cloudera®

Cloudera Navigator Data Management

Important Notice

© 2010-2021 Cloudera, Inc. All rights reserved.

Cloudera, the Cloudera logo, and any other product or
service names or slogans contained in this document are trademarks of Cloudera and its suppliers or licensors, and may not be copied, imitated or used, in whole or in part, without the prior written permission of Cloudera or the applicable trademark holder. If this documentation includes code, including but not limited to, code examples, Cloudera makes this available to you under the terms of the Apache License, Version 2.0, including any required notices. A copy of the Apache License Version 2.0, including any notices, is included herein. A copy of the Apache License Version 2.0 can also be found here: https://opensource.org/licenses/Apache-2.0

Hadoop and the Hadoop elephant logo are trademarks of the Apache Software Foundation. All other trademarks, registered trademarks, product names and company names or logos mentioned in this document are the property of their respective owners. Reference to any products, services, processes or other information, by trade name, trademark, manufacturer, supplier or otherwise does not constitute or imply endorsement, sponsorship or recommendation thereof by us.

Complying with all applicable copyright laws is the responsibility of the user. Without limiting the rights under copyright, no part of this document may be reproduced, stored in or introduced into a retrieval system, or transmitted in any form or by any means (electronic, mechanical, photocopying, recording, or otherwise), or for any purpose, without the express written permission of Cloudera.

Cloudera may have patents, patent applications, trademarks, copyrights, or other intellectual property rights covering subject matter in this document. Except as expressly provided in any written license agreement from Cloudera, the furnishing of this document does not give you any license to these patents, trademarks copyrights, or other intellectual property. For information about patents covering Cloudera products, see http://tiny.cloudera.com/patents.

The information in this document is subject to change without notice. Cloudera shall not be liable for any damages resulting from technical errors or omissions which may be present in this document, or from use of this document.

Cloudera, Inc.
395 Page Mill Road
Palo Alto, CA 94306
info@cloudera.com
US: 1-888-789-1488
Intl: 1-650-362-0488
www.cloudera.com

Release Information

Version: Cloudera Navigator 2.14.x
Date: January 15, 2021

Table of Contents

Lineage Diagrams..56

Administration (Navigator Console)...77

Navigator Configuration and Management...83

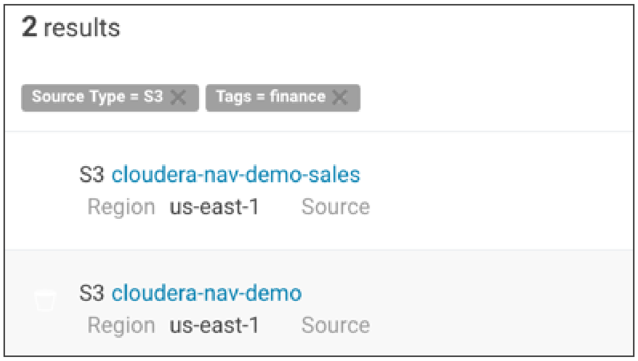
About Cloudera Navigator Data Management

This guide shows you how to use Cloudera Navigator Data Management component for comprehensive data governance, compliance, data stewardship, and other data management tasks.

Cloudera Navigator Overview

Cloudera Navigator Data Management component is a complete solution for data governance, auditing, and related data management tasks that is fully integrated with the Hadoop platform, and that collects governance artifacts—lineage, metadata, and auditing—automatically. Cloudera Navigator lets compliance groups, data stewards, administrators, and others work effectively with data at scale. Working "effectively with data at scale" means that finding specific data entities—to prove to regulators that deposit reserves have not been artificially manipulated, for example—is easier when the data entities in multi-hundred-gigabyte (or terabyte, and beyond) clusters have been ***cataloged***.

An effective catalog of cluster data supports self-service data discovery for an organization. For example, business users can find all the data associated with particular projects by looking for meaningful labels without needing to know the low-level structures within the cluster. Finding all the tables or files relevant for a specific project in a given department can be as simple as applying filters to the Search page. For example, to start exploring the finance team's data stored in an organization's Amazon Simple Storage Service (S3), authorized users can select the `source type` and the `tag` filters:



2 results

Source Type = S3 ✕ Tags = finance ✕

S3 cloudera-nav-demo-sales
Region us-east-1 Source

S3 cloudera-nav-demo
Region us-east-1 Source

Cloudera Navigator enables the cataloging function for Hadoop clusters thanks to its metadata architecture, which lets organizations devise comprehensive metadata models and apply them automatically as data is ingested into the cluster. Using the Cloudera Navigator console, data stewards and other business users can get an at-a-glance view of cluster data through charts, graphs, and histograms that allow further drill-down into all the details, including displaying lineage diagrams that capture transformations to data entities that may have occurred since origination. By tracing data entities back to their source, lineage diagrams show an entity's provenance and can be used to authenticate values by rendering precisely the transformations that may have occurred.

In addition to its metadata infrastructure, Cloudera Navigator also provides auditing infrastructure. Finding the data needed to pull together reports for regulators using standard Hadoop tools can take days but Cloudera Navigator lets organizations find needed information easily and quickly, from menu selectable reports, dashboards, and the like. Using the analytics feature to look at HDFS utilization, system administrators can glean meaningful information about data operations that might be tying up system resources and many other details. With further drill-down, administrators can identify root causes of issues and can also pro-actively monitor and pre-empt potential issues that could occur due to poor organization or consumption of data resources.

This Cloudera Navigator Data Management guide contains information needed by data stewards, compliance teams, and business users to solve business problems using cluster metadata. The guide also includes information for administrators to configure and manage Cloudera Navigator servers and users. The table lists other documentation for Cloudera Navigator:

Introduction	Cloudera Navigator Data Management Overview provides brief overview of common Cloudera Navigator data management functionality for data stewards, governance and compliance teams, data engineers, and administrators. Includes FAQs and an introduction to the Cloudera Navigator APIs with some resources for more information.
Installation	Installing the Cloudera Navigator Data Management Component provides all the details about installing and setting up Cloudera Navigator Data Management component. Cloudera Navigator requires a Cloudera Enterprise license. See Managing Licenses for details.

Upgrade	Upgrading the Cloudera Navigator Data Management Component guides administrators through the upgrade process. Be sure to read the Upgrade Issues and Limitations before starting an upgrade.
Release Notes	Cloudera Navigator Data Management Release Notes includes new features, changed features, known issues, and resolved issues for each release. Always read the Cloudera Navigator Data Management Release Notes before upgrading.

Cloudera Navigator Console

The Cloudera Navigator console is the web-based user interface that provides data stewards, compliance groups, auditing teams, data engineers, and other business users access to Cloudera Navigator auditing, metadata, lineage, analytics, and other capabilities.

For example, compliance teams use the Cloudera Navigator console to view audit event reports, save reports for offline use (such as providing documented audit trails to bank auditors), and identify logon attempts by unauthorized users. Data stewards use the Cloudera Navigator console to define managed metadata models that apply to the various use cases in their organizations, define policies that apply the metadata as needed upon ingestion into the cluster, and allow other users to trace the lineage of data that has been transformed over its lifetime in the cluster, back to its source (provenance).

The Cloudera Navigator console provides a unified view of auditing, lineage, and other data management capabilities across all clusters managed by a given Cloudera Manager instance. That is, if the Cloudera Manager instance manages five clusters, the Cloudera Navigator console can gather audit events for all five clusters, as well as manage metadata and display lineage diagrams that allow tracking data sources through any number of transformations to any end result across the five clusters.

Note: The Cloudera Navigator console invokes the REST APIs exposed by the web service on the host supporting the Navigator Metadata Server role instance. The APIs can be called directly by in-house, third-party, and other developers who want to automate tasks or implement functionality not currently provided by the Cloudera Navigator console. See Cloudera Navigator APIs for an overview and other details.

Assuming that the Cloudera Navigator data management component is running, that you have a login account for Cloudera Navigator, and that you know the host name and port of Navigator Metadata Server role (or have been given this information by your system administrator), follow the steps below to access the Cloudera Navigator console.

Accessing the Cloudera Navigator Console

The Cloudera Navigator console can be accessed from the Cloudera Manager Admin Console or directly on the Navigator Metadata Server instance. Only Cloudera Manager users with the role of Navigator Administrator (or Full Administrator) can access Cloudera Navigator console from the Cloudera Manager Admin Console.

From the Cloudera Manager Admin Console:

1. Open your browser.
2. Navigate to the Cloudera Manager Admin Console.
3. Log in as either Navigator Administrator or Full Administrator.
4. From the menu, select **Clusters** > ***Cluster-n***.
5. Select **Cloudera Navigator** from the menu.
6. Log in to the Cloudera Navigator console.

To access the Cloudera Navigator console directly:

1. Open your browser.

2. Navigate to the host within the cluster running the Cloudera Navigator Metadata Server role.

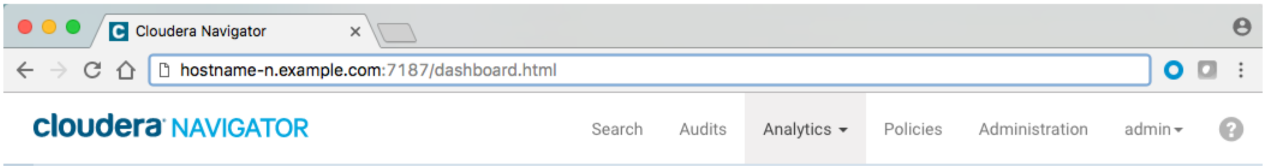
```
http://fqdn-1.example.com:7187/login.html
```

   In this example, node 1 of the cluster is running the Navigator Metadata Server role, hosted on the default port 7187. The login page displays.
3. Log in to the Cloudera Navigator console using the credentials assigned by your administrator.

If your Cloudera Navigator instance has been configured to integrate with your organization's Active Directory (or other LDAP instance) for authentication, your credentials may be simply the same user account and password you use every day for your other production systems.

Menu and Icon Overview

The Cloudera Navigator console opens to an empty Search results page and displays the following menu.



The *user_name* (the account that is logged in to Cloudera Navigator) and question mark icon (see the table) always display. However, other available menu choices depend on the Cloudera Navigator user role of the logged in account. In this example, the **admin** account is logged in.

This table provides a reference to all menu choices.

Icon or menu	Description
Search	Displays sets of filters that can be applied to find specific entities by source type, type, owner, cluster name, and tags.
Audits	Displays summary list of current audit events for the selected filter. Define filters for audit events, create reports based on selected time frames and filters, export selected audit details as CSV or JSON files.
Analytics	Menu for HDFS Analytics and Data Stewardship Analytics selections. This is your entry point for several dashboards that display the overall state of cluster data and usage trends: • Data Stewardship Analytics displays Dashboard and Data Explorer tabs. • HDFS Analytics displays Metadata and Audit tabs.
Policies	Displays a list of existing policies and enables you to create new policies.
Administration	Displays tabs for Managed Metadata, Role Management, and Purge schedule settings.
user_name	Displays account (**admin**, for example) currently logged in to Cloudera Navigator. Menu for Command Actions, My Roles, Enable Debug Mode, and Logout selections.
?	Help icon and menu. Provides access to Help, API Documentation, and About selections. Select Help to display Cloudera Navigator documentation. Select About to display version information.

Menu selections available for any specific login session depend on the privileges that have been granted to the account holder, through their assigned user role. In other words, a user with the Navigator Administrator user role has all menu selections and functions available, while a user with the Auditing Viewer user role can only access the Audits menu to view, report on, and analyze audit events gathered by the system.

Displaying Documentation

Online documentation is accessible from Cloudera Navigator console as follows:

1. Click Help.
2. Select **Help** from the menu.

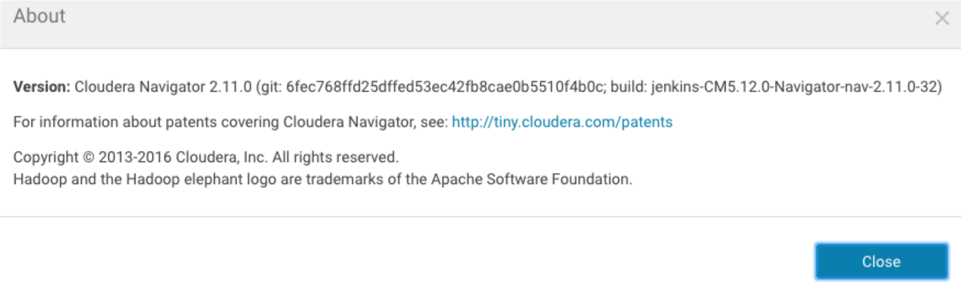
The Cloudera Data Management guide displays.

> **Note:** You can also view the Cloudera Data Management guide outside the scope of a running instance of Cloudera Navigator.

Displaying Version Information

To display the version and build number for the Cloudera Navigator data management component:

1. Click Help.
2. Select **About** from the menu. The versions for both Cloudera Navigator and the Cloudera Manager instance with which it is associated display, as shown below:


About

Version: Cloudera Navigator 2.11.0 (git: 6fec768ffd25dffed53ec42fb8cae0b5510f4b0c; build: jenkins-CM5.12.0-Navigator-nav-2.11.0-32)

For information about patents covering Cloudera Navigator, see: http://tiny.cloudera.com/patents

Copyright © 2013-2016 Cloudera, Inc. All rights reserved.
Hadoop and the Hadoop elephant logo are trademarks of the Apache Software Foundation.

3. Click **Close** to dismiss the message and redisplay the Cloudera Navigator console.

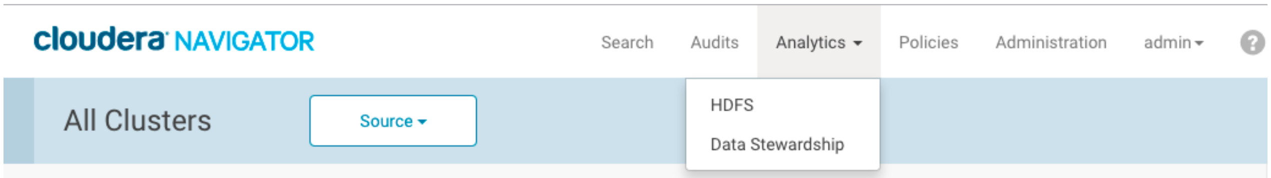
Data Stewardship Dashboard

The Cloudera Navigator Data Stewardship dashboard captures a variety of information about data, metadata, and user jobs that process the data. The Data Stewardship dashboard provides information and metrics to help you understand the state of the data and data usage, and lets you visualize trends and averages for a variety of data sources and actions.

For example, system administrators use the Dashboard (**Analytics** > **Data Stewardship Dashboard**) to look at the Activity Summary page, which provides a comprehensive overall view—databases created, tables created, tables dropped, SQL queries started, and so on.

Administrators can look for trends, the administrator navigates to the Data Explorer tab, makes two selections to filter for the past several weeks on SQL Queries Started as source type and gleans some clues about a rogue SQL query.

Access the dashboard by clicking **Analytics** and then choosing **Data Stewardship** on the navigation bar. Specify the source clusters by clicking **Source** and clicking a cluster name or **All Clusters**.



On the Data Stewardship dashboard, select a tab for the information you want to view:

- Dashboard. Provides "at-a-glance" information about databases, tables, operations, and files and directories
- Data Explorer. Lets you select cluster actions to view and compare for specific time periods, in conjunction with charts that show averages and trend lines.

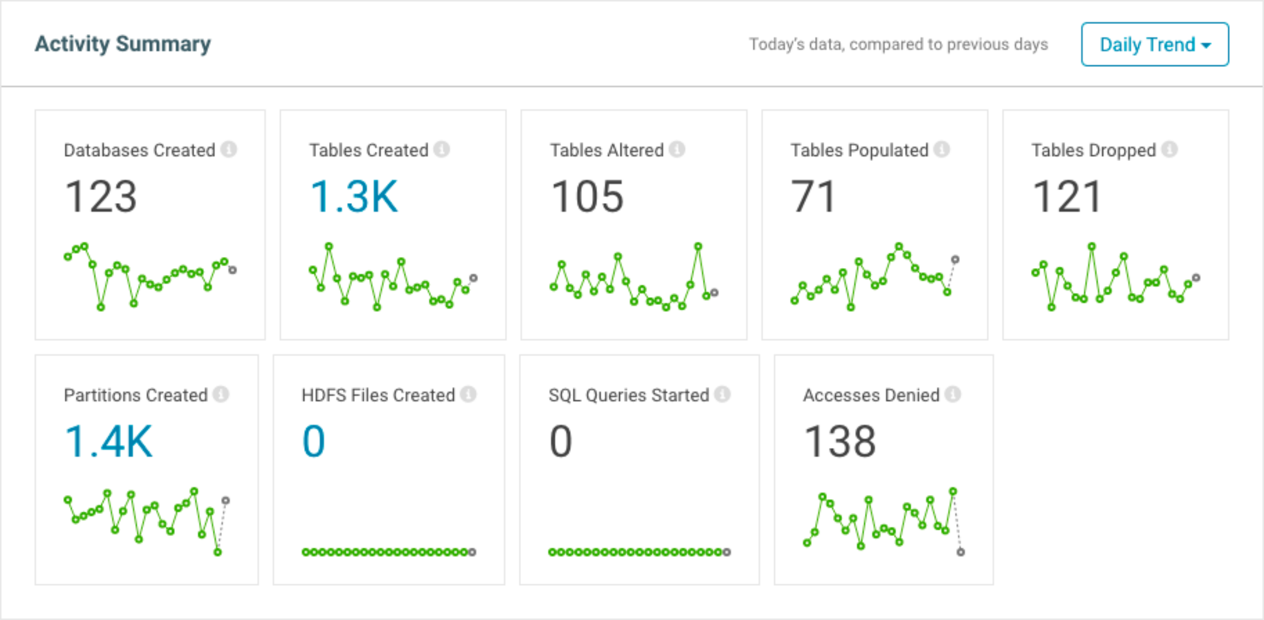
The dashboard is divided into the following major information areas:

- Activity Summary
- Databases

- Hive Tables
- Files and Directories
- Operations and Operation Executions

Dashboard

Activity Summary



Activity Summary

Today's data, compared to previous days

Databases Created 123

Tables Created 1.3K

Tables Altered 105

Tables Populated 71

Tables Dropped 121

Partitions Created 1.4K

HDFS Files Created 0

SQL Queries Started 0

Accesses Denied 138

Each tile in the Activity Summary section provides summary information for actions on a particular entity type and includes the following:

- The name of the activity
- The number of occurrences for that activity for a time period that you select (daily, weekly, monthly, quarterly, all time)
- A line graph showing activity trends based on the time period that you select

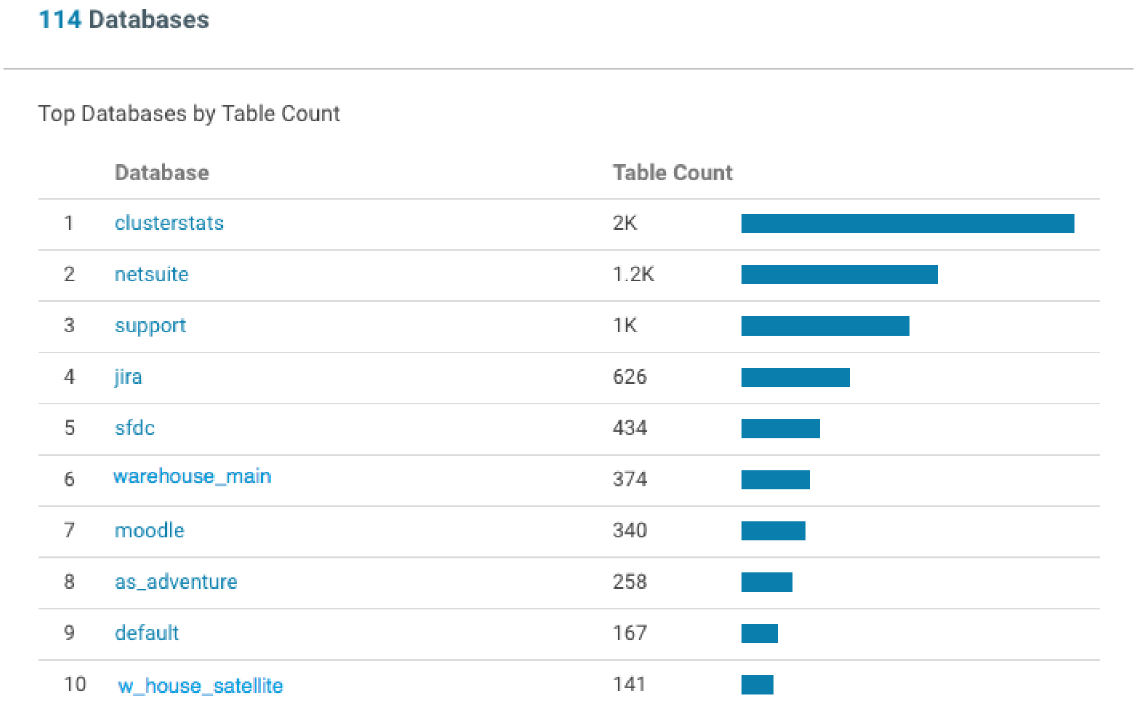
A graphical representation of the time-lapse summary for each activity tile is located at the bottom of the tile. Hovering over a point displays the value for that entity on a particular date. For example, if you select Daily Trend, the number in the graph shows number of occurences for the day so far (since midnight), and hovering over a graph point shows the number of occurrences for that full day as well as the average for the 20-day period represented by the graph.

The Activity Summary area includes the following information:

Databases Created	Number of new databases that were added to the cluster.
Tables Created	Number of new tables that were added to the cluster. Click the value to link to the Search page that shows the search results of the query defined. You can apply filters to narrow the search results and perform any other search actions.
Tables Altered	Number of tables that were changed.
Tables Populated	Number of tables that were populated with data.
Tables Dropped	Number of tables that were deleted.
Partitions Created	Number of partitions added. You can apply filters to narrow the search results and perform any other search actions.
HDFS Files Created	Files that were created. Click the new files value to link the Search page that shows the results of the query defined. You can apply filters to narrow the search results and perform any other search actions.

SQL Queries Started	Number of SQL queries that were run.
Accesses Denied	Number of access attempts by users that were denied.

Databases



114 Databases

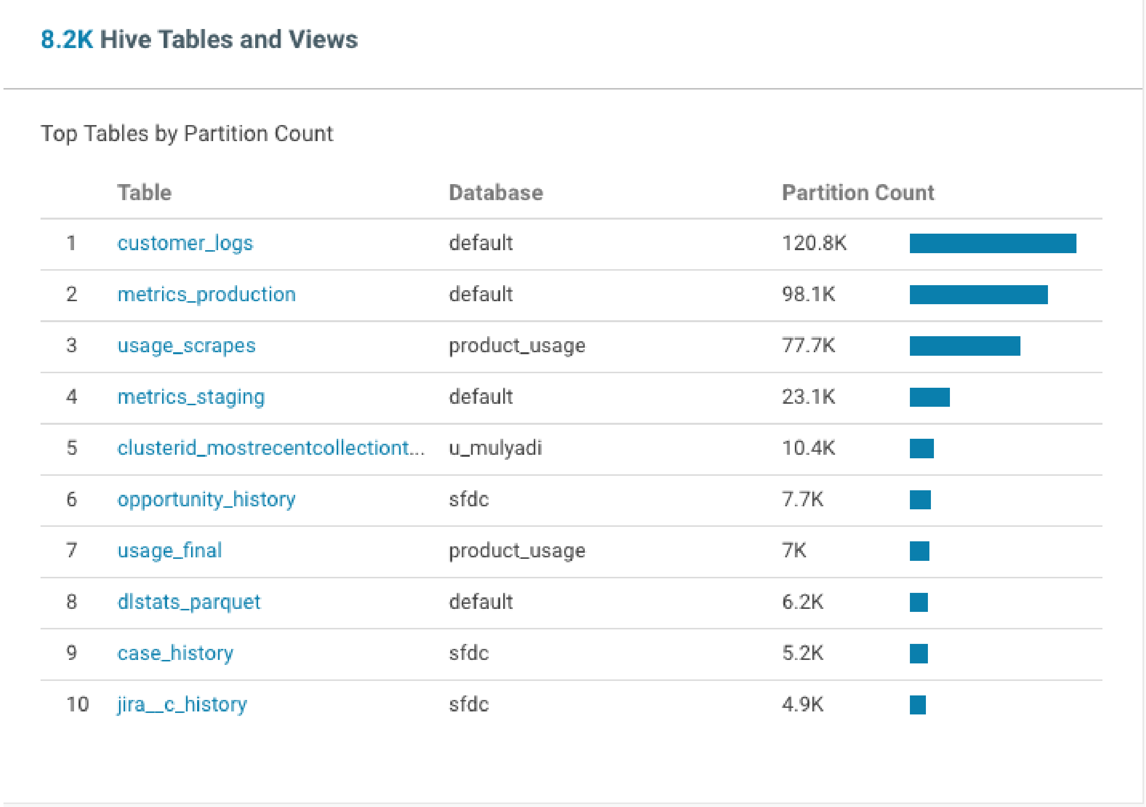
Top Databases by Table Count

	Database	Table Count
1	clusterstats	2K
2	netsuite	1.2K
3	support	1K
4	jira	626
5	sfdc	434
6	warehouse_main	374
7	moodle	340
8	as_adventure	258
9	default	167
10	w_house_satellite	141

The Databases area of the Dashboard shows the total number of databases in the source clusters. The top 10 databases, by table count, are displayed in the bar graph.

Click a heading or the bar to open the Details page for that database.

Hive Tables



8.2K Hive Tables and Views

Top Tables by Partition Count

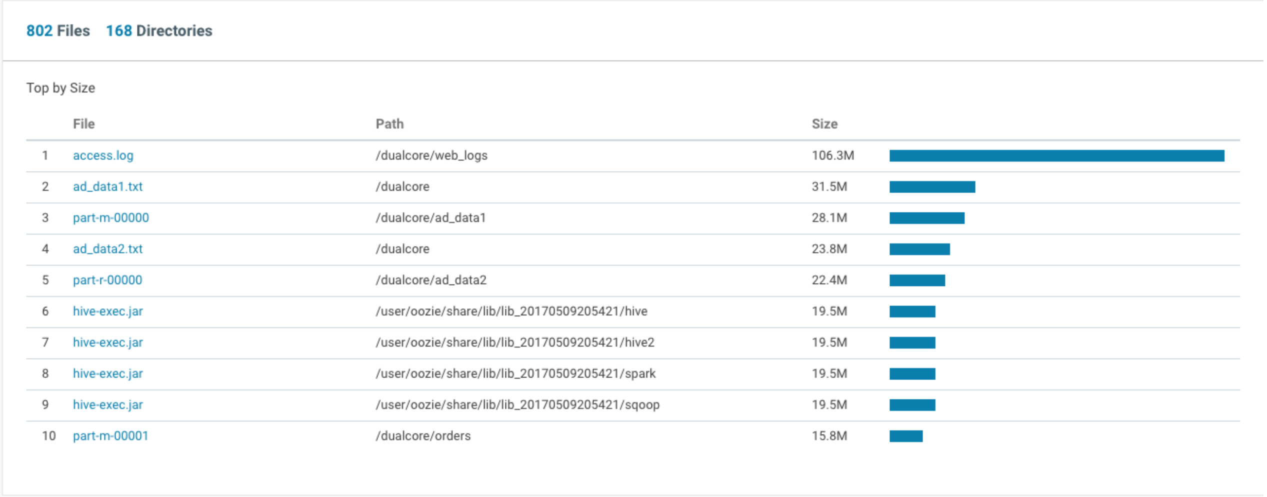
	Table	Database	Partition Count
1	customer_logs	default	120.8K
2	metrics_production	default	98.1K
3	usage_scrapes	product_usage	77.7K
4	metrics_staging	default	23.1K
5	clusterid_mostrecentcollectiont...	u_mulyadi	10.4K
6	opportunity_history	sfdc	7.7K
7	usage_final	product_usage	7K
8	dlstats_parquet	default	6.2K
9	case_history	sfdc	5.2K
10	jira__c_history	sfdc	4.9K

The Tables area of the dashboard shows the total number of Hive tables in the cluster. The top 10 tables, by partition count, are displayed in the bar graph.

Click the value next to the Hive Tables heading (in this case, 8.2K) to view matching tables in Search.

In the chart, click the bar for a particular table to open the Details page for that table.

Files and Directories



802 Files 168 Directories

Top by Size

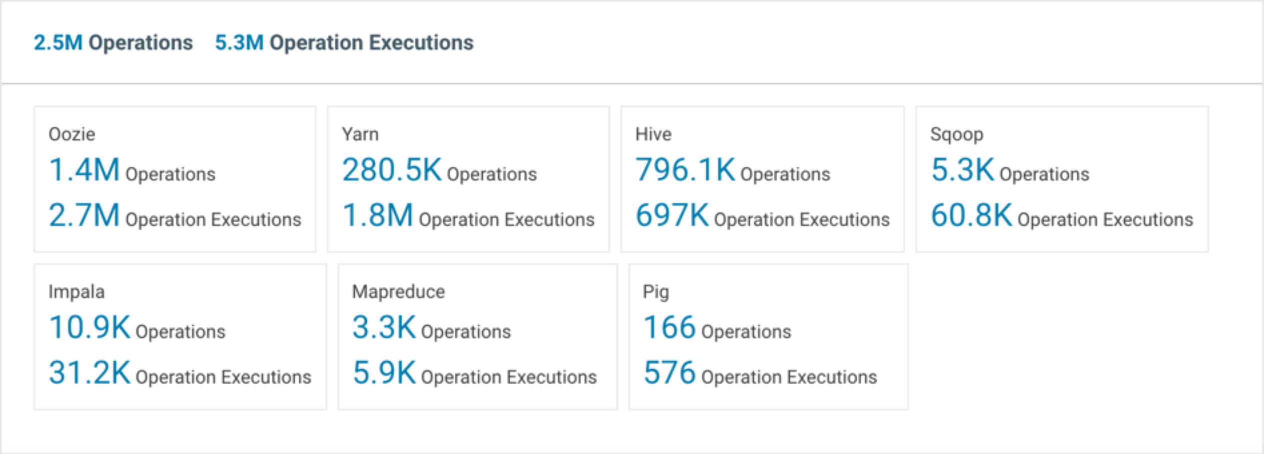
	File	Path	Size
1	access.log	/dualcore/web_logs	106.3M
2	ad_data1.txt	/dualcore	31.5M
3	part-m-00000	/dualcore/ad_data1	28.1M
4	ad_data2.txt	/dualcore	23.8M
5	part-r-00000	/dualcore/ad_data2	22.4M
6	hive-exec.jar	/user/oozie/share/lib/lib_20170509205421/hive	19.5M
7	hive-exec.jar	/user/oozie/share/lib/lib_20170509205421/hive2	19.5M
8	hive-exec.jar	/user/oozie/share/lib/lib_20170509205421/spark	19.5M
9	hive-exec.jar	/user/oozie/share/lib/lib_20170509205421/sqoop	19.5M
10	part-m-00001	/dualcore/orders	15.8M

The Files and Directories area of the Dashboard shows the total number of files and directories in the cluster.

Clicking the value next to the Files or Directory heading (in this case, 802 or 168, respectively) to show matching files or directories in Search.

The bar graph displays the top 10 files, based on size. Click the file name or the corresponding bar to open the Details page for that file.

Operations and Operation Executions



2.5M Operations **5.3M Operation Executions**

Oozie
1.4M Operations
2.7M Operation Executions

Yarn
280.5K Operations
1.8M Operation Executions

Hive
796.1K Operations
697K Operation Executions

Sqoop
5.3K Operations
60.8K Operation Executions

Impala
10.9K Operations
31.2K Operation Executions

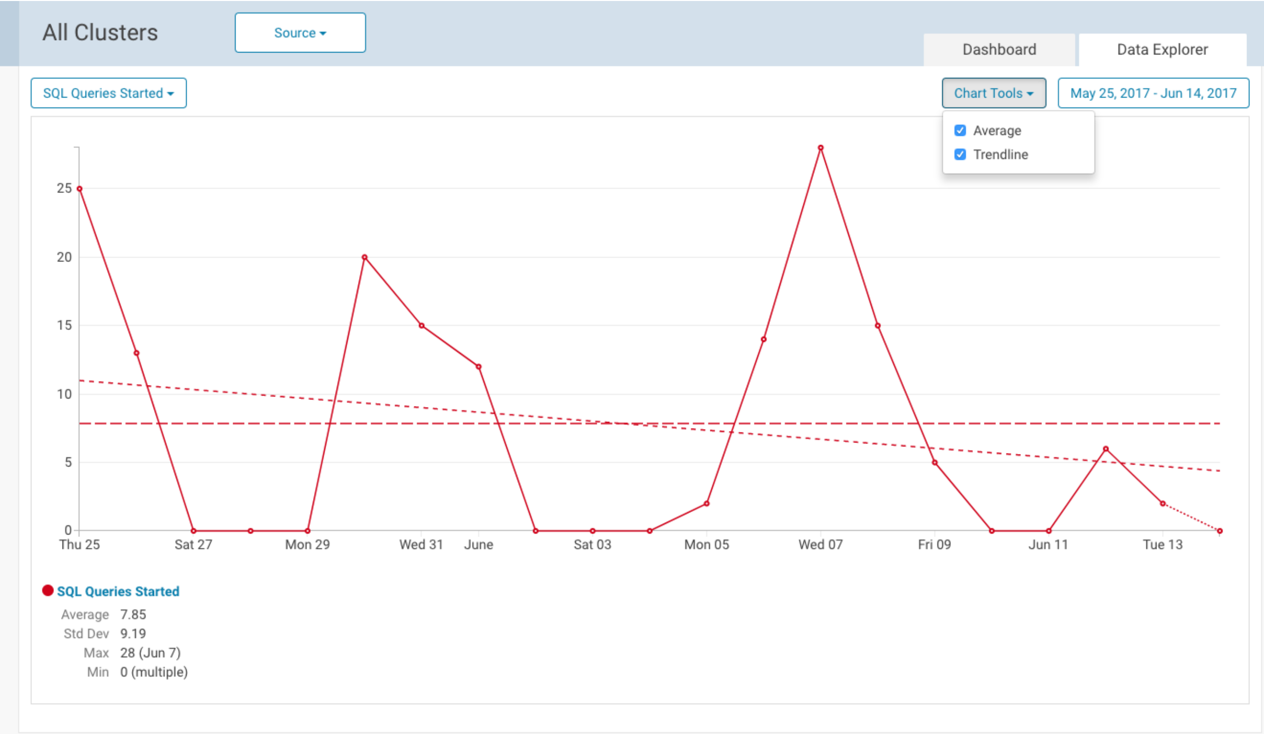
Mapreduce
3.3K Operations
5.9K Operation Executions

Pig
166 Operations
576 Operation Executions

The Operations and Operation Executions area of the Dashboard shows the total number of operations and operation executions that occurred in the cluster for the specified period of time.

Click the value next to the Operations or Operations Executions for a service to view matching operations or operation executions in Search.

Data Explorer



May 25, 2017 - Jun 14, 2017

☑ Average
☑ Trendline

● **SQL Queries Started**

Average	7.85
Std Dev	9.19
Max	28 (Jun 7)
Min	0 (multiple)

Cloudera Navigator Auditing

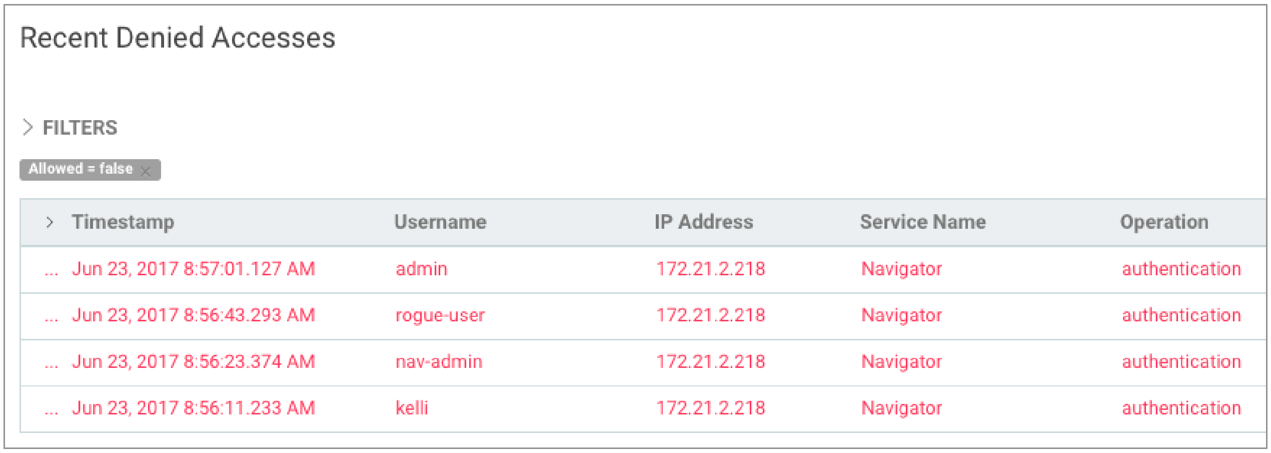
Cloudera Navigator auditing has been designed to meet demanding corporate governance and compliance requirements, especially for organizations in regulated industries. The Navigator Audit Server collects audit events from selected cluster services. Authorized users can use the Cloudera Navigator console to display audit event reports, create reports, and export audit details as CSV or other file formats. They can also search using configurable filters—a specific user name, IP address, or service name, for example—to quickly obtain answers to a variety of questions (see Using Audit Events to Understand Cluster Activity on page 18 for details).

Audit details for HDFS, the distributed storage layer that underlies any Hadoop cluster, are also characterized using histograms and other graphical charts that can be seen in the **analytics** area of the Cloudera Navigator console.

Events are the activities that occur during regular operations within the cluster. Events often result in messages that record the success or failure of activity along with other relevant details about the specific internal process, such as a hostname, IP address, or service name. Event messages from various services are typically sent to local log files, and from there, the Cloudera Manager Agent process sends them to the Navigator Audit Server (see Navigator Auditing Architecture on page 86 for details).

In addition to individual service events audited by Cloudera Navigator, Cloudera Manager Server records lifecycle events at the cluster, host, role, service, and user level, and records actions that involve licenses and parcels. For example, starting up the cluster is a lifecyle event captured by Cloudera Manager, as is downloading a parcel to update software. Cloudera Manager also captures security-related events, such as adding users, deleting users, login failures, and login successes. For more information about Cloudera Manager auditing capabilities, see Lifecycle and Security Auditing.

Cloudera Navigator tracks and coalesces events collected by Cloudera Manager and generates some of its own events as well. Audit events are viewable in the Cloudera Navigator console. Several pre-configured reports are available from the Audit tab of the Cloudera Navigator console, where you can also filter for specific types of events, create new reports, and export detailed audit reports as CSV or JSON. For example, here is a partial export of Recent Denied Accesses—user accounts without sufficient privileges (user roles) that attempted to log in to Cloudera Navigator but were prevented from doing so:



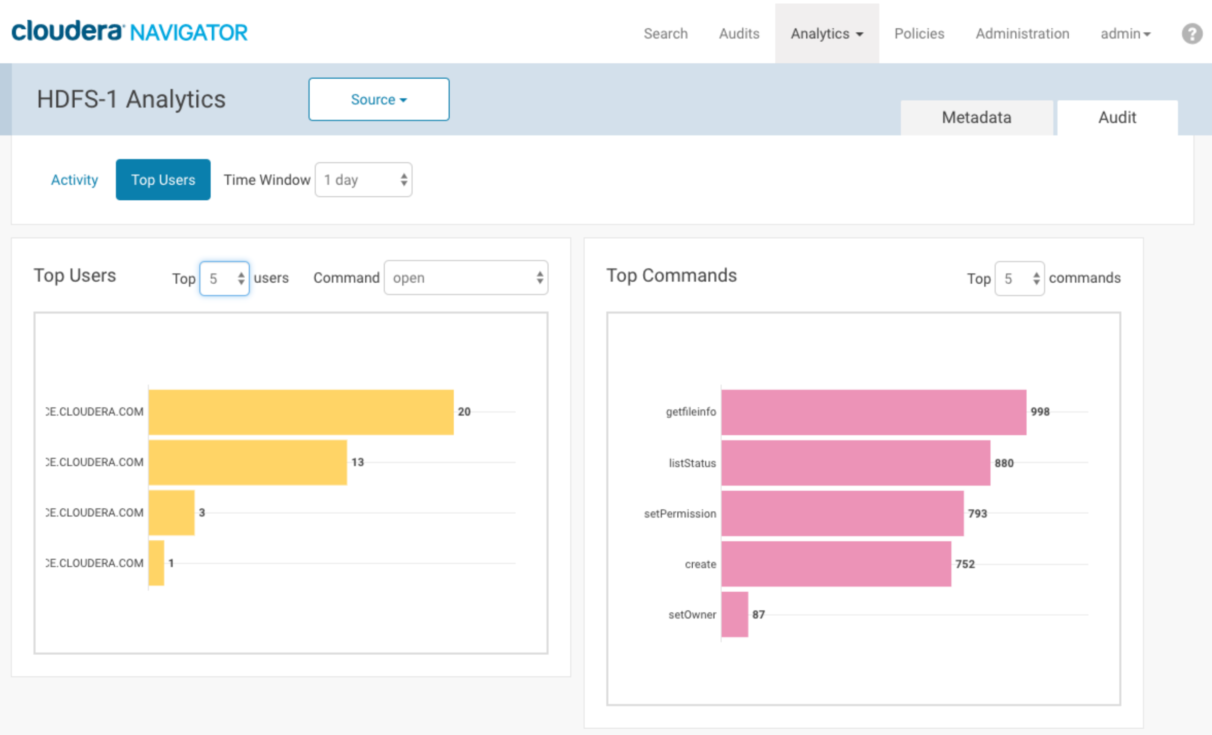
Recent Denied Accesses

Timestamp	Username	IP Address	Service Name	Operation
Jun 23, 2017 8:57:01.127 AM	admin	172.21.2.218	Navigator	authentication
Jun 23, 2017 8:56:43.293 AM	rogue-user	172.21.2.218	Navigator	authentication
Jun 23, 2017 8:56:23.374 AM	nav-admin	172.21.2.218	Navigator	authentication
Jun 23, 2017 8:56:11.233 AM	kelli	172.21.2.218	Navigator	authentication

Viewing Audit Analytics

Required Role: Auditing Viewer (or **Full Administrator**)

1. Log in to the Cloudera Navigator console.
2. Click the **Analytics** tab and select HDFS from the menu. The Audit tab displays. The Metadata tab may also display if the account has the appropriate permissions. The **Source** button displays in the banner section of the console if the Cloudera Navigator instance supports multiple clusters.



- Click the **Source** button (if it displays, meaning more than one instance) and select an HDFS instance from those available.

3. The Activity tab displays a bar graph that lists the number of files that have been read the number of times listed in the x-axis.
    - To display at the right the directories containing the files that have been read, click an activity bar. This draws a blue selection outline around the bar and selects the Activity checkbox.
    - To select more than one value, grab a bar edge and brush a range of values.
    - To change a range, click a bar, drag to a different range of values, and drop.
    - To reduce a range, grab a bar edge and contract the range.
    - To clear Activity, clear the checkbox. The previous selection is indicated with a gray outline.
    - When you select Activity and the graph had a previous selection, the previous selection is reused. For example, if you had previously selected values spanning six through nine for the number of times files have been read, and you select the checkbox, six through nine will be reselected.
4. In the directory listing on the right:
    - Filter the directories by typing directory strings in the search box and pressing **Enter** or **Return**.

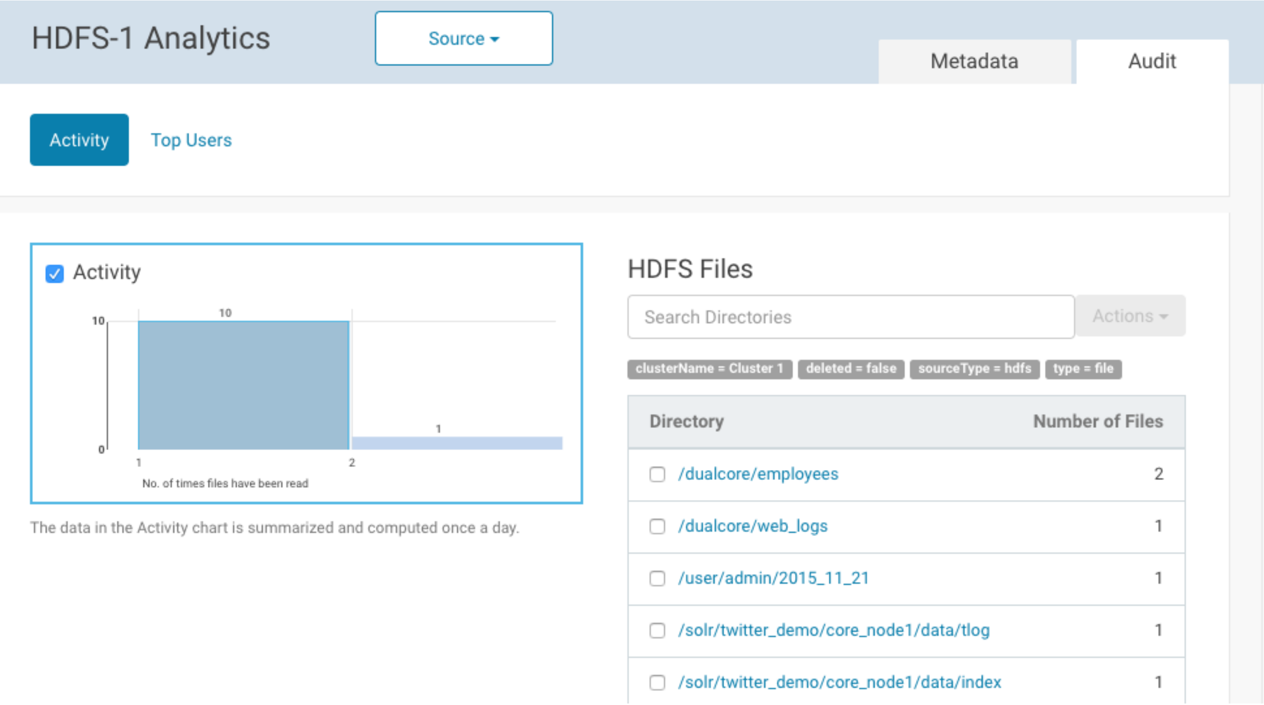
      Required Role: Metadata & Lineage Viewer (or Managed & Custom Metadata Editor, or **Full Administrator**)

      Add selected directories to a search query and display the Search tab by doing one of the following:

      – Clicking a directory name link.
      – Selecting one or more directory checkboxes and selecting **Actions** > **Show selection in search**.
    - **Required Role:** Metadata & Lineage Viewer (or Managed & Custom Metadata Editor, or **Full Administrator**)

      Add selected directories to the search query of a new policy and display the Policies tab by selecting one or more directory checkboxes and selecting **Actions** > **Create a policy from selection**.

For example, the following screenshot shows files that have been accessed once and match the string `staging`. Each directory has six files that has been accessed.



The data in the Activity chart is summarized and computed once a day.

clusterName = Cluster 1 | deleted = false | sourceType = hdfs | type = file

Directory	Number of Files
□ /dualcore/employees	2
□ /dualcore/web_logs	1
□ /user/admin/2015_11_21	1
□ /solr/twitter_demo/core_node1/data/tlog	1
□ /solr/twitter_demo/core_node1/data/index	1

Using Audit Events to Understand Cluster Activity

Actions performed on the cluster by users and by services are tracked by Cloudera Navigator. Using the filters available on the Audit page of the Cloudera Navigator console lets you quickly find answers to a variety of questions such as:

- What Did a Specific User Do on a Specific Day? on page 18
- Who Deleted Files from Hive Warehouse Directory? on page 20
- What Happened to Data in the Database? on page 21
- Who ran which operation on a table?

The examples below step through these common use cases.

To work with Audit Events in the Cloudera Navigator console, you must have an account with the user role of Auditing Viewer or Navigator Administrator .

To view Audit Events in the Cloudera Navigator console and apply filters:

1. Log in to the Cloudera Navigator console.
2. Click the **Audits** tab. The default view displays a list of all Audit Events for the past hour (note the date range field above the listing, below the Actions button).
3. Configure and apply filters as needed to find specific events by username, by source, for selected time frames, and so on.

What Did a Specific User Do on a Specific Day?

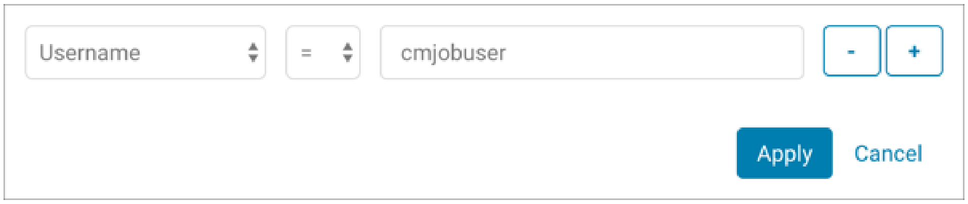
A data engineer complains that a job was not running as well as expected one afternoon and wants to find out what might have occurred.

To filter the audit details to these specifics, you need only the user name and the time frame. The example isolates actions by the user name **cmjobuser** for a one-hour period on November 3, 2016:

1. Limit the list of audit events to those for a specific user by defining a username filter:
   a. Click **Filters** to open the filter selector.
   b. Select **Username** from the Select Property... drop-down selector.

c. Set the evaluation operator (=, `like`, `!=`) to **=** (equals sign).

d. Type the username (**cmjobuser** for this example).

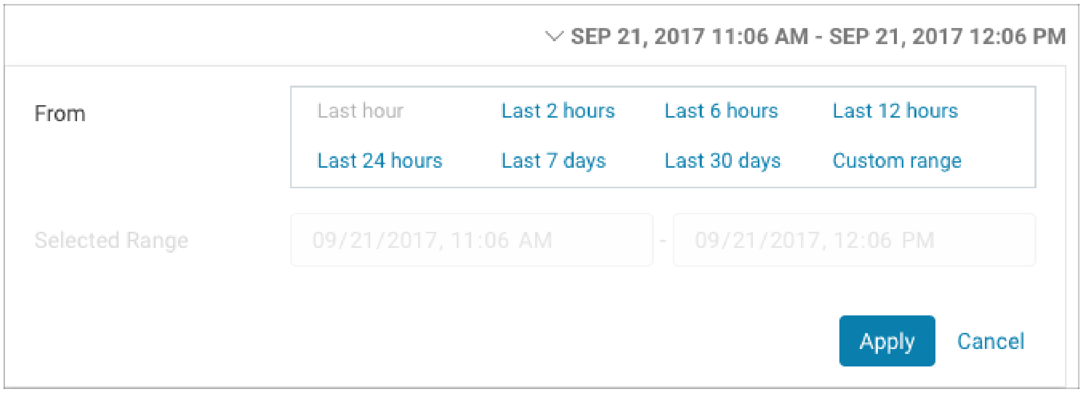


Username = cmjobuser

e. Click **Apply**. The filter is applied to the audit events and the list displays only those events for the selected username.

2. Limit the Audit Events list for the selected username to only those events that occurred on a specific date at a specific time:

a. Click the arrow next to the current date range field to open the date and time range options selector. Time frame options range from the last 2, 6, 12, or 24 hours to the last 7 or last 30 days, but also let you set a custom range.

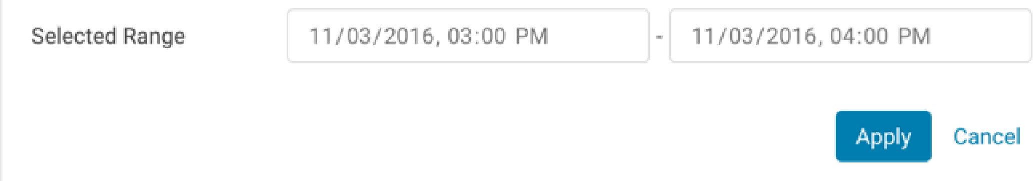


SEP 21, 2017 11:06 AM - SEP 21, 2017 12:06 PM

Selected Range 09/21/2017, 11:06 AM - 09/21/2017, 12:06 PM

b. Click the **Custom Range** link to open the date and time range selector.

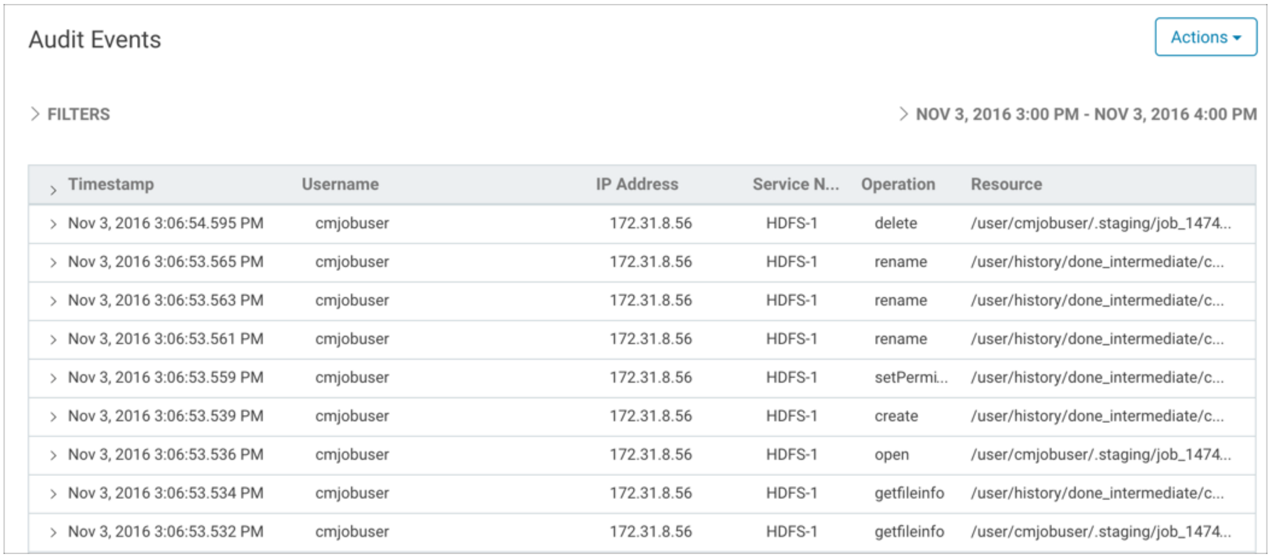
c. Use the field controls to set the start date and time and the end date and time for your custom time frame, as shown in this example:



Selected Range 11/03/2016, 03:00 PM - 11/03/2016, 04:00 PM

d. Click **Apply**.

The date and time range is applied to the Audit Events filtered by username and displays the resulting list in reverse chronological order (end date and time at the top of the list). The Audit Events for username **cmjobuser** during the one-hour period from 3:00 to 4:00 PM on November 3, 2016 are shown below.



Audit Events

> FILTERS

> NOV 3, 2016 3:00 PM - NOV 3, 2016 4:00 PM

Timestamp	Username	IP Address	Service N...	Operation	Resource
Nov 3, 2016 3:06:54.595 PM	cmjobuser	172.31.8.56	HDFS-1	delete	/user/cmjobuser/.staging/job_1474...
Nov 3, 2016 3:06:53.565 PM	cmjobuser	172.31.8.56	HDFS-1	rename	/user/history/done_intermediate/c...
Nov 3, 2016 3:06:53.563 PM	cmjobuser	172.31.8.56	HDFS-1	rename	/user/history/done_intermediate/c...
Nov 3, 2016 3:06:53.561 PM	cmjobuser	172.31.8.56	HDFS-1	rename	/user/history/done_intermediate/c...
Nov 3, 2016 3:06:53.559 PM	cmjobuser	172.31.8.56	HDFS-1	setPermi...	/user/history/done_intermediate/c...
Nov 3, 2016 3:06:53.539 PM	cmjobuser	172.31.8.56	HDFS-1	create	/user/history/done_intermediate/c...
Nov 3, 2016 3:06:53.536 PM	cmjobuser	172.31.8.56	HDFS-1	open	/user/cmjobuser/.staging/job_1474...
Nov 3, 2016 3:06:53.534 PM	cmjobuser	172.31.8.56	HDFS-1	getfileinfo	/user/history/done_intermediate/c...
Nov 3, 2016 3:06:53.532 PM	cmjobuser	172.31.8.56	HDFS-1	getfileinfo	/user/cmjobuser/.staging/job_1474...

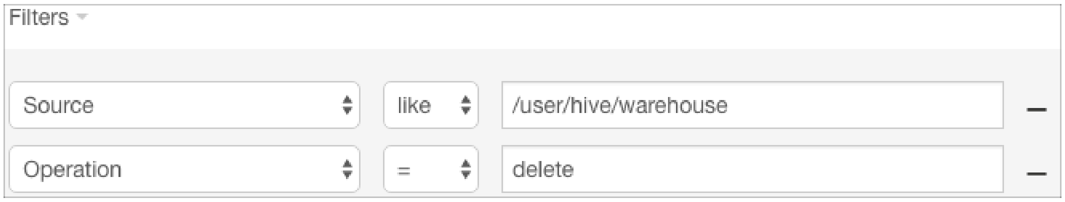
Who Deleted Files from Hive Warehouse Directory?

A data steward is wondering what happened to some critical files in the data warehouse—they seem to have been deleted. The organization uses the Hive warehouse located in the default directory:

- `/user/hive/warehouse`

To find out who deleted files from this directory, create a filter that uses the Source property in conjunction with the Delete operation.

1. Limit the list of Audit Events to only those for the `/user/hive/warehouse` directory:
   - a. Click **Filters**.
   - b. Select **Source** from the Select Property... drop-down selector.
   - c. Set the evaluation operator to **like**.
   - d. Type **/user/hive/warehouse** in the entry field for the Source property.
   - e. Click **Apply**. The source filter added to the list of filters and applied to Audit Events, returning an updated Audit Events list.
2. Find all delete operations that occurred on the source (the Hive warehouse directory, in this example):
   - a. Click **Filters**. The Source filter displays the filter previously configured. Click the plus sign (+) at the end of the filter definition to add new filter setting fields.
   - b. Select **Operation** from the Select Property... drop-down selector.
   - c. Set the evaluation operator to **=**.
   - d. Type **delete** in the entry field for Operation property.



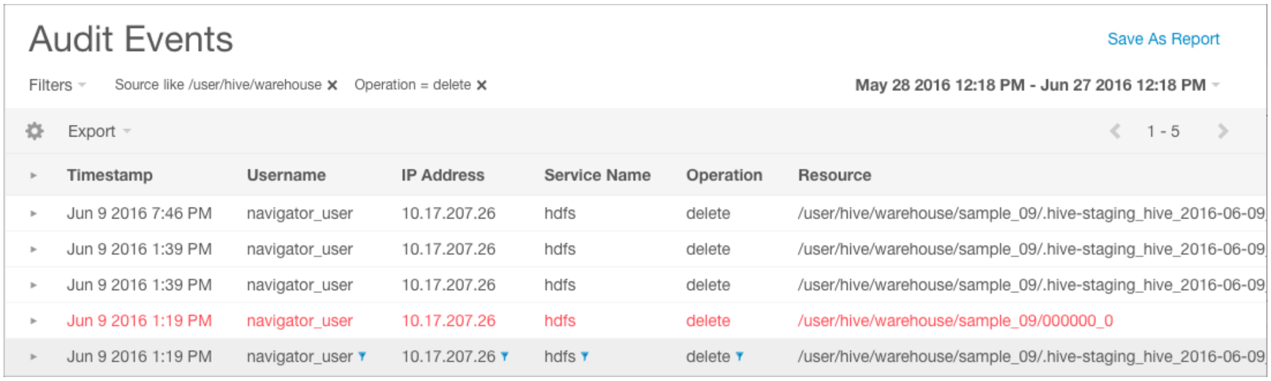
Filters

Source like /user/hive/warehouse

Operation = delete

   - e. Click **Apply**. The filter to select delete operations is added to the list of filters and applied to Audit Events. An updated Audit Events list is returned, showing only delete operations for sources similar to /user/hive/warehouse.

The results show both completed and attempted delete operations (attempted but unsuccessful are in red). All these events are associated with username **navigator_user** from the same IP address and using the same service (hdfs) over the course of a day (June 9, 2016).



Audit Events

Source like /user/hive/warehouse ✕ Operation = delete ✕

May 28 2016 12:18 PM - Jun 27 2016 12:18 PM

Timestamp	Username	IP Address	Service Name	Operation	Resource
Jun 9 2016 7:46 PM	navigator_user	10.17.207.26	hdfs	delete	/user/hive/warehouse/sample_09/.hive-staging_hive_2016-06-09
Jun 9 2016 1:39 PM	navigator_user	10.17.207.26	hdfs	delete	/user/hive/warehouse/sample_09/.hive-staging_hive_2016-06-09
Jun 9 2016 1:39 PM	navigator_user	10.17.207.26	hdfs	delete	/user/hive/warehouse/sample_09/.hive-staging_hive_2016-06-09
Jun 9 2016 1:19 PM	navigator_user	10.17.207.26	hdfs	delete	/user/hive/warehouse/sample_09/000000_0
Jun 9 2016 1:19 PM	navigator_user	10.17.207.26	hdfs	delete	/user/hive/warehouse/sample_09/.hive-staging_hive_2016-06-09

With this information, a Navigator Administrator can go to the Administration tab of the Cloudera Navigator console and find out who is associated with the navigator_user account.

- Log in to the Cloudera Navigator console.
- Click the **Administration** tab.
- Click the **Role Management** tab.

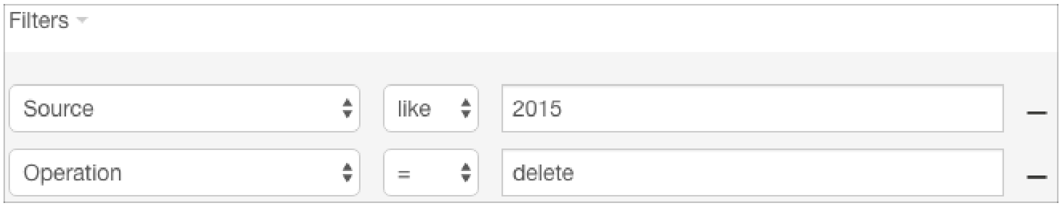
What Happened to Data in the Database?

The data files associated with a database are typically partitioned into files or directories by date, often by year. The system admin discovers that the data from 2015 is missing from the production database—only data prior to 2010 has been archived off the system, so data from 2015 should still be there.

Files for data created in 2015 include `2015` in their filenames.

To determine what happened to the data stored in folders and files in the year 2015, do the following:

1. Filter the list of events for sources containing 2015:
    a. Click **Filters**.
    b. Select **Source** from the Select Property... drop-down selector. Sources can be paths to HDFS files or directories.
    c. Set the evaluation operator to **like**.
    d. Type **2015** in the entry field for the Source property.
    e. Click **Apply**. The source filter added to the list of filters and applied to Audit Events, returning an updated Audit Events list.
2. Filter the list of events for the delete operation:
    a. Click **Filters**. The Source filter displays the filter previously configured. Click the plus sign (+) at the end of the filter definition to add new filter setting fields.
    b. Select **Operation** from the Select Property... drop-down selector.
    c. Set the evaluation operator to **=**.
    d. Type **delete** in the entry field for the Operation property.



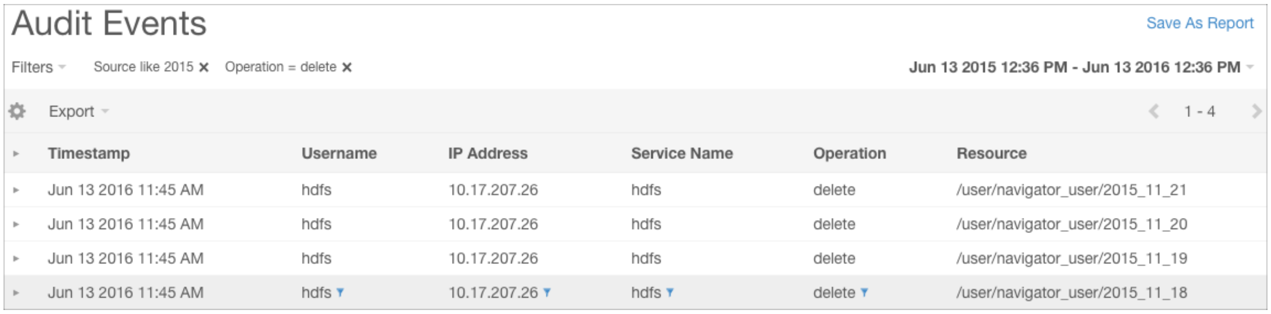
Source like 2015

Operation = delete

    e. Click **Apply**. The operation filter added to the list of filters and applied to Audit Events, returning an updated list containing Audit Events for delete operations from sources like 2015.
3. Set the date range to one year:
    a. Click the date-time field at the top right of the Audit Events page.
    b. To set the range to be the last year, click **Custom Range**. The Selected Range field is enabled for input.

  c. In the left date field, use the field controls to specify a date one year ago.
  d. Click **Apply**.

The result of all filters and the selected time frame reveals that the **hdfs** username deleted directories containing 2015 in their names:



Audit Events

Save As Report

Filters ▾ Source like 2015 ✕ Operation = delete ✕

Jun 13 2015 12:36 PM - Jun 13 2016 12:36 PM ▾

Export ▾ 1 - 4

Timestamp	Username	IP Address	Service Name	Operation	Resource
Jun 13 2016 11:45 AM	hdfs	10.17.207.26	hdfs	delete	/user/navigator_user/2015_11_21
Jun 13 2016 11:45 AM	hdfs	10.17.207.26	hdfs	delete	/user/navigator_user/2015_11_20
Jun 13 2016 11:45 AM	hdfs	10.17.207.26	hdfs	delete	/user/navigator_user/2015_11_19
Jun 13 2016 11:45 AM	hdfs	10.17.207.26	hdfs	delete	/user/navigator_user/2015_11_18

Who ran which operation against a table?

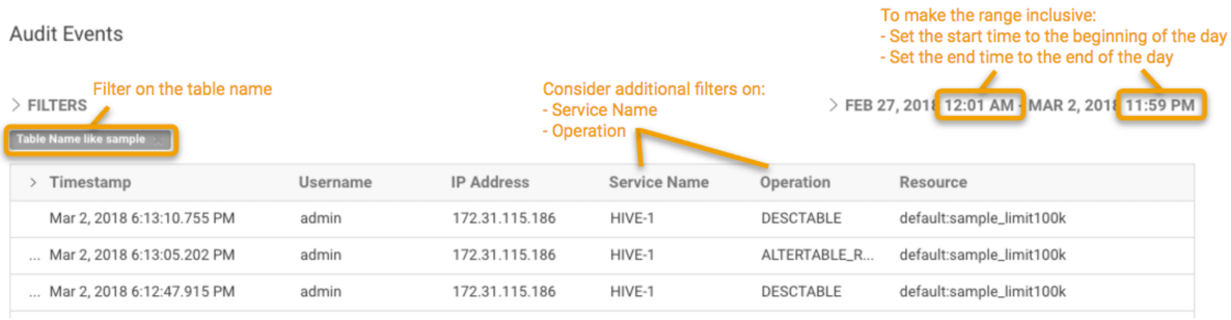
When a change occurs to a data asset, it can cause problems to reports or other processes that use the data asset. You can use the Audit events to find when and what caused a change in a data asset. This example describes how to use audits to determine what caused a schema change to a table so you can identify the user or process that may be causing unwanted changes.

To find all operations against a specific table in a general time range:

1. Filter the list of events for the table.
   a. Click **Filters**.
   b. Select **Table Name** from the Select Property... drop-down selector.
   c. Set the evaluation operator to **like**.
   d. Type the part or all of the table name in the entry field for the Table Name property.
   e. Click **Apply**. The source filter added to the list of filters and applied to Audit Events, returning an updated Audit Events list.
2. Set the date range to the general time frame where the change occurred:
   a. Click the date-time field at the top right of the Audit Events page.
   b. To set the range, click **Custom Range**. The Selected Range field is enabled for input.
   c. In the left date field, use the field controls to specify the earliest date where the change may have occurred.

      To include the entire day, set the time to indicate the beginning of the day, such as `12:01 AM`.
   d. In the right date field, specify the latest date where the change may have occurred.

      To include the entire day, set the time to indicate the end of the day, such as `11:59 PM`.
   e. Click **Apply**.
3. Review the results, looking at both the operation and the service name.
4. If the results are too large, consider adding additional filters:
   - **By Service Name.** For example, to show all Hive operations, use `Service Name like hive`.
   - **By Operation.** For example, to show only Hive operations that change the table metadata, use `Operation like alter`.



Audit Events

Filter on the table name

Consider additional filters on:
- Service Name
- Operation

To make the range inclusive:
- Set the start time to the beginning of the day
- Set the end time to the end of the day

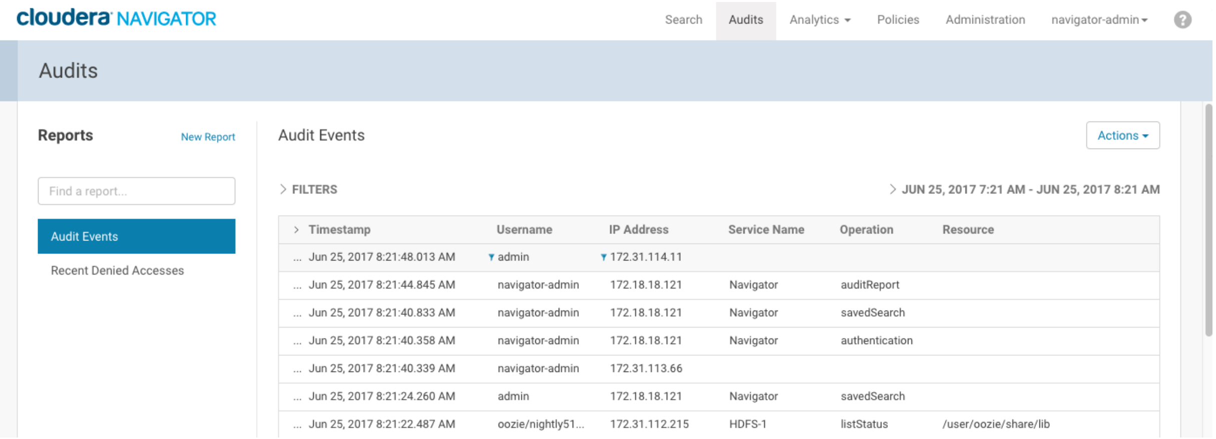
Timestamp	Username	IP Address	Service Name	Operation	Resource
Mar 2, 2018 6:13:10.755 PM	admin	172.31.115.186	HIVE-1	DESCTABLE	default:sample_limit100k
Mar 2, 2018 6:13:05.202 PM	admin	172.31.115.186	HIVE-1	ALTERTABLE_R...	default:sample_limit100k
Mar 2, 2018 6:12:47.915 PM	admin	172.31.115.186	HIVE-1	DESCTABLE	default:sample_limit100k

Exploring Audit Data

Required Role: Auditing Viewer (or **Full Administrator**)

Viewing Audit Events

1. Click the **Audits** tab. By default, the Audit Events report opens, listing all events that occurred within the last hour, with the most recent at the top:



Timestamp	Username	IP Address	Service Name	Operation	Resource
Jun 25, 2017 8:21:48.013 AM	admin	172.31.114.11			
Jun 25, 2017 8:21:44.845 AM	navigator-admin	172.18.18.121	Navigator	auditReport	
Jun 25, 2017 8:21:40.833 AM	navigator-admin	172.18.18.121	Navigator	savedSearch	
Jun 25, 2017 8:21:40.358 AM	navigator-admin	172.18.18.121	Navigator	authentication	
Jun 25, 2017 8:21:40.339 AM	navigator-admin	172.31.113.66			
Jun 25, 2017 8:21:24.260 AM	admin	172.18.18.121	Navigator	savedSearch	
Jun 25, 2017 8:21:22.487 AM	oozie/nightly51...	172.31.112.215	HDFS-1	listStatus	/user/oozie/share/lib

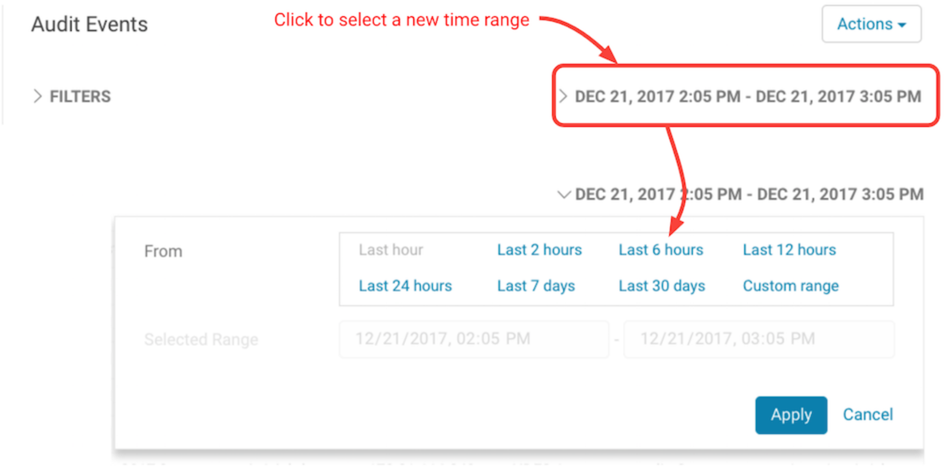
The Audit Events and Recent Denied Accesses reports are available by default. You create your own reports and apply a variety of filters as detailed in the next section.

Filtering Audit Events

You filter audit events by specifying a time range or adding one or more filters containing an audit event field, operator, and value.

Specifying a Time Range

1. Click the date-time range at the top right of the Audits tab to open a range selector.



Selected Range: 12/21/2017, 02:05 PM - 12/21/2017, 03:05 PM

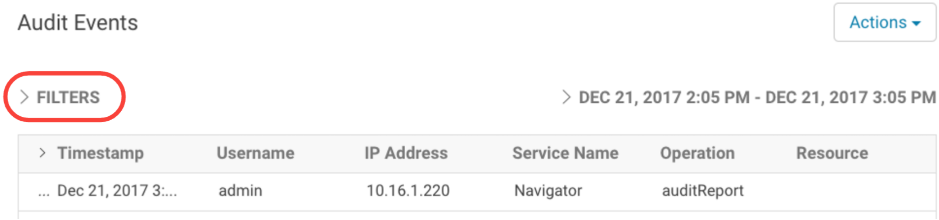
2. Select one of the pre-defined ranges.

   To enter a specific time range, choose **Custom range** and use the controls in **Selected Range** to specify start and end dates and times.

3. Click **Apply**.

Adding a Filter

1. Click the **Filters** link.



> Timestamp	Username	IP Address	Service Name	Operation	Resource
... Dec 21, 2017 3:...	admin	10.16.1.220	Navigator	auditReport	

   The Filters pane displays.

2. Click + if a filter field is not already open.
3. Choose a field in the **Select Property** drop-down list.

   The properties correspond to the audit fields listed in Service Audit Events on page 166.

4. Choose an operator in the operator drop-down list.

   Choose from **=** (equals), **!=** (not equals), **like**, and **not like**. The **like** operator matches to substrings. For example, to see all the audit events for files created in the folder `/user/joe/out`, specify `Source like /user/joe/out`.

   Use **not like** to filter out events based on a partial string match. For example, to show audit events for a set of IP addresses that start with the same sequence 172.39.109, you can specify `IP Address` not `like` `172.39.109`.
5. Type a field value in the value text field.

   For example, to see the events listed for Navigator, enter `Service Name` = `Navigator`.

6. To specify an additional filter, click + and define the new criteria.

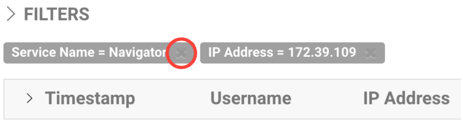
   Audit events show that match all filters (AND).

7. Click **Apply**.

A filter breadcrumb appears above the list of audit events and the list of events displays all events that match all the filter criteria.

Removing a Filter

1. Click the **x** next to the filter breadcrumb.



You can also click **Filters** and modify or remove filter criteria.

Cloudera Navigator Audit Event Reports

Required Role: Auditing Viewer (or **Full Administrator**)

Cloudera Navigator console provides two default reports for display by default:

- Audit Events listing, which displays all recent events in reverse chronological order
- Recent Denied Accesses, which displays all accesses within the cluster and highlights denied access attempts in red, for easy identification.

These two default reports are starting points. Use the Audit Report and define filters to create new reports can be created by defining and applying filters to fine-tune the selected results. Give the filtered report specifications for future use, and export (download) any report to CSV and JSON file formats.

In addition, the metadata about the audit reports you create and save is recorded by the Navigator Metadata Server.

This section shows you how to use the Cloudera Navigator console to create audit reports.

Note: All steps below start from the Cloudera Navigator console.

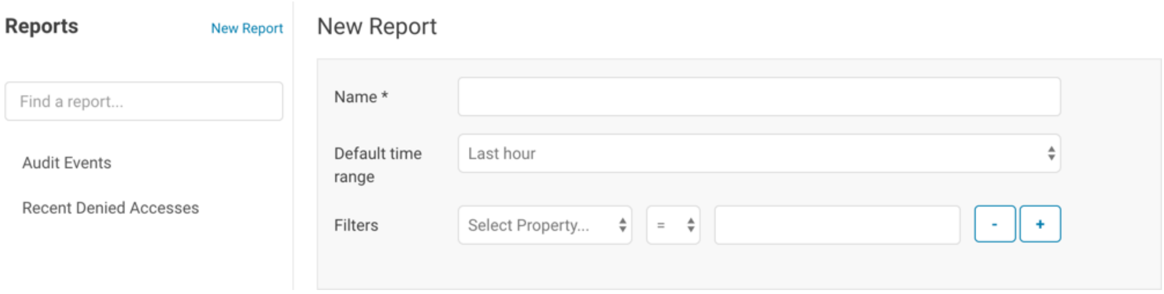
Creating Audit Event Reports

Selecting the Audit menu in the Cloudera Navigator console displays the Audit Events report. This report displays all audit events captured in the last 1 hour. You can modify the filters configured for this report and save it, giving it a new name, as follows.

1. To save a filtered version of the Audit Events report:

   a. Optionally specify filters (seeFiltering Audit Events on page 23) .
   b. Click **Save As Report**.

   - Create a new report by clicking **New Report**.



2. Enter a report name.
3. In the **Default time range** field, specify a relative time range. If you had specified a custom absolute time range before selecting **Save As Report**, the *custom absolute time range is discarded*.
4. Optionally add filters (seeFiltering Audit Events on page 23).
5. Click **Save**.

Editing Audit Event Reports

1. In the left pane, click a report name.
2. Click **Edit Report**.
3. In the **Default time range** field, specify a relative time range. If you had specified a custom absolute time range before selecting **Save As Report**, the *custom absolute time range is discarded*.
4. Optionally add filters (seeFiltering Audit Events on page 23).
5. Click **Save**.

Downloading Audit Event Reports

You can download audit event reports in the Cloudera Navigator console or using in CSV and JSON formats. An audit event contains the following fields:

- `timestamp`
- `service`
- `username`
- `ipAddress`
- `command`
- `resource`
- `allowed`
- `[operationText]`
- `serviceValues`

The values for `resource` and `serviceValues` fields depend on the type of the service. In addition, Hive, Hue, Impala, and Sentry events have the `operationText` field, which contains the operation string. See Service Audit Events on page 166 for details.

In addition to downloading audit events, you can configure the Navigator Audit Server to publish audit events to a Kafka topic or syslog. See Publishing Audit Events.

Downloading Audit Event Reports from

1. Do one of the following:
   - Add filters ((seeFiltering Audit Events on page 23).
   - In the left pane, click a report name.
2. Select **Export** > ***format***, where *format* is CSV or JSON.

Downloading Audit Events Using the Audit API

You can filter and download audit events using the Cloudera Navigator APIs.

Hive Audit Events Using the Audit API

To use the API to download the audits events for a service named `hive`, use the `audits` endpoint with the `GET` method:

```
http://fqdn-n.example.com:port/api/APIversion/audits/?parameters
```

where *fqdn-n.example.com* is the host running the Navigator Metadata Server role instance listening for HTTP connections at the specified *port* number (`7187` is the default port number). *APIversion* is the running version of the

API as indicated in the footer of the API documentation (available from the Help menu in the Navigator console) or by calling `http://fqdn-n.example.com:port/api/version`.

For example:

```
curl http://node1.example.com:7187/api/v13/audits/?query=service%3D%3Dhive\
&startTime=1431025200000&endTime=1431032400000&limit=5&offset=0&format=JSON&attachment=false\
-X GET -u username:password
```

The `startTime` and `endTime` parameters are required and must be specified in epoch time in milliseconds.

The request could return the following JSON items:

```
[ {
  "timestamp" : "2015-05-07T20:34:39.923Z",
  "service" : "hive",
  "username" : "hdfs",
  "ipAddress" : "12.20.199.170",
  "command" : "QUERY",
  "resource" : "default:sample_08",
  "operationText" : "INSERT OVERWRITE \n  TABLE sample_09 \nSELECT \n
sample_07.code,sample_08.description \n  FROM sample_07 \n  JOIN sample_08 \n  WHERE
sample_08.code = sample_07.code",
  "allowed" : true,
  "serviceValues" : {
    "object_type" : "TABLE",
    "database_name" : "default",
    "operation_text" : "INSERT OVERWRITE \n  TABLE sample_09 \nSELECT \n
sample_07.code,sample_08.description \n  FROM sample_07 \n  JOIN sample_08 \n  WHERE
sample_08.code = sample_07.code",
    "resource_path" : "/user/hive/warehouse/sample_08",
    "table_name" : "sample_08"
  }
}, {
  "timestamp" : "2015-05-07T20:33:50.287Z",
  "service" : "hive",
  "username" : "hdfs",
  "ipAddress" : "12.20.199.170",
  "command" : "SWITCHDATABASE",
  "resource" : "default:",
  "operationText" : "USE default",
  "allowed" : true,
  "serviceValues" : {
    "object_type" : "DATABASE",
    "database_name" : "default",
    "operation_text" : "USE default",
    "resource_path" : "/user/hive/warehouse",
    "table_name" : ""
  }
}, {
  "timestamp" : "2015-05-07T20:33:23.792Z",
  "service" : "hive",
  "username" : "hdfs",
  "ipAddress" : "12.20.199.170",
  "command" : "CREATETABLE",
  "resource" : "default:",
  "operationText" : "CREATE TABLE sample_09 (code string,description string) ROW FORMAT
 DELIMITED FIELDS TERMINATED BY '\\t' STORED AS TextFile",
  "allowed" : true,
  "serviceValues" : {
    "object_type" : "DATABASE",
    "database_name" : "default",
    "operation_text" : "CREATE TABLE sample_09 (code string,description string) ROW
FORMAT DELIMITED FIELDS TERMINATED BY '\\t' STORED AS TextFile",
    "resource_path" : "/user/hive/warehouse",
    "table_name" : ""
  }
} ]
```

Cloudera Navigator Metadata

Cloudera Navigator lets organizations catalog data contained in Hadoop clusters. With data entities in the cluster tagged with relevant metadata properties, data stewards can provide curated datasets, business users can do their own self-service discovery, and system administrators can develop effective archival strategies.

The Navigator Metadata Server is the role instance that provides the metadata definition, tagging, and management system. Any given entity can be identified by one or more of the three different classes of metadata.

Cloudera Navigator console lets you view metadata through various dashboards, such as the Data Stewardship Dashboard and Data Explorer, that provide at-a-glance views of cluster assets.

This section focuses on the HDFS Analytics menu of the Cloudera Navigator console.

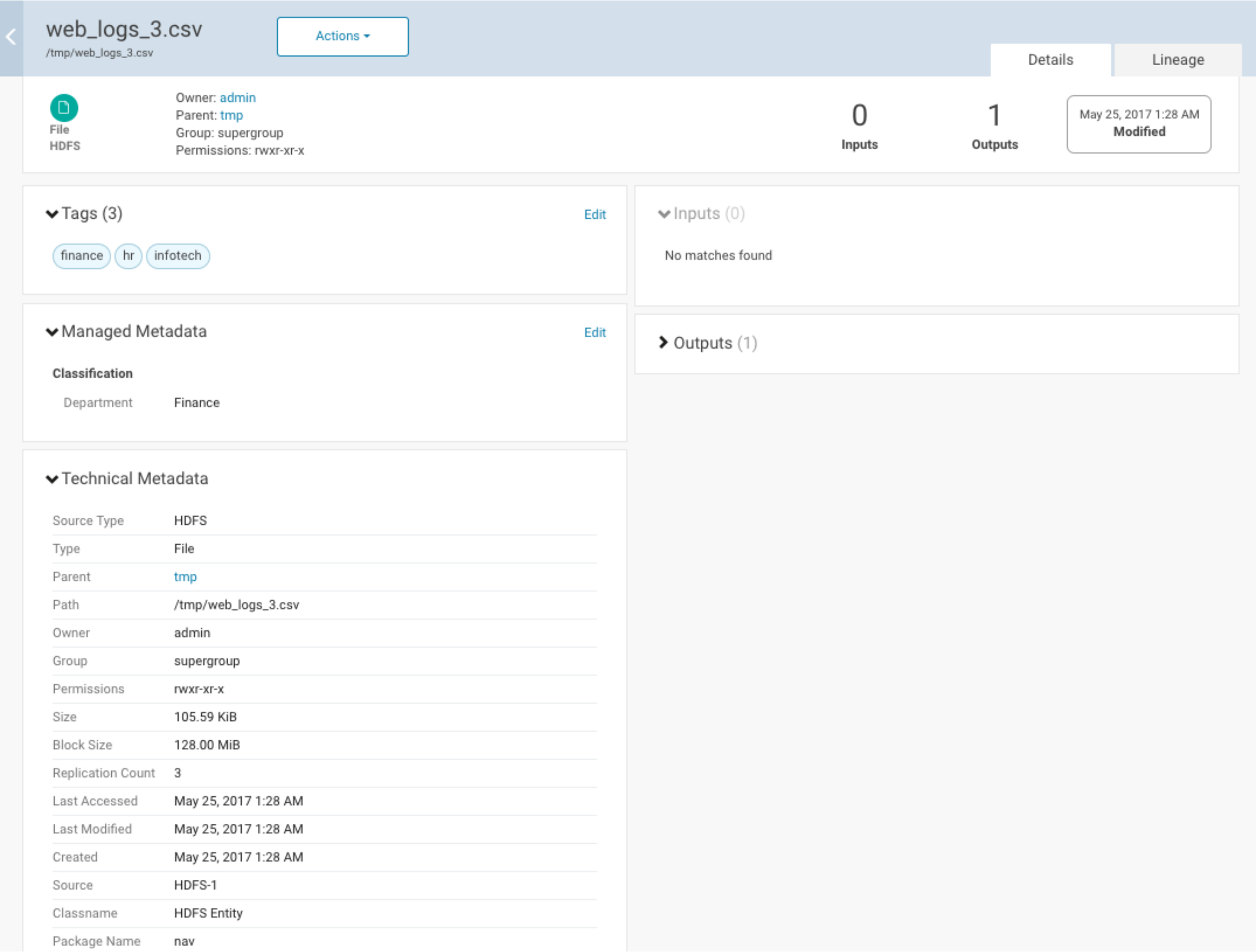
Three Different Classes of Metadata

Cloudera Navigator supports extraction of three different types of metadata from the data contained in the cluster. The characteristics of each type are summarized in the table.

Category	**Description**	**Usage Note**
Technical Metadata	Characteristics inherent to the entity that are obtained when extracted.	Not modifiable.
Managed Metadata	Descriptions, tags, and key-value pairs that can be added to entities after extraction. Keys are defined within namespaces, and values can be constrained by type (Text, Number, Boolean, Date, Enumeration, for example).	Add to entities or modify after extraction only.
Custom Metadata	Key-value pairs that can be added to entities before or after extraction. Displayed in the Tags area of the Details page for a given entity.	Add to entities before or after extraction.

The screenshot below (from the Cloudera Navigator console) shows the details of a web log saved to HDFS as a comma-separated value (CSV) file. This particular entity has all three types of metadata associated with it:

- The Technical Metadata was provided to the entity by the source system, in this example, HDFS.
- The Managed Metadata was defined by a data steward from the Finance department to augment entities processed by the system with properties that enable self-service data discovery for cluster data. That is, business users looking for data handled by the Finance department can more easily locate files that have been labeled with Managed Metadata.
- Custom Metadata has also been applied to this file (see the Tags area of file details below).



web_logs_3.csv
/tmp/web_logs_3.csv

File
HDFS

Owner: admin
Parent: tmp
Group: supergroup
Permissions: rwxr-xr-x

0 Inputs
1 Outputs
May 25, 2017 1:28 AM Modified

Tags (3)
finance hr infotech

Inputs (0)
No matches found

Outputs (1)

Managed Metadata
Classification
Department Finance

Technical Metadata

Source Type	HDFS
Type	File
Parent	tmp
Path	/tmp/web_logs_3.csv
Owner	admin
Group	supergroup
Permissions	rwxr-xr-x
Size	105.59 KiB
Block Size	128.00 MiB
Replication Count	3
Last Accessed	May 25, 2017 1:28 AM
Last Modified	May 25, 2017 1:28 AM
Created	May 25, 2017 1:28 AM
Source	HDFS-1
Classname	HDFS Entity
Package Name	nav

Technical Metadata is obtained from the source entity and cannot be modified. Common examples of Technical Metadata include an entity's name, type (directory or file, for example), path, creation date and time, and access permissions. For entities created or managed by cluster services, Technical Metadata may include the name of the service that manages or uses that entity and relations—parent-child, data flow, and instance of—between entities.

As another example, Technical Metadata for an Amazon S3 bucket includes Bucket name, Region (AWS Region, such as us-west-1), S3 Encryption, S3 Storage Class, S3 Etag, Source (S3), and so on. Technical Metadata is simply whatever metadata is provided for the entity by the system that created the entity.

For example, for Hive entities, Cloudera Navigator extracts the extended attributes added by Hive clients to the entity.

Viewing Metadata Analytics

Required Role: Metadata & Lineage Viewer and **Policy Editor** (or **Full Administrator**)

1. Open your browser.
2. Navigate to the host within the cluster running the Navigator Metadata Server role as shown in this example (7187 is the default port for Navigator Metadata Server):

```
http://fqdn-1.example.com:7187/login.html
```

   The login page displays.
3. Log in to the Cloudera Navigator console using the credentials assigned by your administrator.
4. Click the **Analytics** tab. The Metadata analytics tab displays.
5. Click the `Source` button and select an HDFS service instance from the drop-down list.

6. The Metadata tab displays a set of bar graphs that list the number of files that satisfy groups of values for last access time, created time, size, block size, and replication count.
   - To display the files at the right, click a bar. This draws a blue selection outline around the bar and selects the property checkbox.
   - To select more than one value, grab a bar edge and brush a range of values.
   - To change a range, click a bar, drag to a different range of values, and then drop.
   - To reduce a range, grab a bar edge and contract the range.
   - To clear a property, clear the checkbox. The previous selection is indicated with a gray outline.
   - When you select a previously selected property, the previous selection is reused. For example, if you had previously selected one and three for replication count, and you reselect the replication count checkbox, the values one and three are reselected.
   - To clear all current and past selections, click **Clear all selections**.
7. In the listing on the right, select an option to display the number of files by directory, owner, or tag. In the listing:
   - Filter the selections by typing strings in the search box and pressing **Enter** or **Return**.
   - Add categories (directory, owner, or tag) to a search query and display the Search tab by doing one of the following:
     - Clicking a directory, owner, or tag name link.
     - Selecting **Actions** > **Show in search**. To further refine the query, select one or more checkboxes, and select **Actions** > **Show selection in search**.
   - **Required Role: Policy Editor** (or **Full Administrator**)

     Add categories to the search query of a new policy and display the Policies tab by selecting **Actions** > **Create a policy**. To further refine the query, select one or more checkboxes, and select **Actions** > **Create a policy from selection**.

Defining Properties for Managed Metadata

Required Role: Metadata Administrator (or **Full Administrator**)

You can use managed metadata to add typed metadata to classes of entities. You can add namespaces and properties.

A ***namespace*** is a container for properties. Four namespaces are reserved:

- nav for Navigator metadata classes (for example, `fselement` and user-defined custom fields)
- up (custom metadata)
- `tp` (technical properties)
- `xt` (partner applications)

The combination of namespace and property name must be unique.

> **Note:** The Cloudera Navigator console cannot delete namespaces. Empty namespaces can be deleted using the Cloudera Navigator APIs.

A property can be one of the following types:

- Boolean
- date
- integer
- long
- float
- double
- text (with optional maximum length and regular expression validation criteria)

- enum (of string)

A property can be single-valued or assume multiple values.

After metadata properties have been assigned to specific entities in the cluster, the property types and values can be used as filters for Cloudera Navigator Search, to find specific entities.

Creating Custom Properties with the Cloudera Navigator Console

To create custom properties:

1. Log in to the Cloudera Navigator console.
2. Click the **Administration** link in the upper right. The **Managed Metadata** tab displays the list of namespaces and the properties defined in the namespaces.
3. Click the **New Property...** button.
4. In the Classes field, click the filter icon (▾) or start typing one of the Cloudera Navigator entity built-in class names.
5. Select the class of entities to which the property applies. To clear the field, hover over the field and click the delete icon (x) that displays at the right of the field.
6. Click the Namespace field and select a namespace. If the Namespace drop-down list is empty, click **Create Namespace...**.

   a. Specify a namespace name and optional description.
   b. Click **Continue**.

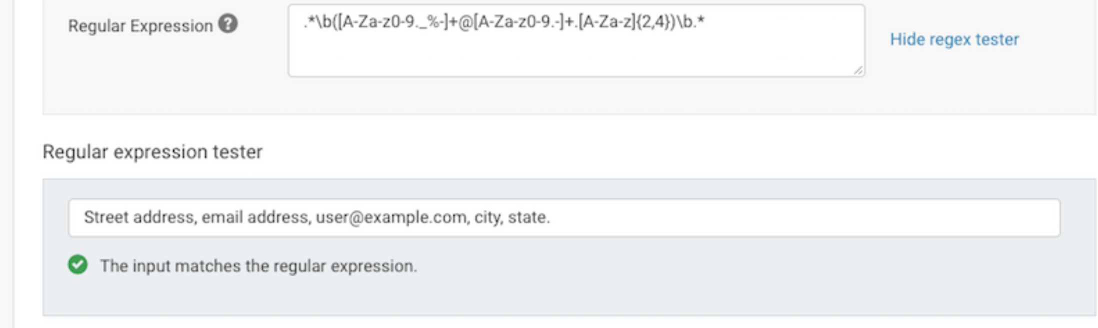
7. Add the name for the property.

   The name can contain letters, numbers, underscores, and hyphens and can be up to 50 characters long.

8. Specify an optional description.
9. Select the **Multivalued Enable** checkbox if the property can have more than one value. For example, an `emailFrom` property should accept only one value, but an `emailTo` property could accept more than one value.
10. In the **Type** drop-down list, select the property type and specify constraints on the value.

    - **Boolean** - Boolean: true or false.
    - **Date** - Date and time.
    - **Enumeration** - A set of values. In the **Enumeration** field, type valid enumeration values and press **Enter** or **Tab**.
    - **Number** - A number. In the **Number Type** field, select the type of the number: **Integer**, **Long**, **Float**, **Double**.
    - **Text** - A string.

      – **Maximum Length** - The maximum length of the string.
      – **Regular Expression** - A regular expression that determines whether a string is a valid value. You can test the expression by clicking **Show regex tester** and entering input that you expect to match the expression.



Regular Expression ?

```
.*\b([A-Za-z0-9._%-]+@[A-Za-z0-9.-]+.[A-Za-z]{2,4})\b.*
```

Regular expression tester

Street address, email address, user@example.com, city, state.

✓ The input matches the regular expression.

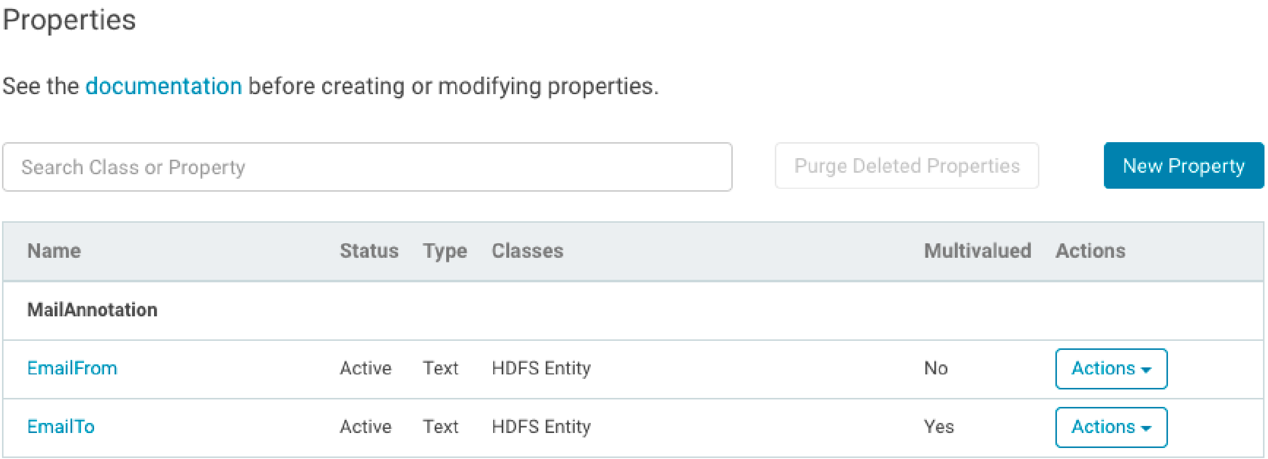
If you change the regular expression, click outside the field to trigger the tester to re-evaluate the expression.

11. Click **Continue to Review**. The Review screen displays.

12. Click **Create** to create the property, **Cancel** to return to the Properties page, or **Back to Edit Property** to continue editing the property.

Example Properties

The following figure shows two properties in the namespace `MailAnnotation` that apply to entities of the `HDFS Entity` class (HDFS files and directories). The `emailFrom` property is of type TEXT and can be assigned a single value. The `MailTo` property is also of type TEXT but can have multiple values.



Properties

See the documentation before creating or modifying properties.

Name	Status	Type	Classes	Multivalued	Actions
MailAnnotation					
EmailFrom	Active	Text	HDFS Entity	No	Actions ▾
EmailTo	Active	Text	HDFS Entity	Yes	Actions ▾

Using Cloudera Navigator Console to Manage Properties

You can view managed metadata property summary details by clicking property name in the Properties table, or by clicking the **Actions** box in the property row and then clicking **View** in the dropdown.

You can also edit some aspects of a property, delete and restore a property, and purge a deleted property.

Editing a Property

After a property is created, you can edit property data in the following ways:

- Add classes to which the property applies
- Add and remove enumeration values
- Change the description
- Change the maximum length
- Change the regex pattern

1. Log in to the Cloudera Navigator console using administrator credentials roles:
   - Cloudera Manager Full Administrator
   - Cloudera Manager Navigator Administrator
   - Cloudera Navigator Full Administrator
   - Cloudera Navigator Metadata Administrator
2. Click the **Administration** link in the upper right. The **Managed Metadata** tab displays the list of namespaces and the properties defined in the namespaces.
3. Open the property Edit page by clicking the **Actions** box in the property row and then clicking **Edit** in the dropdown.
4. In the Additional Class field, click the ▾ or type the name of a Cloudera Navigator class entity. For example, start typing "Hive.." to see
5. Select the class of entities to which the property applies. To clear the field, hover over the field and click the delete icon (x) that displays at the right of the field.
6. In the Description field, add a description or edit an existing description.
7. If the property is of the Enumeration type, you can add or remove values in the Enumeration field.

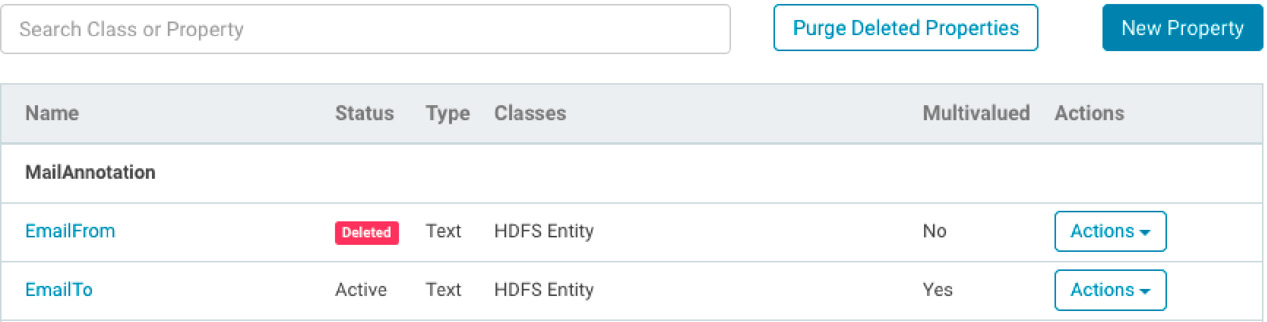
Note: If you delete an enumeration value, it cannot be used in new Managed Metadata assignments, but it continues to exist in entities or policies that are already using them.

8. For Text properties:
   - In the Maximum Length field, add or change the value for the maximum length.
   - In the Regular Expression field, edit the expression. Click Show regex tester to test input against any changes you make.
9. Click **Continue to Review**. The Review screen displays.
10. Click **Update** to commit the change or **Back to Edit Property** to continue editing the property, or **Cancel** to return to the Properties page.

Deleting, Restoring, and Purging Managed Metadata Properties

After a property is deleted, it cannot be assigned to entities. However, the property still exists and the entities that have already been tagged with the property retain the tag until the purge operation is run.

Deleted properties display status as Deleted in the Cloudera Navigator console (on the Managed Metadata tab of the Administration menu). For example, the `EmailFrom` property has been deleted:



Name	Status	Type	Classes	Multivalued	Actions
MailAnnotation					
EmailFrom	Deleted	Text	HDFS Entity	No	Actions ▾
EmailTo	Active	Text	HDFS Entity	Yes	Actions ▾

The Status displays only to users with the Navigator Administrator or Managed & Custom Metadata Editor user roles.

The Cloudera Navigator purge process permanently removes properties and any values from all entities. Policies that assign metadata using a property that has been purged will fail the next time they are run. Because deleted properties are not removed from the system until they have been purged, the name of any deleted property cannot be re-used until after purging the system.

Deleting a Property

1. In the Properties table, for the property that you are deleting, click the **Actions** button, and then click **Delete** in the drop-down menu.
2. In the Delete Property dialog box, review the property deletion information. If any entities are affected, you see a **View affected entities** link; click to see all entities that use the property.
3. Click **Confirm Delete** to delete the property, or click **Cancel**.

Restoring a Property

If you have not yet purged a deleted property, you can restore it.

- In the Properties table, for the property that you are restoring, click the **Actions** button, and then click **Restore** in the drop-down menu.

Purging a Property

You can permanently remove deleted properties by purging them. All values assigned to the deleted properties are lost; however, the affected entities are not deleted. Purging permanently removes all properties marked as Deleted in the Status column.

> **Note:** Purging is a long-running task and may take some time. Navigator is unavailable to all users until the purge is completed.

1. In the Properties table, click **Purge Deleted Properties**. The Purge all Deleted Properties dialog box opens, describing the effects of the purge and reporting the number of entities that use the property.
2. In the Purge all Deleted Properties dialog box, click **Confirm Purge** to permanently remove all deleted properties, or click **Cancel** to return to the Properties page.

Navigator Built-in Classes

Class	Description
`HDFS Dataset`	Logical dataset backed by a path in HDFS.
`HDFS Dataset Field`	Field in an HDFS dataset.
`HDFS Entity`	HDFS file or directory.
`Hive Column`	Column in a Hive table.
`Hive Database`	Hive database.
`Hive Partition`	Partition of a Hive table.
`Hive Query`	Hive query template.
`Hive Query Execution`	Instance of a Hive query.
`Hive Query Part`	Component of a Hive query that maps specific input columns to output columns.
`Hive Table`	A Hive table.
`Hive View`	View on one or more Hive tables.
`Impala Query`	Impala query template.
`Impala Query Execution`	Instance of an Impala query.
`Impala Query Part`	Component of an Impala query that maps specific input columns to output columns.
`Job Instance`	Instance of a MapReduce, YARN, or Spark job.
`Job Template`	Template for a MapReduce, YARN, or Spark job.
`Oozie Workflow`	Template for an Oozie workflow.
`Oozie Workflow Instance`	Instance of an Oozie workflow.
`Pig Field`	Field for a relation in Pig; similar to a column in a Hive table.
`Pig Operation`	Template for a Pig transformation.
`Pig Operation Execution`	Instance of a Pig transformation.
`Pig Relation`	Pig relation; similar to a Hive table.
`S3 Bucket`	A bucket in S3.
`S3 Object`	A file or directory in an S3 bucket.
`Sqoop Export Sub-operation`	Sqoop export component that connects specific columns.
`Sqoop Import Query`	Sqoop import job with query options.

Class	Description
`Sqoop Import Sub-operation`	Sqoop import component that connects specific columns.
`Sqoop Operation Execution`	Instance of a Sqoop job.
`Sqoop Table Export`	Sqoop table export operation template.
`Sqoop Table Import`	Sqoop table import operation template.
`User Sub-operation`	User-specified sub-operation of a MapReduce or YARN job; used for specifying custom column-level lineage.

Defining Metadata with the Navigator API and Navigator SDK

In addition to accessing and defining metadata with the Cloudera Navigator console, you can also use the Cloudera Navigator API and the Navigator SDK.

For information on the Navigator API, see Cloudera Navigator APIs on page 144.

The Navigator SDK is a client library that can be used to extract metadata directly from Navigator Metadata Server or to enrich metadata with custom metadata models, entities, and relationships. The SDK is located in Github in the cloudera/navigator-sdk repository.

Adding and Editing Metadata

Required Role: Metadata Administrator (or **Full Administrator**)

Cloudera Navigator provides two different types of customer-defined metadata that can be applied to entities extracted from the cluster:

- **Managed metadata** consists of the comprehensive organization-wide labeling scheme typically set up by data stewards to provide centralized, curated data sets. Different namespaces can be created for different departments, functional groups, or data type, or any categorization scheme needed, and each namespace contains the key-value pairs that are used to tag entities. Values can be constrained by data type (text, number, boolean, date, enumeration, for example). Managed metadata can be applied to entities after extraction (not before), and can be applied automatically by using the API or configuring the Navigator Metadata Server to apply policies.
- **Custom metadata** consists of key-value pairs that users define on an ad hoc basis and can be applied to entities before and after extraction. Business users who want to classify and organize data for their own use can use the Cloudera Navigator console to do so easily, as detailed below.

Editing Metadata Using the Cloudera Navigator Console

1. Log in to the Cloudera Navigator console.
2. Search for any entity in the Cloudera Navigator console.
3. Click an entity link returned in the search. The Details tab displays.
4. To the left of the Details tab, click **Actions** > **Edit Metadata...**. The Edit Metadata dialog box drops down.
5. Add metadata fields:
   - In the Name field, type a new display name.
   - In the Description field, type a description (500 characters maximum).
   - **Managed Metadata**
     1. Click the ▾ and select a property.
     2. Click the value field after the `:` to display type-specific selection controls such as integer spinners and date selection controls. Either type the value or use the controls to select a value.

   Click the plus icon (+) to add another managed property key-value pair or another value for a given key.

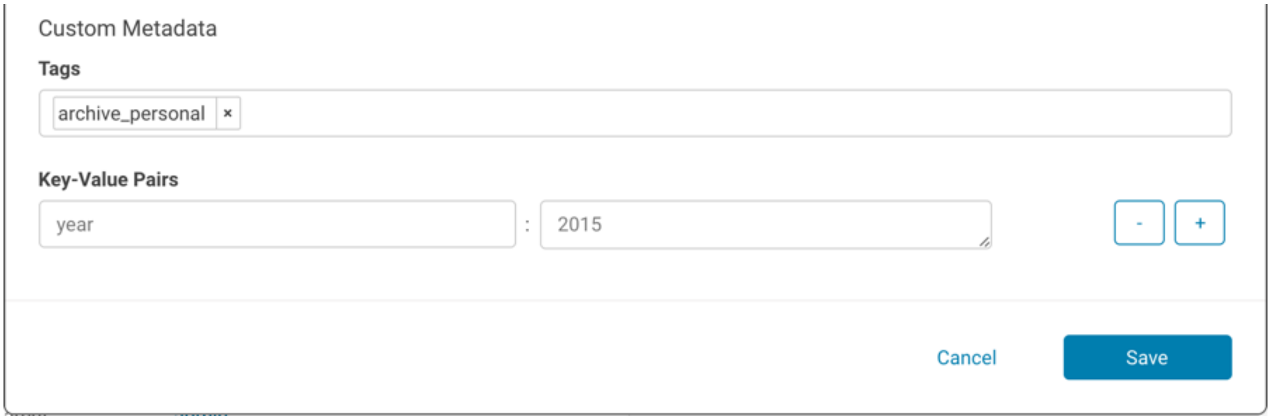
- **Custom Metadata**: In the Tags field, type a tag and press **Enter** or **Tab** to create new tag entries.
- **Key-Value Pairs**
  1. Click the plus icon to add a key-value pair.
  2. Type a key and a value. You can specify special characters (for example, ".", " ") in the name, but it makes searching for the entity more difficult because some characters collide with special characters in the search syntax.

> **Note:** The Key-Value Pairs field is used for specifying custom metadata only. Managed metadata includes a namespace property which cannot be entered in this field.

6. Click **Save**. The newly defined metadata appears in the Managed Metadata or Custom Metadata pane.

Custom Metadata Example

In the following example, the tag `archive_personal` and the property `year` with value `2015` have been added to the file `2015_11_20`:



Custom Metadata

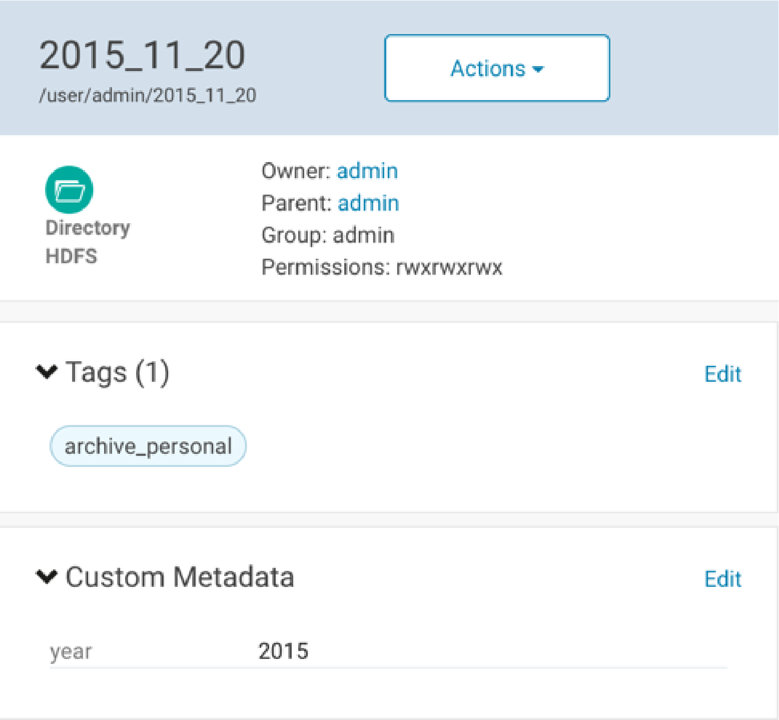
Tags

archive_personal ×

Key-Value Pairs

year : 2015

After you save, the metadata appears in the Tags and Custom Metadata panes:



2015_11_20

/user/admin/2015_11_20

Directory
HDFS

Owner: admin
Parent: admin
Group: admin
Permissions: rwxrwxrwx

Tags (1)

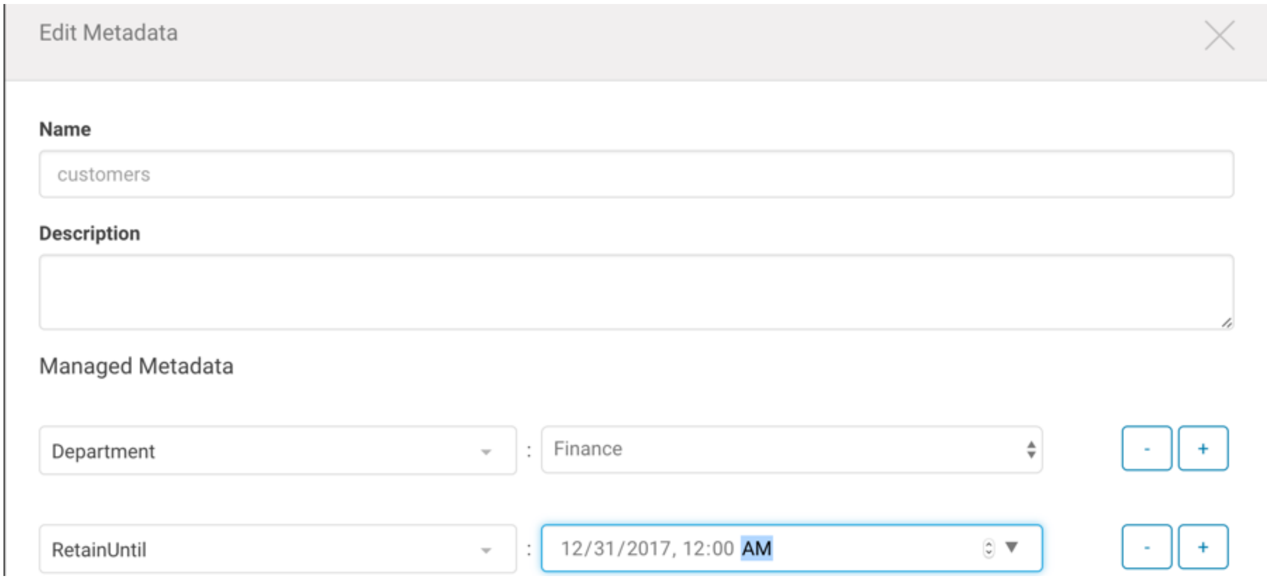
archive_personal

Custom Metadata

year	2015

Managed Metadata Example

The following example shows the `Department` and `RetainUntil` managed properties for the `customers` entity:



Edit Metadata

Name: customers

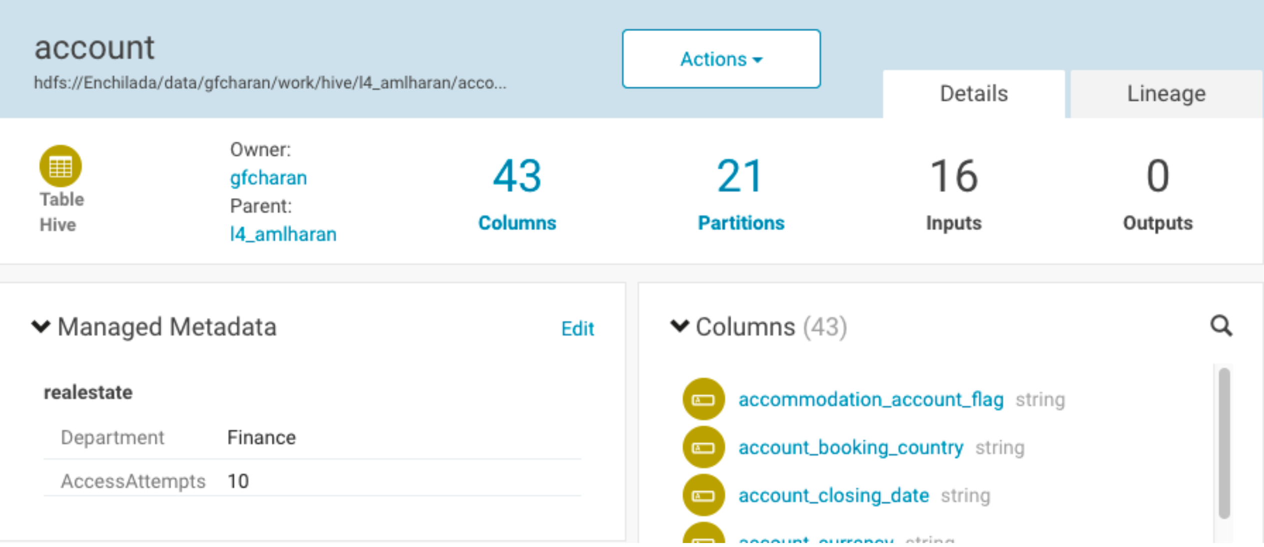
Description:

Managed Metadata

Department : Finance

RetainUntil : 12/31/2017, 12:00 AM

After you specify the values and save, the properties display in the Managed Metadata pane:



account

hdfs://Enchilada/data/gfcharan/work/hive/l4_amlharan/acco...

Table Hive

Owner: gfcharan

Parent: l4_amlharan

43 Columns

21 Partitions

16 Inputs

0 Outputs

Managed Metadata

realestate

Department	Finance
AccessAttempts	10

Columns (43)

accommodation_account_flag string

account_booking_country string

account_closing_date string

Finding Specific Entities by Searching Metadata

Required Role: Metadata Viewer (or **Metadata Administrator**, **Full Administrator**)

You can find entities matching selected criteria using the Cloudera Navigator console, as detailed below.

Searching Metadata

1. Open your browser.
2. Navigate to the host within the cluster running the Cloudera Navigator Metadata Server role.

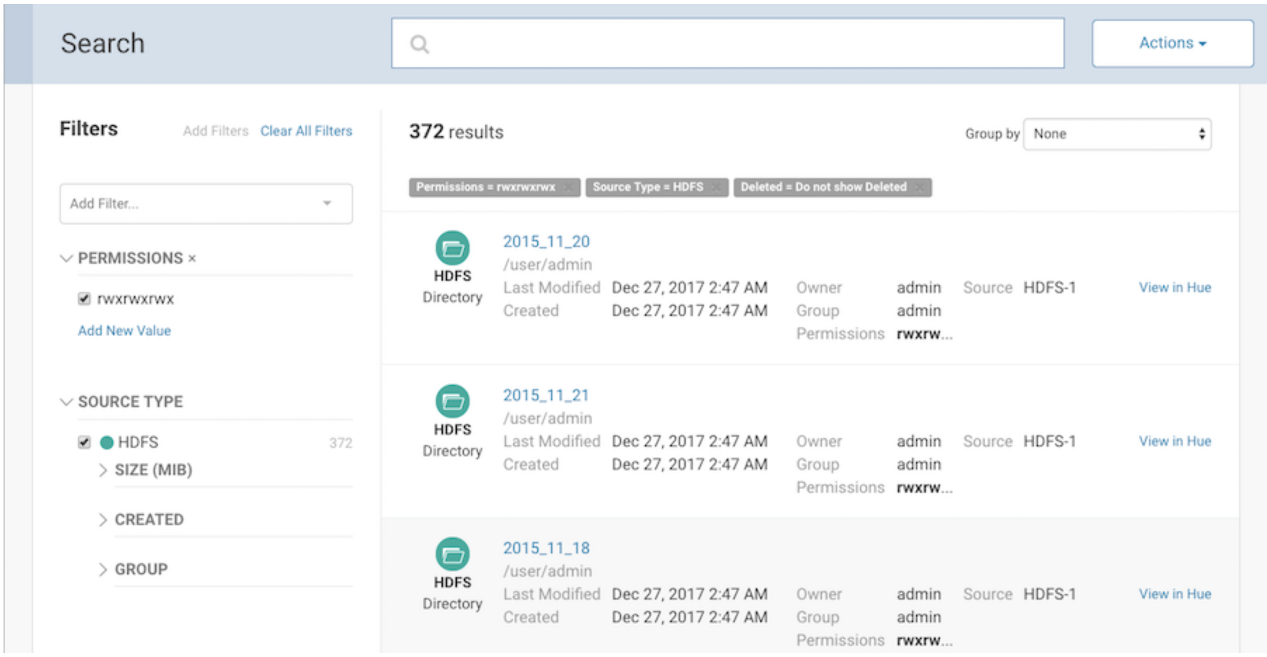
```
http://fqdn-1.example.com:7187/login.html
```

In this example, node 1 of the cluster is running the Navigator Metadata Server role, hosted on the default port 7187. The login page displays.

3. Log in to the Cloudera Navigator console using the credentials assigned by your administrator. The Cloudera Navigator console opens to the Search tab.
4. To display all entity types in the search results, click **Clear all filters**. Or, limit search results to specific source types, entity types, or other characteristics by applying filters.
5. Enter the search strings in the Search box.

Filter Example

The following filter example demonstrates how to narrow search results by selecting a built-in Source Type filter set to **HDFS** and the technical property **PERMISSIONS** with the value **rwxrwxrwx**. Breadcrumbs for each filter value show above the results. The "Deleted = Do not show Deleted" breadcrumb is included in the filter by default.



Search

Actions ▾

Filters   Add Filters   Clear All Filters

Add Filter...

PERMISSIONS ×

☑ rwxrwxrwx

Add New Value

SOURCE TYPE

☑ ● HDFS   372

SIZE (MIB)

CREATED

GROUP

372 results   Group by None

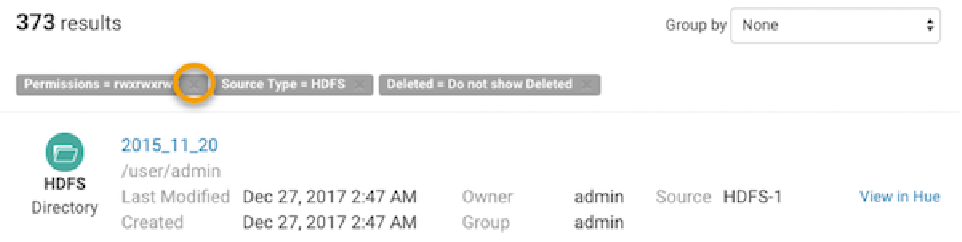
Permissions = rwxrwxrwx ×   Source Type = HDFS ×   Deleted = Do not show Deleted ×

HDFS Directory
2015_11_20
/user/admin
Last Modified Dec 27, 2017 2:47 AM   Owner admin   Source HDFS-1   View in Hue
Created Dec 27, 2017 2:47 AM   Group admin
Permissions rwxrw...

HDFS Directory
2015_11_21
/user/admin
Last Modified Dec 27, 2017 2:47 AM   Owner admin   Source HDFS-1   View in Hue
Created Dec 27, 2017 2:47 AM   Group admin
Permissions rwxrw...

HDFS Directory
2015_11_18
/user/admin
Last Modified Dec 27, 2017 2:47 AM   Owner admin   Source HDFS-1   View in Hue
Created Dec 27, 2017 2:47 AM   Group admin
Permissions rwxrw...

When you select a property value, a filter breadcrumb shows above the search results. Click the "x" in the breadcrumb to remove that criteria from the filter.

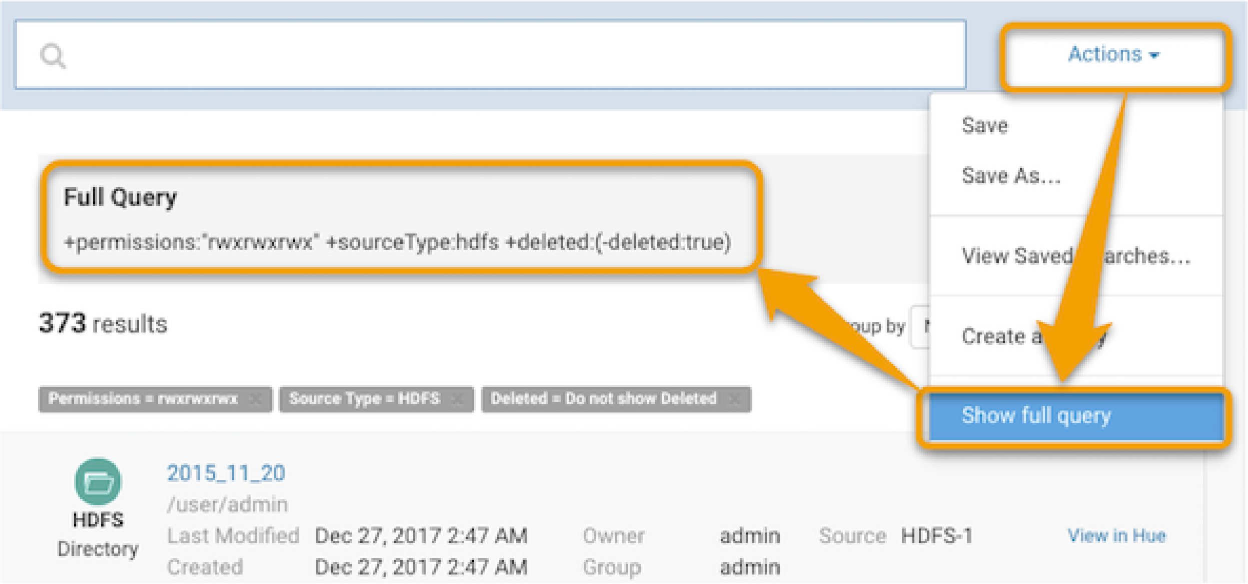


373 results   Group by None

Permissions = rwxrwxrw ×   Source Type = HDFS ×   Deleted = Do not show Deleted ×

HDFS Directory
2015_11_20
/user/admin
Last Modified Dec 27, 2017 2:47 AM   Owner admin   Source HDFS-1   View in Hue
Created Dec 27, 2017 2:47 AM   Group admin

You can also display the details of the search query by choosing Actions Show full query



Full Query

+permissions:"rwxrwxrwx" +sourceType:hdfs +deleted:(-deleted:true)

373 results

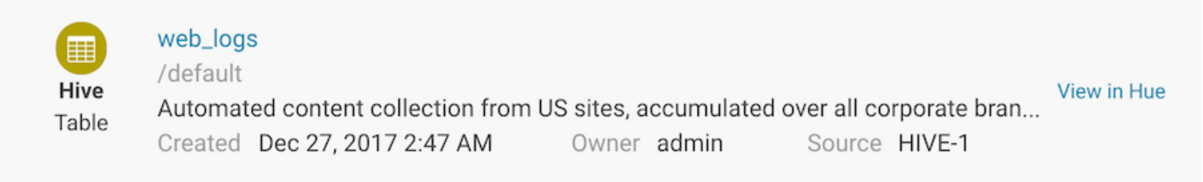
2015_11_20
/user/admin
Last Modified Dec 27, 2017 2:47 AM Owner admin Source HDFS-1
Created Dec 27, 2017 2:47 AM Group admin

Viewing Search Results

The Search Results pane displays the number of matching entries in pages listing 25 entities per page. You can view the pages using the page control at the bottom of each page.

Each entry in the result list contains:

- Source type
- Name - A link to a page that displays the entity details and lineage diagram
- Properties
- If Hue is running, a link at the far right labeled **View in Hue** that opens the Hue browser for the entity. For example:



web_logs
/default
Automated content collection from US sites, accumulated over all corporate bran...
Created Dec 27, 2017 2:47 AM Owner admin Source HIVE-1

Displaying Entity Details

The entity Details page displays all three types of metadata for an entity—technical, managed, and custom—and entity type-specific information:

- HDFS directories - Directory contents
- HDFS datasets and fields - Schema
- Hive and Impala databases - Tables and views
- Hive tables - Extended attributes, table schema, partitions
- Impala tables - Table schema
- MapReduce, YARN, and Spark operations - Instances
- Pig operation executions - Tables
- S3 buckets and folders - Folder contents

All entity types can display inputs and outputs. See Enabling Inputs and Outputs to Display.

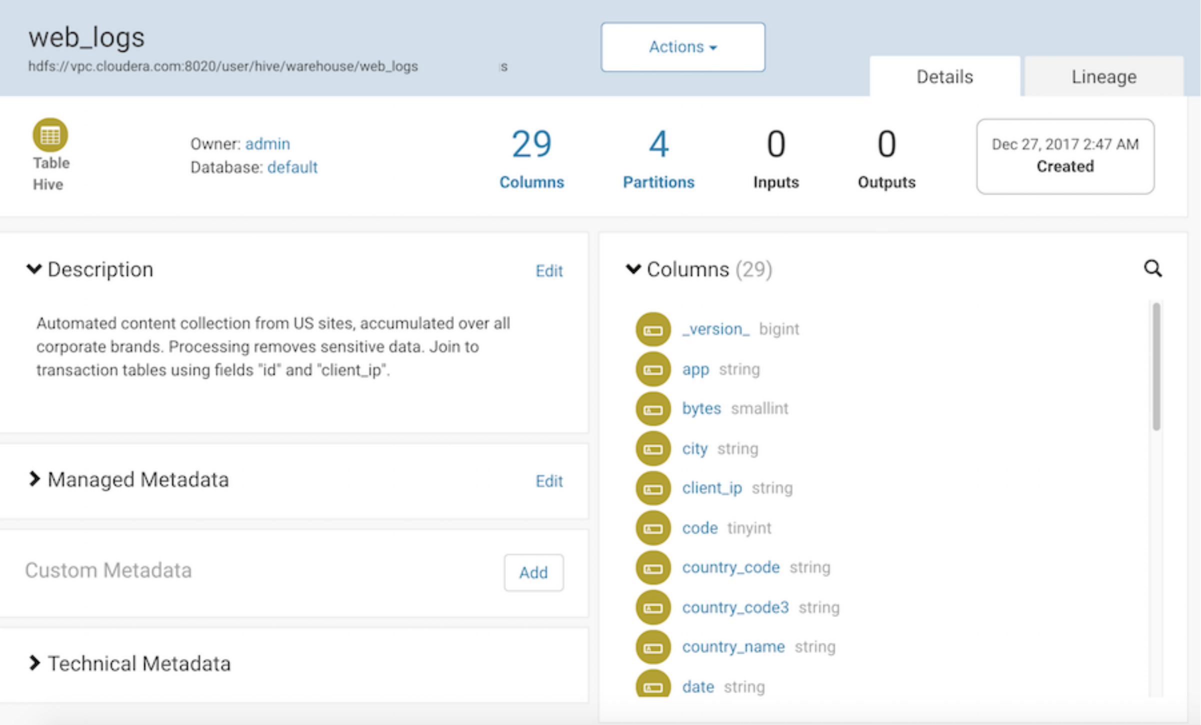
If managed properties have been defined for a particular entity type, the **Show All** checkbox in the Managed Metadata pane displays all properties that can be assigned values for the selected entity. To display only those properties that have values, clear the checkbox. If all properties have values, the checkbox has no effect.

To display entity details:

1. Perform a search.
2. In the search results, click an entity name link. The Details tab displays.

Hive Table Entity Details

For example, if you click the Hive table `web_logs` link in the search result displayed in preceding example, you see the following details:



web_logs
hdfs://vpc.cloudera.com:8020/user/hive/warehouse/web_logs

Table Hive — Owner: admin — Database: default — 29 Columns — 4 Partitions — 0 Inputs — 0 Outputs — Dec 27, 2017 2:47 AM Created

Description

Automated content collection from US sites, accumulated over all corporate brands. Processing removes sensitive data. Join to transaction tables using fields "id" and "client_ip".

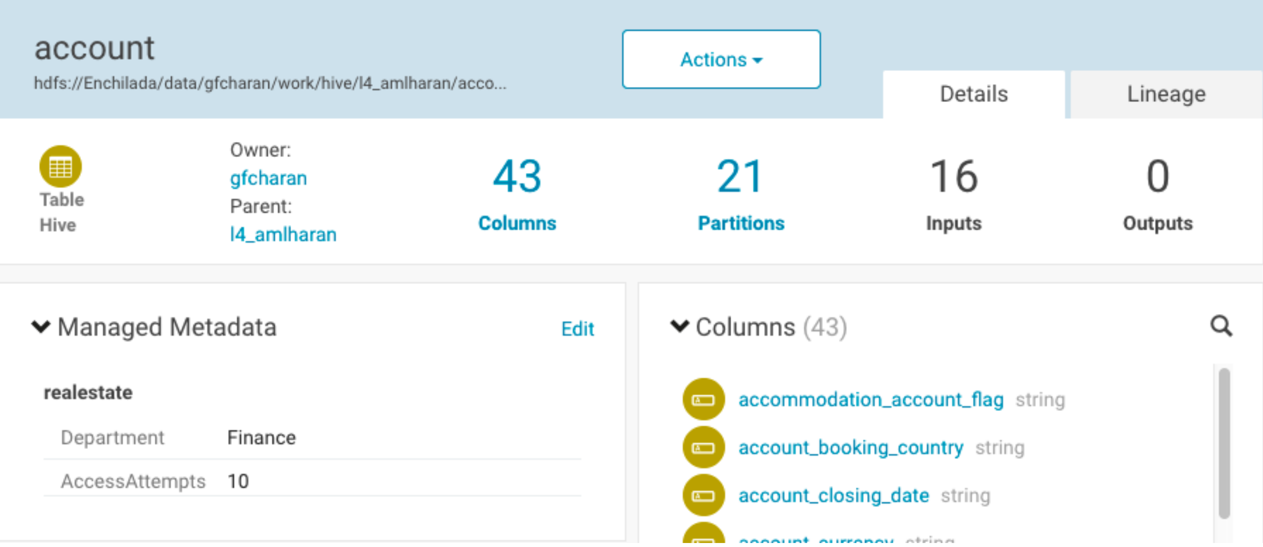
Columns (29)

version	bigint
app	string
bytes	smallint
city	string
client_ip	string
code	tinyint
country_code	string
country_code3	string
country_name	string
date	string

The caret **>** indicates fields with content; click to expand them. In addition to managed metadata, custom metadata, and technical metadata, you can view the names of the columns and the inputs and outputs.

Managed Metadata Example

The following `account` table entity has two managed properties in the `realestate` namespace: `Department` and `AccessAttempts`.



account
hdfs://Enchilada/data/gfcharan/work/hive/l4_amlharan/acco...

Table Hive — Owner: gfcharan — Parent: l4_amlharan — 43 Columns — 21 Partitions — 16 Inputs — 0 Outputs

Managed Metadata

realestate

Department	Finance
AccessAttempts	10

Columns (43)

accommodation_account_flag	string
account_booking_country	string
account_closing_date	string
account_currency	string

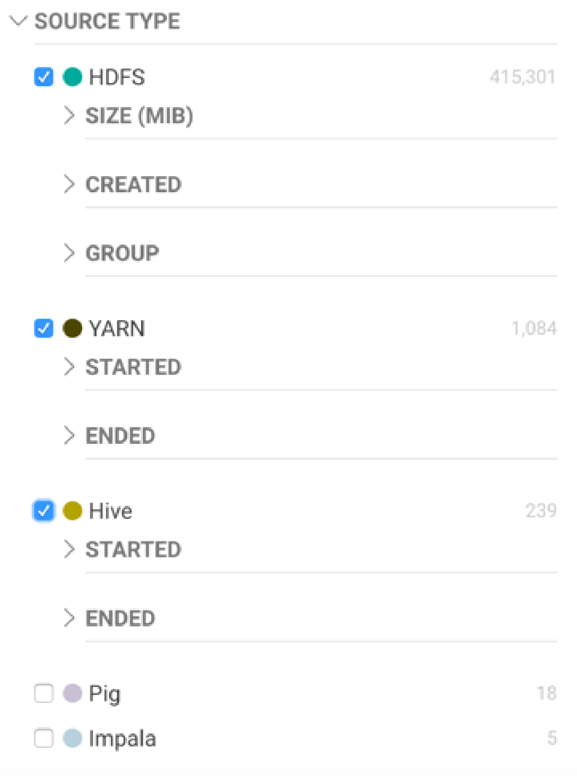
Filtering Search Results

To filter search results, choose filter values in the Filters pane or type search strings in the **Search** box.

The Filters pane lists default properties (source type, type, owner, cluster, and tags) and their values. You can add or remove properties from this list: click **Add Filters...** and choose from the defined technical and metadata properties. To remove non-default filter properties, click the x in the filter.

Note that when filter values are timestamps, the server stores the timestamp in UTC, and the UI displays the timestamp converted to the local timezone.

The number to the right a property value is the number of extracted entities that have that property value:



SOURCE TYPE

☑ ● HDFS 415,301
- SIZE (MIB)
- CREATED
- GROUP

☑ ● YARN 1,084
- STARTED
- ENDED

☑ ● Hive 239
- STARTED
- ENDED

☐ ● Pig 18

☐ ● Impala 5

Facet values with the count 0 are not displayed.

When you enter values, the value is enclosed in quotes; the value inside the quotes must match the metadata exactly. For example:

- Typing "sample_*" in the `originalName` property returns only entities whose names match that exact string.
- To perform a wildcard search, type the wildcard string in the Search box. For example, typing the string "sample_*" in the Search box returns all entities with "sample_" at the beginning of their original name.

When you construct search strings with filters, use parentheses ( ) to specify multiple values of a property. Add multiple properties by using the + operator. For example, entities of type HDFS or Hive that are of type file or directory:

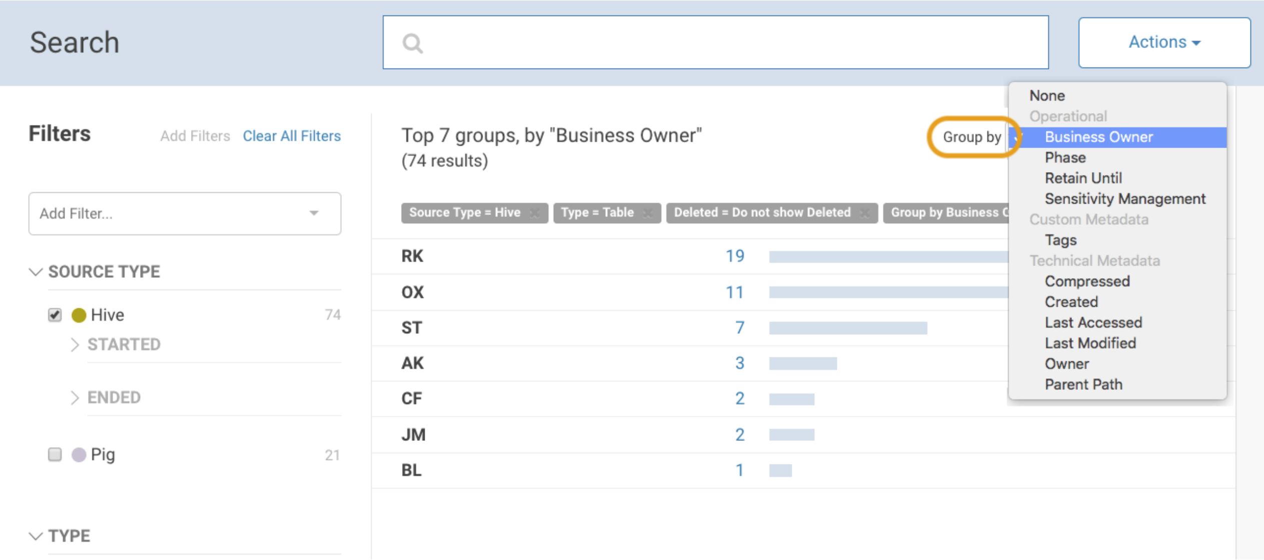
```
+(sourceType:hdfs sourceType:hive) +(type:file type:directory)
```

and:

```
 ((+sourceType:hdfs +created:[NOW/DAY-30DAYS TO NOW/DAY+1DAY]) sourceType:hive)
```

Grouping Search Results Using Metadata

Using the Group by option, you can organize the search results into groups based on the common properties of the entities in your search, including managed, custom, and some technical metadata. When you choose a group by property, the search panel lists the property values and shows how many search results correspond to that value.



Search

Actions ▾

Filters Add Filters Clear All Filters

Add Filter...

SOURCE TYPE

☑ ● Hive 74

> STARTED

> ENDED

☐ ● Pig 21

TYPE

Top 7 groups, by "Business Owner"
(74 results)

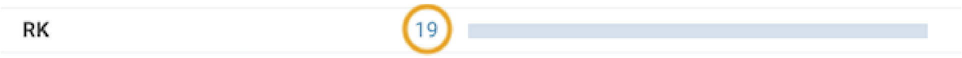
Group by

Source Type = Hive × | Type = Table × | Deleted = Do not show Deleted × | Group by Business O

RK	19
OX	11
ST	7
AK	3
CF	2
JM	2
BL	1

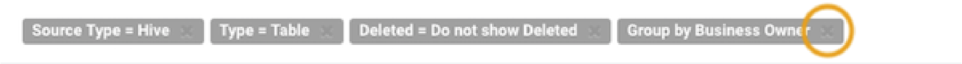
From the Group by view, you can:

- Click the number for a group to show the search results for that group.



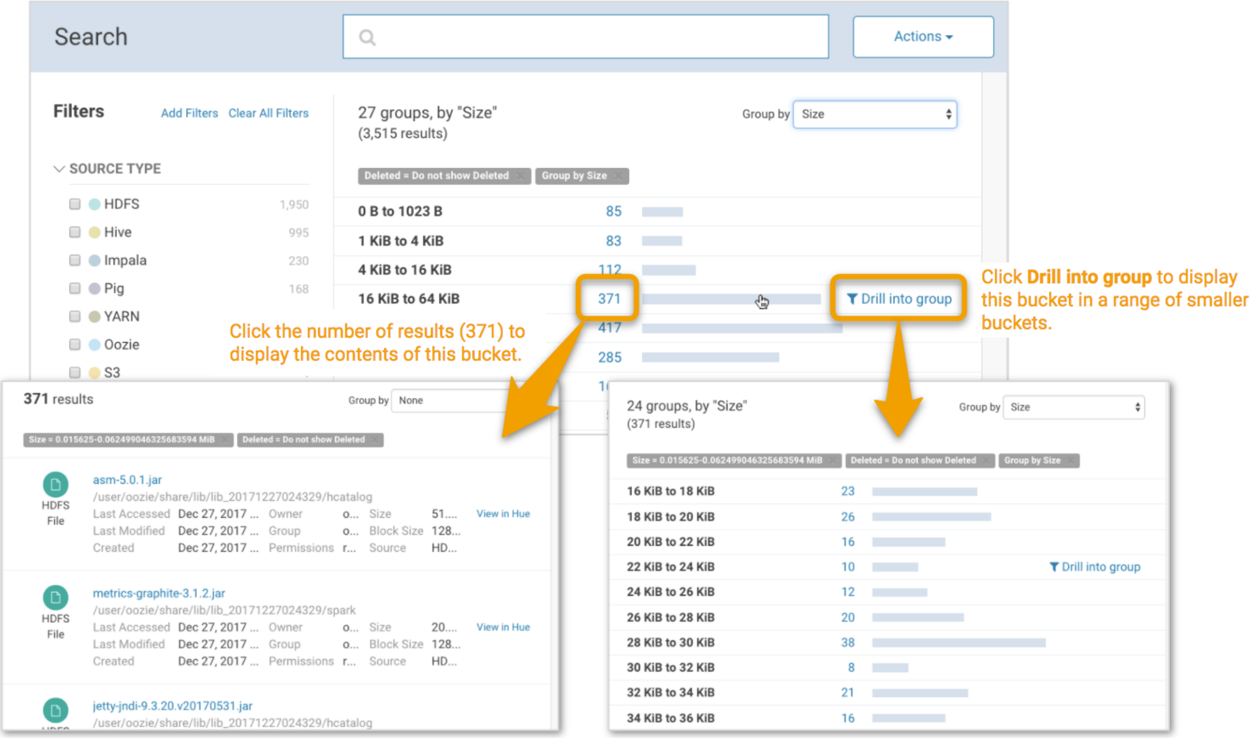
RK 19

- Click the "x" on the Group by breadcrumb to remove the groupings.



Source Type = Hive × | Type = Table × | Deleted = Do not show Deleted × | Group by Business Owner ×

When you group results by a numeric or date property, you can also choose to "drill down" into a single group: the results from that group are grouped into smaller buckets. Hover over the group row to show the **Drill into group** control.



Search

Actions ▾

Filters Add Filters Clear All Filters

SOURCE TYPE

☐	HDFS	1,950
☐	Hive	995
☐	Impala	230
☐	Pig	168
☐	YARN	
☐	Oozie	
☐	S3	

27 groups, by "Size"
(3,515 results)

Group by Size

Deleted = Do not show Deleted × | Group by Size ×

0 B to 1023 B	85
1 KiB to 4 KiB	83
4 KiB to 16 KiB	112
16 KiB to 64 KiB	371
	417
	285

Drill into group

Click the number of results (371) to display the contents of this bucket.

Click **Drill into group** to display this bucket in a range of smaller buckets.

371 results Group by None

Size = 0.015625-0.062499046325683594 MiB × | Deleted = Do not show Deleted ×

HDFS File
asm-5.0.1.jar
/user/oozie/share/lib/lib_20171227024329/hcatalog
Last Accessed Dec 27, 2017 ... Owner o... Size 51....
Last Modified Dec 27, 2017 ... Group o... Block Size 128...
Created Dec 27, 2017 ... Permissions r... Source HD...
View in Hue

HDFS File
metrics-graphite-3.1.2.jar
/user/oozie/share/lib/lib_20171227024329/spark
Last Accessed Dec 27, 2017 ... Owner o... Size 20....
Last Modified Dec 27, 2017 ... Group o... Block Size 128...
Created Dec 27, 2017 ... Permissions r... Source HD...
View in Hue

jetty-jndi-9.3.20.v20170531.jar
/user/oozie/share/lib/lib_20171227024329/hcatalog

24 groups, by "Size"
(371 results)

Group by Size

Size = 0.015625-0.062499046325683594 MiB × | Deleted = Do not show Deleted × | Group by Size ×

16 KiB to 18 KiB	23
18 KiB to 20 KiB	26
20 KiB to 22 KiB	16
22 KiB to 24 KiB	10
24 KiB to 26 KiB	12
26 KiB to 28 KiB	20
28 KiB to 30 KiB	38
30 KiB to 32 KiB	8
32 KiB to 34 KiB	21
34 KiB to 36 KiB	16

Drill into group

The Group by view shows at most 50 values of a property.

Saving Searches

1. Specify a search string or set of filters.
2. To the right of the Search box, select **Actions** > **Save**, **Actions** > **Save *Search_name***, or **Actions** > **Save As...**.
3. If you have not previously saved the search, specify a name and click **Save**.

Reusing a Saved Search

1. To the right of the Search box, select **Actions** > **View saved searches...**. A label with the saved search name is added under the Search box.
2. Click the saved search name. The breadcrumbs and full query if displayed are updated to reflect the saved search, and the search results are refreshed immediately.

Performing Actions on Entities

Required Role: Policy Editor (or **Full Administrator**)

Moving an HDFS Entity and Moving an HDFS Entity to Trash

You can move an HDFS entity to another HDFS location, and to HDFS trash. To perform such actions, you must be a member of a user group that has the appropriate access to HDFS files.

> **Note:** To move HDFS entities to another file system such as S3, consider designating an HDFS directory as an archive location, define a Navigator policy to move the HDFS entities to that directory, and define a `CRON` job or other process to regularly move the content of the archive directory to the non-HDFS location.

You can also schedule a move or move to trash in a policy.

After an HDFS entity is deleted, its record stays in Navigator until it is purged, which is 60 days by default. For information on what gets purged and when, see Scheduling the Purge Process on page 79.

1. Open your browser.
2. Navigate to the host within the cluster running the Cloudera Navigator Metadata Server role using the correct host name and port for your instance:

   ```
   http://fqdn-1.example.com:7187/login.html
   ```

   The login prompt displays.
3. Log in to the Cloudera Navigator console using the credentials assigned by your administrator.
4. Run a search in the Cloudera Navigator console.
5. Click an HDFS entity link returned in the search. The entity Details tab displays.
6. To the left of the Details tab, select **Actions** > **Move...** or **Actions** > **Move to Trash...**.
7. For a move, specify the target path.
8. Click **Run Action**.

   When you delete a file, after a short delay the file displays a Deleted badge.

Viewing Command Action Status

1. Access the Cloudera Navigator console using the correct host name and port for your instance:

   ```
   http://fqdn-1.example.com:7187/login.html
   ```

The login prompt displays.

2. Log in to the Cloudera Navigator console using the credentials assigned by your administrator.
3. In the top right, click ***username*** > **Command Actions**. The Command Actions status page displays with a list of actions performed and the policy that caused the action, if applicable.
4. If an action failed, a View Log button displays, which you can click to view the error message associated with the failure.

Viewing an Entity in Hue

If the Hue component is running on the cluster view some entities using Hue and related tools, as follows:

File Browser	HDFS directories and files
Hive Metastore Manager (HMS)	Hive database and tables
Job Browser	YARN, Oozie

1. Access the Cloudera Navigator console using the correct host name and port for your instance:

```
http://fqdn-1.example.com:7187/login.html
```

The login prompt displays.

2. Log in to the Cloudera Navigator console using the credentials assigned by your administrator.
3. Run a search in the Cloudera Navigator console.
4. Do one of the following:

   - Search results

     1. Click the **View in Hue** link in a search result entry.

   - Entity details

     1. Click an entity link returned in the search. The entity Details tab displays.
     2. To the left of the Details tab, select **Actions** > **View in Hue**.

   The entity displays in the supported Hue application.

Using Policies to Automate Metadata Tagging

Cloudera Navigator lets you automate the application of metadata to specific entity classes using the policies you define. The policy specifies the actions to be performed by Navigator Metadata Server and the conditions under which to apply them. For data stewards who want to facilitate self-service discovery in their organizations, Cloudera Navigator's metadata policy feature provides a robust mechanism for streamlining the metadata management tasks. For example, you can define policies that:

- Add managed metadata, tags, and custom metadata to entities as they are ingested by the cluster
- Move entities of specific class to a specific target path, or to the trash
- Send messages to a JMS message queue for notifications. This requires configuring the JMS server on the Cloudera Management Service. See Configuring a JMS Server for Policy Messages for details.

Messages sent to JMS queues are formatted as JSON and contain the metadata of the entity to which the policy should apply and the policy's specified message text. For example:

```
{
 "entity":entity_property,
 "userMessage":"some message text"
}
```

Policies are executed in the home directory of their creator and can only take actions (run commands) for which the creator has privileges. At runtime, a policy fails if the user account of the policy creator does not have privileges to perform all the commands specified in the policy.

Policy ownership can be changed by cloning the policy:

- Log in to the Cloudera Navigator console using the account name to which you want to transfer ownership.
- Clone the policy.
- Log out from this account, and then log in again using account identity of original policy owner.
- Delete or disable the original policy.

> **Note:** To ensure that command actions do not fail, policies containing command actions should be created by data stewards who are members of a user group that has the appropriate access to HDFS files.

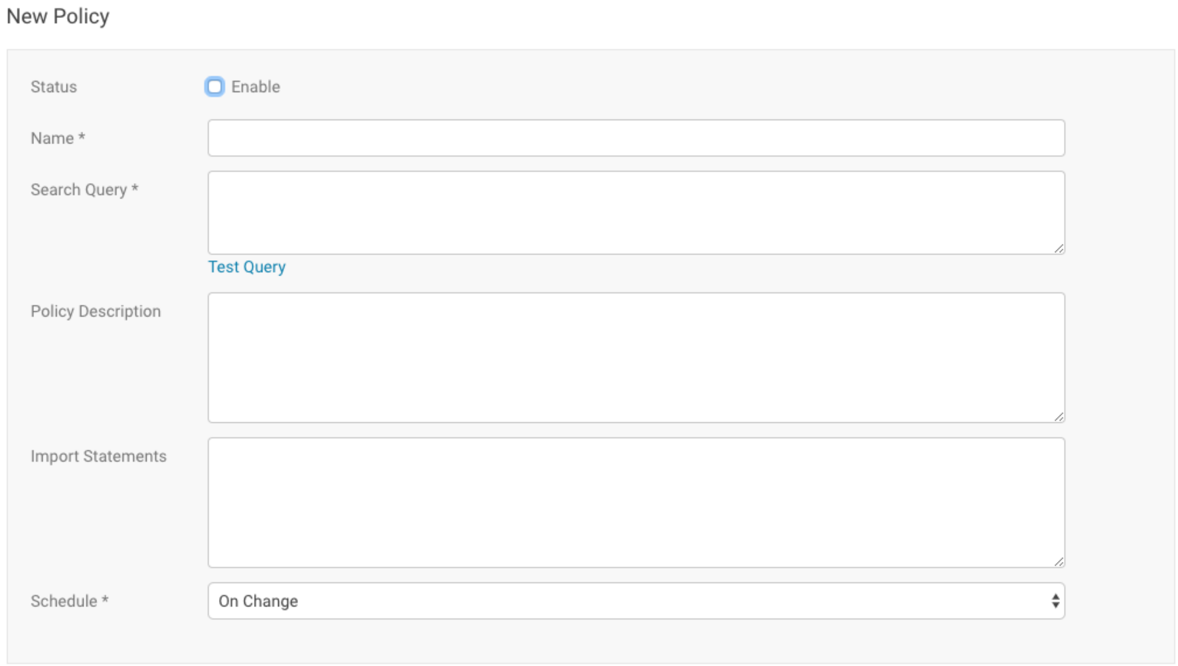
Certain actions can be specified using Java expressions. See Metadata Policy Expressions on page 47 for details.

Creating Policies

Required Role: Policy Editor (or **Full Administrator**)

These steps begin from the Cloudera Navigator console.

1. Click the **Policies** tab.
2. Click the **New Policy** button.



New Policy

Status □ Enable

Name *

Search Query *

Test Query

Policy Description

Import Statements

Schedule * On Change

3. Click the **Enable** checkbox.
4. Enter a meaningful name for the policy.
5. In the **Search Query** field, specify the search query that defines the class of entities to which the policy should apply.
6. Click the **Test Query** link to see a list of results based on the query and revise the query as needed.
7. Enter a **Policy Description** to document some of the functional aspects of this policy in the context of your organization. This field is optional but it is recommended for use especially if your organization has many policies defined for use by different teams, departments, and so on.
8. For a policy that includes Java expressions, enter the classes that the expressions will use in the **Import Statements** field. See Metadata Policy Expressions on page 47 for details, including examples and a class reference.

9. Choose the schedule for applying the policy:

   - **On Change** - When the entities matching the search string change.
   - **Immediate** - When the policy is created.
   - **Once** - At the time specified in the Start Time field.
   - **Recurring** - At recurring times specified by the Start and End Time fields at the interval specified in the Interval field.

   For Once and Recurring fields, specify dates and times using the calendar, time, and date tools available for the setting.
10. Follow the appropriate procedure for the actions performed by the policy:

    - **Metadata Assignments**: Specify the custom metadata or managed metadata to be assigned. Optionally, you can define Java expressions for fields in the policy that support them. Check the **Expression** checkbox to select this capability. The following fields support expressions:

      – Name
      – Description
      – Managed Metadata
      – Key-Value Pairs

    - **Command Actions**: Select **Add Action** > **Move to Trash** or **Add Action** > **Move**. For a move, specify the location to move the entity to in the Target Path field. If you specify multiple actions, they are run in the order in which they are specified.

      Command actions are supported only for HDFS entities. If you configure a command action for unsupported entities, a runtime error is logged when the policy runs.

      See Viewing Command Action Status on page 43.

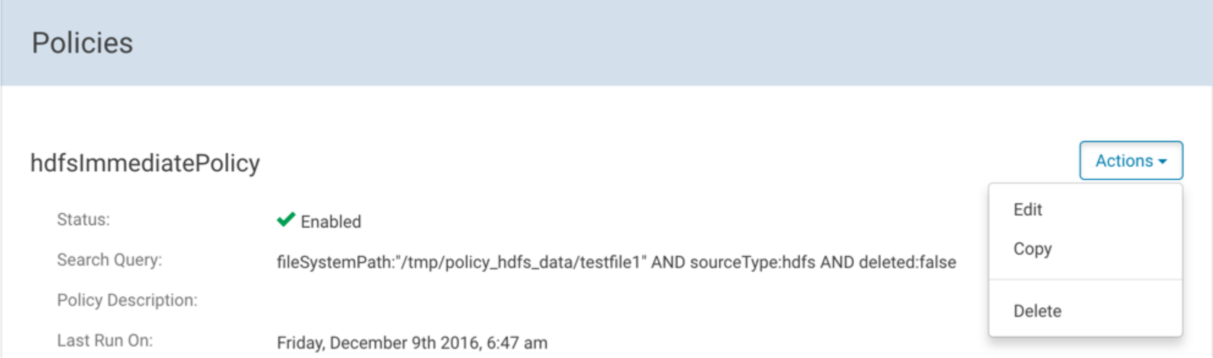
    - **JMS Notifications**: If not already configured, configure a JMS server and queue. Specify the queue name and message. Optionally, check the **Expression** checkbox and specify a policy expression for the message.
11. Click **Save**.

Viewing Policies

Required Role: Policy Viewer (or **Policy Editor**, or **Full Administrator**)

1. Log in to the Cloudera Navigator console.
2. Click the **Policies** tab.
3. In a policy row, click a policy name link or select **Actions** > **View**. The policy detail page is displayed.

   You can also edit, copy, or delete a policy from the policy details page by clicking the **Actions** button.



Policies

hdfsImmediatePolicy

Status: ✓ Enabled

Search Query: fileSystemPath:"/tmp/policy_hdfs_data/testfile1" AND sourceType:hdfs AND deleted:false

Policy Description:

Last Run On: Friday, December 9th 2016, 6:47 am

Enabling and Disabling Policies

As a policy administrator, you can manage access to policies by enabling and disabling them.

Required Role: **Policy Editor** (or **Full Administrator**)

1. Log in to the Cloudera Navigator console.
2. Click the **Policies** tab.
3. In a policy row, click a policy name link or select **Actions** > **Enable** or **Actions** > **Disable**.

Copying and Editing a Policy

If you have an existing policy that you want to use as a template for another similar property, you can copy it and then make any required adjustments. You can also edit existing policies if you need to make changes to it.

Required Role: **Policy Editor** (or **Full Administrator**)

1. Log in to the Cloudera Navigator console.
2. Click the **Policies** tab.
3. In a policy row, select **Actions** > **Copy** or **Actions** > **Edit**. You can also click the policy row and then on the policy details page, select **Actions** > **Copy** or **Actions** > **Edit**.
4. Edit the policy name, search query, or policy actions.
5. Click **Save**.

Deleting Policies

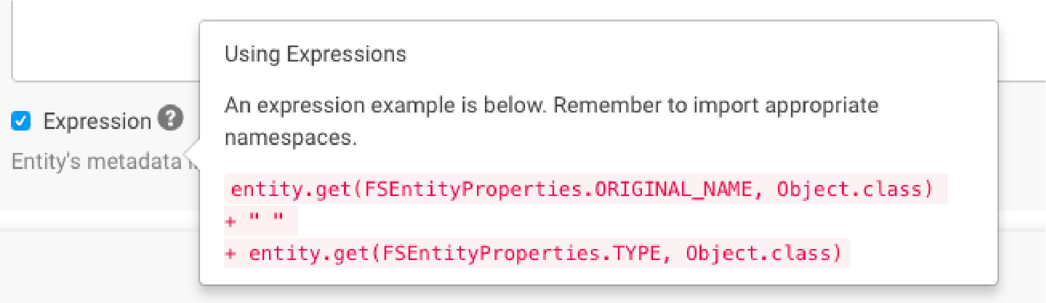
Required Role: **Policy Editor** (or **Full Administrator**)

1. Log in to the Cloudera Navigator console.
2. Click the **Policies** tab.
3. In a policy row, select **Actions** > **Delete** and **OK** to confirm.

Metadata Policy Expressions

A ***metadata policy expression*** is a Java expression that uses Java expressions instead of string literals to define properties for a metadata extraction policy. Properties that can be defined using Java expressions include entity names and descriptions, managed metadata, key-value pairs, and JMS notification messages. Declare classes for the expression to use in the policy's `import` statement. The Java expressions defined to apply policies must evaluate to strings.

The Cloudera Navigator console displays an **Expression** check box near entities that can use Java expressions. Click the help icon for a pop-up example of an expression:



Using Expressions

An expression example is below. Remember to import appropriate namespaces.

```
entity.get(FSEntityProperties.ORIGINAL_NAME, Object.class)
+ " "
+ entity.get(FSEntityProperties.TYPE, Object.class)
```

Expressions can support the following:

- Metadata Assignments
  - Name
  - Description
  - Managed Metadata
  - Key-Value Pairs
- JMS Notification Messages

Note: Using Java expressions to define policies is not enabled by default. See Configuring the Server for Policy Messages to enable this feature.

Including Entity Properties in Policy Expressions

To include entity properties in property expressions, use the `entity.get` method and pass the property and return type as follows:

```
entity.get(EnumTypeProperties.PROPERTY, return_type)
```

The *EnumType*`Properties`.*PROPERTY* and respective values for *return_type* are detailed in full in the Entity Property Enum Reference below. The *EnumType* class names are:

- FSEntity
- HiveColumn
- HiveDatabase
- HivePartition
- HiveQueryExecution
- HiveQueryPart
- HiveQuery
- HiveTable
- HiveView
- JobExecution
- Job
- WorkflowInstance
- Workflow
- PigField
- PigOperationExecution
- PigOperation
- PigRelation
- SqoopExportSubOperation
- SqoopImportSubOperation
- SqoopOperationExecution
- SqoopQueryOperation
- SqoopTableExportOperation
- SqoopTableImportOperation

For any operation based on return type (*`return_type`*), use the return type listed in Entity Property Enum Reference on page 49. Each *PROPERTY* listed for a given *EnumType* has its data type (*return_type*) specified following the Java comment (//).

For example, the return type for the `ORIGINAL_NAME` property of the `FSEntityProperties` class is `java.lang.String`, which means you can use `String` methods such as `toLowerCase()` to modify the returned value:

```
entity.get(FSEntityProperties.ORIGINAL_NAME, String.class).toLowerCase()
```

Note: For expressions that do not require specific type, use `Object.class` as the return type.

Metadata Policy Expression Examples

Here are some short examples showing how to use Java expressions for metadata policies. The examples include the import statements to enter into to the **Import Statements** field when creating policies in the Cloudera Navigator console.

- Set a filesystem entity name to the original name concatenated with the entity type:

```
entity.get(FSEntityProperties.ORIGINAL_NAME, Object.class) + " " +
entity.get(FSEntityProperties.TYPE, Object.class)
```

  Import Statements:

```
import com.cloudera.nav.hdfs.model.FSEntityProperties;
```

- Add the entity's creation date to the entity name:

```
entity.get(FSEntityProperties.ORIGINAL_NAME, Object.class) + " - "
+ new SimpleDateFormat("yyyy-MM-dd").format(entity.get(FSEntityProperties.CREATED,
Instant.class).toDate())
```

  Import Statements:

```
import com.cloudera.nav.hdfs.model.FSEntityProperties; import java.text.SimpleDateFormat;
 import org.joda.time.Instant;
```

- Set the key-value pair: retain_util-seven years from today's local time:

```
new DateTime().plusYears(7).toLocalDateTime().toString("MMM dd yyyy", Locale.US)
```

  Import statements:

```
import org.joda.time.DateTime; import java.util.Locale;
```

Entity Property Enum Reference

The Java enumerations for retrieving properties from each entity type are listed below.

```
com.cloudera.nav.hdfs.model.FSEntityProperties
public enum FSEntityProperties implements PropertyEnum {
  PERMISSIONS, // Return type: java.lang.String
  TYPE, // Return type: java.lang.String
  SIZE, // Return type: java.lang.Long
  OWNER, // Return type: java.lang.String
  LAST_MODIFIED, // Return type: org.joda.time.Instant
  SOURCE_TYPE, // Return type: java.lang.String
  DELETED, // Return type: java.lang.Boolean
  FILE_SYSTEM_PATH, // Return type: java.lang.String
  CREATED, // Return type: org.joda.time.Instant
  LAST_ACCESSED, // Return type: org.joda.time.Instant
  GROUP, // Return type: java.lang.String
  MIME_TYPE, // Return type: java.lang.String
  DELETE_TIME, // Return type: java.lang.Long
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.hive.model.HiveColumnProperties
public enum HiveColumnProperties implements PropertyEnum {
  TYPE, // Return type: java.lang.String
  SOURCE_TYPE, // Return type: java.lang.String
  DELETED, // Return type: java.lang.Boolean
  DATA_TYPE, // Return type: java.lang.String
  ORIGINAL_DESCRIPTION, // Return type: java.lang.String
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.hive.model.HiveDatabaseProperties
public enum HiveDatabaseProperties implements PropertyEnum {
  TYPE, // Return type: java.lang.String
  ORIGINAL_DESCRIPTION, // Return type: java.lang.String
  SOURCE_TYPE, // Return type: java.lang.String
  DELETED, // Return type: java.lang.Boolean
  FILE_SYSTEM_PATH, // Return type: java.lang.String
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.hive.model.HivePartitionProperties
public enum HivePartitionProperties implements PropertyEnum {
  TYPE, // Return type: java.lang.String
  SOURCE_TYPE, // Return type: java.lang.String
  DELETED, // Return type: java.lang.Boolean
  FILE_SYSTEM_PATH, // Return type: java.lang.String
  CREATED, // Return type: org.joda.time.Instant
  LAST_ACCESSED, // Return type: org.joda.time.Instant
  COL_VALUES, // Return type: java.util.List
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.hive.model.HiveQueryExecutionProperties
public enum HiveQueryExecutionProperties implements PropertyEnum {
  SOURCE_TYPE, // Return type: java.lang.String
  TYPE, // Return type: java.lang.String
  ENDED, // Return type: org.joda.time.Instant
  INPUTS, // Return type: java.util.Collection
  OUTPUTS, // Return type: java.util.Collection
  STARTED, // Return type: org.joda.time.Instant
  PRINCIPAL, // Return type: java.lang.String
  WF_INST_ID, // Return type: java.lang.String
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.hive.model.HiveQueryPartProperties
public enum HiveQueryPartProperties implements PropertyEnum {
  TYPE, // Return type: java.lang.String
  SOURCE_TYPE, // Return type: java.lang.String
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.hive.model.HiveQueryProperties
public enum HiveQueryProperties implements PropertyEnum {
  SOURCE_TYPE, // Return type: java.lang.String
  INPUTS, // Return type: java.util.Collection
  OUTPUTS, // Return type: java.util.Collection
  QUERY_TEXT, // Return type: java.lang.String
  TYPE, // Return type: java.lang.String
  WF_IDS, // Return type: java.util.Collection
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.hive.model.HiveTableProperties
public enum HiveTableProperties implements PropertyEnum {
  OWNER, // Return type: java.lang.String
  INPUT_FORMAT, // Return type: java.lang.String
  OUTPUT_FORMAT, // Return type: java.lang.String
  DELETED, // Return type: java.lang.Boolean
  FILE_SYSTEM_PATH, // Return type: java.lang.String
  COMPRESSED, // Return type: java.lang.Boolean
  PARTITION_COL_NAMES, // Return type: java.util.List
  CLUSTERED_BY_COL_NAMES, // Return type: java.util.List
  SORT_BY_COL_NAMES, // Return type: java.util.List
  SER_DE_NAME, // Return type: java.lang.String
  SER_DE_LIB_NAME, // Return type: java.lang.String
  TYPE, // Return type: java.lang.String
  SOURCE_TYPE, // Return type: java.lang.String
  CREATED, // Return type: org.joda.time.Instant
  LAST_ACCESSED, // Return type: org.joda.time.Instant
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.hive.model.HiveViewProperties
public enum HiveViewProperties implements PropertyEnum {
  DELETED, // Return type: java.lang.Boolean
  QUERY_TEXT, // Return type: java.lang.String
  TYPE, // Return type: java.lang.String
  SOURCE_TYPE, // Return type: java.lang.String
  CREATED, // Return type: org.joda.time.Instant
  LAST_ACCESSED, // Return type: org.joda.time.Instant
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.mapreduce.model.JobExecutionProperties
public enum JobExecutionProperties implements PropertyEnum {
  SOURCE_TYPE, // Return type: java.lang.String
  JOB_ID, // Return type: java.lang.String
  ENDED, // Return type: org.joda.time.Instant
  INPUT_RECURSIVE, // Return type: boolean
  TYPE, // Return type: java.lang.String
  INPUTS, // Return type: java.util.Collection
  OUTPUTS, // Return type: java.util.Collection
  STARTED, // Return type: org.joda.time.Instant
  PRINCIPAL, // Return type: java.lang.String
  WF_INST_ID, // Return type: java.lang.String
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.mapreduce.model.JobProperties
public enum JobProperties implements PropertyEnum {
  ORIGINAL_NAME, // Return type: java.lang.String
  INPUT_FORMAT, // Return type: java.lang.String
  OUTPUT_FORMAT, // Return type: java.lang.String
  OUTPUT_KEY, // Return type: java.lang.String
  OUTPUT_VALUE, // Return type: java.lang.String
  MAPPER, // Return type: java.lang.String
  REDUCER, // Return type: java.lang.String
  SOURCE_TYPE, // Return type: java.lang.String
  TYPE, // Return type: java.lang.String
  WF_IDS, // Return type: java.util.Collection
  NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.oozie.model.WorkflowInstanceProperties
public enum WorkflowInstanceProperties implements PropertyEnum {
  TYPE, // Return type: java.lang.String
  SOURCE_TYPE, // Return type: java.lang.String
  CREATED, // Return type: org.joda.time.Instant
  JOB_ID, // Return type: java.lang.String
  STATUS, // Return type: java.lang.String
  ENDED, // Return type: org.joda.time.Instant
  INPUTS, // Return type: java.util.Collection
  OUTPUTS, // Return type: java.util.Collection
  STARTED, // Return type: org.joda.time.Instant
  PRINCIPAL, // Return type: java.lang.String
  WF_INST_ID, // Return type: java.lang.String
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.oozie.model.WorkflowProperties
public enum WorkflowProperties implements PropertyEnum {
  TYPE, // Return type: java.lang.String
  SOURCE_TYPE, // Return type: java.lang.String
  WF_IDS, // Return type: java.util.Collection
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.pig.model.PigFieldProperties
public enum PigFieldProperties implements PropertyEnum {
  TYPE, // Return type: java.lang.String
  INDEX, // Return type: int
  SOURCE_TYPE, // Return type: java.lang.String
  DATA_TYPE, // Return type: java.lang.String
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.pig.model.PigOperationExecutionProperties
public enum PigOperationExecutionProperties implements PropertyEnum {
  SOURCE_TYPE, // Return type: java.lang.String
  TYPE, // Return type: java.lang.String
  ENDED, // Return type: org.joda.time.Instant
  INPUTS, // Return type: java.util.Collection
  OUTPUTS, // Return type: java.util.Collection
  STARTED, // Return type: org.joda.time.Instant
  PRINCIPAL, // Return type: java.lang.String
  WF_INST_ID, // Return type: java.lang.String
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.pig.model.PigOperationProperties
public enum PigOperationProperties implements PropertyEnum {
  SOURCE_TYPE, // Return type: java.lang.String
  OPERATION_TYPE, // Return type: java.lang.String
  SCRIPT_ID, // Return type: java.lang.String
  TYPE, // Return type: java.lang.String
  WF_IDS, // Return type: java.util.Collection
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.pig.model.PigRelationProperties
public enum PigRelationProperties implements PropertyEnum {
  TYPE, // Return type: java.lang.String
  SOURCE_TYPE, // Return type: java.lang.String
  FILE_SYSTEM_PATH, // Return type: java.lang.String
  SCRIPT_ID, // Return type: java.lang.String
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.sqoop.model.SqoopExportSubOperationProperties
public enum SqoopExportSubOperationProperties implements PropertyEnum {
  TYPE, // Return type: java.lang.String
  SOURCE_TYPE, // Return type: java.lang.String
  INPUTS, // Return type: java.util.Collection
  FIELD_INDEX, // Return type: int
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.sqoop.model.SqoopImportSubOperationProperties
public enum SqoopImportSubOperationProperties implements PropertyEnum {
  DB_COLUMN_EXPRESSION, // Return type: java.lang.String
  TYPE, // Return type: java.lang.String
  SOURCE_TYPE, // Return type: java.lang.String
  INPUTS, // Return type: java.util.Collection
  FIELD_INDEX, // Return type: int
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.sqoop.model.SqoopOperationExecutionProperties
public enum SqoopOperationExecutionProperties implements PropertyEnum {
  SOURCE_TYPE, // Return type: java.lang.String
  TYPE, // Return type: java.lang.String
  ENDED, // Return type: org.joda.time.Instant
  INPUTS, // Return type: java.util.Collection
  OUTPUTS, // Return type: java.util.Collection
  STARTED, // Return type: org.joda.time.Instant
  PRINCIPAL, // Return type: java.lang.String
  WF_INST_ID, // Return type: java.lang.String
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.sqoop.model.SqoopQueryOperationProperties
public enum SqoopQueryOperationProperties implements PropertyEnum {
  SOURCE_TYPE, // Return type: java.lang.String
  INPUTS, // Return type: java.util.Collection
  QUERY_TEXT, // Return type: java.lang.String
  DB_USER, // Return type: java.lang.String
  DB_URL, // Return type: java.lang.String
  OPERATION_TYPE, // Return type: java.lang.String
  TYPE, // Return type: java.lang.String
  WF_IDS, // Return type: java.util.Collection
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.sqoop.model.SqoopTableExportOperationProperties
public enum SqoopTableExportOperationProperties implements PropertyEnum {
  DB_TABLE, // Return type: java.lang.String
  SOURCE_TYPE, // Return type: java.lang.String
  DB_USER, // Return type: java.lang.String
  DB_URL, // Return type: java.lang.String
  OPERATION_TYPE, // Return type: java.lang.String
  TYPE, // Return type: java.lang.String
  WF_IDS, // Return type: java.util.Collection
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

```
com.cloudera.nav.sqoop.model.SqoopTableImportOperationProperties
public enum SqoopTableImportOperationProperties implements PropertyEnum {


  DB_TABLE, // Return type: java.lang.String
  DB_WHERE, // Return type: java.lang.String
  SOURCE_TYPE, // Return type: java.lang.String
  DB_USER, // Return type: java.lang.String
  DB_URL, // Return type: java.lang.String
  OPERATION_TYPE, // Return type: java.lang.String
  TYPE, // Return type: java.lang.String
  WF_IDS, // Return type: java.util.Collection
  NAME, // Return type: java.lang.String
  ORIGINAL_NAME, // Return type: java.lang.String
  USER_ENTITY, // Return type: boolean
  SOURCE_ID, // Return type: java.lang.String
  EXTRACTOR_RUN_ID, // Return type: java.lang.String
  PARENT_PATH; // Return type: java.lang.String
}
```

Lineage Diagrams

When it comes to making important business decisions, filing financial records, or complying with all manner of regulations, organizations need **verifiable** data. Public corporations in the United States must be able to prove to the IRS or to the SEC that values supplied in balance sheets and income statements are legitimate, for example. In pharmaceuticals research, data collected over multi-year clinical trials that may be combined with anonymous patient statistics must be able to be traced to data sources.

Cloudera Navigator lineage diagrams are designed to enable this type of verification. Lineage diagrams can reveal the ***provenance*** of data entities—the history of the data entity, back to its source with all changes along the way to its present form.

A ***lineage diagram*** is a directed graph that shows how data entities are related and how an entity may have changed over its lifetime in the cluster. Cloudera Navigator uses the metadata associated with entities contained in the cluster to render lineage diagrams that can trace data sources back to the column level and show relations and the results of transformations. See Lineage Diagram Icons on page 157 for details about the line colors, styles, and icons used to render lineage diagrams, some of which are explained in the context of the examples below.

Using the Lineage View

For information about how lineage relationships are formed, see Generating Lineage Diagrams on page 66.

Exploring Lineage Diagrams

Required Role: Metadata & Lineage Viewer (or **Managed & Custom Metadata Editor**, or **Full Administrator**)

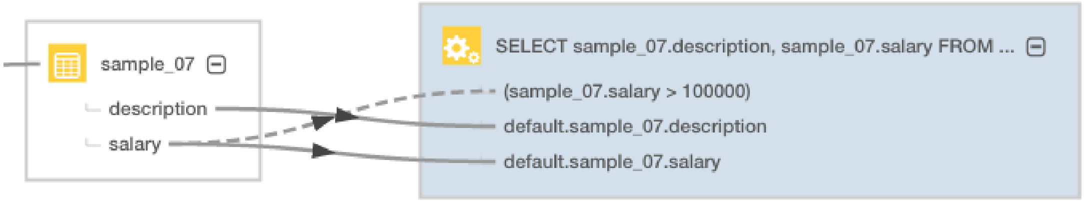
Lineage diagrams are accessible in various ways in the Cloudera Navigator console. This example uses Search to first find a specific entity and then display its lineage diagram. Use this approach if you know the name, data type, source type, or another property value for a specific entity. The example uses the Hive sample data warehouse (installed by default) and assumes the following query has been run:

```
SELECT sample_07.description, sample_07.salary FROM sample_07
WHERE (sample_07.salary > 100000)
ORDER BY sample_07.salary DESC LIMIT 1000
```

The query returns values from `description` and `salary` columns for salaries over 100,000 from the `sample_07` table. Because Cloudera Navigator automatically collects metadata from entities, it can render lineage diagrams on any data contained in the cluster, including operations, such as the SELECT query of the example.

To display the lineage diagram based on this query in Cloudera Navigator console:

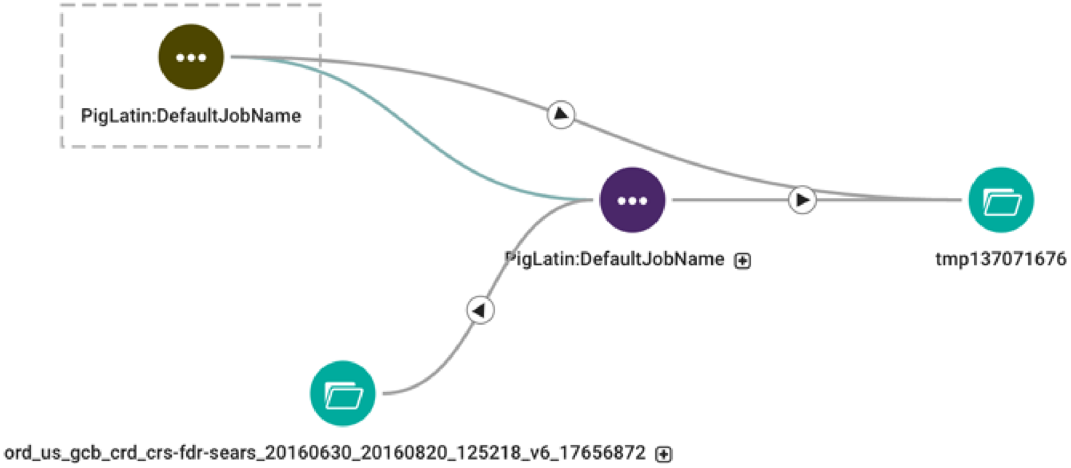
- Click the **Search** tab.
- Click **Hive** and **Operation** filters limit the scope of the search.
- Type the word `salary` or `sample_07` to find the query created above.
- Find the returned entity that contains the query and click on it to display its Details page.
- Click the query and then click the **Lineage** tab to display the lineage diagram.


sample_07
description
salary
SELECT sample_07.description, sample_07.salary FROM ...
(sample_07.salary > 100000)
default.sample_07.description
default.sample_07.salary

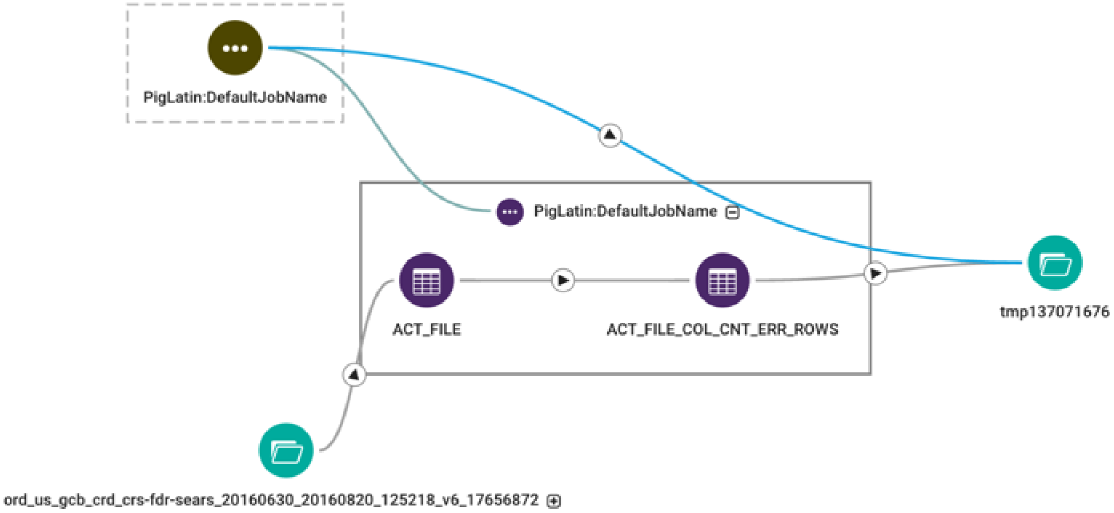
The columns identified in the select clause use solid directed lines to the source table (shown with the Hive Table icon) and a dashed line to the source column of the where clause (shown with the Operation icon).

Expanding Entities

The example shows how one lineage diagram can expand to another. The first image shows a YARN operation (PigLatin:DefaultJobName) that runs an associated Pig script of the same name (DefaultJobName). The solid lines represent data flow relationships, from the source file (in the ord_us_gcb_crd_crs-fdr-sears folder) through the script execution, to the destination (in folder tmp137071676). The YARN operation PigLatin:DefaultJobName is rendered using a dashed (rather than solid) line because it is the starting point for this particular lineage diagram. In lineage diagrams, lines change to the color blue when they are selected. Containment is signalled using the plus icon:


PigLatin:DefaultJobName
PigLatin:DefaultJobName ⊞
tmp137071676
ord_us_gcb_crd_crs-fdr-sears_20160630_20160820_125218_v6_17656872 ⊞

Click the plus icon to expand a parent entity and display child entities. For example, expanding the Pig script reveals the two Pig tables (ACT_FILE, ACT_FILE_COL_CNT_ERR_ROWS) referenced by the script. The solid directional line between the two tables indicates the data flow relationship between these two tables.


PigLatin:DefaultJobName
PigLatin:DefaultJobName ⊟
ACT_FILE
ACT_FILE_COL_CNT_ERR_ROWS
tmp137071676
ord_us_gcb_crd_crs-fdr-sears_20160630_20160820_125218_v6_17656872 ⊞

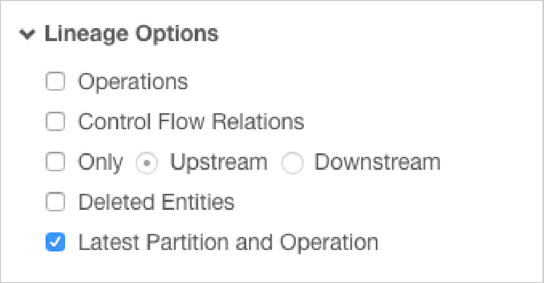
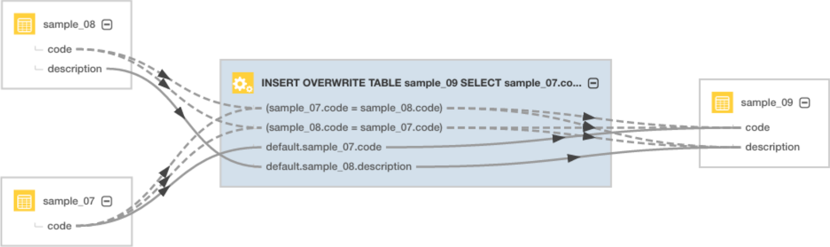
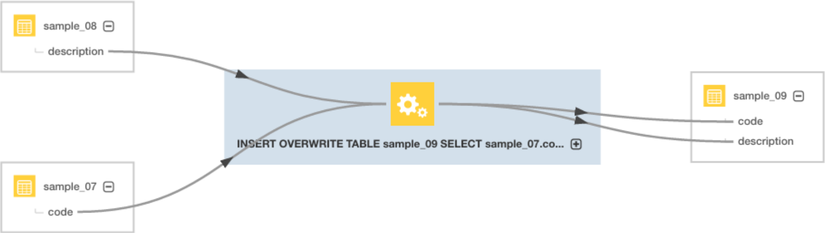
Adjusting the Lineage Layout for Readability

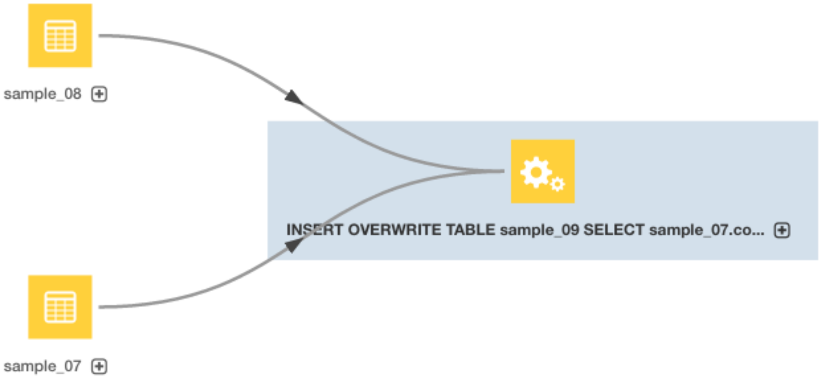
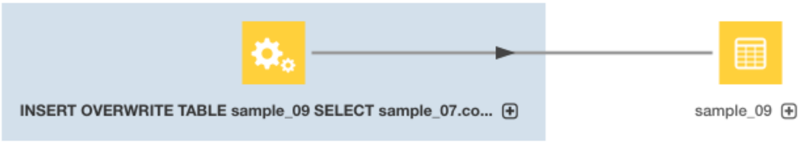
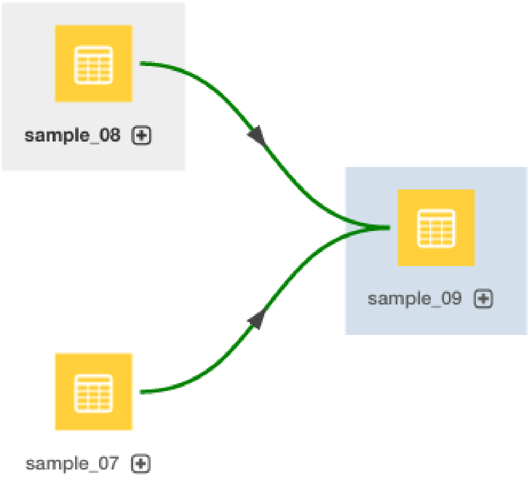
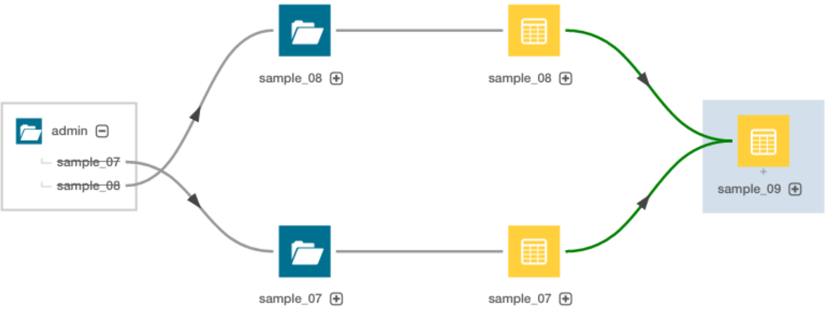
Lineage diagrams displayed in the Cloudera Navigator console can be manipulated by as follows:

- Click and drag entities outside their parent boxes.
- Use the plus-minus control displayed in the lineage diagram or the mouse scroll wheel to expand and shrink (zoom in, zoom out) the image size
- Relocate the lineage diagram within the pane using click-hold-drag gesture.

Filtering Lineage Diagrams

Lineage diagrams can render faster when filters are applied. Filters can limit or specify the entities displayed.

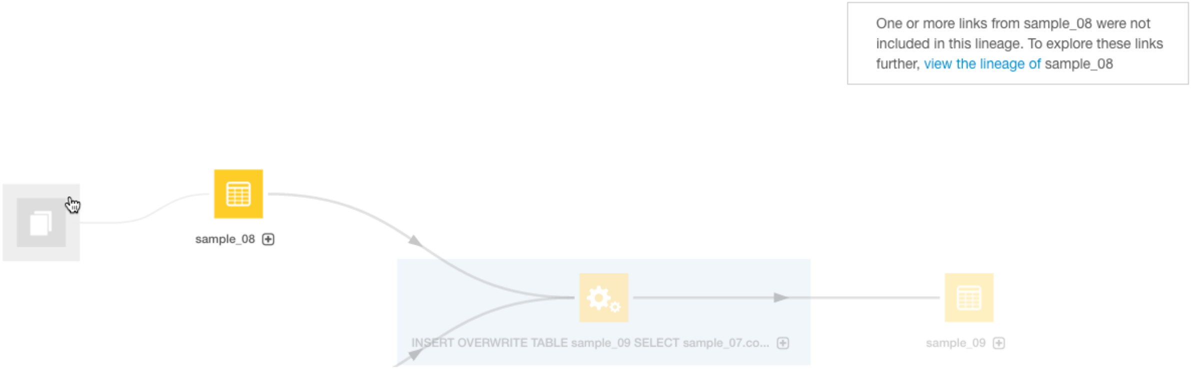
Filter	Result
The **Lineage Options** default selection applies the Latest Partition and Operation filter, which displays only the most recent partitions and operations. For example, if Hive partitions are created daily, the filter displays only the latest partition. **Note:** This filter applies only to metadata collected with Navigator Metadata Server installed with Cloudera Manager version 5.12 or later. Operations against multiple partitions that were collected by earlier versions will not collapse into a single partition.	 Lineage Options □ Operations □ Control Flow Relations □ Only ● Upstream ○ Downstream □ Deleted Entities ☑ Latest Partition and Operation
Lineage diagram of the `sample_09` table filtering deleted items only.	 sample_08 code description INSERT OVERWRITE TABLE sample_09 SELECT sample_07.co... (sample_07.code = sample_08.code) (sample_08.code = sample_07.code) default.sample_07.code default.sample_08.description sample_09 code description sample_07 code
Control Flow Relations. The operation is collapsed and control flow links are hidden.	 sample_08 description INSERT OVERWRITE TABLE sample_09 SELECT sample_07.co... sample_09 code description sample_07 code

Filter	Result
The **Only Upstream** filter displays only input (upstream) entities and links. The **Only Downstream** filter displays only output (downstream) entities and links. The operation is collapsed and only upstream (or downstream) entities and links display. The output table is hidden.	 sample_08 INSERT OVERWRITE TABLE sample_09 SELECT sample_07.co... sample_07
Here, the operation is collapsed and only downstream entities and links are shown. The input tables are hidden.	 INSERT OVERWRITE TABLE sample_09 SELECT sample_07.co... sample_09
The **Operations** filter collapses operations into green links between entities.	
The **Deleted Entities** filter displays entities that have been deleted but maintains relations to other entities.	 sample_08 sample_08 admin ~~sample_07~~ ~~sample_08~~ sample_09 sample_07 sample_07

Exploring Hidden Entities in a Lineage Diagram

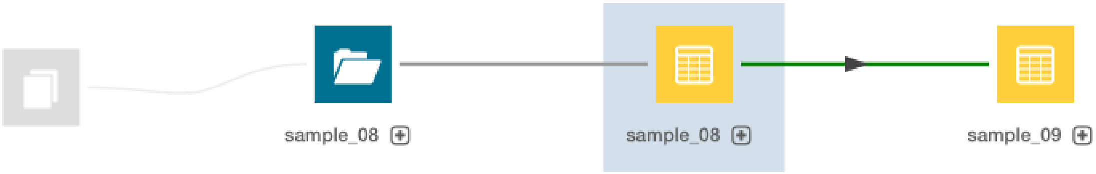
Lineage diagrams use the hidden icon to indicate areas in the diagram available for further exploration. The basic mouse gestures to use to traverse a lineage diagram with hidden information are as follows (there are many alternative approaches, including simply double-clicking the hidden icon):

1. Hover over the hidden icon (note the hand floating at the top of the hidden icon) to display an information text (box, upper-right) with the link that provides access to lineage for the additional entities.



One or more links from sample_08 were not included in this lineage. To explore these links further, view the lineage of sample_08

2. Click the hidden icon to select it.
3. Click the **view the lineage** link to display a new lineage diagram contained at that intersect point. The green line is a summary line that contains

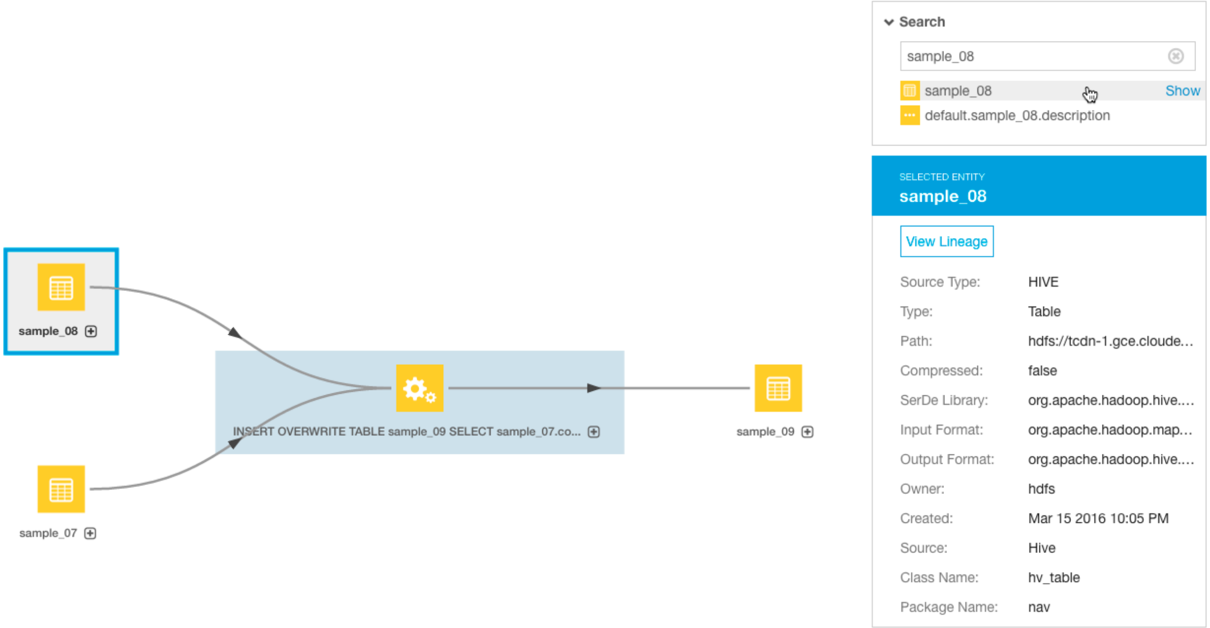


This shows that the `sample_08` table is actually contained in a folder, `sample_08`.

Finding Specific Entities in Lineage Diagrams

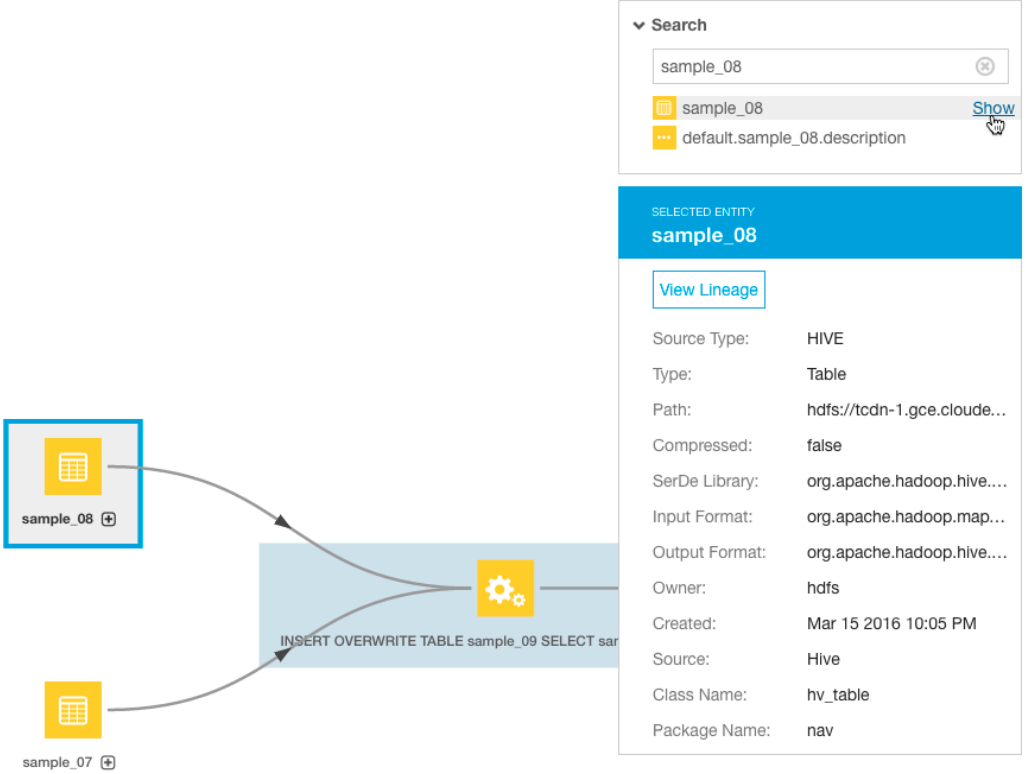
Cloudera Navigator's Search function can be used in the context of an open lineage diagram. This is useful especially when lineage diagrams have hidden entities that are may not be visible.

1. In the **Search** box at the right of the diagram, type an entity name. A list of matching entities displays below the box.
2. Click an entity in the list. A blue box is drawn around the entity and its details display in a box below the Search box.



Source Type:	HIVE
Type:	Table
Path:	hdfs://tcdn-1.gce.cloude…
Compressed:	false
SerDe Library:	org.apache.hadoop.hive.…
Input Format:	org.apache.hadoop.map…
Output Format:	org.apache.hadoop.hive.…
Owner:	hdfs
Created:	Mar 15 2016 10:05 PM
Source:	Hive
Class Name:	hv_table
Package Name:	nav

3. Click the **Show** link next to the entity. The selected entity moves to the center of the diagram.



Source Type:	HIVE
Type:	Table
Path:	hdfs://tcdn-1.gce.cloude…
Compressed:	false
SerDe Library:	org.apache.hadoop.hive.…
Input Format:	org.apache.hadoop.map…
Output Format:	org.apache.hadoop.hive.…
Owner:	hdfs
Created:	Mar 15 2016 10:05 PM
Source:	Hive
Class Name:	hv_table
Package Name:	nav

4. To view the lineage of the selected entity, click the **View Lineage** link in the entity details box.

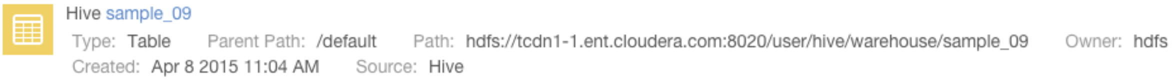
Displaying a Template Lineage Diagram

A ***template lineage diagram*** contains template entities, such as jobs and queries, that can be instantiated, and the input and output entities to which they are related.

To display a template lineage diagram:

1. Perform a metadata search.

2. In the list of results, click an entity. The entity Details page displays. For example, when you click the `sample_09` result entry:

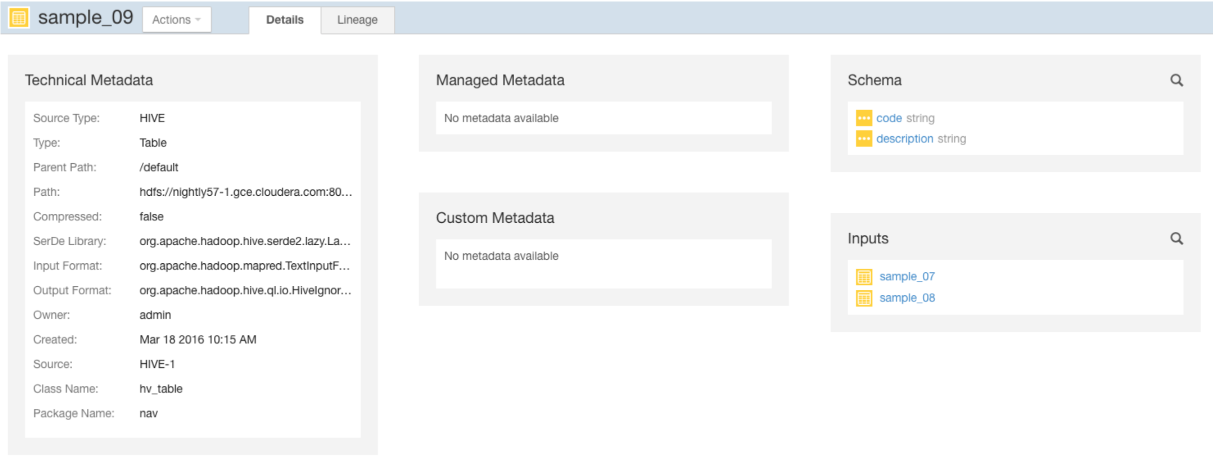


Hive sample_09

Type: Table   Parent Path: /default   Path: hdfs://tcdn1-1.ent.cloudera.com:8020/user/hive/warehouse/sample_09   Owner: hdfs

Created: Apr 8 2015 11:04 AM   Source: Hive

the Search screen is replaced with a Details page that displays the entity property sheet:



Technical Metadata

Source Type:	HIVE
Type:	Table
Parent Path:	/default
Path:	hdfs://nightly57-1.gce.cloudera.com:80...
Compressed:	false
SerDe Library:	org.apache.hadoop.hive.serde2.lazy.La...
Input Format:	org.apache.hadoop.mapred.TextInputF...
Output Format:	org.apache.hadoop.hive.ql.io.HiveIgnor...
Owner:	admin
Created:	Mar 18 2016 10:15 AM
Source:	HIVE-1
Class Name:	hv_table
Package Name:	nav

Managed Metadata

No metadata available

Custom Metadata

No metadata available

Schema

code string

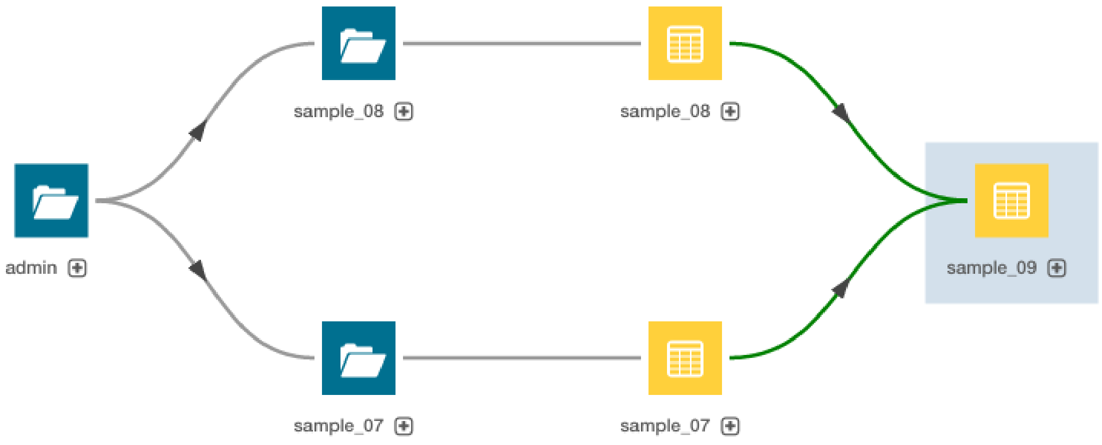
description string

Inputs

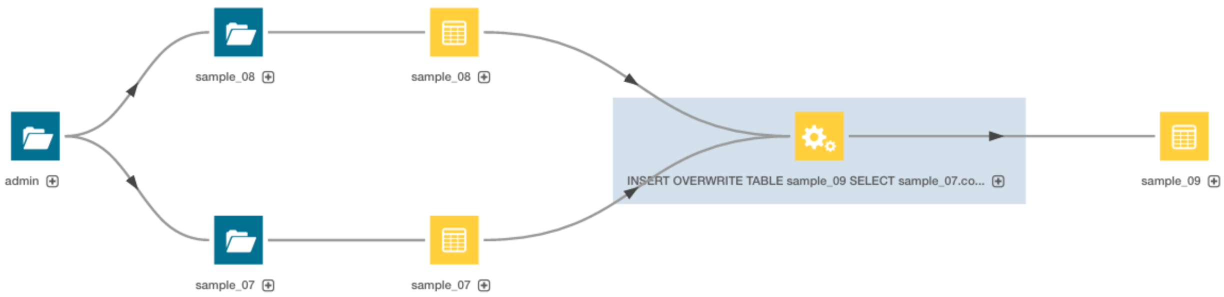
sample_07

sample_08

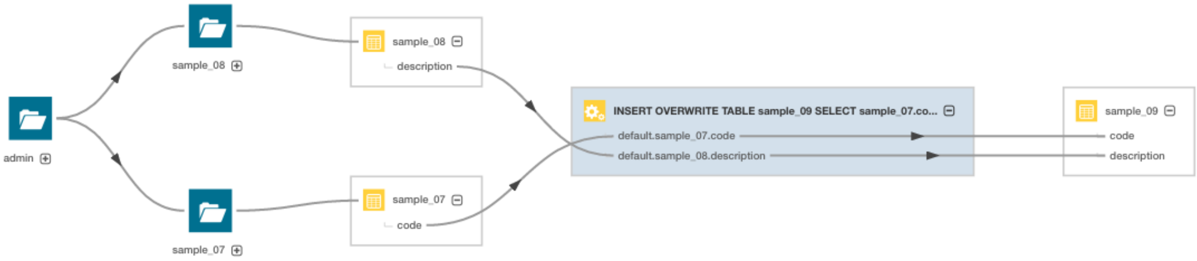
3. Click the **Lineage** tab. For example, clicking the Lineage tab for the sample_09 table displays the following lineage diagram:



This example shows the relations between a Hive query execution entity and its source and destination tables:



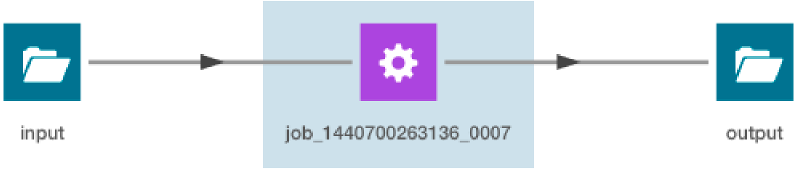
Click the plus icon to display the columns and lines connecting the source and destination columns display:



Displaying an Instance Lineage Diagram

An ***instance lineage diagram*** displays instance entities, such as job and query executions, and the input and output entities to which they are related. To display an instance lineage diagram:

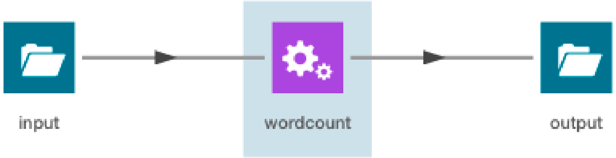
1. Perform a search and click a link of type Operation.
2. Click a link in the **Instances** box.
3. Click the **Lineage** tab.



Displaying the Template Lineage Diagram for an Instance Lineage Diagram

To browse from an instance diagram to its template:

1. Display an instance lineage diagram.
2. Click the **Details** tab.
3. Click the value of the **Template** property to go to the instance's template.



Using Lineage to Display Table Schema

Required Role: Metadata & Lineage Viewer (or **Managed & Custom Metadata Editor**, or **Full Administrator**)

A table schema contains information about the names and types of the columns of a table.

A Kite dataset ingested into HDFS contains information about the names and types of the fields in an HDFS Avro or Parquet file used to create the dataset.

Displaying Hive, Impala, and Sqoop Table Schema

1. Use the Cloudera Navigator console to search for entities of source type **Hive** and type **Table**.
2. In the list of results, click a result entry. The table schema displays in the Details tab.

Displaying Pig Table Schema

1. Use the Cloudera Navigator console to search for entities of source type **Pig**.
2. In the list of results, click a result entry of type **Table**. The table schema displays in the Details tab.

Displaying HDFS Dataset Schema

If you ingest a Kite dataset into HDFS, you can view the schema of the dataset. The schema is represented as an entity of type Dataset and is implemented as an HDFS directory.

For Avro datasets, primitive types such as null, string, int, and so on, are not separate entities. For example, if you have a record type with a field A that's a record type and a field B that's a string, the subfields of A become entities themselves, but B has no children. Another example would be if you had a union of null, string, map, array, and record types; the union has 3 children - the map, array, and record subtypes.

To display an HDFS dataset schema:

1. Use the Cloudera Navigator console to search for specific **Dataset**.
2. Click a result entry. The dataset schema displays in the Details tab.

Stocks Schema

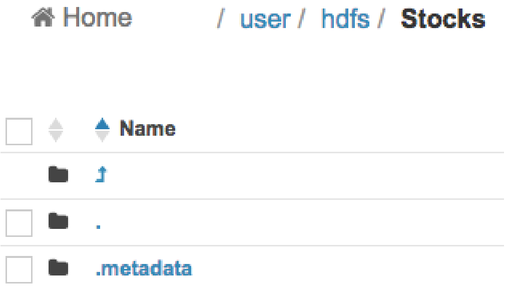
1. Use the Stocks Avro schema file:

```
{
  "type" : "record",
  "name" : "Stocks",
  "namespace" : "com.example.stocks",
  "doc" : "Schema generated by Kite",
  "fields" : [ {
    "name" : "Symbol",
    "type" : [ "null", "string" ],
    "doc" : "Type inferred from 'AAIT'"
  }, {
    "name" : "Date",
    "type" : [ "null", "string" ],
    "doc" : "Type inferred from '28-Oct-2014'"
  }, {
    "name" : "Open",
    "type" : [ "null", "double" ],
    "doc" : "Type inferred from '33.1'"
  }, {
    "name" : "High",
    "type" : [ "null", "double" ],
    "doc" : "Type inferred from '33.13'"
  }, {
    "name" : "Low",
    "type" : [ "null", "double" ],
    "doc" : "Type inferred from '33.1'"
  }, {
    "name" : "Close",
    "type" : [ "null", "double" ],
    "doc" : "Type inferred from '33.13'"
  }, {
    "name" : "Volume",
    "type" : [ "null", "long" ],
    "doc" : "Type inferred from '400'"
  } ]
}
```

and the `kite-dataset` command to create a Stocks dataset:

```
kite-dataset create dataset:hdfs:/user/hdfs/Stocks -s Stocks.avsc
```

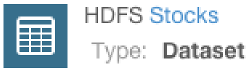
The following directory is created in HDFS:



Home / user / hdfs / **Stocks**

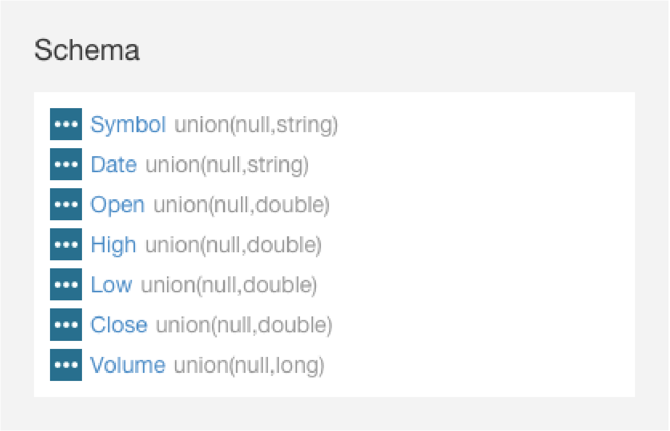
□		**Name**
	📁	↥
□	📁	.
□	📁	.metadata

2. In search results, the Stocks dataset appears as follows:



HDFS Stocks
Type: **Dataset**

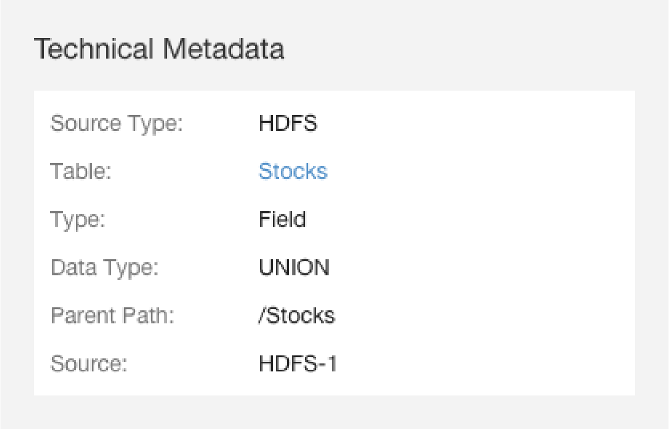
3. Click the **Stocks** link. The schema displays at the right of the Details tab.



Schema

- Symbol union(null,string)
- Date union(null,string)
- Open union(null,double)
- High union(null,double)
- Low union(null,double)
- Close union(null,double)
- Volume union(null,long)

Each subfield of the Stocks record is an entity of type Field.



Technical Metadata

Source Type:	HDFS
Table:	Stocks
Type:	Field
Data Type:	UNION
Parent Path:	/Stocks
Source:	HDFS-1

4. Then use the `kite-dataset` command to import structured data:

```
kite-dataset csv-import ./Stocks.csv dataset:hdfs:/user/hdfs/Stocks --no-header
```

where `Stocks.csv` is:

```
AAPL,20150206,120.02,120.25,118.45,118.93,43372000
AAPL,20150205,120.02,120.23,119.25,119.94,42246200
GOOG,20150304,571.87,577.11,568.01,573.37,1713800
GOOG,20150303,570.45,575.39,566.52,573.64,1694300
GOOG,20150302,560.53,572.15,558.75,571.34,2118400
GOOG,20150209,528,532,526.02,527.83,1264300
GOOG,20150206,527.64,537.2,526.41,531,1744600
GOOG,20150205,523.79,528.5,522.09,527.58,1844700
FB,20150304,79.3,81.15,78.85,80.9,28014500
```

```
FB,20150303,79.61,79.7,78.52,79.6,18567300
FB,20150302,79,79.86,78.52,79.75,21604400
FB,20150227,80.68,81.23,78.62,78.97,30635700
FB,20150226,79.88,81.37,79.72,80.41,31111900
TWTR,20150211,46.27,47.78,46.11,47.5,24747000
TWTR,20150210,47.35,47.39,45.57,46.26,32287800
TWTR,20150209,46.73,47.69,46.5,47.32,36177900
TWTR,20150206,46.12,48.5,45.8,48.01,102669800
TWTR,20150205,42.04,42.47,40.91,41.26,61997300
MSFT,20150304,43.01,43.21,42.88,43.06,25705800
MSFT,20150303,43.56,43.83,43.09,43.28,31748600
MSFT,20150302,43.67,44.19,43.55,43.88,31924000
MSFT,20150227,44.13,44.2,43.66,43.85,33807700
MSFT,20150226,43.99,44.23,43.89,44.06,28957300
ORCL,20150304,43.2,43.66,42.82,43.61,14663900
ORCL,20150303,43.83,43.88,43.17,43.38,10058700
ORCL,20150302,43.81,44.04,43.48,44.03,11091000
ORCL,20150227,43.77,44.11,43.68,43.82,9549500
ORCL,20150226,43.8,44.15,43.71,43.89,8519300
ORCL,20150225,43.83,44.09,43.38,43.73,11785400
```

Generating Lineage Diagrams

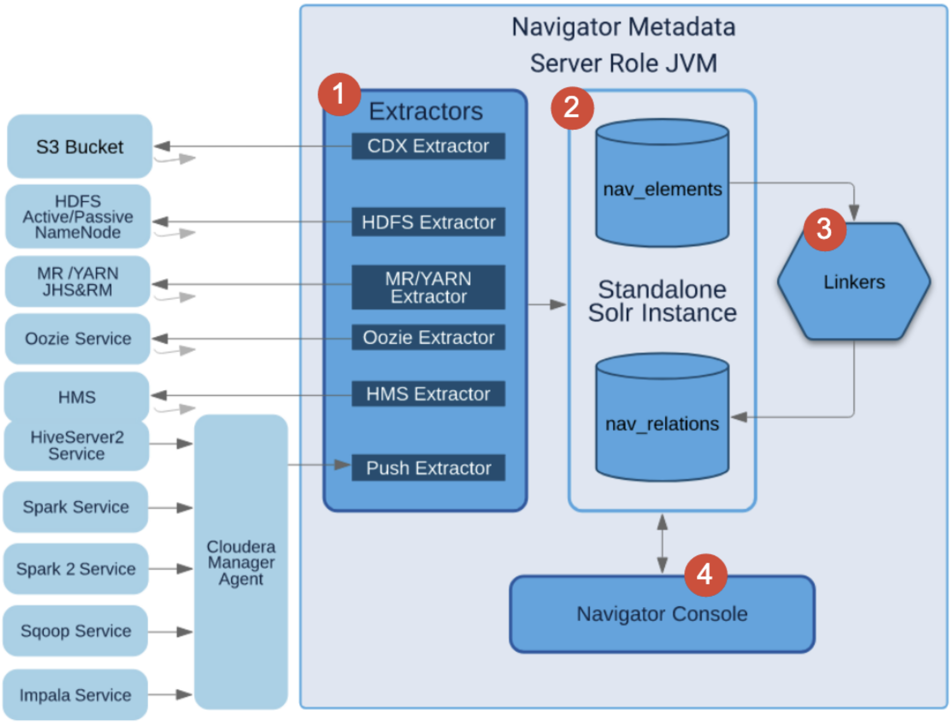
Navigator Metadata Server uses the metadata it collects to generate lineage graphs. These graphs tell you what data and processes were used to generate a given data asset.

This documentation describes

- Where the lineage information comes from
- How the lineage varies based on the source of the metadata
- Life cycle of lineage info as assets change on the cluster

Lineage Generation Architecture

Navigator Metadata Server collects metadata from CDH services, creates records in Solr for each of the data assets and operations, then uses the operation metadata to build relations among the data assets. You see the relations among data assets in the Navigator Console as a lineage graph. Here's the process in a little more detail:



1. Extractors collect metadata from services in the cluster.

   The extractors are components within Navigator that communicate with each service that Navigator supports. For example, for Navigator Metadata Server to collect HDFS metadata, the Navigator HDFS extractor talks to the namenode to request file system information.

   There are two types of extractors:

   - Pull extractors (CDX, HDFS, YARN, Oozie, HMS). The extractor requests metadata from the service about every 10 minutes. The CDX extractor pulls metadata from S3.
   - Push extractors (Spark, Impala, Hive Server 2, Sqoop). The service saves metadata to the local file system for every operation; the Cloudera Manager agent running on the same host passes the metadata to Navigator Metadata Server about every five seconds.

2. Navigator indexes each data asset and operation.

   For each new data asset and operation it finds in the extracted metadata, Navigator Metadata Server creates an entry in its Solr index. These entries appear in `nav_elements` core. The most recently extracted metadata is always used to update any existing entity entry. In addition, Navigator Metadata Server creates a `nav_relation` entry in the Solr index to store relationship information, such as between a directory and a file or subdirectory or between a table and the directory backing it. Navigator saves a variety of relationship information:

   - Parent - child: Directory and subdirectory, directory and file, parent Oozie job and child Hive Server 2 query.
   - Logical - physical: Hive table and the HDFS directory that contains the data.
   - Instance of: Operation and operation execution.
   - Data flow: Query operation that refers to input or output tables.
   - Control flow: Column level details in an operation that refers to specific column or field details in a table, view, or file.

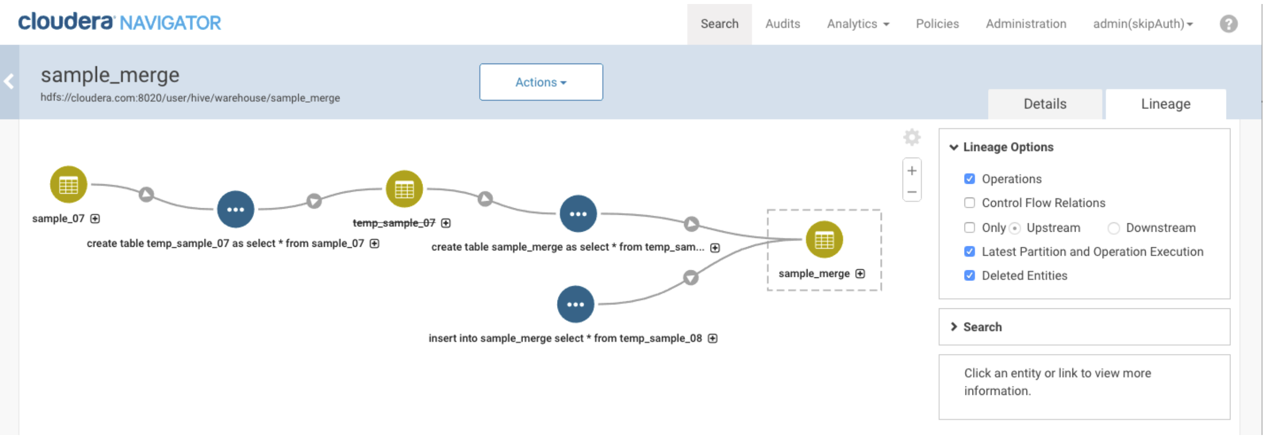
   If Navigator doesn't have all the information it needs to fill in both ends of a relationship, it creates an "unlinked" relation. For example, when an HMS table is extracted, but the corresponding HDFS directory is not already in the index, Navigator will create an unlinked relation for the table that will be filled in later with the directory metadata.

3. Linker fills in missing relation endpoints.

After it receives metadata from an extraction, Navigator Metadata Server runs a process ("linker") that uses the new metadata to fill in unlinked relations.

4. Navigator console displays the relations as a lineage diagram.

The Navigator console reads `nav_relation` to show entity relationships in a directed graph, where the graph flows from input to output, left to right. You can choose how much detail you want to see in the graph, including showing the operations that give details on how data was transformed.


cloudera NAVIGATOR
Search
Audits
Analytics
Policies
Administration
admin(skipAuth)
sample_merge
hdfs://cloudera.com:8020/user/hive/warehouse/sample_merge
Actions
Details
Lineage
sample_07
create table temp_sample_07 as select * from sample_07
temp_sample_07
create table sample_merge as select * from temp_sam...
sample_merge
insert into sample_merge select * from temp_sample_08
Search
Click an entity or link to view more information.

Lineage Options

☑ Operations

☐ Control Flow Relations

☐ Only ● Upstream ○ Downstream

☑ Latest Partition and Operation Execution

☑ Deleted Entities

The entities shown in a lineage picture are determined by the service where the metadata came from. The lineage for data assets includes other data assets and the operations that relate them; lineage for query and compute operations include existing data assets used as inputs or outputs.

For more about how to use the lineage view to show more information, see Exploring Lineage Diagrams on page 56.

Lineage Life-cycle

The contents of a lineage diagram are determined by what metadata is extracted from services. If an object doesn't exist when the extraction occurs, it will not be reflected in the lineage diagram.

Metadata extraction operation and timing

The appearance of entities in a lineage graph can depend on metadata from multiple sources, each of which is extracted independently. To understand lineage generation, it is important to understand when extractors run and any dependencies on their success.

Navigator triggers metadata extraction for each type of pull extractor every 10 minutes after the completion of the previous extraction. The extractor operations run until the extractor processes all the metadata provided by the service; an extraction could be running for minutes or hours depending on the volume of metadata being extracted and the resources available. HDFS extraction—generally the largest volume of metadata—performs an incremental extraction, so after it runs once, subsequent extractions are significantly faster.

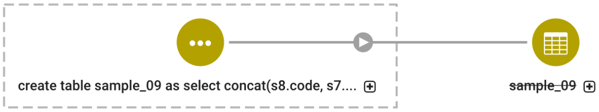
Push extractors work differently: instead of waiting for Navigator to ask for the metadata, the services write out metadata when an event occurs; the Cloudera Manager agent on the host polls every 5 seconds and forwards whatever metadata it finds to Navigator Metadata Server.

The extraction processes are limited by the amount of memory available for Solr to generate the index from the incoming metadata and the Navigator Metadata Server heap. If the extractor fails to connect to its service, it will try again at the next interval.

Navigator runs the linking process after each extractor completes processing an extraction. The linking process can also take minutes or hours, depending on the volume of data being processed and resources available.

Deleted data assets

Each metadata extraction from a service is a snapshot of the objects managed by that service at a given time. If one extraction includes a reference to a specific table and the following extraction does not, Navigator Metadata Server flags the entity for that table as deleted. These relations are hidden in lineage diagrams. You can show them again by enabling the Deleted Entities in the lineage view options. The deleted entities are indicated with a line through their name.



Metadata Purge and Lineage

Metadata purge reviews lineage relations where at least one endpoint of the relation is a candidate for removal. A data asset entity would be flagged as deleted; operation executions would have to have been executed earlier than the purge threshold date. What gets purged is slightly different among the different types of objects. See What Metadata is Purged? on page 81 for purge details. Here's how purge affects lineage:

- "Instance of" relations between operation and operation executions are removed when the operation execution was executed earlier than the threshold date for purge.
- Data flow relations for operations are removed in two cases:
  - When the operation doesn't have an output entity; that is, the operation does not produce a table or view or other entities produced by Sqoop jobs or associated with Pig tables.
  - When the relation refers to HDFS entities associated with a MapReduce or Spark job.

  Both cases assume that none of the associated operation executions are within the purge threshold date.
- Parent child relations between HDFS files and their parent directory are only removed when the directory has been flagged as deleted longer than the purge threshold date.

The following items are not affected by purge:

- Hive tables and the operations that produce them are never removed, even if the tables were deleted before the purge threshold date.
- Logical-physical relations between Hive tables and HDFS directories are not removed, even if the tables were deleted before the purge threshold date.

Temporary data assets

Sometimes operations include data assets that are created and then deleted as part of the operation (or as part of a series of operations that occur close together in time). These temporary objects may or may not be captured as part of a Navigator pull extraction. The operation that produced the object is likely be extracted through a push extractor. When temporary objects are not captured, Navigator Metadata Server produces an unlinked relation based on the operation metadata. The technical metadata for the operation, such as query text, includes a reference to the temporary object; the object itself will not be listed in the Navigator console and will not appear in lineage diagrams.

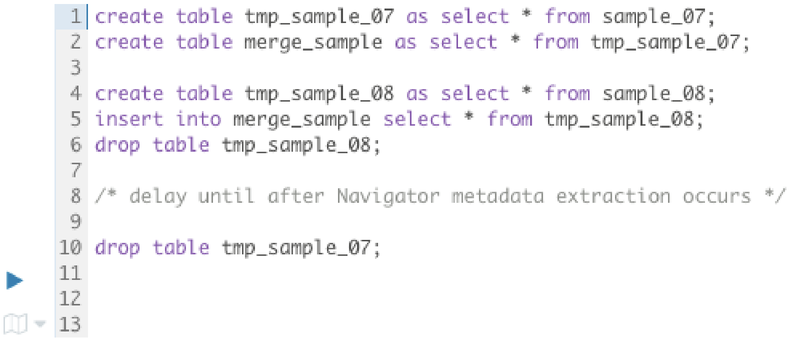
For example, consider a Hive pipeline that writes data to a table, transforms the data and writes it to a second table, then removes the first table. The lineage content is different depending on whether or not metadata extraction captured the temporary table before it was dropped.

If the Navigator-HMS extractor runs when the first table was present, Navigator will create a metadata entity for the first table. When Navigator links the details of the operation with known entities, it will translate the operation details into a lineage diagram including the first and second tables. After the table is deleted and when the next extraction runs, Navigator Metadata Server flags the entity for the first table as deleted. The lineage diagram for the second table shows the first table as deleted (you may have to enable Deleted Entities in the lineage view options). The operation and operation executions still show in the lineage diagram.

If the first table is created and deleted between Navigator-HMS extractions, no metadata entity is created for the table, and the operation details don't link up to an existing entity as an operation input (unlinked relation). If you look at the lineage diagram for the second table and turn on the option to show operations, you'll see the operation that created the second table, but you won't see the first table. In the lineage view, you can see the query run by the operation. That query text shows the first table in the FROM clause.

Example of lineage across temporary tables

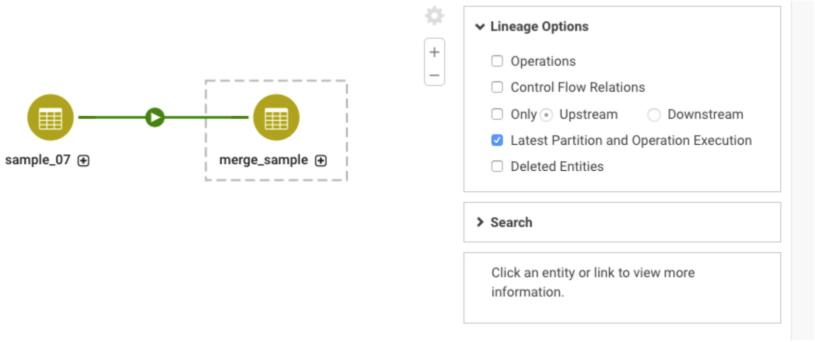
This example shows how the lineage diagram changes depending on whether a temporary table was included in a metadata extraction. The following Impala queries were run in Hue to create temporary tables (`temp_sample_07` and `temp_sample_08`, then use those tables to load data into a third table (`sample_merge`):



```
create table tmp_sample_07 as select * from sample_07;
create table merge_sample as select * from tmp_sample_07;

create table tmp_sample_08 as select * from sample_08;
insert into merge_sample select * from tmp_sample_08;
drop table tmp_sample_08;

/* delay until after Navigator metadata extraction occurs */

drop table tmp_sample_07;



```

Assume that the `temp_sample_08` table was created and dropped between two metadata extractions and that the `temp_sample_07` DROP TABLE command is run only after metadata extraction occurred.

After extractions are run and linking occurs, the lineage picture for the `sample_merge` table shows an "upstream" relationship with sample_07.



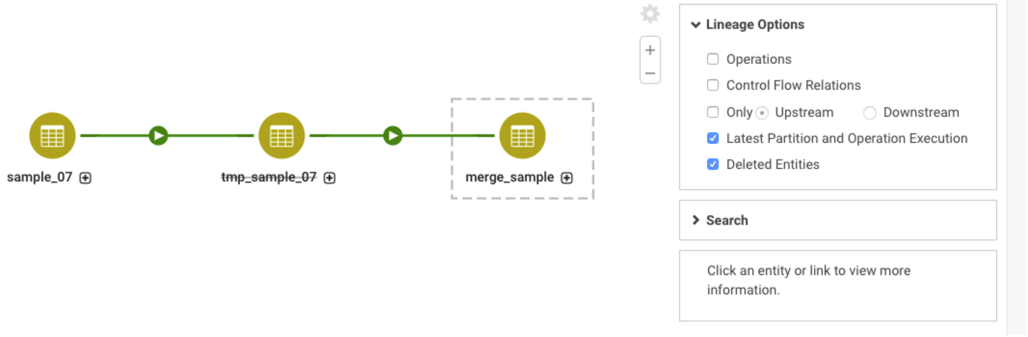
Lineage Options

- ☐ Operations
- ☐ Control Flow Relations
- ☐ Only ● Upstream ○ Downstream
- ☑ Latest Partition and Operation Execution
- ☐ Deleted Entities

Search

Click an entity or link to view more information.

After turning on the option for **Deleted Entities**, the temporary table `temp_sample_07` appears. It exists in the system because it was captured by the first metadata extraction and then it was deleted by the second extraction.



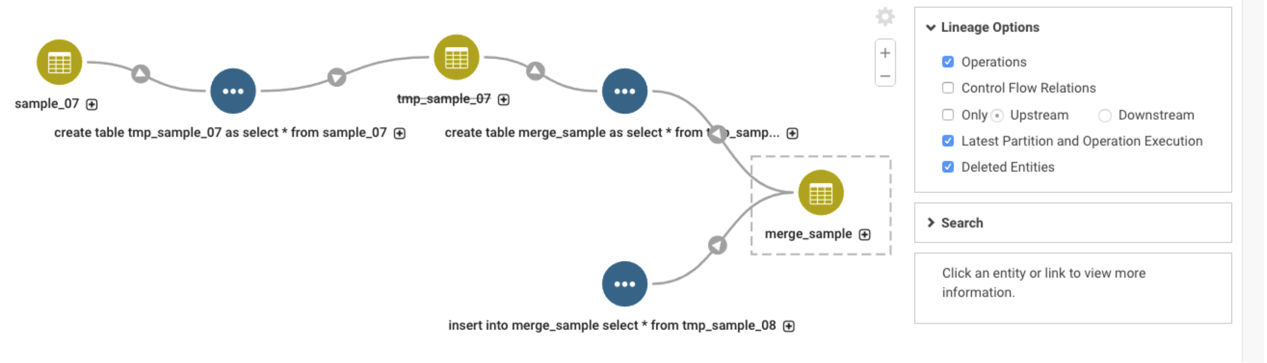
Lineage Options

- ☐ Operations
- ☐ Control Flow Relations
- ☐ Only ● Upstream ○ Downstream
- ☑ Latest Partition and Operation Execution
- ☑ Deleted Entities

Search

Click an entity or link to view more information.

Turning on the option for **Operations** shows the queries that created and inserted rows into the `sample_merge` table. Note in particular that the operation shows for inserting data into the `sample_merge` table from the temporary table `temp_sample_08` even though the table was not captured by a metadata extraction.


sample_07
create table tmp_sample_07 as select * from sample_07
tmp_sample_07
create table merge_sample as select * from t...samp...
merge_sample
insert into merge_sample select * from tmp_sample_08
+
−

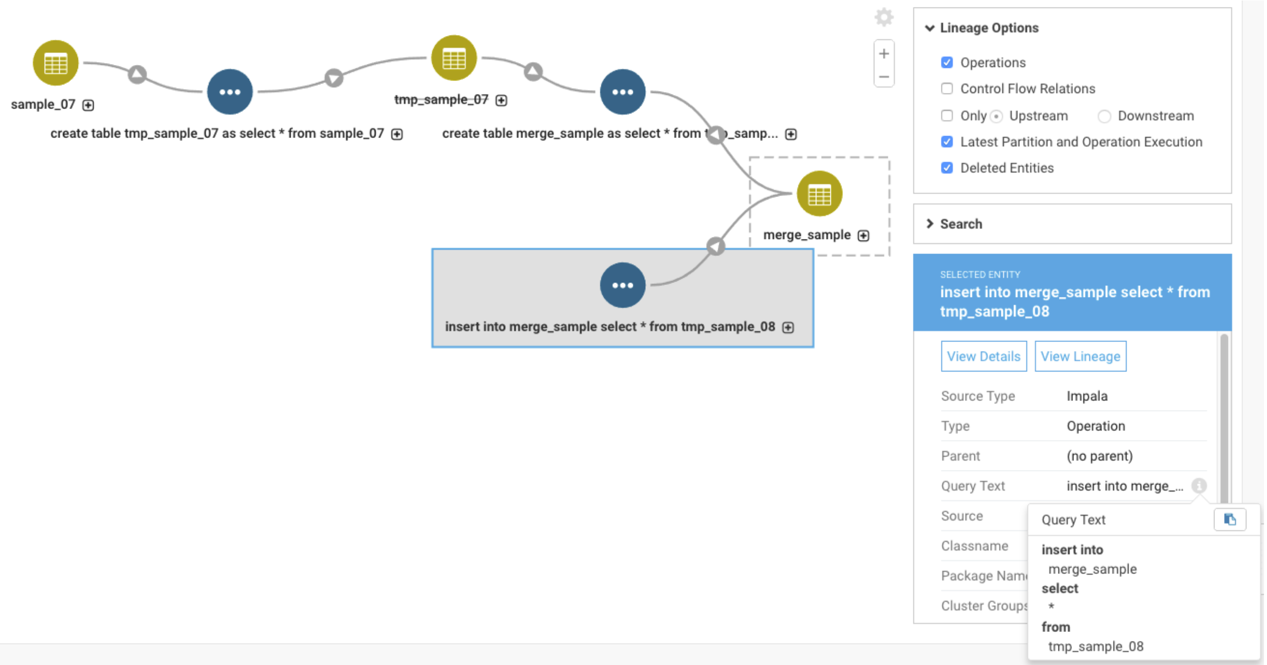
Lineage Options

☑ Operations
□ Control Flow Relations
□ Only ● Upstream ○ Downstream
☑ Latest Partition and Operation Execution
☑ Deleted Entities

Search

Click an entity or link to view more information.

If you select the insert operation, you can see the query details to identify the operation input.


sample_07
create table tmp_sample_07 as select * from sample_07
tmp_sample_07
create table merge_sample as select * from t...samp...
merge_sample
insert into merge_sample select * from tmp_sample_08
+
−
View Details
View Lineage

Lineage Options

☑ Operations
□ Control Flow Relations
□ Only ● Upstream ○ Downstream
☑ Latest Partition and Operation Execution
☑ Deleted Entities

Search

SELECTED ENTITY
insert into merge_sample select * from tmp_sample_08

Source Type	Impala
Type	Operation
Parent	(no parent)
Query Text	insert into merge_...
Source	
Classname	
Package Name	
Cluster Groups	

Query Text

```
insert into
 merge_sample
select
 *
from
 tmp_sample_08
```

If you wanted to further trace the origin of the temporary table, you can use the table name to search for operations that affected the temporary table by searching on the query text:

```
queryText:*temp_sample_08*
```

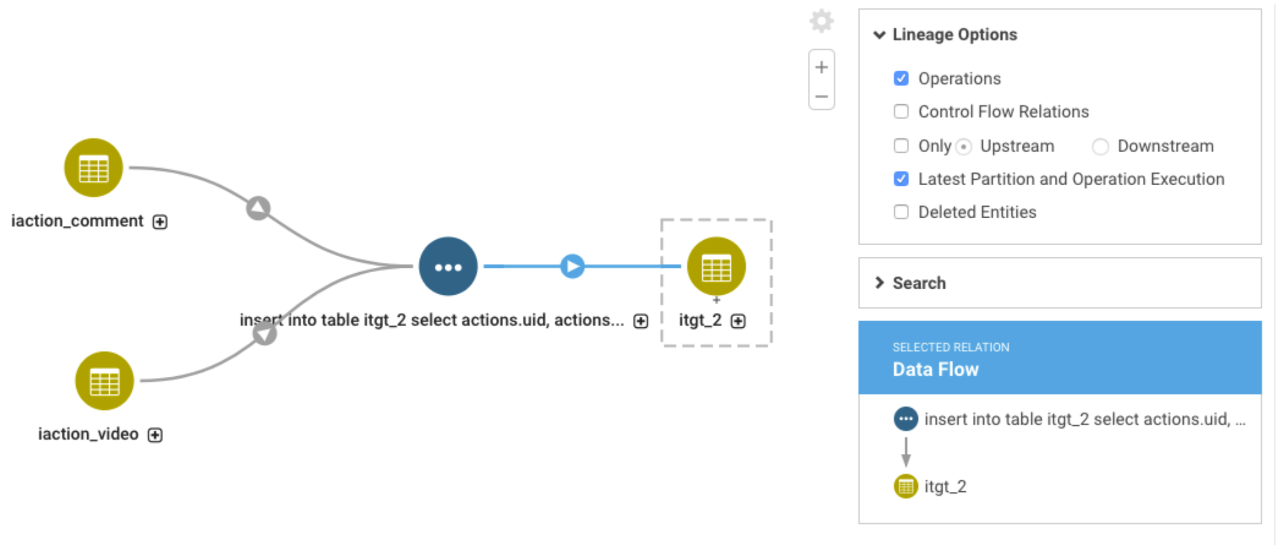
Lineage Behavior by Service

Lineage graphs follow some rules based on the kinds of metadata provided by services. This section describes how the metadata is formed into relations; the conventions for how the relations are displayed on the lineage diagram as listed in Lineage Diagram Icons on page 157. For a list of the specific operations that produce entities in Navigator, see Service Metadata Entity Types on page 170.

Hive, Impala

Lineage is generated for (most) operations against the Hive Metastore that create data assets or modify data, including operations from HiveServer2, Impala, and Impala queries on Kudu tables. Lineage is not produced for operations performed using the Hive Server 1 CLI. For a list of the specific operations captured by Navigator extractors, see Hive Operations and Cloudera Navigator Support Matrix on page 170.

For each query operation, a relation is created for each data asset referenced as an input or output (or both) in the query. The lineage diagrams include tables, views, and operations. The metadata indicates whether the data asset is an input or output.



Lineage Options

- ☑ Operations
- □ Control Flow Relations
- □ Only ◉ Upstream ○ Downstream
- ☑ Latest Partition and Operation Execution
- □ Deleted Entities

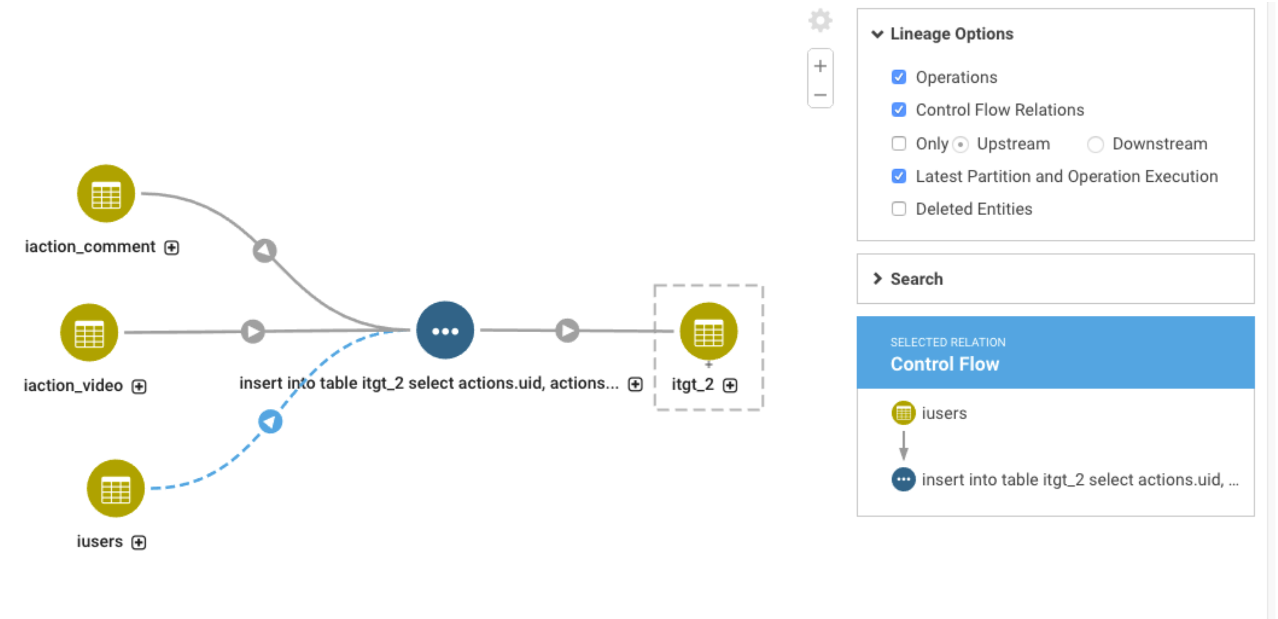
Search

SELECTED RELATION
Data Flow

insert into table itgt_2 select actions.uid, ...
↓
itgt_2

Figure 1: Impala Lineage

The query information provided by Hive Metastore (HMS) includes query information that allows Navigator to show data assets referenced in joins or lookups. You can see these tables when you turn on Control Flow Relations.



Lineage Options

- ☑ Operations
- ☑ Control Flow Relations
- □ Only ◉ Upstream ○ Downstream
- ☑ Latest Partition and Operation Execution
- □ Deleted Entities

Search

SELECTED RELATION
Control Flow

iusers
↓
insert into table itgt_2 select actions.uid, ...

Figure 2: Lineage Showing Control Flow Relations

When Navigator has column level information, the lineage diagram shows a + next to the name of the object. Opening the column level information shows you how columns in source tables contribute to columns in the destination tables. Columns referenced in joins or lookups are indicated with dashed lineage relations and appear when the view includes control flow information. (Move the cursor over a column to highlight only that column's lineage through all the objects.) Because the information is generated by HMS, column-level tracing is available regardless of the underlying compute engine.

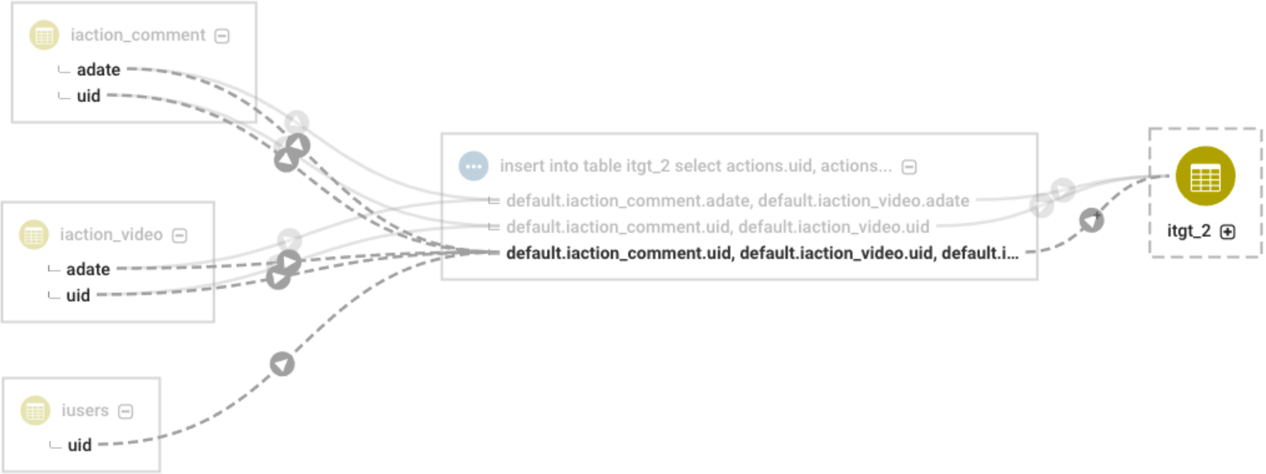

iaction_comment
adate
uid
iaction_video
adate
uid
iusers
uid
insert into table itgt_2 select actions.uid, actions...
default.iaction_comment.adate, default.iaction_video.adate
default.iaction_comment.uid, default.iaction_video.uid
default.iaction_comment.uid, default.iaction_video.uid, default.i...
itgt_2

Figure 3: Lineage Showing Control Flow Relations at the Column Level

Only database-layer objects appear in the lineage for query services: Navigator doesn't show the logical-to-physical relationships such as the backing HDFS directory for each Hive table. If you want to know the location of the underlying HDFS files for a table, you can see this information in the `Path` property of the technical metadata for the table. Note that lineage shown for an HDFS file or directory, you will see the logical-to-physical relationship to Hive tables or views.

Only operations that include output appear in lineage for tables and views. To see a lineage diagram for operations such as SELECT that do not produce a data asset, view lineage for the operation. To see all such activity run against a specific table, you may find it useful to go the **Audits** tab in the Navigator console and filter on the table name.

Lineage for query services does not expose the compute engine used to perform the query; Hive operations appear the same whether they are run on MapReduce or Spark. This information is available in the technical metadata for the operation execution. Note that queries run directly in Spark are different because Spark provides different metadata than HMS.

HDFS, S3

Navigator collects metadata for file system entities. It does not collect metadata for file-system level operations, such as moves or copies. Lineage metadata appears when applications perform operations against file-system entities. For example, when a Spark job copies an HDFS directory, the lineage diagrams show the relationship between the source directory and the copied directory as connected by the Spark operation.

When HDFS directories are used as backing data for tables managed in Hive Metastore (including Impala tables), the lineage for the directory and any of the files included in the directory will show a logical-physical relation to the table.

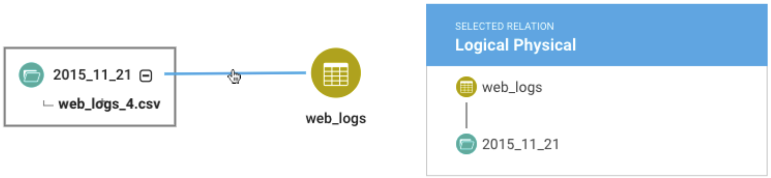
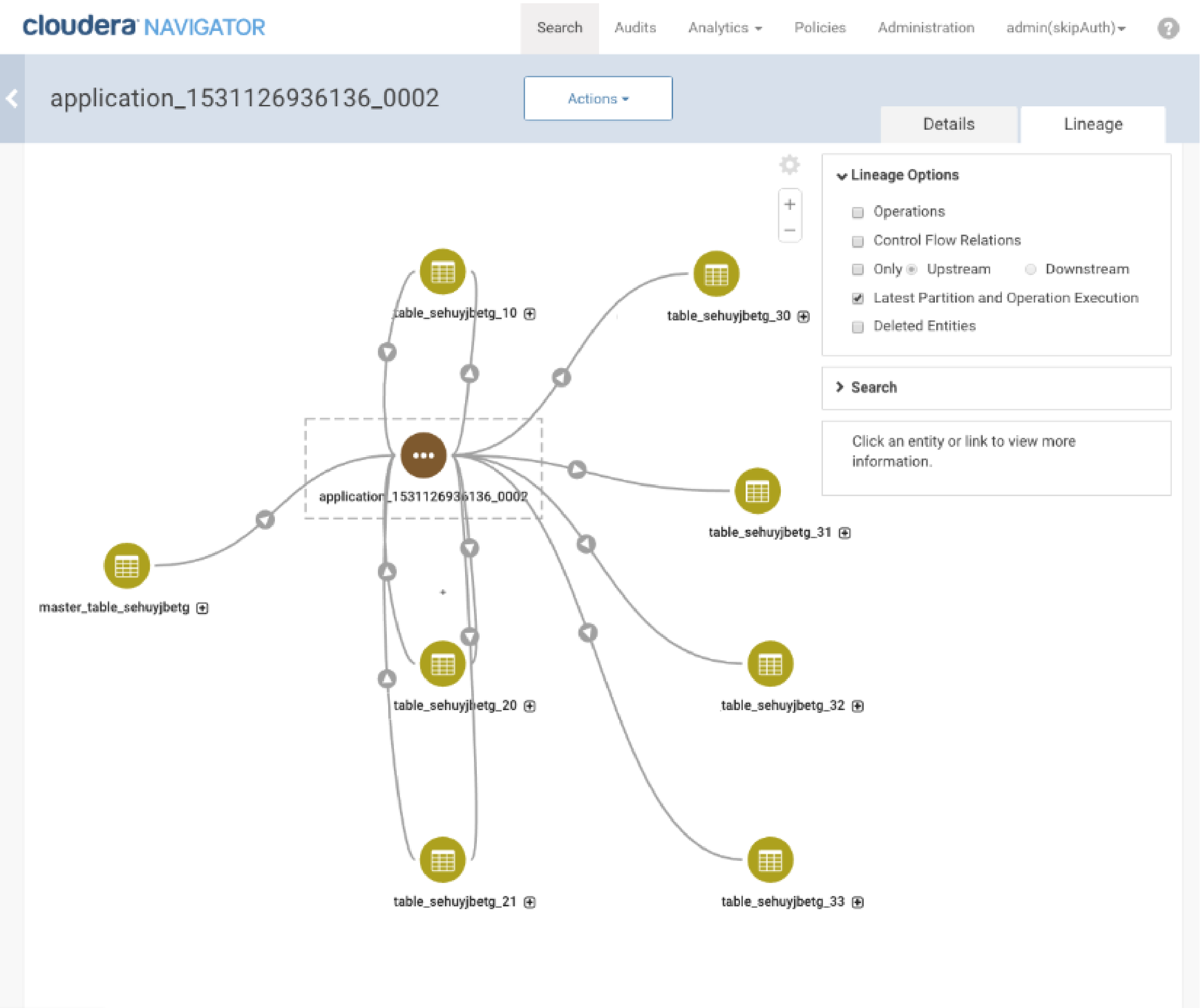


Figure 4: Logical Physical Relationship between HDFS File and Hive Table

MapReduce, Spark, Sqoop

Navigator shows lineage diagrams for operations performed by compute engines such as MapReduce v1, YARN (MRV2), or Spark (all Spark 1 versions and Spark 2 starting with version 2.3). Lineage reflects data processed using Spark SQL, including the Datasets/Dataframe APIs. Other services such as Apache Sqoop contribute metadata that Navigator can use to create lineage diagrams as well.

For compute operations, a relation is created for each data asset referenced as an input or output (or both) in the operation. As in this image, the input and output relations are shown with arrows.



Lineage Options

- □ Operations
- □ Control Flow Relations
- □ Only ● Upstream ○ Downstream
- ☑ Latest Partition and Operation Execution
- □ Deleted Entities

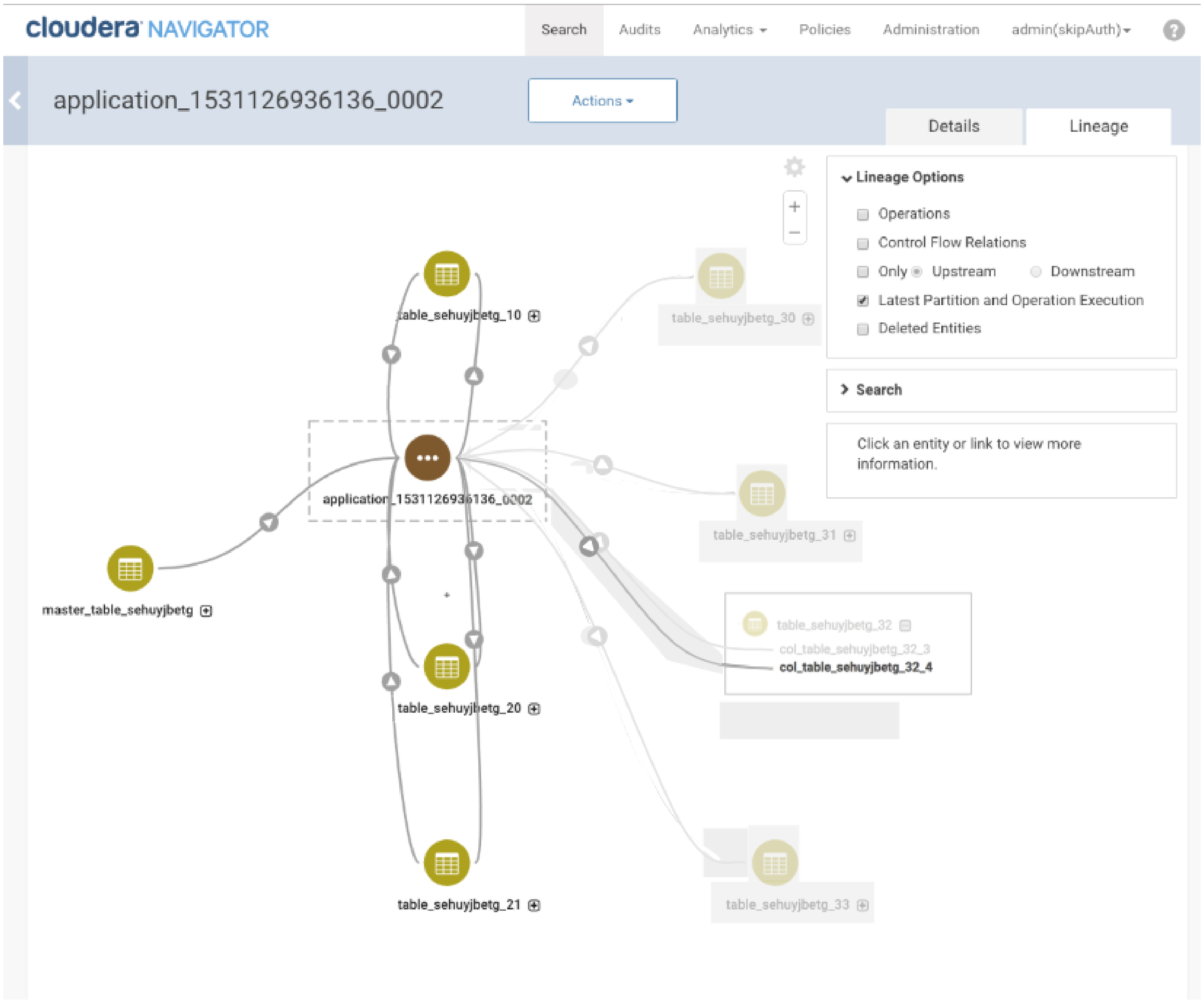
Click an entity or link to view more information.

Figure 5: Spark Lineage Shows All Data Assets Accessed by the Operation

Data assets that are used for both output from and input to stages of the operation appear with two lineage lines, one with an arrow pointing into the entity; another pointing out. In the Navigator lineage diagram, entities that are both input and output to the same operation may be shown parallel to the operation rather than on the left or right.

The Navigator extractors for MapReduce and Spark services trace data lineage at the application level only. The result is that when you show the lineage diagram for a single column in a table that is affected by a Spark operation, the diagram shows other data assets that contribute to the column, but how the specific columns inside those assets contribute to the selected column is not shown.

Navigator shows all the lineage information available for Spark operations, but does not include SQL statements executed in Spark. This limitation is because Spark does not keep the SQL statement: the Spark parser creates the plan from the SQL statement and, from that point on, the SQL statement provided by the client is not retained as part of the metadata associated with the Spark job. For many Spark operations, SQL isn't part of the original request. For example: `spark.read.parquet("/input").write.parquet("/output")` generates lineage, but there is no SQL statement used at all.



Lineage Options

□ Operations
□ Control Flow Relations
□ Only ● Upstream ○ Downstream
☑ Latest Partition and Operation Execution
□ Deleted Entities

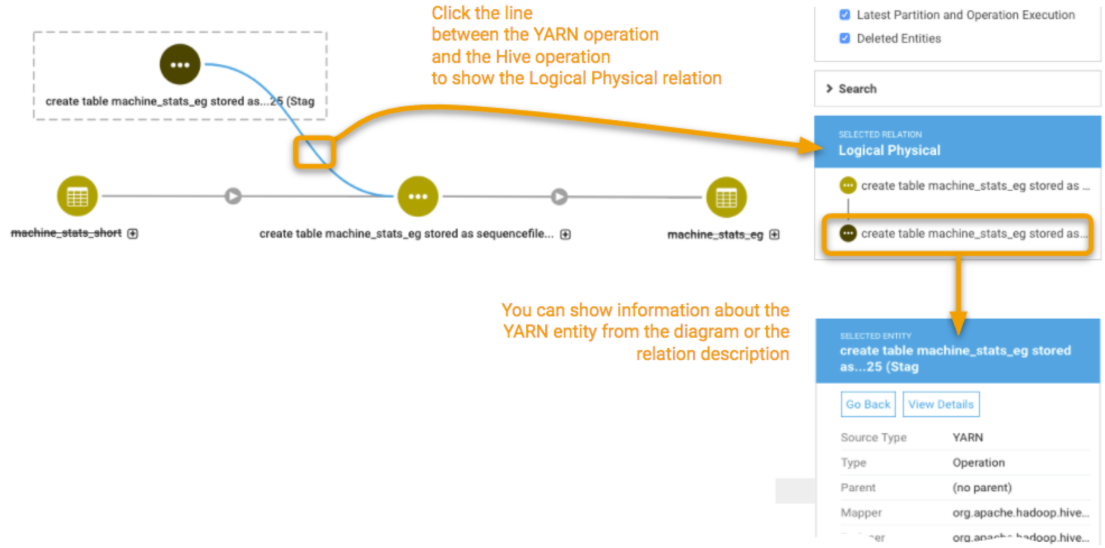
Figure 6: Column Filtering for Spark Lineage Identifies Contributing Assets

Note: Lineage diagrams differ slightly between Spark 1 and Spark 2 operations. In Spark 1, table creation commands are not captured as a lineage relation: when a table is created and then used by another command, the table appears only as an input to the operation. In Spark 2, table creation commands are captured: the table shows as an output (creation) and an input to the operation.

YARN, Oozie

Lineage for resource management operations, such as YARN and Oozie, include lineage relations to other operations; the metadata for YARN and Oozie entities does not reveal specific data assets touched by the processing.

Navigator shows lineage diagrams for operations performed by resource management tools such as Oozie and YARN. Relations are created for each operation controlled by job managers. These lineage diagrams show processing stages, including the connection between a YARN operation and the operations triggered from YARN. Navigator captures the relation between a YARN job and the operations it triggers as "Logical Physical" relations: the physical operation is the YARN process; the operation it triggers, such as a Hive query or a MapReduce job, is the logical operation.



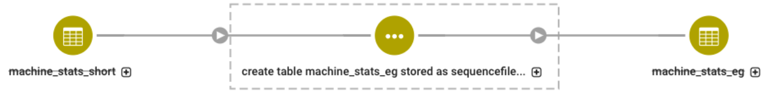
Click the line between the YARN operation and the Hive operation to show the Logical Physical relation

You can show information about the YARN entity from the diagram or the relation description

create table machine_stats_eg stored as...25 (Stag
~~machine_stats_short~~
create table machine_stats_eg stored as sequencefile...
~~machine_stats_eg~~
☑ Latest Partition and Operation Execution
☑ Deleted Entities
Search
SELECTED RELATION
Logical Physical
create table machine_stats_eg stored as ...
create table machine_stats_eg stored as...
SELECTED ENTITY
create table machine_stats_eg stored as...25 (Stag
Go Back
View Details

Source Type YARN
Type Operation
Parent (no parent)
Mapper org.apache.hadoop.hive...

Viewing the lineage from the logical operation (in this case, a Hive query), the Logical Physical relations to the triggering operations are not shown.



Troubleshooting Lineage

When you don't see the lineage relations you expect, look for the following possible issues:

Give time for extractors to run

Pull extractors run every ten minutes assuming the previous run completed. For large data sets, the extractor process may require more time to run. In addition, if there are connectivity issues or if the corresponding service is busy or not available, the extraction time can lengthen. For HMS in particular, the actual time required to extract all the metadata required to draw new lineage relations can be as much as an hour if the multiple extractors involved run offset from each other.

View lineage from the appropriate entity

If you want to see a logical-physical relation between an HDFS directory and a Hive table, you need to access lineage from the HDFS directory.

If you want to see all the times a query is run against a Hive table you may not see it in the Hive table lineage; if the operation doesn't produce output, access the lineage from the operation, not the Hive table.

Are extractors running successfully?

Navigator won't show lineage information if it's not receiving it. Check to make sure that the extractor is running properly:

- Check the Navigator Metadata Server log for errors that would indicate that an extractor isn't running. You can access Navigator Metadata Server logs from Cloudera Manager or from the command line on the host where the service is running. See Accessing Navigator Data Management Logs on page 83. Extractor status messages include the word "extractor", such as `com.cloudera.nav.hive.extractor.HiveOperationExtractor`.
- Check Cloudera Manager agent log to find out more detail about an error.

  If you find an error in the Navigator Metadata Server log that indicates a problem with one of the push extractors, go to the Cloudera Manager agent log for the host indicated by the log error.

Administration (Navigator Console)

The Cloudera Navigator console provides an Administration menu for several different tasks, including setting up a schedule to remove stale and deleted metadata from the system ("purge"), setting up users and groups, and defining managed metadata.

For information on defining managed metadata, see Defining Properties for Managed Metadata on page 30.

Administering Navigator User Roles

Cloudera Navigator user roles can be assigned to groups that are managed by an external LDAP-compliant identity/authentication system (Active Directory, OpenLDAP) using the Role Management tab of the Cloudera Navigator console. The Role Management feature only becomes available in the Cloudera Navigator console after the external system has been successfully configured for use by Cloudera Navigator. See Authentication for Cloudera Navigator for configuration details.

Assigning User Roles to Groups

Cloudera Navigator user roles determine the Cloudera Navigator features and functions available to the logged in account holders. Data stewards, auditors, and other business users log in to the Cloudera Navigator console and have available only those menu selections and options appropriate for the ***user role*** (or roles) granted to group of which they are a member. The groups are defined in an external LDAP service that has been configured for use by Cloudera Navigator. See Authentication for Cloudera Navigator for details.

For example, a user belonging to a group granted only the Policy Editor role is limited to the **Search**, **Analytics** (metadata), and **Policies** tabs of the Cloudera Navigator console and to the features and functions available from those menus. See User Roles and Privileges Reference on page 171 for details about each Cloudera Navigator user role. Assigning or editing user roles requires logging in to the Cloudera Navigator console with an account having one of the following roles:

- Cloudera Manager Full Administrator or Navigator Administrator, or Cloudera Navigator User Administrator.

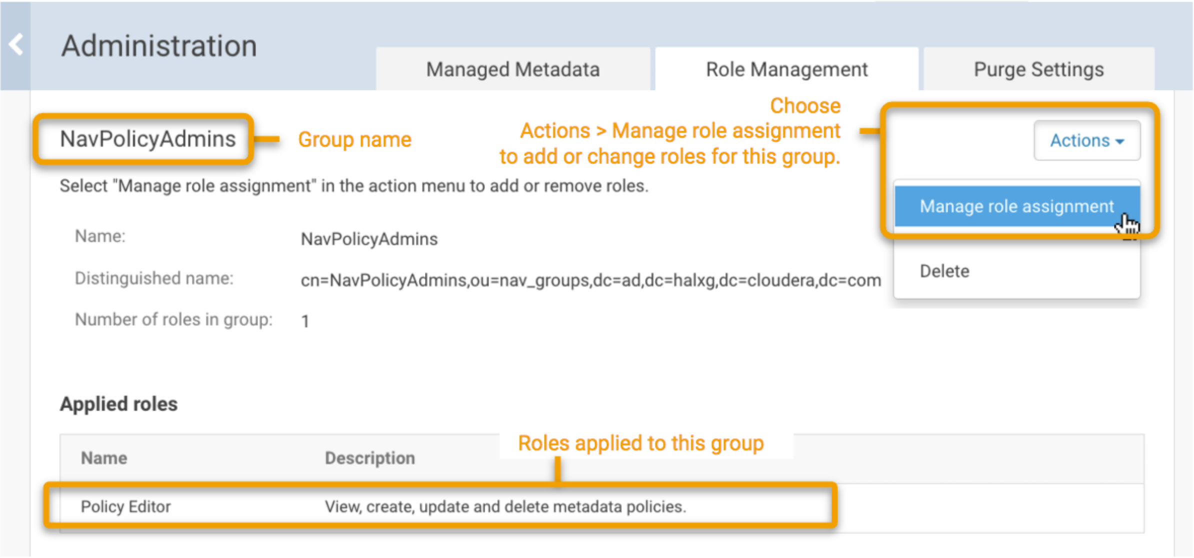
To assign Cloudera Navigator user roles to a group:

1. Log in to Cloudera Navigator console.
2. Click the **Administration** menu.
3. Click the **Role Management** tab.
4. Select **Search for groups** to search among all groups in the external directory.

   The **Groups with Navigator roles** choice shows groups that have already been assigned one or more Cloudera Navigator user roles.

5. Enter the name of the specific group in the search field.
6. Select the group from among those returned in the list.

   The details list any existing roles associated with this group. For example:



Select "Manage role assignment" in the action menu to add or remove roles.

Name: NavPolicyAdmins

Distinguished name: cn=NavPolicyAdmins,ou=nav_groups,dc=ad,dc=halxg,dc=cloudera,dc=com

Number of roles in group: 1

Applied roles

Name	Description
Policy Editor	View, create, update and delete metadata policies.

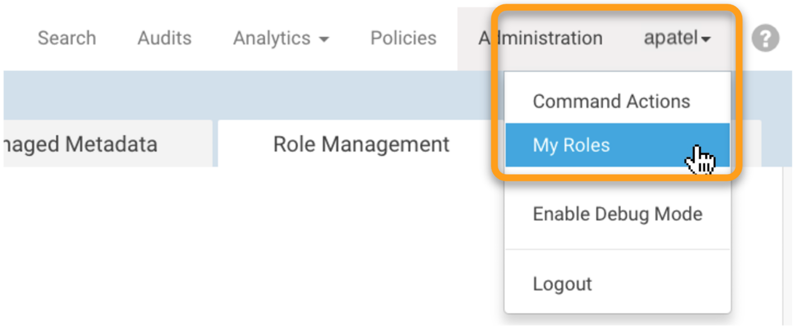
Figure 7: Group to Role Mapping

7. Click **Manage Role Assignment** in the upper right corner.
8. Select each user role you want to assign to the group.
9. Click **Save**.

Changes to user role assignments take effect the next time users in the group log in to Cloudera Navigator.

Displaying Roles for Current User Account Login

From the Cloudera Navigator console, you can verify the user roles associated with your current login by selecting **My Roles** from the account drop-down menu.



Managing Metadata Storage with Purge

The volume of metadata maintained by Navigator Metadata Server can grow quickly and exceed the capacity of the Solr instance that processes the index, which can affect search results speed and time to display data lineage. In addition, stale metadata may show relationships that no longer exist, or the lineage may take longer to display than necessary as the system processes extraneous details.

Cloudera Navigator's purge function removes metadata for files that have been deleted or for operations that are older than the specified timeframe. The result is faster search and more precise (up-to-date) lineage diagrams.

> **Note:** Metadata for deleted files are only purged when the containing directory is also deleted.

In addition, purging before upgrading Cloudera Navigator to a new release can speed-up the upgrade process and reduce the chance of out-of-memory errors.

The purge function can be used in different ways:

- After deleting metadata, as detailed in Purging a Property.
- By using the Cloudera Navigator APIs, as detailed in Using the Purge APIs for Metadata Maintenance Tasks.
- For Cloudera Navigator 2.11 (and higher) releases, by using the Cloudera Navigator console and scheduling a regular weekly Purge, as detailed below.

Scheduling the Purge Process

Use the Cloudera Navigator console to configure a schedule for a regular weekly purge of deleted and stale metadata from the Navigator Metadata Server and its associated database.

Note: Cloudera recommends scheduling the purge process for non-production hours because other users and processes will be unable to use Cloudera Navigator until the purge process completes.

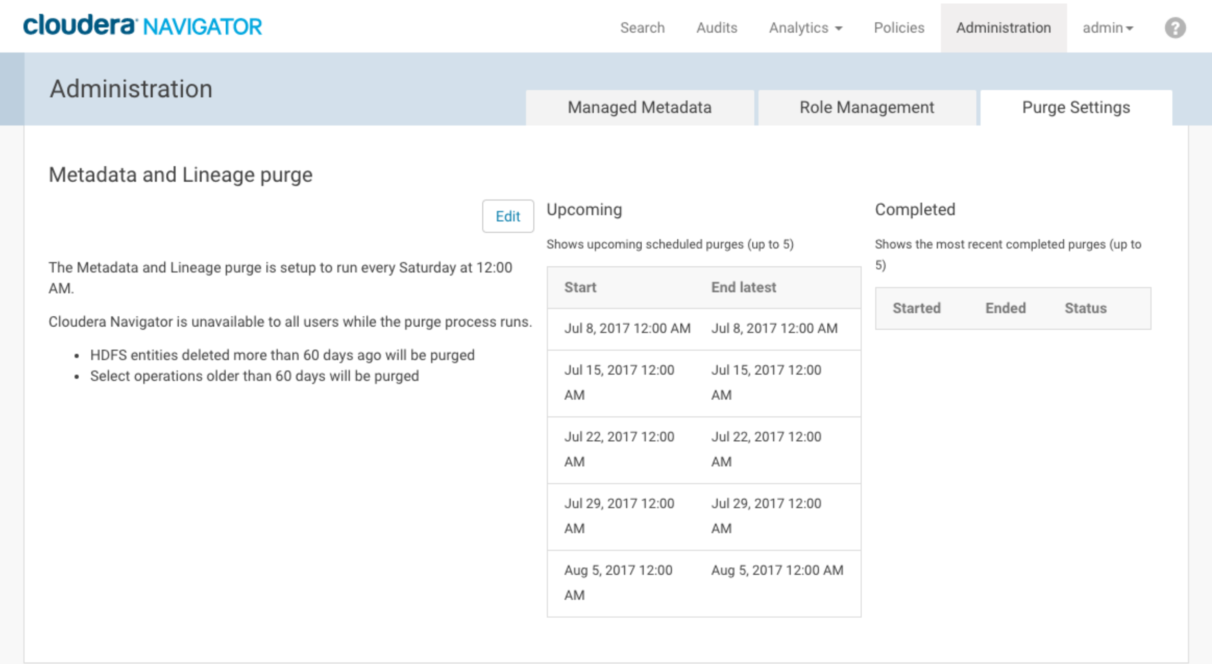
Warning: Purging and policies: The purge process won't run in circumstances where metadata extractors are running, then the purge request is submitted (scheduled or manually through the API), then a scheduled policy runs.

The purge process waits to run for the extractors to finish. In that mode, its state is recorded as "maintenance scheduled". However, the policy checks for "maintenance running" state, which it doesn't find. The policy will run, causing the service to slow down and effectively causing purge to not run at all. The log repeats the message "Checking if maintenance is running." To avoid this problem in this release, temporarily delete all policies and re-run purge. This problem is fixed in 2.15.2 (Cloudera Manager 5.16.2) and 6.x releases.

To configure the automated purge schedule:

1. Log in to the Cloudera Navigator console using an account with Full Administrator privileges.
2. Go to **Administration** > **Purge Settings** tab.

   The current Metadata and Lineage purge schedule displays, along with lists of up to five upcoming scheduled purges and a list of up to five most recent completed purges.



Metadata and Lineage purge

The Metadata and Lineage purge is setup to run every Saturday at 12:00 AM.

Cloudera Navigator is unavailable to all users while the purge process runs.

- HDFS entities deleted more than 60 days ago will be purged
- Select operations older than 60 days will be purged

Upcoming

Shows upcoming scheduled purges (up to 5)

Start	End latest
Jul 8, 2017 12:00 AM	Jul 8, 2017 12:00 AM
Jul 15, 2017 12:00 AM	Jul 15, 2017 12:00 AM
Jul 22, 2017 12:00 AM	Jul 22, 2017 12:00 AM
Jul 29, 2017 12:00 AM	Jul 29, 2017 12:00 AM
Aug 5, 2017 12:00 AM	Aug 5, 2017 12:00 AM

Completed

Shows the most recent completed purges (up to 5)

Started	Ended	Status

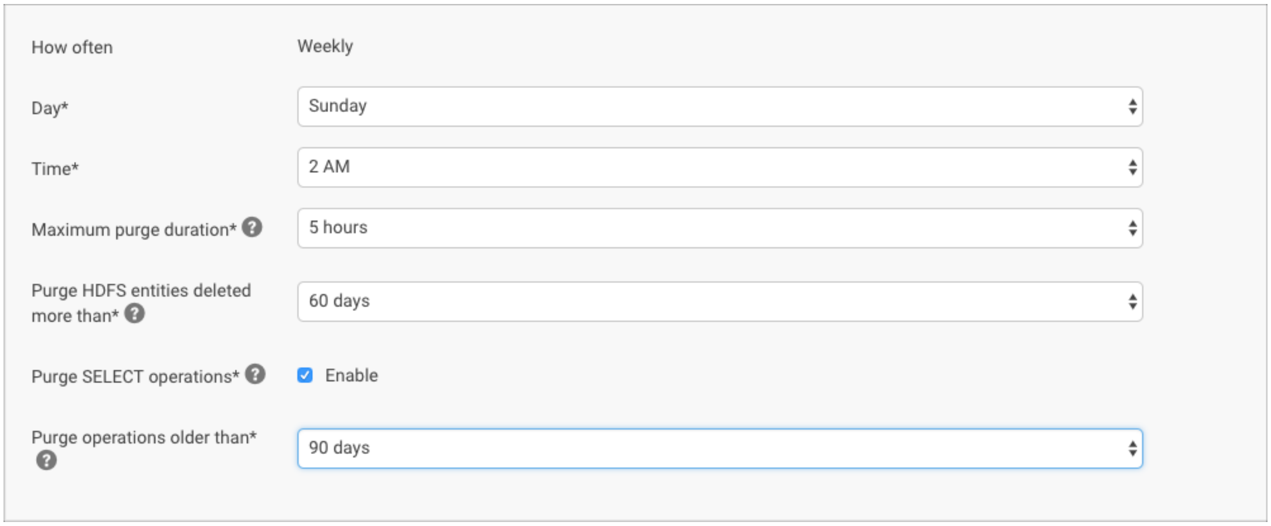
To change the existing schedule:

1. Click **Edit**.
2. Set the purge process options.

Option	Default	Range of selectable values and usage note
How often	Weekly	Not configurable. The purge runs weekly per your specifications for Day and Time. It is enabled by default.
Day	Saturday	Select a day for the purge that will have minimal impact to your user community.
Time	12 Midnight	Hourly time, from 12 Midnight through 11 PM. Select a time that will have minimal impact on production.
Maximum purge duration	12 hours	Set the amount of time you want to allow for the purge process to run. If not already complete, the HDFS purge process will not add any new items to purge after your specified duration. Entities purged to that point remain purged. All non-HDFS purge processes will run without limit. If set to 0, the purge is disabled. No other Cloudera Navigator operations, including through the console, can occur during the purge process.
Purge HDFS entities deleted more than*	60 days	The number of days after an entity is deleted that elapse until the purge process removes its metadata. For example, a setting of 1 day purges entities deleted before two days ago but retains entities deleted yesterday.
Purge SELECT operations*	Enabled	Hive and Impala SELECT operations older than days specified in **Only Purge SELECT operations older than** will be purged.
Purge operations older than*	60 days	Yarn, Sqoop, and Pig operations older than the specified date will be purged. If **Purge SELECT Operations** is enabled, Hive and Impala SELECT operations older than the specified date will also be purged.

3. Click **Save** when finished.

Here is an example of a revised schedule:



How often	Weekly
Day*	Sunday
Time*	2 AM
Maximum purge duration*	5 hours
Purge HDFS entities deleted more than*	60 days
Purge SELECT operations*	☑ Enable
Purge operations older than*	90 days

Note: If no schedules appear after you configure the purge process, your environment may not have automated purge enabled. To check if the automated purge is enabled, add `/debug` to the Navigator URL (`http://fqdn-a.example.com:7187/debug`), click **Configuration**, and check the value of `nav.purge.enabled`. If the property is set to false, you can enabled it in the debug page for this Navigator session; change the property in Cloudera Manager by adding `nav.purge.enabled=true` to the **Navigator Metadata Server Advanced Configuration Snippet (Safety Valve) for cloudera-navigator.properties**.

What Metadata is Purged?

Purge processes look for metadata that is associated with deleted files and tables and with operation executions that are older than the configured threshold date.

Hive Metadata

- Hive operations
  - That don't produce output
  - That have all operation executions that were executed earlier than the threshold date
- Hive operation executions
  - Associated with Hive operations that don't produce output
  - That were executed earlier than the threshold date
- Hive sub-operations
  - Associated with Hive operations that were purged
- All relations associated with the purged entities

Impala Metadata

- Impala operations
  - That don't produce output
  - That have all operation executions that were executed earlier than the threshold date
- Impala operation executions
  - Associated with Impala operations that don't produce output
  - That were executed earlier than the threshold date
- Impala sub-operations

    - Associated with Impala operations that were purged
- All relations associated with the purged entities

Sqoop Metadata

- Sqoop import and export operations
    - That have all operation executions that were executed earlier than the threshold date and no existing downstream entities
- Sqoop operation executions
    - that were executed earlier than the threshold date
- All relations associated with the purged entities

YARN Metadata

- YARN operations
    - That have all operation executions that were executed earlier than the threshold date
- YARN operation executions
    - That were executed earlier than the threshold date
- All relations associated with the purged entities

Pig Metadata

- Pig operations
    - That have all operation executions that were executed earlier than the threshold date and don't apply to tables connected to existing HDFS files
- Pig operation executions
    - That were executed earlier than the threshold date
- Pig tables
    - That were created by an operation execution executed earlier than the threshold date and also not connected to an existing HDFS file
- Pig fields
    - Fields in purged tables
- All relations associated with the purged entities

HDFS Metadata

- HDFS directories
    - That have been deleted longer than the configured threshold
    - AND don't have a logical-physical relation with another entity (such as a Hive table)
    - AND don't have children (sub directories or files) that aren't ready to be purged
- HDFS files
    - Deleted file metadata are purged only when the containing directory is purged
- All relations that have both endpoints associated with purged entities

Navigator Configuration and Management

Cloudera Navigator runs as two discrete roles—Navigator Audit Server and Navigator Metadata Server—in the context of Cloudera Manager Server. Features and configuration options available for these server-side processes are managed using the Cloudera Manager Admin Console. Management tasks include configuring filters to fine-tune audit event collection, tuning the Navigator Metadata Server for optimal performance, and configuring auditing for select services.

Management tasks also include implementing a backup system for Navigator metadata, and configuring security features, such as TLS/SSL to support HTTPS and client-server encrypted communications over the network.

Topics in this section apply to Navigator in general or to either Navigator Audit Server or Navigator Metadata Server specifically.

Accessing Navigator Data Management Logs

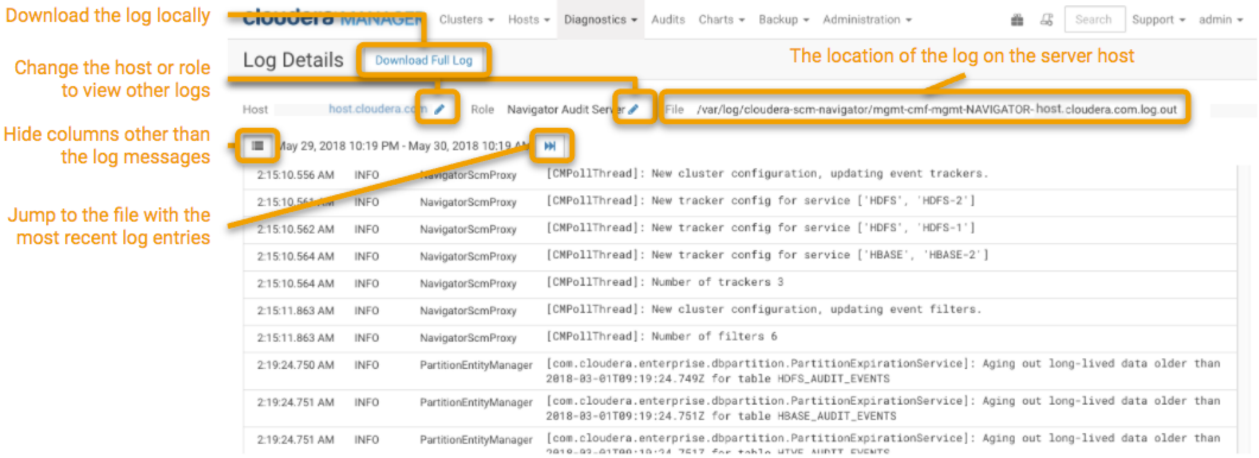
You can access Navigator Metadata Server and Navigator Audit Server logs from Cloudera Manager or from the command line on the host where each server is running.

Accessing Navigator Logs from Cloudera Manager

To access Navigator Metadata Server Logs from Cloudera Manager:

1. Select **Clusters** > **Cloudera Management Service**.
2. In the Status Summary, click **Navigator Audit Server** or **Navigator Metadata Server**.
3. Choose **Log Files** > **Role Log File**.

A new browser tab opens with a page of the most recent log. This example shows the audit server log; the metadata server log behaves the same.



/var/log/cloudera-scm-navigator/mgmt-cmf-mgmt-NAVIGATOR-host.cloudera.com.log.out

ay 29, 2018 10:19 PM - May 30, 2018 10:19 A

```
2:15:10.556 AM   INFO   avigatorScmProxy        [CMPollThread]: New cluster configuration, updating event trackers.
2:15:10.56       INFO   NavigatorScmProxy       [CMPollThread]: New tracker config for service ['HDFS', 'HDFS-2']
2:15:10.562 AM   INFO   NavigatorScmProxy       [CMPollThread]: New tracker config for service ['HDFS', 'HDFS-1']
2:15:10.564 AM   INFO   NavigatorScmProxy       [CMPollThread]: New tracker config for service ['HBASE', 'HBASE-2']
2:15:10.564 AM   INFO   NavigatorScmProxy       [CMPollThread]: Number of trackers 3
2:15:11.863 AM   INFO   NavigatorScmProxy       [CMPollThread]: New cluster configuration, updating event filters.
2:15:11.863 AM   INFO   NavigatorScmProxy       [CMPollThread]: Number of filters 6
2:19:24.750 AM   INFO   PartitionEntityManager  [com.cloudera.enterprise.dbpartition.PartitionExpirationService]: Aging out long-lived data older than
                                                2018-03-01T09:19:24.749Z for table HDFS_AUDIT_EVENTS
2:19:24.751 AM   INFO   PartitionEntityManager  [com.cloudera.enterprise.dbpartition.PartitionExpirationService]: Aging out long-lived data older than
                                                2018-03-01T09:19:24.751Z for table HBASE_AUDIT_EVENTS
2:19:24.751 AM   INFO   PartitionEntityManager  [com.cloudera.enterprise.dbpartition.PartitionExpirationService]: Aging out long-lived data older than
                                                2018-03-01T09:19:24.751Z for table HIVE_AUDIT_EVENTS
```

Figure 8: Navigator Audit Server Log in Cloudera Manager

Accessing Navigator Logs from the Command Line

By default, the Navigator server logs are located in `/var/log` on the host where the server is running. The host name is part of the log file name:

Audit Server	`/var/log/cloudera-scm-navigator/mgmt-cmf-mgmt-NAVIGATOR-`*`host`*`.log.out`
Metadata Server	`/var/log/cloudera-scm-navigator/mgmt-cmf-mgmt-NAVIGATORMETASERVER-`*`host`*`.log.out`

Backing Up Cloudera Navigator Data

Backups of Cloudera Manager include the data stored for Navigator Audit Server and Navigator Metadata Server data, as described in Backing up Cloudera Manager. Follow these steps if you need to back up either storage independently from Cloudera Manager:

Backup Navigator Audit Server Data

Navigator Audit Server stores audit information in a database instance. The audit metadata does not need to be backed up at the same time as the Navigator Metadata Server metadata.

1. Confirm the Navigator Audit Server database location and connection information.

   To locate this information, log in to the Cloudera Manager Admin Console and go to **Clusters** > **Cloudera Management Service**. Click the **Configuration** tab. Select **Scope** > **Navigator Audit Server** and **Category** > **Database**. The results indicate the type, host, database name, and login account.

2. Using the appropriate tool for the database instance (such as MySQL), backup the database. See Backing up Cloudera Manager.

Backup Navigator Metadata Server Data

Navigator Metadata Server stores metadata in an embedded Solr data directory and in a database instance. Back up these locations together so the backups describe the same metadata state.

1. Shut down the Navigator Metadata Server role.
2. Backup the data directory.

   The Navigator Metadata Server default directory is `/var/lib/cloudera-scm-navigator`. To confirm that this is the path your deployment uses, log in to the Cloudera Manager Admin Console and search for the **Navigator Metadata Server Storage Dir** property (`nav.data.dir`).

3. Backup the database instance.

   - Confirm the Navigator Metadata Server database location and connection information.

     To locate this information, log in to the Cloudera Manager Admin Console and go to **Clusters** > **Cloudera Management Service**. Click the **Configuration** tab. Select **Scope** > **Navigator Metadata Server**. Select **Category** > **Database**. The results indicate the type, host, database name, and login account.

   - Using the appropriate tool for the database instance (such as MySQL), backup the database. See Backing up Cloudera Manager.

4. Start the Navigator Metadata Server role.

Authentication and Authorization

To support its user role-based authorization scheme, Cloudera Navigator integrates with **external authentication mechanisms**. External authentication mechanisms include:

- LDAP-compliant identity/authentication services, such as Active Directory and OpenLDAP
- SAML-based SSO solutions, such as Shibboleth and SiteMinder

Cloudera Manager Server has its own internal authentication mechanism, a database repository of user accounts. However, the user accounts defined in the internal Cloudera Manager account repository cannot be assigned Cloudera Navigator user roles. The only Cloudera Navigator user role that can be effectively applied to an account created in the Cloudera Manager internal repository is that of Navigator Administrator.

In other words, assigning Cloudera Navigator user roles to user accounts requires using an external authentication mechanism, such as Active Directory or OpenLDAP. See the following topics in the Cloudera Security guide for details:

- Configuring Authentication for Cloudera Navigator
  - Cloudera Navigator and External Authentication
    - Configuring Cloudera Navigator for Active Directory
    - Configuring Cloudera Navigator for OpenLDAP
    - Configuring Cloudera Navigator for SAML

Configuring Cloudera Navigator to work with Hue HA

Cloudera Navigator Search results include links to open data assets in Hue. No special configuration is required to enable these links.

However, for multiple Hue instances deployed behind external load-balancers such as in certain Hue high availability configurations, the links are properly generated only if the host name of the external load-balancer is set as the preferred URL, by configuring the Advanced Configuration Property (Safety Valve) as follows:

1. Log in to Cloudera Manager Admin Console using an account with Full Administrator privileges.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Under filter Scope, click **Navigator Metadata Server**.
5. Under the Category filter, click **Advanced**.
6. Scroll to the property **Navigator Metadata Server Advanced Configuration Snippet (Safety Valve) for cloudera-navigator.properties**.
7. Replace the cluster name and set the `nav.hue.preferred_baseurl.<clusterName>` to the fully-qualified domain name (FQDN) or specific URL of your Hue load-balancer using one of the following formats:

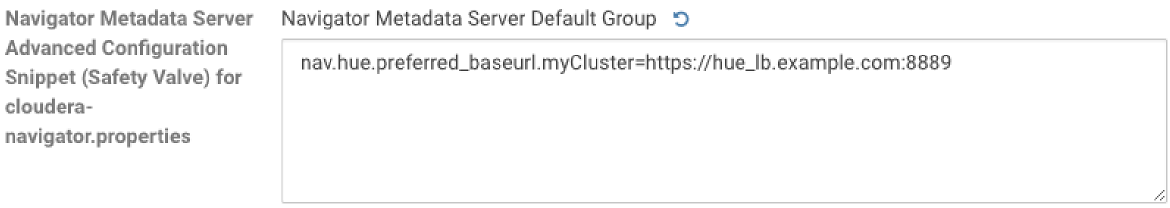
```
nav.hue.preferred_baseurl.<clusterName>=<FQDN>
```

   or

```
nav.hue.preferred_baseurl.<clusterName>=https://<FQDN>:<port>
```

   Use the full URL format when Hue is configured to use TLS/SSL; indicate `https` and the secure port number for the load balancer.

   For example, if a load-balancer for multiple Hue services is setup on host `hue_lb_nginx.example.com` and configured for TLS/SSL on port 8889, the entry would be as follows:



Navigator Metadata Server Advanced Configuration Snippet (Safety Valve) for cloudera-navigator.properties

Navigator Metadata Server Default Group

```
nav.hue.preferred_baseurl.myCluster=https://hue_lb.example.com:8889
```

8. Click **Save**.
9. Restart the Navigator Metadata Server role.

   Links to Hue will now be properly created and available in the Search results lists in the Cloudera Navigator console.

Encryption (TLS/SSL) and Cloudera Navigator

Cloudera Navigator supports TLS/SSL encryption for network communications between the Navigator Metadata Server and clients, such as the web browser used for Cloudera Navigator console, and between RPC client and server processes for Navigator Metadata Server and Navigator Audit Server. See Cloudera Security for configuration details, specifically:

- Configuring TLS/SSL for Cloudera Navigator Audit Server
- Configuring TLS/SSL for Cloudera Navigator Metadata Server

Limiting Sensitive Data in Navigator Logs

Cloudera Navigator collects metadata for cluster activities and assets; typically, this information does not include data and therefore doesn't provide an opportunity to expose sensitive data through the user interface. However, there could be sensitive data exposed the Navigator logs: queries from Impala or Hive may include a specific data value, such as a phone number or US social security number.

To guard against sensitive data exposures through Navigator logs, you can use Cloudera Manager's log redaction feature to filter out string patterns using regular expressions. For example, you could mask all quoted strings, social security numbers, and phone numbers.

The log redaction rules can apply across all cluster services.

For details, see the Cloudera Security guide, specifically Log and Query Redaction.

Preventing Concurrent Logins from the Same User

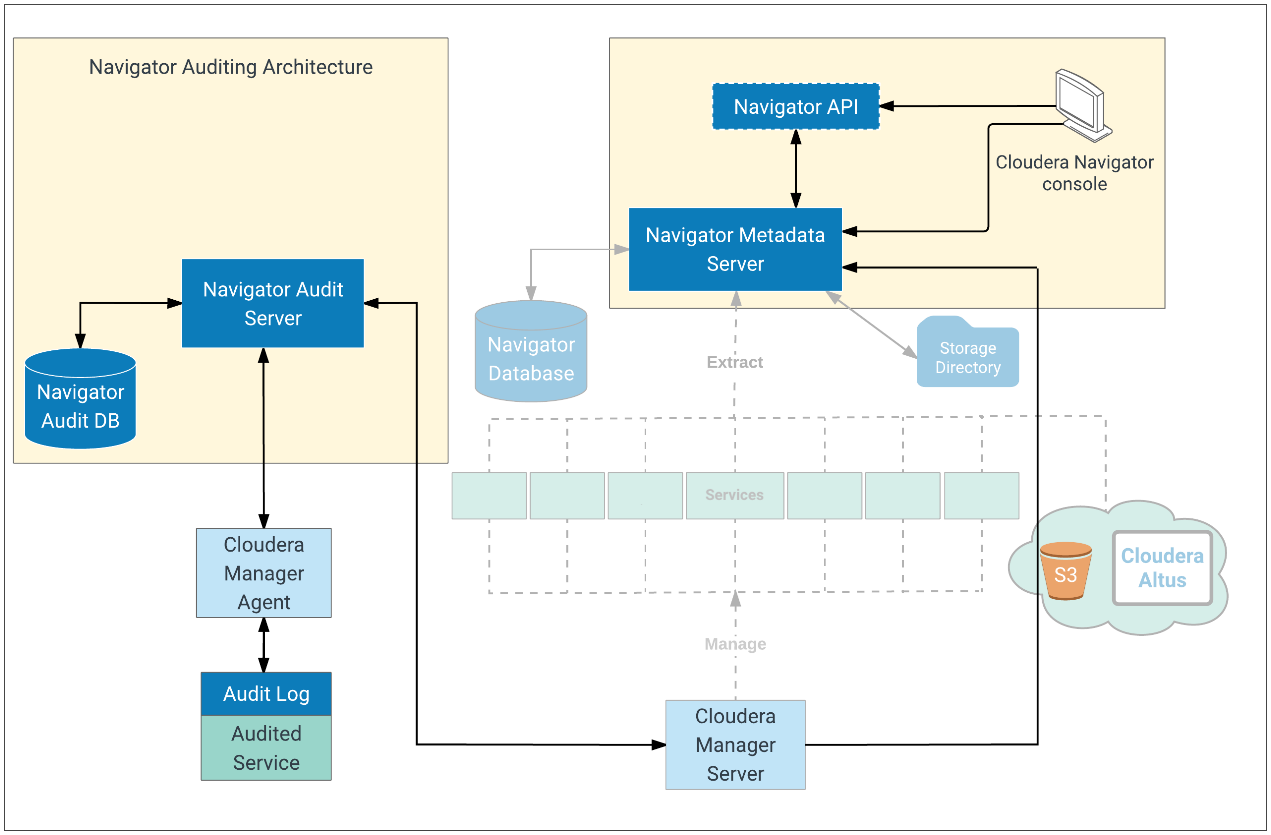
You can configure a limit to the number of simultaneous sessions authenticated against the same user name. The property `nav.max.concurrent.sessions` takes an integer value as a limit; set the value to -1 (default) to turn off the limit. To change the default behavior, in Cloudera Manager, add the property with a new value to the **Navigator Metadata Server Advanced Configuration Snippet (Safety Valve) for cloudera-navigator.properties**. Restart the Navigator Metadata Server to apply the change.

Navigator Audit Server Management

The Navigator Audit Server tracks and coalesces events from Cloudera Manager and stores them in the Navigator Audit database. This section provides a high level view of the auditing architecture and shows administrators how to use Cloudera Manager Admin Console to add the Navigator Audit Server to an existing cluster, how to configure some of its features.

Navigator Auditing Architecture

The figure below shows a high level view of the Cloudera Navigator auditing architecture:



During system setup, plug-ins for the various services—HDFS, HBase, and Hive (HiveServer2, Beeswax servers) services, for example—are enabled. These plug-ins work with the service to collect and filter events emitted by the respective service, writing the events to an audit log on the local filesystem. Impala, Sentry, and the Cloudera Navigator Metadata Server also collect and filter events and write them to their respective audit log files.

Note: When upgrading Cloudera Navigator, always check the requirements for any preliminary tasks or constraints due to service plug-ins.

Auditing Architecture In More Detail: How It Works

Here is some more detail about the auditing architecture and interaction among Cloudera Manager Agent, local log file, and Navigator Audit Server.

The Cloudera Manager Agent process on each host in the cluster:

- Monitors local audit log files
- Sends events captured in the logs to the Navigator Audit Server
- Retries sending any event that fails to transmit successfully
- Keeps track of successfully transmitted events from the logfile (offset position in the file) to prevent re-sending any already processed events after a system failure and restart
- Deletes old audit logs after successful transmission to the Navigator Audit Server

After any event is written to the audit log file (and assuming space available on the filesystem), its delivery is guaranteed. In other words, transient (in-memory) buffer handling is not involved in this part of the process. Audit logs are rotated and the Cloudera Manager Agent follows the rotation of the log.

The plug-in for each of the various services effectively writes the events to the audit log file. A plug-in that fails to write an event to the audit log file can either drop the event or can shut down the process in which it is running depending on the configured queue policy.

The Navigator Audit Server performs the following functions:

- Tracks and coalesces events obtained from Cloudera Manager
- Stores events to the Navigator Audit database

Auditing can be enabled for the core services listed in the table. Use the Cloudera Manager Admin Console to change the configuration details and to create whitelists and blacklists for better control over audit details collected by Navigator Audit Server. See Configuring Audit and Log Properties for details.

Audited Service	Note
HBase	hbase-MASTER, hbase-REGIONSERVER
HDFS	hdfs-NAMENODE
Hive	Hive Server 2 only (hive-HIVESERVER2). Command line `beeline` (not `hive`).
Hue	
Impala	impala-IMPALAD (Auditing data and lineage data both collected by Cloudera Manager Agent).
Navigator Metadata Server	
Sentry	
Solr	

Setting Up Navigator Audit Server

The steps below show you how to add the Navigator Audit Server role to an existing Cloudera Manager cluster.

The Navigator Audit Server role runs on the Cloudera Management Service. By default, the installation process installs both Navigator Audit Server and Navigator Metadata Server roles on the same Cloudera Management Service instance, but that may not be optimal, especially for very large clusters.

Adding the Navigator Audit Server Role

Cloudera Manager Required Role: Navigator Administrator (or **Full Administrator**)

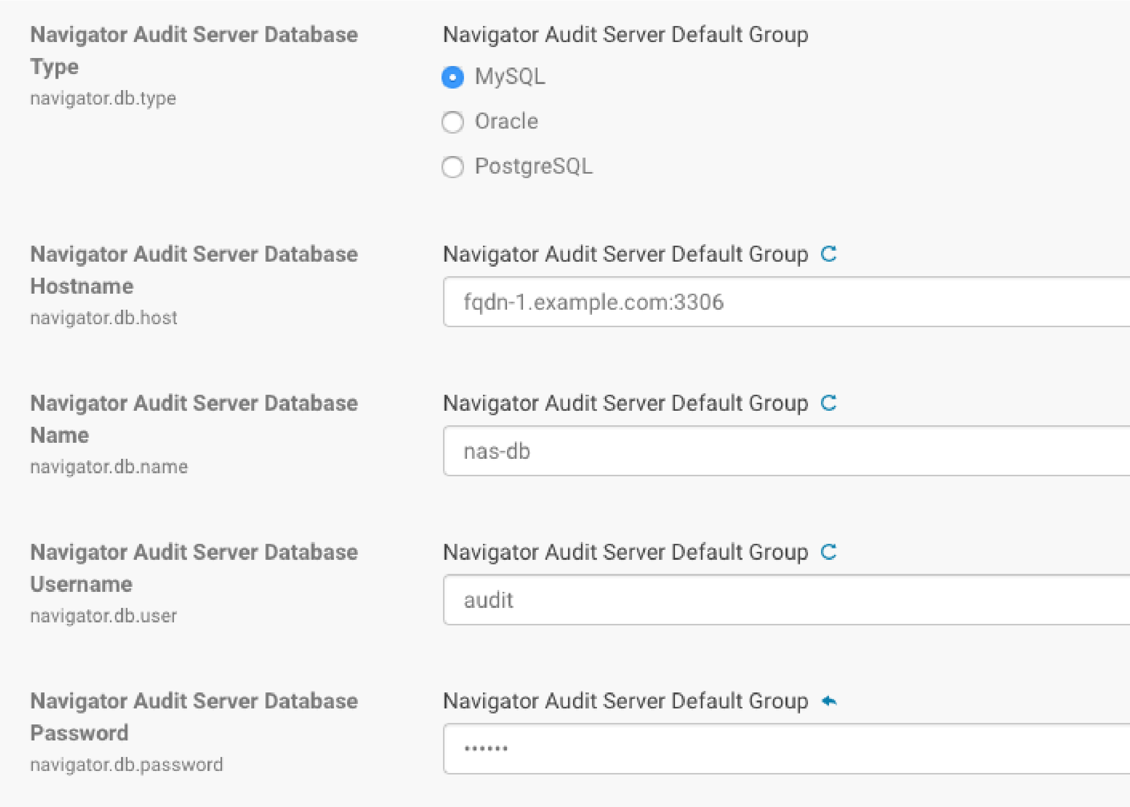
The steps below assume that an external database is running and available to be used with the Navigator Audit Server role. Before adding this role, gather the configuration details about the external database instance so you can enter them when needed during this process.

To add the Navigator Audit Server role to the cluster:

1. Log in to the Cloudera Manager Admin Console.
2. From the menu, select **Clusters** > **Cloudera Management Service**.
3. Click the**Instances** tab.
4. Click **Add Role Instances**. The Customize Role Assignments page displays and lists the nodes available to support additional roles, assuming the cluster has available resources. Reassign and customize role instances as needed.
5. Select the **Navigator Audit Server** role and assign it to appropriate host for your cluster.
6. When finished, click **Continue**. The Database Setup page displays.
7. Click **Use Custom Database**.
8. In the **Navigator Audit Server** section, enter the details of your database instance:
    - Database host name
    - Database type
    - Database name
    - Username
    - Password

> **Note:** For **non-production use only**, you can select **Use Embedded Database**. Cloudera Manager creates and configures the databases for you. Make a note of the generated passwords.

Here is an example of a configured external database instance:



Navigator Audit Server Database Type
navigator.db.type
Navigator Audit Server Default Group
● MySQL
○ Oracle
○ PostgreSQL

Navigator Audit Server Database Hostname
navigator.db.host
Navigator Audit Server Default Group
fqdn-1.example.com:3306

Navigator Audit Server Database Name
navigator.db.name
Navigator Audit Server Default Group
nas-db

Navigator Audit Server Database Username
navigator.db.user
Navigator Audit Server Default Group
audit

Navigator Audit Server Database Password
navigator.db.password
Navigator Audit Server Default Group
••••••

9. Click **Test Connection** to verify the communication between the cluster and the external database. If the test fails, check the database settings and try again. If you selected embedded database, a message displays regarding database creation.
10. Click **Continue**.
11. The **Cluster Setup Review Changes** page displays.
12. Click **Finish**.

Starting, Stopping, and Restarting the Navigator Audit Server

1. Log in to the Cloudera Manager Admin Console.
2. From the menu, select **Clusters** > **Cloudera Management Service**.
3. Click the **Instances** tab.
4. Click the link for the **Navigator Audit Server** from the Role Type list. The Actions for Selected button activates and displays (1) for the selected role.
5. From the **Actions for Selected (1)** menu, select the ***Action*** you want to perform on this role instance:

   - Start
   - Stop
   - Restart
   - Enter Maintenance Mode
   - Exit Maintenance Mode
   - Delete

   A confirmation message displays prompting you to **Cancel** or complete the specified ***Action***.
6. Click Cancel to abandon the process, or click ***Action*** to execute the action.

Configuring the Navigator Audit Server Data Expiration Period

By default, the Navigator Audit Server keeps **90 days** worth of audit events in its database. The setting can be changed to a shorter timeframe by configuring the number of hours or days of audit events to keep in the Navigator Audit Server database as follows:

1. Log in to the Cloudera Manager Admin Console.
2. From the menu, select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Select **Navigator Audit Server** from the **Scope** filter.
5. For the **Navigator Audit Server Data Expiration Period**, enter the number of days or hours or audit events that should be retained in the database before purging and select either **day(s)** or **hour(s)** from the drop-down to label the value accordingly.
6. Restart the Navigator Audit Server role.

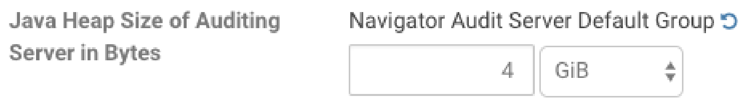
Setting the Navigator Audit Server Java Heap Size

Cloudera Manager Required Role: [Navigator Administrator]() (or [Full Administrator]())

The Navigator Audit Server performance is typically bound by the performance of the database. With that in mind, consider increasing the Navigator Audit Server Java heap to as much as 4 GB; increasing heap beyond this point is unlikely to change the server performance. The default Java heap is set to 1.5 GiB.

You can change the setting as follows:

1. Log in to the Cloudera Manager Admin Console.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Select **Scope** > **Navigator Audit Server**.
5. For Filter **Category**, click **Resource Management** to display the Java Heap Size property.



Java Heap Size of Auditing Server in Bytes

Navigator Audit Server Default Group

4 GiB

6. Use the drop-down selector to change the unit scale to B (Bytes), KiB, MiB, or GiB and set your preferred heap size.
7. Click **Save Changes**.

   The setting takes effect only after restarting the role. Restart the Navigator Metadata Server role now or make other configuration changes and restart after you are finished with all changes.

8. [Restart the role]().

Configuring the Navigator Audit Server Log Directory

The default location for the Navigator Audit Server logs is:

```
/var/log/cloudera-scm-navigator
```

To change the location for the log directory:

1. Log in to the Cloudera Manager Admin Console.
2. From the menu, select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Select **Category** > **Logs**.
5. Enter the path for the **Navigator Audit Server Log Directory** property.
6. Restart the Navigator Audit Server role.

Enabling Audit and Log Collection for Services

Cloudera Manager Required Role: **Navigator Administrator** (or **Full Administrator**)

Auditing of every service and role in the cluster may not be necessary and may degrade performance, which is why auditing is not always enabled by default. In addition, auditing can be configured to capture only specific events, as detailed in Configuring Service Auditing Properties.

Enabling Audit Collection

Any service or role instance that can be audited by Cloudera Navigator has an **Enable Audit Collection** property. When enabled, the Cloudera Manager Agent process on the node monitors the audit log file (or files) and sends collected audit records to the Navigator Audit Server.

1. Log in to Cloudera Manager Admin Console
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Select ***ServiceName*** **(Service-Wide)** for the **Scope** filter.
5. Select **Navigator Metadata Server** for the **Category** filter.
6. Click the **Enable Audit Collection** checkbox to activate auditing for the service.
7. Click **Save Changes**.
8. Restart the service.

Configuring Impala Daemon Logging

To enable logging for the Impala Daemon role.

1. Log in to Cloudera Manager Admin Console
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Select **Impala Daemon** for the **Scope** filter.
5. Select **Logs** for the **Category** filter.
6. Edit the **Enable Impala Audit Event Generation**.
7. Click **Save Changes**.
8. Restart the Impala daemon.

To set the log file size:

1. Click the Impala service.
2. Select **Scope** > **Impala Daemon**.
3. Select **Category** > **Logs**.
4. Set the **Impala Daemon Maximum Audit Log File Size** property.
5. Click **Save Changes**.
6. Restart the Impala service.

Enabling Solr Auditing

Solr auditing is disabled by default. To enable auditing:

1. Enable Sentry authorization for Solr following the procedure in Enabling Sentry Policy File Authorization for Solr.
2. Go to the Solr service.
3. Click the **Configuration** tab.
4. Select **Scope** > ***Solr Service*** **(Service-Wide)**
5. Select **Category** > **Policy File Based Sentry** category.
6. Select or clear the **Enable Sentry Authorization** checkbox.
7. Select **Category** > **Cloudera Navigator** category.
8. Select or clear the **Enable Audit Collection** checkbox. See Configuring Service Audit Collection and Log Properties.
9. Click **Save Changes** to commit the changes.

10. Restart the service.

Configuring Audit Logs

The following properties apply to an audit log file:

- **Audit Log Directory** - The directory in which audit log files are written. By default, this property is not set if Cloudera Navigator is not installed.

  A validation check is performed for all lifecycle actions (stop/start/restart). If the Enable Collection flag is selected and the Audit Log Directory property *is not set*, the validator displays a message that says that the Audit Log Directory property must be set to enable auditing.

  If the value of this property is changed, and service is restarted, then the Cloudera Manager Agent will start monitoring the new log directory for audit events. In this case it is possible that not all events are published from the old audit log directory. To avoid loss of audit events, when this property is changed, perform the following steps:

  1. Stop the service.
  2. Copy audit log files and (for Impala only) the `impalad_audit_wal` file from the old audit log directory to the new audit log directory. This needs to be done on all the hosts where Impala Daemons are running.
  3. Start the service.

- **Maximum Audit Log File Size** - The maximum size of the audit log file before a new file is created. The unit of the file size is service dependent:

  - **HDFS, HBase, Hive, Hue, Navigator Metadata Server, Sentry, Solr** - MiB
  - **Impala** - lines (queries)

- **Number of Audit Logs to Retain** - Maximum number of rolled over audit logs to retain. The logs will not be deleted if they contain audit events that have not yet been propagated to the Audit Server.

To configure audit logs do the following:

1. Do one of the following:

   - Service - Go to a supported service.
   - Navigator Metadata Server

     - Do one of the following:

       - Select **Clusters** > **Cloudera Management Service**.
       - On the **Home** > **Status** tab, in **Cloudera Management Service** table, click the **Cloudera Management Service** link.

2. Click the **Configuration** tab.
3. Select the scope according to the service:

   - All services except Impala - **Scope** > ***ServiceName*** **(Service-Wide)**.
   - Impala - **Scope** > **Impala Daemon**.
   - Navigator Metadata Server - **Scope** > **Navigator Metadata Server**.

4. Select **Category** > **Logs**.
5. Configure the log properties. For Impala, preface each log property with **Impala Daemon**.
6. Click **Save Changes**.
7. Restart the service.

Configuring Audit Properties

Set auditing properties for a service in the service's configuration settings in Cloudera Manager.

Cloudera Manager Required Role: **Navigator Administrator** (or **Full Administrator**)

Setting Audit Properties

To review or update audit properties for a service:

1. Log in to the Cloudera Manager Admin Console.
2. Select select any service that supports auditing. Select **Cluster** > ***Service-Name***
3. Click the **Configuration** tab.
4. Select ***Service* (Service-Wide)** for the **Scope** filter.
5. Select **Cloudera Navigator** for the **Category** filter.
6. Edit the properties.
7. Click **Save Changes** to commit the changes.
8. Restart the service if needed.

   It is necessary to restart the service to update an audit filter.

In addition, for Impala and Solr auditing, perform the steps in Configuring Impala Daemon Logging on page 91 and Enabling Solr Auditing on page 91 and for all services perform the steps in Configuring Audit Logs on page 92.

Operations within Navigator are also audited. To update Navigator's audits:

1. Select **Clusters** > **Cloudera Management Service**.
2. Click the **Configuration** tab.
3. Select **Navigator Metadata Server** for the **Scope** filter.
4. Select **Category** > **Cloudera Navigator** category.
5. Edit the properties.
6. Click **Save Changes** to commit the changes.
7. Restart the service if needed.

   It is necessary to restart the service to update an audit filter.

Service-level Audit Properties

Each service (with exceptions noted) that supports auditing has the following properties:

- **Enable Audit Collection** - See Enabling Audit Collection on page 91 and Enabling Solr Auditing on page 91.
- **Audit Log properties** - See Configuring Audit Logs on page 92 and Configuring Impala Daemon Logging.
- **Audit Event Filter** - A set of rules that capture properties of auditable events and actions to be performed when an event matches those properties. The Cloudera Manager Agent uses this property to filter events out *before* they are sent to Cloudera Navigator. The default filter settings discard the following events:
  - **HDFS**
    - Generated by the internal Cloudera and Hadoop users (`cloudera-scm`, `hbase`, `hive`, `impala`, `mapred`, `solr`, `spark`, and `dr.who`)
    - Generated by the `hdfs` user running the listStatus, listCachePools, listCacheDirectives, and getfileinfo operations
    - That affect files in the `/tmp` directory
  - **HBase** - That affect the -ROOT-, .META., and acl tables
  - **Hive** - Generated by Hive MapReduce jobs in the /tmp directory
  - **Impala**, **Solr**, **Solr**, **Navigator Metadata Server** - No default filter
- **Audit Event Tracker** - A set of rules for tracking and coalescing events. This feature is used to define equivalency between different audit events. Tracking works by keeping a reference to events when they first appear, and comparing other incoming events against the tracked events according to the rules defined. When events match, according to a set of configurable parameters, only one entry in the audit list is generated for all the matching events. This property is not supported for the Navigator Metadata Server.

- **Audit Queue Policy** - The action to take when the audit event queue is full. The options are Drop or Shutdown. When a queue is full and the queue policy of the service is Shutdown, before shutting down the service, *N* audits will be discarded, where *N* is the size of the Cloudera Navigator Audit Server queue.

  > **Note:** If the queue policy is Shutdown, the Impala service is shut down only if Impala is unable to write to the audit log file. It is possible that an event may not appear in the audit event log due to an error in transfer to the Cloudera Manager Agent or database. In such cases Impala will not shut down and will keep writing to the log file. When the transfer problem is fixed the events will be transferred to the database.

  This property is not supported for Hue or the Navigator Metadata Server.

Finding Audit Filter Properties for Each Service

For information on the structure of the objects, and the properties for which you can set filters, display the description on the configuration page as follows:

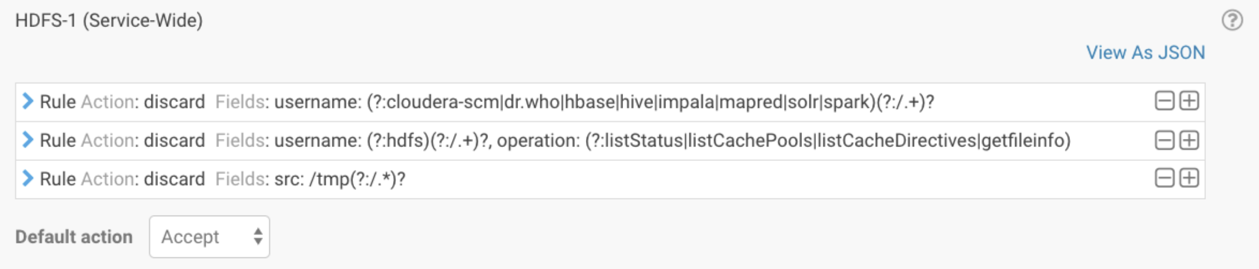
1. Log in to the Cloudera Manager Admin Console.
2. Select select any service that supports auditing. Select **Cluster** > ***Service-Name***
3. Click the **Configuration** tab.
4. Select ***Service*** **(Service-Wide)** for the **Scope** filter.
5. Select **Cloudera Navigator** for the **Category** filter.
6. Click ? for **Audit Event Tracker** to open the property description.

   For example, the Hive properties are:

   - operation: the Hive operation being performed.
   - userName: the user performing the action.
   - ipAddress: the IP from where the request originated.
   - allowed: whether the operation was allowed or denied.
   - databaseName: the databaseName for the operation.
   - tableName: the tableName for the operation.
   - objectType: the type of object affected by the operation.
   - resourcePath: the path of the resource affected by the operation.

Entering Audit Filter Properties

The Audit Event Filter and Audit Event Tracker rules for filtering and coalescing events are expressed as JSON objects. You can edit these rules using a rule editor. The `username` filters shown here include an optional phrase (`(?:/.+)?`) to filter events where the user name is constructed with a slash as part of the name, such as a Kerberos principal (`username/instance@REALM`). It applies only if the regular expression matches one of the usernames listed in the first phrase. The `src` filter shows a similar optional phrase (`(?:/.*)?`) that filters for subdirectories under the `/tmp` directory. The regular expression looks for occurrences of slash followed by zero or more characters; this makes sure that subdirectories are included but other directories whose name starts with "tmp" are not included in the filter.



HDFS-1 (Service-Wide)

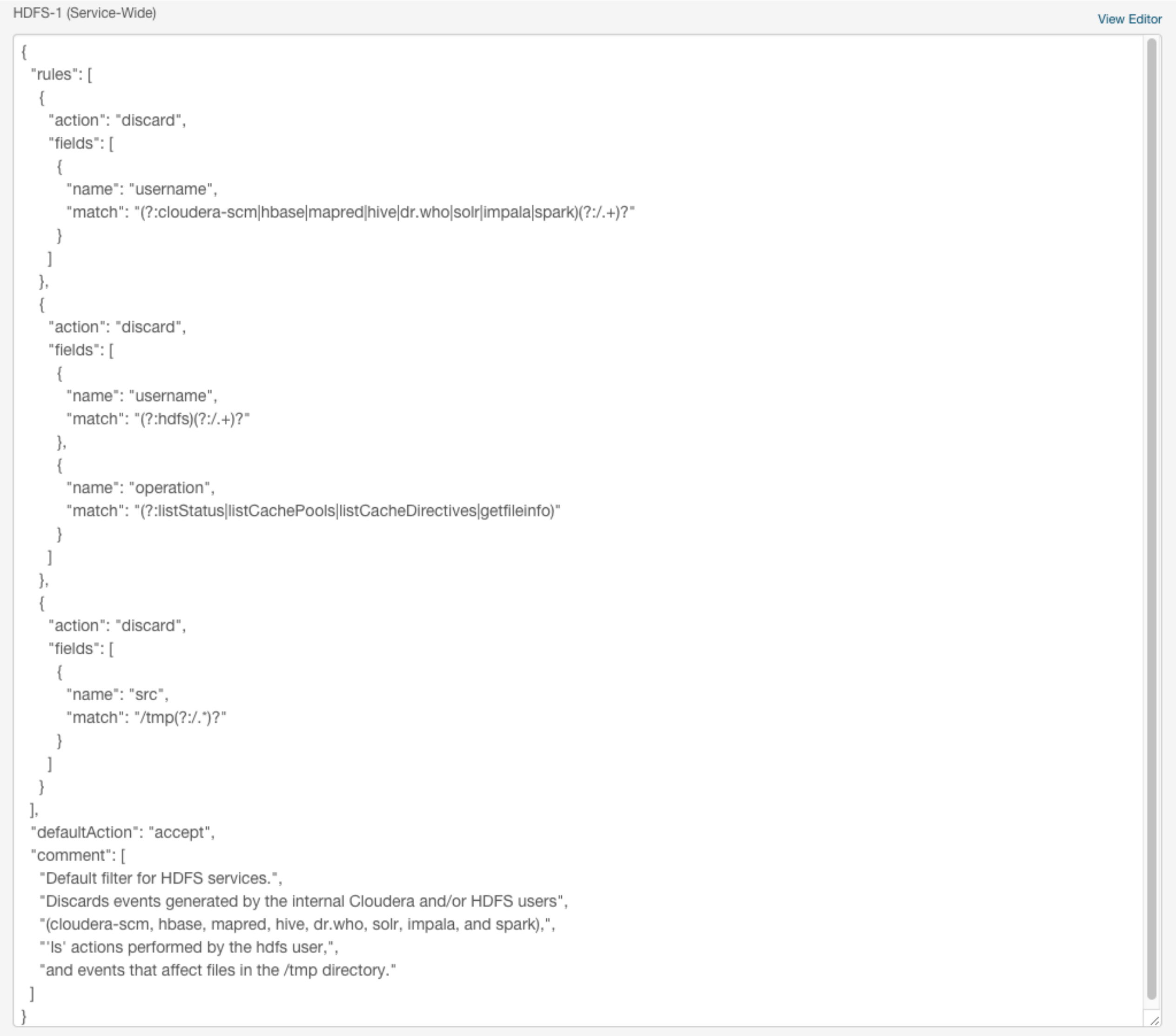
Rule Action: discard Fields: username: (?:cloudera-scm|dr.who|hbase|hive|impala|mapred|solr|spark)(?:/.+)?

Rule Action: discard Fields: username: (?:hdfs)(?:/.+)?, operation: (?:listStatus|listCachePools|listCacheDirectives|getfileinfo)

Rule Action: discard Fields: src: /tmp(?:/.*)?

Default action: Accept

or in a JSON text field:



```
{
 "rules": [
  {
   "action": "discard",
   "fields": [
    {
     "name": "username",
     "match": "(?:cloudera-scm|hbase|mapred|hive|dr.who|solr|impala|spark)(?:/.+)?"
    }
   ]
  },
  {
   "action": "discard",
   "fields": [
    {
     "name": "username",
     "match": "(?:hdfs)(?:/.+)?"
    },
    {
     "name": "operation",
     "match": "(?:listStatus|listCachePools|listCacheDirectives|getfileinfo)"
    }
   ]
  },
  {
   "action": "discard",
   "fields": [
    {
     "name": "src",
     "match": "/tmp(?:/.*)?"
    }
   ]
  }
 ],
 "defaultAction": "accept",
 "comment": [
  "Default filter for HDFS services.",
  "Discards events generated by the internal Cloudera and/or HDFS users",
  "(cloudera-scm, hbase, mapred, hive, dr.who, solr, impala, and spark),",
  "'ls' actions performed by the hdfs user,",
  "and events that affect files in the /tmp directory."
 ]
}
```

Audit Filter Examples

Use audit filters to control what information is collected by Navigator Audit Server. The following sections describe cases where a filter can allow you to remove noise from the audit events or otherwise improve the quality of the audit trail.

Removing audit events for automated tasks

If you find that the audit events include references to automated tasks against HDFS or other services that you don't want to include in your audit, you can include the tasks in a "discard" filter. For example, to discard all tasks performed against HDFS by the user under which the automated tasks are performed, create an HDFS filter:

```
Action: Discard
Fields: username: (?:automationuser|automationuser@realm.example.com)
```

This rule would discard any event performed by the `automationuser` account, where the user is specified by itself or with a Kerberos realm designation. Note that the filter is not case sensitive. As a performance optimization, the expression is included in parentheses with `?:` to indicate that the matched values are not retained.

Removing audit events for low priority operations

You may find that your audit log includes reference to events that you are not interested in tracking. You can prevent these events from being included in the audit log by filtering them out by operation. For example, if the audit event that you don't want to track looks like this:

```
2170816,hdfs,1,someuser@MYREALM.COM,null,192.168.12.18,1477605498525,getfileinfo,
/user/someuser/.staging/jobx/status,null,null,null
```

where the HDFS operation `getfileinfo` ran against the file `status` for the user `someuser` on a node in the cluster. The user account is indicated with a Kerberos realm.

To remove the HDFS getfileinfo accesses by this user, the audit filter would reference the user (by itself or with a Kerberos realm name) and the getfileinfo operation:

```
Action: Discard
Fields: username: (?:username|username@MYREALM.com)
        operation: (?:getfileinfo)
```

As a performance optimization, the expressions are included in parentheses with `?:` to indicate that the matched values are not retained.

To include more than one operation in the same filter, include both operations with an OR operator `|.`:

```
Action: Discard
Fields: username: (?:username|username@MYREALM.com)
        operation: (?:getfileinfo|liststatus)
```

Monitoring Navigator Audit Service Health

Cloudera recommends monitoring the Navigator Audit Service to ensure that it is always running. This is especially important to ensure that complete and immutable audit records will be available when needed for corporate governance and compliance purposes.

The Navigator Audit Service has a self-check mechanism, the Audit Pipeline Health Check, that generates warning messages when the system slows down or fails. The health check determines failures and slow downs by keeping track of the number of bytes of audit data sent, bytes unsent, or failures during the send process that occur within the monitoring window. Healthy state for a given monitoring period results when all audit data is sent (no data remaining), with error-free transmission from agent to server.

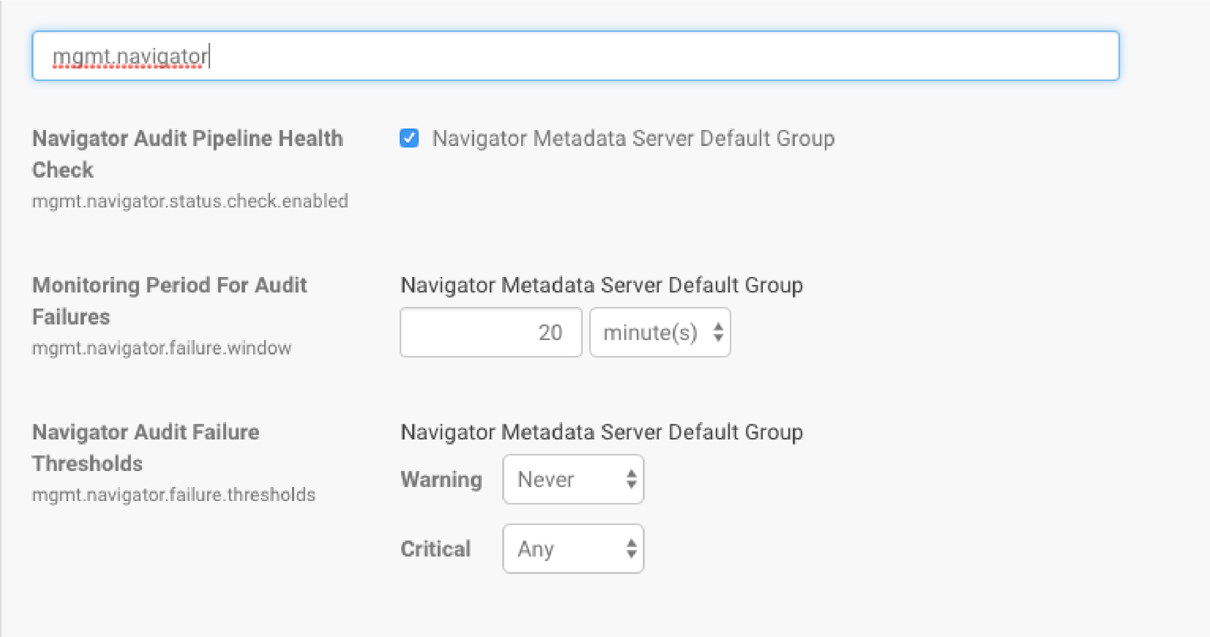
The health check can be run for each service role instance (daemon) that can generate events. By default, all service role groups are selected when you enabled the health check, and the default monitoring period is 20 minutes. Thresholds for warning messages and the monitoring period are configurable using the Cloudera Manager Admin, as detailed below.

Configuring the Audit Pipeline Health Check

Cloudera Manager Required Role: **Navigator Administrator** (or **Full Administrator**)

Log in to the Cloudera Manager Admin Console. For each service that you want to enable the health check, follow the steps below.

1. Select **Clusters** > ***service-name***.
2. Click the **Configuration** tab.
3. In the Search field, type **mgmt.navigator** to display the health check configuration properties for the service:



mgmt.navigator

Navigator Audit Pipeline Health Check
mgmt.navigator.status.check.enabled

☑ Navigator Metadata Server Default Group

Monitoring Period For Audit Failures
mgmt.navigator.failure.window

Navigator Metadata Server Default Group
20 minute(s)

Navigator Audit Failure Thresholds
mgmt.navigator.failure.thresholds

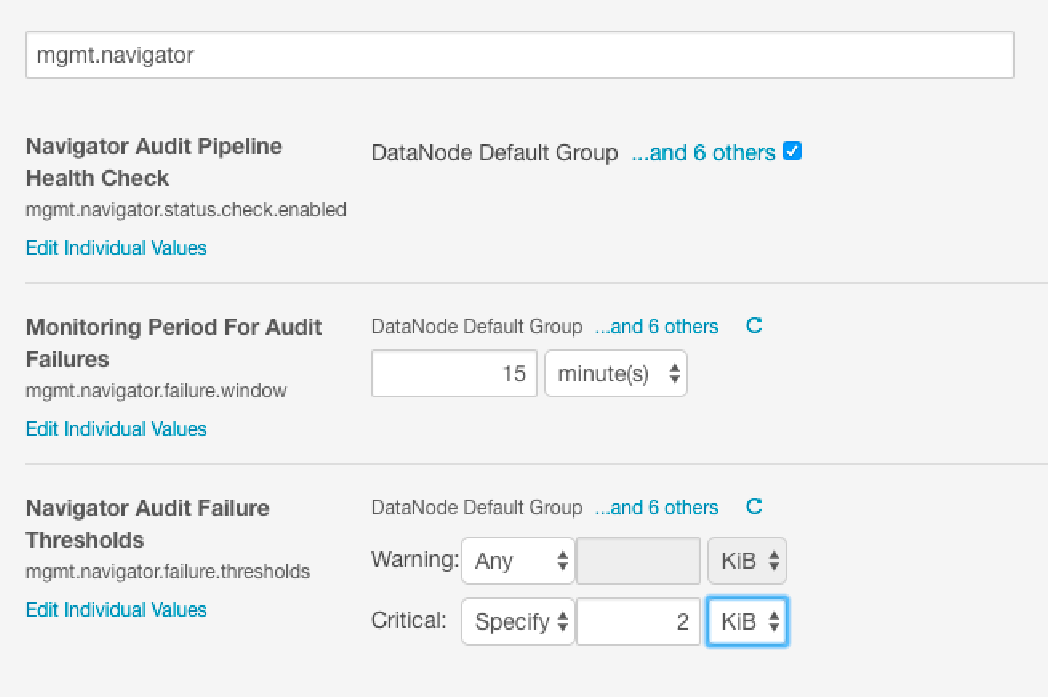
Navigator Metadata Server Default Group
Warning Never
Critical Any

4. Modify the settings to shorten (or lengthen) the monitoring period as needed for your system and set bytes for Warning and Critical thresholds.

Property	Description
Navigator Audit Pipeline Health Check	Check the box to enable the health check. Health check can be enabled for specific groups. By default, the health check is enabled for all groups.
Monitoring Period for Audit Failures	Default is 20 minutes. The amount of time to process audit events (count processed and evaluate other metrics before generating warnings.
Navigator Audit Failure Thresholds	Size (in bytes) of failures that will trigger messages. • Warning—Default is Never. Set this to an amount of bytes and condition (which to trigger a warning message. • Critical—Default is Any, meaning that any amount of failed audit data sent from Cloudera Manager to the server will trigger a critical messagse.

5. Click **Save Changes**.

For example, as shown in the Cloudera Manager Admin Console, the pipeline health check is enabled for all groups in the service. The failure period is set to 15 minutes, and the health check sends a warning for failures of any size and a critical error when 2 KiB of audit events have not been sent.



mgmt.navigator

Navigator Audit Pipeline Health Check
mgmt.navigator.status.check.enabled
Edit Individual Values

DataNode Default Group ...and 6 others ☑

Monitoring Period For Audit Failures
mgmt.navigator.failure.window
Edit Individual Values

DataNode Default Group ...and 6 others
15 minute(s)

Navigator Audit Failure Thresholds
mgmt.navigator.failure.thresholds
Edit Individual Values

DataNode Default Group ...and 6 others
Warning: Any KiB
Critical: Specify 2 KiB

Publishing Audit Events

Minimum Required Role: **[Navigator Administrator](#)** (also provided by **Full Administrator**)

Audit events can be published to a Kafka topic or to the system log (syslog). After configuring Cloudera Navigator to send audit events, failures to send events are logged to the [Audit Server log](#).

Publishing Audit Events to Kafka

Navigator can stream audit events to a Kafka topic so the events can be used by another application or archived outside of the Navigator Audit Server database. To configure Navigator to stream audits to a Kafka topic:

1. Create the topic in Kafka.

   If the Kafka instance is configured with **Topic Auto Creation** enabled, you can skip this step. The topic will be created when the first event is sent to Kafka.

   For steps for creating a Kafka topic, see the Kafka `kafka-topics` command in [Using Apache Kafka Command-line Tools](#).

2. Log in to Cloudera Manager Admin Console using either Navigator Administrator or Full Administrator privileged account.
3. Select **Clusters** > **Cloudera Management Service**.
4. Click the **Configuration** tab.
5. If Kafka is managed by the same Cloudera Manager instance as Navigator:

   a. In the Search field, type "kafka" to display the configurable settings.
   b. For the **Kafka Service** property, select the Kafka service to which Cloudera Navigator will publish audit events.
   c. For the **Kafka Topic** property, enter the name of the topic to which Cloudera Navigator will publish the audit events.

6. If Kafka is not managed by the same Cloudera Manager instance as Navigator, add properties to accommodate logging for Kafka:

   a. In the Search field, type "logging" to display the configurable settings.

b. For the **Navigator Audit Server Logging Advanced Configuration Snippet (Safety Valve)** property, insert the following logging properties, inserting the `brokerList` and `topic` values with the values for your system:

```
log4j.logger.kafkaAuditStream=TRACE,KAFKA
log4j.appender.KAFKA=org.apache.kafka.log4jappender.KafkaLog4jAppender
log4j.additivity.kafkaAuditStream=false
log4j.appender.KAFKA.layout=org.apache.log4j.PatternLayout
log4j.appender.KAFKA.layout.ConversionPattern=%m%n
log4j.appender.KAFKA.syncSend=false
log4j.appender.KAFKA.brokerList=<comma-separated list of brokers as host:port>
log4j.appender.KAFKA.topic=<topic>
```

If Kafka is managed using Cloudera Manager, you can find the broker host names in the **Instances** tab for the Kafka service. List the host and port numbers in a comma-separated list without spaces. For example:

```
kafka-dedicated-1.example.com:9092,kafka-dedicated-2.example.com:9092,kafka-dedicated-3.example.com:9092
```

c. If Kafka is not managed by the same Cloudera Manager instance as Navigator **and** Kerberos is enabled in the Kafka cluster, there are additional configuration steps.

These steps are described in the Kafka client documentation for security, Configuring Apache Kafka Security.

- Include the following additional properties in the **Navigator Audit Server Logging Advanced Configuration Snippet (Safety Valve)**, inserting the truststore `location` and truststore `password` with the values from your system:

```
log4j.appender.KAFKA.SaslKerberosServiceName=kafka
log4j.appender.KAFKA.clientJaasConfPath=navigator.jaas.conf
log4j.appender.KAFKA.SecurityProtocol=SASL_SSL
log4j.appender.KAFKA.SslTruststoreLocation=</path/to/truststore>
log4j.appender.KAFKA.SslTruststorePassword=<password>
```

- For the Navigator Kafka client create a `jaas.conf` file with keytabs.

  To generate keytabs, see Step 6: Get or Create a Kerberos Principal for Each User Account).

  Insert the `keyTab` and `principal` with the values from your system.

```

KafkaClient {
  com.sun.security.auth.module.Krb5LoginModule required
  useKeyTab=true
  keyTab="/etc/security/keytabs/mykafkaclient.keytab"
  principal="mykafkaclient/clients.hostname.com@EXAMPLE.COM";
};
```

- Set the location of the `jaas.conf` in the Navigator host environment.

```

export KAFKA_OPTS="-Djava.security.auth.login.config=/home/user/jaas.conf"
```

7. Add a description of the changes and click **Save Changes**.
8. Restart the role.
9. You can validate that events are published to the topic using the Kafka `kafka-console-consumer`command as described in Using Apache Kafka Command-line Tools.

Publishing Audit Events to Syslog

The Audit Server logs all audit records into a Log4j logger called `auditStream`. The log messages are logged at the TRACE level, with the attributes of the audit records. By default, the `auditStream` logger is inactive because the logger level is set to FATAL. It is also connected to a `NullAppender`, and does not forward to other appenders (additivity set to false).

To record the audit stream, configure the `auditStream` logger with the desired appender. For example, the standard `SyslogAppender` allows you to send the audit records to a remote syslog.

The Log4j `SyslogAppender` supports only UDP. An example syslog configuration would be:

```
$ModLoad imudp
$UDPServerRun 514
# Accept everything (even DEBUG messages)
local2.* /my/audit/trail.log
```

Other appenders can be attached to the `auditStream` to implement other integration behaviors.

Audit events published to syslog can be formatted as JSON or RSA EnVision. To configure audit logging to syslog:

1. Log in to Cloudera Manager Admin Console using either Navigator Administrator or Full Administrator privileged account.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Locate the **Navigator Audit Server Logging Advanced Configuration Snippet** property by typing its name in the Search box.
5. Depending on the format type, enter:

```
log4j.appender.SYSLOG = org.apache.log4j.net.SyslogAppender
log4j.appender.SYSLOG.SyslogHost = hostname[:port]
log4j.appender.SYSLOG.Facility = local2
log4j.appender.SYSLOG.FacilityPrinting = true
```

To configure the specific stream type, enter:

Format	Property

JSON	`log4j.logger.auditStream = TRACE,SYSLOG`
	`log4j.additivity.auditStream = false`

RSA EnVision	`log4j.logger.auditStreamEnVision = TRACE,SYSLOG`
	`log4j.additivity.auditStreamEnVision = false`

6. Click **Save Changes**.
7. Restart the role.

Maintaining Navigator Audit Server

Cloudera Manager Required Role: Navigator Administrator (or **Full Administrator**)

When you have Cloudera Navigator running, Navigator Audit Server is enabled by default. Audits are enabled for all supported services, including HDFS, Hive, Impala, Hue, HBase, Sentry, and Solr as well as Cloudera Manager and Navigator itself. Events are retained for 90 days with some default filters defined.

Because the default settings may not work for all environments, we recommend that you review your Navigator Audit Server setup to review these three areas:

What events are collected?

Default filters remove some service-to-service events. However, you should check to make sure that the role names used in the filters match what's used in your system.

How long are events retained?

To determine the best expiration period for events in your audit system, consider the volume of incoming events, the disk space available for the audit database, and how your organization is using the audits from the Navigator console or API.

How are events archived?

Mot organizations keep audit events in storage well after they are useful for casual queries through the Navigator console. Your archiving solution should balance the effort required to access archived audit data with the cost of implementing your archiving system. Be sure that whatever system you design can handle the volume of audits you intend to maintain.

This Navigator YouTube video gives an overview of the audit tuning process and some database queries and other techniques that will help you make sure your audit system is working well.

Reviewing Navigator Audits for Unproductive Events

You can use the Navigator console, Audit tab to get a general feel for what events are audited and if you are seeing too many audit events that don't add value. In addition, here are some queries you can run against the audit database itself to identify users or operations that produce more events than expected or needed.

Review Audited Operations

1. Log into the database as a privileged user.

   For example for MySQL:

```
$ mysql -u user_name -p
```

   You are prompted for a password.

2. Show the databases and look for the Navigator database.

```

mysql> show databases;
mysql> use navigator audit server database
```

   If you aren't sure of the name, you can check the **Navigator Audit Server Database Name** in Cloudera Manager.

3. List the tables to see that the table names show the service and the day the audits are from.

```
mysql> show tables;
```

4. Pick a table and run a query to show the events recorded by user.

```
mysql> select username, operation, count(*) as usercount from audit table group by
username order by usercount DESC;
```

   If you find that a relatively large number of events were collected for a single user, it may be that this user is a system user. The default filters discard events performed by the HDFS superuser, but only if the role name is `hdfs`. You may need to add another audit filter to discard events by this additional system user name.

5. Pick a table and run a query to show the events recorded by operation.

```
mysql> select operation, username, count(*) as opcount
              from audit table group by operation order by
              opcount DESC;
```

   This query may indicate that your audit system includes large numbers of events that you may not care to track. In that case, consider adding an audit filter to discard the unneeded events by operation.

Reviewing Default Audit Filters

To see the default Navigator Audit Filters:

1. Log in to the Cloudera Manager Admin Console.
2. Select the service you want to review. Select **Cluster** > ***Service-Name***
3. Click the **Configuration** tab.
4. Select ***Service*** **(Service-Wide)** for the **Scope** filter.
5. Select **Cloudera Navigator** for the **Category** filter.

6. Click ? for **Audit Event Tracker** to open the property description.

The make sure the default filters are doing what they are designed to do, check that the user names in the filters correspond to the role names in your environment. For example, one default filter is configured to discard redundant audit events produced in HDFS when operations are performed in Hive or other services. This filter is configured for the user `hdfs`. If your environment uses other names for HDFS superusers, consider creating additional filters to discard the same operations performed under the other superuser names.

Review and Predict Audit Volume

One way to calculate the volume of disk space you'll need for the Navigator Audit Server database is to look at the event count for a single day or average of days and multiply that volume by the number of days in the audit event expiration period. You can modify the expiration period in Cloudera Manager, in the Navigator Audit Server Data Expiration Period property. The default value is 90 days.

Calculate Audit Volume

1. To see the size of all audit tables for a given date, query against a set of tables. For example, in MySQL:

```
mysql> SELECT table_name AS `Table`, round(((data_length + index_length) / 1024 / 1024),
 2) `Size in MB`  FROM information_schema.TABLES  WHERE table_schema = "navigator audit
 database" and table_name like "%YYYY_MM_DD";
```

   Insert your Navigator Audit Database name and a valid audit date (`YYYY_MM_DD` format) in the query.

2. To see the total size of audits for each day for a give year of audits, query against the event tables in the database for a given year:

```
SELECT sum(round(((data_length + index_length) / 1024 / 1024), 2)) `Size in MB across
all audits`, right(table_name,10) as dateset  FROM information_schema.TABLES  WHERE
table_schema = "navigator audit database" and table_name like "%YYYY_%"  group by dateset;
```

   Insert your Navigator Audit Database name and a valid audit year (YYYY format) in the query.

3. Calculate the expected size of your audit database by selecting a representative size for a day of audit data and multiplying that value by the number of days in the expiration period.

   For example, if your system is generating about 5 GB of events per day and you are keeping the default 90 days of audits, you'll need about 450 GB of space for the audit database.

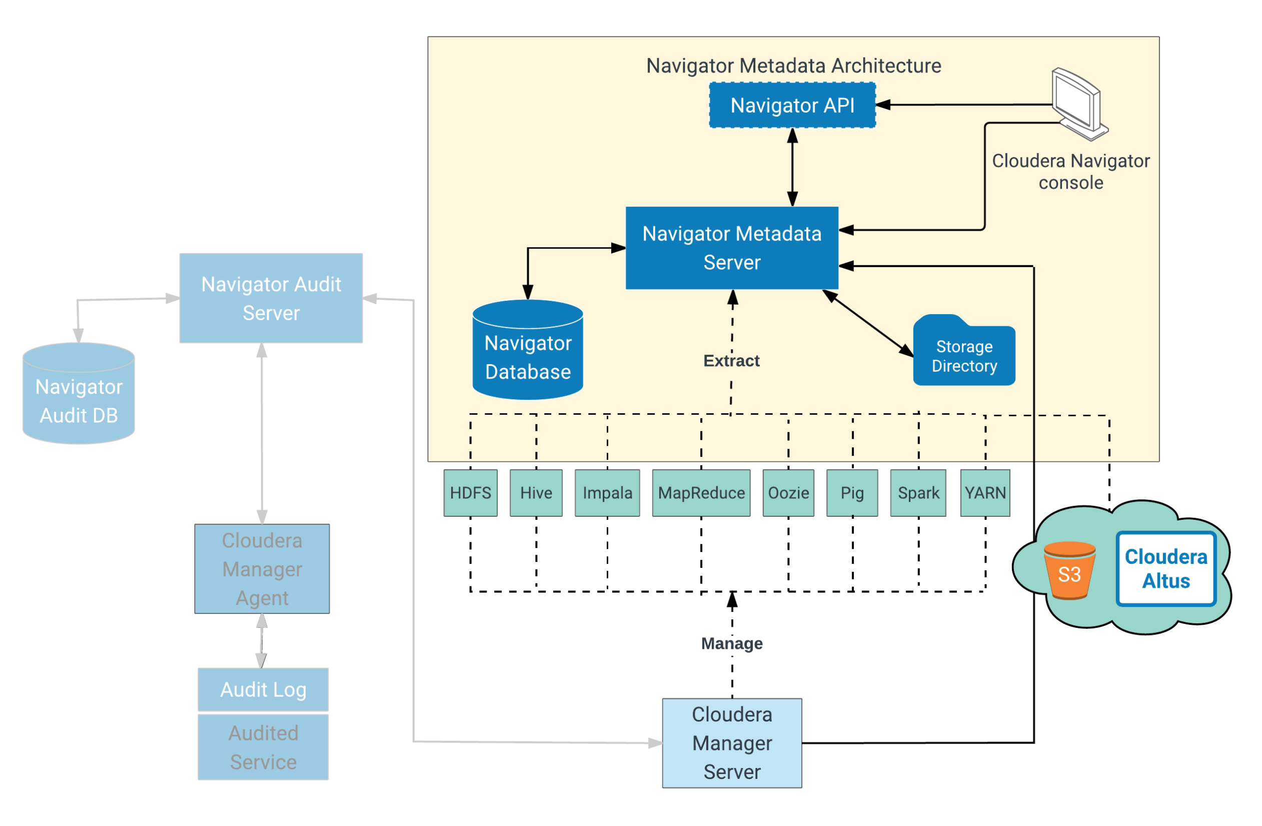
Navigator Metadata Server Management

The Navigator Metadata Server is one of the two roles that provides Cloudera Navigator data management functionality. The Navigator Metadata Server manages, indexes, and stores entity metadata extracted from cluster services. Using policies defined by data stewards and others, the Navigator Metadata Server can tag entities with metadata or take other actions during the extraction process. It is the metadata that enables data discovery and data lineage functions for Cloudera Navigator.

This section starts with an overview of the Navigator Metadata Server system architecture and then covers administrator tasks that require Cloudera Manager Admin Console such as adding the Navigator Metadata Server role to an existing cluster, tuning for optimal performance, and setting up the LDAP or Active Directory groups to use Cloudera Navigator role-based access privileges.

Navigator Metadata Architecture

The figure below shows a high-level view of the key components that make up the Cloudera Navigator Metadata Architecture. Extracting, indexing, and storing metadata from cluster entities, both on-premises and in the cloud, are some of the important processes implemented by this architecture. As shown in the figure below, Cloudera Navigator can also extract metadata from entities stored on cloud services (Amazon S3) and from clusters running on Amazon EC2 or Cloudera Altus.



Organizations use the Cloudera Navigator console to define their own managed metadata properties to apply to entities contained in the cluster. The Navigator Metadata Server periodically connects to the Cloudera Manager Server and extracts metadata from the entities CDH services (HDFS, Hive, Impala, and so on).

Note: Not all services are shown in the image above (for example, Sqoop1).

As it extracts metadata, the Navigator Metadata Server can also apply any policies that have been configured.

For example, a policy may specify that all Hive table entities with table name `budget_2017` be tagged with the managed metadata property name *finance-team*, or that any entities with a file creation date (technical metadata) prior to 2014 be labeled with the prefix *archive-yyyy*, with the specific year obtained from the file creation date and applied to the label.

Extracted metadata is then indexed for later search using the embedded Solr instance. Solr Documents that comprise the index are stored on disk in the storage directory at the location configured in Cloudera Manager Admin Console for the Navigator Metadata Server datadir. See Services Supported for Metadata Extraction on page 104 for more detail.

The Navigator Metadata Server also:

- Manages authorization data for Cloudera Navigator users
- Manages audit report metadata
- Generates metadata and audit analytics
- Exposes the Cloudera Navigator APIs
- Hosts the web server that provides the Cloudera Navigator console. (The web server and the console are also used to support the Cloudera Navigator Auditing services.)

The Navigator Database stores policies, user authorization and audit report metadata, and analytic data. Extracted metadata and the state of extractor processes is kept in the storage directory.

Services Supported for Metadata Extraction

The Navigator Metadata Server extracts metadata for the resource types listed in the table. Metadata is "pulled" by Navigator Metadata Server or "pushed" from the service through the Cloudera Manager agent on the host where the service is running.

Resource Type	Metadata Extracted	Extraction Method
HDFS	HDFS metadata at the next scheduled extraction run after an HDFS checkpoint. If the cluster is configured for high availability (HA), metadata is extracted at the same time it is written to the JournalNodes.	Pull
Hive Server 2	Query metadata is pushed to Navigator as queries occur. See Managing Hive and Impala Lineage Properties.	Push
Hive Metastore	Database asset metadata (database, tables, views, partitions, columns). See Managing Hive and Impala Lineage Properties. HMS entities include tables that result from Impala queries and Sqoop jobs.	Pull
Impala	Query metadata is pushed to Navigator from the Impala Daemon lineage logs. See Managing Hive and Impala Lineage Properties.	Push
MapReduce	Job metadata from the JobTracker. The default setting in Cloudera Manager retains a maximum of five jobs; if you run more than five jobs between Navigator extractions, the Navigator Metadata Server extracts the five most recent jobs.	Pull
Oozie	Oozie workflows from the Oozie Server.	Pull
Pig	Pig script runs from the JobTracker or Job History Server.	Pull
S3	Bucket and object metadata.	Pull
Spark	Query metadata is pushed to Navigator as queries occur. Spark job metadata from YARN logs is pulled as part of the YARN extractor. Note that Spark 1. 6, which is included with CDH, and CDS 2 Powered by Apache Spark include integration with Navigator. Third-party versions of Spark do not produce metadata for Navigator lineage.	Push
Sqoop 1	Query metadata is pushed to Navigator as queries occur. Database and table metadata comes from the HMS extraction.	Push
YARN	Job metadata from the ResourceManager.	Pull

Metadata Extraction Timing

The two types of Navigator extractors have different timing: Push extractors send metadata to Navigator after each event that generates metadata (Hive Server 2, Impala, Spark, Sqoop). Pull extractors run about every 10 minutes, when Navigator Metadata Server triggers them (Oozie, YARN, HDFS, HMS, S3). When the 10 minute mark comes around for a given service, Navigator checks to see if an extraction process is already running; if one is, Navigator resets the wait time without starting another extraction. Extractors for different services typically run simultaneously, inserting new metadata into Navigator in a regular cadence. However, extractor behavior and timing for HMS and HDFS can be more complicated because of the volume of metadata they collect in a single extractor run.

HMS Extraction

Navigator extracts metadata from Hive Metastore (HMS) through a pull extractor where Navigator Metadata Server triggers the extraction. Every time Navigator extracts HMS metadata, it reviews all databases for all data assets: tables, views, partitions, etc. There is no incremental extraction from HMS. When your HMS includes many databases and lots of assets, the extraction can take a long time: certainly more than the 10 minute extraction interval.

As it progresses through the extraction, Navigator creates new entities for any data assets that aren't already represented in Navigator.

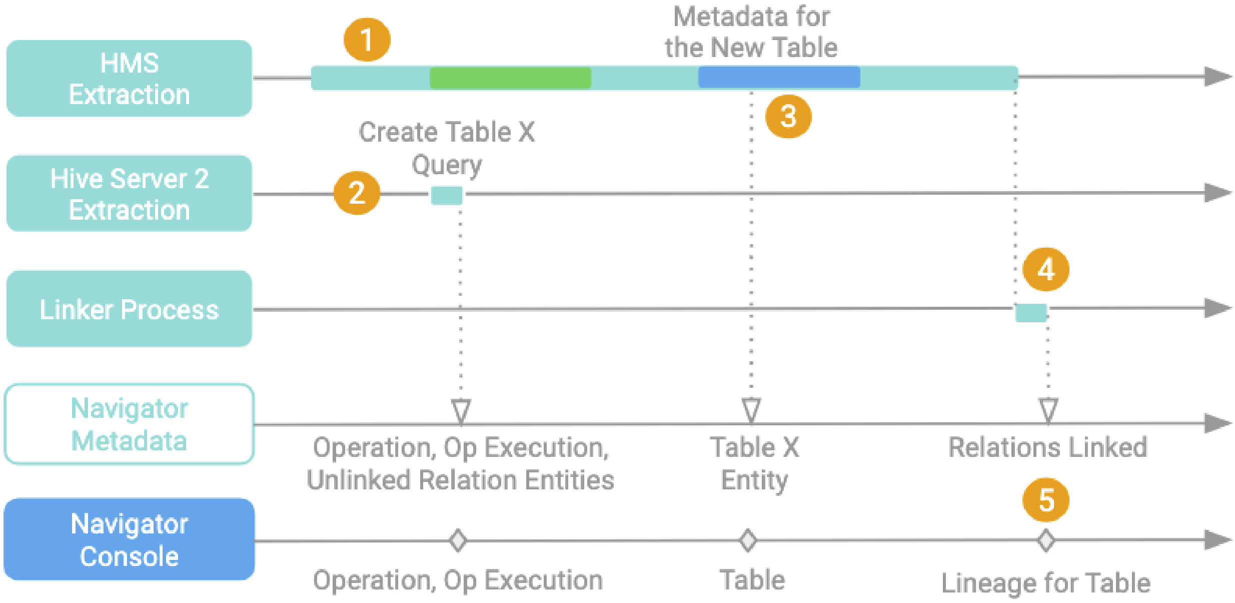
HDFS Extraction

Navigator extracts metadata for HDFS from the namenode. After the initial extraction, Navigator users iNotify to extract changes to HDFS contents rather than re-extracting all entities again. The initial HDFS extraction process still requires a long period; subsequent extractions may be more likely to conform to the 10-minute pattern. If Navigator encounters an a iNotify failure, it will fall back to bulk extraction.

Calculating Lineage from Metadata

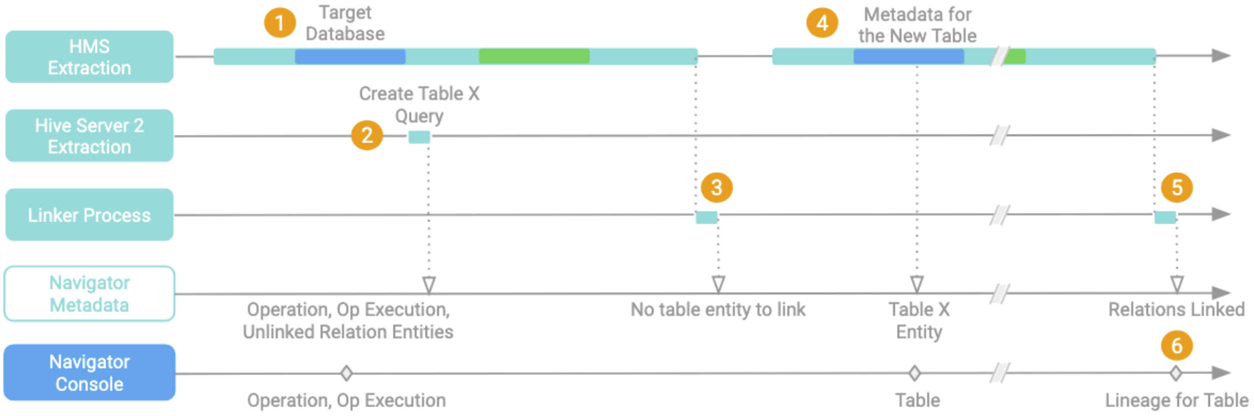
As described in detail in Lineage Generation Architecture on page 66, lineage is generated when Navigator combines the metadata for data assets (such as file, tables, views) with the metadata for operation executions (queries and jobs). Tables and views come from HMS extraction, while operation executions come from push extractors for Impala, Hive Server 2, Spark, YARN, and Sqoop. If any of the metadata is missing (not extracted yet), lineage relationships aren't calculated or displayed. For lineage relationships to be displayed completely, Navigator must have completed extraction from each of the services involved and then it must run a lineage calculation process called "linking."

To understand the timing of how metadata and lineage relationships become available in the Navigator console, consider the pull extractor for HMS and a push extractor from Hive Server 2 as they run independently. Lineage metadata, which requires metadata from both HMS and a query engine, appears in the Navigator console only after both extraction operations are complete and the linker process runs. The following illustration describes the timing for each of the processes that must complete for lineage to appear in the console:



1. HMS Extraction is a long-running process that steps through HMS one database at a time.
2. Query engines such as Hive Server 2 push metadata updates to Navigator as soon as an event occurs: In this example, a query that creates table X is pushed to Navigator and Navigator creates an operation entity and an operation execution entity to represent the query. Navigator creates lineage relationship entities for the new table, but the relationships are left "unlinked" because the new table doesn't yet exist in Navigator.
3. The HMS extraction gets to the database where the table was created and passes the metadata to Navigator, which creates a new entity for the table.
4. After the HMS extraction finishes, Navigator triggers a linker process that reviews the "unlinked" lineage relations and connects them to the correct entities. Now the table created in step 2 is included in the lineage relationship created to describe the query.
5. Lineage for the new table appears in the Navigator console.

Note that step 3 is a variable here: it's possible that the HMS extraction run may have already processed the relevant database (1) before the query occurred (2). In that case, the HMS extraction would complete and linking would run (3), but there would not be an entity in place for the new table. Lineage for the new table doesn't appear until the next HMS extraction run reaches the relevant database (4) to create the table entity; then linking runs at the end of the HMS extraction (5) and adds the correct lineage information (6).



Troubleshooting

If Navigator is missing entities for:

- Queries: check the push extractor processing. The Navigator logs won't show any problems in this case. Instead, check the Cloudera Manager agent log on the host where the suspect service is running.
- Data asset entities: check the HMS pull extractor processing in the Navigator Metadata Server log.
- Filesystem entities: check the HDFS or S3 extractor processing in the Navigator Metadata Server log.

If Navigator is missing lineage, make sure that Navigator shows the entities for both the data assets and the queries that describe the lineage; then give enough time for the lineage processing to complete. If you still don't see lineage relations, check to make sure the linker is running (in the Navigator Metadata Server log). If HMS extraction never completes, you may see metadata for some data assets, but the linking process may not have been triggered. Check the Navigator Metadata Server log.

The pull extraction frequency can be configured using `nav.extractor.poll_period` in the **Navigator Metadata Server Advanced Configuration Snippet (Safety Valve) for cloudera-navigator.properties** in Cloudera Manager. Note that lowering the polling period won't affect latency if your system has one of the problems described here.

To find pull extractor events in the Navigator Metadata Server log, look for "extraction tasks for service", then filter further on the specific services you are interested in. For example:

```
2019-04-15 20:15:58,858 INFO com.cloudera.nav.extract.CdhClientExtractionTask
[[ExtractorServiceExecutor-3] Cluster 1::HIVE-1]: Enqueuing 6 extraction tasks for
service 'Cluster 1::HIVE-1'...
2019-04-15 20:26:00,095 INFO com.cloudera.nav.extract.CdhClientExtractionTask
[[ExtractorServiceExecutor-3] Cluster 1::HIVE-1]: All cdh-client extraction tasks for
service 'Cluster 1::HIVE-1' finished.
2019-04-15 20:35:58,882 INFO com.cloudera.nav.extract.CdhClientExtractionTask
[[ExtractorServiceExecutor-7] Cluster 1::HIVE-1]: Enqueuing 6 extraction tasks for
service 'Cluster 1::HIVE-1'...
2019-04-15 20:56:00,541 INFO com.cloudera.nav.extract.CdhClientExtractionTask
[[ExtractorServiceExecutor-7] Cluster 1::HIVE-1]: All cdh-client extraction tasks for
service 'Cluster 1::HIVE-1' finished.
2019-04-15 21:05:59,117 INFO com.cloudera.nav.extract.CdhClientExtractionTask
[[ExtractorServiceExecutor-4] Cluster 1::HIVE-1]: Enqueuing 6 extraction tasks for
service 'Cluster 1::HIVE-1'...
```

In this example, it took 10 minutes to finish the first extraction (20:26:00 - 20:15:58). Navigator waited 10 minutes to start the second extraction (20:35:58). The second extraction took 20 minutes to finish (20:56:00 - 20:35:58). The third extraction started 10 minutes after the second one finished (21:05:59), a total of 30 minutes after the start time of the second extraction.

Metadata Indexing

After metadata is extracted, the embedded Solr engine indexes it and makes it available for searching. The Solr instance indexes entity properties and the relations among entities. Relationship metadata is implicitly visible in lineage diagrams and explicitly available by downloading the lineage using the Cloudera Navigator APIs.

Data stewards and other business users explore entities of interest using the Cloudera Navigator console. Metadata and lineage that has been extracted, linked, and indexed can be found using Search. See Lineage, Metadata and other sections in this guide for Cloudera Navigator console usage information. The following sections focus on using the Cloudera Manager Admin Console for systems management tasks.

Setting Up Navigator Metadata Server

In addition to the basic configuration topics discussed below, see Navigator Metadata Server Tuning for memory sizing and other considerations.

Setting up Navigator Role Instances on Different Hosts

By default, the Cloudera Manager installation wizard assigns the Navigator Audit Server and Navigator Metadata Server roles to the same Cloudera Management Service host. This configuration can support small clusters but larger production clusters often need these roles distributed to different nodes for better performance. You can distribute these roles to different nodes at install time or you can move the Navigator Metadata Server later if necessary.

Adding the Navigator Metadata Server Role

Cloudera Manager Required Role: Navigator Administrator (or **Full Administrator**)

1. Configure the database where policies, roles, and audit report metadata is stored. For production environments, Cloudera supports only external databases. The internal PostgreSQL database should be used for non-production clusters only, such as proof-of-concept.

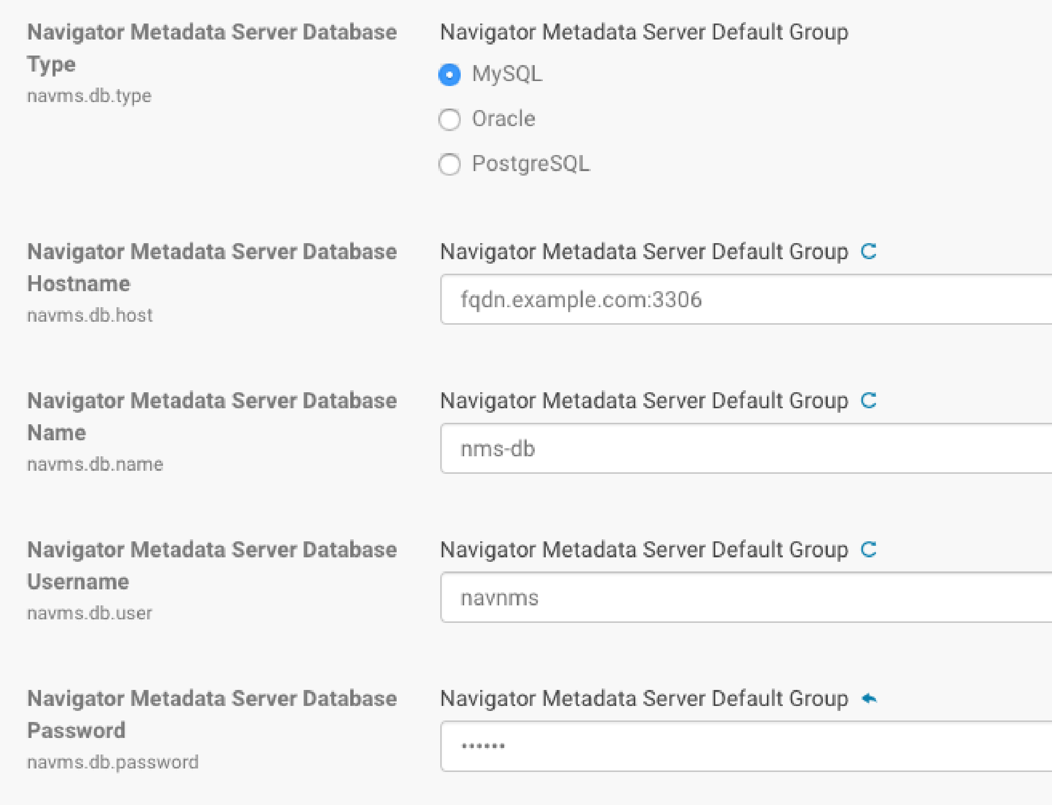
    - For external databases (production environments): The database should be up and running before you add the Navigator Metadata Server role to the cluster. You must have the database schema name (user name), password, and other details to provide when adding the role. When you have these ready, you can proceed.
    - For internal databases (non-production environments): No additional preliminary information is needed. You can proceed.

2. Log in to the Cloudera Manager Admin Console.
3. Select **Clusters** > **Cloudera Management Service**.
4. Click the **Instances** tab.
5. Click the **Add Role Instances** button. The Customize Role Assignments page displays and lists the nodes available to support additional roles, assuming the cluster has available resources. Reassign and customize role instances as needed.
6. Select the **Navigator Metadata Server** role and assign it to appropriate host for your cluster.
7. When finished, click **Continue**. The Database Setup page displays.
8. Click **Use Custom Database**.
9. In the **Navigator Metadata Server** section, enter the details of your database instance:

    - Database host name
    - Database type
    - Database name
    - Username
    - Password

> **Note:** Do not use the embedded database for production deployments. It is not a supported configuration. For non-production environments only you can select Use Embedded Database to have Cloudera Manager create and configure the database for you. Make a note of the generated passwords.

Here is an example of a configured custom (external) database instance that uses MySQL for the Navigator Metadata Server database:



Navigator Metadata Server Database Type
navms.db.type
Navigator Metadata Server Default Group
● MySQL
○ Oracle
○ PostgreSQL

Navigator Metadata Server Database Hostname
navms.db.host
Navigator Metadata Server Default Group
fqdn.example.com:3306

Navigator Metadata Server Database Name
navms.db.name
Navigator Metadata Server Default Group
nms-db

Navigator Metadata Server Database Username
navms.db.user
Navigator Metadata Server Default Group
navnms

Navigator Metadata Server Database Password
navms.db.password
Navigator Metadata Server Default Group
••••••

10. Click **Test Connection** to verify the communication between the cluster and the external database. If the test fails, check the database settings and try again. If you selected embedded database, a message displays regarding database creation.
11. Click **Continue**.
12. The **Cluster Setup Review Changes** page displays.
13. Click **Finish**.

Removing the Navigator Metadata Server Role

Cloudera Manager Required Role: **Navigator Administrator** (or **Full Administrator**)

1. Log in to the Cloudera Manager Admin Console.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Instances** tab.
4. Select the Navigator Metadata Server role type.
5. If the Navigator Metadata Server role is not already stopped, choose **Actions for Selected** > **Stop**.

   Click **Stop** to confirm the action.
6. Select the Navigator Metadata Server role type.
7. Choose **Actions for Selected** > **Delete**.

   Click **Delete** to confirm the action.

Starting, Stopping, and Restarting a Navigator Metadata Server Role Instance

Cloudera Manager Required Role: **Navigator Administrator** (or **Full Administrator**)

1. Log in to the Cloudera Manager Admin Console.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Instances** tab.
4. Click the link for the **Navigator Metadata Server** from the Role Type list. The Actions for Selected button activates and displays (1) for the selected role.
5. From the **Actions for Selected (1)** menu, select the ***Action*** you want to perform on this role instance:

   - Start
   - Stop
   - Restart
   - Enter Maintenance Mode
   - Exit Maintenance Mode
   - Delete

   A confirmation message displays giving you the option to **Cancel** or complete the specified ***Action***.
6. Click Cancel to abandon the process, or click ***Action*** to execute the action.

Backup Navigator Metadata Server Data

Navigator Metadata Server stores metadata in an embedded Solr data directory and in a database instance. Back up these locations together so the backups describe the same metadata state.

1. Shut down the Navigator Metadata Server role.
2. Backup the data directory.

   The Navigator Metadata Server default directory is `/var/lib/cloudera-scm-navigator`. To confirm that this is the path your deployment uses, log in to the Cloudera Manager Admin Console and search for the **Navigator Metadata Server Storage Dir** property (`nav.data.dir`).

3. Backup the database instance.

   - Confirm the Navigator Metadata Server database location and connection information.

     To locate this information, log in to the Cloudera Manager Admin Console and go to **Clusters** > **Cloudera Management Service**. Click the **Configuration** tab. Select **Scope** > **Navigator Metadata Server**. Select **Category** > **Database**. The results indicate the type, host, database name, and login account.

   - Using the appropriate tool for the database instance (such as MySQL), backup the database. See Backing up Cloudera Manager.

4. Start the Navigator Metadata Server role.

Moving the Navigator Metadata Server to a New Host

Cloudera Manager Required Role: **Navigator Administrator** (or **Full Administrator**)

When resources become tight on the host where Navigator servers are installed, one solution is to move one or both servers to another host or hosts. These instructions describe moving only the Navigator Metadata Server. Be sure to stop the Navigator Metadata Server before backing up the storage directory.

1. Stop the Navigator Metadata Server role.
2. Backup the Navigator Metadata Server database and storage directory.
3. Delete the Navigator Metadata Server role from the existing host.
4. If the storage directory is not on NFS/SAN, move the data to the same path on the new host.

   By default, the Navigator Metadata Server storage directory is `/var/lib/cloudera-scm-navigator`. This value is set in the Cloudera Manager**Navigator Metadata Server Storage Dir** property (`nav.data.dir`). If you want to put the directory in a different location, change the property when you reconfigure the Navigator Metadata Server role and before you restart the role.

5. Add the role to a new host.

   This step includes configuring the new storage directory location and specifying the database connection information. See Adding the Navigator Metadata Server Role on page 107 for details.

6. Make sure the Navigator Metadata Server storage directory is configured correctly for the new host. See Configuring the Navigator Metadata Server Storage Directory on page 111.

> **Important:** Make sure that the storage directory is in place and the Cloudera Manager configuration is correct before starting the Navigator Metadata Server role on the new host. If Navigator Metadata Server starts without finding the storage directory, it will create a new one, which will not be synchronized with the database and the move will fail. If this happens, stop the server, replace the newly created storage directory with the backup from step 2 and restart the server.

7. Start the Navigator Metadata Server role.

Setting the Navigator Metadata Server Java Heap Size

Cloudera Manager Required Role: Navigator Administrator (or **Full Administrator**)

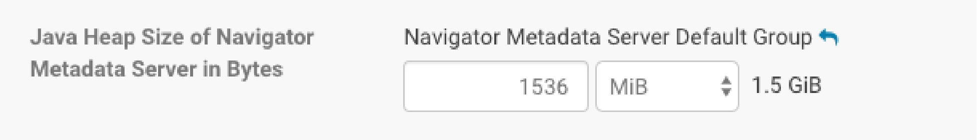
Use the formula discussed in Memory Sizing Considerations for Navigator Metadata Server to calculate optimal Java heap size:

```
(num_nav_elements * 200 bytes) + 2 GB
```

Briefly, the total of *num_nav_elements* is the number of Solr element documents (per the Navigator Metadata Server log file) that comprise the index. See sizing guidelines for complete details. If you are just starting your Navigator deployment, set the Java heap size to at least 10 GB and as much as 30 GB if you have the memory available on the Navigator host.

After you have determined an appropriate Java heap setting using this or another technique, you can change the setting as follows:

1. Log in to the Cloudera Manager Admin Console.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Select **Scope** > **Navigator Metadata Server**.
5. For Filter **Category**, click **Resource Management** to display the Java heap size property. The default value is 1.5 GiB (specified in binary units).



Java Heap Size of Navigator Metadata Server in Bytes

Navigator Metadata Server Default Group

1536 MiB 1.5 GiB

6. Use the drop-down selector to change the unit scale to B (Bytes), KiB, MiB, or GiB and set your preferred heap size.
7. Click **Save Changes**. The setting takes effect only after restarting the role. Restart the Navigator Metadata Server role now or make other configuration changes and restart after you are finished with all changes. To restart the role:
8. Click the **Instances** tab to display list the list of instances of each role type.
9. Click the link for the **Navigator Metadata Server** to select it.
10. From the **Actions for Selected (1)** menu, select **Restart** to restart the Navigator Metadata Server role instance using the new Java heap size.

Configuring the Navigator Metadata Server Storage Directory

Cloudera Manager Required Role: Navigator Administrator (or **Full Administrator**)

Navigator Metadata Server uses a Solr instance (a search engine) to index extracted metadata for fast search and retrieval. The searchable Solr documents are stored in a directory on the host on which the Navigator Metadata Server runs. The default location for the directory is `/var/lib/cloudera-scm-navigator`.

To change the location of the storage directory:

1. Log in to the Cloudera Manager Admin Console.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Instances** tab.
4. Click the link for the **Navigator Metadata Server** to select it.
5. From the **Actions for Selected (1)** menu, select **Stop**.
6. Open a terminal session and log in to the host configured to run Navigator Metadata Server.
7. Copy the contents of the current storage directory to the new location. When copying is complete, return to the Cloudera Manager Admin Console.
8. Click the **Configuration** tab.
9. Select **Scope** > **Navigator Metadata Server**.
10. Enter the directory path in the **Navigator Metadata Server Storage Dir** property. The property applies to the default role group, but you can apply to other role groups as needed. See Modifying Configuration Properties Using Cloudera Manager for details.
11. Click **Save Changes**. This change does not take effect until the Navigator Metadata Server role is restarted.
12. Click the **Instances** tab.
13. Click the link for the **Navigator Metadata Server** from the list of instances.
14. From the **Actions for Selected** menu, select **Restart** to restart the Navigator Metadata Server role instance.

Configuring the Navigator Metadata Server Port

Cloudera Manager Required Role: Navigator Administrator (or **Full Administrator**)

The Cloudera Navigator console is accessed at port 7187 by default, on the host supporting the Navigator Metadata Server role. Follow the steps below to change setting.

1. Log in to the Cloudera Manager Admin Console.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. In the Search box, type the word "ports" to display properties.
5. Specify the port in the **Navigator Metadata Server Port** property. The property applies to the default role group, but you can apply to other role groups as needed. See Modifying Configuration Properties Using Cloudera Manager for details.
6. Click **Save Changes**.
7. Click the **Instances** tab.
8. Restart the Navigator Metadata Server role.

Configuring the Navigator Metadata Server Log Directory

Cloudera Manager Required Role: Navigator Administrator (or **Full Administrator**)

The default location of the Navigator Metadata Server logs is `/var/log/cloudera-scm-navigator`, but you can change to a different location, as follows:

1. Log in to the Cloudera Manager Admin Console.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Under the Filter for **Scope**, click **Navigator Metadata Server**.
5. Under Filter **Category**, click **Logs**.

6. Set the **Navigator Metadata Server Log Directory** property. The property applies to the default role group, but you can apply to other role groups as needed. See Modifying Configuration Properties Using Cloudera Manager for details.
7. Click **Save Changes**.
8. Restart the Navigator Metadata Server role instance.

Configuring the Navigator Metadata Server Session Timeout

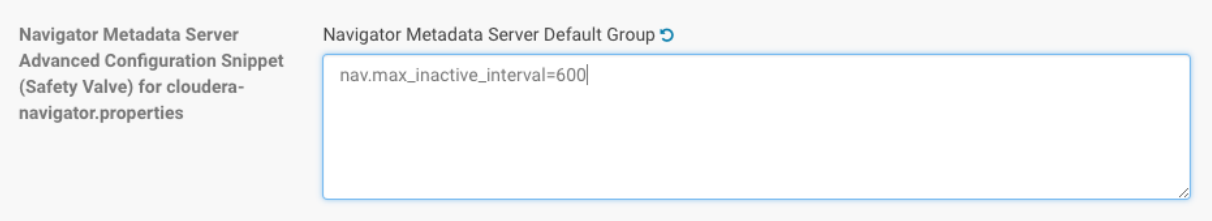
Cloudera Manager Required Role: **Navigator Administrator** (or **Full Administrator**)

The default session timeout is 30 minutes (1800 seconds). To change the timeout period:

1. Log in to the Cloudera Manager Admin Console.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Under the Filter for **Scope**, click **Navigator Metadata Server**.
5. For Filter **Category**, click **Advanced.** Scroll to find the Advanced Configuration Snippet (Safety Valve) entry field for **cloudera-navigator.properties**.
6. Set the value for the `nav.max_inactive_interval` property to the number of seconds that can elapse before system times out:

```
nav.max_inactive_interval=num-seconds-until-timeout
```

This example reduces the timeout period from the default of 30 minutes to 15 minutes:



Navigator Metadata Server Advanced Configuration Snippet (Safety Valve) for cloudera-navigator.properties

Navigator Metadata Server Default Group

```
nav.max_inactive_interval=600
```

7. Click **Save Changes**.
8. Restart the Navigator Metadata Server role instance.

Disabling Anonymous Usage Collection

Cloudera Manager Required Role: **Navigator Administrator** (or **Full Administrator**)

Cloudera Navigator by default sends anonymous usage information to Cloudera for analysis. The usage information helps Cloudera improve Cloudera Navigator functionality and pro-actively identify areas of the product to enhance. The information is completely anonymous and cannot be traced to any customer installation.

To disable anonymous usage information collection:

1. Log in to the Cloudera Manager Admin Console.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Under the Filter for **Scope**, click **Navigator Metadata Server**.
5. Click the **Allow Usage Data Collection** to clear the checkbox.
6. Click **Save Changes**.
7. Restart the Navigator Metadata Server role instance.

Cloudera Navigator stops emitting anonymous usage information.

This capability can be re-enabled at any time by clicking the Allow Usage Data Collection box that has been cleared.

Configuring Navigator Metadata Server for Kerberos and Custom Keytab Retrieval

If Navigator is running on a Kerberized cluster and the cluster is set up to use a custom keytab retrieval script, you need to manually put keytabs for HDFS and Hue principals into the Navigator home directory (typically `/var/lib/cloudera-scm-navigator`) for use by the Navigator web server.

If the keytabs are not available, you'll see Navigator Metadata Server log errors such as the following:

```
Error running extraction task.
  java.lang.RuntimeException: java.util.concurrent.ExecutionException:
  java.lang.RuntimeException: java.io.IOException: Login failure for
hdfs/node.example.com@EXAMPLE.COM from keytab
/var/lib/cloudera-scm-navigator/temp/1234/hadoop1234.keytab:
  javax.security.auth.login.LoginException: Unable to obtain password from user
```

Navigator Metadata Server Configuration Settings Summary

Access to the Cloudera Manager Admin Console and the ability to change any of the settings in the table below requires the Cloudera Manager user role of Navigator Administrator or Full Administrator.

Property	Default	Usage
Java Heap Size of Cloudera Navigator Metadata Server in Bytes	1536 MiB (1.5 GiB)	Increase Java heap size temporarily during an upgrade. Increase Java heap size for large Solr indexes. See Estimating Optimal Java Heap Size Using Solr Document Counts for details.
Navigator Metadata Storage Dir	/var/lib/cloudera-scm-navigator	Change to another path if you like. Be sure to move existing content from the default directory to the new directory to maintain state. Offload content from this directory prior to upgrading for faster upgrades.
Cloudera Navigator Server Port	7187	Change to another port if necessary. This is the port used to access Cloudera Navigator console.
Navigator Metadata Server Log Directory	/var/log/cloudera-scm-navigator	Examine the log to find out how many documents the Solr index contains, and use that count to estimate Java heap size needed for normal operations and for upgrades. Use the log to troubleshoot issues.
Server Session Timeout	30 minutes (1800 seconds)	Timeout is specified in number of seconds that must elapse before the system generates a timeout event.
Allow Usage Data Collection	enabled	Cloudera Navigator uses Google Analytics to anonymous usage data to Cloudera for product enhancement. Disable this setting if you do not want to send usage data.

Navigator Metadata Server Tuning

This page can help you tune your Navigator Metadata Server instance for peak performance. See also Setting up Navigator Role Instances on Different Hosts.

Memory Sizing Considerations for Navigator Metadata Server

Unlike Navigator Audit Server for which configured Java heap size is rarely an issue, Navigator Metadata Server encompasses two processes that have a direct impact on memory, specifically:

- Extracting metadata from the cluster and creating relationships among the metadata entities (facilitating lineage)
- Querying to find entities

Navigator Metadata Server uses Solr to index, store, and query metadata. Indexing occurs during the extraction process, with the resulting Solr documents—data structure used by Solr for index and search—stored in the specified Navigator

Metadata Server Storage Dir. Because the metadata is indexed, querying is fast and efficient. However, Solr indexing runs in-process with Navigator Metadata Server, so the amount of memory configured for the Java heap is critical.

There is a direct correlation between the number of Solr documents contained in the index and the size of the Java heap required by Navigator Metadata Server, so this setting may need to be changed over time as the number of Solr documents making up the index increases. To calculate optimal Java heap setting for your system, see Estimating Optimal Java Heap Size Using Solr Document Counts.

Estimating Optimal Java Heap Size Using Solr Document Counts

Each time it starts up, Navigator Metadata Server counts and logs the number of Solr documents in the datadir (the Navigator Metadata Server storage directory), as shown below:

```
2016-11-11 09:24:58,013 INFO com.cloudera.nav.server.NavServerUtil:
  Found 68813088 documents in solr core nav_elements
2016-11-11 09:24:58,705 INFO com.cloudera.nav.server.NavServerUtil:
  Found 78813930 documents in solr core nav_relations
```

These counts can be used to estimate optimal Java heap size for the server, as detailed below. If your normal setup provides less than 8 GB for the Navigator Metadata Server heap, consider increasing the heap before performing an upgrade. See Setting the Navigator Metadata Server Java Heap Size for details about using Cloudera Manager Admin Console to modify this setting when needed.

> **Note:** If your system has been running without interruption for awhile, the data in the log may be stale. Restart the Navigator Metadata Server when it is convenient and then look at the log to find the current number of documents to use in the calculation.

To estimate the Java heap size:

1. Open the log file for Navigator Metadata Server. By default, logs are located in `/var/log/cloudera-scm-navigator`.
2. Find the number of documents in `solr core nav_elements` line in the log.
3. Find the number of documents in `solr core nav_relations` line in the log.

> **Warning:** If the number of relations is more than 2 times the number of elements, you may have encountered the problem described by TSB-259 Upgrade needed for Cloudera Navigator due to high risk of failure through exhausting data directory resources. Follow the instructions for mitigating the problem rather than simply changing your Java heap.

4. Multiply the total number of element documents by 200 bytes per document and add to a baseline of 2 GB:

```
(num_nav_elements * 200 bytes) + 2 GB
```

For example, using the log shown above, the recommended Java heap size is ~14 GiB:

```
(68813088 * 200) + 2 GB
13762617600 bytes = ~12.8 GiB + 2 GB (~1.8 GiB) = ~ 14–15 GiB
```

> **Important:** If you are upgrading to a Cloudera Manager version 5.10.0 or later, you'll need considerably more Java heap to perform the upgrade. Upgrading to the 5.10 release includes the unusual performance of a schema change in Solr. This operation requires additional Java heap for the duration of the upgrade process. To calculate the recommended Java heap for the upgrade, multiply the total number of documents by 200 bytes per document and add to a baseline of 2 GB:
>
> ```
> ((num_nav_elements + num_nav_relations) * 200 bytes) + 2 GB
> ```
>
> For example, using the log shown above, the recommended Java heap size is ~31 GiB:
>
> ```
> ((68813088 + 78813930) * 200) + 2 GB
> 29525403600 bytes = ~29.5 GiB + 2 GB (~1.8 GiB) = ~ 31.3 GiB
> ```

Reducing the Metadata collected by Navigator Metadata Server

You can choose to leave some file system paths out of the scope of information tracked in Cloudera Navigator. Cloudera Manager provides a blacklist where you can specify file systems paths that should be filtered out of metadata extracted from HDFS and S3.

To filter file system paths from tracked metadata:

1. Log in to Cloudera Manager Admin Console.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Select **Navigator Metadata Server** for the **Scope** filter.
5. Select **Extractor Filter** for the **Category** filter.
6. Enable the filter:

   - **HDFS Filter Enable**
   - **S3 Filter Enable**

7. In the appropriate filter list, include the file system path that you want to exclude from Navigator Metadata Server tracking:

   - **HDFS Filter Blacklist**
   - **S3 Filter list**

   The entry can be a specific path or a Java regular expression specifying a path. For example, to specify a directory and all subdirectories, use an expression such as

```
/path/to/dir(?:/.*)?
```

8. Enter additional entries in the filter list by clicking ⊞ to open another entry.
9. For S3, set the **S3 Filter Default Action** to DISCARD.
10. Click **Save Changes**.
11. Click the **Instances** tab.
12. Restart the role.

Navigator Heap Size calculations:

- Normal operation

```
(num_nav_elements * 200 bytes) + 2 GB
```

- Upgrade between CM 5.9 and 5.10

```
((num_nav_elements + num_nav_relations) * 200 bytes) + 2 GB
```

Purging the Navigator Metadata Server of Deleted and Stale Metadata

Administrators can manage the Java heap requirements by clearing the Navigator Metadata Server of stale and deleted metadata prior to an upgrade or whenever system performance seems slow. Purging stale and deleted metadata also helps speed up display of lineage diagrams. Purge fully removes metadata that has been deleted.

For Cloudera Navigator 2.11 (and higher) releases—Cloudera Navigator console (**Administration** tab) provides a fully configurable **Purge Settings** page. See Managing Metadata Storage with Purge for details.

For Cloudera Navigator 2.10 (and prior releases)—The Purge capability can be directly invoked using the Cloudera Navigator APIs. See Using the Purge APIs for Metadata Maintenance Tasks for details.

Hive and Impala Lineage Configuration

Cloudera Manager Required Role: Configurator (or **Cluster Administrator**, or **Full Administrator**)

Unlike for other services running in the cluster (such as Pig), lineage data from Hive and Impala queries is not extracted by Navigator Metadata Server. Instead, these two services write query data to log files collected in a specific directory on the cluster node. The Cloudera Manager Agent process running on that node monitors the directory and routinely sends the log files to the Navigator Metadata Server, where the query data is coalesced with other metadata collected by the system.

Lineage collection from Hive and from Impala log files is enabled by default—each of these services has its own **Enable Lineage Collection** property and some related configuration properties, which can be disabled or reconfigured as detailed below.

Modifying Lineage Collection Settings for Hive

Property	Default	Description
Enable Lineage Collection	Enabled for Hive, Service-Wide	Enable collection of lineage from the service's roles.
Hive Lineage Log Directory (lineage_event_log_dir)	/var/log/hive/lineage	Directory in which Hive lineage log files are written.
Hive Maximum Lineage Log File Size (max_lineage_log_file_size)	100 MiB	Maximum size (MiB, GiB) of Hive lineage log file before a new file is created.

To disable Hive lineage collection:

control whether the Impala Daemon role logs to the lineage log and whether the Cloudera Manager Agent collects the Hive and Impala lineage entries:

1. Log in to Cloudera Manager Admin Console.
2. Select **Clusters** > **Hive**.
3. Click the **Configuration** tab.
4. Type `lineage` in the Search box.
5. Click the **Enable Lineage Collection** check-box to deselect it and disable lineage collection.
6. Click **Save Changes**.
7. Restart the Hive service.

Modifying Lineage Collection Settings for Impala

Property	Default	Description
Enable Impala Lineage Generation (enable_lineage_log)	Enabled for the Impala daemon default group	When enabled, Impala daemon process creates a logfile containing lineage data and stores it in the directory specified by the Impala Daemon Log Lineage Directory property.

Property	Default	Description
Enable Lineage Collection	Enabled for Impala Service-Wide	Enable collection of lineage from the service's roles.
Impala Daemon Lineage Log Directory (lineage_event_log_dir)	`/var/log/impalad/lineage`	Directory in which Impala daemon lineage log files are written. When Impala Lineage Generation property is enabled, Impala generates its lineage logs in this directory.
Impala Daemon Maximum Lineage Log File Size (max_lineage_log_file_size)	5000	Maximum number of Impala daemon lineage log file entries (queries) written to file before a new file is created.

The **Enable Lineage Collection** property determines whether lineage logs should be collected by the Cloudera Manager Agent. To control whether the Impala Daemon role logs to the lineage log and whether the Cloudera Manager Agent collects the Hive and Impala lineage entries:

To disable lineage collection for Impala queries:

1. Log in to Cloudera Manager Admin Console.
2. Select **Clusters** > **Impala**.
3. Click the **Configuration** tab.
4. Type `lineage` in the Search box.
5. Click the **Enable Lineage Collection** check-box to deselect it and disable lineage collection.
6. Click the **Enable Impala Lineage Generation** check-box to deselect it.
7. Click **Save Changes**.
8. Restart the Impala service.

De-selecting either Enable Lineage Collection or Enable Impala Lineage Generation disables lineage collection for Impala.

Configuring Hive on Spark and Impala Daemon Lineage Logs

If the value of a log directory property is changed, and service is restarted, the Cloudera Manager Agent starts monitoring the new log directory. In this case it is possible that not all events are published from the old directory. To avoid losing lineage information when this property is changed, perform the following steps:

1. Stop the affected service.
2. Copy the lineage log files and (for Impala only) the `impalad_lineage_wal` file from the old log directory to the new log directory. This needs to be done on the HiveServer2 host and all the hosts where Impala Daemon roles are running.
3. Start the service.

To edit lineage log properties:

1. Go to the service.
2. Click the **Configuration** tab.
3. Type `lineage` in the Search box.
4. Edit the lineage log properties.
5. Click **Save Changes**.
6. Restart the service.

Configuring and Managing Extraction

Entities extracted from cluster services and the metadata that is applied to them supports Cloudera Navigator features, such as the ability to trace entities to their source in lineage diagrams, search for specific entities, and so on. Extraction is enabled for some services by default, while for other services, extraction must be specifically enabled. For example, extraction is enabled for Spark by default. Extraction consumes computing resources, such as memory and storage, so administrators may want to disable extraction for some services entirely, or configure more selective extraction for specific services.

In addition to configuring extraction for specific services, specific filters can be configured to blacklist specific HDFS paths to remove them from the extraction process which both speeds up the process and cuts down on indexing time, as well as the amount of storage consumed by the datadir. Filters can also be configured to blacklist or whitelist Amazon S3 buckets.

> **Note:** To ensure that the extraction process runs optimally, data stewards should regularly delete metadata for entities no longer needed. Deleting metadata should be followed by using the purge function, which cleans the datadir of Solr documents associated with the deleted entities. Using purge on a regular basis facilitates fast search and noise-free lineage diagrams.

Cloudera Manager Required Role: Navigator Administrator (or **Full Administrator**)

Enabling Hive Metadata Extraction in a Secure Cluster

To extract entities from Hive, the Navigator Metadata Server authenticates to the Hive metastore using the hue user account. By default the hue user has privileges and can log in to the Hive metastore for authentication. That means that if the Hive metastore configuration was changed from the defaults, user hue may not be able to authenticate and the Navigator Metadata Server will be prevented from extracting from Hive. The specific configuration properties are the following two, which work together for authentication for Hive:

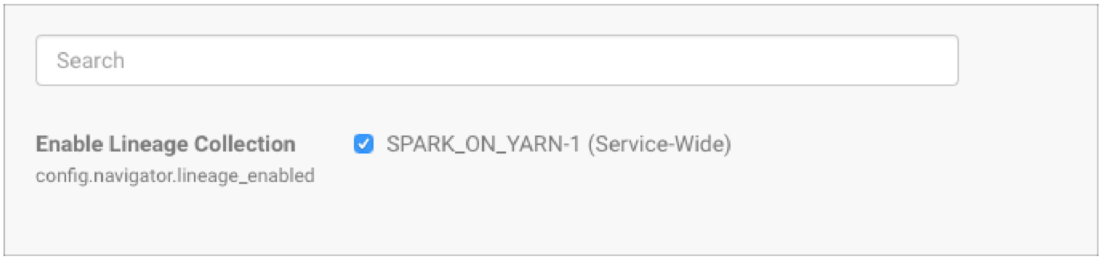
- Hive Metastore Access Control and Proxy User Groups Override (Inherits from Hive Proxy User Groups when left empty (the default)
- Hive Proxy User Groups

1. Log in to Cloudera Manager Admin Console.
2. Select **Clusters** > **Hive-1**.
3. Click the **Configuration** tab.
4. Select **Proxy** for the **Category** filter.
5. Add hue to the **Hive Metastore Access Control and Proxy User Groups Override** list if necessary:
   - Click the plus icon to open an entry field to add a row to the property.
   - Type **hue** in the entry field.
6. Click **Save Changes**, and repeat the process to add the Hive Proxy User Groups property on the HDFS server:
   - Select **Clusters** > **Hive-1**.
   - Click the **Configuration** tab.
   - Select **Proxy** for the **Category** filter.
   - Add hue to the **Hive Proxy User Groups** list by adding a row and typing **hue** in the entry field.
7. Click **Save Changes**.
8. Restart the Hive service.

Disabling Spark Metadata Extraction

Metadata and lineage for Spark is extracted by default (see Apache Spark Known Issues for limitations). To disable Spark metadata extraction:

1. Log in to Cloudera Manager Admin Console.
2. Select **Clusters** > **Spark_on_YARN-1**.
3. Click the **Configuration** tab.
4. Select **Cloudera Navigator** for the **Category** filter. The state of the Enable Lineage Collection feature displays, as in this example:



Enable Lineage Collection
config.navigator.lineage_enabled
☑ SPARK_ON_YARN-1 (Service-Wide)

5. To disable lineage collection, click the checked box.

Removing Manually Enabled Lineage Collection Property

Prior to Cloudera Navigator 2.10 (Cloudera Manager 5.11), enabling lineage collection from Spark required setting a safety valve. If the cluster was upgraded from a previous release of Cloudera Navigator and an Advanced Configuration Snippet (Safety Valve) was used to enable lineage, you must remove that snippet to avoid conflict with the new Enable Lineage Collection property. Using a safety valve to enable Spark metadata extraction has been deprecated.

> **Note:** Applies only to systems with safety valve configured to enable lineage collection from Spark prior to the default configuration provided in Cloudera Navigator 2.10.

To remove the deprecated safety valve setting:

1. Log in to the Cloudera Manager Admin Console.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Select **Navigator Metadata Server** for the **Scope** filter.
5. Select **Advanced** for the **Category** filter.
6. Scroll to the **Navigator Metadata Server Advanced Configuration Snippet (Safety Valve) for cloudera-navigator.properties** setting.
7. Remove any deprecated setting for Spark extraction, such as:

```
nav.spark.extraction.enable
```

8. Click **Save Changes**.
9. Restart the Navigator Metadata Server role.

Filtering File System Metadata

You can choose to leave some file system paths out of the scope of information tracked in Cloudera Navigator. Cloudera Manager provides a blacklist where you can specify file systems paths that should be filtered out of metadata extracted from HDFS and S3.

To filter file system paths from tracked metadata:

1. Log in to Cloudera Manager Admin Console.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Select **Navigator Metadata Server** for the **Scope** filter.
5. Select **Extractor Filter** for the **Category** filter.
6. Enable the filter:
   - **HDFS Filter Enable**
   - **S3 Filter Enable**
7. In the appropriate filter list, include the file system path that you want to exclude from Navigator Metadata Server tracking:
   - **HDFS Filter Blacklist**

- **S3 Filter list**

The entry can be a specific path or a Java regular expression specifying a path. For example, to specify a directory and all subdirectories, use an expression such as

```
/path/to/dir(?:/.*)?
```

8. Enter additional entries in the filter list by clicking ⊞ to open another entry.
9. For S3, set the **S3 Filter Default Action** to DISCARD.
10. Click **Save Changes**.
11. Click the **Instances** tab.
12. Restart the role.

Navigator Heap Size calculations:

- Normal operation

```
(num_nav_elements * 200 bytes) + 2 GB
```

- Upgrade between CM 5.9 and 5.10

```
((num_nav_elements + num_nav_relations) * 200 bytes) + 2 GB
```

Editing MapReduce Custom Metadata

You can associate custom metadata with arbitrary configuration parameters to MapReduce jobs and job executions. The configuration parameters to be extracted by Cloudera Navigator can be specified statically or dynamically.

To specify configuration parameters statically for all MapReduce jobs and job executions, do the following:

1. Log in to Cloudera Manager Admin Console.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Select **Navigator Metadata Server** for the **Scope** filter.
5. Select **Advanced** for the **Category** filter.
6. Scroll to find the **Navigator Metadata Server Advanced Configuration Snippet for cloudera-navigator.properties** and enter the custom
7. Specify values for the following properties:
   - `nav.user_defined_properties` - A comma-separated list of user-defined property names.
   - `nav.tags` - A comma-separated list of property names that serve as tags. The property `nav.tags` can point to multiple property names that serve as tags, but each of those property names can only specify a *single* tag.
8. Click **Save Changes**.
9. Click the **Instances** tab.
10. Restart the role.
11. In the MapReduce job configuration, set the value of the property names you specified in ste.

To specify configuration parameters dynamically:

1. Specify one or more of the following properties in a job configuration:
   - Job properties (`type:OPERATION`)
     - `nav.job.user_defined_properties` - A comma-separated list of user-defined property names
     - `nav.job.tags` - A comma-separated list of property names that serve as tags
   - Job execution properties (`type:OPERATION_EXECUTION`)

- `nav.jobexec.user_defined_properties` - A comma-separated list of user-defined property names
- `nav.jobexec.tags` - A comma-separated list of property names that serve as tags

The properties `nav.job.tags` and `nav.jobexec.tags` can point to multiple property names that serve as tags, but each of those property names can only specify a *single* tag.

2. In the MapReduce job configuration, set the value of the property names you specified in step 1.

Setting Properties Dynamically

Add the tags `onetag` and `twotag` to a job:

1. Dynamically add the `job_tag1` and `job_tag2` properties:

```
conf.set("nav.job.tags", "job_tag1, job_tag2");
```

2. Set the `job_tag1` property to `onetag`:

```
conf.set("job_tag1", "onetag");
```

3. Set the `job_tag2` property to `twotag`:

```
conf.set("job_tag2", "twotag");
```

Add the tag `atag` to a job execution:

1. Dynamically add the `job_tag` property:

```
conf.set("nav.jobexec.tags","job_exec_tag");
```

2. Set the `job_exec_tag` property to `atag`:

```
conf.set("job_exec_tag", "atag");
```

Add the user-defined key `key` with the value `value`:

1. Dynamically add the user-defined key `bar`:

```
conf.set("nav.job.user_defined_properties", "key");
```

2. Set the value of the user-defined key `key` to `value`:

```
conf.set("key", "value")
```

Enabling Inputs and Outputs to Display

The Cloudera Navigator console displays a Details page for selected entities. Details include an entity's type and can optionally include table inputs and operation inputs and outputs. The inputs and outputs are not displayed by default because rendering them can slow down the display. Enabling the display of inputs and outputs in the Details page requires changing the `nav.ui.details_io_enabled` on the Navigator Metadata Server to `true`, as follows:

1. Log in to the Cloudera Manager Admin Console.
2. Select **Clusters** > **Cloudera Management Service**.
3. Click the **Configuration** tab.
4. Select **Navigator Metadata Server** for the **Scope** filter.
5. Select **Advanced** for the **Category** filter.

6. In the **Navigator Metadata Server Advanced Configuration Snippet (Safety Valve) for cloudera-navigator.properties**, enter the following:

```
nav.ui.details_io_enabled=true
```

7. Click **Save Changes**.
8. Restart the Navigator Metadata Server role.

Configuring the Server for Policy Messages

Cloudera Navigator can send notifications to a JMS message queue whenever entities change as a result of policies set for that class of entity. To use this capability, an administrator must setup a JMS server with a queue for the messages and then configure the JMS server using the Cloudera Manager Admin Console, as detailed below.

In addition to setting up and configuring the server side components, the policies (that include notifications about changes) are defined using the Cloudera Navigator console. See Using Policies to Automate Metadata Tagging for details about defining policies.

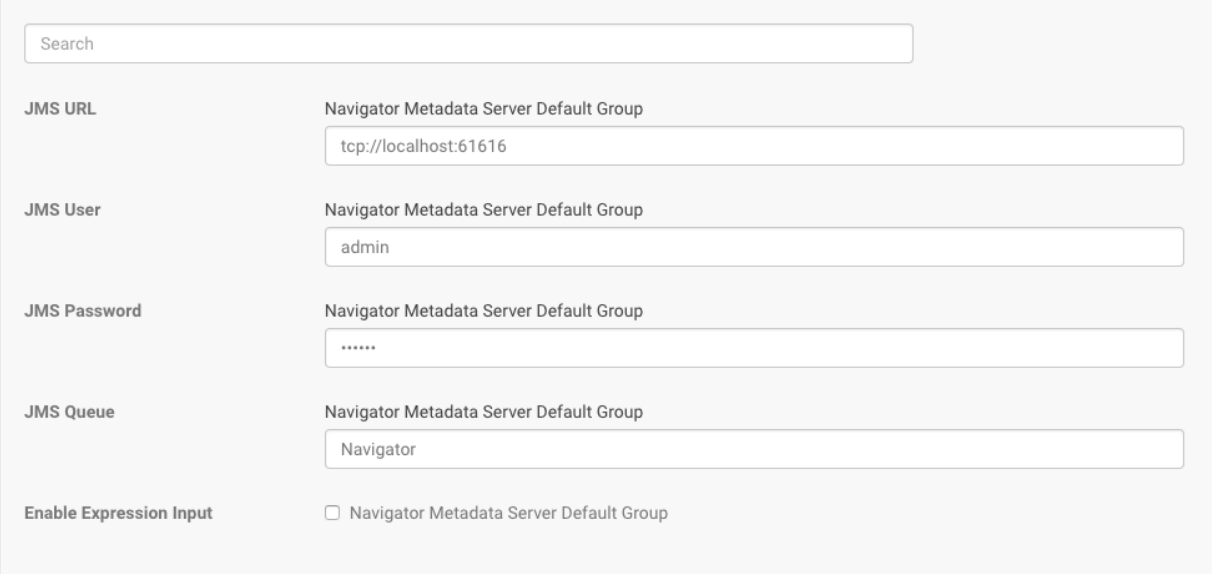
Configuring a JMS Server for Policy Messages

Cloudera Manager Required Role: Navigator Administrator (or **Full Administrator**)

Only the JMS URL, JMS User, and JMS Password settings are required to set up the JMS Server. **Enable Expression Input** only if you want to use Java expressions to define your policies. See Metadata Policy Expressions on page 47 for details about using Java expressions in your policy definitions.

These steps begin from the Cloudera Manager Admin Console home page.

1. Select **Clusters** > **Cloudera Management Service**.
2. Click the **Configuration** tab.
3. For choice of Filters, select **Category** > **Policies**. The configurable properties display:



Search

JMS URL
Navigator Metadata Server Default Group
tcp://localhost:61616

JMS User
Navigator Metadata Server Default Group
admin

JMS Password
Navigator Metadata Server Default Group
••••••

JMS Queue
Navigator Metadata Server Default Group
Navigator

Enable Expression Input
□ Navigator Metadata Server Default Group

4. Set the following properties for each role group

Property	Default	Description
JMS URL	tcp://localhost:61616	The URL of the JMS server. Notifications of changes to entities affected by policies you define are sent to this URL.
JMS User	admin	The JMS user to which notifications of changes to entities affected by policies are sent.

Property	Default	Description
JMS Password	admin	The password of the JMS user to which notifications of changes to entities affected by policies are sent.
JMS Queue	Navigator	The JMS queue to which notifications of changes to entities affected by policies are sent.
Enable Expression Input	Disabled.	Click the box to enable if you want to use Java expressions to define policies. See Metadata Policy Expressions on page 47 for details.
		When enabled, feature applies to the Navigator Metadata Server Default Group. If this configuration should apply to another role group (or groups), edit the value for the appropriate role group. See Modifying Configuration Properties Using Cloudera Manager.

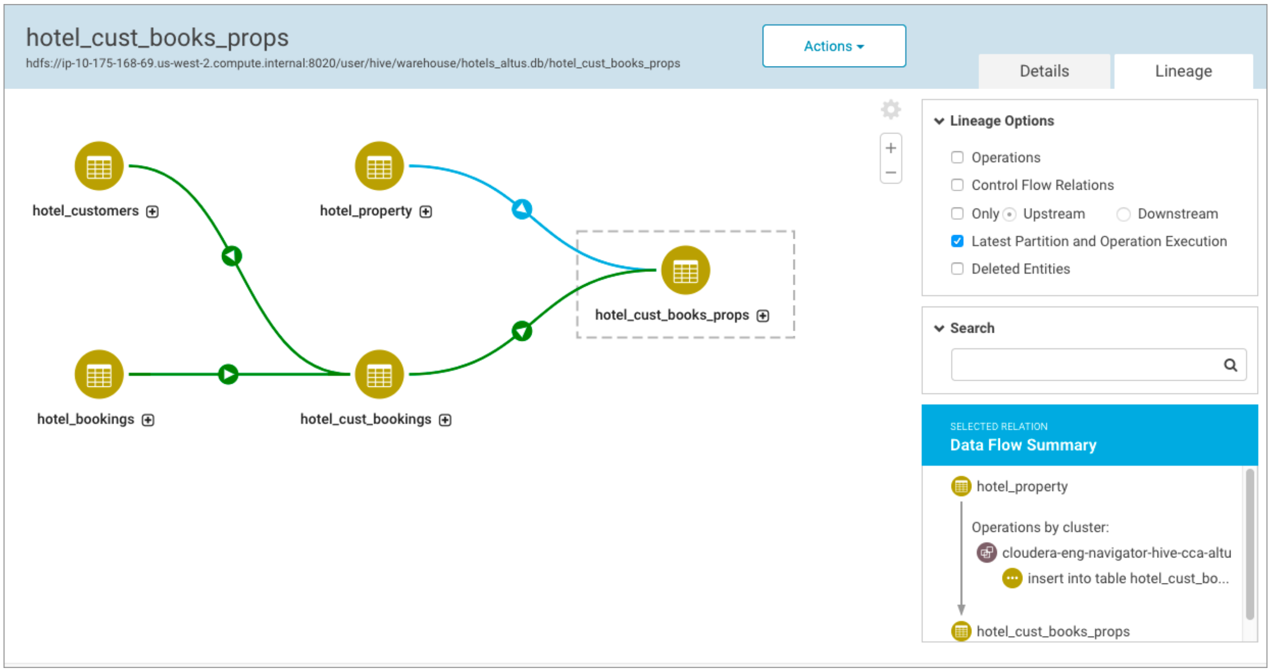
5. Click **Save Changes**.
6. Restart the Navigator Metadata Server role instance.

Cloudera Navigator and the Cloud

Market-leading organizations today are deploying clusters to the cloud to increase efficiency and reduce costs. Using public cloud infrastructure lets companies create optimal solutions that combine both on-premises and cloud clusters in persistent or transient deployment model. With Cloudera Altus, transient clusters are provisioned quickly, expand and shrink in response to varying workloads, and can be terminated just as easily when no longer needed. See Cloudera Enterprise in the Cloud for an overview.

In addition to full-scale cluster deployments to the cloud, on-premises Cloudera clusters can leverage cloud resources, such as Amazon Simple Storage Service (S3). For example, an Amazon S3 storage bucket can be used as the source or target for BDR (backup and disaster recovery), enabling organizations to replicate HDFS files and Hive data to and from the S3 bucket. As another example, an S3 bucket is often used as a persistent data store, with data copied to HDFS on a transient cluster for interactive or iterative workloads. Other supported cloud-based functionality includes using Amazon Simple Queue Service (SQS) to support notification from changes to Amazon S3 bucket objects.

Cloudera Navigator can collect metadata from clusters running on Cloudera Altus and from objects stored on Amazon S3. That means that the entities resulting from Hive jobs, for example, running on clusters instantiated by Cloudera Altus users can be seen in lineage diagrams in a centralized on-premises Cloudera Navigator instance running on a persistent or long-running Cloudera Manager cluster.



□ Operations
□ Control Flow Relations
□ Only ○ Upstream ○ Downstream
☑ Latest Partition and Operation Execution
□ Deleted Entities

Note: The Cloudera Navigator instance runs in an on-premises or persistent cluster.

This chapter provides the details for setting up Cloudera Navigator to extract from cloud-based resources, including Cloudera Altus clusters and Amazon S3 buckets. After configuring support, data stewards, data engineers, and others use the Cloudera Navigator console to explore metadata, relationships, and trace data lineage to its source as with any other type of entity.

Using Cloudera Navigator with Altus Clusters

Cloudera Navigator can extract metadata and lineage from Cloudera Altus clusters. That means that data engineers running jobs on transient clusters and processing jobs using Hive on Altus clusters can view metadata and lineage in

Cloudera Navigator. Because Cloudera Navigator identifies `cluster`, `cluster group`, and other properties related to Altus deployed clusters, data engineers can use the lineage diagrams available in the Cloudera Navigator console to trace data back to its source, even when data processing spans different clusters.

Support for Cloudera Altus metadata and lineage extraction from Cloudera Navigator is not enabled by default. Configuration tasks must be completed in the Cloudera Altus console and in the Cloudera Manager Admin Console to enable this capability. Completing the configuration tasks requires your organization to have a Cloudera Altus account, and assume that you are successfully running jobs on clusters according to the processes detailed in the Cloudera Altus documentation.

> **Note:** Cloudera Altus requires an account on the cloud service provider. For more information about Cloudera Altus and for a demonstration, visit Introducing Cloudera Altus. To request a Cloudera Altus account, go to the Altus registration page.

How it Works: Background to the Setup Tasks

Every cluster deployed using Cloudera Altus is deployed as a Cloudera Manager cluster, that is, it has its own Cloudera Manager Server. This Cloudera Manager Server instance is read-only, but an Altus user—for example, a data engineer developing a new Hive or MapReduce2 script—can use Cloudera Manager to view execution and other details. This Cloudera Manager Server also includes the Telemetry Publisher role instance (daemon) that publishes data from the transient cluster to other systems. The Telemetry Publisher stores metadata and lineage details from the running transient cluster to a cloud-based storage location (for example, an Amazon S3 bucket) specified in the Altus Environment used to instantiate the cluster.

It is the Telemetry Publisher role instance running in the Cloudera Manager Server of a Cloudera Altus cluster and the cloud-based storage mechanism that enables Cloudera Navigator to obtain metadata and lineage information from single-user transient clusters. Before the cluster shuts down, an internal process checks to ensure that all metadata and lineage from that transient cluster has been successfully published to the specified cloud-based storage resource.

Meanwhile, the on-premises Cloudera Navigator instance has been collecting the metadata and lineage information by reading from the same cloud-based storage location. Because cloud storage is a persistent store that runs independently and is not part of the transient cluster, it remains a viable source of data for Cloudera Navigator.

These system interactions are all but transparent to both Cloudera Altus users and Cloudera Navigator data stewards and other users. However, enabling the interaction involves several preliminary tasks across both Cloudera Altus and Cloudera Navigator. The specifics vary, depending on the cloud provider.

Configuring Extraction for Altus Clusters on AWS

Follow the steps below to configure Cloudera Navigator to extract metadata and lineage from single-user transient clusters deployed to Amazon Web Services using Cloudera Altus. The Cloudera Navigator extraction process for clusters launched by Cloudera Altus works as follows:

- Any HDFS paths in a job, query, or data entity are extracted as proxy entities for the path, similar to how Hive entities are extracted. That means that HDFS is not bulk extracted from an Altus cluster.
- Hive Metastore (HMS) entities are also not bulk extracted. Cloudera Navigator extracts Hive entities used in queries that generate lineage, such as databases, tables, and so on.

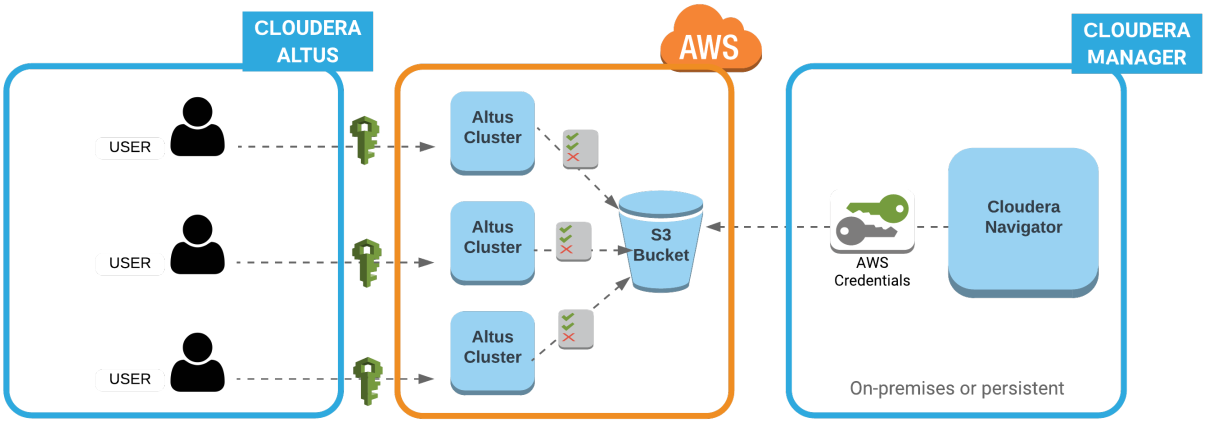
Requirements

Cloudera Navigator collects metadata and lineage entities from transient clusters deployed to AWS by Cloudera Altus users. The metadata and lineage data is not collected directly from the transient clusters but rather from an Amazon S3 bucket that serves as the storage mechanism for the Telemetry Publisher running in the cluster (see How it Works: Background to the Setup Tasks on page 125 for details).

As detailed in the steps below, successful integration of Cloudera Navigator and Cloudera Altus clusters depends on correctly:

- Identifying an Amazon S3 bucket for storing metadata

- Configuring correct access permissions to the S3 bucket from both Cloudera Altus and Cloudera Navigator. Transient clusters instantiated by Altus users must have read and write permissions to the Amazon S3 bucket used by Telemetry Publisher. The on-premises centralized Cloudera Navigator instance must have read permissions on the same Amazon S3 bucket.



🔑—Altus user account (with cross-account privileges to AWS account). Privileges to launch EC2 clusters and use other AWS resources, including Amazon S3 buckets identified in the Altus environment (data input, data output, logs, and the bucket for Telemetry Publisher).

☑— Read and write privileges to the Amazon S3 bucket configured in the Altus environment assigned to the Altus user.

🗝—AWS access key ID and AWS secret key for the AWS account associated with the Amazon S3 bucket.

The steps below assume that you have:

- An Amazon Web Services account.
- A Cloudera Altus account.
- A Cloudera Altus user account that can run jobs on transient clusters deployed to AWS.
- Access to the on-premises or persistent Cloudera Manager cluster running Cloudera Navigator. The Cloudera Manager user role of Full Administrator and the ability to log in to the Cloudera Manager Admin Console is required.
- AWS Credentials for the AWS account hosting the Amazon S3 bucket that serves as the storage mechanism for metadata and lineage data from clusters on AWS launched by Cloudera Altus.

Obtaining AWS Credentials for the Amazon S3 Bucket

AWS Credentials are available to be downloaded whenever you create an IAM user account through the AWS Management Console. If you are configuring an existing Amazon S3 bucket and you do not have the AWS Credentials for it, you can generate new AWS Credentials from the AWS account using either the AWS Management Console or the AWS CLI.

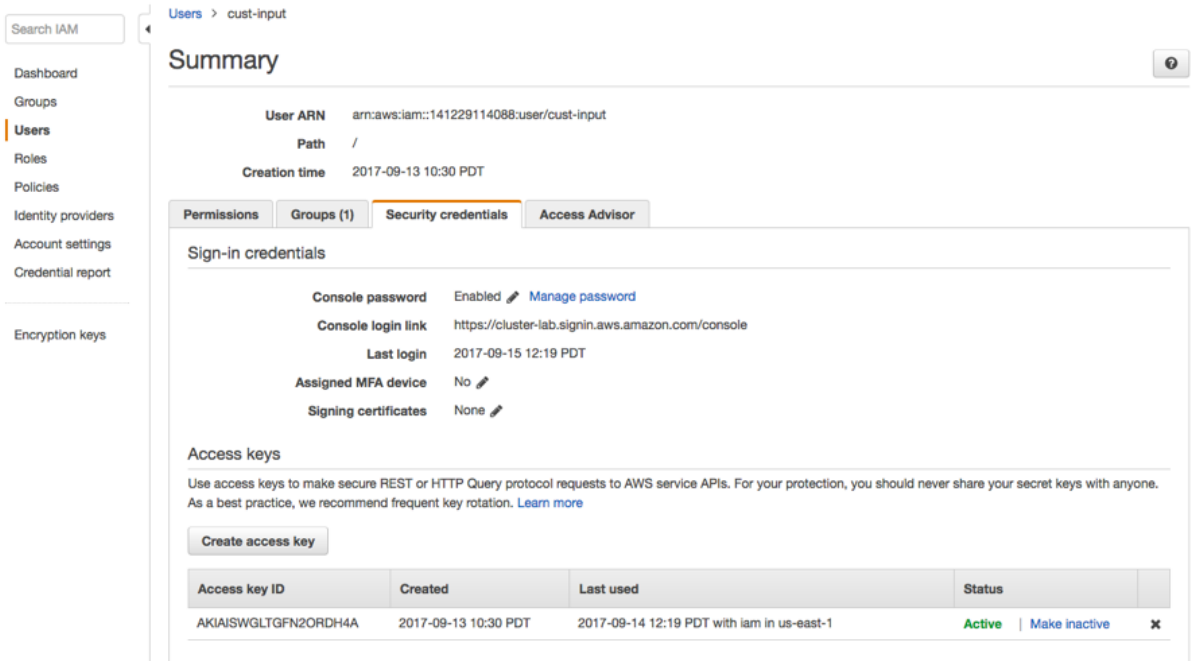
> **Important:** The AWS credentials must have read and write access to the Amazon S3 bucket.

Generating new AWS Credentials deactivates any previously issued credentials and makes the newly generated credentials **Active** for the AWS account. Keep that in mind if you obtain new AWS Credentials to use for the Cloudera Navigator-Cloudera Altus integration.

> **Note:** If you have the AWS Credentials obtained when the account was created, do not regenerate a new set of AWS Credentials unless you want to change the credentials.

These steps assume you have an AWS account and that an Amazon S3 bucket exists on that account that you want to use as the storage location for metadata and lineage.

- Log in to the AWS Management Console using the account associated with the Amazon S3 bucket.
- Navigate to the **Security credentials** section of the Users page in IAM for this account. For example:



Summary

User ARN: arn:aws:iam::141229114088:user/cust-input
Path: /
Creation time: 2017-09-13 10:30 PDT

Sign-in credentials

Console password: Enabled Manage password
Console login link: https://cluster-lab.signin.aws.amazon.com/console
Last login: 2017-09-15 12:19 PDT
Assigned MFA device: No
Signing certificates: None

Access keys

Use access keys to make secure REST or HTTP Query protocol requests to AWS service APIs. For your protection, you should never share your secret keys with anyone. As a best practice, we recommend frequent key rotation. Learn more

Access key ID	Created	Last used	Status	
AKIAISWGLTGFN2ORDH4A	2017-09-13 10:30 PDT	2017-09-14 12:19 PDT with iam in us-east-1	Active | Make inactive	✖

- Click the **Create access key** button to generate new AWS Credentials. Extract the credentials (the Access Key Id and Secret Key) from the user interface or download the `credentials.csv` for later use.

New credentials can be created by using the AWS CLI rather than the AWS Management Console. See Amazon documentation for details.

Cloudera Altus Configuration

Cloudera Altus instantiates single-user transient clusters focused on data engineering workloads that use compute services such as Hive or MapReduce2. The typical deployment scenario involves running scripts that invoke the Cloudera Altus CLI to instantiate the cluster, in this case, using Amazon Web Services according to the details specified in the Altus Environment. An Altus environment specifies all resources needed by the cluster, including the AWS account that will be used to instantiate the cluster. The Cloudera Altus user account is configured to provide cross-account access to the AWS account that has permissions to launch AWS Elastic Compute Cloud (EC2) instances and use other AWS resources, including Amazon S3 buckets.

Although the Altus Environment can be created using Quickstart, Cloudera recommends using the Environment Wizard or the Altus CLI instead. The environment wizard provides better control over configuring resources, including letting you specify the Amazon S3 bucket that clusters will use to store metadata and lineage information for collection by Cloudera Navigator. Specifically, the **Instance Profile Role** page of the Configuration Wizard lets you enable integration with Cloudera Navigator and specify the Amazon S3 bucket that will hold collected metadata and lineage information.

On the **Instance Profile Role** page of the Configuration Wizard, complete the following steps:

- Click the **Enable** checkbox for **Cloudera Navigator Integration**.

- In the **Cloudera Navigator S3 Bucket** field, enter the path to the Amazon S3 bucket, including the final /, which identifies the target as an S3 bucket. For example:

```
s3a://cluster-lab.example.com/cust-input/
```

To provide the correct access to the S3 bucket, you must also create the appropriate policy in the AWS Management Console and apply the policy to the Amazon S3 bucket.

For more information about using Cloudera Altus, see the Cloudera Altus documentation.

Cloudera Navigator Configuration

The Cloudera Navigator runs in the context of Cloudera Manager Server. Its two role instances, the Navigator Audit Server and Navigator Metadata Server, run on the Cloudera Management Service. The Navigator Metadata Server role instance is the component that extracts metadata and lineage from the Amazon S3 bucket using the AWS Credentials configured for connectivity in the steps below:

- Follow the steps in Adding AWS Credentials and Configuring Connectivity on page 128 to add new or regenerated AWS Credentials to the Cloudera Manager Server and then configure connectivity.
- Follow the steps in Configuring Connectivity for AWS Credentials on page 130 to configure connectivity for AWS Credentials that are already available to be used for the Amazon S3 bucket but have not yet been configured for connectivity.

> **Important:** Cloudera Navigator extracts metadata and lineage for clusters deployed using Altus from one Amazon S3 bucket only. In addition, for any given Amazon S3 bucket collecting metadata and lineage from Altus clusters, configure only one Cloudera Navigator instance to extract from that Amazon S3 bucket. Using multiple Cloudera Navigator instances to extract from the same Amazon S3 bucket is not supported and has unpredictable results.

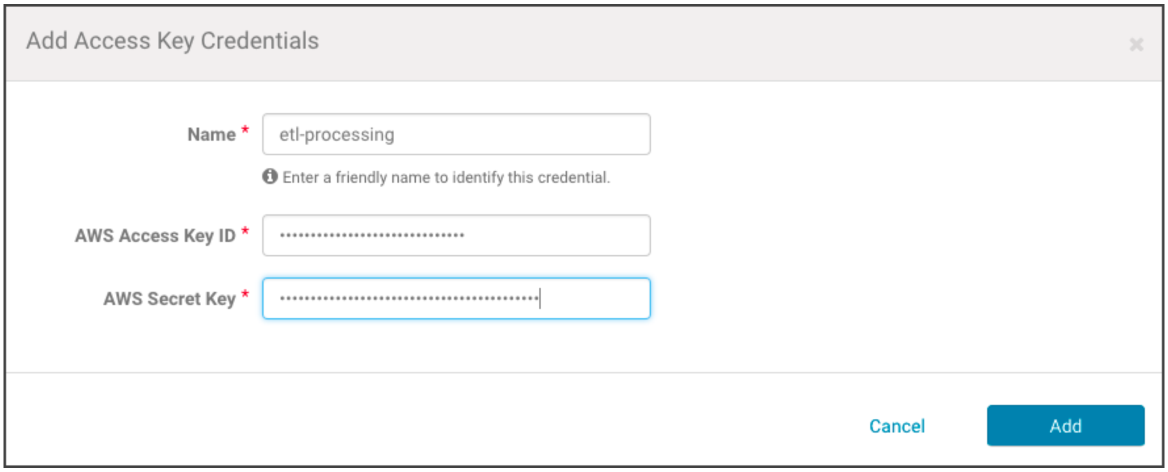
Adding AWS Credentials and Configuring Connectivity

Cloudera Manager Required Role: Full Administrator

The AWS Credentials must be added to the Cloudera Manager Server for use by Cloudera Navigator. These credentials must be from the AWS account hosting the Amazon S3 bucket that is configured in the Altus environment.

> **Note:** The AWS account associated with these credentials must have cross-account access permissions from the Altus user account that will launch clusters on AWS and run jobs. These credentials must also have read and write permissions on the S3 bucket because the clusters launched must be able to write metadata and lineage information to the Amazon S3 bucket as jobs run.

1. Log in to the Cloudera Manager Admin Console.
2. Select **Administration** > **AWS Credentials**.
3. Click the **Add Access Key Credentials** button on the AWS Credentials page.
   a. Enter a meaningful name for the AWS Credential, such as the type of jobs the associated clusters will run (for example, **etl-processing**). This name is for your own information and is not checked against any Cloudera Altus or AWS attributes.
   b. Enter the AWS Access Key ID and the AWS Secret Key.



Add Access Key Credentials

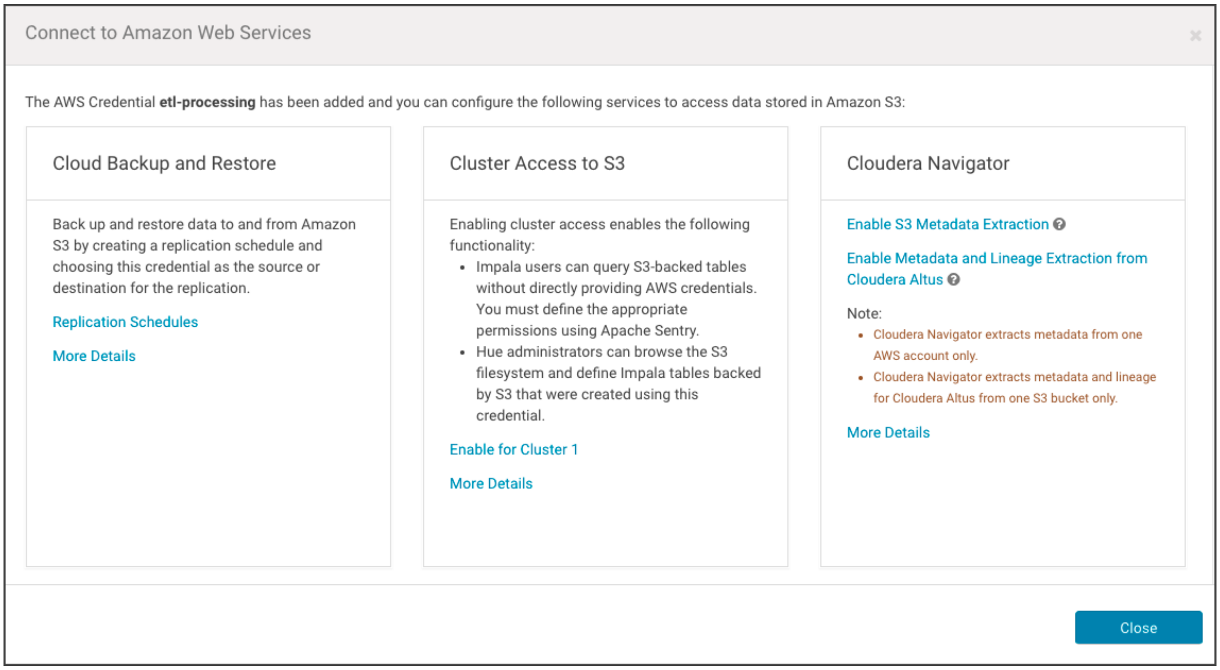
Name * etl-processing

Enter a friendly name to identify this credential.

AWS Access Key ID * ••••••••••••••••••••••••••••••

AWS Secret Key * ••

4. Click **Add** to save the credentials. The S3Guard option page displays, reflecting the credential name (for example, **Edit S3Guard: etl-processing**). Disregard this option.
5. Click **Save**. The Connect to Amazon Web Services page displays, showing the options available for this specific AWS credential.



Connect to Amazon Web Services

The AWS Credential **etl-processing** has been added and you can configure the following services to access data stored in Amazon S3:

Cloud Backup and Restore

Back up and restore data to and from Amazon S3 by creating a replication schedule and choosing this credential as the source or destination for the replication.

Replication Schedules

More Details

Cluster Access to S3

Enabling cluster access enables the following functionality:

- Impala users can query S3-backed tables without directly providing AWS credentials. You must define the appropriate permissions using Apache Sentry.
- Hue administrators can browse the S3 filesystem and define Impala tables backed by S3 that were created using this credential.

Enable for Cluster 1

More Details

Cloudera Navigator

Enable S3 Metadata Extraction

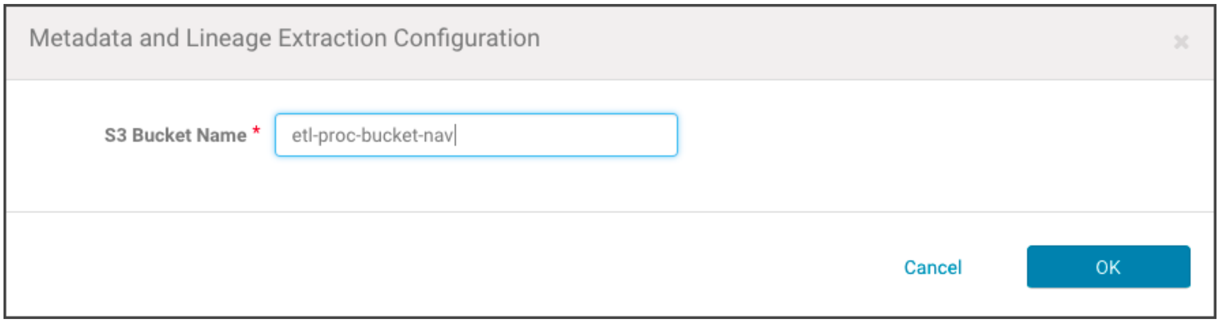
Enable Metadata and Lineage Extraction from Cloudera Altus

Note:

- Cloudera Navigator extracts metadata from one AWS account only.
- Cloudera Navigator extracts metadata and lineage for Cloudera Altus from one S3 bucket only.

More Details

6. Click **Enable Metadata and Lineage Extraction from Cloudera Altus**. The Metadata and Lineage Extraction Configuration setting page displays a field for specifying the Amazon S3 bucket name.
7. Enter the name of the Amazon S3 bucket. For example:



Metadata and Lineage Extraction Configuration

S3 Bucket Name * etl-proc-bucket-nav

8. Click **OK**. The AWS Credentials page re-displays, and the newly added AWS Credential is listed with any other AWS Credentials held by the Cloudera Manager Server.

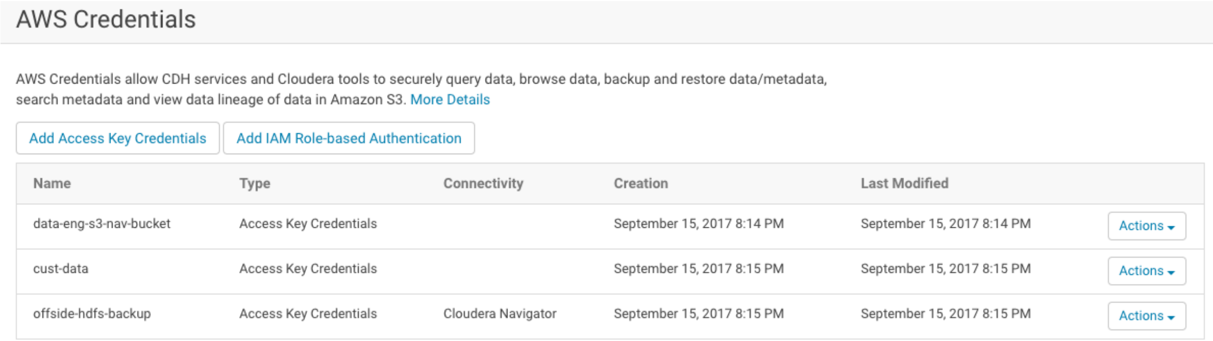
9. Restart the Cloudera Management Service.

When the service restarts, the AWS credentials will be used by Cloudera Navigator to authenticate to the AWS account and extract metadata and lineage stored on the specified S3 bucket.

Configuring Connectivity for AWS Credentials

If the AWS Credentials are available for the Amazon S3 bucket, you can configure them as follows:

1. Log in to the Cloudera Manager Admin Console.
2. Select **Administration** > **AWS Credentials**.
3. Find the available AWS Credentials that provide access to the Amazon S3 bucket used to collect metadata and lineage from transient clusters.



AWS Credentials

AWS Credentials allow CDH services and Cloudera tools to securely query data, browse data, backup and restore data/metadata, search metadata and view data lineage of data in Amazon S3. More Details

Name	Type	Connectivity	Creation	Last Modified	
data-eng-s3-nav-bucket	Access Key Credentials		September 15, 2017 8:14 PM	September 15, 2017 8:14 PM	Actions
cust-data	Access Key Credentials		September 15, 2017 8:15 PM	September 15, 2017 8:15 PM	Actions
offside-hdfs-backup	Access Key Credentials	Cloudera Navigator	September 15, 2017 8:15 PM	September 15, 2017 8:15 PM	Actions

4. Click the **Actions** drop-down menu and select **Edit Connectivity**. The Connect to Amazon Web Services page displays the three sections of possible configurations.
5. In the Cloudera Navigator section, click the **Enable Metadata and Lineage Extraction from Cloudera Altus** link. The Metadata and Lineage Extraction Configuration page displays.
6. Enter the name of the Amazon S3 bucket in the **S3 Bucket Name** field.
7. Click **OK**.
8. Restart the Cloudera Management Service.

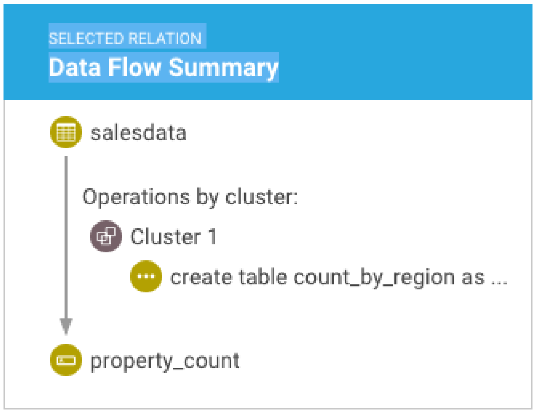
This completes the setup process. After the restart, metadata and lineage for transient clusters deployed using Cloudera Altus should be available in the Cloudera Navigator console.

Note: See Troubleshooting to identity possible issues if metadata and lineage do not display in the Cloudera Navigator console after completing the configuration and restarting the system.

Technical metadata specific to clusters deployed using Altus include the following property names and types:

- Cluster (Source Type)
- Cluster-*name* (Cluster Group)
- Transient (Deployment Type)
- Cluster Template, Cluster Instance (Classname)

For example:



SELECTED RELATION

Data Flow Summary

salesdata

Operations by cluster:

Cluster 1

create table count_by_region as ...

property_count

See Search Syntax and Properties on page 160 and Cloudera Navigator Metadata on page 28 for more information.

Using Cloudera Navigator with Amazon S3

Amazon Simple Storage Service (S3) is a storage solution offered by Amazon Web Services (AWS) that provides highly available storage in the cloud. Clusters deployed not only in the AWS cloud but also on-premises are using Amazon S3 as persistent storage. Common use cases include BDR (backup and disaster recovery) and persistent storage for transient clusters deployed to the cloud, such as storage for ETL workload input and output.

As with data stored on HDFS and processed using compute engines like Hive and Impala, Cloudera Navigator can obtain metadata and lineage from Amazon S3 storage. There are some limitations and constraints as discussed below, and some setup is required to enable this capability (see Configuring Extraction for Amazon S3 on page 135).

Note: Cloudera Navigator does not audit Amazon S3 storage buckets. Only Cloudera Navigator metadata and lineage are supported.

This section provides conceptual information about Amazon S3 storage and shows you how to configure Cloudera Navigator to extract metadata and lineage from an Amazon S3 bucket.

Continue reading:

Amazon S3 Storage Characteristics

Amazon S3 is an object store rather than a file store or block store. It does not have the hierarchy found in typical filesystems. Amazon S3 uses the construct of a ***bucket*** as a container for ***objects***. An object can be any kind of file—text file, image, photo, graphic, video, an ETL bundle to be ingested into a cluster, and so on.

Files can be added to Amazon S3 through the AWS Management Console, by using the AWS CLI, or by using scripts that invoke the CLI.

Amazon S3 storage is highly available because Amazon replicates data across multiple servers within its data centers and uses an ***eventual consistency*** model—not all accesses of an object on Amazon S3 may be reflected concurrently or instantaneously. However, eventually, all updates to data across servers are synchronized. The eventual consistency model can result in a short delay between the time objects are uploaded to Amazon S3 and the time their metadata is available in Cloudera Navigator. This is expected behavior and simply how eventual consistency works.

> **Note:** The eventual consistency model of Amazon S3 can be augmented by using S3Guard, which leverages Amazon DynamoDB to provide support for transactions. See Configuring and Managing S3Guard in the Cloudera Administration guide for details.

For more information about Amazon S3, see Amazon S3 documentation.

Cloudera Navigator and Amazon S3

Despite the implementation details of Amazon S3 storage, Cloudera Navigator collects metadata for Amazon S3 entities in much the same way as for HDFS entities, with some exceptions shown in the table below.

> **Note:** In addition to metadata, Cloudera Navigator extracts lineage from Hive, Impala, and MapReduce (except for MapReduce Glob paths) on Amazon S3.

The following table lists some differences between object types and supported features offered by Amazon S3 and how those are supported by Cloudera Navigator:

Feature	Amazon S3	Cloudera Navigator
User-defined metadata consists of custom key-value pairs (in which each key is prefixed with `x-amz-meta-`) that can be used to tag objects on Amazon S3.	✔	⊘
System-defined metadata includes properties such as `Date`, `Content-Length`, `Last-Modified`. Some system-defined properties comprise the Technical Metadata for the object in Cloudera Navigator.	✔	✔
Tags for buckets and objects	✔	⊘
Versioning is not supported. Cloudera Navigator extracts metadata and lineage from the latest version only.	✔	⊘
Unnamed directories	✔	⊘
Object lifecyle rules. See Object Lifecycle Rules Constraints on page 132 for more information.	✔	✓
Amazon Simple Queue Service (SQS). See Amazon SQS and Amazon SNS Constraints for usage limitations and requirements.	✔	✓
Amazon Simple Notification Service (SNS). See Amazon SQS and Amazon SNS Constraints for usage limitations and requirements.	✔	✓

Object Lifecycle Rules Constraints

Cloudera Navigator does not support lifecycle rules that remove objects from Amazon S3. For example, an object lifecycle rule that removes objects older than *n* days deletes the object from Amazon S3 but the event is not tracked by Cloudera Navigator. This limitation applies to removing objects only. Using lifecycle rules requires using bulk-only extraction. See Custom Configurations on page 137 for details about configuring the necessary AWS Policy and applying it to the Amazon S3 bucket for use by Cloudera Navigator.

Amazon SQS and Amazon SNS Constraints

Amazon Simple Queue Service (SQS) is a distributed, highly scalable hosted queue for storing messages. Amazon Simple Notification Service (SNS) is publish-subscribe notification service that coordinates message delivery. Both services can be configured for use with Amazon S3 storage buckets. For example, Amazon S3 storage buckets can send notification messages to one or more queues or to email addresses whenever specified events occur, such as creating, renaming, updating, or deleting data on the Amazon S3 bucket.

During the default configuration process, Cloudera Navigator transparently sets up an Amazon SQS queue and configures Amazon S3 event notification for each bucket. The queue is used to hold event messages that are subsequently collected by the Cloudera Navigator S3 extractor process, for incremental extracts. Use the default configuration process only for Amazon S3 buckets that do not have existing queues or notifications configured.

For Amazon S3 buckets that are already configured for queues, use the custom configuration process—sometimes referred to as "Bring Your Own Queue" (BYOQ)—to manually configure queues for Cloudera Navigator. For Amazon S3 buckets that are already configured for notifications, use the BYOQ custom configuration in conjunction with Amazon SNS in a fan-out configuration. In a fan-out scenario, an Amazon SNS message is sent to a topic and then replicated and pushed to multiple Amazon SQS queues, HTTP endpoints, or email addresses. See Common Amazon SNS Scenarios for more information about fan-out configuration, and see Custom Configurations on page 137 for details about configuring Cloudera Navigator when the Amazon S3 bucket is already set up for either Amazon SQS or Amazon SNS.

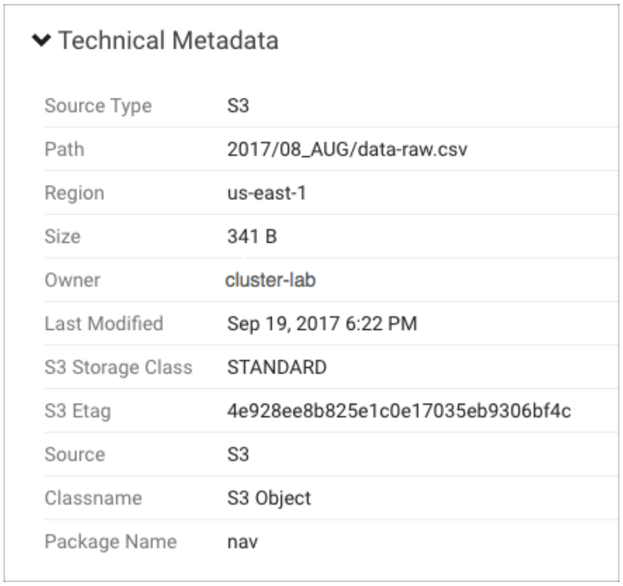
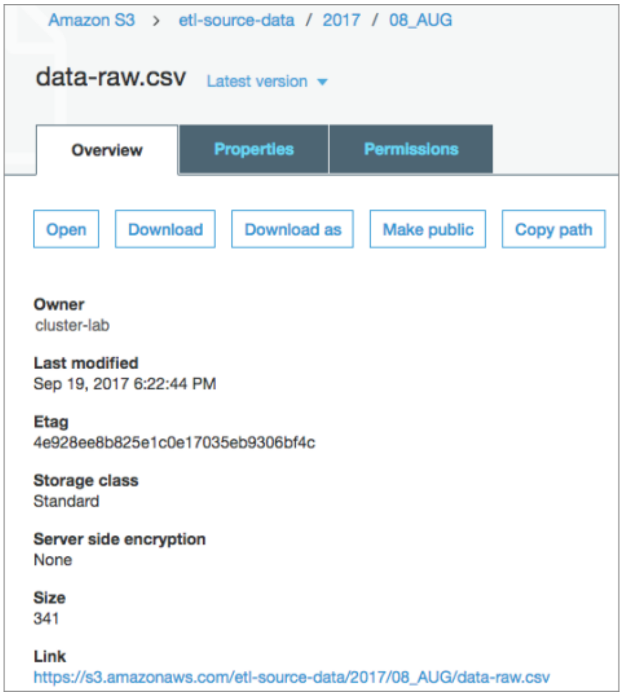
Object Storage and Implicit Folder Limitation

Amazon S3 storage does not use a directory structure or other hierarchy as found in a traditional file system. Each object has an ***object key name*** that identifies the object by its S3Uri location—the path to the object. This path includes the ***object***, ***prefix*** if any, and ***bucket*** name. Including the S3 protocol specifier, the pattern is as follows:

s3://*bucketname/prefix/objectkey*

There can be more than one prefix in an object key name. Prefixes are separated by the forward slash character (/). Although Amazon S3 provides a ***folder*** metaphor for organizing objects in an S3 bucket, the folder does not provide actual containment or structure: it is the object key name and its S3Uri location that identifies the object.

Cloudera Navigator mimics file system behavior by mapping elements of the object key name to implicit folders. For example, for an Amazon S3 file with the object key name **2017/08_AUG/data-raw.csv**, Cloudera Navigator creates an entity with the path **2017/08_AUG/data-raw.csv** and also creates two directories: **2017** and **2017/08_AUG**.

Cloudera Navigator	Amazon S3
	

Technical Metadata

Source Type	S3
Path	2017/08_AUG/data-raw.csv
Region	us-east-1
Size	341 B
Owner	cluster-lab
Last Modified	Sep 19, 2017 6:22 PM
S3 Storage Class	STANDARD
S3 Etag	4e928ee8b825e1c0e17035eb9306bf4c
Source	S3
Classname	S3 Object
Package Name	nav

data-raw.csv

Owner
cluster-lab

Last modified
Sep 19, 2017 6:22:44 PM

Etag
4e928ee8b825e1c0e17035eb9306bf4c

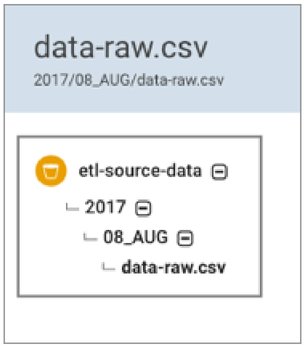
Storage class
Standard

Server side encryption
None

Size
341

Link
https://s3.amazonaws.com/etl-source-data/2017/08_AUG/data-raw.csv

Cloudera Navigator console Lineage tab for the file with object key `2017/08_AUG/data-raw.csv` shows it in the context of implicit folders:


data-raw.csv

2017/08_AUG/data-raw.csv

Cloudera Navigator has some limitations specifically for deleted objects and implicit folders as follows:

- Cloudera Navigator does not mark an implicit folder as deleted even after all its child objects have been deleted.
- Cloudera Navigator does not mark as deleted any objects and folders deleted using Amazon S3 tools, such as the AWS CLI (`aws s3` commands) or the AWS Management Console.

> **Note:** To filter out implicit folders from the S3 entities displayed, enter `implicit:false` in the Search field. Conversely, to find implicit entities enter `implicit:true` in the Search field.

For more details about the properties shown by Cloudera Navigator, see S3 Properties on page 165 in the Reference section of this guide.

Despite the differences between an object store and a hierarchical store, data engineers can work with Amazon S3 using the Cloudera Navigator in much the same way as for HDFS and other entities.

Overview of Amazon S3 Extraction Processes

By default, Cloudera Navigator uses combined bulk and incremental extraction processes. An initial bulk process extracts all metadata from an Amazon S3 bucket during the configuration process. Subsequent extracts are incremental. Changes are collected from an Amazon SQS queue created by Cloudera Navigator during the default configuration process.

This bulk-plus-incremental extraction combination provides the optimal performance for production systems and is also the most cost-effective in terms of Amazon API usage:

- For the bulk extract, Cloudera Navigator invokes the Amazon S3 API.
- For the incremental extract, Cloudera Navigator invokes the Amazon SQS API.

Amazon meters usage and charges differently for each of these APIs.

API Usage and Setting Limits

Amazon bills on a monthly basis and resets the billing cycle each month. To help manage the monthly cost of using these APIs, Cloudera Navigator provides a safety valve property that can be set to limit its use of the AWS APIs. If you decide to configure this property to set a limit on API usage, keep the following in mind:

- If the limit is set is reached in any given 30-day interval, Cloudera Navigator suspends extraction from the configured Amazon S3 buckets until the next 30-day interval begins.
- When the new 30-day interval begins, Cloudera Navigator extracts any data that was not extracted while extraction was suspended.

To set a limit on the AWS API usage:

- Use Cloudera Manager Admin Console to access the **Navigator Metadata Server Advanced Configuration Snippet (Safety Valve) for cloudera-navigator.properties**.
- Set the value of *any_int* to your chosen limit.

```
nav.aws.api.limit=any_int
```

See Setting Properties with Advanced Configuration Snippets on page 141 for details about using Cloudera Manager Admin Console for this task.

> **Note:** Cloudera Navigator does not notify you if extraction is ever suspended due to the limit you have set in the safety valve. Cloudera recommends setting a billing alarm in the AWS Management Console to get notified by Amazon when your monthly use of the APIs exceeds the limit you have set in the safety valve.

Configuring Extraction for Amazon S3

Depending on the specifics of the Amazon S3 bucket targeted for extraction by Cloudera Navigator, the configuration process follows one of two alternative paths:

- **Default configuration**—The default configuration is available for Amazon S3 buckets that have no existing Amazon SQS or Amazon SNS services configured. During configuration, Cloudera Navigator accesses the configured AWS account, performs an initial bulk extract from the Amazon S3 bucket, sets up Amazon SQS queues in each region with buckets, and sets up event notifications for each bucket for subsequent incremental extracts—all transparently to the Cloudera Manager administrator handling the configuration process.
- **Custom configuration**—Custom configuration is required for any Amazon S3 bucket that is currently using Amazon SQS (has queues set up for other applications, for example) or is setup for notifications using Amazons SNS. In these cases you must manually configure a new queue—***bring your own queue***—and in some cases, additionally configure Amazon SNS for ***fanout***.

Continue reading:

AWS Credentials Requirements

Cloudera Manager can have multiple AWS credentials configured for various purposes at any given time. These are listed by name on the AWS Credentials page which is accessible from the Cloudera Manager Admin Console, under the Administration menu. However, there are specific constraints on AWS credentials for Cloudera Navigator as follows:

- Navigator supports a single key for authentication; only one AWS credential can be used for a given Navigator instance. Navigator can extract metadata from any number of S3 buckets, assuming the buckets can be accessed with the configured credential.
- An AWS credential configured for connectivity from one Cloudera Navigator instance cannot be used by another Cloudera Navigator instance. Configuring the same AWS credentials for use with different Cloudera Navigator instances can result in unpredictable behavior.
- Cloudera Navigator requires an AWS credential associated with an IAM ***user*** identity rather than an IAM ***role***.
- Any changes to the AWS credentials (for example, if you rotate credentials on a regular basis) must be for the same AWS account (IAM user). Changing the AWS credentials to those of a different IAM user results in errors

from the Amazon Simple Queue Service (used transparently by Cloudera Navigator). If a new key is provided to Cloudera Navigator, the key must belong to the same AWS account as the prior key.

- For the default configuration, the account for this AWS credential must have administrator privileges for:
  - Amazon S3
  - Amazon Simple Queue Service (SQS)
- For the custom configurations, the account needs privileges for Amazon S3, Amazon SQS, and for Amazon Simple Notification Service (SNS).

Default Configuration

The steps below assume that you have the required AWS credentials for the IAM user with the Amazon S3 bucket. Amazon Web Services (AWS) account (an IAM user account) and that you can use the AWS Management Console . The AWS credentials for the IAM user are configured for Cloudera Navigator using the Cloudera Manager Admin Console during the configuration process below.

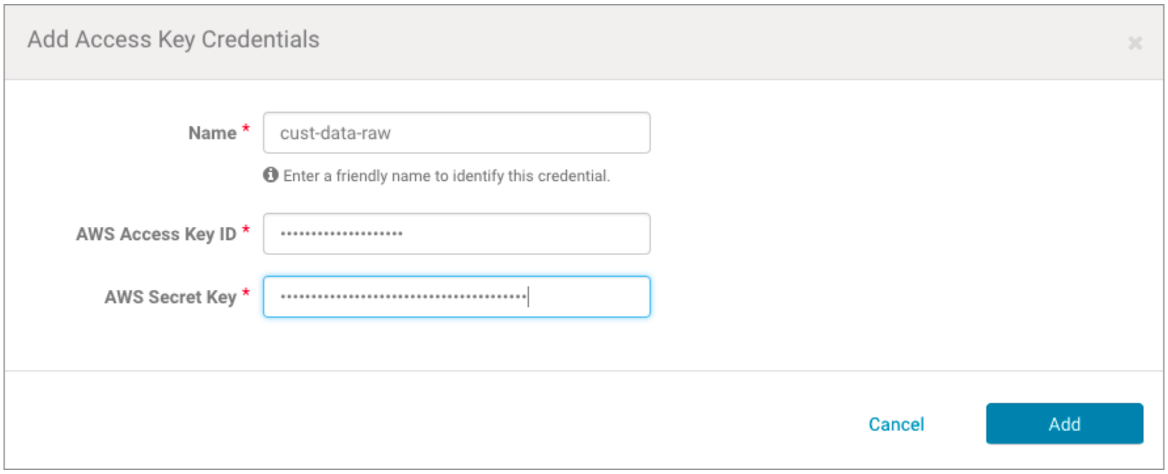
> **Important:** If the Amazon S3 bucket is already configured for queuing or notification, do not follow the steps in this section. See Custom Configurations on page 137 instead.

Configuring Cloudera Navigator for Amazon S3

At the end of the configuration process detailed below, Cloudera Navigator authenticates to AWS using the credentials and performs an initial bulk extract of entities from the Amazon S3 bucket. It also sets up the necessary Amazon SQS queue (or queues, one for each region) to use for subsequent incremental extracts.

The steps below assume you have the required AWS credentials available.

1. Log in to the Cloudera Manager Admin Console.
2. Click **Administration** > **AWS Credentials.** The AWS Credentials page displays, listing any existing credentials that have been setup for the Cloudera Manager cluster.
3. Click the **Add Access Key Credentials** button. In the Add Access Key Credentials page:
   a. Enter a **Name** for the credentials. The name can contain alphanumeric characters and can include hyphens, underscores, and spaces but should be meaningful in the context of your production environment. Use the name of the Amazon S3 bucket or its functionality, for example, *cust-data-raw* or *post-proc-results*.
   b. Enter the **AWS Access Key ID**.
   c. Enter the **AWS Secret Key**.



Add Access Key Credentials

Name * cust-data-raw

Enter a friendly name to identify this credential.

AWS Access Key ID * ••••••••••••••••••••

AWS Secret Key * ••

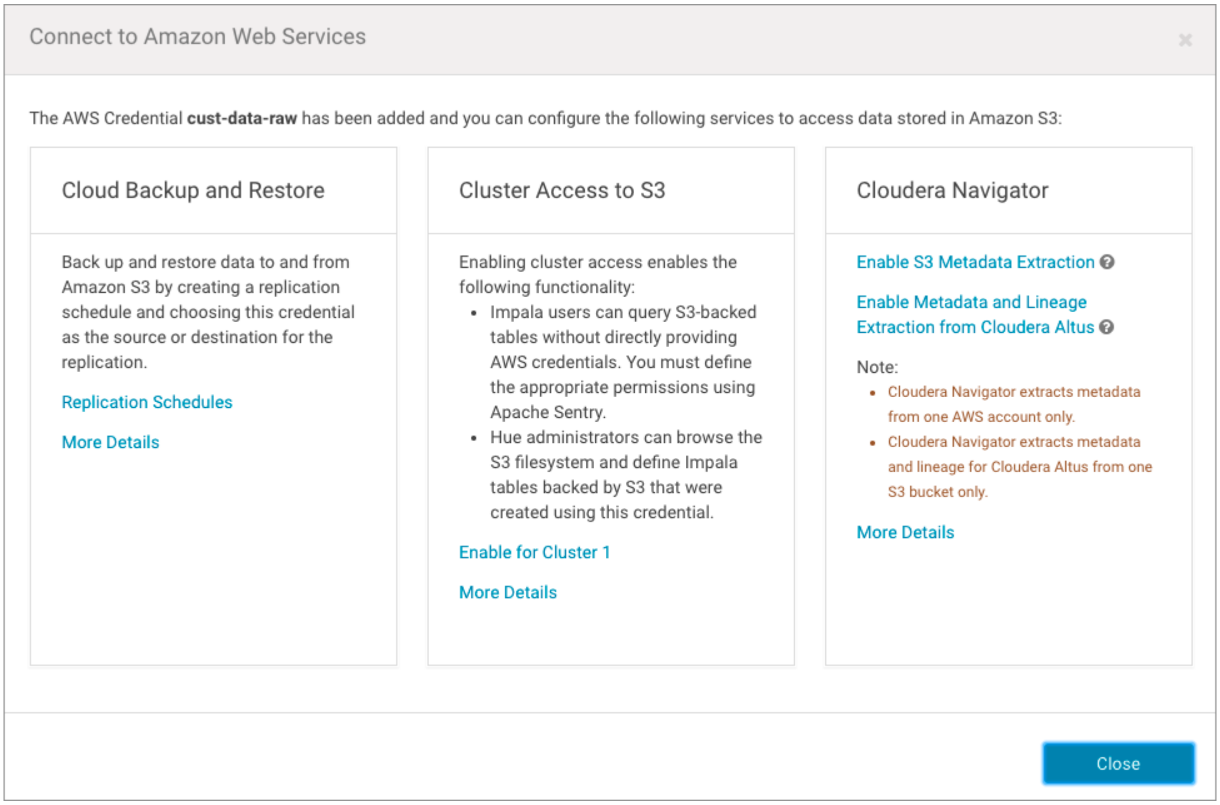
4. Click **Add**. The **Edit S3Guard:*aws-cred-name*** page displays, giving you the option to enable S3Guard for the S3 bucket.

- Click the Enable S3Guard box only if the AWS credential has privileges on Amazon DynamoDB and if the preliminary S3Guard configuration is complete. See Cloudera Administration for details about Configuring and Managing S3Guard.

5. Click **Save**.

> **Note:** Cloudera Manager stores the AWS credential securely in a non-world readable location. The access key ID and secret values are masked in the Cloudera Manager Admin Console, encrypted before being passed to other processes, and redacted in the logfiles.

The Connect to Amazon Web Services page displays the credential name and services available for its use:



Connect to Amazon Web Services

The AWS Credential **cust-data-raw** has been added and you can configure the following services to access data stored in Amazon S3:

Cloud Backup and Restore

Back up and restore data to and from Amazon S3 by creating a replication schedule and choosing this credential as the source or destination for the replication.

Replication Schedules

More Details

Cluster Access to S3

Enabling cluster access enables the following functionality:

- Impala users can query S3-backed tables without directly providing AWS credentials. You must define the appropriate permissions using Apache Sentry.
- Hue administrators can browse the S3 filesystem and define Impala tables backed by S3 that were created using this credential.

Enable for Cluster 1

More Details

Cloudera Navigator

Enable S3 Metadata Extraction

Enable Metadata and Lineage Extraction from Cloudera Altus

Note:

- Cloudera Navigator extracts metadata from one AWS account only.
- Cloudera Navigator extracts metadata and lineage for Cloudera Altus from one S3 bucket only.

More Details

6. Click the **Enable S3 Metadata Extraction** link in the Cloudera Navigator section of the page. A Confirm prompt displays, notifying you that Cloudera Navigator must be manually restarted after this change.
7. Click **OK** to enable the connection.
8. At the top of the Cloudera Manager Admin Console, click the **Stale Configuration** restart button when you are ready to restart Cloudera Navigator.

Metadata and lineage for Amazon S3 buckets will be available in the Cloudera Navigator console along with other sources, such as HDFS, Hive, and so on. It may take several minutes to complete the initial extraction depending on the number of objects stored on the Amazon S3 bucket.

Custom Configurations

Follow these steps for Amazon S3 buckets that are already configured with queues or event notifications. Custom configurations include coinfiguring your own queue (BYOQ) and BYOQ with Fan-out, as detailed below.

Configuring Your Own Queues

Sometimes referred to as Bring Your Own Queue (BYOQ), configuring your own queue is required if the Amazon S3 bucket being targeted for extraction by Cloudera Navigator already has existing queues or is configured for notifications. The process involves stopping Cloudera Navigator and then using the AWS Management Console for the following tasks:

- Creating and configuring an Amazon Simple Queue Service (SQS) queue for Cloudera Navigator for each region in which the AWS (IAM user) account has Amazon S3 buckets.
- Configuring Amazon Simple Notification Service (SNS) on each bucket to send Create, Rename, Update, Delete (CRUD) events to the Cloudera Navigator queue.
- Configuring the bucket for Notification Fan-Out if needed to support existing notifications configured for other applications.
- Adding a Policy for the appropriate extraction process (Bulk + Incremental, Bulk Only) to the IAM user account.
- Adding the Policy for event notifications to the IAM user account.

> **Important:** Always make sure any newly created Amazon S3 buckets are configured for event notifications before adding data so the queues are properly updated.

Configure the Queue for Cloudera Navigator

This manual configuration process requires stopping Cloudera Navigator. You must create a queue for each region that has S3 buckets.

1. Log in to Cloudera Manager Admin Console and stop Cloudera Navigator:
   - Select **Clusters** > **Cloudera Management Service**
   - Click the **Instances** tab.
   - Click the checkbox next to **Navigator Audit Server** and **Navigator Metadata Server** in the Role Type list to select these roles.
   - From the **Actions for Selected (2)** menu button, select **Stop**
2. Log in to the AWS Management Console with AWS account (IAM user) and open the **Simple Queue Service** setup page (select **Services** > **Messaging** > **Simple Queue Service**. Click Create New Queue or Get Started Now if region has no configured queues.)
3. For each region that has Amazon S3 buckets, create a queue as follows:
   a. Click the **Create New Queue** button. Enter a Queue Name, click the Standard Queue (not FIFO), and then click **Configure Queue**. Configure the queue using the following settings:

Default Visibility Timeout	10 minutes
Message Retention Period	14 days
Delivery Delay	0 seconds
Receive Message Wait Time	0 seconds

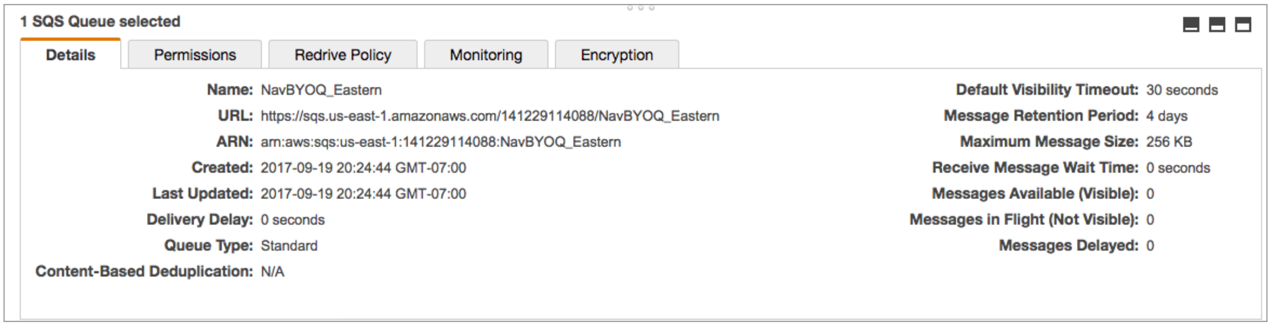
   b. Select the queue you created, click the **Permissions** tab, click **Add a Permission**, and configure the following in the **Add a Permision to...** dialog box:

Effect	Allow
Principal	Everybody
Actions	SendMessage

   c. Click the **Add Conditions (optional)** link open the condition fields and enter the following values:

Qualifier	None
Condition	ArnLike
Key	aws:SourceArn
Value	arn:aws:s3::*:*

- **d.** Click **Add Condition** to save the settings.
- **e.** Click **Add Permission** to save all settings for the queue.



Name: NavBYOQ_Eastern
URL: https://sqs.us-east-1.amazonaws.com/141229114088/NavBYOQ_Eastern
ARN: arn:aws:sqs:us-east-1:141229114088:NavBYOQ_Eastern
Created: 2017-09-19 20:24:44 GMT-07:00
Last Updated: 2017-09-19 20:24:44 GMT-07:00
Delivery Delay: 0 seconds
Queue Type: Standard
Content-Based Deduplication: N/A

Default Visibility Timeout: 30 seconds
Message Retention Period: 4 days
Maximum Message Size: 256 KB
Receive Message Wait Time: 0 seconds
Messages Available (Visible): 0
Messages in Flight (Not Visible): 0
Messages Delayed: 0

Repeat this process for each region that has Amazon S3 buckets.

Configure Event Notification for the Queues

After creating queues for all regions with Amazon S3 buckets, you must configure event notification for each Amazon S3 bucket. Assuming you are still logged into the AWS Management Console:

1. Navigate to the Amazon S3 bucket for the region (**Services** > **Storage** > **S3**).
2. Select the bucket.
3. Click the **Properties** tab.
4. Click the **Events** settings box.
5. Click **Add notification.**
6. Configure event notification for the bucket as follows:

Name	nav-send-metadata-on-change
Events	• ObjectCreated(All) • ObjectRemoved(All)
Send to	SQS Queue
SQS queue	Enter the name of your queue

Important: Cloudera Navigator extracts metadata from one queue only for each region.

Configuring Amazon SNS Fan-out

Configure SNS fanout if you have existing S3 event notification. For more information about SNS fanout, see Amazon documentation for Common SNS Scenarios

1. Add the following to the **Navigator Metadata Server Advanced Configuration Snippet (Safety Valve) for cloudera-navigator.properties**. See Setting Properties with Advanced Configuration Snippets on page 141 for details about using Cloudera Manager Admin Console if necessary.

```
nav.s3.extractor.incremental.enable=true
nav.s3.extractor.incremental.auto_setup.enable=false
nav.s3.extractor.incremental.queues=queue_json
```

   Specify the queue properties using the following JSON template (without any spaces). Escape commas (,) by preceding them with two backslashes (\\), as shown in the template:

```
[{"region":"us-west-1"\\,"queueUrl":"https://sqs.aws_region.amazonaws.com/account_num/queue_name"}\\,{queue_2}\\,
...
{queue_n}]
```

2. Restart Cloudera Navigator.

Defining and Attaching Policies

Event Notification Policy for Custom Queues

To enable event notification for an custom queue, create the following policy by copying the policy text and pasting it in the policy editor, and then attaching it to the Cloudera Navigator user in AWS.

```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Sid": "Stmt1481678612000",
            "Effect": "Allow",
            "Action": [
                "sqs:DeleteMessage",
                "sqs:DeleteMessageBatch",
                "sqs:GetQueueAttributes",
                "sqs:ReceiveMessage"
            ],
            "Resource": "*"
        },
        {
            "Sid": "Stmt1481678744000",
            "Effect": "Allow",
            "Action": [
                "s3:GetBucketLocation",
                "s3:ListAllMyBuckets",
                "s3:ListBucket",
                "s3:GetObject",
                "s3:GetObjectAcl",
                "s3:GetBucketNotification",
                "s3:PutBucketNotification"
            ],
            "Resource": [
                "arn:aws:s3:::*"
            ]
        }
    ]
}
```

Extraction Policies for Custom Queues

Custom configurations require a valid extraction policy be defined and attached to the AWS user account associated with the Amazon S3 bucket. The policy is a JSON document that specifies the type of extraction. As mentioned in Overview of Amazon S3 Extraction Processes on page 134, the two types of extraction are as follows:

- Bulk + Incremental—This is the recommended approach for both cost and performance reasons and is used by the Default Configuration process automatically.
- Bulk Only—This approach is recommended for proof-of-concept deployments. It is required for the BYOQ with Fan-out configuration. In addition to applying the policy as detailed below, this approach also requires setting the `nav.s3.extractor.incremental.enable` property to `false`. See Setting Properties with Advanced Configuration Snippets on page 141 and the Cloudera Navigator Properties for Amazon S3 on page 142 for details.

To configure the policy:

- Log in to the AWS Management Console using the IAM user account associated with the target Amazon S3 bucket.
- Copy the appropriate JSON text from the table below Extraction Policies JSON Reference on page 140and paste into the AWS Management Console policy editor for the Navigator user account on (the IAM user) through the AWS Management Console.

Extraction Policies JSON Reference

<table>
<tr><th>Bulk + Incremental (Recommended)</th><th>Bulk Only</th></tr>
<tr><td>

- Initial bulk process extracts all metadata.
- Subsequent incremental process extracts changes only (CRUD).
- Cannot be used with Amazon S3 buckets that use event notification.

</td><td>

- Must be used for Amazon S3 buckets configured for event notifications.

</td></tr>
<tr><td><pre>
{
    "Version": "2012-10-17",
    "Statement": [
        {
           "Sid": "Stmt1481678612000",

            "Effect": "Allow",
            "Action": [
                "sqs:CreateQueue",
                "sqs:DeleteMessage",

"sqs:DeleteMessageBatch",

"sqs:GetQueueAttributes",
                "sqs:GetQueueUrl",
                "sqs:ReceiveMessage",

"sqs:SetQueueAttributes"
            ],
            "Resource": "*"
        },
        {
           "Sid": "Stmt1481678744000",

            "Effect": "Allow",
            "Action": [
              "s3:GetBucketLocation",

               "s3:ListAllMyBuckets",

                "s3:ListBucket",
                "s3:GetObject",
                "s3:GetObjectAcl",

"s3:GetBucketNotification",

"s3:PutBucketNotification"
            ],
            "Resource": [
                "arn:aws:s3:::*"
            ]
        }
    ]
}
</pre></td><td><pre>
{
    "Version": "2012-10-17",
    "Statement": [
        {
           "Sid": "Stmt1481676614000",

            "Effect": "Allow",
            "Action": [
              "s3:GetBucketLocation",

               "s3:ListAllMyBuckets",

                "s3:ListBucket",
                "s3:GetObject",
                "s3:GetObjectAcl"
            ],
            "Resource": [
                "arn:aws:s3:::*"
            ]
        }
    ]
}
</pre></td></tr>
</table>

Setting Properties with Advanced Configuration Snippets

Certain features require additional settings or changes to the Cloudera Navigator configuration. For example, configuring BYOQ queues to use bulk-only extraction requires not only creating and attaching the extraction policy but also adding the following snippet to the **Navigator Metadata Server Advanced Configuration Snippet (Safety Valve) for cloudera-navigator.properties** setting:

```
nav.s3.extractor.incremental.enable=false
```

To change property values by adding an advanced configuration snippet:

- Log in to the Cloudera Manager Admin Console.
- Select **Clusters** > **Cloudera Management Service**.
- Click **Configuration**.

- Click **Navigator Metadata Server** under the Scope filter, and click **Advanced** under the Category filter.
- Enter **Navigator Metadata Server Advanced Configuration Snippet (Safety Valve) for cloudera-navigator.properties** in the Search field to find the property.
- Enter the property and its setting as a key-value pair, for example:

```
property=your_setting
```

in:

- Click **Save Changes**.
- Restart the Navigator Metadata Server instance.

Cloudera Navigator Properties for Amazon S3

The table below lists the Navigator Metadata Server properties (`cloudera-navigator.properties`) that control extraction and other features related to Amazon S3. These properties can be set using the Cloudera Manager Admin Console to set properties in the advanced configuration settings.

Changing any of the values in the table requires a restart of Cloudera Navigator.

Option	Description
`nav.aws.api.limit`	Default is `5,000,000`. Maximum number of Amazon Web Services (AWS) API calls that Cloudera Navigator can make per month.
`nav.sqs.max_receive_count`	Default is `10`. Number of retries for inconsistent SQS messages (inconsistent due to eventual consistency).
`nav.s3.extractor.enable`	Default is `true` when an AWS credential has been configured to extract metadata from Amazon S3.
`nav.s3.extractor.incremental.auto_setup.enable`	Default is `true`. Enables Cloudera Navigator to set up Amazon SQS queues to receive notifications from Amazon S3 events. Set to `false` to disable the automatic setup and custom configure your own queue (BYOQ with Fan-out).
`nav.s3.extractor.incremental.batch_size`	Default is `1000`. Number of messages held in memory during the extraction process.
`nav.s3.extractor.incremental.enable`	Default is `true`. Enables incremental extraction. Setting to `false` disables incremental extraction and effectively enables bulk-only extraction.
`nav.s3.extractor.incremental.event.overwrite`	Default is `false`. Prevents any existing event notifications from being overwritten by Cloudera Navigator auto-generated queues created during default configuration process. **Important:** Do not set to `true` unless you fully understand the impact of overwriting event notifications. Setting to `true` may overwrite critical existing business logic.
`nav.s3.extractor.incremental.queues`	No default queue. Used by the custom configuration only. Specify a list of queues for the custom configuration using the JSON template. The list of queues should include the existing queues already in use and the newly configured queue that Cloudera Navigator will use for incremental extracts.
`nav.s3.extractor.max_threads`	Default is 3. The number of extractors (worker processes) to run in parallel.
`nav.s3.home_region`	Default is `us-west-1`. AWS region closest to the cluster and the Cloudera Navigator instance. Select the same AWS region (or the nearest one geographically) to minimize latency for API requests.

Option	Description
`nav.s3.implicit.batch_size`	Default is `1000`. Number of Solr documents held in memory when updating the state of implicit directories.

Cloudera Navigator APIs

Cloudera Navigator exposes REST APIs on the host running the Navigator Metadata Server role instance. In-house, third-party, and other developers can use the APIs to provide functionality not currently available through the Cloudera Navigator console or to customize behavior.

The APIs are used by the Cloudera Navigator console at runtime as users interact with the system. The Cloudera Navigator console has a debug mode that captures API calls and responses to a file that can then be downloaded and analyzed, not only for development projects but also for troubleshooting. Several examples of direct use of the APIs are included in this section.

Navigator APIs Overview

Documentation and a brief tutorial for the Navigator APIs are available on the same node of the cluster that runs the Navigator Metadata Server role. These are also accessible from the Cloudera Navigator console. Example pathnames for direct access (outside the Cloudera Navigator console) are shown in the table.

Resource	Default location
APIs	http://*fqdn-n.example.com:port*/api/v*n*/*operation*
API Documentation	http://*fqdn-n.example.com:port*/api-console/index.html
API Usage Tutorial	http://*fqdn-n.example.com:port*/api-console/tutorial.html

Operations on the API are invoked using the following general pattern:

```
http://fqdn-n.example.com:port/api/vn/operation
```

The *n* in v*n* for the APIs represents the version number, for example, v11 for the Cloudera Navigator version 2.11.x. The API version number is located at the bottom of the Cloudera Navigator API documentation page.

The API uses HTTP Basic Authentication and accepts the same users and credentials that have access to the Cloudera Navigator console.

The resources listed in the table are aimed at technical and general audiences for Cloudera Navigator Data Management. The GitHub repository is aimed at developers.

Resource	Default location
GitHub cloudera/navigator-sdk	Cloudera Navigator SDK is a client library that provides functionality to help users extract metadata from Navigator and to enrich the metadata in Navigator with custom metadata models, entities, and relationships.
Cloudera Community Data Management forum	Cloudera Community > Data Management > Data Discovery, Optimization forum for Cloudera Navigator users and developers.
Cloudera Engineering Blog	In-depth technical content provided by Cloudera engineers about components and specific subject areas.

Accessing API Documentation

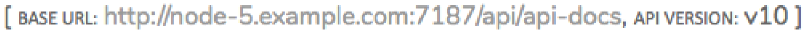
The API documentation is available from the Cloudera Navigator console from a menu selection that navigates to the same URL listed in the table above.

To access the API documentation and tutorial:

1. Click Help.
2. Select **API Documentation**. The interactive API documentation page displays in a new window.
3. Click the Tutorial link near the top of the page to view the Cloudera Navigator API Usage Tutorial to learn about the APIs.

Locating the Version Information for the Navigator API

1. Click Help.
2. Select **API Documentation** to display the API documentation.
3. Scroll to the bottom of the page. The version number is the last item on this page:



[BASE URL: http://node-5.example.com:7187/api/api-docs, API VERSION: v10]

The API is structured into resource categories. Click a category to display the resource endpoints.

Mapping API Versions to Product Versions

The following table identifies the compatibility between API versions and Cloudera Manager and Cloudera Navigator product versions.

Cloudera Manager	Cloudera Navigator	Navigator API
5.14 – 5.16 and later	2.13 – 2.15 and later	v13
5.13	2.12	v12
5.12	2.11	v11
5.10 – 5.11	2.9 – 2.10	v10
5.7 – 5.9	2.6 – 2.8	v9
5.6	2.5	v8

Using Debug Mode

Cloudera Navigator console debug mode captures API responses and requests during interaction with the server. Use debug mode to facilitate development efforts or when asked by Cloudera Support to troubleshoot issues.

Tip: Exploring debug files can be a good way to learn about the APIs.

The general process for obtaining debug files to send to Cloudera Support is as follows:

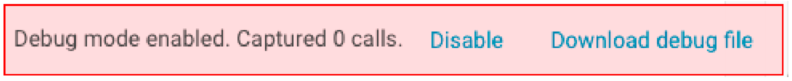
1. Navigate to the Cloudera Navigator console menu item or page for which you want to obtain debug information.
2. Enable debug mode.
3. Reload the page and perform the specific action. For example, if you need to send a debug file to Cloudera Support for an error message that displays when you click on an entity in one of the charts, perform that action to raise the error message.
4. Download the debug file or files. Each time the counter changes, the content of the debug file content changes, so you should download each time the counter updates.
5. Disable debug mode.

To follow these steps you must be logged in to the Cloudera Navigator console.

Enable Debug Mode

The Enable Debug Mode menu selection is effectively a toggle. In other words, when you Enable Debug Mode, the menu selection changes to Disable Debug Mode. To enable debug mode:

1. Click the ***user_name*** from the menu to open the drop-down menu.
2. Select **Enable Debug Mode**. The Cloudera Navigator consoles displays a notification message in the bottom right of the page:

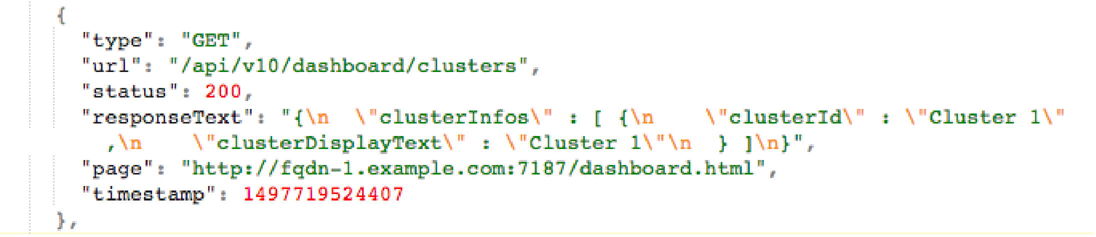


Debug mode enabled. Captured 0 calls. Disable Download debug file

Notice the links to Disable and Download debug file, which you can use at any time to do either. Do not disable debug mode until you have downloaded the debug file you need.

3. Reload the browser page.

The counter *n* displays the number of API calls captured in the debug file for the current session interaction. Here is an example from a downloaded debug file showing one of the responses after reloading the page:



```
{
  "type": "GET",
  "url": "/api/v10/dashboard/clusters",
  "status": 200,
  "responseText": "{\n  \"clusterInfos\" : [ {\n    \"clusterId\" : \"Cluster 1\"
    ,\n    \"clusterDisplayText\" : \"Cluster 1\"\n  } ]\n}",
  "page": "http://fqdn-1.example.com:7187/dashboard.html",
  "timestamp": 1497719524407
},
```

Download Debug File or Files

As you perform actions with the Cloudera Navigator console, the counter refreshes and keeps tracks of current calls only (stateless nature of REST). In other words, download the debug file for any given action or selection that you want to examine.

To download the debug file:

- Click the **Download debug file** link in the debug-enabled notification message.
- Save the file to your local workstation.

Debug files use a naming convention that includes the prefix "api-data" followed by the name of the host and the UTC timestamp of the download time and the JSON file extension. The pattern is as follows:

```
api-data-fqdn-yyyy-mm-ddThh-mm-ss.json
```

For example:

```
api-data-fqdn-2.example.com-2017-06-15T09-00-32.json
```

Disable Debug Mode

When you are finished capturing and downloading debug files, you can disable debug mode.

- Click the **Disable debug mode** link in the notification message box.

The message box is dismissed and debug mode is disabled.

Or, use the Cloudera Navigator console menu:

- Select ***user_name*** > **Disable Debug Mode**.

Set Debug Logging Levels

The Cloudera Navigator Debug Mode allows you to configure the logging levels for individual methods in the application code. For example, to increase the logging detail for API calls, you would set the logging level for the `org.apache.cxf.interceptor` class to "DEBUG" level. If you are collecting debugging information for a specific issue, Cloudera support will provide the class name.

To set the logging level for a Cloudera Navigator application class:

1. Log in to the Cloudera Navigator console.

2. Add /debug to the Navigator URL:

```
http://fqdn-a.example.com:7187/debug
```

   The debugging console appears.

3. Click **Configure Logging**.
4. In the **Logger** drop-down menu, select a Navigator class, such as org.apache.cxf.interceptor for API calls.
5. Set the logging level for the class.

   For example, for the API call logging, select **DEBUG**.

6. Click **Submit**.

When changed in Debug Mode, logging levels will return to their default values after restarting the Navigator Metadata Server. To permanently change the logging levels, use Cloudera Manager to add an entry in the Navigator Metadata Server Logging Advanced Configuration Snippet. Create the entry as follows:

```
log4j.logger.<classname>=<level>
```

For example, to set the API logging level to "DEBUG", include the following string in the Advanced Configuration Snippet:

```
log4j.logger.org.apache.cxf.interceptor=DEBUG
```

See Modifying Configuration Properties Using Cloudera Manager.

Applying Metadata to HDFS and Hive Entities using the API

Using the Navigator API and JSON formatted metadata definition files, entities can be assigned properties in bulk, prior to extraction.

Metadata Definition Files

You can add tags and properties to HDFS entities using metadata files. With metadata files, you can assign metadata to entities in bulk and create metadata before it is extracted. A metadata file is a JSON file with the following structure:

```
{
  "name" : "name",
  "description" : "description",
  "properties" : {
    "key_name_1" : "value_1",
        "key_name_2" : "value_2"
  },
  "tags" : [ "tag_1" ]
}
```

To add metadata files to files and directories, create a metadata file with the extension .navigator, naming the files as follows:

- **File** - The path of the metadata file must be .*filename*.navigator. For example, to apply properties to the file /user/test/file1.txt, the metadata file path is /user/test/.file1.txt.navigator.
- **Directory** - The path of the metadata file must be *dirpath*/.navigator. For example, to apply properties to the directory /user, the metadata path must be /user/.navigator.

The metadata file is applied to the entity metadata when the extractor runs.

Applying HDFS and Hive Metadata

The Navigator APIs can be used modify metadata of HDFS or Hive entities, such as databases, tables, and operations, before or after entity extraction.

- If an entity has been extracted when the API is called, the metadata is applied immediately.
- If the entity has not been extracted, you can preregister metadata, which is then applied once the entity is extracted.

The Navigator SDK includes examples of pre-registering entities. For example, see this example of creating a Hive operation, which will allow you to see lineage for pre-registered entities.

Metadata is saved regardless of whether or not a matching entity is extracted. Cloudera Navigator does not perform any cleanup of unused metadata.

If you call the API before the entity is extracted, the custom metadata is stored with the entity's:

- Identity
- Source ID
- Metadata fields (name, description, tags, properties)
- Fields relevant to the identifier

Other fields (attributes) for the entity, such as Type, are not present.

To view all stored metadata, use the API to search for entities without an internal type, specifically the `entities` endpoint with the `GET` method:

```
http://fqdn-n.example.com:port/api/APIversion/entities/
```

where *fqdn-n.example.com* is the host running the Navigator Metadata Server role instance listening for HTTP connections at the specified *port* number (`7187` is the default port number). *APIversion* is the running version of the API as indicated in the footer of the API documentation (available from the Help menu in the Navigator console) or by calling `http://fqdn-n.example.com:port/api/version`.

For example:

```
curl http://node1.example.com:7187/api/v13/entities/?query=-internalType:* \
-u username:password -X GET
```

User-defined metadata provided through the API overwrites existing metadata. For example, passing empty name and `description` fields with an empty array for `tags` and empty property dictionary with the API call removes the existing metadata. If you omit the tags or properties fields, the existing values remain unchanged. If you want to add a tag to a list of existing tags, you must include the existing tags in your update.

Modifying custom metadata using metadata files and the metadata API at the same time *is not* supported. You must use one or the other, because the two methods work differently.

Metadata specified in JSON files is merged with existing metadata, whereas the API overwrites metadata. Also, the updates provided by metadata files wait in a queue before being merged, but API changes are committed immediately. Some inconsistency can occur if a metadata file is merged when the API is in use.

Metadata is modified using either the `PUT` or `POST` method. Use the `PUT` method if the entity has been extracted, and the `POST` method to preregister metadata. Use the following syntax:

- PUT

```
curl http://fqdn-n.example.com:port/api/APIversion/entities/identity \
-u username:password \
-X PUT \
-H "Content-Type: application/json" \
-d '{properties}'
```

where *identity* is an entity ID and *properties* are:

- `name` - Name metadata.
- `description` - Description metadata.
- `tags` - Tag metadata.
- `properties` - Custom metadata properties. The format is `{key: value}`.

  - `customProperties` - Managed metadata properties. The format is `{namespace: {key: value}}`. If a property is assigned a value that does not conform to type constraints, an error is returned.

  All existing naming rules apply, and if any value is invalid, the entire request is denied.

- `POST`

```
curl http://fqdn-n.example.com:port/api/APIversion/entities/ \
-u username:password \
-X POST \
-H "Content-Type: application/json" \
-d '{properties}'
```

  where *properties* are:

  - [`sourceId`] (required) - An existing source ID. After the first extraction, you can retrieve source IDs using the call:

```
curl http://fqdn-n.example.com:port/api/APIversion/entities/?query=type:SOURCE \
-u username:password -X GET
```

    For example:

```
[ ...
{  {
"identity": "61cfefd303d4284b7f5014b701f2c76d",
"originalName": "source.listing",
"originalDescription": null,
"sourceId": "012437f9eeb3c23dc69e679ac94a7fa2",
"firstClassParentId": null,
"parentPath": "/user/hdfs/.cm/distcp/2016-02-03_487",
...
"properties": {
"__cloudera_internal__hueLink":
"http://fqdn-2.example.com:8888/filebrowser/#/user/hdfs/.cm/distcp/2016-02-03_487/source.listing"

 },
"technicalProperties": null,
"fileSystemPath": "/user/hdfs/.cm/distcp/2016-02-03_487/source.listing",
"type": "FILE",
"size": 92682,
"created": "2016-02-03T21:12:16.587Z",
"lastModified": "2016-02-03T21:12:16.587Z",
"lastAccessed": "2016-02-03T21:12:16.587Z",
"permissions": "rw-r--r--",
"owner": "hdfs",
"group": "supergroup",
"blockSize": 134217728,
"mimeType": "application/octet-stream",
"replication": 3,
"userEntity": false,
"deleted": false,
"sourceType": "HDFS",
"metaClassName": "fselement",
"packageName": "nav",
"internalType": "fselement"
}, ...
```

    If you have multiple services of a given type, you must specify the source ID that contains the entity you expect it to match.

  - `parentPath` - The path of the parent entity, defined as:

    - HDFS file or directory - `fileSystemPath` of the parent directory. (Do not provide this field if the entity affected is the root directory.) Example `parentPath` for `/user/admin/input_dir`: `/user/admin`. If you add metadata to a directory, the metadata does not propagate to any files or folders in that directory.
    - Hive database - If you are updating database metadata, do not specify this field.

    - Hive table or view - The name of database containing the table or view. Example for a table in the default database: `default`.
    - Hive column - *database name*/*table name*/*view name*. Example for a column in the sample_07 table: `default/sample_07`.

- `originalName` (required) - The name as defined by the source system.
    - HDFS file or directory- Name of file or directory (`ROOT` if the entity is the root directory). Example `originalName` for `/user/admin/input_dir`: `input_dir`.
    - Hive database, table, view, or column - The name of the database, table, view, or column.
        - Example for default database: `default`
        - Example for sample_07 table: `sample_07`

- `identity`
- Metadata fields (name, description, tags, properties)
- Fields relevant to the identifier

All existing naming rules apply, and if any value is invalid, the entire request is denied.

API Usage Examples

This section contains some examples.

HDFS PUT Custom Metadata Example for /user/admin/input_dir Directory

```
curl http://node1.example.com:7187/api/v13/entities/e461de8de38511a3ac6740dd7d51b8d0 \
-u username:password \
-X PUT \
-H "Content-Type: application/json"\
-d '{"name":"my_name",
   "description":"My description",
   "tags":["tag1","tag2"],
   "properties":{"property1":"value1","property2":"value2"}}'
```

HDFS POST Custom Metadata Example for /user/admin/input_dir Directory

```
curl http://node1.example.com:7187/api/v13/entities/ \
-u username:password \
-X POST \
-H "Content-Type: application/json" \
-d '{"sourceId":"a09b0233cc58ff7d601eaa68673a20c6",
     "parentPath":"/user/admin",
     "originalName":"input_dir",
     "name":"my_name",
     "description":"My description",
     "tags":["tag1","tag2"],
     "properties":{"property1":"value1","property2":"value2"}}'
```

Hive POST Custom Metadata Example for total_emp Column

```
curl http://node1.example.com:7187/api/v13/entities/\
-u username:password \
-X POST \
-H "Content-Type: application/json" \
-d '{"sourceId":"4fbdadc6899638782fc8cb626176dc7b",
     "parentPath":"default/sample_07",
     "originalName":"total_emp",
     "name":"my_name",
     "description":"My description",
     "tags":["tag1","tag2"],
     "properties":{"property1":"value1","property2":"value2"}}'
```

HDFS PUT Managed Metadata Example

This example adds a property and a tag to the entity identified as "14", which happens to be the Hive `email_preferences` column in the `customers` sample table. The `Approved` property is a Boolean to indicate whether or not the metadata for this column was reviewed and approved. The `ToBeReviewed` tag marks the column temporarily so a data steward can easily find this column for review:

```
curl http://node1.example.com:7187/api/v13/entities/14 \
-u username:password \
-X PUT \
-H "Content-Type: application/json" \
-d '{"tags": ["ToBeReviewed"], \
     "customProperties": {"Operations": \
      {"Approved": false}}}'
```

The server responds:

```
{
  "originalName" : "email_preferences",
  "originalDescription" : null,
  "sourceId" : "7",
  "firstClassParentId" : "13",
  "parentPath" : "/default/customers",
  "deleteTime" : null,
  "extractorRunId" : "7##1",
  "customProperties" : {
    "Operations" : {
      "Approved" : true
    }
  },
  "name" : null,
  "description" : null,
  "tags" : [ "ToBeReviewed" ],
  "properties" : {
    "__cloudera_internal__hueLink" :
"https://node1.example.com:8889/hue/metastore/table/default/customers"
  },
  "technicalProperties" : null,
  "dataType" :
"struct<email_format:string,frequency:string,categories:struct<promos:boolean,surveys:boolean>>",

  "type" : "FIELD",
  "sourceType" : "HIVE",
  "userEntity" : false,
  "metaClassName" : "hv_column",
  "deleted" : false,
  "packageName" : "nav",
  "identity" : "14",
  "internalType" : "hv_column"
}
```

GET Existing Metadata Examples

This section shows some examples of useful `GET /entity` calls:

To retrieve a specific entity:

Use the entity identifier that shows in the URL in the Navigator console. This example gets the metadata for the entity with identifier 21302.

```
curl https://node1.example.com:7187/api/v14/entities/21302 \
-X GET -b NavCookie
```

To retrieve entities that describe the sources Navigator extracts data from:

```
curl https://node1.example.com:7187/api/v14/entities/?query=type%3ASOURCE \
-b NavCookie -X GET
```

To use the source in a query, find its `identity`: In the output, find the name of the source, then collect the identity for that entity. In this example, the `HIVE-1` source has the `identity` "6".

```
{
  "originalName" : "HIVE-1",
  "originalDescription" : null,
  "sourceId" : null,
  "firstClassParentId" : null,
  "parentPath" : null,
  "deleteTime" : null,
  "extractorRunId" : null,
  "customProperties" : null,
  "name" : "HIVE-1",
  "description" : null,
  "tags" : null,
  "properties" : null,
  "technicalProperties" : null,
  "clusterName" : "Cluster 1",
  "sourceUrl" : "thrift://node2.example.com:9083",
  "sourceType" : "HIVE",
  "sourceExtractIteration" : 15,
  "sourceTemplate" : true,
  "hmsDbHost" : "node1.example.com",
  "hmsDbName" : "hive1",
  "hmsDbPort" : "3306",
  "hmsDbUser" : "hive1",
  "type" : "SOURCE",
  "userEntity" : false,
  "deleted" : null,
  "metaClassName" : "source",
  "packageName" : "nav",
  "identity" : "6",
  "internalType" : "source"
}
```

To retrieve all entities from a single source:

Run the previous call to determine the `identity` of the source, then use that value as the `sourceId` in the query. This example uses `sourceId` of 6.

```
curl https://node1.example.com:7187/api/v14/entities/?query=sourceId%3A6 \
-b NavCookie -X GET
```

To retrieve all entities marked with a specific tag:

Use quotes around the tag name. This example retrieves metadata for entities tagged with "sensitive".

```
curl https://node1.example.com:7187/api/v14/entities/?query=tags%3A%22sensitive%22 \
-b NavCookie -X GET
```

To retrieve all entities from a single source and marked with a tag:

This example includes a plus sign (+) before each of the query components to ensure they are treated as an AND relation. Note that this is a case where the query returns the correct results only with the ASCII codes.

```
curl
https://node1.example.com:7187/api/v14/entities/?query=%2btags%3A%22sensitive%22%20%2bsourceId%3A6
 \
-b cookie -X GET
```

To search for pre-registered entities:

This example shows how to get metadata for pre-registered entities, which do not include an internal type:

```
curl http://node1.example.com:7187/api/v13/entities/?query=-internalType:* \
-b cookie -X GET
```

Using the Cloudera Navigator SDK for Metadata Management

To facilitate working with metadata using the Cloudera Navigator APIs, Cloudera provides the Cloudera Navigator SDK. Cloudera Navigator SDK is a client library that provides functionality for extracting and enriching metadata with custom models, entities, and relationships. See GitHub cloudera/navigator-sdk for details.

Using the Purge APIs for Metadata Maintenance Tasks

Required Role: Cloudera Navigator **Full Administrator**

The volume of metadata maintained by Navigator Metadata Server can grow quickly and exceed the capacity of the Solr instance that processes the index and supports the search capability. For faster search and cleaner lineage tracing, use the purge feature to routinely delete unwanted metadata from the system.

Purging stale metadata is also recommended prior to upgrading an existing Cloudera Navigator instance. See Avoiding Out-of-Memory Errors During an Upgrade for details.

Note: Use the Cloudera Navigator console to purge deleted properties from managed metadata. See Deleting, Restoring, and Purging Managed Metadata Properties on page 33. As of Cloudera Navigator 2.11 (Cloudera Manager/CDH 5.12), the Cloudera Navigator console includes a configurable scheduling feature for Purge operations. See Defining Properties for Managed Metadata on page 30.

Purging Metadata for HDFS Entities, Hive and Impala Select Queries, and YARN, Sqoop, and Pig Operations

You can delete obsolete metadata using the `purge` method. Purge is a long-running task that requires exclusive access to the Solr instance and does not allow any concurrent activities, including extraction. For a list of what entities are affected by a purge task, see What Metadata is Purged? on page 81.

To purge metadata, do the following:

1. Back up the Navigator Metadata Server storage directory.
2. Invoke the `maintenance/purge` endpoint with the `POST` method with parameters from the following table:

```
http://fqdn-n.example.com:port/api/APIversion/maintenance/purge?parameters
```

where *fqdn-n.example.com* is the host running the Navigator Metadata Server role instance listening for HTTP connections at the specified *port* number (7187 is the default port number). *APIversion* is the running version of the API as indicated in the footer of the API documentation (available from the Help menu in the Navigator console) or by calling `http://fqdn-n.example.com:port/api/version`.

Table 1: Purge Parameters

Metadata	Parameter	Description
HDFS	`deleteTimeThresholdMinutes`	After an HDFS entity is deleted, the amount of time that elapses before the entity can be purged. **Default:** 86400 minutes (60 days).
	`runtimeCapMinutes`	Amount of time allowed for the HDFS purge process to run. When specified time is reached, the state is saved and the purge process stops. Run purge again to remove any remaining items held in state. **Default:** 720 minutes (12 hours). Set to 0 to effectively disable purge for HDFS files and directories (none will be purged). **Default:** 720 minutes (12 hours).

Metadata	Parameter	Description
Hive and Impala Select Queries; YARN, Sqoop, Pig Operations	deleteSelectOperations	Set to true to enable purge for Hive and Impala SELECT queries, and to enable YARN, Sqoop, and Pig operations older than the `staleQueryThresholdDays` value to be purged. **Default:** false By default, does not purge Hive and Impala SELECT queries, nor are YARN, Sqoop, and Pig operations purged.
	staleQueryThresholdDays	Number of days at which Hive and Impala SELECT queries and YARN, Sqoop, and Pig operations will be identified as stale, effectively marking them 'ready for purge.' They will be purged automatically within hours of the value being reached. **Default:** 60 days. To disable marking entities as stale for the foreseeable future, set the value to very large number, such as 36500.

For example, the following call purges the metadata of all deleted HDFS entities (elapsed minutes value set to 0):

```
$ curl -X POST -u admin:admin
"http://node1.example.com:7187/api/v13/maintenance/purge?deleteTimeThresholdMinutes=0"
```

Purge tasks do not start until all currently running extraction tasks finish.

3. When all tasks have completed, click **Continue** to return to the Cloudera Navigator console.

Retrieving Purge Status

To view the status of the purge process, invoke the `maintenance/running` endpoint with the GET method:

```
http://fqdn-n.example.com:port/api/APIversion/maintenance/running
```

For example:

```
curl -X GET -u admin:admin "http://node1.example.com:7187/api/v13/maintenance/running"
```

A result would look similar to:

```
[{
  "id" : 5,
  "type" : "PURGE",
  "startTime" : "2016-03-10T23:17:41.884Z",
  "endTime" : "1970-01-01T00:00:00.000Z",
  "status" : "IN_PROGRESS",
  "message" : "Purged 2661984 out of 4864714 directories. Averaging 1709 directories
per minute.",
  "username" : "admin",
  "stage" : "HDFS_DIRECTORIES",
  "stagePercent" : 54
}]
```

Retrieving Purge History

To view the purge history, invoke the `maintenance/history` endpoint with the GET method with parameters from the following table:

```
http://fqdn-n.example.com:port/api/APIversion/maintenance/history?parameters
```

where *fqdn-n.example.com* is the host running the Navigator Metadata Server role instance listening for HTTP connections at the specified *port* number (7187 is the default port number). *APIversion* is the running version of the API as indicated in the footer of the API documentation (available from the Help menu in the Navigator console) or by calling `http://`*`fqdn-n.example.com`*`:`*`port`*`/api/version`.

Table 2: History Parameters

Parameter	Description
`offset`	First purge history entry to retrieve. Default: 0.
`limit`	Number of history entries to retrieve from the offset. Default: 100.

For example:

```
curl -X GET -u admin:admin
"http://node1.example.com:7187/api/v13/maintenance/history?offset=0&limit=100"
```

A result would look similar to:

```
[
  {
    "id": 1,
    "type": "PURGE",
    "startTime": "2016-03-09T18:57:43.196Z",
    "endTime": "2016-03-09T18:58:33.337Z",
    "status": "SUCCESS",
    "username": "admin",
    "stagePercent": 0
  },
  {
    "id": 2,
    "type": "PURGE",
    "startTime": "2016-03-09T19:47:39.401Z",
    "endTime": "2016-03-09T19:47:40.841Z",
    "status": "SUCCESS",
    "username": "admin",
    "stagePercent": 0
  },
  {
    "id": 3,
    "type": "PURGE",
    "startTime": "2016-03-10T01:27:39.632Z",
    "endTime": "2016-03-10T01:27:46.809Z",
    "status": "SUCCESS",
    "username": "admin",
    "stagePercent": 0
  },
  {
    "id": 4,
    "type": "PURGE",
    "startTime": "2016-03-10T01:57:40.461Z",
    "endTime": "2016-03-10T01:57:41.174Z",
    "status": "SUCCESS",
    "username": "admin",
    "stagePercent": 0
  },
  {
    "id": 5,
    "type": "PURGE",
    "startTime": "2016-03-10T23:17:41.884Z",
    "endTime": "2016-03-10T23:18:06.802Z",
    "status": "SUCCESS",
    "username": "admin",
    "stagePercent": 0
    }
]
```

Stopping a Purge Operation

To stop a purge operation that is running too long and blocking user access to Navigator, restart the Navigator Metadata Server. To complete the operation, rerun the purge command at a later time.

Cloudera Navigator Reference

This section provides the following reference information:

Lineage Diagram Icons

Entity Types and Icons Reference

In lineage diagrams, entity types are represented by icons that vary depending upon the source system. The table below lists source system and shows the icons that can display in lineage diagrams.

Lineage diagrams are limited to 400 entities. After 400 entities, Cloudera Navigator lineage diagrams use the hidden icon to provide an entry point for exploring additional entities.

Cluster	
⧉	Cluster group
⧉	Cluster instance
HDFS	
🗋	File
📂	Directory
Hive and Impala	Hive entities include tables that result from Impala queries and Sqoop jobs.
▦	Table
▭	Field
•••	Operation, sub-operation, execution
•••	Impala operation, sub-operation, execution
MapReduce and YARN	
•••	MapReduce operation and operation execution
•••	YARN operation and operation execution
Oozie	
•••	Operation, operation execution

Pig	
▦	Table
▭	Pig field
•••	Pig operation, operation execution
Spark	Supported in CDH 5.11 (and higher). Spark lineage is rendered only for data that is read/written or processed using the Dataframe and SparkSQL APIs. Lineage is not available for data that is read/written or processed using Spark RDD APIs. Metadata extraction for Spark can be enabled or disabled. See Configuring and Managing Extraction on page 117 for details.
•••	Operation, operation execution. (Spark RDDs and aggregation operations are not included in the diagrams.)
Sqoop	
•••	Operation, sub-operation, execution
S3	
📂	Directory
🗋	File
🪣	S3 Bucket

Other Icons and Visual Elements in Lineage Diagrams

▢	**Hidden** entities. Used in lineage diagrams containing more than 400 entities. Click this icon to display the hidden entity details. See Exploring Hidden Entities in a Lineage Diagram for more information.
•••	**Placeholder** for an entity that has not yet been extracted. This icon is replaced by the correct entity icon after Cloudera Navigator extracts and links the entity. Hive entities deleted from the system before extraction completes also use this icon, in which case, the icon remains in the lineage diagram.
⊞	**Plus** icon. Click this icon in a lineage diagram to see more information about the entity.

See Metadata Extraction and Indexing for more information the extraction process, including length of time to extract newly created entities.

Types of Relations Shown in Lineage Diagrams

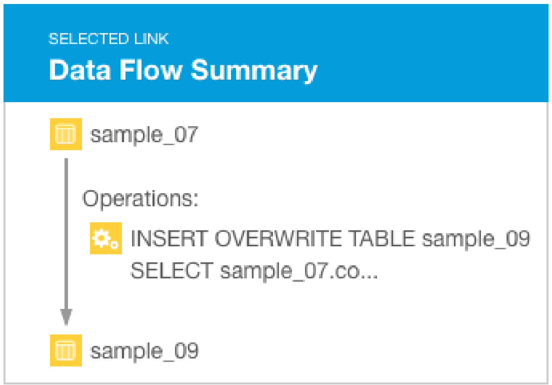
Lineage diagrams render relationships between entities using different line styles and colors. Arrows indicate data flow direction. Cloudera Navigator supports the following types of relations:

Relation Type	Description
Data flow	A relation between data and a processing activity, such as between a file and a MapReduce job or vice versa. Sometime you may see a data flow relation without data assets. If that happens, it may be because they've been deleted. Turn on **Deleted Entities** in the lineage view to see the original data assets.
Parent-child	A parent-child relation. For example, the relation between a directory (parent) and a file (child).
Logical-physical	The relation between a logical entity and its physical entity. For example, between a Hive query and a MapReduce job.
Instance of	The relation between an operation execution and its operation. **Instance of** relations are not rendered in lineage diagrams.
Control flow	A relation in which a source entity controls the data flow of the target entity. For example, the relation between the columns of an `insert` clause and the `where` clause of a Hive query.

Lineage diagrams contain the line types shown in the table:

▬▬▬▬	A solid line depicts a **data flow** relationship, indicating that the columns appear (possibly transformed) in the output (when line has directional arrow) and logical-physical (when line does not have an arrow). For example, a solid line appears between the columns used in a `select` clause. If you don't see the data assets involved, it may be because they've been deleted. Turn on **Deleted Entities** in the lineage view to see the original data assets.
▬ ▬ ▬ ▬ ▬	A dashed line depicts a **control flow** relationship, indicating that the columns determine which rows flow to the output. For example, a dashed line appears between the columns used in an `insert` or `select` clause and the `where` clause of a Hive query. Control flow lines are hidden by default. See Filtering Lineage Diagrams on page 58.
🟦	A blue line depicts a link within the lineage diagram that has been selected.
🟩	A green line depicts a summary link that contains operations. When clicked, the green line turns blue denoting it has been selected, and the nested operations display in a selected link summary.

Selected Link Summary



SELECTED LINK

Data Flow Summary

sample_07

Operations:

INSERT OVERWRITE TABLE sample_09 SELECT sample_07.co...

sample_09

Search Syntax and Properties

Cloudera Navigator search uses an embedded Solr engine that follows the syntax specified for the LuceneQParserPlugin.

Search Syntax

Search strings are constructed by specifying a default property value and one of the four types of key-value pairs as follows:

- **Technical metadata key-value pairs** - *key*:*value*
  - *key* is one of the properties listed in Searchable Properties Reference on page 161.
  - *value* is a single value or range of values specified as `[value1 TO value2]`. In a value, `*` is a wildcard. In property values, you must escape special characters `:`, `-`, `/`, and `*` with the backslash character (`\`), or enclose the property value in quotes.

  Technical metadata key-value pairs are read-only and cannot be modified.
- **Custom metadata key-value pairs** - `up_key:value`
  - *key* is a user-defined property.
  - *value* is a single value or range of values specified as `[value1 TO value2]`. In a value, `*` is a wildcard. In property values, you must escape special characters `:`, `-`, `/`, and `*` with the backslash character (`\`), or enclose the property value in quotes.

  Custom metadata key-value pairs can be modified.
- **Hive extended attribute key-value pairs** - `tp_key:value`
  - *key* is an extended attribute set on a Hive entity. The syntax of the attribute is specific to Hive.
  - *value* is a single value supported by the entity type.

  Hive extended attribute key-value pairs are read-only and cannot be modified.
- **Managed metadata key-value pairs** - *namespace*.*key*:*value*
  - *namespace* is the namespace containing the property. See Defining Properties for Managed Metadata on page 30.
  - *key* is the name of a managed metadata property.
  - *value* is a single value, a range of values specified as `[value1 TO value2]`, or a set of values separated by spaces. In a value, `*` is a wildcard. In property values, you must escape special characters `:`, `-`, `/`, and `*` with the backslash character (`\`), or enclose the property value in quotes.

  Only the values of managed metadata key-value pairs can be modified.
- **S3 key-value pairs** - `tp_key:value`
  - *key* is the name of user-defined metadata.
  - *value* is a single value.
  - Only file metadata is extracted; bucket and folder metadata is not extracted.

Constructing Compound Search Strings

To construct compound search strings, you can join multiple property-value pairs using the Lucene Query Parser Boolean operators:

- `+`, `-`
- `OR`, `AND`, `NOT`

In both syntax m use `( )` to group multiple clauses into a single field and to form sub-queries.

When you filter Search results in the Cloudera Navigator console, the constructed search strings use the `+`, `-` syntax.

Example Search Strings

- Entities in the path `/user/hive` that have not been deleted - `+("/user/hive") +(-deleted:true)`
- Descriptions that start with the string "Banking" - `description:Banking*`
- Entities of type MapReduce or entities of type Hive - `sourceType:mapreduce sourceType:hive` or `sourceType:mapreduce OR sourceType:hive`
- Entities of type HDFS with size equal to or greater than 1024 MiB or entities of type Impala - `(+sourceType:hdfs +size:[1073741824 TO *]) sourceType:impala`
- Directories owned by `hdfs` in the path `/user/hdfs/input` - `+owner:hdfs +type:directory +fileSystemPath:"/user/hdfs/input"` or `owner:hdfs AND type:directory AND fileSystemPath:"/user/hdfs/input"`
- Job started between 20:00 to 21:00 UTC - `started:[2013-10-21T20:00:00.000Z TO 2013-10-21T21:00:00.000Z]`
- Custom key-value - `project-customer1` - `up_project:customer1`
- Technical key-value - In Hive, specify table properties like this:

```
ALTER TABLE table_name SET TBLPROPERTIES ('key1'='value1');
```

To search for this property, specify `tp_key1:value1`.

- Managed key-value with multivalued property - `MailAnnotation.emailTo:"dana@example.com" MailAnnotation.emailTo:"lee@example.com"`

> **Note:** When viewing MapReduce jobs in the Cloudera Manager Activities page, the string that appears in a job Name column equates to the `originalName` property. To specify a MapReduce job name in a search, use the string `(sourceType:mapreduce) and (originalName:`*`jobName`*`)`, where *jobName* is the value in the job Name column.

Searchable Properties Reference

The following sections describe the categories (types) of properties that can be searched.

Default Properties

The following properties can be searched by specifying a property value: `type`, `fileSystemPath`, `inputs`, `jobId`, `mapper`, `mimeType`, `name`, `originalName`, `outputs`, `owner`, `principal`, `reducer`, and `tags`.

Common Properties

Name	Type	Description
`description`	text	Description of the entity.
`group`	caseInsensitiveText	The group to which the owner of the entity belongs.
`name`	ngramedText	The overridden name of the entity. If the name has not been overridden, this value is empty. Names cannot contain spaces.
`operationType`	ngramedText	The type of an operation: • Pig - SCRIPT • Sqoop - Table Export, Query Import
`originalName`	ngramedText	Entity name at extraction time.
`originalDescription`	text	Entity description at extraction.
`owner`	caseInsensitiveText	Entity owner.

Name	Type	Description
principal	caseInsensitiveText	For entities with type OPERATION_EXECUTION, the initiator of the entity.
properties	string	Set of key-value pairs that describe the entity.
tags	ngramedText	Set of tags that describe the entity.
type	tokenizedCaseInsensitiveText	Entity type. Source type of entity determines set of types available. • hdfs - directory, file • hive - database, table, field, operation, operation_execution, sub_operation, partition, view • impala - operation, operation_execution, sub_operation • mapreduce - operation, operation_execution • oozie - operation, operation_execution • pig - operation, operation_execution • spark - operation, operation_execution • sqoop - operation, operation_execution, sub_operation • yarn - operation, operation_execution • cluster - cluster_template,cluster_instance • s3 - file, s3bucket
userEntity	Boolean	Indicates whether an entity was added using the Cloudera Navigator SDK.
Query		
queryText	string	The text of a Hive, Impala, or Sqoop query.
Source		
clusterName	string	The name of the cluster in which the source is managed.
sourceId	string	The ID of the source type.
sourceType	caseInsensitiveText	The source type of the entity: hdfs, hive, impala, mapreduce, oozie, pig, spark, sqoop, or yarn.
sourceUrl	string	The URL of web application for a resource.
Timestamps		
Fields vary by source type: • hdfs - created, lastAccessed, lastModified • hive - created, lastModified • impala, mapreduce, pig, spark, sqoop, and yarn - started, ended	date	Timestamps in the Solr Date Format. For example: • lastAccessed:[* TO NOW] • created:[1976-03-06T23:59:59.999Z TO *] • started:[1995-12-31T23:59:59.999Z TO 2007-03-06T00:00:00Z] • ended:[NOW-1YEAR/DAY TO NOW/DAY+1DAY] • created:[1976-03-06T23:59:59.999Z TO 1976-03-06T23:59:59.999Z+1YEAR] • lastAccessed:[1976-03-06T23:59:59.999Z/YEAR TO 1976-03-06T23:59:59.999Z]

Entity Types

Source	Entity Types
hdfs	DIRECTORY,FILE, DATASET, FIELD
hive	DATABASE, TABLE, FIELD, OPERATION, OPERATION_EXECUTION, SUB_OPERATION, PARTITION, RESOURCE, VIEW
impala	OPERATION, OPERATION_EXECUTION, SUB_OPERATION
mapreduce	OPERATION, OPERATION_EXECUTION
oozie	OPERATION, OPERATION_EXECUTION
pig	OPERATION, OPERATION_EXECUTION
spark	OPERATION, OPERATION_EXECUTION
sqoop	OPERATION, OPERATION_EXECUTION, SUB_OPERATION
yarn	OPERATION, OPERATION_EXECUTION, SUB_OPERATION

Dataset Properties

Name	Type	Description
`compressionType`	tokenizedCaseInsensitiveText	The type of compression of a dataset file.
`dataType`	string	The data type: record.
`datasetType`	tokenizedCaseInsensitiveText	The type of the dataset: Kite.
`fileFormat`	tokenizedCaseInsensitiveText	The format of a dataset file: Avro or Parquet.
`fullDataType`	string	The full data type: record.
`partitionType`	string	The type of the partition.
`schemaName`	string	The name of the dataset schema.
`schemaNameSpace`	string	The namespace of the dataset schema.

HDFS Properties

Name	Type	Description
`blockSize`	long	The block size of an HDFS file.
`deleted`	Boolean	Indicates whether the entity has been moved to the Trash folder.
`deleteTime`	long	The time the entity was moved to the Trash folder.
`fileSystemPath`	path	The path to the entity.
`mimeType`	ngramedText	The MIME type of an HDFS file.
`parentPath`	string	The path to the parent entity of a child entity. For example: `parent path:/default/sample_07` for the table `sample_07` from the Hive database `default`.
`permissions`	string	The UNIX access permissions of the entity.
`replication`	int	The number of copies of HDFS file blocks.
`size`	long	The exact size of the entity in bytes or a range of sizes. Range examples: `size:[1000 TO *]`, `size: [* TO 2000]`, and `size:[* TO *]` to find all fields with a size value.

Hive Properties

Name	Type	Description
Field		
dataType	ngramedText	The type of data stored in a field (column).
Table		
compressed	Boolean	Indicates whether a table is compressed.
serDeLibName	string	The name of the library containing the SerDe class.
serDeName	string	The fully qualified name of the SerDe class.
Partition		
partitionColNames	string	The table columns that define the partition.
partitionColValues	string	The table column values that define the partition.
technical_properties	string	Hive extended attributes.
clusteredByColNames	string	The column names that identify how table content is divided into buckets.
sortByColNames	string	The column names that identify how table content is sorted within a bucket.

MapReduce and YARN Properties

Name	Type	Description
inputRecursive	Boolean	Indicates whether files are searched recursively under the input directories, or only files directly under the input directories are considered.
jobId	ngramedText	The ID of the job. For a job spawned by Oozie, the workflow ID.
mapper	string	The fully qualified name of the mapper class.
outputKey	string	The fully qualified name of the class of the output key.
outputValue	string	The fully qualified name of the class of the output value.
reducer	string	The fully qualified name of the reducer class.

Operation Properties

Name	Type	Description
Operation		
inputFormat	string	The fully qualified name of the class of the input format.
outputFormat	string	The fully qualified name of the class of the output format.
Operation Execution		
inputs	string	The name of the entity input to an operation execution. For entities of resource type mapreduce, yarn, and spark, it is usually a directory. For entities of resource type hive, it is usually a table.

Name	Type	Description
outputs	string	The name of the entity output from an operation execution. For entities of resource type mapreduce, yarn, and spark, it is usually a directory. For entities of resource type hive, it is usually a table.
engineType	string	The type of the engine used for an operation: MR or Spark.

Oozie Properties

Name	Type	Description
status	string	The status of the Oozie workflow: RUNNING, SUCCEEDED, or FAILED.

Pig Properties

Name	Type	Description
scriptId	string	The ID of the Pig script.

S3 Properties

Name	Type	Description
Object Properties		
region	string	The geographic region in which the bucket is stored
bucketName	string	The name of the bucket in which the object is stored
fileSystemPath	path	The key of the S3 object.
size	long	Object size in bytes.
lastModified	date	Object creation date or the last modified date, whichever is the latest.
etag	string	A hash of the object. The ETag reflects changes only to the contents of an object, not its metadata. The ETag may or may not be an MD5 digest of the object data.
storageClass	string	Storage class used for storing the object.
owner	string	Owner of the object.
sequencer	string	Latest S3 event notification sequencer. Used to order events.
parentPath	string	Parent of the S3 object.
technicalProperties	key-value pairs	Custom metadata for each S3 object.
Bucket Properties		
region	string	Region for the bucket.
created	date	Date the bucket was created.
owner	string	Owner of the bucket.

Sqoop Properties

Name	Type	Description
dbURL	string	The URL of the database from or to which the data was imported or exported.
dbTable	string	The table from or to which the data was imported or exported.
dbUser	string	The database user.
dbWhere	string	A where clause that identifies which rows were imported.
dbColumnExpression	string	An expression that identifies which columns were imported.

Service Audit Events

Service audit events are the events generated by a given service running on the cluster. Users with the appropriate permissions (Auditing Viewer, Full Administrator) can view audit events in the Cloudera Navigator console or by using the APIs. Audit events can include the fields listed in the tables below. The field names differ between the Navigator API and the events as they appear when streaming to Kafka or syslog.

The Cloudera Navigator console Audits includes events collected by Cloudera Manager: service ***lifecycle events*** (activate, create, delete, deploy, download, install, start, stop, update, upgrade, and so on) and user ***security-related events*** (add and delete user, login failed and succeeded). See Lifecycle and Security Auditing for more details on Cloudera Manager audit events.

Display Name	Field in API	Field in Streaming	Description
Additional Info	additional_info	additionalInfo	JSON text that contains more details about an operation performed on entities in Navigator Metadata Server.
Allowed	allowed	allowed	Indicates whether the request to perform an operation failed or succeeded. A failure occurs if the user is not authorized to perform the action.
Collection Name	collection_name	collectionName	The name of the affected Solr collection.
Database Name	database_name	db databaseName (Sentry)	For Sentry, Hive, and Impala, the name of the database on which the operation was performed.
Delegation Token ID	delegation_token_id	delegationTokenId	Delegation token identifier generated by HDFS NameNode that is then used by clients when submitting a job to JobTracker.
Destination	dest	dst	Path of the final location of an HDFS file in a rename or move operation.
Entity ID	entity_id	entityId	Identifier of a Navigator Metadata Server entity. The ID can be retrieved using the Navigator Metadata Server API.
Event Time	timestamp	time	Date and time an action was performed. The Navigator Audit Server stores the timestamp in the timezone of the Navigator Audit Server. The Cloudera Navigator console displays the timestamp converted to the local timezone. Exported audit events contain the stored timestamp.
Family	family	family	HBase column family.
Impersonator	impersonator	impersonator	Name of user (service) that invokes an action on behalf of another user (service). Impersonator field always displays

Display Name	Field in API	Field in Streaming	Description
			values when Sentry is not used with the cluster. For clusters that use Sentry, the Impersonator field displays values for all services other than Hive.
IP Address	ipAddress	ip	The IP address of the host where an action occurred.
Object Type	object_type	objType objectType (Sentry)	For Sentry, Hive, and Impala, the type of the object (TABLE, VIEW, DATABASE) on which operation was performed.
Operation	command	op	Commands executed by component. See Operations by Component on page 168 for details. For Cloudera Navigator operations, see Navigator Metadata Server Sub Operations on page 169.
Operation Params	operation_params	operationParams	Solr query or update parameters used when performing the action.
Operation Text	operation_text	opText operationText (Sentry)	For Sentry, Hive, and Impala, the SQL query that was executed by user. For Hue, the user or group that was added, edited, or deleted.
Permissions	permissions	perms	HDFS permission of the file or directory on which the HDFS operation was performed.
Privilege	privilege	privilege	Privilege needed to perform an Impala operation.
Qualifier	qualifier	qualifier	HBase column qualifier.
Query ID	query_id	—	The query ID for an Impala operation. (Internal use only)
Resource	resource	—	A service-dependent combination of multiple fields generated during fetch. This field is not supported for filtering as it is not persisted.
Resource Path	resource_path	path resourcePath (Sentry)	HDFS URL of Hive objects (TABLE, VIEW, DATABASE, and so on). Used for HDFS, Sentry.
Service Name	service	service	The name of the service that performed the action.
Session ID	session_id	—	Impala session ID. (Internal use only)
Solr Version	solr_version	solrVersion	Solr version number.
Source	src	src	Path of the HDFS file or directory present in an HDFS operation.
Status	status	status	Status of an Impala operation providing more information on success or failure.
Stored Object Name	stored_object_name	name	Name of a policy, saved search, or audit report in Navigator Metadata Server.
Sub Operation	sub_operation	subOperation	Operations performed by Navigator Metadata Server are identified by subsystem (authorization, auditing, for example) and by sub-operation within that subsystem. See Navigator Metadata Server Sub Operations on page 169 for details.

Display Name	Field in API	Field in Streaming	Description
Table Name	table_name	table tableName (Sentry)	For Sentry, HBase, Hive, and Impala, the name of the table on which action was performed.
Url		url	Hue only. The URL for the Hue page or API that triggered the event.
Usage Type		objUsageType	Hive only.
Username	username	user	The name of the user that performed the action.

Operations by Component

The Operation field of an audit event includes the actions taken (commands run) on the component. Operations for Cloudera Navigator (and sub-operations) are listed Navigator Metadata Server Sub Operations on page 169.

Note:

Cloudera Navigator does not capture audit events for queries that are run on Spark or HiveServer1/Hive CLI. If you want to use Cloudera Navigator to capture auditing for Hive operations, upgrade to HiveServer2 if you have not done so already.

Component	Action taken
HBase	addColumn, append, assign, balance, balanceSwitch, checkAndDelete, checkAndPut, compact, compactSelection, createTable, delete, deleteColumn, deleteTable, disableTable, enableTable, exists, flush, get, getClosestRowBefore, grant, increment, incrementColumnValue, modifyColumn, modifyTable, move, put, revoke, scannerOpen, shutdown, split, stopMaster, unassign
HDFS	append, concat, create, createSymlink, delete, fsck, getfacl[*], getfileinfo, listEncryptionZones, listSnapshottableDirectory, listStatus, mkdirs, open, rename, setfacl[*], setOwner, setPermission, setReplication, setTimes
HiveServer2 /Beeline	ALTER_PARTITION_MERGE, ALTER_TABLE_MERGE, ALTERDATABASE, ALTERINDEX_PROPS, ALTERINDEX_REBUILD, ALTERPARTITION_FILEFORMAT, ALTERPARTITION_LOCATION, ALTERPARTITION_PROTECTMODE, ALTERPARTITION_SERDEPROPERTIES, ALTERPARTITION_SERIALIZER, ALTERTABLE_ADDCOLS, ALTERTABLE_ADDPARTS, ALTERTABLE_ARCHIVE, ALTERTABLE_CLUSTER_SORT, ALTERTABLE_DROPPARTS, ALTERTABLE_FILEFORMAT, ALTERTABLE_LOCATION, ALTERTABLE_PROPERTIES, ALTERTABLE_PROTECTMODE, ALTERTABLE_RENAME, ALTERTABLE_RENAMECOL, ALTERTABLE_RENAMEPART, ALTERTABLE_REPLACECOLS, ALTERTABLE_SERDEPROPERTIES, ALTERTABLE_SERIALIZER, ALTERTABLE_TOUCH, ALTERTABLE_UNARCHIVE, ALTERVIEW_PROPERTIES, CREATEDATABASE, CREATEFUNCTION, CREATEINDEX, CREATEROLE, CREATETABLE_AS_SELECT, CREATETABLE, CREATEVIEW, DESCDATABASE, DESCFUNCTION, DESCTABLE, DROPDATABASE, DROPFUNCTION, DROPINDEX, DROPROLE, DROPTABLE, DROPVIEW, EXPLAIN, EXPORT, GRANT_PRIVILEGE, GRANT_ROLE, IMPORT, LOAD, LOCKTABLE, MSCK, QUERY, REVOKE_PRIVILEGE, REVOKE_ROLE, SHOW_GRANT, SHOW_ROLE_GRANT, SHOW_TABLESTATUS, SHOW_TBLPROPERTIES, SHOWDATABASES, SHOWFUNCTIONS, SHOWINDEXES, SHOWLOCKS, SHOWPARTITIONS, SHOWTABLES, SWITCHDATABASE, UNLOCKTABLE
Hue	ADD_LDAP_GROUPS, ADD_LDAP_USERS, CREATE_GROUP, CREATE_USER, DELETE_GROUP, DELETE_USER, DOWNLOAD, EDIT_GROUP, EDIT_PERMISSION, EDIT_USER, EXPORT, NAVIGATOR_ADD_TAG, NAVIGATOR_DELETE_TAG, SYNC_LDAP_USERS_GROUPS, USER_LOGIN, USER_LOGOUT

Component	Action taken
Impala	CREATE ROLE, DELETE, DROP ROLE, GRANT *privilege*, GRANT ROLE, INSERT, Query, REVOKE *privilege*, REVOKE ROLE, SHOW GRANT ROLE, SHOW ROLE GRANT, UPDATE, Data Manipulation Language statements
Sentry	ADD_ROLE_TO_GROUP, CREATE_ROLE, DELETE_ROLE_FROM_GROUP, DROP_ROLE, GRANT_PRIVILEGE, REVOKE_PRIVILEGE
Solr	add, commit, CREATE, CREATEALIAS, CREATESHARD, DELETE, DELETEALIAS, deleteById, deleteByQuery, DELETESHARD, finish, LIST, LOAD_ON_STARTUP, LOAD, MERGEINDEXES, PERSIST, PREPRECOVERY, query, RELOAD, RENAME, REQUESTAPPLYUPDATES, REQUESTRECOVERY, REQUESTSYNCSHARD, rollback, SPLIT, SPLITSHARD, STATUS, SWAP, SYNCSHARD, TRANSIENT, UNLOAD

* See HDFS Audit Logging for ACL Operations on page 169.

HDFS Audit Logging for ACL Operations

HDFS audit logging for ACL operations has some variation based on the command options.

Command	Option	Audit Event
`getfacl`	—	getAclStatus
`setfacl`	`--b`	removeAcl
`setfacl`	`--k`	removeDefaultAcl
`setfacl`	`--m`	modifyAclEntries
`setfacl`	`--x`	removeAclEntries
`setfacl`	`--set`	setAcl

There is a difference in audit logging behavior based on how the ACL operations are run:

- Over FileSystem ACL APIs, all `setfacl` and `getfacl` operations produce audit log events.
- Over FsShell (that is, `hadoop fs` or `hdfs dfs` command lines):
  - All `setfacl` operations produce audit log events.
  - `getfacl` operations produce audit log events only if the file has ACLs set.

That is, `setfacl` operations always produce audit log events and `getfacl` operations always produce audit log events when ACLs are set.

Navigator Metadata Server Sub Operations

Operation	Sub Operation
auditReport	createAuditReport, deleteAuditReport, fetchAllReports, updateAuditReport
authorization	deleteGroup, fetchGroup, fetchRoles, searchGroup, updateRoles
metadata	fetchAllMetadata, fetchMetadata, updateMetadata
policy	createPolicy, deletePolicy, deletePolicySchedule, fetchAllPolicies, fetchPolicySchedule, updatePolicy, updatePolicySchedule
savedSearch	createSavedSearch, deleteSavedSearch, fetchAllSavedSearches, fetchSavedSearch, updateSavedSearch

Service Metadata Entity Types

Metadata entities are the data assets stored in and operations generated by services running on the cluster. Users with the appropriate permissions (Metadata and Lineage Viewer, Full Administrator) can view metadata entities in the Cloudera Navigator console or by using the APIs.

The Cloudera Navigator console includes entities extracted from services that are enabled for integration with Navigator Metadata Service.

Navigator creates the following entities from metadata extracted from these services:

Service	Navigator Entity Types Created from Metadata
HDFS	directory, file
HiveServer2	database, table, field, operation, operation_execution, sub_operation, partition, view
Impala	operation, operation_execution, sub_operation
Mapreduce (v1 and v2)	operation, operation_execution
Oozie	operation, operation_execution
Pig	operation, operation_execution
Spark (v1 and v2)	operation, operation_execution
Sqoop (v1)	operation, operation_execution, sub_operation
YARN	operation, operation_execution
Cluster	cluster_template,cluster_instance
S3	file, s3bucket

Hive Operations and Cloudera Navigator Support Matrix

The table below lists Hive DDL and DML statements and whether Cloudera Navigator supports the operation with metadata and lineage extraction.

Hive operations	Cloudera Navigator Metadata Support	Comment
Abort	⊘	Operation does not generate data flow.
Alter Table/Partition/Column	✓	ALTER TABLE RENAME TO does not create query entity. ALTER TABLE CHANGE column name does not create query entity. .
Create Table	✓	
Create/Drop Macro	⊘	Operation does not generate data flow.
Create/Drop/Alter Index	⊘	Operation does not generate data flow.
Create/Drop/Alter View	⊘	Operation does not generate data flow.
Create/Drop/Alter/Use Database	⊘	Operation does not generate data flow.
Create/Drop/Grant/Revoke Roles and Privileges	⊘	Operation does not generate data flow.
Create/Drop/Reload Function	⊘	Operation does not generate data flow.

Hive operations	Cloudera Navigator Metadata Support	Comment
DELETE	⊘	Requires ACID support. Hive ACID not supported.
Describe	⊘	Operation does not generate data flow.
Drop/Truncate Table	⊘	
EXPORT	⊘	Known Issue. . External tables can be exported to HDFS but Cloudera Navigator does not create a query entity for the EXPORT.
IMPORT	⊘	Known Issue. External tables can be imported from HDFS but Cloudera Navigator does not create a query entity for the IMPORT.
INSERT data into Hive Tables from queries	✓	
INSERT data into the filesystem from queries	✓	
INSERT values into tables from SQL	✓	
LOAD	⊘	Known Issue. LOADing a CSV from HDFS into an existing Hive table does not generate lineage.
MERGE	⊘	Requires ACID support. Hive ACID not supported.
MSCK REPAIR	⊘	Tables track their respective partitions. Queries to create or repair partitions using MSCK are not captured as query entities.
Show	⊘	Operation does not generate data flow.
UPDATE	⊘	Requires ACID support. Hive ACID not supported.

Cloudera Navigator extractor for Hive does not support all Hive statements, specifically these:

- Table-generating functions
- Lateral views
- Transform clauses
- Regular expressions (regex) in SELECT clause

Hive queries that include any of the above will prevent lineage diagrams from completing successfully.

User Roles and Privileges Reference

Cloudera Navigator lets authenticated users—those who have successfully logged in to Cloudera Navigator console—access features and functionality according to specifically assigned user roles. The Cloudera Navigator user role scheme requires the use of an external LDAP-compliant identity-directory service, such as OpenLDAP or Microsoft Server Active Directory. See Cloudera Navigator Authentication Overview for details.

After users have been assigned to various groups in the external LDAP-compliant identity-directory service, Cloudera Navigator administrators can grant user roles to various groups as needed. See Administering Navigator User Roles on page 77 for details.

Information about user roles and the specific privileges to Cloudera Navigator is contained in the high-level summary and detailed matrix below.

Cloudera Navigator User Roles

Cloudera Navigator provides the following user roles for organizing and applying user permissions:

- **Auditing Viewer**—View audit events, view audit analytics, and create audit reports.
- **Custom Business Metadata Editor**—Search for entities, view metadata, view lineage, view metadata analytics, edit user-defined properties and tags.
- **Managed and Custom Business Metadata Editor**—Search for entities, view metadata, view lineage, edit user-defined properties, edit managed properties, and define managed metadata models.
- **Metadata & Lineage Viewer**—Search for entities, view metadata, view lineage, and view metadata analytics such as the Data Stewardship Dashboard and the Data Explorer.
- **Policy Editor**—View, create, update, and delete metadata policies.
- **Policy Viewer**—View policies that can be applied to metadata. Note that this role needs to be combined with other roles to give view access to Navigator metadata.
- **User Administrator**—Assign user roles to groups. Requires the group (and the user accounts it contains) to exist in an LDAP-compliant directory service. See Configuring Navigator User Roles and Authentication and Cloudera Navigator for details.
- **Full Administrator**—All Navigator permissions.

Cloudera Manager provides the following user roles for managing Cloudera Manager and Cloudera Navigator.

- **Full Administrator**—Complete administrative and management access, including assigning user roles to groups. Required to install Cloudera Navigator. Users with this role are automatically assigned the Navigator Full Administrator role.
- **Navigator Administrator**—View data in Cloudera Manager, view service and monitoring information, administer Cloudera Navigator, view audit events. Users with this role are automatically assigned the Navigator Full Administrator role.

Cloudera Navigator User Role Details

The Cloudera Manager user roles **Full Administrator** and **Navigator Administrator** have the privileges listed for Full Administrator in the table below.

	Cloudera Navigator User Role							
	Auditing Viewer	**Custom Business Metadata Editor**	**Managed and Custom Business Metadata Editor**	**Metadata & Lineage Viewer**	**Policy Editor**	**Policy Viewer**	**User Administrator**	**Full Administrator**
Role-to-group mapping	⊘	⊘	⊘	⊘	⊘	⊘	✓	✓
Define metadata models	⊘	⊘	✓	⊘	⊘	⊘	⊘	✓
Edit entity name or description	⊘	⊘	✓	⊘	✓	⊘	⊘	✓
Edit custom metadata	⊘	✓	✓	⊘	✓	⊘	⊘	✓
Edit managed metadata	⊘	⊘	✓	⊘	✓	⊘	⊘	✓
Edit policies	⊘	⊘	⊘	⊘	✓	⊘	⊘	✓

	Cloudera Navigator User Role							
	Auditing Viewer	Custom Business Metadata Editor	Managed and Custom Business Metadata Editor	Metadata & Lineage Viewer	Policy Editor	Policy Viewer	User Administrator	Full Administrator
Search for entities	⊘	✓	✓	✓	✓	⊘	⊘	✓
Start maintenance job	⊘	⊘	⊘	⊘	⊘	⊘	⊘	✓
View audit analytics	✓	⊘	⊘	⊘	⊘	⊘	⊘	✓
View audit events and create reports	✓	⊘	⊘	⊘	⊘	⊘	⊘	✓
View lineage	⊘	⊘	✓	✓	⊘	⊘	⊘	✓
View maintenance history	⊘	⊘	⊘	⊘	⊘	⊘	⊘	✓
View metadata analytics	⊘	✓	✓	✓	✓	⊘	⊘	✓
View metadata policies	⊘	⊘	⊘	⊘	✓	✓	⊘	✓
Enable debugging tools	⊘	⊘	⊘	⊘	⊘	⊘	⊘	✓

Troubleshooting Navigator Data Management

This page contains troubleshooting tips and workarounds for various issues that can arise.

Cloudera Navigator-Cloudera Altus

No metadata or lineage collected from an Altus deployed cluster.

Symptom: No metadata collected from a Cloudera Altus instantiated cluster. Although both the Cloudera Altus environment has been setup to use a given Amazon S3 bucket and the Cloudera Navigator instance has been configured to read from that same S3 bucket, no metadata is collected.

Possible cause: Permissions on the Amazon S3 bucket have not been applied correctly.

Steps to resolve: To determine the root cause of this issue:

- Check that permissions have been set properly on the Amazon S3 bucket.
- Verify that the Amazon S3 bucket name has not been changed.

To determine if the cause of the issue is misconfiguration, look at the Telemetry Publisher logs. A failure message in the log such as the following means that the Amazon S3 bucket has either not been properly identified, or that the correct permissions have not been set:

```
...Metadata export failed com.amazonaws.services.s3.model.AmazonS3Exception: The specified
 bucket does not exist
  (Service: Amazon S3; Status Code: 404; Error Code: NoSuchBucket; Request ID:
D28543E2494BD521), S3 Extended Request ID:
...
```

The 404 status code and "NoSuchBucket" in the error message indicate the Telemetry Publisher was unable to write to Amazon S3 bucket because the bucket was misidentified or that permissions were configured incorrectly.

Navigator Audit Server

"No serializer found" error

Symptom: Selecting an Audits page results in error message.

Error message:

```
No serializer found
```

Possible cause: Communication failure somewhere between Navigator Metadata Server and Cloudera Manager Server and its communication to Navigator Audit Server. This is an existing Known Issue that needs to be resolved so that the error message can be properly mapped.

Workaround: This workaround does not resolve the issue, but provides additional information as to the actual source of the underlying error.

1. Log in to the Cloudera Navigator console.
2. Enable Navigator API logging.
3. Perform your action on the Audits page that raised the error message and see if the underlying issue is caught in the API log. If the Navigator API logging reveals no additional information, turn on API logging for Cloudera Manager:
    - Log in to the Cloudera Manager Admin Console.
    - Select **Administrator** > **Settings**

- Select **Advanced** for the **Category** filter.
- Click the **Enable Debugging of API** check box to select it. The server log will contain all API calls. Try your request again and see if the source error message displays in the response.

Processing a backlog of audit logs

Problem: You have logs that include audit events that were not processed by the Cloudera Navigator Audit Server, such as logs for events that took place before audit server was online or during a period when audit server was offline.

Solution: A backlog of logs can be processed by audit server as follows:

1. Backup audit files for all roles on all hosts.

   Do this right away as there are retention periods configured for these files and they will gradually be deleted.

2. Determine what days were not processed. The audit log files have the UNIX epoch appended to their name:

```
hdfs-NAMENODE-341ad9b94435839ce45b8b22e7c805b3-HdfsAuditLogger-1499844328581
```

   You want the dates from the oldest and newest files. You can do this by sorting the list and identifying the first and last files. For example, for HDFS audit files:

   The oldest: `$ ls ./hdfs* | head -1`

   The newest: `$ ls ./hdfs* | tail -1`

   Depending on your shell, you can convert the epoch value to a date using `date -r` *`epoch`*.

3. Create partitions in the Navigator Audit Server database for days that have missing audits.

   Create a partition from an existing template table using SQL commands. Use `SHOW TABLES` to list the template tables. For example, the template table for HDFS is `HDFS_AUDIT_EVENTS`.

   Using MySQL as an example, if you have partitions up to March 31, 2017 and your audit logs include HDFS data for the first week of April, you would run the following SQL commands:

```
CREATE TABLE HDFS_AUDIT_EVENTS__2017_04_01 LIKE HDFS_AUDIT_EVENTS;
CREATE TABLE HDFS_AUDIT_EVENTS__2017_04_02 LIKE HDFS_AUDIT_EVENTS;
CREATE TABLE HDFS_AUDIT_EVENTS__2017_04_03 LIKE HDFS_AUDIT_EVENTS;
CREATE TABLE HDFS_AUDIT_EVENTS__2017_04_04 LIKE HDFS_AUDIT_EVENTS;
CREATE TABLE HDFS_AUDIT_EVENTS__2017_04_05 LIKE HDFS_AUDIT_EVENTS;
CREATE TABLE HDFS_AUDIT_EVENTS__2017_04_06 LIKE HDFS_AUDIT_EVENTS;
CREATE TABLE HDFS_AUDIT_EVENTS__2017_04_07 LIKE HDFS_AUDIT_EVENTS;
```

4. In the PARTITION_INFO table, add new rows for each of the tables you created in the previous step, including the "END_TS" in Unix epoch time, 24 hours after the previous entry.

   The following example command inserts a row for Feb 14, 2019 into PARTITION_INFO table with correct END_TS value for multiple partition tables:

```
insert into PARTITION_INFO values (PARTITION_INFO_SEQUENCE.nextval,
‘HDFS_AUDIT_EVENTS_2019_02_03’ ,‘HDFS_AUDIT_EVENTS’, 1550145600000, null,0);
```

5. Change the Navigator Audit expiration period to be longer than the time period of the logs you want to process.

   Set the expiration period in Cloudera Manager. Search for the property “Navigator Audit Server Data Expiration Period”.

6. Stop the Cloudera Manager agent on the host running the role for the service whose logs will be restored.

   For example, if the logs are for HDFS, stop the agent on the namenode. For HiveServer2, stop the Cloudera Manager agent on the node where HiveServer2 is running. See Starting, Stopping, and Restarting Cloudera Manager Agents.

   If you aren’t sure of which host is involved, the log files contain the UUID of the role which generated them. Go to the host defined for that role. For high-availability clusters, make sure that you stop the role on the active host.

7. On that host, copy the backed up audit logs to the audit directory.

   The location is typically `/var/log/`*`service`*`/audit`. For example, `/var/log/hadoop-hdfs/audit`. The specific locations are configured in the Cloudera Manager `audit_event_log_dir` properties for each service.

8. Move the WAL file out of this directory. (Back it up in a safe location.)
9. Restart the Cloudera Manager agent.

   On restart, Cloudera Manager agent will not find the WAL file and will create a new one. It will process the older audit logs one by one.

10. Verify that the audits appear in Navigator.

    You can also check the contents of the WAL file to see which logs were processed.

Navigator Metadata Server

"Missing required field: id" (Solr exception)

Symptom: After removing the Navigator Metadata Server storage directory (the `datadir`), an error message for the `id` field displays.

Error message:

```
[qtp1676605578-63]: org.apache.solr.common.SolrException:
  [doc=0002ac6b75cb17721ad8324700f473cb] missing required field: id
```

Possible cause: This error indicates that the Navigator Metadata Server database and storage directory are out-of-sync because of a change that was made in the Cloudera Navigator 2.9 (Cloudera Manager 5.10) release. When the Navigator Metadata Server role starts, it compares state information in the database with the same information in the storage directory. This error can appear if the storage directory has been deleted but the database has not.

Steps to resolve: If this error message occurs and the storage directory was recently deleted, you can remove the stale state information from the database. To do this:

1. Take note of the Navigator Metadata Server Storage Dir directory.

   Log into Cloudera Manager and browse to **Cloudera Management Services** > **Configuration** > **Navigator Metadata Server** > **Navigator Metadata Server Storage Dir**. Note the storage directory location.

2. Stop the Navigator Metadata Server role by navigating to **Cloudera Management Service Instances** > **Navigator Metadata Server** > **Actions** > **Stop**.
3. Log in to the database instance configured for use with Navigator Metadata Server.
4. Run the following SQL commands:

```
delete from NAV_UPGRADE_ORDINAL;
insert into nav_upgrade_ordinal values (-1, -1);
```

5. Start Navigator Metadata Server role using **Cloudera Management Service Instances** > **Navigator Metadata Server** > **Actions** > **Start**.

The Navigator Metadata Server role should restart successfully.

Repairing metadata in the storage directory after upgrading

If you ran Cloudera Navigator on Cloudera Manager versions 5.10.0, 5.10.1, or 5.11.0, you should upgrade to a later release immediately to avoid a known software problem as reported in the knowledge base entry "Upgrade needed for Cloudera Navigator included with Cloudera Manager releases 5.10.0, 5.10.1, and 5.11.0 due to high risk of failure through exhausting data directory resources." This document describes some additional steps to perform after upgrade to mitigate for duplicate and potentially broken relation metadata added to the Navigator storage directory because of the broken versions.

To fully recover the Navigator storage directory:

1. Upgrade Cloudera Manager to 5.10.2, 5.11.1, or later releases.

   See Upgrading Cloudera Manager.

2. Set properties to enable background repair tasks.

   From Cloudera Manager, go to **Cloudera Management Service** > **Navigator Metadata Server** > **Advanced**.

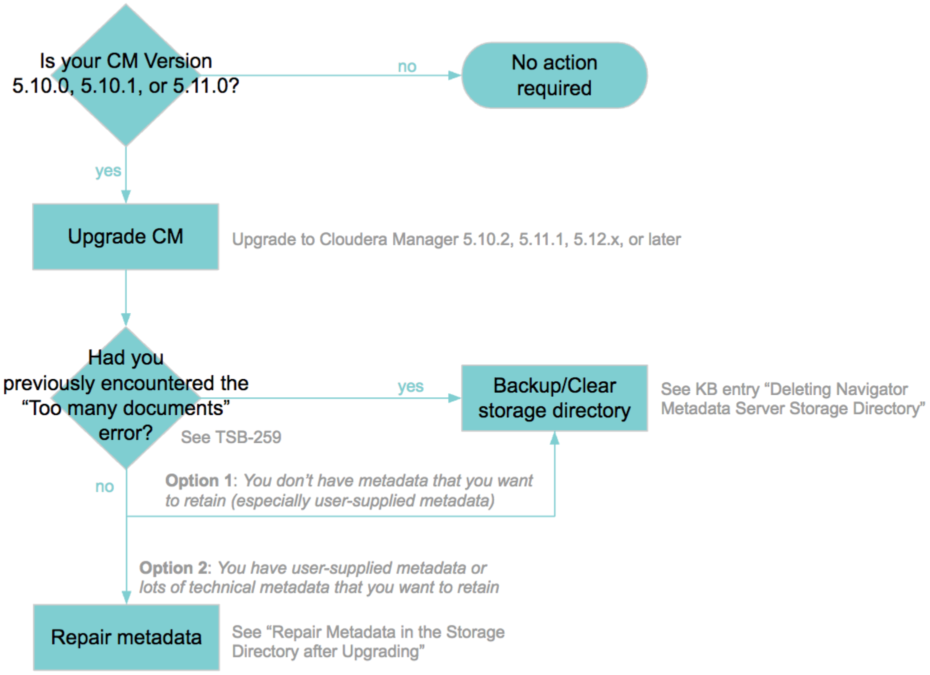
   Enter the following configurations to the "Navigator Metadata Server Advanced Configuration Snippet (Safety Valve) for cloudera-navigator.properties" property.

```
nav.backend.task.TRIGGER_HIVE_TABLES_EXTRACTION.enabled=true
nav.backend.task.HDFS_PC_RELATIONS_BUILDER.enabled=true
nav.backend.task.HDFS_MR_RELATIONS_BUILDER.enabled=true
nav.backend.task.PIG_HDFS_RELATIONS_BUILDER.enabled=true
```

3. Restart the Navigator Metadata Server role.

The full cycle of cleaning up the relations may take days or weeks depending on the number of relations affected.

These instructions correspond to “Repair metadata” in the following decision tree:


Is your CM Version
5.10.0, 5.10.1, or 5.11.0?
no
No action required
yes
Upgrade CM
Upgrade to Cloudera Manager 5.10.2, 5.11.1, 5.12.x, or later
Had you previously encountered the “Too many documents” error?
See TSB-259
yes
Backup/Clear storage directory
See KB entry “Deleting Navigator Metadata Server Storage Directory”
no
Option 1: You don't have metadata that you want to retain (especially user-supplied metadata)
Option 2: You have user-supplied metadata or lots of technical metadata that you want to retain
Repair metadata
See “Repair Metadata in the Storage Directory after Upgrading”

Appendix: Apache License, Version 2.0

SPDX short identifier: Apache-2.0

Apache License
Version 2.0, January 2004
http://www.apache.org/licenses/

TERMS AND CONDITIONS FOR USE, REPRODUCTION, AND DISTRIBUTION

1. Definitions.

"License" shall mean the terms and conditions for use, reproduction, and distribution as defined by Sections 1 through 9 of this document.

"Licensor" shall mean the copyright owner or entity authorized by the copyright owner that is granting the License.

"Legal Entity" shall mean the union of the acting entity and all other entities that control, are controlled by, or are under common control with that entity. For the purposes of this definition, "control" means (i) the power, direct or indirect, to cause the direction or management of such entity, whether by contract or otherwise, or (ii) ownership of fifty percent (50%) or more of the outstanding shares, or (iii) beneficial ownership of such entity.

"You" (or "Your") shall mean an individual or Legal Entity exercising permissions granted by this License.

"Source" form shall mean the preferred form for making modifications, including but not limited to software source code, documentation source, and configuration files.

"Object" form shall mean any form resulting from mechanical transformation or translation of a Source form, including but not limited to compiled object code, generated documentation, and conversions to other media types.

"Work" shall mean the work of authorship, whether in Source or Object form, made available under the License, as indicated by a copyright notice that is included in or attached to the work (an example is provided in the Appendix below).

"Derivative Works" shall mean any work, whether in Source or Object form, that is based on (or derived from) the Work and for which the editorial revisions, annotations, elaborations, or other modifications represent, as a whole, an original work of authorship. For the purposes of this License, Derivative Works shall not include works that remain separable from, or merely link (or bind by name) to the interfaces of, the Work and Derivative Works thereof.

"Contribution" shall mean any work of authorship, including the original version of the Work and any modifications or additions to that Work or Derivative Works thereof, that is intentionally submitted to Licensor for inclusion in the Work by the copyright owner or by an individual or Legal Entity authorized to submit on behalf of the copyright owner. For the purposes of this definition, "submitted" means any form of electronic, verbal, or written communication sent to the Licensor or its representatives, including but not limited to communication on electronic mailing lists, source code control systems, and issue tracking systems that are managed by, or on behalf of, the Licensor for the purpose of discussing and improving the Work, but excluding communication that is conspicuously marked or otherwise designated in writing by the copyright owner as "Not a Contribution."

"Contributor" shall mean Licensor and any individual or Legal Entity on behalf of whom a Contribution has been received by Licensor and subsequently incorporated within the Work.

2. Grant of Copyright License.

Subject to the terms and conditions of this License, each Contributor hereby grants to You a perpetual, worldwide, non-exclusive, no-charge, royalty-free, irrevocable copyright license to reproduce, prepare Derivative Works of, publicly display, publicly perform, sublicense, and distribute the Work and such Derivative Works in Source or Object form.

3. Grant of Patent License.

Subject to the terms and conditions of this License, each Contributor hereby grants to You a perpetual, worldwide, non-exclusive, no-charge, royalty-free, irrevocable (except as stated in this section) patent license to make, have made, use, offer to sell, sell, import, and otherwise transfer the Work, where such license applies only to those patent claims licensable by such Contributor that are necessarily infringed by their Contribution(s) alone or by combination of their Contribution(s) with the Work to which such Contribution(s) was submitted. If You institute patent litigation against any entity (including a cross-claim or counterclaim in a lawsuit) alleging that the Work or a Contribution incorporated within the Work constitutes direct or contributory patent infringement, then any patent licenses granted to You under this License for that Work shall terminate as of the date such litigation is filed.

4. Redistribution.

You may reproduce and distribute copies of the Work or Derivative Works thereof in any medium, with or without modifications, and in Source or Object form, provided that You meet the following conditions:

1. You must give any other recipients of the Work or Derivative Works a copy of this License; and
2. You must cause any modified files to carry prominent notices stating that You changed the files; and
3. You must retain, in the Source form of any Derivative Works that You distribute, all copyright, patent, trademark, and attribution notices from the Source form of the Work, excluding those notices that do not pertain to any part of the Derivative Works; and
4. If the Work includes a "NOTICE" text file as part of its distribution, then any Derivative Works that You distribute must include a readable copy of the attribution notices contained within such NOTICE file, excluding those notices that do not pertain to any part of the Derivative Works, in at least one of the following places: within a NOTICE text file distributed as part of the Derivative Works; within the Source form or documentation, if provided along with the Derivative Works; or, within a display generated by the Derivative Works, if and wherever such third-party notices normally appear. The contents of the NOTICE file are for informational purposes only and do not modify the License. You may add Your own attribution notices within Derivative Works that You distribute, alongside or as an addendum to the NOTICE text from the Work, provided that such additional attribution notices cannot be construed as modifying the License.

You may add Your own copyright statement to Your modifications and may provide additional or different license terms and conditions for use, reproduction, or distribution of Your modifications, or for any such Derivative Works as a whole, provided Your use, reproduction, and distribution of the Work otherwise complies with the conditions stated in this License.

5. Submission of Contributions.

Unless You explicitly state otherwise, any Contribution intentionally submitted for inclusion in the Work by You to the Licensor shall be under the terms and conditions of this License, without any additional terms or conditions. Notwithstanding the above, nothing herein shall supersede or modify the terms of any separate license agreement you may have executed with Licensor regarding such Contributions.

6. Trademarks.

This License does not grant permission to use the trade names, trademarks, service marks, or product names of the Licensor, except as required for reasonable and customary use in describing the origin of the Work and reproducing the content of the NOTICE file.

7. Disclaimer of Warranty.

Unless required by applicable law or agreed to in writing, Licensor provides the Work (and each Contributor provides its Contributions) on an "AS IS" BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied, including, without limitation, any warranties or conditions of TITLE, NON-INFRINGEMENT, MERCHANTABILITY, or FITNESS FOR A PARTICULAR PURPOSE. You are solely responsible for determining the appropriateness of using or redistributing the Work and assume any risks associated with Your exercise of permissions under this License.

8. Limitation of Liability.

In no event and under no legal theory, whether in tort (including negligence), contract, or otherwise, unless required by applicable law (such as deliberate and grossly negligent acts) or agreed to in writing, shall any Contributor be liable to You for damages, including any direct, indirect, special, incidental, or consequential damages of any character arising as a result of this License or out of the use or inability to use the Work (including but not limited to damages for loss of goodwill, work stoppage, computer failure or malfunction, or any and all other commercial damages or losses), even if such Contributor has been advised of the possibility of such damages.

9. Accepting Warranty or Additional Liability.

While redistributing the Work or Derivative Works thereof, You may choose to offer, and charge a fee for, acceptance of support, warranty, indemnity, or other liability obligations and/or rights consistent with this License. However, in accepting such obligations, You may act only on Your own behalf and on Your sole responsibility, not on behalf of any other Contributor, and only if You agree to indemnify, defend, and hold each Contributor harmless for any liability incurred by, or claims asserted against, such Contributor by reason of your accepting any such warranty or additional liability.

END OF TERMS AND CONDITIONS

APPENDIX: How to apply the Apache License to your work

To apply the Apache License to your work, attach the following boilerplate notice, with the fields enclosed by brackets "[]" replaced with your own identifying information. (Don't include the brackets!) The text should be enclosed in the appropriate comment syntax for the file format. We also recommend that a file or class name and description of purpose be included on the same "printed page" as the copyright notice for easier identification within third-party archives.

```
Copyright [yyyy] [name of copyright owner]

Licensed under the Apache License, Version 2.0 (the "License");
you may not use this file except in compliance with the License.
You may obtain a copy of the License at

  http://www.apache.org/licenses/LICENSE-2.0

Unless required by applicable law or agreed to in writing, software
distributed under the License is distributed on an "AS IS" BASIS,
WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
See the License for the specific language governing permissions and
limitations under the License.
```