Operation log and the trace log. For specific web APIs, the correlation ID may also be passed to the LDAP subsystem. For the SCIM 1, Delegated Admin, Consent, and Directory REST APIs, the correlation ID will also appear with associated requests in LDAP logs in the `correlationID` key. The correlation ID is also used as the default client request ID value in Intermediate Client Request Controls used by the SCIM 2, Consent, and Directory REST APIs. Values related to the Intermediate Client Request Control appear in the LDAP logs in the `via` key, and are forwarded to downstream LDAP servers when received by the PingDirectoryProxy Server. The correlation ID header is also added to requests forwarded by the PingDataGovernance gateway.

For Server SDK extensions that have access to the current HttpServletRequest, the current correlation ID can be retrieved as a string through the HttpServletRequest's `com.pingidentity.pingdata.correlation_id` attribute. For example:

```
(String) request.getAttribute("com.pingidentity.pingdata.correlation_id");
```

Configure HTTP Correlation ID Support

Correlation ID support is enabled by default for each HTTP Connection Handler.

- To enable correlation ID support for the HTTPS Connection Handler:

```
$ dsconfig set-connection-handler-prop \
  --handler-name "HTTPS Connection Handler" \
  --set use-correlation-id-header:true
```

- To disable correlation ID support for the HTTPS Connection Handler:

```
$ dsconfig set-connection-handler-prop \
  --handler-name "HTTPS Connection Handler" \
  --set use-correlation-id-header:false
```

Configuring the correlation ID response header

- The server will generate a correlation ID for every HTTP request and send it in the response through the `Correlation-Id` response header. This response header name can be customized. The following example changes the `correlation-id-response-header` property to "X-Request-Id."

```
$ dsconfig set-connection-handler-prop \
   --handler-name "HTTPS Connection Handler" \
   --set correlation-id-response-header:X-Request-Id
```

Accepting an incoming correlation ID from the request

- By default, the server generates a new, unique correlation ID for each HTTP request, and ignores any correlation ID that may be set on the request. This can be changed by designating the names of one or more HTTP request headers that contain an existing correlation ID value. This enables the server to integrate with a larger system consisting of every servers using correlation IDs.

```
$ dsconfig set-connection-handler-prop --handler-name "HTTPS Connection
 Handler" \
  --set correlation-id-request-header:X-Request-Id \
  --set correlation-id-request-header:X-Correlation-Id \
  --set correlation-id-request-header:Correlation-Id \
  --set correlation-id-request-header:X-Amzn-Trace-Id
```

HTTP Correlation ID Example Use

In this example, a request to the Directory REST API is made and the correlation ID enables finding HTTP-specific log messages with LDAP-specific log messages. The response to the API call includes a Correlation-Id header with the value `a54aee33-c6c6-4467-be25-efd1db7a8b76`.

```
GET /directory/v1/me?includeAttributes=mail HTTP/1.1
 Accept: */*
 Accept-Encoding: gzip, deflate
 Authorization: Bearer ...
 Connection: keep-alive
 Host: localhost:1443
 User-Agent: HTTPie/0.9.9

 HTTP/1.1 200 OK
 Content-Length: 266
 Content-Type: application/hal+json
 Correlation-Id: ee919049-6710-4594-9c66-28b4ada4b127
 Date: Fri, 02 Nov 2018 15:16:50 GMT
 Request-Id: 369

 {
      "_dn": "uid=user.86,ou=People,dc=example,dc=com",
      "_links": {
         "schemas": [
            {
              "href": "https://localhost:1443/directory/v1/schemas/
inetOrgPerson"
            }
         ],
         "self": {
              "href": "https://localhost:1443/directory/v1/
uid=user.86,ou=People,dc=example,dc=com"
         }
     },
```

```
    "mail": [
        "user.86@example.com"
    ]
 }
```

This correlation ID can be used to search the HTTP trace log for matching log records, as follows:

```
$  grep 'correlationID="ee919049-6710-4594-9c66-28b4ada4b127"'
 PingDirectory/logs/debug-trace
 [02/Nov/2018:10:16:50.294 -0500] HTTP REQUEST requestID=369
 correlationID="ee919049-6710-4594-9c66-28b4ada4b127" product="Ping Identity
 Directory Server" instanceName="ds1" startupID="W9ikqA==" threadID=52358
 from=[0:0:0:0:0:0:0:1]:58918 method=GET url="https://0:0:0:0:0:0:0:1:1443/
directory/v1/me?includeAttributes=mail"
 [02/Nov/2018:10:16:50.526 -0500] DEBUG ACCESS-TOKEN-VALIDATOR-PROCESSING
 requestID=369 correlationID="ee919049-6710-4594-9c66-28b4ada4b127"
 msg="Identity Mapper with DN 'cn=User ID Identity Mapper,cn=Identity
 Mappers,cn=config' mapped ID 'user.86' to entry DN
 'uid=user.86,ou=people,dc=example,dc=com'"
 [02/Nov/2018:10:16:50.526 -0500] DEBUG ACCESS-TOKEN-VALIDATOR-PROCESSING
 requestID=369 correlationID="ee919049-6710-4594-9c66-28b4ada4b127"
 accessTokenId="201811020831" msg="Token Validator 'Mock Access Token
 Validator' validated access token with active = 'true', sub = 'user.86',
 owner = 'uid=user.86,ou=people,dc=example,dc=com', clientId = 'client1',
 scopes = 'ds', expiration = 'none', not-used-before = 'none', current time
 = 'Nov 2, 2018 10:16:50 AM CDT' "
 [02/Nov/2018:10:16:50.531 -0500] HTTP RESPONSE requestID=369
 correlationID="ee919049-6710-4594-9c66-28b4ada4b127"
 accessTokenId="201811020831" product="Ping Identity Directory Server"
 instanceName="ds1" startupID="W9ikqA==" threadID=52358 statusCode=200
 etime=236.932 responseContentLength=266
 [02/Nov/2018:10:16:50.531 -0500] DEBUG HTTP-FULL-REQUEST-AND-RESPONSE
 requestID=369 correlationID="ee919049-6710-4594-9c66-28b4ada4b127"
 accessTokenId="201811020831" product="Ping Identity Directory
 Server" instanceName="ds1" startupID="W9ikqA==" threadID=52358
 from=[0:0:0:0:0:0:0:1]:58918 method=GET url="https://0:0:0:0:0:0:0:1:1443/
directory/v1/me?includeAttributes=mail" statusCode=200 etime=236.932
 responseContentLength=266 msg="
```

The LDAP log messages associated with this request can also be located:

```
$  grep 'correlationID="ee919049-6710-4594-9c66-28b4ada4b127"'
 PingDirectory/logs/access
 [02/Nov/2018:10:16:50.529 -0500] SEARCH RESULT instanceName="ds1"
 threadID=52358 conn=-371045 op=1657393 msgID=1657394
 origin="Directory REST API" httpRequestID="369"
 correlationID="ee919049-6710-4594-9c66-28b4ada4b127"
 authDN="uid=user.86,ou=people,dc=example,dc=com" requesterIP="internal"
 requesterDN="uid=user.86,ou=People,dc=example,dc=com"
 requestControls="1.3.6.1.4.1.30221.2.5.2" via="app='PingDirectory-
ds1' clientIP='0:0:0:0:0:0:0:1' sessionID='201811020831'
 requestID='ee919049-6710-4594-9c66-28b4ada4b127'"
 base="uid=user.86,ou=people,dc=example,dc=com" scope=0 filter="(&)"
 attrs="mail,objectClass" resultCode=0 resultCodeName="Success" etime=0.684
 entriesReturned=1
 [02/Nov/2018:10:16:50.530 -0500] EXTENDED RESULT
 instanceName="ds1" threadID=52358 conn=-371046 op=1657394
 msgID=1657395 origin="Directory REST API" httpRequestID="369"
 correlationID="ee919049-6710-4594-9c66-28b4ada4b127"
 authDN="cn=Internal Client,cn=Internal,cn=Root DNs,cn=config"
 requesterIP="internal" requesterDN="cn=Internal Client,cn=Internal,cn=Root
 DNs,cn=config" requestControls="1.3.6.1.4.1.30221.2.5.2"
 via="app='PingDirectory-ds1' clientIP='0:0:0:0:0:0:0:1'
```

```
 sessionID='201811020831' requestID='ee919049-6710-4594-9c66-28b4ada4b127'"
 requestOID="1.3.6.1.4.1.30221.1.6.1" requestType="Password
 Policy State" resultCode=0 resultCodeName="Success"
 etime=0.542 usedPrivileges="bypass-acl,password-reset"
 responseOID="1.3.6.1.4.1.30221.1.6.1" responseType="Password Policy State"
 dn="uid=user.86,ou=People,dc=example,dc=com"
 [02/Nov/2018:10:16:50.530 -0500] SEARCH RESULT instanceName="ds1"
 threadID=52358 conn=-371048 op=1657397 msgID=1657398
 origin="Directory REST API" httpRequestID="369"
 correlationID="ee919049-6710-4594-9c66-28b4ada4b127" authDN="cn=Internal
 Client,cn=Internal,cn=Root DNs,cn=config" requesterIP="internal"
 requesterDN="cn=Internal Client,cn=Internal,cn=Root DNs,cn=config"
 requestControls="1.3.6.1.4.1.30221.2.5.2" via="app='PingDirectory-
ds1' clientIP='0:0:0:0:0:0:0:1' sessionID='201811020831'
 requestID='ee919049-6710-4594-9c66-28b4ada4b127'" base="cn=Default Password
 Policy,cn=Password Policies,cn=config" scope=0 filter="(&)" attrs="ds-
cfg-password-attribute" resultCode=0 resultCodeName="Success" etime=0.065
 preAuthZUsedPrivileges="bypass-acl,config-read" entriesReturned=1
```

Domain Name Service (DNS) caching

If needed, two global configuration properties can be used to control the caching of hostnameto- numeric IP address (DNS lookup) results returned from the name resolution services of the underlying operating system. Use the `dsconfig` tool to configure these properties.

network-address-cache-ttl

Sets the Java system property networkaddress.cache.ttl, and controls the length of time in seconds that a hostname-to-IP address mapping can be cached. The default behavior is to keep resolution results for one hour (3600 seconds). This setting applies to the server and all extensions loaded by the server.

network-address-outage-cache-enabled

Caches hostname-to-IP address results in the event of a DNS outage. This is set to true by default, meaning name resolution results are cached. Unexpected service interruptions may occur during planned or unplanned maintenance, network outages or an infrastructure attack. This cache may allow the server to function during a DNS outage with minimal impact. This cache is not available to server extensions.

IP address reverse name lookups

Ping Identity servers do not explicitly perform numeric IP address-to-hostname lookups. However address masks configured in Access Control Lists (ACIs), Connection Handlers, Connection Criteria, and Certificate handshake processing may trigger implicit reverse name lookups. For more information about how address masks are configured in the server, review the following information for each server:

- ACI dns: bind rules under *Managing Access Control* (PingDirectory Server and PingDirectoryProxy Servers)
- ds-auth-allowed-address: *Adding Operational Attributes that Restrict Authentication* (PingDirectory Server)
- Connection Criteria: *Restricting Server Access Based on Client IP Address* (PingDirectory Server and PingDirectoryProxy Servers)
- Connection Handlers: *Restricting server access using Connection Handlers* (Configuration Reference Guide for all servers)

Problems with SSL communication

Enable TLS debugging in the server to troubleshoot SSL communication issues:

```
                $ dsconfig create-debug-target \
```

```
                --publisher-name "File-Based Debug Logger" \
                --target-name
com.unboundid.directory.server.extensions.TLSConnectionSecurityProvider \
                --set debug-level:verbose \
                --set include-throwable-cause:true
```

```
                $ dsconfig set-log-publisher-prop \
                --publisher-name "File-Based Debug Logger" \
                --set enabled:true \
                --set default-debug-level:disabled
```

In the `java.properties` file, add -Djavax.net.debug=ssl to the start-ds line, and run `bin/dsjavaproperties` to make the option take effect on a scheduled server restart.

Conditions for automatic server shutdown

All Ping servers will shut down in an out of memory condition, a low disk space error state, or for running out of file descriptors. The PingDirectory Server will enter lockdown mode on unrecoverable database environment errors, but can be configured to shut down instead with this setting:

```
$ dsconfig set-global-configuration-prop \
  --set unrecoverable-database-error-mode:initiate-server-shutdown
```

Configuring traffic through a load balancer

If an Ping Identity server is sitting behind an intermediate HTTP server, such as a load balancer, a reverse proxy, or a cache, it will log incoming requests as originating with the intermediate HTTP server instead of the client that actually sent the request. If the actual client's IP address should be recorded to the trace log, enable X-Forwarded-* handling in both the intermediate HTTP server and Ping server. For Ping servers:

- Edit the appropriate Connection Handler object (HTTPS or HTTP) and set useforwarded-headers to true.
- When use-forwarded-headers is set to true, the server will use the client IP address and port information in the X-Forwarded-* headers instead of the address and port of the entity that's actually sending the request, the load balancer. This client address information will show up in logs where one would normally expect it to show up, such as in the from field of the HTTP REQUEST and HTTP RESPONSE messages.

On the load balancer, configure settings to provide the X-Forwarded-* information, such as XForwarded-Host:. See the product documentation for the device type.

System alarms, alerts, and gauges

Ping servers provide tools to monitor and manage the health of the system. The Data Governance Server provides delivery mechanisms (handlers) for administrative alerts using JMX or SNMP, in addition to standard error logging. All can be configured with the `dsconfig` tool.

Alerts and alarms reflect state changes within the server that may be of interest to a user or monitoring service. An alarm represents a stateful condition of the server or a resource that may indicate a problem, such as low disk space or external server unavailability. A gauge defines a set of threshold values with a specified severity that, when crossed, cause the server to enter or exit an alarm state. Gauges are used for monitoring continuous values like CPU load or free disk space (Numeric Gauge), or an enumerated set of values such as 'server available' or ‘server unavailable’ (Indicator Gauge). Gauges generate alarms, when the gauge’s severity changes due to changes in the

monitored value. Like alerts, alarms have severity (NORMAL, WARNING, MINOR, MAJOR, CRITICAL), name, and message. Alarms will always have a Condition property, and may have a Specific Problem or Resource property. If surfaced through SNMP, a Probable Cause property and Alarm Type property are also listed. Alarms can be configured to generate alerts when the alarm's severity changes.

There are two alert types supported by the server—standard and alarm-specific. The server constantly monitors for conditions that may attention by administrators, such as low disk space. For this condition, the standard alert is `low-disk-space-warning`, and the alarm-specific alert is `alarm-warning`. The server can be configured to generate alarm-specific alerts instead of, or in addition to, standard alerts. By default, standard alerts are generated for conditions internally monitored by the server. However, gauges can only generate alarm alerts.

The server installs gauges for CPU, disk, and memory usage that can be cloned or configured through the dsconfig tool. Existing gauges can be tailored to fit each environment by adjusting the update interval and threshold values. Configuration of system gauges determines the criteria by which alarms are triggered. The Stats Logger can be used to view historical information about the value and severity of all system gauges.

The server is compliant with the International Telecommunication Union CCITT Recommendation X.733 (1992) standard for generating and clearing alarms. If configured, entering or exiting an alarm state can result in one or more alerts. An alarm state is exited when the condition no longer applies. An `alarm_cleared` alert type is generated by the system when an alarm's severity changes from a non-normal severity to any other severity. An `alarm_cleared` alert will correlate to a previous alarm when Condition and Resource property are the same. The Alarm Manager, which governs the actions performed when an alarm state is entered, is configurable through the `dsconfig` tool.

Like the Alerts back end, which stores information in cn=alerts, the Alarm back end stores information within the cn=alarms back end. Unlike alerts, alarm thresholds have a state over time that can change in severity and be cleared when a monitored value returns to normal. Alarms can be viewed with the status tool.

As with other alert types, alert handlers can be configured to manage the alerts generated by alarms. A complete listing of system alerts, alarms, and their severity is available in `<serverroot>/ docs/admin-alerts-list.csv`.

Alert handlers

Alert notifications can be sent to administrators when significant problems or events occur during processing, such as problems during server startup or shutdown. The PingDataGovernance Server provides a number of alert handler implementations configured with the `dsconfig` tool or the Administrative Console, including:

- Error Log Alert Handler – Sends administrative alerts to the configured server error logger(s).
- JMX Alert Handler – Sends administrative alerts to clients using the Java Management Extensions (JMX) protocol. The server uses JMX for monitoring entries and requires that the JMX connection handler be enabled.
- SNMP Alert Handler – Sends administrative alerts to clients using the Simple Network Monitoring Protocol (SNMP). The server must have an SNMP agent capable of communicating through SNMP 2c.

If needed, the Server SDK can be used to implement additional, third-party alert handlers.

Test alarms and alerts

After gauges, alarms, and alert handlers are configured, verify that the server takes the appropriate action when an alarm state changes by manually increasing the severity of a gauge. Alarms and alerts can be verified with the `status` tool.

Perform the following steps to test alarms and alerts:

1. Configure a gauge with dsconfig and set the override-severity property to critical. The following example uses the CPU Usage (Percent) gauge.

```
$ dsconfig set-gauge-prop \
  --gauge-name "CPU Usage (Percent)" \
  --set override-severity:critical
```

2. Run the `status` tool to verify that an alarm was generated with corresponding alerts. The `status` tool provides a summary of the server's current state with key metrics and a list of recent alerts and alarms. The sample output has been shortened to show just the alarms and alerts information.

```
$ bin/status
```

```
--- Administrative Alerts ---
Severity : Time        : Message
---------:-------------:-----------------------------------------------------
Error    : 11/Aug/2015 : Alarm [CPU Usage (Percent). Gauge CPU Usage
 (Percent)
         : 15:41:00    : for Host System Recent CPU and Memory has
         : -0500       : a current value of '18.583333333333332'.
         :             : The severity is currently OVERRIDDEN in the
         :             : Gauge's configuration to 'CRITICAL'.
         :             : The actual severity is: The severity is
         :             : currently 'NORMAL', having assumed this severity
         :             : Mon Aug 11 15:41:00 CDT 2015. If CPU use is high,

         :             : check the server's current workload and make any
         :             : needed adjustments. Reducing the load on the
 system
         :             : will lead to better response times.
         :             : Resource='Host System']
         :             : raised with critical severity
Shown are alerts of severity [Info,Warning,Error,Fatal] from the past 48
 hours
Use the --maxAlerts and/or --alertSeverity options to filter this list
```

```
--- Alarms ---
Severity : Severity     : Condition : Resource  : Details
: Start Time   :          :           :
---------:------------:----------:------------:--------------------------
Critical : 11/Aug/2015: CPU Usage : Host System : Gauge CPU Usage
 (Percent) for
         : 15:41:00   : (Percent) :             : Host System
         : -0500      :           :             : has a current value of
         :            :           :             : '18.785714285714285'.
         :            :           :             : The severity is
 currently
         :            :           :             : 'CRITICAL', having
 assumed
         :            :           :             : this severity Mon Aug 11
         :            :           :             : 15:49:00 CDT 2015. If
 CPU use
         :            :           :             : is high, check the
 server's
         :            :           :             : current workload and
 make any
         :            :           :             : needed adjustments.
 Reducing
         :            :           :             : the load on the system
 will
         :            :           :             : lead to better response
 times

Shown are alarms of severity [Warning,Minor,Major,Critical]
```

```
Use the --alarmSeverity option to filter this list
```

Consume admin alerts health check for PingDirectoryProxy Server

If the PingDataGovernance Server relies on a PingDirectoryProxy Server as a back-end store, two health check instances are available to determine if the LDAP store adapter is reporting itself as degraded or unavailable, and if so, remove it from rotation:

- Consume Admin Alerts. This health check detects administrative alerts from the server, as soon as they are issued, by maintaining an LDAP persistent search for changes within the cn=alerts branch. When the PingDataGovernance Server is notified by the PingDirectoryProxy Server of a new alert, it immediately retrieves the base cn=monitor entry of the PingDirectoryProxy Server. If this entry has a value for the unavailable-alert-type attribute, then the PingDataGovernance Server will consider it unavailable. If this entry has a value for the degraded-alert-type attribute, then the PingDataGovernance Server will consider it degraded.
- Get Root DSE. This health check detects if the root DSE entry exists on the LDAP external server. As this entry always exists on an PingDirectoryProxy Server, the absence of the entry suggests that the LDAP external server may be degraded or unavailable.

Make the following configuration changes to the PingDirectoryProxy Server, if it is configured as an external store to the PingDataGovernance Server:

```
$ bin/dsconfig set-gauge-prop --gauge-name "Data Set Local Availability" \
  --set server-unavailable-severity-level:critical
```

```
$ bin/dsconfig set-gauge-prop --gauge-name "Data Set Availability" \
  --set server-unavailable-severity-level:critical
```

These changes modify two gauges to report the PingDirectoryProxy Server as unavailable if the gauges determine that the PingDirectoryProxy Server's data set is unavailable.

Logs and log publishers

Ping supports different types of log publishers that can be used to provide the monitoring information for operations, access, debug, and error messages that occur during normal server processing. The server provides default log files as well as mechanisms to configure custom log publishers with their own log rotation and retention policies.

Types of log publishers

Log publishers can be used to log processing information about the server, including:

- Error loggers – provide information about warnings, errors, or significant events that occur within the server.
- Trace logger – provides information about each HTTP, OAuth2, XACML policy, and SCIM request and response that is processed by the PingDataGovernance Server.

View and configure log publishers

Log publishers can be created or modified on each server using the `dsconfig` tool or through the Administrative Console **Logging, monitoring, and notifications** -> **Log Publishers**.

Create a new log publisher

Ping provides customization options to create log publishers with the `dsconfig` command or through the Administrative Console.

After creating a new log publisher, configure the log retention and rotation policies. For more information, see *Configure the log rotation policy* on page 82 and *Configure the log retention policy* on page 82.

The following example shows how to create a trace logger that collects debug information for HTTP, external identity provider, XACML policy, and store adapter operations with the `dsconfig` command:

```
$ bin/dsconfig create-log-publisher \
  --publisher-name NewTraceLogger \
  --type file-based-trace \
  --set enabled:true \
  --set debug-message-type:external-identity-provider-request-and-response \
  --set debug-message-type:http-full-request-and-response \
  --set debug-message-type:policy-decision-trace \
  --set debug-message-type:store-adapter-processing \
  --set http-message-type:request \
  --set http-message-type:response \
  --set xacml-policy-message-type:result \
  --set 'exclude-path-pattern:/**/*.css' \
  --set 'exclude-path-pattern:/**/*.gif' \
  --set 'exclude-path-pattern:/**/*.jpg' \
  --set 'exclude-path-pattern:/**/*.png' \
  --set log-file:myfile \
  --set "rotation-policy:24 Hours Time Limit Rotation Policy" \
  --set "rotation-policy:Size Limit Rotation Policy" \
  --set "retention-policy:File Count Retention Policy" \
  --set "retention-policy:Free Disk Space Retention Policy" \
  --set compression-mechanism:gzip
```

Compression cannot be disabled or turned off once configured for the logger. Determine logging requirements before configuring this option.

Configure log compression

Ping servers support the ability to compress log files as they are written. Because of the inherent problems with mixing compressed and uncompressed data, compression can only be enabled when the logger is created. Compression cannot be turned on or off once the logger is configured. If the server encounters an existing log file at startup, it will rotate that file and begin a new one rather than attempting to append it to the previous file.

Compression is performed using the standard gzip algorithm. Because it can be useful to have an amount of uncompressed log data for troubleshooting, having a second logger defined that does not use compression may be desired.

Configure compression by setting the compression-mechanism property to have the value of gzip when creating a new logger. See *Create a new log publisher* on page 78 for details.

Configure log file encryption

The server supports the ability to encrypt log files as they are written. The encrypt-log configuration property controls whether encryption will be enabled for the logger. Enabling encryption causes the log file to have an .encrypted extension (and if both encryption and compression are enabled, the extension will be .gz.encrypted). Any change that affects the name used for the log file could prevent older files from getting properly cleaned up.

Like compression, encryption can only be enabled when the logger is created. Encryption cannot be turned on or off once the logger is configured. For any log file that is encrypted, enabling compression is also recommended to reduce the amount of data that needs to be encrypted. This will also reduce the overall size of the log file. The `encrypt-file` tool (or custom code, using the LDAP SDK's `com.unboundid.util.PassphraseEncryptedInputStream`) is used to access the encrypted data.

To enable encryption, at least one encryption settings definition must be defined in the server. Use the one created during setup, or create a new one with the `encryption-settings create` command. By default, the encryption will be performed with the server's preferred encryption settings definition. To explicitly specify which definition should be used for the encryption, the encryption-settings-definition-id property can be set with the ID of that definition. It is recommended that the encryption settings definition is created from a passphrase so that the

file can be decrypted by providing that passphrase, even if the original encryption settings definition is no longer available. A randomly generated encryption settings definition can also be created, but the log file can only be decrypted using a server instance that has that encryption settings definition.

When using encrypted logging, a small amount of data may remain in an in-memory buffer until the log file is closed. The encryption is performed using a block cipher, and it cannot write an incomplete block of data until the file is closed. This is not an issue for any log file that is not being actively written. To examine the contents of a log file that is being actively written, use the `rotate-log` tool to force the file to be rotated before attempting to examine it.

The following commands can be used to set log file encryption:

1. Use `dsconfig` to enable encryption for a Log Publisher. In this example, the FilebasedAccess Log Publisher "Encrypted Access" is created, compression is set, and rotation and retention policies are set.

```
$ bin/dsconfig create-log-publisher-prop --publisher-name "Encrypted
 Access" \
  --type file-based-access \
  --set enabled:true \
  --set compression-mechanism:gzip \
  --set encryption-settings-definition-
id:332C846EF0DCD1D5187C1592E4C74CAD33FC1E5FC20B726CD301CDD2B3FFBC2B \
  --set encrypt-log:true \
  --set log-file:logs/encrypted-access \
  --set "rotation-policy:24 Hours Time Limit Rotation Policy" \
  --set "rotation-policy:Size Limit Rotation Policy" \
  --set "retention-policy:File Count Retention Policy" \
  --set "retention-policy:Free Disk Space Retention Policy" \
  --set "retention-policy:Size Limit Retention Policy"
```

2. To decrypt and decompress the file:

```
$ bin/encrypt-file --decrypt \
  --decompress-input \
  --input-file logs/encrypted-access.20180216040332Z.gz.encrypted \
  --output-file decrypted-access
Initializing the server's encryption framework...DoneWriting decrypted
data to file '/ds/PingDirectory/decrypted-access' using akey generated
from encryption settings definition
'332c846ef0dcd1d5187c1592e4c74cad33fc1e5fc20b726cd301cdd2b3ffbc2b'Succes
sfully wrote 123,456,789 bytes of decrypted data
```

Configure log signing

Ping servers support the ability to cryptographically sign a log to ensure that it has not been modified. For example, financial institutions require tamper-proof audit logs files to ensure that transactions can be properly validated and ensure that they have not been modified by a third-party entity or internally by an unauthorized person.

When enabling signing for a logger that already exists, the first log file will not be completely verifiable because it still contains unsigned content from before signing was enabled. Only log files whose entire content was written with signing enabled will be considered completely valid. For the same reason, if a log file is still open for writing, then signature validation will not indicate that the log is completely valid because the log will not include the necessary "end signed content" indicator at the end of the file.

To validate log file signatures, use the `validate-file-signature` tool provided in the `bin` directory of the server (or the `bat` directory on Windows systems). Once this property is enabled, disable and then re-enable the log publisher for the changes to take effect. Perform the following steps to configure log signing:

1. Use `dsconfig` to enable log signing for a Log Publisher. In this example, set the sign-log property on the File-based Trace Log Publisher.

```
$ bin/dsconfig set-log-publisher-prop \
  --publisher-name "File-Based Trace Logger" \
  --set sign-log:true
```

2. Disable and then re-enable the Log Publisher for the change to take effect.

```
$ bin/dsconfig set-log-publisher-prop \
  --publisher-name "File-Based Trace Logger" \
  --set enabled:false
```

```
$ bin/dsconfig set-log-publisher-prop \
  --publisher-name "File-Based Trace Logger" \
  --set enabled:true
```

3. To validate a signed file, use the `validate-file-signature` tool to check if a signed file has been altered.

```
    $ bin/validate-file-signature --file logs/trace
```

```
All signature information in file 'logs/trace' is valid
```

If any validations errors occur, a message appears that is similar to this:

```
One or more signature validation errors were encountered while
validating the contents of file 'logs/trace':
* The end of the input stream was encountered without encountering the
end of an active signature block. The contents of this signed block
cannot be trusted because the signature cannot be verified
```

Configure log retention and log rotation policies

Ping servers enable configuring log rotation and log retention policies.

Log retention – When any retention limit is reached, the server removes the oldest archived log prior to creating a new log. Log retention is only effective if a log rotation policy is in place. A new log publisher must have at least one log retention policy configured. The following policies are available:

- **File Count Retention Policy** – Sets the number of log files you want the sever to retain. The default file count is 10 logs. If the file count is set to 1, the log will continue to grow indefinitely without being rotated.
- **Free Disk Space Retention Policy** – Sets the minimum amount of free disk space. The default free disk space is 500 MB.
- **Size Limit Retention Policy** – Sets the maximum size of the combined archived logs. The default size limit is 500 MB.
- **Custom Retention Policy** – Create a new retention policy that meets the server's requirements.
- **Never Delete Retention Policy** – Used in a rare event that does not require log deletion.

Log rotation – When a rotation limit is reached, the server rotates the current log and starts a new log. A new log publisher must have at least one log rotation policy configured. The following policies are available:

- **Time Limit Rotation Policy** – Rotates the log based on the length of time since the last rotation. Default implementations are provided for rotation every 24 hours and every seven days.

- **Fixed Time Rotation Policy** – Rotates the logs every day at a specified time (based on 24-hour). The default time is 2359.
- **Size Limit Rotation Policy** – Rotates the logs when the file reaches the maximum size. The default size limit is 100 MB.
- **Never Rotate Policy** – Used in a rare event that does not require log rotation.

Configure the log rotation policy

Use `dsconfig` to modify the log rotation policy for the access logger:

```
$ bin/dsconfig set-log-publisher-prop \
  --publisher-name "File-Based Error Logger" \
  --remove "rotation-policy:24 Hours Time Limit Rotation Policy" \
  --add "rotation-policy:7 Days Time Limit Rotation Policy"
```

Configure the log retention policy

Use `dsconfig` to modify the log retention policy for the access logger:

```
$ bin/dsconfig set-log-publisher-prop \
  --publisher-name "File-Based Error Logger" \
  --set "retention-policy:Free Disk Space Retention Policy"
```

Server monitoring

While the server is running, it generates a significant amount of information available through monitor entries. This section contains information about the following:

- Back-end monitor entries
- View system and consent data through the PingDataMetrics Server
- Use the status tool

Back-end monitor entries

Each Ping server exposes its monitoring information under the cn=monitor entry. Administrators can use various means to monitor the servers through SNMP, LDAP command-line tools, and the Stats Logger.

The Monitor back end contains an entry per component or activity being monitored. The list of all monitor entries can be seen using the `ldapsearch` command as follows:

```
$ bin/ldapsearch --hostname server1.example.com \
  --port 1389 \
  --bindDN "uid=admin,dc=example,dc=com" \
  --bindPassword secret \
  --baseDN "cn=monitor" "(objectclass=*)" cn
```

The following table lists a subset of monitor entries.

Table 12: Monitoring components

Component	Description
Active Operations	Provides information about the operations currently being processed by the server including the number of operations, information on each operation, and the number of active persistent searches.
Backends	Provides general information about the state of a server back end, including the entry count. If the back end is a local database, there is a corresponding database environment monitor entry with information on cache usage and on-disk size.
Client Connections	Provides information about all client connections to the server including a name followed by an equal sign and a quoted value, such as connID="15", connectTime="20100308223038Z".
Connection Handlers	Provides information about the available connection handlers on the server including the LDAP and LDIF connection handlers.
Disk Space Usage	Provides information about the disk space available to various components of the server.
General	Provides general information about the state of the server, including product name, vendor name, and server version.
Index	Provides information on each index including the number of preloaded keys and counters for read, write, remove, open-cursor, and read-for-search actions. These counters provide insight into how useful an index is for a given workload.
HTTP/HTTPS Connection Handler Statistics	Provides statistics about the interaction that the associated HTTP connection handler has had with its clients, including the number of connections accepted, average requests per connection, average connection duration, total bytes returned, and average processing time by status code.
JVM Stack Trace	Provides a stack trace of all threads processing within the JVM.
LDAP Connection Handler Statistics	Provides statistics about the interaction that the associated LDAP connection handler has had with its clients, including the number of connections established and closed, bytes read and written, LDAP messages read and written, and operations initiated, completed, and abandoned.
Processing Time Histogram	Categorizes operation processing times into a number of user-defined buckets of information, including the total number of operations processed, overall average response time (ms), and number of processing times between 0ms and 1ms.
System Information	Provides general information about the system and the JVM on which the server is running, including system host name, operation system, JVM architecture, Java home, and Java version.
Version	Provides information about the server version, including build ID, and revision number.
Work Queue	Provides information about the state of the server work queue, which holds requests until they can be processed by a worker thread, including the requests rejected, current work queue size, number of worker threads, and number of busy worker threads. The work queue configuration has a monitor-queue-time property set to true by default. This logs messages for new operations with a qtime attribute

Component	Description
	included in the log messages. Its value is expressed in milliseconds and represents the length of time that operations are held in the work queue.

View system and consent data through the PingDataMetrics Server

The PingDataMetrics Server contains several charts to measure and monitor PingDataGovernance Server system and user consent activity. Charts and data are configured from the PingDataMetrics Server. The following categories can be made available through a PingDataMetrics Server dashboard:

Authorization Requests – Displays the number of blocked and permitted token requests from client applications.

Request Volume – Displays authorization activity according to grant or deny.

Grant Types – Displays the number of authorization grants by type.

Consent/Deny by Application – Displays authorization activity based on client application.

Consent/Deny by Data Type – Displays authorization activity based on data type.

Most Requested Data – Displays most requested data.

Most Active Applications – Displays most active client applications.

Most Active Policies – Displays most active policies.

See the *PingDataMetrics Server Administration Guide* for more information.

Use the status tool

Ping servers provide the `status` tool, which lists the health of the server. The `status` tool polls the current health of the server and displays summary information about the number of operations processed in the network. The tool provides the following information:

Table 13: Status tool sections

Status Section	Description
Server Status	Displays the server start time, operation status, number of connections (open, max, and total).
Server Details	Displays the server details including host name, administrative users, install path, server version, and Java version.
Connection Handlers	Displays the state of the connection handlers including address, port, protocol and current state.
Admin Alerts	Displays the 15 administrative alerts that were generated over the last 48-hour period. Limit the number of displayed alerts using the --maxAlerts option. For example, status --maxAlerts 0 suppresses all alerts.

Server SDK extensions

Custom server extensions can be created with the Server SDK. Extension bundles are installed from a .zip archive or a file system directory. Use the `manage-extension` tool to install or update any extension that is packaged using the extension bundle format. It opens and loads the extension bundle, confirms the correct extension to install, stops the server if necessary, copies the bundle to the server install root, and then restarts the server.

Note: The `manage-extension` tool must be used with Java extensions packaged using the extension bundle format. For more information, see the "Building and Deploying Java-Based Extensions" section of the Server SDK documentation.

The Server SDK enables creating extensions for the PingDirectory Server, PingDirectoryProxy Server, PingDataMetrics Server, PingDataGovernance Server, and PingDataSync Server. Cross-product extensions include:

- Access Loggers
- Alert Handlers
- Error Loggers
- Key Manager Providers
- Monitor Providers
- Trust Manager Providers
- OAuth Token Handlers
- Manage Extension Plugins

Extensions for the PingDataGovernance Server include:

- Policy Information Provider
- Store Adapter

Chapter 7

Advanced server configuration

Topics:

When a PingDataGovernance Server is set up from a peer, its server configuration is cloned to the new PingDataGovernance Server, and the two configurations are linked so that changes to the configuration are applied to both PingDataGovernance Servers by default. See *Install an additional PingDataGovernance Server in a topology* on page 22. If a server is installed in an existing topology (an installation option), the server configurations are also linked.

The server's configuration is stored in an LDIF-based back end under the cn=config base DN. It can be accessed using the LDAP protocol and is managed by the `dsconfig` tool, Configuration API, or the Administrative Console.

Configure third-party store adapters

Third-party adapters can be created for directory servers, that are not the PingDirectory Server, with the Server SDK available in the `unboundid-server-sdk-<version>.zip` package.

Configuring a custom store adapter includes the following steps:

1. Create a store adapter.
2. Store it in the `/extensions` directory of the PingDataGovernance Server.
3. Create a SCIM Resource Type schema.
4. Map Store Adapter(s) and SCIM Resource Types using the Administrative Console or the `dsconfig` tool.

Example third-party store adapter

The Server SDK provides an example implementation of a third-party store adapter. View the example and associated Javadocs in the Server SDK `docs/examplehtml/ ExampleStoreAdapter.java.html` directory.

`ExampleStoreAdapter.java` is an implementation of a flat-file JSON store adapter, which stores the SCIM user data in JSON. At startup, all resources are loaded from the json-filepath parameter (resource/user-database.json). The example uses an in-memory hash map of SCIM resources mapped to their SCIM ID.

The example provides full operations plus filterable search support for add, update, and deletes. The example will perform a full-file rewrite on every change, because the file format is a serialized list of Resources<BaseResource>. The code example does not support sorting or resource versioning.

Cross-Origin Resource Sharing support

Cross-Origin Resource Sharing (CORS) enables client applications to make JavaScript requests to the PingDataGovernance Server (or PingDirectory Server) by specifying the domain from which the request is made. These cross-domain requests are generally not allowed by web browsers without CORS support. CORS defines a way in which the browser and the server can interact to determine whether a request is coming from a trusted domain.

CORS Implementation

CORS is implemented per HTTP servlet extension. Access is governed by HTTP Servlet Cross Origin Policies defined through the `dsconfig` tool. Trusted domains can be added to these policies or defined with registered applications in the Administrative Console or with the `dsconfig` tool.

Note: By default, HTTP servlet extensions do not have CORS defined. Without a CORS policy defined, the configuration of the browser will determine application access.

The following are configuration options in `dsconfig`:

```
>>>> HTTP Servlet Cross Origin Policy menu
What would you like to do?
1) List existing HTTP Servlet Cross Origin Policies
2) Create a new HTTP Servlet Cross Origin Policy
3) View and edit an existing HTTP Servlet Cross Origin Policy
4) Delete an existing HTTP Servlet Cross Origin Policy
b) back
q) quit
Enter option [b]:
```

HTTP servlet services

Enabling CORS for a particular servlet can impact another service provided by the same servlet. It is important to know which services will be affected when enabling CORS for an PingDataGovernance Server servlet. The following are available servlets and their functions.

Servlet	Functions
API Explorer Servlet	Manages requests to the API Explorer, which enables testing PingDataGovernance Server functions.
Authentication Servlet	Manages requests to the `/authentication` API endpoint (used by the `auth-ui`).
Configuration	Enables read and write access to the server's Configuration API.
Documentation	Manages requests for the `/docs` content, which includes the `index.html` page, the generated *Configuration Reference Guide*, and other product documents.
JWK Servlet	Provides access to the JSON Web Key for token validation.
OAuth2 Servlet	OAuth2 authorization, token, revocation, and validation endpoints.
Policy Decision Point Servlet	XACML PDP endpoint.
SCIM2	Profile access by SCIM Resource Type using SCIM.
UserInfo Servlet	Profile access using OpenID Connect.

Note: Any servlet accepting JavaScript calls from client applications that are hosted at a different location than that of the Data Governance Server APIs, such as the Velocity servlet, must have CORS enabled.

HTTP servlet cross origin policies

Two sample policies are available after installation. They can be associated with a servlet extension, or used as templates for additional policies.

Per-Application Origins

This policy trusts origins that are listed as trusted by applications registered with the PingDataGovernance Server.

Restrictive

This policy rejects all cross-origin requests unless explicitly defined with the cors-allowed-origins property. Requests from application origins that are not specified are rejected with a 403 Forbidden return code.

Each policy accepts values for the following properties.

Property	Description
cors-enabled	Specifies if the CORS protocol is allowed by the servlet. The default value is false.
cors-allowed-methods	Specifies the list of HTTP methods allowed for access to resources. The default value is GET.
cors-enable-per-application-origins	Specifies that a per-application list of allowed origins is consulted. The default value is false in the Restrictive policy and true in the Per-Application Origins policy.
cors-allowed-origins	Specifies a global list of allowed origins. If the cors-enable-per-application-origins property is set to true, and there are origins listed here, this list is consulted in addition to the per-application list. A value of "*" specifies that all origins are allowed. The default is an empty list.

Property	Description
cors-exposed-headers	Specifies a list of HTTP headers that browsers are allowed to access. Simple response headers, as defined in the Cross-Origin Resource Sharing Specification, are allowed. The default is an empty list.
cors-allowed-headers	Specifies the list of header field names that are supported for a resource and can be specified in a cross-origin request. The default values are Origin, Accept, X-Requested-With, Content-Type, Access-Control-Request-Method, and Access-Control-Request-Headers.
cors-preflight-max-age	Specifies the maximum number of seconds that a preflight request can be cached by the client. The default value is 1800 (30 minutes).
cors-allow-credentials	Specifies whether requests that include credentials are allowed. This value should be false for servlets that use OAuth2 authorization. The default value is false.

Assign a CORS policy to an HTTP servlet extension

CORS policies are assigned to HTTP servlet extensions through `dsconfig`.

The following are configuration options for the SCIM servlet extension:

```
>>>> Configure the properties of the SCIM Resource Type SCIM HTTP Servlet
 Extension
Property Value(s)
---------------------------------------------------------------------------
1) description -
2) cross-origin-policy No cross-origin policy is defined and no CORS headers
 are
recognized or returned.
3) base-context-path /scim
?) help
f) finish - apply any changes to the SCIM Resource Type SCIM HTTP Servlet
 Extension
a) show advanced properties of the SCIM Resource Type SCIM HTTP Servlet
 Extension
d) display the equivalent dsconfig command lines to either re-create this
 object or only
to apply pending changes
b) back
q) quit
Enter option [b]: 2
```

Choose the cross-origin-policy option. Defined policies are listed.

```
>>>> Configuring the 'cross-origin-policy' property
The cross-origin request policy to use for the HTTP Servlet Extension.
A cross-origin policy is a group of attributes defining the level of cross-
origin request
supported by the HTTP Servlet Extension.
Do you want to modify the 'cross-origin-policy' property?
1) Keep the default behavior: No cross-origin policy is defined and no CORS
 headers are
recognized or returned.
2) Change it to the HTTP Servlet Cross Origin Policy: Per-Application
 Origins
3) Change it to the HTTP Servlet Cross Origin Policy: Restrictive
4) Create a new HTTP Servlet Cross Origin Policy
```

```
?) help
q) quit
```

Choose the CORS policy to assign to this servlet extension.

Public and private key store configuration

The PingDataGovernance Server can be configured to validate access tokens with a private key and expose a public key to enable client applications to read the content of the tokens. If there are multiple PingDataGovernance Servers in an environment, a key-pair created on one server will automatically be mirrored on all other servers. The PingDataGovernance Server supports RSA key pairs.

A certificate key pair can be created by or imported to the server with the `dsconfig` tool, or through the advanced setting **System** -> **Key Pairs** in the Administrative Console. For example, the following command can be used to create a new key pair:

```
$ bin/dsconfig -n create-key-pair --pair-name jwt2
```

When a key-pair is created or imported, the private key is encrypted by the preferred encryption settings definition in the encryption settings database and a Certificate Signing Request attribute is created. The private key and Certificate Signing Request are read-only properties, but not the certificate chain. The public key is wrapped in the certificate chain.

The Certificate Signing Request can be taken to a Certificate Signing Authority to obtain a signed, public key certificate. This can then be imported with `dsconfig` to replace the self-signed certificate.

Note:

The PingDataGovernance Server does not automatically rotate expired keys. If using self-signed certificates, reset the certificate-chain property when needed. This will regenerate a new self-signed certificate with the specified validity (self-signed-certificate-validity). If using signed certificates, renew the certificate (extend its validity) from the Certificate Signing Authority and set the certificate-chain property in the key-pair.

Long keys may require more CPU for processing and affect performance, if request volume is high.

Manage server encryption settings

The server encryption settings database is managed by the `encryption-settings` command line tool. The keys stored for the server are used to encrypt tokens, authorization codes, account linking codes, and external identity provider tokens. Encryption settings definitions can be created, listed, exported and imported. Help and examples are available with the following command:

```
$ bin/encryption-settings --help
```

Information about the cipher algorithms and transformations available for use is located in the *Java Cryptography Architecture Reference Guide* and *Standard Algorithm Name Documentation* available on the Oracle website.

Rotate the encryption key

Perform the following steps for routine rotation of the encryption key:

1. Create a new encryption settings definition.

```
$ encryption-settings create \
  --cipher-algorithm AES \
```

```
  --key-length-bits 128
```

```
Successfully created a new encryption settings definition with ID <ID>
```

2. Verify the new definition was created.

```
$ encryption-settings list
Encryption Settings Definition ID: <old-key>
  Preferred for New Encryption: true
  Cipher Transformation: AES
  Key Length (bits): 128

Encryption Settings Definition ID: <ID>
  Preferred for New Encryption: false
  Cipher Transformation: AES
  Key Length (bits): 128
```

3. Create a PIN file that will be used for the exported definition.

```
$ echo "secret" > /tmp/exported-key.pin
```

4. Export the encrypt settings, referring to the generated encryption settings ID.

```
  $ encryption-settings export \
  --id <ID> \
  --output-file /tmp/exported-key \
  --pin-file /tmp/exported-key.pin

Successfully exported encryption settings definition <ID> to file
/tmp/exported-key
```

5. For every Data Governance Server instance in the topology, copy the exported definition and PIN file to the PingDataGovernance Server's host. Import the encryption settings, without setting them as preferred. Delete the exported settings and PIN file when finished.

```
$ encryption-settings import \
  --input-file /tmp/exported-key \
  --pin-file /tmp/exported-key.pin

Successfully imported encryption settings definition <ID> from file
/tmp/exported-key
```

```
$ rm /tmp/exported-key
$ rm /tmp/exported-key.pin
```

6. Perform the previous steps for all existing key pairs, as private keys will still be encrypted with the previous preferred encryption definition. Delete the existing key pairs and re-import them (which will automatically use the new preferred encryption definition for the private key).

7. After importing the encryption settings definition to all PingDataGovernance Servers, including the instance where the definition was originally created, set the new definition as preferred.

```
$ encryption-settings set-preferred \
  --id <ID>

Encryption settings definition <ID> is was successfully set as the
preferred definition for subsequent encryption operations.
```

Address a compromised encryption key

If an encryption settings definition becomes compromised, perform the following to create a new definition and update the PingDataGovernance Servers. See the command line help for the `encryption-settings` tool for arguments.

Note: If the PingDataGovernance Server's encryption key is compromised, and the PingDataGovernance Server has been collecting access tokens for external identity providers through the relying party feature, make sure those tokens are revoked.

1. Back up the encryption settings back end.
2. Back up the user store.
3. Revoke all authorizations for each client.
4. Stop the HTTPS Connection Handler that is used for the Data Governance Server's REST APIs.

```
$ dsconfig set-connection-handler-prop \
  --handler-name "HTTPS Connection Handler" \
  --set enabled:false
```

5. Create a new encryption settings definition and set it as preferred. The following will encrypt data using a 128-bit AES cipher:

```
$ encryption-settings create \
  --cipher-algorithm AES \
  --key-length-bits 128
  --set-preferred
```

6. Restart the HTTPS Connection Handler.

```
$ dsconfig set-connection-handler-prop \
  --handler-name "HTTPS Connection Handler" \
  --set enabled:true
```

If the deployment includes multiple PingDataGovernance Servers, all servers should be taken offline, and the encryption settings database must be updated on every server.

Note: Do not delete the compromised encryption definition. It will still be used to decrypt tokens, authorization codes, and links that were encrypted with the previous key.

Customize the authentication user interface

The PingDataGovernance Server interface is implemented as a client-side Angular 2 application without a back-end server component. It is written using TypeScript and JavaScript. The project's build process leverages `node` and `npm` (like the Administrative Console), and is packaged as a WAR file. See the Angular 2 documentation for more details about tools and customization.

The PingDataGovernance Server application is deployed as a Web Application Extension with a base-context path of `/auth-ui`. The `auth-ui` source code is shipped with the PingDataGovernance Server in the `auth-ui-source.tar.gz` file in the `/webapps` directory. This can be extracted into a directory on a development machine for customization. There are additional details included in a readme file.

Most of the npm scripts defined in the auth project's `package.json` file are subcommands used by the top-level scripts `dev`, `test`, and `prod`.

Example usage:

```
npm run [dev | test | prod]
```

Note: The PingDataGovernance Server's Authentication API uses a cookie to track user sessions. Cookie management and server domains should be considered when deploying any clients that will use the Authentication API.

The `auth-ui` implementation uses the `/oauth/authorize` and the `/authentication/*` APIs through AJAX to implement the following views and flows:

- Consent prompts
- Error messages
- Login fields and options
- Second-factor authentication
- Recover username or password
- Register new user account
- IDP-callback

Branding

The `auth-ui` interface styling comes from the `assets/css/ubid-account.css` file. To override its styles, this file can be edited directly, or an additional CSS override file can be added to the project and included in the `copy-assets` script in `package.json`. For example:

1. Add a file called `shopco.css` to the `assets/css` directory.
2. Add the following to the file:

```
.login-div {
  background-color: #222;
}
.login-container a,
.login-container a:hover {
  color: #e15656;
}
```

3. Change the `package.json` file's `copy-assets` script to include the new file in the CSS by replacing this:

```
cleancss -o ../dist/css/ubid-account.min.css css/ubid-account.css
```

with this:

```
cleancss -o ../dist/css/ubid-account.min.css css/ubid-account.css
css/shopco.css
```

Schema changes

The `auth-ui` implementation assumes the sample reference schema is being used. To change the reference schema, surface additional attributes, or use another schema, the `auth-ui` project will need to be modified.

The following example adds the urn:pingidentity:schemas:sample:profile:1.0:birthDate attribute from the sample reference schema to the registration form:

1. Edit the `app/register/register.html.ts` file in the `auth-ui` project.
2. Add the following after the "Mobile Number" field's form-group element:

```
<div class="form-group">
  <label for="birthDate" class="control-label">Birth Date</label>
    <input
[(ngModel)]="resource
['urn:pingidentity:schemas:sample:profile:1.0:birthDate']"
    type="date" class="form-control input-sm" name="birthDate"
    placeholder="Birth Date" tabindex="9">
</div>
```

3. Optionally disable the customization warning message in `app/register/register.component.ts` by replacing this:

```
isExpectedRegistrableAttributes = (registrableAttributes &&
registrableAttributes.length === 5 &&
registrableAttributes.indexOf('userName') !== -1 &&
registrableAttributes.indexOf('name') !== -1 &&
registrableAttributes.indexOf('password') !== -1 &&
registrableAttributes.indexOf('emails[type eq "home"].value') !== -1 &&
registrableAttributes.indexOf('phoneNumbers[type eq "mobile"].value')
!== -1);
```

   with this:

```
isExpectedRegistrableAttributes = true;
```

4. On the PingDataGovernance Server development server, add birthDate to the register-resource-attribute for the Registration Identity Authenticator with the following `dsconfig` command:

```
$ bin/dsconfig set-identity-authenticator-prop \
  --authenticator-name Registration \
  --add register-resource-
attribute:urn:pingidentity:schemas:sample:profile:1.0:birthDate
```

Chapter 8

Topology configuration

Topics:

Topology configuration enables grouping servers and mirroring configuration changes automatically. It uses a master/slave architecture for mirroring shared data across the topology. All writes and updates are forwarded to the master, which forwards them to all other servers. Reads can be served by any server in the group.

Servers can be added to an existing topology at installation. See *Install an additional PingDataGovernance Server in a topology* on page 22 for details.

Note: To remove a server from the topology, it must be uninstalled with the uninstall tool. See *Uninstall the PingDataGovernance Server* on page 26 for details.

Topology master requirements and selection

A topology master server receives any configuration change from other servers in the topology, verifies the change, then makes the change available to all connected servers when they poll the master. The master always sends a digest of its subtree contents on each update. If the node has a different digest than the master, it knows it's not synchronized. The servers will pull the entire subtree from the master if they detect that they are not synchronized. A server may detect it is not synchronized with the master under the following conditions:

- At the end of its periodic polling interval, if a server's subtree digest differs from that of its master.
- If one or more servers have been added to or removed from the topology.

The master of the topology is selected by prioritizing servers by minimum supported product version, most available, newest server version, earliest start time, and startup UUID (a smaller UUID is preferred).

After determining a master, the topology data is reviewed from all available servers (every five seconds by default) to determine if any new information makes a server better suited to being the master. If a new server can be the master, it will communicate that to the other servers, if no other server has advertised that it should be the master. This ensures that all servers accept the same master at approximately the same time (within a few milliseconds of each other). If there is no better master, the initial master maintains the role.

After the best master has been selected for the given interval, the following conditions are confirmed:

- A majority of servers is reachable from that master. (The master server itself is considered while determining this majority.)
- There is only a single master in the entire topology.

If either of these conditions is not met, the topology is without a master and the peer polling frequency is reduced to 100 milliseconds to find a new master as quickly as possible. If there is no master in the topology for more than one minute, a `mirrored-subtree-manager-nomaster-found` alarm is raised. If one of the servers in the topology is forced as master with the force-as-master-for-mirrored-data option in the Global Configuration configuration object, a `mirrored-subtree-manager-forced-as-master-warning` alarm is raised. If multiple servers have been forced as masters, then a `mirrored-subtree-manager-forced-as-master-error` critical alarm will be raised.

Topology components

When a server is installed, it can be added to an existing topology, which will clone the server's configuration. Topology settings are designed to operate without additional configuration. If required, some settings can be adjusted to fit the needs of the environment.

Server configuration settings

Configuration settings for the topology are configured in the Global Configuration and in the Config File Handler back end. Though they are topology settings, they are unique to each server and are not mirrored. Settings must be kept the same on all servers.

The Global Configuration object contains a single topology setting, force-as-master-for-mirrored-data. This should be set to true on only one of the servers in the topology, and is used only if a situation occurs where the topology cannot determine a master because a majority of servers is not available. A server with this setting enabled will be assigned the role of master, if no suitable master can be determined. See *Topology master requirements and selection* on page 98 for details about how a master is selected for a topology.

The Config File Handler back end defines three topology (mirrored-subtree) settings:

- mirrored-subtree-peer-polling-interval – Specifies the frequency at which the server polls its topology peers to determine if there are any changes that may warrant a new master selection. A lower value will ensure a faster failover, but it will also cause more traffic among the peers. The default value is five seconds. If no suitable master is found, the polling frequency is adjusted to 100 milliseconds until a new master is selected.

- mirrored-subtree-entry-update-timeout – Specifies the maximum length of time to wait for an update operation (add, delete, modify or modify-dn) on an entry to be applied by the master on all of the servers in the topology. The default is 10 seconds. In reality, updates can take up to twice as much time as this timeout value if master selection is in progress at the time the update operation was received.
- mirrored-subtree-search-timeout – Specifies the maximum length of time in milliseconds to wait for search operations to complete. The default is 10 seconds.

Topology settings

Topology meta-data is stored under the cn=topology,cn=config subtree and cluster data is stored under the cn=cluster,cn=config subtree. The only setting that can be changed is the cluster name.

Monitor data for the topology

Each server has a monitor that exposes that server's view of the topology in its monitor back end, so that peer servers can periodically read this information to determine if there are changes in the topology. Topology data includes the following:

- The server ID of the current master, if the master is not known.
- The instance name of the current master, or if a master is not set, a description stating why a master is not set.
- A flag indicating if this server thinks that it should be the master.
- A flag indicating if this server is the current master.
- A flag indicating if this server was forced as master.
- The total number of configured peers in the topology group.
- The peers connected to this server.
- The current availability of this server.
- A flag indicating whether or not this server is not synchronized with its master, or another node in the topology if the master is unknown.
- The amount of time in milliseconds where multiple masters were detected by this server.
- The amount of time in milliseconds where no suitable server is found to act as master.
- A SHA-256 digest encoded as a base-64 string for the current subtree contents.

The following metrics are included if this server has processed any operations as master:

- The number of operations processed by this server as master.
- The number of operations processed by this server as master that were successful.
- The number of operations processed by this server as master that failed to validate.
- The number of operations processed by this server as master that failed to apply.
- The average amount of time taken (in milliseconds) by this server to process operations as the master.
- The maximum amount of time taken (in milliseconds) by this server to process an operation as the master.

Update the server instance listener certificate

To change the SSL certificate for the server, update the keystore and truststore files with the new certificate. The certificate file must have the new certificate in PEM-encoded format, such as:

```
-----BEGIN CERTIFICATE-----
MIIDKTCCAhGgAwIBAgIEacgGrDANBgkqhkiG9w0BAQsFADBFMR4wHAYDVQQKExVVbmJvdW5kSUQgQ2VydGlmaWNh
GUxIzAhBgNVBAMTGnZtLW1lZGl1bS03My51bmJvdW5kaWQubGFiMB4XDTE1MTAxMjE1MzU0OFoXDTM1MTAwNzE1M
U0OFowRTEeMBwGA1UEChMVVW5ib3VuZElEIENlcnRpZmljYXRlMSMwIQYDVQQDExp2bS1tZWRpdW0tNzMudW5ib3
uZGlkLmxhYjCCASIwDQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBAKN4tAN3o9Yw6Cr9hivwVDxJqF6+aEi9Ir3
GFYLSrggRNXsiAOfWkSMWdIC5vyF5OJ9DlIgvHL4OuqP/
YNEGzKDkgr6MwtUeVSK14+dCixygJGC0nY7k+f0WSCjt
```

```
IHzrmc4WWdrZXmgb
+qv9LupS30JG0FXtcbGkYpjaKXIEqMg4ekz3B5cAvE0SQUFyXEdN4rWOn96nVFkb2CstbiPzA
gne2tu7paJ6SGFOW0UF7v018XY1m2WHBIoD0WC8nOVLTG9zFUavaOxtlt1TlhClkI4HRMNg8n2EtSTdQRizKuw9I
TXJBb6Kfvnp/nI73VHRyt47wUVueehEDfLtDP8pMCAwEAAaMhMB8wHQYDVR0OBBYEFMrwjWxl2K
+yd9+Y65oKn0g5
jITgMA0GCSqGSIb3DQEBCwUAA4IBAQBpsBYodblUGew+HewqtO2i8Wt+vAbt31zM5/kRvo6/
+iPEASTvZdCzIBcgl
etxKGKeCQ0GPeHr42+erakiwmGDlUTYrU3LU5pTGTDLuR2IllTT5xlEhCWJGWipW4q3Pl3cX/9m2ffY/
JLYDfTJao
JvnXrh7Sg719skkHjWZQgOHXlkPLx5TxFGhAovE1D4qLVRWGohdpWDrIgFh0DVfoyAn1Ws9ICCXdRayajFI4Lc6P
m6SA5+25Y9nno8BhVPf4q5OW6+UDc8MsLbBsxpwvR6RJ5cv3ypfOriTehJsG
+9ZDo7YeqVsTVGwAlW3PiSd9bYP/8
yu9Cy+0MfcWcSeAE
-----END CERTIFICATE-----
```

If clients that already have a secure connection established with this server need to be maintained, information about both certificates can reside in the same file (each with their own begin and end headers and footers).

After the keystore and truststore files are updated, run the following `dsconfig` command to update the server's certificate in the topology registry:

```
$ bin/dsconfig set-server-instance-listener-prop \
  --instance-name <server-instance-name> \
  --listener-name ldap-listener-mirrored-config \
  --set listener-certificate <path-to-new-certificate-file>
```

The listener-certificate in the topology registry is like a trust store. The public certificates that it has are automatically trusted by the local server. When the local server attempts a secure LDAP connection to a peer, and the peer presents it with its certificate, the local server will check the listener-certificate property for that server in the topology registry. If the property contains the peer server's certificate, the local server will trust the peer.

Remove the self-signed certificate

The server is installed with a self-signed certificate and key (ads-certificate), which are used for internal purposes such as replication authentication, inter-server authentication in the topology registry, reversible password encryption, and encrypted backup/LDIF export. The ads-certificate lives in the keystore file called `ads-truststore` under the server's `/config` directory. If your deployment requires removing the self-signed certificate, it can be replaced.

The certificate is stored in the topology registry, which enables replacing it on one server and having it mirrored to all other servers in the topology. Any change is automatically mirrored on other servers in the topology. It is stored in human-readable PEM-encoded format and can be updated with `dsconfig`. The following general steps are required to replace the self-signed certificate:

1. Prepare a new keystore with the replacement key-pair.
2. Update the server configuration to use the new certificate by adding it to the server's list of certificates in the topology registry so that it is trusted by other servers.
3. Update the server's `ads-truststore` file to use the new key-pair.
4. Retire the old certificate by removing it from the topology registry.

Note: Replacing the entire key-pair instead of just the certificate associated with the original private key can make existing backups and LDIF exports invalid. This should be performed immediately after setup or before the key-pair is used. After the first time, only the certificate associated with the private key should have to be changed, for example, to extend its validity period or replace it with a certificate signed by a different CA.

Prepare a new keystore with the replacement key-pair

The self-signed certificate can be replaced with an existing key-pair, or the certificate associated with the original key-pair can be used.

Use an existing key-pair

If a private key and certificate(s) in PEM-encoded format already exist, both the original private key and self-signed certificate can be replaced in ads-truststore with the `manage-certificates` tool. The following command imports existing certificates into a new keystore file, `ads-truststore.new`:

```
$ bin/manage-certificates import-certificate \
  --keystore ads-truststore.new \
  --keystore-type JKS \
  --keystore-password-file ads-truststore.pin \
  --alias ads-certificate \
  --private-key-file existing.key \
  --certificate-file existing.crt \
  --certificate-file intermediate.crt \
  --certificate-file root-ca.crt
```

The certificates listed using the --certificate-file options must be ordered so that each subsequent certificate is the issuer for the previous one. So the server certificate comes first, the intermediate certificates next (if any), and the root CA certificate last.

Use the certificate associated with the original key-pair

The certificate associated with the original server-generated private key can be replaced with the following commands:

1. Create a CSR for the ads-certificate:

   ```
   $ bin/manage-certificates generate-certificate-signing-request \
     --keystore ads-truststore \
     --keystore-type JKS \
     --keystore-password-file ads-truststore.pin \
     --alias ads-certificate \
     --use-existing-key-pair \
     --subject-dn "CN=ldap.example.com,O=Example Corporation,C=US" \
     --output-file ads.csr
   ```

2. Submit `ads.csr` to a CA for signing.
3. Export the server's private key into `ads.key`:

   ```
   $ bin/manage-certificates export-private-key \
     --keystore ads-truststore \
     --keystore-password-file ads-truststore.pin \
     --alias ads-certificate \
     --output-file ads.key
   ```

4. Import the certificates obtained from the CA (the CA-signed server certificate, any intermediate certificates, and root CA certificate) into `ads-truststore.new`:

   ```
   $ bin/manage-certificates import-certificate \
     --keystore ads-truststore.new \
     --keystore-type JKS \
     --keystore-password-file ads-truststore.pin \
     --alias ads-certificate \
     --private-key-file ads.key \
     --certificate-file new-ads.crt \
     --certificate-file intermediate.crt \
     --certificate-file root-ca.crt
   ```

Update the server configuration to use the new certificate

To update the server to use the desired key-pair, the inter-server-certificate property for the server instance must first be updated in the topology registry. The old and the new certificates may appear within their own begin and end headers in the inter-server-certificate property to support transitioning from the old certificate to the new one.

1. Export the server's old ads-certificate into `old-ads.crt`:

```
$ bin/manage-certificates export-certificate \
  --keystore ads-truststore \
  --keystore-password-file ads-truststore.pin \
  --alias ads-certificate \
  --export-certificate-chain \
  --output-file old-ads.crt
```

2. Concatenate the old, new certificate, and issuer certificates into one file. On Windows, an editor like notepad can be used. On Unix platforms, use the following command:

```
$ cat old-ads.crt new-ads.crt intermediate.crt root-ca.crt > chain.crt
```

3. Update the inter-server-certificate property for the server instance in the topology registry using `dsconfig`:

```
$ bin/dsconfig -n set-server-instance-prop \
  --instance-name <instance-name> \
  --set "inter-server-certificate<chain.crt"
```

Update the ads-truststore file to use the new key-pair

The server will still use the old ads-certificate. When the new ads-certificate needs to go into effect, the old `ads-truststore` file must be replaced with `ads-truststore.new` in the server's `config` directory.

```
$ mv ads-truststore.new ads-truststore
```

Retire the old certificate

The old certificate is retired by removing it from the topology registry when it has expired. All existing encrypted backups and LDIF exports are not affected because the public key in the old and new server certificates are the same, and the private key will be able to decrypt them.

```
$ cat new-ads.crt intermediate.crt root-ca.crt > chain.crt
```

```
$ bin/dsconfig -n set-server-instance-prop \
  --instance-name <instance-name> \
  --set "inter-server-certificate<chain.crt"
```

Remove a server from the topology

When removing a server from the topology, the remaining servers need to be made aware of the change. If the server to be removed is defunct, then run the `remove-defunct-server` command from another server in the topology. Similar to the `enable` command, more that 50% of servers not being removed from the topology need to be online during the process.

If there are additional servers that are offline and can not be online while the offline server is being removed, then it's important to make a distinction between offline servers that are permanently offline, and those that are temporarily offline. If servers are permanently defunct, they should also be removed with `remove-defunct-server`. If servers are temporarily offline, once they are online, they will automatically update. The `remove-defunct-server` tool can be used after setting the JVM property `"com.unboundid.connectionutils.LdapResponseTimeoutMillis"` to change the default ten minute time out for each server to be taken out of rotation. If there are multiple servers to be removed, this can speed up the process.

```
$ bin/remove-defunct-server \
  --serverInstanceName austin01 \
  --bindDN "cn=Directory Manager" \
  --bindPassword password
```

Run the `remove-defunct-server` tool on each server removed from the topology to remove any topology references.

```
$ bin/remove-defunct-server --no-prompt
```