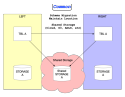

hms-mirror utility

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Introduction

is a utility used to bridge the gap between two clusters and migrate `hive` *metadata*. HMS-Mirror is distributed under the APLv2 (License APLv2) license.

The application will migrate hive metastore data (metadata) between two clusters. With SQL (SQL) and EXPORT_IMPORT (EXPORT_IMPORT) data strategies, we can move data between the two clusters using Hive SQL.

As an alternative to using Hive SQL to move data between two clusters, `hms-mirror` can build `distcp` plans and scripts that can be run in concert with the metadata scripts to complete the migration.

You start by picking a 'Data Strategy' that fits your needs. A **Data Strategy** defines how you're choosing to migrate 'metadata' and 'data' between two clusters. Some of the strategies are 'metadata' only, and some are 'metadata' and 'data'. Others are used to migrate data 'within' a cluster (STORAGE_MIGRATION) to facilitate changes in the storage layer. This can be to move data into an encrypted zone or to a different storage layer, like Ozone.

There are two interface (working on a third) for `hms-mirror`: CLI (CLI Interface) and WebUI (Web Interface)

From both interfaces, reports are generated that detail the actions taken by the application. You can direct it to run the conversion scripts automatically or just generate the scripts for you to run later.

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Release Notes

v.2.x Changes

This is a big release for `hms-mirror`. We've added a Web interface to `hms-mirror` that makes it easier to configure and run varies scenarios.

Along with the Web interface, we've made some significant adjustments to the `hms-mirror` engine which is much more complete than the previous release. The engine now supports a wider range of strategies and has a more robust configuration system.

We do our best to guide you through configurations that make sense, help you build plans and manage complex scenarios.

Automatic Configuration Adjustments

To ensure that configuration settings are properly set, the application will automatically adjust the configuration settings to match a valid scenario. These changes will be recorded in the 'run status config messages' section and can be seen on reports or the web interface.

Changes are mostly related to the acceptable strategy configurations. See Location Alignment (Location Alignment) for more details.

Evaluate Partition Locations and Reset to Default Location

These properties are no longer valid. An added property called 'translationType' is used to determine this functionality.

Before the `epl|evaluate-partition-locations` would gather partition location information from the Metastore Direct connection to ensure they were aligned. We've adjusted/simplified the concept with `translationType`, which defined either `RELATIVE` or `ALIGNED` strategy types.

See Location Alignment (Location Alignment) for more details.

Concurrency

In previous releases using the CLI, concurrency could be set through the configuration files `transfer:concurrency` setting. The default was 4 if no setting was provided. This

setting in the control file is NO LONGER supported and will be ignored. The new default concurrency setting is `10` and can be overridden only during the application startup.

See Concurrency (Concurrency) for more details.

Global Location Maps

Previous releases had a fairly basic implementation of 'Global Location Maps'. These could be supplied through the cli option `-glm`, which is still supported, but limited in functionality. The improved implementation work from the concept of building 'Warehouse Plans' which are then used to build the 'Global Location Maps'.

See Warehouse Plans for more details.

The `-glm` option can take an addition element to identify the mapping for a particular table type. As a result, any configuration files save with this setting will not be loaded and will need to be updated.

While the `-glm` option will still honor the old format of `source_dir=target_dir`, the new format is `source_dir:<table_type>:target_dir`. The `table_type` is a new addition to the configuration and is required for the new implementation. When omitted, the mapping will be created for both EXTERNAL and MANAGED tables.

`<table_type>` can be one of: `EXTERNAL_TABLE` or `MANAGED_TABLE`.

`-glm /tpsds_base_dir=EXTERNAL_TABLE:/alt/ext/location`

Old Format

```
globalLocationMap:
  /tpcds_base_dir: "/alt/ext/location"
  /tpcds_base_dir2/web: "/alt/ext/location"
```

New Format

```
userGlobalLocationMap:
  /tpcds_base_dir:
    EXTERNAL_TABLE: "/alt/ext/location"
  /tpcds_base_dir2/web:
    EXTERNAL_TABLE: "/alt/ext/location"
```

JDK 11 Support

The application now supports JDK 11, as well as JDK 8.

Kerberos Support and Platform Libraries

We are still working to replicate the options available in previous release with regard to Kerberos connections. Currently, `hms-mirror` can only support a single Kerberos connection. This is the same as it was previously. `hms-mirror` packaging includes the core Hadoop classes required for Kerberos connections pulled from the latest CDP release.

In the past, we 'could' support kerberos connections to lower versions of Hadoop clusters (HDP and CDH) by running `hms-mirror` on a cluster with those hadoop libraries installed and specifying `--hadoop-classpath` on the commandline. This is no longer supported, as the packaging required to support the Web and REST interfaces is now different.

We are investigating the possibility of supporting kerberos connections to lower clusters in the future.

Metastore Direct Access

In later 1.6 releases we introduced a 'Metastore Direct' connection type when defining a LEFT(source) cluster. To help build a more complete picture of locations in the metadata, we found it necessary to gather detailed location information for each partition of the datasets being inspected. Because Hive was so configurable regarding location preferences and the ability to set locations at the partition level, we needed to ensure that the locations were aligned. The only sure way to get this complete picture was to connect directly to the Metastore backend database. We currently support 'MYSQL' and 'POSTGRES' metastore backends. 'Oracle' coming soon.

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Getting Started

- Setup
- Picking an interface
- Starting the application
- Building a Configuration

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Setup

Binary Package

Download the latest version of `hms-mirror-<version>-dist.tar.gz` (https://github.com/cloudera-labs/hms-mirror/releases)

HMS-Mirror Setup from Binary Distribution

On the edgenode:

- Remove previous install directory `rm -rf hms-mirror-install-<version>`
  - If you don't remove the previous install directory, the default `tar` behaviour will NOT overwrite the existing directory, hence you won't get the new version.
- Expand the tarball `tar zxvf hms-mirror-<version>-dist.tar.gz`.

  > ⚠ This produces a child `hms-mirror-install-<version>` directory.

- Two options for installation:
  - As the root user (or `sudo`), run `hms-mirror-install-<version>/setup.sh`. This will install the `hms-mirror` packages in `/usr/local/hms-mirror` and create symlinks for the executables in `/usr/local/bin`. At this point, `hms-mirror` should be available to all user and in the default path.
  - As the local user, run `hms-mirror-install-<version>/setup.sh`. This will install the `hms-mirror` packages in `$HOME/.hms-mirror` and create symlink in `$HOME/bin`. Ensure `$HOME/bin` is in the users path and run `hms-mirror`.

DO NOT RUN `hms-mirror` from the installation directory.

If you install both options, your environment PATH will determine which one is run. Make note of this because an upgrade may not be reachable.

Quick Start

After installation (above), run `hms-mirror` for the particular interface that interests you.

Web UI

Run:
`hms-mirror --service`
Open a browser to `http://hostname:8090/hms-mirror` to access the Web UI.

CLI

`hms-mirror` requires a configuration file describing the LEFT (source) and RIGHT (target) cluster connections. There are two ways to create the config:

- Use the default config template (Default Configuration Template)) as a starting point. Edit and place a copy here `$HOME/.hms-mirror/cfg/default.yaml`.
- `hms-mirror --setup` - Prompts a series of questions about the LEFT and RIGHT clusters to build the default configuration file.

If either or both clusters are Kerberized, please review the detailed configuration guidance here ("Running Against a LEGACY (Non-CDP) Kerberized HiveServer2" in "Running") and here ("Kerberized Connections" in "Running").

General Guidance

- Run `hms-mirror` from the RIGHT cluster on an Edge Node.

> ⚠ `hms-mirror` is built (default setting) with CDP libraries and will connect natively using those libraries. The edge node should have the hdfs client installed and configured for that cluster. The application will use this connection for some migration strategies.

- If running from the LEFT cluster, note that the `-ro/--read-only` feature examines HDFS on the RIGHT cluster. The HDFS client on the LEFT cluster may not support this access.

- Connecting to HS2 through KNOX (in both clusters, if possible) reduces the complexities of the connection by removing Kerberos from the picture.
- The libraries will only support a Kerberos connection to a 'single' version of Hadoop at a time. This is relevant for 'Kerberized' connections to Hive Server 2. The default libraries will support a kerberized connection to a CDP clusters HS2 and HDFS. If the LEFT (source) cluster is Kerberized, including HS2, you will need to make some adjustments.
  - The LEFT clusters HS2 needs to support any auth mechanism BUT Kerberos.
  - Use an Ambari Group to setup an independent HS2 instance for this exercise or use KNOX.

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Runtime Interfaces

The classic 'hms-mirror' interface is the command line interface (CLI). This is the interface that most users have used in the past. Support for this is still provided but is quickly being replaced by the Web interface.

The CLI interface requires users to define a configuration file that the is used to control connection endpoints, and cluster attributes. Runtime operations are controlled by command line options that are passed to the application.

The Web interface provides a much more complete experience for users and allows configurations to be built and validated in a more interactive way. The Web interface is the preferred interface for users who are new to the application and we encourage existing users to adopt this interface as well since it's capabilities and usability a vast improvement over the CLI.

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Concurrency

This controls how many parallel operations can be performed at once. The default is `10` and can be overridden during application startup.

The 'concurrency' setting was previously in the configuration file, but is now only set at startup. The setting in the configuration file will be ignored.

WebUI

To adjust the concurrency setting for the Web Service, add `hms-mirror.concurrency.max-threads=n` to the startup command.

CLI

To adjust the concurrency setting, use the `-c|--concurrency` option when starting the application.

This setting dictates the number of connections made to the various endpoints like both Hive Server 2's (LEFT and RIGHT) and the Metastore Direct connections.

> ⚠ These services need to be able to support these connections.

Web Interface

Starting

The `hms-mirror` web application is started by running:

```
hms-mirror --service
```

This will start the web application on the default port of `8090`. The port can be changed by using the `--service.port` option during startup.

```
hms-mirror --service --service.port=8080
```

Point your browser to `http://server-host:8090/hms-mirror` to access the web application.

The web application will use the user home directory to store configuration files, logs, and reports. This isn't as much a concern as it is for the `cli` version since the web application will manage all this from the user's browser.

The web application works on the premise of a 'session'. Although the application is stateless, the session is used to store the user's configuration and state while they are using the application. This allows the user to navigate the application and make changes without losing their work. Currently, the session is global throughout the application and is not tied to a specific user browser session. An 'hms-mirror' session is NOT synonymous with a browser session.

An instance of the web application can only run ONE session at a time.

Stopping

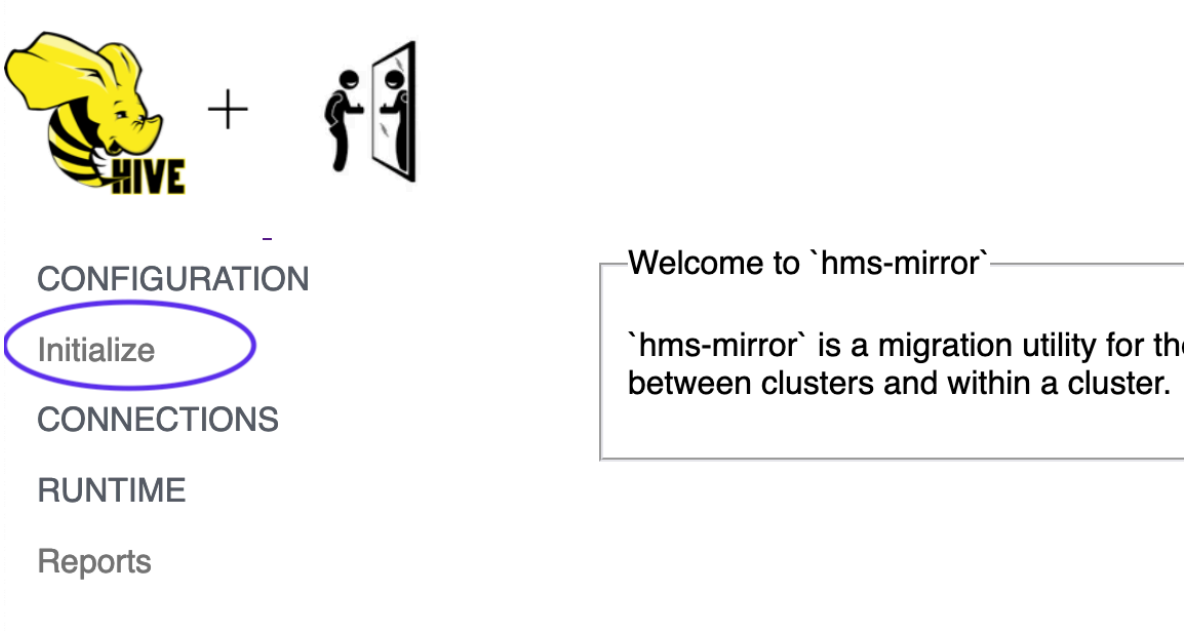
`hms-mirror --stop`

Security

Coming Soon...

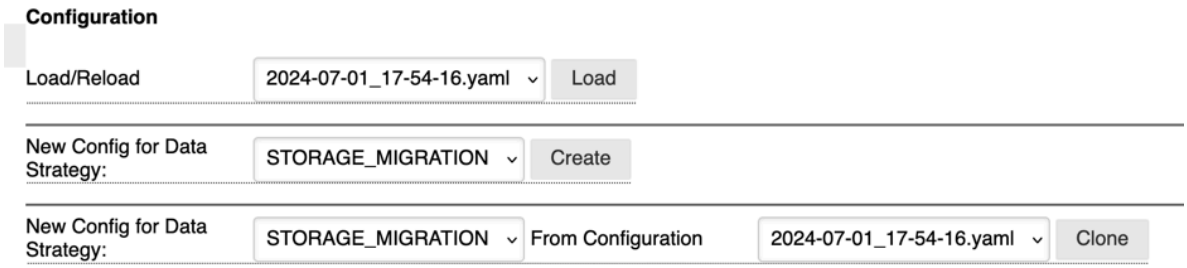
Where to Start?

There are three methods to building/loading a configuration. From the main page, select 'Initialize'.



web_init_menu

This will bring up the 'Initialize' page where one of the following options can be selected.



web_init.png

> ⚠ Configurations are specific to a Data Strategy (Strategies). Once created, you can NOT change the Data Strategy but, you can clone the configuration and change the Data Strategy (last option).

Pick an Existing Configuration

Load a previously saved configuration. Changes can be made and saved back to the same file or a new file.

Create a New Configuration

Create a new configuration from scratch.

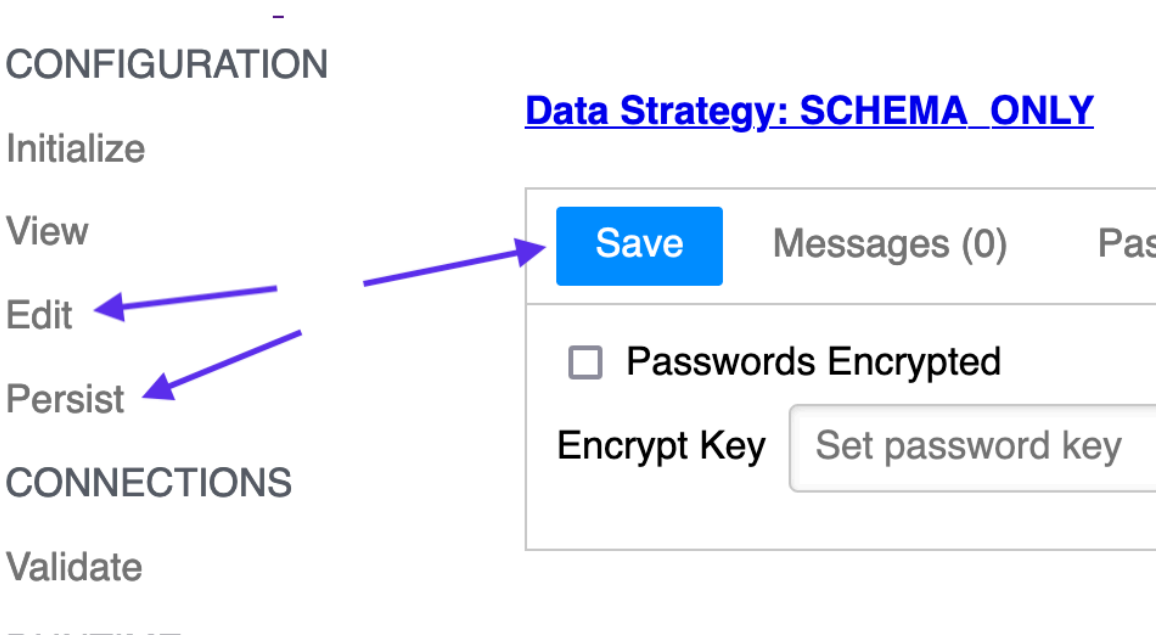
Clone an Existing Configuration

Using an existing configuration, clone it and change the Data Strategy. This will allow you to maintain any previously configured endpoints to Hive Server 2 and Metastore Direct connections.

Managing the Session Configuration

There are 2 states for a session. The in-memory state and the persisted state.

When you choose to 'Edit' a session configuration, you'll need to 'Save' the configuration for those changes to be applied to the session. 'Saving' the configuration will ONLY update the in-memory state of the session.



session_mngt.png

You will need to 'Persist' the session to save it for future use.

CLI Interface

Start typing here...

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Commandline Help (Options)

```
usage: hms-mirror <options>
                  version:1.6.5.0-SNAPSHOT
Hive Metastore Migration Utility
 -accept,--accept
Accept ALL confirmations and silence

prompts
 -ap,--acid-partition-count <limit>                                Set
the limit of partitions that the

ACID strategy will work with. '-1'

means no-limit.
 -asm,--avro-schema-migration
Migrate AVRO Schema Files referenced
                                                                   in
TBLPROPERTIES by

'avro.schema.url'.  Without migration
                                                                   it
is expected that the file will

exist on the other cluster and match
                                                                   the
'url' defined in the schema DDL.
                                                                   If
it's not present, schema creation

will FAIL.

Specifying this option REQUIRES the

LEFT and RIGHT cluster to be LINKED.
                                                                   See
```

```
docs:

https://github.com/cloudera-labs/hms-

mirror#linking-clusters-storage-layer
                                                                    s
 -at,--auto-tune
Auto-tune Session Settings for

SELECT's and DISTRIBUTION for

Partition INSERT's.
 -cfg,--config <filename>
Config with details for the

HMS-Mirror.  Default:

$HOME/.hms-mirror/cfg/default.yaml
 -cine,--create-if-not-exist
CREATE table/partition statements

will be adjusted to include 'IF NOT

EXISTS'.  This will ensure all

remaining sql statements will be run.

This can be used to sync partition

definitions for existing tables.
 -cs,--common-storage <storage-path>
Common Storage used with Data

Strategy HYBRID, SQL, EXPORT_IMPORT.

This will change the way these

methods are implemented by using the
```

```
specified storage location as an

'common' storage point between two

clusters.  In this case, the cluster
                                                                do
NOT need to be 'linked'.  Each

cluster DOES need to have access to
                                                                the
location and authorization to

interact with the location.  This may

mean additional configuration

requirements for 'hdfs' to ensure

this seamless access.
 -cto,--compress-test-output
Data movement (SQL/STORAGE_MIGRATION)
                                                                of
TEXT based file formats will be

compressed in the new table.
 -d,--data-strategy <strategy>
Specify how the data will follow the

schema. [DUMP, SCHEMA_ONLY, LINKED,

SQL, EXPORT_IMPORT, HYBRID,

CONVERT_LINKED, STORAGE_MIGRATION,

COMMON, ICEBERG_CONVERSION]
 -da,--downgrade-acid
Downgrade ACID tables to EXTERNAL
```

```
tables with purge.
 -db,--database <databases>
Comma separated list of Databases

(upto 100).
 -dbo,--database-only
Migrate the Database definitions as

they exist from LEFT to RIGHT
 -dbp,--db-prefix <prefix>
Optional: A prefix to add to the

RIGHT cluster DB Name. Usually used
                                                                  for

testing.
 -dbr,--db-rename <rename>
Optional: Rename target db to ...

This option is only valid when '1'

database is listed in `-db`.
 -dbRegEx,--database-regex <regex>
RegEx of Database to include in

process.
 -dc,--distcp <flow-direction default:PULL>
Build the 'distcp' workplans.

Optional argument (PULL, PUSH) to

define which cluster is running the

distcp commands.  Default is PULL.
 -dp,--decrypt-password <encrypted-password>
Used this in conjunction with '-pkey'
                                                                  to

decrypt the generated passcode
```

```
from `-p`.
 -ds,--dump-source <source>
Specify which 'cluster' is the source
                                                                  for
the DUMP strategy (LEFT|RIGHT).
 -dtd,--dump-test-data
Used to dump a data set that can be

feed into the process for testing.
 -e,--execute
Execute actions request, without this

flag the process is a dry-run.
 -ep,--export-partition-count <limit>                             Set
the limit of partitions that the

EXPORT_IMPORT strategy will work

with.
 -epl,--evaluate-partition-location                               For
SCHEMA_ONLY and DUMP

data-strategies, review the partition

locations and build partition

metadata calls to create them is they

can't be located via 'MSCK'.
 -ewd,--external-warehouse-directory <path>                       The
external warehouse directory

path.  Should not include the

namespace OR the database directory.

This will be used to set the LOCATION
```

```
database option.
 -f,--flip
Flip the definitions for LEFT and

RIGHT.  Allows the same config to be

used in reverse.
 -fel,--force-external-location
Under some conditions, the LOCATION

element for EXTERNAL tables is

removed (ie: -rdl).  In which case we

rely on the settings of the database

definition to control the EXTERNAL

table data location.  But for some

older Hive versions, the LOCATION

element in the database is NOT

honored.  Even when the database

LOCATION is set, the EXTERNAL table

LOCATION defaults to the system wide

warehouse settings.  This flag will

ensure the LOCATION element remains
                                                                    in
the CREATE definition of the table
                                                                    to
force it's location.
```

```
 -glm,--global-location-map <key=value>
Comma separated key=value pairs of

Locations to Map. IE:

/myorig/data/finance=/data/ec/finance
                                                                .
This reviews 'EXTERNAL' table

locations for the path

'/myorig/data/finance' and replaces
                                                               it
with '/data/ec/finance'.  Option
                                                               can
be used alone or with -rdl. Only

applies to 'EXTERNAL' tables and if
                                                               the
tables location doesn't contain
                                                               one
of the supplied maps, it will be

translated according to -rdl rules if
                                                               -
rdl is specified.  If -rdl is not

specified, the conversion for that

table is skipped.
 -h,--help
Help
 -ip,--in-place
Downgrade ACID tables to EXTERNAL

tables with purge.
 -is,--intermediate-storage <storage-path>
Intermediate Storage used with Data
```

```
Strategy HYBRID, SQL, EXPORT_IMPORT.

This will change the way these

methods are implemented by using the

specified storage location as an

intermediate transfer point between
                                                                two
clusters.  In this case, the

cluster do NOT need to be 'linked'.

Each cluster DOES need to have access
                                                                to
the location and authorization to

interact with the location.  This may

mean additional configuration

requirements for 'hdfs' to ensure

this seamless access.
 -itpo,--iceberg-table-property-overrides <key=value>
Comma separated key=value pairs of

Iceberg Table Properties to

set/override.
 -iv,--iceberg-version <version>
Specify the Iceberg Version to use.

Specify 1 or 2.  Default is 2.
 -ltd,--load-test-data <file>                                   Use
the data saved by the `-dtd`
```

```
option to test the process.
 -ma,--migrate-acid <bucket-threshold (2)>
Migrate ACID tables (if strategy

allows). Optional:

ArtificialBucketThreshold count that

will remove the bucket definition if

it's below this.  Use this as a way
                                                                to
remove artificial bucket

definitions that were added

'artificially' in legacy Hive.

(default: 2)
 -mao,--migrate-acid-only <bucket-threshold (2)>
Migrate ACID tables ONLY (if strategy

allows). Optional:

ArtificialBucketThreshold count that

will remove the bucket definition if

it's below this.  Use this as a way
                                                                to
remove artificial bucket

definitions that were added

'artificially' in legacy Hive.

(default: 2)
```

```
 -mnn,--migrate-non-native <arg>
Migrate Non-Native tables (if

strategy allows). These include table

definitions that rely on external

connection to systems like: HBase,

Kafka, JDBC
 -mnno,--migrate-non-native-only
Migrate Non-Native tables (if

strategy allows). These include table

definitions that rely on external

connection to systems like: HBase,

Kafka, JDBC
 -np,--no-purge                                                  For
SCHEMA_ONLY, COMMON, and LINKED

data strategies set RIGHT table to
                                                                NOT
purge on DROP
 -o,--output-dir <outputdir>
Output Directory (default:

$HOME/.hms-mirror/reports/<yyyy-MM-dd

_HH-mm-ss>
 -p,--password <password>
Used this in conjunction with '-pkey'
                                                                to
generate the encrypted password

that you'll add to the configs for
```

```
                                                                  the
JDBC connections.
 -pkey,--password-key <password-key>                              The
key used to encrypt / decrypt the

cluster jdbc passwords.  If not

present, the passwords will be

processed as is (clear text) from the

config file.
 -po,--property-overrides <key=value>
Comma separated key=value pairs of

Hive properties you wish to

set/override.
 -pol,--property-overrides-left <key=value>
Comma separated key=value pairs of

Hive properties you wish to

set/override for LEFT cluster.
 -por,--property-overrides-right <key=value>
Comma separated key=value pairs of

Hive properties you wish to

set/override for RIGHT cluster.
 -q,--quiet
Reduce screen reporting output.  Good
                                                                  for
background processes with output

redirects to a file
 -rdl,--reset-to-default-location
Strip 'LOCATION' from all target
```

```
cluster definitions.  This will allow
                                                                the
system defaults to take over and

define the location of the new

datasets.
 -replay,--replay <report-directory>                            Use
to replay process from the report

output.
 -rid,--right-is-disconnected
Don't attempt to connect to the

'right' cluster and run in this mode
 -ro,--read-only                                                For
SCHEMA_ONLY, COMMON, and LINKED

data strategies set RIGHT table to
                                                                NOT
purge on DROP. Intended for use

with replication distcp strategies
                                                                and
has restrictions about existing

DB's on RIGHT and PATH elements.  To

simply NOT set the purge flag for

applicable tables, use -np.
 -rr,--reset-right                                              Use
this for testing to remove the

database on the RIGHT using CASCADE.
 -s,--sync                                                      For
SCHEMA_ONLY, COMMON, and LINKED
```

```
data strategies.  Drop and Recreate

Schema's when different.  Best to use

with RO to ensure table/partition

drops don't delete data. When used

WITHOUT `-tf` it will compare all the

tables in a database and sync

(bi-directional).  Meaning it will

DROP tables on the RIGHT that aren't
                                                                    in
the LEFT and ADD tables to the

RIGHT that are missing.  When used

with `-ro`, table schemas can be

updated by dropping and recreating.

When used with `-tf`, only the tables

that match the filter (on both sides)

will be considered.
 -sdpi,--sort-dynamic-partition-inserts
Used to set

`hive.optimize.sort.dynamic.partition
                                                                    `
in TEZ for optimal partition

inserts.  When not specified, will
```

```
                                                                    use
prescriptive sorting by adding

'DISTRIBUTE BY' to transfer SQL.

default: false
 -sf,--skip-features
Skip Features evaluation.
 -slc,--skip-link-check
Skip Link Check. Use when going

between or to Cloud Storage to avoid

having to configure hms-mirror with

storage credentials and libraries.

This does NOT preclude your Hive

Server 2 and compute environment from

such requirements.
 -slt,--skip-legacy-translation
Skip Schema Upgrades and Serde

Translations
 -smn,--storage-migration-namespace <namespace>
Optional: Used with the 'data

strategy STORAGE_MIGRATION to specify
                                                                    the
target namespace.
 -so,--skip-optimizations
Skip any optimizations during data

movement, like dynamic sorting or

distribute by
```

```
 -sp,--sql-partition-count <limit>                                  Set
the limit of partitions that the
                                                                   SQL
strategy will work with. '-1'

means no-limit.
 -sql,--sql-output
<deprecated>.  This option is no

longer required to get SQL out in a

report.  That is the default

behavior.
 -ssc,--skip-stats-collection
Skip collecting basic FS stats for a

table.  This WILL affect the

optimizer and our ability to

determine the best strategy for

moving data.
 -su,--setup
Setup a default configuration file

through a series of questions
 -tef,--table-exclude-filter <regex>
Filter tables (excludes) with name

matching RegEx. Comparison done with

'show tables' results.  Check case,

that's important.  Hive tables are

generally stored in LOWERCASE. Make
```

```
sure you double-quote the expression
                                                                  on
the commandline.
 -tf,--table-filter <regex>
Filter tables (inclusive) with name

matching RegEx. Comparison done with

'show tables' results.  Check case,

that's important.  Hive tables are

generally stored in LOWERCASE. Make

sure you double-quote the expression
                                                                  on
the commandline.
 -tfp,--table-filter-partition-count-limit <partition-count>
Filter partition tables OUT that are

have more than specified here. Non

Partitioned table aren't filtered.
 -tfs,--table-filter-size-limit <size MB>
Filter tables OUT that are above the

indicated size.  Expressed in MB
 -to,--transfer-ownership                                         If
available (supported) on LEFT

cluster, extract and transfer the

tables owner to the RIGHT cluster.

Note: This will make an 'exta' SQL

call on the LEFT cluster to determine
```

```
                                                                    the
ownership.  This won't be

supported on CDH 5 and some other

legacy Hive platforms. Beware the

cost of this extra call for EVERY

table, as it may slow down the

process for a large volume of tables.
 -v,--views-only
Process VIEWs ONLY
 -wd,--warehouse-directory <path>                                   The
warehouse directory path.  Should
                                                                    not
include the namespace OR the

database directory. This will be used
                                                                    to
set the MANAGEDLOCATION database

option.
```

Output

The output from `hms-mirror` will, by default, be sent to `$HOME/.hms-mirror/reports`. Each run will be place in a sub-directory with a timestamp. You can choose to redirect the output to a different location with the `-o` option. In this case the directory will be created if it doesn't exist and the output will be written to that location (without the timestamp sub-directory).

If you wish to have the reports written to a different location AND have the timestamp sub-directory, use a symbolic link redirect the `$HOME/.hms-mirror/reports` directory to the desired output directory.

A report for each **database** processed will be created in the output directory. Files for a database will be prefixed with the database name. This applies to each of the following report/script types.

Application Report

The output report is in markdown format. You can use a markdown renderer to view the report. If you don't have a renderer, you can still read the report, it will just be harder to read.

The report include various stats regarding the run and details for each tables migration process. In this report, you'll find details on "why" a particular table was skipped, or what actions were taken to migrate the table. The report will even list issue encountered during the process.

SQL Scripts

`hms-mirror` will produce the SQL scripts used to migrate the data. These scripts are written to the output directory. The scripts are prefixed with the **database** name.

- `<db_name>_LEFT_Clueanup_execute.sql` - When present, this scripts represents SQL statements that should be run on the LEFT cluster to cleanup artifacts from the migration process.
- `<db_name>_LEFT_execute.sql` - When present, this scripts represents SQL statements that should be run on the LEFT cluster to migrate the data. If the `-e` option was used, the contents of this script will be executed on the LEFT cluster by `hms-`

`mirror`. If the `-e` option was NOT specified, these script can be verified and executed manually on the LEFT cluster.

- `<db_name>_RIGHT_execute.sql` - When present, this scripts represents SQL statements that should be run on the RIGHT cluster to migrate the data. If the `-e` option was used, the contents of this script will be executed on the RIGHT cluster by `hms-mirror`. If the `-e` option was NOT specified, these script can be verified and executed manually on the RIGHT cluster.
- `<db_name>_RIGHT_Clueanup_execute.sql` - When present, this scripts represents SQL statements that should be run on the RIGHT cluster to cleanup artifacts from the migration process.

YAML Output

The `<db_name>_hms-mirror.yaml` file is a full listing of the migration process as a document. Use this file to programmatically determine what actions were taken during the migration process.

Runbook

The `<db_name>_runbook.md` is a markdown file that is a workbook of 'what' to do. It lays out the steps taken and the steps to be taken to complete the migration process.

distcp Scripts and Workbook

When you include the `-dc|--distcp` option when running `hms-mirror`, we'll build a template `distcp` job for each database that has data to be migrated. The result is a set of **bash scripts** and source files listing the contents to be used in the migration.

Depending other influencing options, there may be a `distcp` script for the LEFT and RIGHT clusters. The scripts will be prefixed with the database name.

The various **distcp** reports include:

- `<db_name>_RIGHT_n_distcp_source.txt` - A list of the source directories to be copied to the RIGHT cluster. The `n` will increment for each one of the jobs created for the database being migrated. These files must be copied to the RIGHT clusters HDFS filesystem. When running the distcp bash shell script, set the bash environment variable `$HCFS_BASE_DIR` to set the 'directory' these are copied to.

- `<db_name>_RIGHT_distcp_script.sh` - The bash script created that will run the `distcp` jobs. This script will be run on the RIGHT cluster. Review the comments in the script for details on how to run it.
- `<db_name>_RIGHT_distcp_workbook.md` - A markdown report table that breakdown what will be moved by the process.

** Example distcp Workbook **

Database	Target	Sources
tpcds_bin_partitioned_orc_10		
	hdfs://HOME90/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db	hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/call_center hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/catalog_page hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/catalog_returns hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/catalog_sales hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/customer hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/customer_address hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/customer_demographics hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/date_dim hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/hous

		ehold_demographics hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/income_band hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/inventory hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/item hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/promotion hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/reason hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/ship_mode hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/store hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/store_returns hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/store_sales hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/time_dim hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/warehouse

		hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/web_page hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/web_returns hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/web_sales hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/web_site

Logs

Logs, as of 1.6.5.6 are now in the same output directory as the reports.

REST Interface (WIP)

Start `hms-mirror` with the `--service` option.

```
hms-mirror --service
```

The REST Swagger documentation is available at `http://server-host:8090/hms-mirror/swagger-ui/index.html`.

The REST base endpoint is `http://server-host:8090/hms-mirror/api/v1`.

The REST service controls the 'current' session in `hms-mirror`. This session is the same as the session available through the Web Interface.

Quick Start Scenarios

- On-prem Sidecar Migrations (On Prem Legacy Hive to Non-Legacy Hive)
- Hybrid Migrations (Hybrid Data LakeHouse)
- Cloud to Cloud DR with Datahub (Cloud to Cloud DR (AWS))

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Pre-Requisites

Hive/TEZ Properties Whitelist Requirements

HiveServer2 has restrictions on what properties can be set by the user in a session. To ensure that `hms-mirror` will be able to set the properties it needs, add `hive.security.authorization.sqlstd.confwhitelist.append` (https://cwiki.apache.org/confluence/display/Hive/Configuration+Properties#ConfigurationProperties-hive.security.authorization.sqlstd.confwhitelist.append) property in the HiveServer2 Advanced Configuration Snippet (Safety Valve) for `hive-site.xml` with at least the following value(s) so `hms-mirror` can set the properties it needs:

```
tez\.grouping\..*
```

Backups

DO NOT SKIP THIS!!!

The process DOES 'DROP' tables when asked. If those tables *manage* data like a *legacy* managed, *ACID*, or *external.table.purge=true* scenario, we do our best NOT to DROP those and ERROR out. But, protect yourself and make backups of the areas you'll be working in.

HDFS Snapshots

Use HDFS Snapshots to make a quick backup of directories you'll be working on. Do this, especially in the *LEFT* cluster. We only drop tables, so a snapshot of the database directory is good. BUT, if you are manually doing any `DROP DATABASE <x> CASCADE` operations, that will delete the snapshotted directory (and the snapshot). In this case, create the *snapshot* one level above the database directory.

Metastore Backups

Take a DB backup of your metastore and keep it in a safe place before starting.

Shared Authentication

The clusters must share a common authentication model to support cross-cluster HDFS access when HDFS is the underlying storage layer for the datasets. This means that a

kerberos ticket used in the RIGHT cluster must be valid for the LEFT cluster.

For cloud storage, the two clusters must have rights to the target storage bucket.

If you can `distcp` between the clusters (Linking Cluster Storage Layers), you have the basic connectivity required to start working with `hms-mirror`.

Warning

Building METADATA

Rebuilding METADATA can be an expensive scenario. Especially when you are trying to reconstruct the entire metastore in a short time period, consider this in your planning. Know the number of partitions and buckets you will be moving and account for this. Test on smaller datasets (volume and metadata elements). Progress to testing higher volumes/partition counts to find limits and make adjustments to your strategy.

Using the SQL and EXPORT_IMPORT strategies will move metadata AND data, but rebuilding the metastore elements can be pretty expensive. So consider migrating the metadata separately from the data (distcp) and use MSCK on the RIGHT cluster to discover the data. This will be considerably more efficient.

If you will be doing a lot of metadata work on the RIGHT cluster. That cluster also serves a current user base; consider setting up separate HS2 pods for the migration to minimize the impact on the current user community. Isolate Migration Activities ("Isolate Migration Activities" in "Optimizations")

Partition Handling for Data Transfers

There are three settings in the configuration to control how and to what extent we'll attempt to migrate *DATA* for tables with partitions.

For non-ACID/transactional tables the setting in:

```
hybrid:
  exportImportPartitionLimit: 100
  sqlPartitionLimit: 500
```

Control both the `HYBRID` strategy for selecting either `EXPORT_IMPORT` or `SQL` and the `SQL` *LIMIT* for how many partitions we'll attempt. When the `SQL` limit is exceeded, you will need to use `SCHEMA_ONLY` to migrate the schema followed by `distcp` to move the data.

For ACID/transactional tables, the setting in:

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```
migrateACID:
  partitionLimit: 500
```

Effectively draws the same limit as above.

Why do we have these limits? Mass migration of datasets via SQL and EXPORT_IMPORT with many partitions is costly and NOT very efficient. It's best that when these limits are reached that you separate the METADATA and DATA migration to DDL and distcp.

Permissions

We use a cross-cluster technique to back metadata in the RIGHT cluster with datasets in the LEFT cluster for data strategies: LINKED, HYBRID, EXPORT_IMPORT, SQL, and SCHEMA_ONLY (with `-ams` AVRO Migrate Schema).

See Linking Clusters Storage Layers (Linking Cluster Storage Layers) for details on configuring this state.

Permissions

In both the METADATA and STORAGE phases of `hms-mirror` the RIGHT cluster will reach down into the LEFT clusters storage layer to either *use* or *copy* the data.

`hms-mirror` access each cluster via JDBC and use the RIGHT cluster for *storage* layer access.

When the RIGHT cluster is using 'non-impersonation' (hive `doas=false`), the *hive* service account on the **RIGHT** cluster (usually `hive`) needs access to the storage layer on the **LEFT** cluster to use this data to support sidecar testing, where we use the data of the LEFT cluster but *mirror* the metadata.

> ⚠ Having Ranger on both clusters helps because you can create additional ACLs to provide the access required.

OR

> ⚠ Checked permissions of '<submitting_user>': Found that the '<submitting_user>' user was NOT the owner of the files in these directories. The user running the process needs to be in 'dfs.permissions.superusergroup' for the LEFT clusters 'hdfs' service. Ambari 2.6 has issues setting this property: https://jira.cloudera.com/browse/EAR-7805

> ⚠ Follow workaround above or add user to the 'hdfs' group. I had to use '/var/lib/ambari-server/resources/scripts/configs.py' to set it manually for Ambari.

> ⚠ `sudo ./configs.py --host=k01.streever.local --port=8080 -u admin -p admin -n hdp50 -c hdfs-site -a set -k dfs.permissions.superusergroup -v hdfs_admin`

Linking Cluster Storage Layers

For the `hms-mirror` process to work, it relies on the RIGHT clusters' ability to *SEE* and *ACCESS* data in the LEFT clusters HDFS namespace. This is the same access/configuration required to support DISTCP for an HA environment and accounts for failovers.

We suggest that `distcp` operations be run from the RIGHT cluster, which usually has the greater 'hdfs' version in a migration scenario.

The RIGHT cluster HCFS namespace requires access to the LEFT clusters HCFS namespace. RIGHT clusters with a greater HDFS version support **LIMITED** functionality for data access in the LEFT cluster.

NOTE: This isn't designed to be a permanent solution and should only be used for testing and migration purposes.

Goal

What does it take to support HDFS visibility between these two clusters?

Can that integration be used to support the Higher Clusters' use of the Lower Clusters HDFS Layer for distcp AND Hive External Table support?

Scenario #1

HDP 2.6.5 (Hadoop 2.7.x)

Kerberized - sharing same KDC as CDP Base Cluster

Configuration Changes

The *namenode kerberos* principal MUST be changed from `nn` to `hdfs` to match the namenode principal of the CDP cluster.

Note: You may need to add/adjust the `auth_to_local` settings to match this change.

If this isn't done, `spark-shell` and `spark-submit` will fail to initialize. When changing this in Ambari on HDP, you will need to *reset* the HDFS zkfc `ha` zNode in Zookeeper and reinitialize the hdfs `zkfc`.

From a Zookeeper Client: `/usr/hdp/current/zookeeper-client/bin/zkCli.sh -server localhost`

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```
rmr /hadoop-ha
```

Initialize zkfc

```
hdfs zkfc -formatZK
```

core-site.xml

```
hadoop.rpc.protection=true
dfs.encrypt.data.transfer=true
dfs.encrypt.data.transfer.algorithm=3des
dfs.encrypt.data.transfer.cipher.key.bitlength=256
```

CDP 7.1.4 (Hadoop 3.1.x)

Kerberized, TLS Enabled

Configuration Changes

Requirements that allow this (upper) cluster to negotiate and communicate with the lower environment.

Cluster Wide hdfs-site.xml Safety Value

```
ipc.client.fallback-to-simple-auth-allowed=true
```

HDFS Service Advanced Config hdfs-site.xml

```
# For this Clusters Name Service
dfs.internal.nameservices=HOME90

# For the target (lower) environment HA NN Services
dfs.ha.namenodes.HDP50=nn1,nn2
dfs.namenode.rpc-address.HDP50.nn1=k01.streever.local:8020
dfs.namenode.rpc-address.HDP50.nn2=k02.streever.local:8020
dfs.namenode.http-address.HDP50.nn1=k01.streever.local:50070
dfs.namenode.http-address.HDP50.nn2=k02.streever.local:50070
dfs.namenode.https
 address.HDP50.nn1=k01.streever.local:50471
```

```
dfs.namenode.https-address.HDP50.nn2=k02.streever.local:50470
dfs.client.failover.proxy.provider.HDP50=org.apache.hadoop.hdfs.se
rver.namenode.ha.ConfiguredFailoverProxyProvider

# For Available Name Services
dfs.nameservices=HOME90,HDP50
```

Running distcp from the RIGHT Cluster

NOTE: Running `distcp` from the **LEFT** cluster isn't supported since the `hcfs client` is not forward compatible.

Copy 'from' Lower Cluster

```
hadoop distcp hdfs://HDP50/user/dstreev/sstats/queues/2020-10.txt
/user/dstreev/temp
```

Copy 'to' Lower Cluster

```
hadoop distcp
/warehouse/tablespace/external/hive/cvs_hathi_workload.db/queue/20
20-10.txt hdfs://HDP50/user/dstreev/temp
```

Sourcing Data from Lower Cluster to Support Upper Cluster External Tables

Proxy Permissions

The lower cluster must allow the upper clusters *Hive Server 2* host as a 'hive' proxy. The setting in the lower clusters *custom* `core-site.xml` may limit this to that clusters (lower) HS2 hosts. Open it up to include the upper clusters HS2 host.

Custom core-site.xml in Lower Cluster

```
hadoop.proxyuser.hive.hosts=*
```

Credentials from the 'upper' cluster will be projected down to the 'lower' cluster. The `hive` user in the upper cluster, when running with 'non-impersonation' will require access to the datasets in the lower cluster HDFS.

For table creation in the 'upper' clusters Metastore, a permissions check will be done on the lower environments directory for the submitting user. So, both the service user AND

`hive` will require access to the directory location specified in the lower cluster.

When the two clusters *share* accounts, and the same accounts are used between environments for users and service accounts, then access should be simple.

When a different set of accounts are used, the 'principal' from the upper clusters service account for 'hive' and the 'user' principal will be used in the lower cluster. This means additional HDFS policies in the lower cluster may be required to support this cross-environment work.

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Configuration

LEFT and RIGHT Clusters

`hms-mirror` defines clusters as LEFT and RIGHT. The LEFT cluster is the source of the metadata and the RIGHT cluster is the target. The LEFT cluster is usually the older cluster version. Regardless, under specific scenario's, `hms-mirror` will use an HDFS client to check directories and move small amounts of data (AVRO schema files). `hms-mirror` will depend on the configuration of the node it's running on to locate the 'hcfs filesystem'. This means that the `/etc/hadoop/conf` directory should contain all the environments settings to successfully connect to `hcfs (Hadoop Compatible File System`.

The configuration is done via a 'yaml' file, details below.

There are two ways to get started:

- The first time you run `hms-mirror` and it can't find a configuration, it will walk you through building one and save it to `$HOME/.hms-mirror/cfg/default.yaml`. Here's what you'll need to complete the setup:
  - URI's for each clusters HiveServer2
  - STANDALONE jar files for EACH Hive version.
    - We support the Apache Hive based drivers for Hive 1 and Hive2/3.
    - Recently added support for the Cloudera JDBC driver for CDP.
  - Username and Password for non-kerberized connections.
    - Note: `hms-mirror` will only support one kerberos connection. For the other, use another AUTH method.
  - The hcfs (Hadoop Compatible FileSystem) protocol and prefix used for the hive table locations in EACH cluster.
- Use the template yaml (Default Configuration Template) for reference and create a `default.yaml` in the running users `$HOME/.hms-mirror/cfg` directory.

You'll need JDBC driver jar files that are * *specific* to the clusters you'll integrate. If the **LEFT** cluster isn't the same version as the **RIGHT** cluster, don't use the same JDBC jar file, especially when integrating Hive 1 and Hive 3 services. The Hive 3 driver is NOT backwardly compatible with Hive 1.

See the running (Running) section for examples on running `hms-mirror` for various environment types and connections.

JDBC Drivers and Configuration

`hms-mirror` requires JDBC drivers to connect to the various end-points needed to perform it's tasks. The `LEFT` and `RIGHT` cluster endpoints for HiveServer2 require the standalone JDBC drivers that are specific to that Hive version.

`hms-mirror` supports the Apache and packaged hive **standalone** drivers that are found with your distribution. For CDP, we also support to Cloudera JDBC driver found and maintained at on the Cloudera Hive JDBC Downloads Page (https://www.cloudera.com/downloads/connectors/hive/jdbc). Note that the URL configurations between the Apache and Cloudera JDBC drivers are different.

Hive JDBC Drivers need to be inline with the version of HS2 you're connecting to. If the cluster is an HDP cluster, get the appropriate **standalone** driver from that cluster. These drivers(jar files) should be stored locally on the machine running `hms-mirror` and referenced in the configuration file.

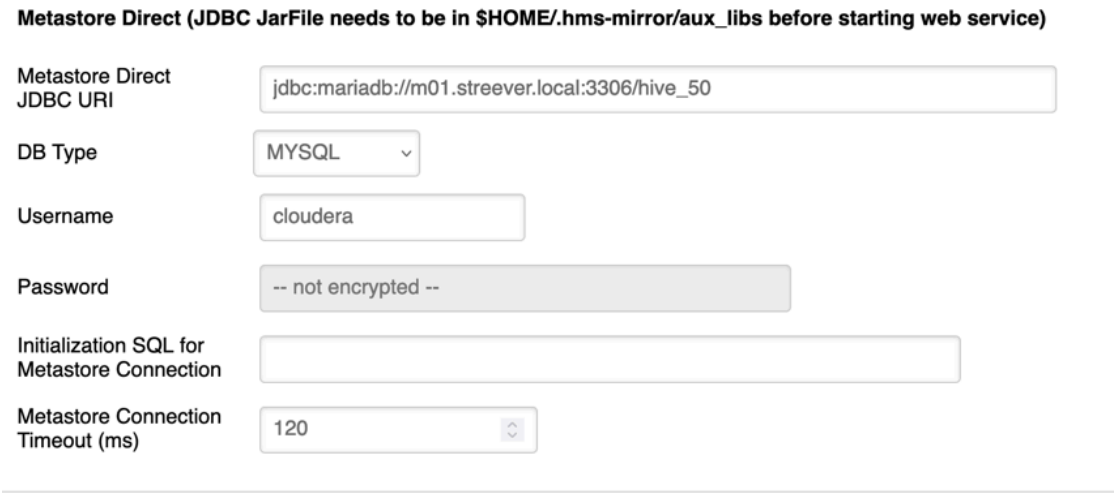
> ⚠ Do NOT put these drivers in $/.hms-mirror/aux_libs or any sub-directory of that location. `hms-mirror` connects to different versions of Hive and the drivers need to be specific to the version of Hive you're connecting to. To do this, we need to manage the classpath and the drivers in a more controlled manner. They should NOT be in the applications main classpath, this will cause connectivity issues.

Web UI

Hive Server 2 Configuration

hs2_cfg.png

Metastore Direct Configuration



metastore_direct_cfg.png

CLI

```
hiveServer2:
  uri: "<cloudera_jdbc_url>"
  driverClassName: "com.cloudera.hive.jdbc.HS2Driver"
  connectionProperties:
```

```
    user: "xxx"
    password: "xxx"
```

Starting with the Apache Standalone driver shipped with CDP 7.1.8 cummulative hot fix parcels, you will need to include additional jars in the configuration `jarFile` configuration, due to some packaging adjustments.

For example: `jarFile: "<cdp_parcel_jars>/hive-jdbc-3.1.3000.7.1.8.28-1-standalone.jar:<cdp_parcel_jars>/log4j-1.2-api-2.18.0.jar:<cdp_parcel_jars>/log4j-api-2.18.0.jar:<cdp_parcel_jars>/log4j-core-2.18.0.jar"` NOTE: The jar file with the Hive Driver MUST be the first in the list of jar files.

The Cloudera JDBC driver shouldn't require additional jars.

Example URL's

CDP Hive via Knox Gateway

Doesn't require Kerberos. Knox is SSL, so depending on whether you've self-signed your certs you may need to make adjustments.

- Apache Hive and CDP Packaged Apache Hive JDBC Driver

> ⚠ `jdbc:hive2://s03.streever.local:8443/;ssl=true;transportMode=http;httpPath=gate`
> `proxy-api/hive;sslTrustStore=/Users/dstreev/bin/certs/gateway-client-trust.jks;trustStorePassword=changeit`

- Cloudera JDBC Driver

> ⚠ `jdbc:hive2://s03.streever.local:8443;transportMode=http;AuthMech=3;httpPath=g`
> `proxy-api/hive;SSL=1;AllowSelfSignedCerts=1`

CDP Hive direct with Kerberos

When connecting to via Kerberos, place the JDBC driver for Hive in the `$HOME/.hms-mirror/aux_libs` directory. This ensures it is loaded in the classpath correctly to support the kerberos connection. If you're NOT using Kerberos connection, the libraries should be reference in the `jarFile` parameter and NOT be in the `aux_libs` directory.

If you are experimenting with different connection types, ensure the jar file is REMOVED from `aux_libs` when trying other configurations.

- Apache JDBC Driver (packaged with CDP)

> ⚠ `tbd` NOTE: Our experience with this driver is that requires the use of `--hadoop-classpath` in the commandline to load the needed kerberos libraries.

- Cloudera JDBC Driver

> ⚠ `jdbc:hive2://s04.streever.local:10001;transportMode=http;AuthMech=1;KrbRealm`
> NOTE: When using this driver, our experience has been that you do NOT need to use `--hadoop-classpath` as a commandline element with versions 1.6.1.0+

HDP2 HS2 with No Auth

Since CDP is usually kerberized AND `hms-mirror` doesn't support the simultanous connections to 2 different kerberos environments, I've setup an HS2 on HDP2 specifically for this effort. NOTE: You need to specify a `username` when connecting to let Hive know what the user is. No password required.

- Apache Hive Standalone Driver shipped with HDP2.

> ⚠ `jdbc:hive2://k02.streever.local:10000`

Direct Metastore DB Acceess for -epl

The `LEFT` and `RIGHT` configurations also suppport 'direct' metastore access to collect detailed partition information when using the flag `-epl`. The support this feature, get the JDBC driver that is appropriate for your metastore(s) backend dbs and place it in `$HOME/.hms-mirror/aux_libs` directory.

Default Configuration Template

Use this as a template for the `default.yaml` configuration file used by the `cli` interface.

```
# Copyright 2024 Cloudera, Inc. All Rights Reserved.
#
# 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.

transfer:
  # Optional (default: 4)
  concurrency:          10
  # Optional (default: 'transfer_')
  transferPrefix:       "hms_mirror_transfer_"
  # This directory is appended to the 'clusters:...:hcfsNamespace'
value to store the transfer package for hive export/import.
  # Optional (default: '/apps/hive/warehouse/export_')
  exportBaseDirPrefix: "/apps/hive/warehouse/export_"
clusters:
  LEFT:
    # Set for Hive 1/2 environments
    legacyHive:    true
    # Is the 'Hadoop COMPATIBLE File System' used to prefix data
locations for this cluster.
```

```
    # It is mainly used as the transfer location for metadata
(export)
    # If the primary storage for this cluster is 'hdfs' than use
'hdfs://...'
    # If the primary storage for this action is cloud storage, use
the
    #    cloud storage prefix. IE: s3a://my_bucket
    hcfsNamespace: "<hdfs://namespace>"
    hiveServer2:
      # URI is the Hive JDBC URL in the form of:
      # jdbc:hive2://<server>:<port>
      # See docs for restrictions
      uri:      "<LEFT-cluster-jdbc-url>"
      connectionProperties:
        user:     "*****"
        password: "*****"
      # Standalone jar file used to connect via JDBC to the LEFT
environment Hive Server 2
      # NOTE-1: Hive 3 jars will NOT work against Hive 1.  The
protocol isn't compatible.
      # NOTE-2: You can specify a 'colon' separated list of jar
files in the jarFile property. We've found this
      #       useful when the JDBC driver requires additional jar
files to be present in the classpath to support it.
      #       For example, the CDH 5 Hive JDBC driver requires
that the `hadoop-common` jar file to be present in the
      #       classpath. You can specify this as follows: jarFile:
"/path/to/hive-jdbc.jar:/path/to/hadoop-common.jar"
      #    The order of the jar files is important. The first jar
file in the list MUST have the JDBC driver class file.
      jarFile: "<environment-specific-jdbc-standalone-driver>"
    # Optional.  Required only for (-epl) with DUMP or SCHEMA_ONLY
    # This will require the user to install the jdbc driver for
the metastoreDirect in $HOME/.hms-mirror/aux_libs
    metastore_direct:
      uri: "<jdbc_url_to_metastore_db_including_db>"
      type: MYSQL|POSTGRES|ORACLE
      connectionProperties:
```

```
        user: "<db_user>"
        password: "<db_password>"
      connectionPool:
        min: 3
        max: 5
  RIGHT:
    legacyHive:    false
    # Is the 'Hadoop COMPATIBLE File System' used to prefix data
locations for this cluster.
    # It is mainly used to as a baseline for where "DATA" will be
transfered in the
    # STORAGE stage.  The data location in the source location
will be move to this
    # base location + the extended path where it existed in the
source system.
    # The intent is to keep the data in the same relative location
for this new cluster
    # as the old cluster.
    hcfsNamespace: "<hdfs://namespace>"
    hiveServer2:
      # URI is the Hive JDBC URL in the form of:
      # jdbc:hive2://<server>:<port>
      # See docs for restrictions
      uri:     "<RIGHT-cluster-jdbc-url>"
      connectionProperties:
        user:     "*****"
        password: "*****"
      # Standalone jar file used to connect via JDBC to the LEFT
environment Hive Server 2
      # NOTE-1: Hive 3 jars will NOT work against Hive 1.  The
protocol isn't compatible.
      # NOTE-2: You can specify a 'colon' separated list of jar
files in the jarFile property. We've found this
      #       useful when the JDBC driver requires additional jar
files to be present in the classpath to support it.
      #       For example, the CDH 5 Hive JDBC driver requires
that the `hadoop-common` jar file to be present in the
      #       classpath. You can specify this as follows: jarFile:
```

```
"/path/to/hive-jdbc.jar:/path/to/hadoop-common.jar"
      #    The order of the jar files is important. The first jar
file in the list MUST have the JDBC driver class file.
      jarFile: "<environment-specific-jdbc-standalone-driver>"
    partitionDiscovery:
      # Addition HMS configuration needed for this
"discover.partitions"="true"
      auto:     true
      # When a table is created, run MSCK when there are
partitions.
      initMSCK: true
```

Password Security

Secure Passwords in Configuration

There are multiple passwords stored in the configuration files. By default, the passwords are in clear text in the configuration file. This usually isn't an issue since the file can be protected at the UNIX level from peering eyes. But if you need to protect those passwords, `hms-mirror` supports storing an encrypted version of the password in the configuration.

When you're using this feature, you need to have a `password-key`. This is a key used to encrypt and decrypt the password in the configuration. The **same** `password-key` must be used for **ALL** passwords in the configuration file.

WEB UI

Passwords are saved in the configuration and can easily be encrypted and decrypted using the Web UI. If the password (s) are encrypted, the 'Passwords Encrypted' checkbox will be checked.

pwd_mngd.png

If the passwords are encrypted, you'll need to specify the 'Encrypt Key' before running or connection to any endpoints. Set the 'Encrypt Key' and click 'Save' to save the key for the session.

> ⚠ The 'Encrypt Key' is only used for the current session and will NOT be saved if you 'persist' the session.

Once encrypted, you'll need to specify the 'password key' with that session to decrypt them for use.

CLI

Generate the Encrypted Password

Use the `-pkey` and `-p` options of `hms-mirror` to generate and decrypt the password(s).

`hms-mirror -pkey cloudera -p have-a-nice-day`

Will generate:

```
=== Errors ===
    38:Password en/de crypt

=== Warnings ===
    56:Encrypted password: HD1eNF8NMFahA2smLM9c4g==
```

Ignore the error 38, it's just a warning that the password is being encrypted. The encrypted password is the value after the `Encrypted password:` string.

Copy this encrypted password and place it in your configuration file for the JDBC connection. Repeat for the other passwords, if it's different, and paste it in the configuration as well.

Running hms-mirror with Encrypted Passwords

Using the **same** `-pkey` you used to generate the encrypted password, we'll run `hms-mirror`

`hms-mirror -db <db> -pkey cloudera ...`

When the `-pkey` option is specified **WITHOUT** the `-p` option (used previously), `hms-mirror` will understand to * *decrypt ** the configuration passwords before connecting to jdbc. If you receive jdbc connection exceptions, recheck the `-pkey` and encrypted password from before.

Testing the Encrypted Password

If you're unsure if the password is being decrypted correctly, you can use the `-dp` option to decrypt the hashed password and print it to the console.

`hms-mirror -pkey cloudera -dp HD1eNF8NMFahA2smLM9c4g==`

Will generate:

```
=== Errors ===
    38:Password en/de crypt

=== Warnings ===
    57:Decrypted password: have-a-nice-day
```

Again, ignore the error 38, it's just a warning that the password is being decrypted. The decrypted password is the value after the `Decrypted password:` string.

This should match the password you used to generate the encrypted password.

Running

After running the `setup.sh` script, `hms-mirror` will be available in the `$PATH` in a default configuration.

Assumptions

1. This process will only 'migrate' EXTERNAL and MANAGED (non-ACID/Transactional) table METADATA (not data, except with SQL (SQL) and EXPORT_IMPORT (EXPORT_IMPORT)).
2. MANAGED tables replicated to the **RIGHT ** cluster will be converted to "EXTERNAL" tables for the 'metadata' stage. They will be tagged as 'legacy managed' in the **RIGHT ** cluster. They will be assigned the `external.table.purge=true` flag, to continue the behaviors of the legacy managed tables.
3. The **RIGHT** cluster has 'line of sight' to the **LEFT** cluster.
4. The **RIGHT** cluster has been configured to access the **LEFT ** cluster storage. See link clusters (Linking Cluster Storage Layers). This is the same configuration required to support `distcp` from the **RIGHT** cluster to the **LEFT** cluster.
5. The movement of metadata/data is from the **LEFT** cluster to the **RIGHT** cluster.
6. With Kerberos, each cluster must share the same trust mechanism.

- The **RIGHT** cluster must be Kerberized IF the **LEFT** cluster is.
- The **LEFT** cluster does NOT need to be kerberized if the **RIGHT** cluster is kerberized.

7. The * *LEFT* cluster does NOT have access to the **RIGHT** cluster.
8. The credentials use by 'hive' (doas=false) in the **RIGHT ** cluster must have access to the required storage (hdfs) locations on the lower cluster.

- If the **RIGHT ** cluster is running impersonation (doas=true), that user must have access to the required storage (hdfs) locations on the lower cluster.

Transfer DATA, beyond the METADATA

HMS-Mirror does NOT migrate data between clusters unless you're using the SQL (SQL) or EXPORT_IMPORT (EXPORT_IMPORT) data strategies. In some cases where data is co-located, you don't need to move it. IE: Cloud to Cloud. As long as the new cluster environment has access to the original location. This is the intended target for strategies COMMON (COMMON) and to some extend LINKED (LINKED).

When you do need to move data, `hms-mirror` creates a workbook of 'source' and 'target' locations in an output file called `distcp_workbook.md`. Use this to help build a transfer job in `distcp` using the `-f` option to specify multiple sources.

Application Return Codes

The `hms-mirror` application returns `0` when everything is ok. If there is a configuration validation issue, the return code will be a negative value who's absolute value represents the bitSets cumulative `OR` value. See: MessageCodes (https://github.com/cloudera-labs/hms-mirror/blob/main/src/main/java/com/cloudera/utils/hadoop/hms/mirror/MessageCode.java) for values and Messages.java for the calculation (https://github.com/cloudera-labs/hms-mirror/blob/df9df251803d8722ef67426a73cbcfb86f981d3e/src/main/java/com/cloudera/utils/hadoop/hms/mirror/Messages.java#L26).

When you receive an error code (negative value), you'll also get the items printed to the screen and the log that make up that error code.

For example, the following would yield a code of `-2305843009214742528` (20 and 61).

```
******* ERRORS *********
20:STORAGE_MIGRATION requires you to specify PATH location for
'managed' and 'external' tables (-wd, -ewd) to migrate storage.
These will be appended to the -smn (storage-migration-namespace)
parameter and used to set the 'database' LOCATION and
MANAGEDLOCATION properties
61:You're using the same namespace in STORAGE_MIGRATION, without
`-rdl` you'll need to ensure you have `-glm` set to map locations.
```

`((2^20)+(2^61))*-1=-2305843009214742528`

Running Against a LEGACY (Non-CDP) Kerberized HiveServer2

`hms-mirror` is pre-built with CDP libraries and WILL NOT be compatible with LEGACY kerberos environments. A Kerberos connection can only be made to ONE cluster when the clusters are NOT running the same 'major' version of Hadoop.

To attach to a LEGACY HS2, run `hms-mirror` with the `--hadoop-classpath` command-line option. This will strip the CDP libraries from `hms-mirror` and use the hosts Hadoop libraries by calling `hadoop classpath` to locate the binaries needed to do this.

On-Prem to Cloud Migrations

On-Prem to Cloud Migrations should run `hms-mirror` from the LEFT cluster since visibility in this scenario is usually restricted to LEFT->RIGHT.

If the cluster is an older version of Hadoop (HDP 2, CDH 5), your connection to the LEFT HS2 should NOT be kerberized. Use LDAP or NO_AUTH.

The clusters LEFT hcfsNamespace (clusters:LEFT:hcfsNamespace) should be the LEFT clusters HDFS service endpoint. The RIGHT hcfsNamespace (clusters:RIGHT:hcfsNamespace) should be the *target* root cloud storage location. The LEFT clusters configuration (/etc/hadoop/conf) should have all the necessary credentials to access this location. Ensure that the cloud storage connectors are available in the LEFT environment.

There are different strategies available for migrations between on-prem and cloud environments.

SCHEMA_ONLY

This is a schema-only transfer, where the `hcfsNamespace` in the metadata definitions is 'replaced' with the `hcfsNamespace` value defined on the RIGHT. NOTE: The 'relative' directory location is maintained in the migration.

No data will be migrated in this case.

There will be a `distcp` Planning Workbook ("distcp Planning Workbook and Scripts" in "Features") generated with a plan that can be used to build the data migration process with `distcp`.

INTERMEDIATE

Connections

`hms-mirror` connects to 3 endpoints. The hive jdbc endpoints for each cluster (2) and the `hdfs` environment configured on the running host. This means you'll need:

- JDBC drivers to match the JDBC endpoints
- For **non** CDP 7.x environments and Kerberos connections, an edge node with the current Hadoop libraries.

See the config (Configuration) section to setup the config file for `hms-mirror`.

Configuring the Libraries

AUX_LIBS - CLASSPATH Additions

S3

The directory $HOME/.hms-mirror/aux_libs will be scanned for 'jar' files. Each 'jar' will be added the java classpath of the application. Add any required libraries here.

The application contains all the necessary hdfs classes already. You will need to add to the aux_libs directory the following:

- JDBC driver for HS2 Connectivity (only when using Kerberos)
- AWS S3 Drivers, if s3 is used to store Hive tables. (appropriate versions)
  - hadoop-aws.jar
  - aws-java-sdk-bundle.jar

JDBC Connection Strings for HS2

See the Apache docs (https://cwiki.apache.org/confluence/pages/viewpage.action?pageId=30758725#HiveServer2Clients-JDBC) regarding these details if you are using the environment 'Standalone' JDBC drivers. Other drivers may have different connect string requirements.

The drivers for the various environments are located:

- HDP - `/usr/hdp/current/hive-server2/jdbc/hive-jdbc-<version>-standalone.jar` (NOTE: Use the hive-1 standalone jar file for HDP 2.6.5, not the hive-2 jar)
- CDH/CDP - `/opt/cloudera/parcels/CDH/jars/hive-jdbc-<version>-standalone.jar`

Non-Kerberos Connections

The most effortless connections are 'non-kerberos' JDBC connections either to HS2 with AUTH models that aren't * *Kerberos** or through a **Knox** proxy. Under these conditions, only the __standalone __ JDBC drivers are required. Each of the cluster configurations contains an element `jarFile` to identify those standalone libraries.

```
hiveServer2:
  uri: "<jdbc-url>"
  connectionProperties:
    user: "*****"
    password: "*****"
  jarFile: "<environment-specific-jdbc-standalone-driver>"
```

When dealing with clusters supporting different Hive (Hive 1 vs. Hive 3) versions, the JDBC drivers aren't forward OR backward compatible between these versions. Hence, each JDBC jar file is loaded in a sandbox that allows us to use the same driver class, but isolates it between the two JDBC jars.

Place the two jdbc jar files in any directory **EXCEPT ** `$HOME/.hms-mirror/aux_libs` and reference the full path in the `jarFile` property for that `hiveServer2` configuration.

SAMPLE Commandline

`hms-mirror -db tpcds_bin_partitioned_orc_10`

Kerberized Connections

`hms-mirror` relies on the Hadoop libraries to connect via 'kerberos'. Suppose the clusters are running different versions of Hadoop/Hive. In that case, we can only support connecting to one of the clusters via Kerberos.

> ⚠ Packaging improvements in version 2.x include all the Kerberos libraries you need to connection to a kerberized Hive Server2 and HDFS. The `--hadoop-classpath` option is no longer required for Kerberos connections. The application will use the embedded Hadoop 3.1 libraries to connect to the

kerberized endpoints. The `--hadoop-classpath` option is still available for connecting to older Hadoop 2.x environments.

The `jarFile` property is NOT used for Kerberos connections. The JDBC jar file for the kerberized cluster should be placed in the `$HOME/.hms-mirror/aux_libs` directory.

There are three scenarios for kerberized connections.

Scenario	LEFT Kerberized/Version	RIGHT Kerberized/Version	Notes	Sample Commandline
1	No HDP2	Yes HDP 3 or CDP 7	1. 'hms-mirror' needs to be run from a node on the HDP3/CDP cluster. 2. place the RIGHT cluster jdbc jar file in `$HOME/.hms-mirror/aux_libs` (yes this contradicts some earlier directions) 3. comment out the `jarFile` property for the RIGHT cluster hiveServer2 setting.	`hms-mirror -db tpcds_bin_partitioned_orc_10 --hadoop-classpath`
2	YES HDP 3 or CDP 7	YES HDP 3 or CDP 7	1. 'hms-mirror' needs to be run from a node on the HDP3/CDP cluster. 2. place the RIGHT cluster jdbc jar file in $HOME/.hms-mirror/aux_libs (yes this contradicts some earlier directions) 3. comment out the `jarFile` property for the LEFT AND RIGHT cluster hiveServer2 settings.	`hms-mirror -db tpcds_bin_partitioned_orc_10 --hadoop-classpath`
3	YES HDP 2 or Hive 1	NO HDP 3 or CDP 7	Limited testing, but you'll need to run `hms-mirror` ON the **LEFT** cluster and include the LEFT clusters hive standalone jdbc driver in `$HOME/.hms-mirror/cfg/aux_libs`.	`hms-mirror -db tpcds_bin_partitioned_orc_10 --hadoop-classpath`
4	YES HDP 2 or Hive	YES HDP 2 or Hive	1. The Kerberos credentials must be TRUSTED to both clusters	`hms-mirror -db tpcds_bin_partitioned_orc_10 -

	1	1	2. Add `--hadoop-classpath` as a commandline option to `hms-mirror`. This replaces the prebuilt Hadoop 3 libraries with the current environments Hadoop Libs. 3. Add the jdbc standalone jar file to `$HOME/.hms-mirror/aux_libs` 4. Comment out/remove the `jarFile` references for BOTH clusters in the configuration file.	-hadoop-classpath`

For Kerberos JDBC connections, ensure you are using an appropriate Kerberized Hive URL.

`jdbc:hive2://s03.streever.local:10000/;principal=hive/_HOST@STREEVER.LOCAL`

ZooKeeper Discovery Connections

You may run into issues connecting to an older cluster using ZK Discovery. This mode brings in a LOT of the Hadoop ecosystem classes and may conflict across environments. We recommend using ZooKeeper discovery on only the RIGHT cluster. Adjust the LEFT cluster to access HS2 directly.

TLS/SSL Connections

If your HS2 connection requires TLS, you will need to include that detail in the jdbc 'uri' you provide. In addition, if the SSL certificate is 'self-signed' you will need to include details about the certificate to the java environment. You have 2 options:

- Set the JAVA_OPTS environment with the details about the certificate.
  - `export JAVA_OPTS=-Djavax.net.ssl.trustStore=/home/dstreev/certs/gateway-client-trust.jks -Djavax.net.ssl.trustStorePassword=changeit`
- Add `-D` options to the `hms-mirror` commandline to inject those details.
  - `hms-mirror -db test_db -Djavax.net.ssl.trustStore=/home/dstreev/certs/gateway-client-trust.jks -Djavax.net.ssl.trustStorePassword=changeit`

Troubleshooting

If each JDBC endpoint is Kerberized and the connection to the LEFT or RIGHT is successful, both NOT both, and the program seems to hang with no exception... it's most likely that the Kerberos ticket isn't TRUSTED across the two environments. You will only be able to support a Kerberos connection to the cluster where the ticket is trusted. The other cluster connection will need to be anything BUT Kerberos.

Add `--show-cp` to the `hms-mirror` command line to see the classpath used to run.

The argument `--hadoop-classpath` allows us to replace the embedded Hadoop Libs (v3.1) with the libs of the current platform via a call to `hadoop classpath`. This is necessary to connect to kerberized Hadoop v2/Hive v1 environments.

Check the location and references to the JDBC jar files. General rules for Kerberos Connections:

- The JDBC jar file should be in the `$HOME/.hms-mirror/aux_libs`. For Kerberos connections, we've seen issues attempting to load this jar in a sandbox, so this makes it available to the global classpath/loader.
- Get a Kerberos ticket for the running user before launching `hms-mirror`.

"Unrecognized Hadoop major version number: 3.1.1.7.1...0-257"

This happens when you're trying to connect to an HS2 instance.

Optimizations

Moving metadata and data between two clusters is a pretty straightforward process but depends entirely on the proper configurations in each cluster. Listed here are a few tips on some crucial configurations.

HMS-Mirror only moves data with the SQL (SQL) and EXPORT_IMPORT (EXPORT_IMPORT) data strategies. All other strategies either use the data as-is (LINKED (LINKED) or COMMON (COMMON)) or depend on the data being moved by something like `distcp`.

Controlling the YARN Queue that runs the SQL queries from hms-mirror

Use the jdbc url defined in `default.yaml` to set a queue.

`jdbc:hive2://host:10000/.....;...?tez.queue.name=batch`

The commandline properties `-po`, `-pol`, and `-por` can be used to override the queue name as well. For example: `-pol tez.queue.name=batch` will set the queue for the "LEFT" cluster while `-por tez.queue.name=migration` will set the queue for the "RIGHT" cluster.

Make Backups before running hms-mirror

Take snapshots of areas you'll touch:

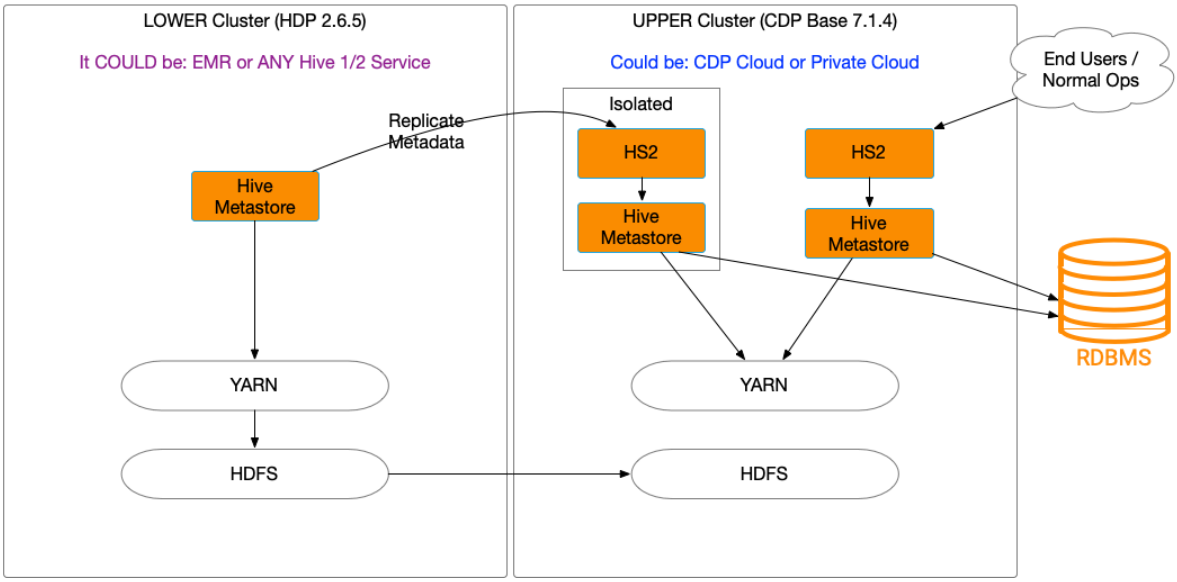
- The HMS database on the LEFT and RIGHT clusters
- A snapshot of the HDFS directories on BOTH the LEFT and RIGHT clusters will be used/touched.

> ⚠ NOTE: If you are testing and "DROPPING" dbs, Snapshots of those data directories could protect you from accidental deletions if you don't manage purge options correctly. Don't skip this... A snapshot of the db directory on HDFS will prevent `DROP DATABASE x CASCADE` from removing the DB directory (observed in CDP 7.1.4+ as tested, check your version) and all sub-directories even though tables were NOT configured with `purge` options.

Isolate Migration Activities

The migration of schemas can put a heavy load on HS2 and the HMS server it's using. That impact can manifest itself as 'pauses' for other clients trying to run queries. Extended schema/discovery operations have a 'blocking' tendency in HS2.

To prevent average user operational impact, I suggest establishing an isolated HMS and HS2 environment for the migration process.



Isolate Migration Service Endpoints

Speed up CREATE/ALTER Table Statements - with existing data

Set `ranger.plugin.hive.urlauth.filesystem.schemes=file` in the Hive Server 2(hive_on_tez) Ranger Plugin Safety Value, via Cloudera Manager.

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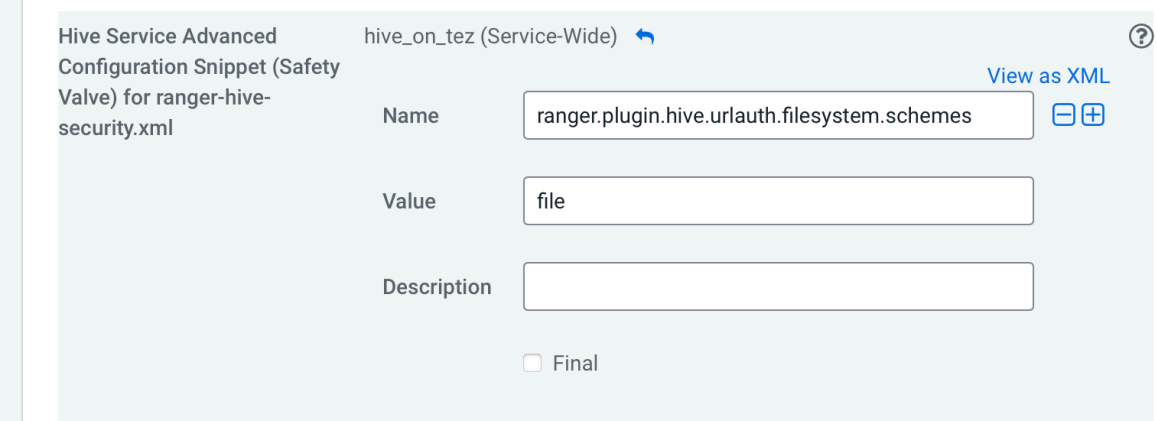

Safety Value

Add this to the HS2 instance on the RIGHT cluster when Ranger is used for Auth. This skips the check done against every directory at the table location (for CREATE or ALTER LOCATION). It is allowing the process of CREATE/ALTER to run much faster.

The default (true) behavior works well for the interactive use case. Still, bulk operations like this can take a long time if this validation needs to happen for every new partition during creation or discovery.

I recommend turning this back after the migration is complete. This setting exposes permissions issues at the time of CREATE/ALTER. So by skipping this, future access issues may arise if the permissions aren't aligned, which isn't a Ranger/Hive issue, it's a permissions issue.

Turn ON HMS partition discovery

In CDP 7.1.4 and below, the housekeeping threads in HMS used to discover partitions are NOT running. Add `metastore.housekeeping.threads.on=true` to the HMS Safety Value to activate the partition discovery thread. Once this has been set, the following parameters can be used to modify the default behavior.

```
hive.metastore.partition.management.task.frequency
hive.exec.input.listing.max.threads
hive.load.dynamic.partitions.thread
hive.metastore.fshandler.threads
```

Source Reference

```
METASTORE_HOUSEKEEPING_LEADER_HOSTNAME("metastore.housekeeping.lea
der.hostname",
            "hive.metastore.housekeeping.leader.hostname", "",
"If multiple Thrift metastore services are running, the hostname
of Thrift metastore " +
        "service to run housekeeping tasks at. By default, this
value is empty, which " +
        "means that the current metastore will run the
housekeeping tasks. If configuration" +
        "metastore.thrift.bind.host is set on the intended leader
metastore, this value should " +
        "match that configuration. Otherwise it should be same as
the hostname returned by " +
        "InetAddress#getLocalHost#getHostName(). Given the
uncertainty in the later " +
        "it is desirable to configure metastore.thrift.bind.host
on the intended leader HMS."),

METASTORE_HOUSEKEEPING_THREADS_ON("metastore.housekeeping.threads.
on",
        "hive.metastore.housekeeping.threads.on", false,
        "Whether to run the tasks under
metastore.task.threads.remote on this metastore instance or
not.\n" +
            "Set this to true on one instance of the Thrift
metastore service as part of turning\n" +
            "on Hive transactions. For a complete list of
parameters required for turning on\n" +
            "transactions, see hive.txn.manager."),
```

The default batch size for partition discovery via `msck` is 3000. Adjustments to this can be made via the `hive.msck.repair.batch.size` property in HS2.

Tips

⚠ Run in `screen` or `tmux`

This process can be a long-running process. It depends on how much you've asked it to do. Having the application terminated because the `ssh` session to the edgenode timed out and your computer went to sleep will be very disruptive.

Using either of these session state tools (or another of your choice) while running it on an edgenode will allow you to sign-off without disrupting the process AND reattach to see the interactive progress at a later point.

⚠ Use `dryrun` FIRST

Before you run a process that will make changes, try running `hms-mirror` with the `dry-run` option first. The report generated at the end of the job will provide insight into what issues (if any) you'll run across.

⚠ Start Small

Use `-db` (database) AND `-tf` (table filter) options to limit the scope of what you're processing. Start with a test database that contains various table types you'd like to migrate.

Review the output report for details/problems you encountered in processing.

Since the process expects the user to have adequate permissions in both clusters, you may find you have some prework to do before continuing.

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Location Alignment

In the Hive Metastore, Database definitions, Table Schemas, and Partition details include the location of their datasets. These locations contain a full URI to the dataset. Migrating from one cluster to another requires us to make adjustments to these locations.

The most simple translation will change the namespace of the URI so everything is RELATIVE. This helps reduce the impact of other tools that might be using these datasets outside the Hive Metastore definitions.

Attributes of location transformations:

- Global Warehouse Directories
- Environment Warehouse Directories

> ⚠ These are pulling automatically from the Hive Environment when available.

- Target Namespace

> ⚠ This is defined in the configuration through the `transfer.targetNamespace` configuration attribute or the `target-namespace` configuration setting. This is used for migrations between two clusters and for STORAGE_MIGRATION's within the cluster.

- Warehouse Plans

> ⚠ Defined for each 'database'. And when defined we should assume that we expect locations of the database, tables, and partitions will be ALIGNED with that location.

Order of Evaluation

Order of Evaluation means that we will evaluate the attribute in the describe order and once a valid mapping is found, we will stop the evaluation. Evaluation order depends on the translation type as well.

ALIGNED

- Target Namespace
- Warehouse Plans (when defined)
- Global Warehouse Directories
- Environment Warehouse Directories (under certain conditions)

RELATIVE

- Target Namespace

Translation Types

Translation types are used to determine how the location should be transformed. The following are the translation types are `ALIGNED` and `RELATIVE`.

Legend

Icon	Description
	Valid
	Invalid
	Ignored
	SQL
	Distcp
	Manual
	Automatic
	Optional
	Metastore Direct
	Global Warehouse
	Warehouse Plan

Translation Scenarios

	Translation Type		Data Movement	Required	Notes
DUMP	✅	RELATIVE			
	❌	ALIGNED			
SCHEMA_ONLY	✅	RELATIVE			⚠ Using distcp here when either table or partition locations aren't standard, will result in data loss because we're not inspecting all the locations through the Metastore Direct connection. It's recommended to use `ALIGNED` with `distcp` to build an accurate `distcp` plan.
	✅	ALIGNED		when Warehouse Plan(s) used (Optional)	

SQL	❌	RELATIVE			
	✅	ALIGNED		(Optional)	
EXPORT_IMPORT	❌	RELATIVE			
	✅	ALIGNED		(Optional)	
HYBRID	❌	RELATIVE			
	✅	ALIGNED		(Optional)	

STORAGE_MIGRATION	❌	RELATIVE			
	✅	ALIGNED	SQL	when Warehouse Plan(s) used (Optional)	
LINKED	☑	RELATIVE			
	☑	ALIGNED			
COMMON	☑	RELATIVE			
	☑	ALIGN			

		E D			

Databases

The whole goal of `hms-mirror` is to move metadata from one cluster to another. Picking which databases to move is a primary function of the application.

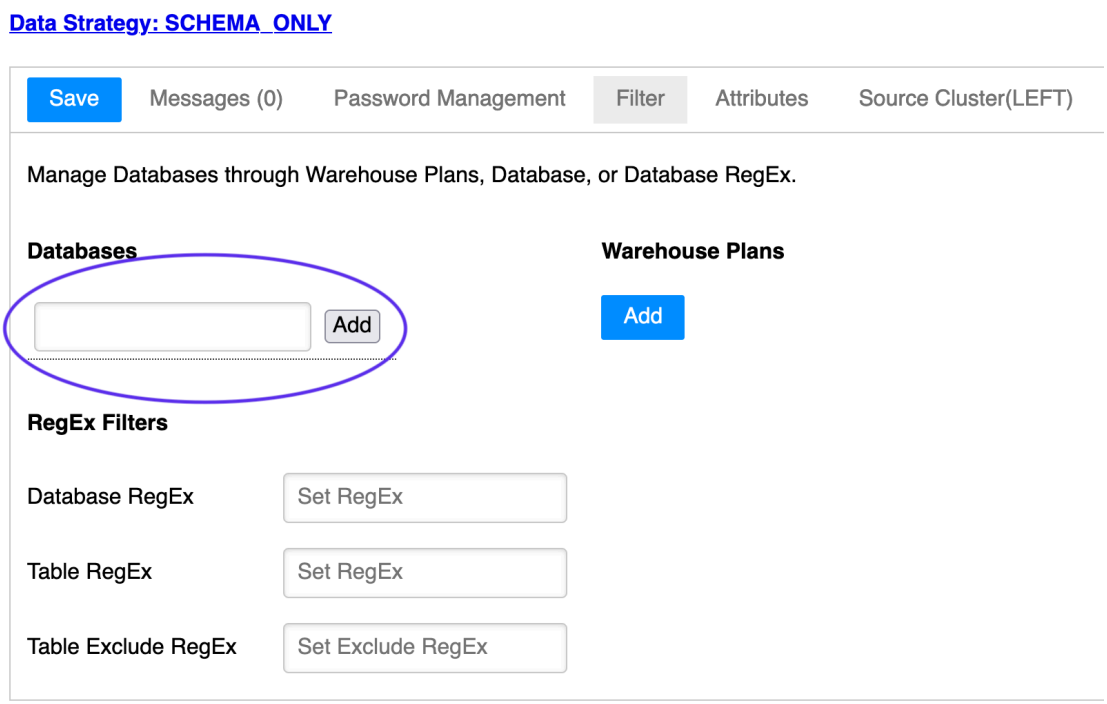
There are several ways to select databases for migration. Each with its own benefits.

Add 'database' names to the runtime configuration.

This is the simplest way to select databases. Additional filtered can be applied to tables through the table **RegEx** filters.

Web UI

Ensure you've selected 'Edit' from the Left Navigation Menu. Enter a comma separated list of databases and press 'Add'.



dbs_by_comma.png

CLI

The `-db|--database` option allows you to list the databases you want to process.

Use the Database RegEx filter to include matching databases found in the source cluster.

Web UI

Ensure you've selected 'Edit' from the Left Navigation Menu. Enter a RegEx pattern to match the databases you want to include and press 'Add'.

CLI

The `-dbRegEx|--database-regex` option allows you to filter matching databases.

Create Warehouse Plans for the databases you want to include.

Web UI

Ensure you've selected 'Edit' from the Left Navigation Menu. Select the 'Warehouse Plans' tab. Create a new Warehouse Plan and add the databases you want to include.

CLI

This feature isn't available through CLI commandline Options. It is possible to use the WebUI to create the configuration and then use the 'persisted' version of that configuration as the configuration for the CLI via `-cfg`.

Warehouse Plans

Start typing here...

Hive Conversions

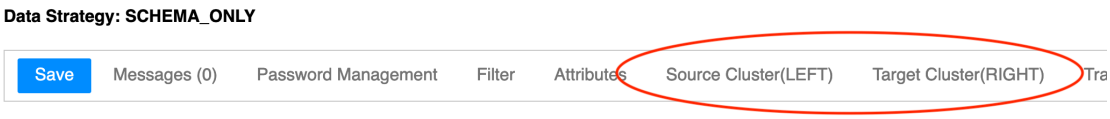
Hive has gone through a lot of changes as it's evolved over the last several years. Especially between Hive 1/2 and Hive 3. The default syntax used to 'create' tables hasn't changed, but the resulting table structure may have.

Understand those changes and what hive flags are available to help influence that structure aren't very clear to even the most seasoned Hive user.

`hms-mirror` uses settings in the 'cluster' configuration to influence **how** tables are translated during the migration.

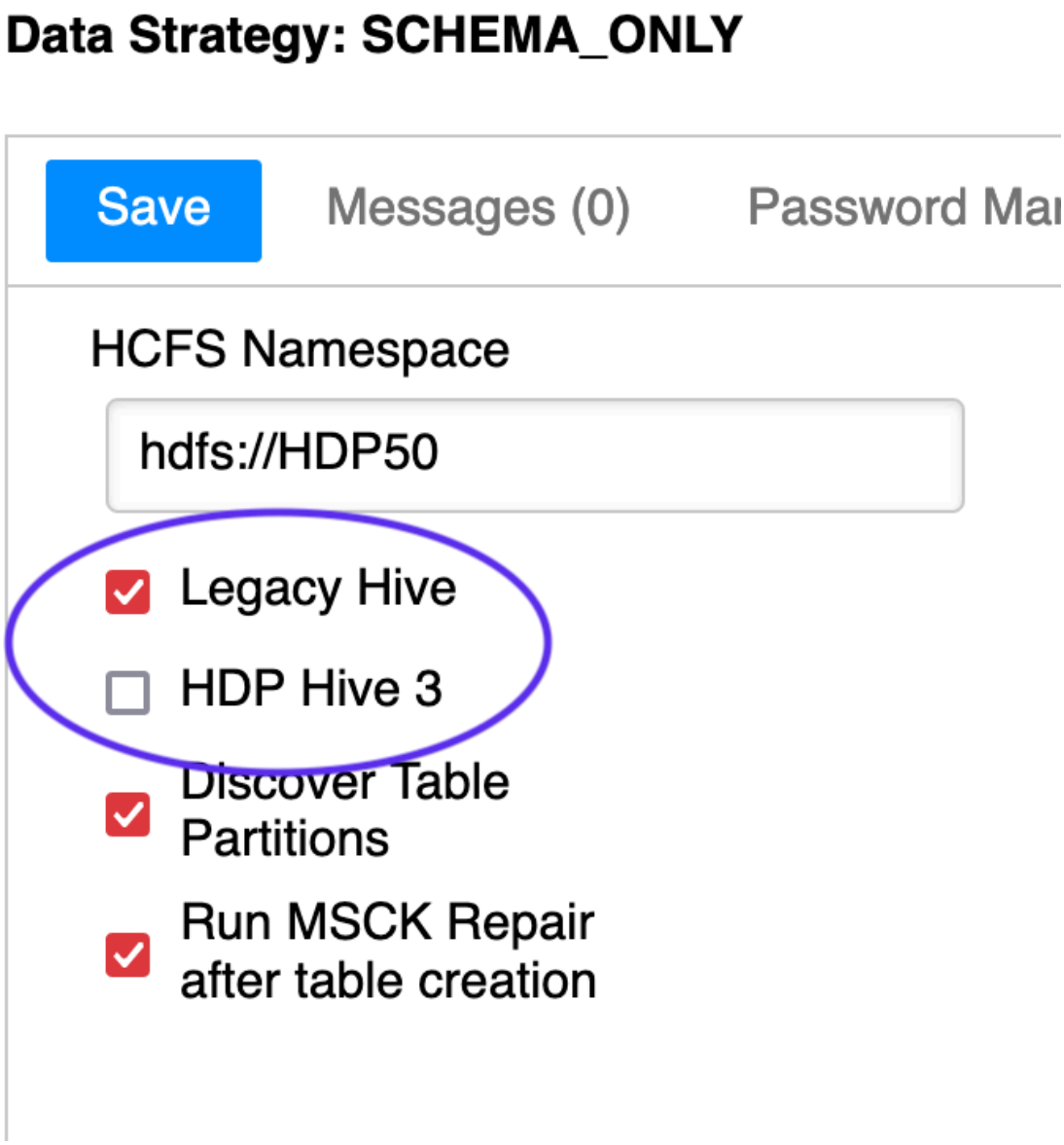
Web Interface

Set the properties in the appropriate cluster configuration(s) for your strategy.



cluster_tabs.png

Set the flags that match you cluster's Hive version.



hive_version_flags.png

CLI

Modify the `hms-mirror` configuration to include the following settings:

```
clusters:
  LEFT|RIGHT:
    legacyHive: true|false
    hdpHive3:   true|false
```

If you were upgrading in-place a Hive 1/2 cluster to Hive 3, the Hive upgrade process would convert 'legacy' managed tables to 'EXTERNAL' tables and add a 'PURGE' flag in the table properties so that tables behavior remains consistent with the original Hive 1/2 behavior while also being a compatible Hive 3 table.

Managed non-ACID tables are NOT a valid state in Hive 3.

With the properties set in the configuration for the cluster (above), `hms-mirror` will make these conversions for you, in the same way that the Hive upgrade process would.

Hive 1/2 Table Types History

Tables in Hive 1/2 are typically 'external' tables. This means that the data is managed independently of the Hive Metastore. The table definition in the Hive Metastore points to the location of the data but does NOT manage the data. In this case, if you drop the table (or a partition), the data remains on the filesystem. These are created with the `CREATE EXTERNAL TABLE` command.

Another table type in Hive 1/2 is the 'managed' table. This is where Hive manages the data. If you drop the table (or partition), Hive will clean up the data on the filesystem. These are created with the `CREATE TABLE` command.

There is also a variant of the 'managed' table that is ACID compliant. These are created with the `CREATE TABLE` command with table properties that enable ACID characteristics `transactional=true`. These tables have special characteristics and are not friendly to the 'schema on read' paradigm, since these tables are 'schema on write' and embed special columns in the data files.

Starting with Hive 3, the default behavior of the `CREATE TABLE` command is to create a 'managed' ACID table. The additional table properties for a 'transactional' table are no longer required to create an ACID table. This is a significant change from Hive 1/2.

There is a web application that allows you to experiment with various commands and settings, showing the resulting table structures.

Regardless, use the following web application to help you quickly through the trial and error phase of understanding these new structural and session settings.

Hive Create Path (https://dstreev.github.io/hive/create_path.html)

Features

`hms-mirror` is designed to migrate schema definitions from one cluster to another or simply provide an extract of the schemas via `-d DUMP`.

Under certain conditions, `hms-mirror` will 'move' data too. Using the data strategies `-d SQL|EXPORT_IMPORT|HYBRID` well use a combination of SQL temporary tables and Linking Clusters Storage Layers (Linking Cluster Storage Layers) to facilitate this.

Iceberg Table Migration via Hive

See Iceberg Migration (ICEBERG_MIGRATION) for details.

File System Stats

SQL based operations, `hms-mirror` will attempt to gather file system stats for the tables being migrated. This is done by running `hdfs dfs -count` on the table location. This is done to help determine the best strategy for moving data and allows us to set certain hive session values and distribution strategies in SQL to optimize the data movement.

But some FileSystems may not be very efficient at gathering stats. For example, S3. In these cases, you can disable the stats gathering by adding `-ssc|--skip-stats-collection` to your command line.

When you have a LOT of tables, collecting stats can have a significant impact on the time it takes to run `hms-mirror` and the general pressure on the FileSystem to gather this information. In this case, you have to option to disable stats collection through `-scc`.

CREATE [EXTERNAL] TABLE IF NOT EXISTS Option

Default behavior for `hms-mirror` is to NOT include the `IF NOT EXISTS` clause in the `CREATE TABLE` statements. This is because we want to ensure that the table is created and that the schema is correct. If the table already exists, we want to fail.

But there are some scenarios where the table is present and we don't want the process to fail on the CREATE statement to ensure the remaining SQL statements are executed. In this case, you can modify add the commandline option `-cine` or add to the configuration:

```
clusters:
  RIGHT|LEFT:
    createIfNotExists: "true"
```

Using this option has the potential to create a table with a different schema than the source. This is not recommended. This option is applied when using the `SCHEMA_ONLY` data strategy.

Auto Gathering Stats (disabled by default)

CDP Default settings have enabled `hive.stats.autogather` and `hive.stats.column.autogather`. This impacts the speed of INSERT statements (used by `hms-mirror` to migrate data) and for large/numerous tables, the impact can be significant.

The default configuration for `hms-mirror` is to disable these settings. You can re-enable this in `hms-mirror` for each side (LEFT|RIGHT) separately. Add the following to your configuration.

```
clusters:
  LEFT|RIGHT:
    enableAutoTableStats: true
    enableAutoColumnStats: true
```

To disable, remove the `enableAutoTableStats` and `enableAutoColumnStats` entries or set them to `false`.

Non-Standard Partition Locations

Partitions created by 'hive' with default locations follow a file system naming convention that allows other partitions of 'hive' to discovery/manage those location and partition associations.

The standard is for partitions to exist as sub-directories of the table location. For example: Table Location is `hdfs://my-cluster/warehouse/tablespace/external/hive/my_test.db/my_table` and the partition location is `hdfs://my-`

`cluster/warehouse/tablespace/external/hive/my_test.db/my_table/dt=2020-01-01`, assuming the partition column name is `dt`.

When this convention is not followed, additional steps are required to build the partition metadata. You can't use `MSCK REPAIR` because it will not find the partitions. You can use `ALTER TABLE ADD PARTITION` but you'll need to provide the location of the partition. `hms-mirror` will do this for you when using the data strategies `-d DUMP|SCHEMA_ONLY` and the commandline flag `-epl|--evaluate-partition-location`.

In order to make this evaluation efficient, we do NOT use standard HiveSQL to discover the partition details. It is possible to use HiveSQL for this, it's just not meant for operations at scale or tables with a lot of partitions.

Hence, we tap directly into the hive metastore database. In order to use this feature, you will need to add the following configuration definition to your hms-mirror configuration file (default.yaml).

```
clusters:
  LEFT|RIGHT:
    ...
    metastore_direct:
      uri: "<db_url>"
      type: MYSQL|POSTGRES|ORACLE
      connectionProperties:
        user: "<db_user>"
        password: "<db_password>"
      connectionPool:
        min: 3
        max: 5
```

You will also need to place a copy of the RDBMS JDBC driver in `$HOME/.hms-mirror/aux_libs`. The driver must match the `type` defined in the configuration file.

Note: Non-Standard Partition Location will affect other strategies like `SQL` where the LEFT clusters storage is accessible to the RIGHT and is used by the RIGHT to source data. The 'mirror' table used for the transfer will NOT discover the partitions and will NOT transfer data. See: Issue #63 (https://github.com/cloudera-labs/hms-mirror/issues/63) for updates on addressing this scenario. If this is affecting you, I highly recommend you comment on the issue to help us set priorities.

Optimizations

The following configuration settings control the various optimizations taken by `hms-mirror`. These settings are mutually exclusive.

- `-at|--auto-tune`
- `-so|--skip-optimizations`
- `-sdpi|--sort-dynamic-partition-inserts`

Auto-Tune

`-at|--auto-tune`

Auto-tuning will use some basic file level statistics about tables/partitions to provide overrides for the following settings:

- `tez.grouping.max-size`
- `hive.exec.max.dynamic.partitions`
- `hive.exec.reducers.max`

in addition to these session level setting, we'll use those basic file statistics to construct migration scripts that address things like 'small-files' and 'large' partition datasets.

We'll set `hive.optimize.sort.dynamic.partition.threshold=-1` and append `DISTRIBUTE BY` to the SQL migration sql statement, just like we do with `-sdpi`. But we'll go one step further and review the average partition size and add an additional 'grouping' element to the SQL to ensure we get efficient writers to a partition. The means that tables with large partition datasets will have more than the standard single writer per partition, preventing the LONG running hanging task that is trying to write a very large partition.

Sort Dynamic Partition Inserts

`-sdpi|--sort-dynamic-partition-inserts`

This will set the session property `hive.optimize.sort.dynamic.partition.threshold=0`, which will enable plans to distribute multi partition inserts by the partition key, therefore reducing partitions writes to a single 'writer/reducer'.

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When this isn't set, we set `hive.optimize.sort.dynamic.partition.threshold=-1`, and append `DISTRIBUTE BY` to the SQL migration sql statement to ensure the same behavior of grouping reducers by partition values.

Skip Optimizations

`-so`

Feature Request #23 (https://github.com/cloudera-labs/hms-mirror/issues/23) was introduced in v1.5.4.2 and give an option to **Skip Optimizations**.

When migrating data via SQL with partitioned tables (OR downgrading an ACID table), there are optimizations that we apply to help hive distribute data more efficiently. One method is to use `hive.optimize.sort.dynamic.partition=true` which will "DISTRIBUTE" data along the partitions via a Reduction task. Another is to declare this in SQL with a `DISTRIBUTE BY` clause.

But there is a corner case where these optimizations can get in the way and cause long-running tasks. If the source table has already been organized into large files (which would be within the partitions already), adding the optimizations above force a single reducer per partition. If the partitions are large and already have good file sizes, we want to skip these optimizations and let hive run the process with only a map task.

HDP3 MANAGEDLOCATION Database Property

HDP3 doesn't support MAANGEDLOCATION (https://github.com/cloudera-labs/hms-mirror/issues/52) so we've added a property to the cluster configuration to allow the system to *SKIP* setting the `MANAGEDLOCATION` database property in HDP 3 / Hive 3 environments.

```
clusters:
  LEFT:
    legacyHive: false
    hdpHive3: true
```

Compress Text Output

`-cto` will control the session level setting for `hive.exec.compress.output'.

VIEWS

`hms-mirror` now supports the migration of VIEWs between two environments. Use the `-v|--views-only` option to execute this path. VIEW creation requires dependent tables to exist.

Run `hms-mirror` to create all the target tables before running it with the `-v` option.

This flag is an `OR` for processing VIEW's `OR` TABLE's. They are NOT processed together.

Requirements

- The dependent tables must exist in the RIGHT cluster
- When using `-dbp|--db-prefix` option, VIEW definitions are NOT modified and will most likely cause VIEW creation to fail.

ACID Tables

`hms-mirror` supports the migration of ACID tables using the `-d HYBRID|SQL|EXPORT_IMPORT` data strategy in combination with the `-ma|--migrate-acid` or `-mao|--migrate-acid-only` flag. You can also simply 'replay' the schema definition (without data) using `-d SCHEMA_ONLY -ma|-mao`. The `-ma|-mao` flag takes an *optional* integer value that sets an 'Artificial Bucket Threshold'. When no parameter is specified, the default is `2`.

Use this value to set a bucket limit where we'll *remove* the bucket definition during the translation. This is helpful for legacy ACID tables which *required* a bucket definition but weren't a part of the intended design. The migration provides an opportunity to correct this artificial design element.

With the default value `2`, we will *remove* CLUSTERING from any ACID table definitions with `2` or fewer buckets defined. If you wish to keep ALL CLUSTERED definitions, regardless of size, set this value to `0`.

There is now an option to 'downgrade' ACID tables to EXTERNAL/PURGE during migration using the `-da` option.

The ACID Migration Process

The ACID migration builds a 'transfer' table on the LEFT cluster, a 'legacy' managed table (when the LEFT is a legacy cluster), or an 'EXTERNAL/PURGE' table. Data is copied to this transfer table from the original ACID table via SQL.

Since the clusters are linked (Linking Cluster Storage Layers), we build a 'shadow' table that is 'EXTERNAL' on the 'RIGHT' cluster that uses the data in the 'LEFT' cluster. Similar to the LINKED data strategy. If the data is partitioned, we run `MSCK` on this 'shadow' table in the 'RIGHT' cluster to discover all the partitions.

The final ACID table is created in the 'RIGHT' cluster, and SQL is used to copy data from the 'LEFT' cluster via the 'shadow' table.

Requirements

- Data Strategy: `HYBRID`, `SQL`, or `EXPORT_IMPORT`
- Activate Migrate ACID: `-ma|-mao`
- Link Clusters (Linking Cluster Storage Layers), unless using the `-is|--intermediate-storage` option.
- This is a 'ONE' time transfer. It is not an incremental update process.
- Adequate Storage on LEFT to make an 'EXTERNAL' copy of the ACID table.
- Permissions:
  - From the RIGHT cluster, the submitting user WILL need access to the LEFT cluster's storage layer (HDFS) to create the shadow table (with location) that points across clusters.
  - doas will have a lot to do with the permissions requirements.
  - The 'hive' service account on the RIGHT cluster will need elevated privileges to the LEFT storage LAYER (HDFS). For example: If the hive service accounts on each cluster DO NOT share the same identity, like `hive`, then the RIGHT hive identity MUST also have privileged access to the LEFT clusters HDFS layer.
- Partitioned tables must have data that is 'discoverable' via `MSCK`. NOTE: The METADATA activity and REDUCER restrictions to the number of BUCKETs can dramatically affect this.- The number of partitions in the source ACID tables must be below the `partitionLimit` (default 500). This strategy may not be successful when the partition count is above this, and we won't even attempt the conversion. Check YARN for the progress of jobs with a large number of partitions/buckets. Progress many appear stalled from 'hms-mirror'.

- ACID table migration to Hive 1/2 is NOT supported due to the lack of support for "INSERT OVERWRITE" on transactional tables. Hive 1/2 to Hive 3 IS support and the target of this implementation. Hive 3 to Hive 3 is also supported.

Replace ACID -r or --replace

When downgrading ACID tables during migration, the `-r` option will give you the option to 'replace' the original ACID table with the a table that is no longer ACID. This option is only available along with the `-da` and `SQL` data strategy options.

Intermediate/Common Storage Options

When bridging the gap between two clusters, you may find they can't share/link storage. In this case, using one of these options will help you with the transfer.

The `-is` or `--intermediate-storage` option is consider a transient location that both cluster can share, see, and have access to. The strategies for transferring data (EXPORT_IMPORT, SQL, HYBRID) will use this location to facilitate the transfer. This is a common strategy when migrating from on-prem environments to the cloud.

The `-cs` or `--common-storage` option is similar to `-is` but this option ends up being the final resting place for the data, not just the transfer location. And with this option, we can streamline the jumps required to migrate data. Again, this location needs to be accessible to both clusters.

Non-Native Hive Tables (Hbase, KAFKA, JDBC, Druid, etc..)

Any table definition without a `LOCATION` element is typically a reference to an external system like: HBase, Kafka, Druid, and/or (but not limited to) JDBC.

Requirements

These references require the environment to be:

- Correctly configured to use these resources
- Include the required libraries in the default hive environment.
- The referenced resource must exist already BEFORE the 'hive' DDL will successfully run.

AVRO Tables

AVRO tables can be designed with a 'reference' to a schema file in `TBLPROPERTIES` with `avro.schema.url`. The referenced file needs to be 'copied' to the *RIGHT* cluster BEFORE the `CREATE` statement for the AVRO table will succeed.

Add the `-asm|--avro-schema-move` option at the command line to *copy* the file from the LEFT cluster to the RIGHT cluster.

As long as the clusters are linked (Linking Cluster Storage Layers) and the cluster `hcfsNamespace` values are accurate, the user's credentials running `hms-mirror` will attempt to copy the schema file to the *RIGHT* cluster BEFORE executing the `CREATE` statement.

Requirements

- Link Clusters (Linking Cluster Storage Layers) for Data Strategies: `SCHEMA_ONLY`, `SQL`, `EXPORT_IMPORT`, and `HYBRID`
- Running user must have 'namespace' access to the directories identified in the `TBLPROPERTIES` key `avro.schema.url`.
- The user running `hms-mirror` will need enough storage level permissions to copy the file.
- When hive is running with `doas=false`, `hive` will need access to this file.

Warnings

- With the `EXPORT_IMPORT` strategy, the `avro.schema.url` location will NOT be converted. It may lead to an issue reading the table if the location includes a prefix of the cluster's namespace OR the file doesn't exist in the new cluster.

Table Translations

Legacy Managed Tables

`hms-mirror` will convert 'legacy' managed tables in Hive 1 or 2 to EXTERNAL tables in Hive 3. It relies on the `legacyHive` setting in the cluster configurations to accurately make

this conversion. So make sure you've set this correctly.

distcp Planning Workbook and Scripts

`hms-mirror` will create source files and a shell script that can be used as the basis for the 'distcp' job(s) used to support the databases and tables requested in `-db`. `hms-mirror` will NOT run these jobs. It will provide the basic job constructs that match what it did for the schemas. Use these constructs to build your execution plan and run these separately.

The constructs created are intended as a *one-time* transfer. If you are using *SNAPSHOTS* or `--update` flags in `distcp` to support incremental updates, you will have to make additional modifications to the scripts/process. Note: For these scenarios, `hms-mirror` supports options like `-ro|--read-only` and `-sync`.

Each time `hms-mirror` is run, *source* files for each database are created. These source files need to be copied to the distributed filesystem and reference with an `-f` option in `distcp`. We also create a *basic* shell script that can be used as a template to run the actual `distcp` jobs.

Depending on the job size and operational expectations, you may want to use *SNAPSHOTS* to ensure an immutable source or use a `diff` strategy for more complex migrations. Regardless, you'll need to make modifications to these scripts to suit your purposes.

If your process requires the data to exist BEFORE you migrate the schemas, run `hms-mirror` in the `dry-run` mode (default) and use the distcp planning workbook and scripts to transfer the datasets. Then run `hms-mirror` with the `-e|--execute` option to migrate the schemas.

These workbooks will NOT include elements for ACID/Transactional tables. Simply copying the dataset for transactional tables will NOT work. Use the `HYBRID` data strategy migration transactional table schemas and datasets.

ACID Table Downgrades

The default table creation scenario for Hive 3 (CDP and HDP 3) installations is to create ACID transactional tables. If you're moving from a legacy platform like HDP 2 or CDH, this may have caught you off guard and resulted in a lot of ACID tables you did NOT intend on.

The `-da|--downgrade-acid` option can be used to convert these ACID tables to *EXTERNAL/PURGE* tables.

If you have ACID tables on the current platform and would like to *downgrade* them, but you're not doing a migration, try the `-ip|--in-place` option. This will archive to existing ACID table and build a new table (with the original table name) that is *EXTERNAL/PURGE*.

Reset to Default Locations

Migrations present an opportunity to clean up a lot of history. While `hms-mirror` was originally designed to migration data and maintain the **relative** locations of the data, some may want to reorganize the data during the migration.

The option `-rdl|--reset-default-location` will overwrite the locations originally used and place the datasets in the 'default' locations as defined by `-wd|--warehouse-directory` and `-ewd|--external-warehouse-directory`.

The `-rdl` option requires `-wd` and `-ewd` to be specified. These locations will be used to `ALTER` the databases `LOCATION` and `MANAGEDLOCATION` values. After which, all new `CREATE \[EXTERNAL\] TABLE` definitions don't specify a `LOCATION`, which means table locations will use the default.

Legacy Row Serde Translations

By default, tables using old row *serde* classes will be converted to the newer serde as the definition is processed by `hms-mirror`. See here (https://github.com/cloudera-labs/hms-mirror/blob/6f6c309f24fbb8133e5bd52e5b18274094ff5be8/src/main/java/com/cloudera/utils/hadoop/hms/mirror/feature/LegacyTranslations.java#L28) for a list of serdes we look for.

If you do NOT want to apply this translation, add the option `-slt|--skip-legacy-translation` to the commandline.

Filtering Tables to Process

There are options to filter tables included in `hms-mirror` process. You can select `-tf|--table-filter` to "include" only tables that match this 'regular-expression'. Inversely, use `-etf|--exclude-table-filter` to omit tables from the list. These options are mutually exclusive.

The filters for `-tf` and `-tef` are expressed as a 'regular-expression'. Complex expressions should be enclosed in quotes to ensure the commandline interpreter doesn't split them.

Additional table filters (`-tfs|--table-filter-size-limit` and `-tfp|--table-filter-partition-count-limit`) that check a tables data size and partition count limits can also be applied to narrow the range of tables you'll process.

The filter does NOT override the requirement for options like `-ma|-mao`. It is used as an additional filter.

Migrations between Clusters WITHOUT line of Site

There will be cases where clusters can't be linked (Linking Cluster Storage Layers). And without this line of sight, data movement needs to happen through some other means.

On-Prem to Cloud

This scenario is most common with "on-prem" to "cloud" migrations. Typically, `hms-mirror` is run from the **RIGHT** cluster, but in this case the **RIGHT** cloud cluster doesn't have line of site to the **LEFT** on-prem cluster. But the on-prem cluster will have limited line of site to the cloud environment. In this case, the only option is to run `hms-mirror` from the on-prem cluster. The on-prem cluster will need access to either an `-is|--intermediate-storage` location that both clusters can access or a `-cs|--common-storage` location that each cluster can see, but can be considered the final resting place for the cloud environment. The `-cs` option usually means there are fewer data hops required to complete the migration.

You'll run `hms-mirror` from a **LEFT** cluster edgenode. This node will require line of site to the Hive Server 2 endpoint in the **RIGHT** cloud environment. The **LEFT** cluster will also need to be configured with the appropriate libraries and configurations to write to the location defined in `-is|-cs`. For example: For S3, the **LEFT** cluster will need the AWS S3 libraries configured and the appropriate keys for S3 access setup to complete the transfer.

Shared Storage Models (Isilon, Spectrum-Scale, etc.)

There are cases where 'HDFS' isn't the primary data source. So the only thing the cluster share is storage in these 'common' storage units. You want to transfer the schema, but the data doesn't need to move (at least for 'EXTERNAL' (non-transactional) tables). In this

case, try the `-d|--data-strategy` COMMON. The schema's will go through all the needed conversions while the data remains in the same location.

Disconnected Mode

Use the `-rid|--right-is-disconnected` mode when you need to build (and/or) transfer schema/datasets from one cluster to another, but you can't connect to both at the same time. See the issues log for details regarding the cases here issue #17 (https://github.com/cloudera-labs/hms-mirror/issues/17).

Use cases:

- Schema Only Transfers
- SQL, EXPORT_IMPORT, and HYBRID only when -is or -cs is used. This might be the case when the clusters are secure (kerberized), but don't share a common kerberos domain/user auth. So an intermediate or common storage location will be used to migrate the data.
- Both clusters (and HS2 endpoints) are Kerberized, but the clusters are NOT the same major hadoop version. In this case, hms-mirror doesn't support connecting to both of these endpoints at the same time. Running in the disconnected mode will help push through with the conversion.

hms-mirror will run as normal, with the exception of examining and running scripts against the right cluster. It will be assumed that the RIGHT cluster elements do NOT exist.

The RIGHT_ 'execution' scripts and distcp commands will need to be run MANUALLY via Beeline on the RIGHT cluster.

Note: This will be know as the "right-is-disconnected" option. Which means the process should be run from a node that has access to the "left" cluster. This is 'counter' to our general recommendation that the process should be run from the 'right' cluster.

No-Purge Option

`-np`

Feature Request #25 (https://github.com/cloudera-labs/hms-mirror/issues/25) was introduced in v1.5.4.2 and gives the user to option to remove the `external.table.purge`

option that is added when converting legacy managed tables to external table (Hive 1/2 to 3). This does affect the behavior of the table from the older platforms.

Property Overrides

`-po[l|r] <key=value>[,<key=value>]...`

Feature Request #27 (https://github.com/cloudera-labs/hms-mirror/issues/27) introduced in v1.5.4.2 provides the ability to set a hive properties at the beginning of each migration part. This is a comma separated list of key=value pairs with no space. If spaces are needed, quote the parameter on the commandline.

You can use `-po` to set the properties for BOTH clusters or `-pol`|`-por` to set them specifically for the 'left' and/or 'right' cluster.

For example: `-po hive.exec.orc.split.strategy=BI,hive.compute.query.using.stats=false`

To provide a consistent list of settings for ALL jobs, add/modify the following section in the configuration file ie: `default.yaml` used for processing. In this case you do NOT need to use the commandline option. Although, you can set basic values in the configuration file and add other via the commandline.

Notice that there are setting for the LEFT and RIGHT clusters.

```yaml
optimization:
  overrides:
    left:
      tez.queue.name: "compaction"
    right:
      tez.queue.name: "migration"
```

Global Location Map

`-glm|--global-location-map <from=to>[,...]`

This is an opportunity to make some specific directory mappings during the migration. You can supply a comma separated list of directory pairs to be use for evaluation.

`-glm /data/my_original_location=/corp/finance_new_loc,/user/hive=/warehouse/hive`

These directory mappings ONLY apply to 'EXTERNAL' and 'DOWNGRADED ACID' tables. You can supply 'n' number of mappings to review through the commandline interface as

describe above. To provide a consistent set of mappings to ALL jobs, add/modify the following section in the configuration file ie: `default.yaml` used for processing.

```
translator:
  globalLocationMap:
    /data/my_original_location: "/corp/finance_new_loc"
    /user/hive: "/warehouse/hive"
```

The list will be sorted by the length of the string, then alpha-numerically. This will ensure the deepest nested paths are evaluated FIRST. When a path is matched during evaluation, the process will NOT look and any more paths in the list. Therefore, avoiding possible double evaluations that may result when there are nested paths in the list.

Paths are evaluated with 'startsWith' on the original path (minus the original namespace). When a match is found, the path 'part' will be replaced with the value specified. The remaining path will remain intact and regardless of the `-rdl` setting, the LOCATION element will be included in the tables new CREATE statement.

Force External Locations

`-fel|--force-external-location`

Under some conditions, the default warehouse directory hierarchy is not honored. We've seen this in HDP 3. The `-rdl` option collects the external tables in the default warehouse directory by omitting the LOCATION element in the CREATE statement, relying on the default location. The default location is set at the DATABASE level by `hms-mirror`.

In HDP3, the CREATE statement doesn't honor the 'database' LOCATION element and reverts to the system wide warehouse directory configurations. The `-fel` flag will simply include the 'properly' adjusted LOCATION element in the CREATE statement to ensure the tables are created in the desired location. This setting overrides the effects intended by the `-rdl` option which intend to place the tables under the stated warehouse locations by omitting the location from the tables definition and relying on the default location specified in the database.

`-fel` will use the original location as a starting point. If `-wd|-ewd` are specified, they aren't not used in the translation, but warnings may be issued if the final location doesn't align with the warehouse directory. The effect change in the location when using `-fel`, add mappings via `-glm`.

HDP 3 Hive

HDP 3 (Hive 3) was an incomplete implementation with regards to complex table 'location' management. When you are working in this environment, add to the cluster configuration (LEFT or RIGHT) the setting: `hdpHive3: true`. There is NOT a commandline switch for this. JUst add it to the configuration file you're using to run the application.

```
clusters:
  LEFT:
    environment: "LEFT"
    legacyHive: false
    hdpHive3: true
```

HDP3 Hive did NOT have a MANAGEDLOCATION attribute for Databases.

The LOCATION element tracked the Manage ACID tables and will control where they go.

This LOCATION will need to be transferred to MANAGEDLOCATION 'after' upgrading to CDP to ensure ACID tables maintain the same behavior. EXTERNAL tables will explicity set there LOCATION element to match the setting in `-ewd`.

Future external tables, when no location is specified, will be created in the `hive.metastore.warehouse.external.dir`. This value is global in HDP Hive3 and can NOT be set for individual databases.

Post upgrade to CDP, you should add a specific directory value at the database level for better control.

Schema Fix Features

Schema Fix Features are a way to inject special considerations into the replay of a schema between clusters. Each schema is automatically check is a particular 'feature' applies.

If you find that this features check is causing issues, add the flag `-sf` to the application parameters and the feature checks will be skipped.

BAD_ORC_DEF

`BAD_ORC_DEF` is a feature that corrects poorly executed schema definitions in legacy Hive 1/2 that don't translate into a functioning table in Hive 3. In this case, the legacy

definition was defined with:

```
ROW FORMAT DELIMITED
  FIELDS TERMINATED BY '\t'
  LINES TERMINATED BY '\n'
STORED AS INPUTFORMAT
  'org.apache.hadoop.hive.ql.io.orc.OrcInputFormat'
OUTPUTFORMAT
  'org.apache.hadoop.hive.ql.io.orc.OrcOutputFormat'
```

when it should have been created with:

```
STORED AS ORC
```

The result, when not modified and replayed in Hive 3 is a table that isn't functional. The `BAD_ORC_DEF` feature will replace:

```
ROW FORMAT DELIMITED
  FIELDS TERMINATED BY '\t'
  LINES TERMINATED BY '\n'
```

with:

```
ROW FORMAT SERDE
  'org.apache.hadoop.hive.ql.io.orc.OrcSerde'
```

BAD_RC_DEF

`BAD_RC_DEF` is a feature that corrects poorly executed schema definitions in legacy Hive 1/2 that doesn't translate into a functioning table in Hive 3. In this case, the legacy definition was defined with:

```
ROW FORMAT DELIMITED,
    FIELDS TERMINATED BY '|'
 STORED AS INPUTFORMAT
  'org.apache.hadoop.hive.ql.io.RCFileInputFormat'
```

```
 OUTPUTFORMAT
  'org.apache.hadoop.hive.ql.io.RCFileOutputFormat'
```

when it should have been created with:

```
STORED AS RCFILE
```

The result, when not modified and replayed in Hive 3 is a table that isn't functional. The `BAD_RC_DEF` feature will replace:

```
ROW FORMAT DELIMITED,
    FIELDS TERMINATED BY '|'
 STORED AS INPUTFORMAT
```

with:

```
STORED AS RCFILE
```

BAD_TEXTFILE_DEF

Older Textfile schemas somehow are corrupted through subsequent ALTER statements that get the table into a state where you can NOT re-run the contents of `SHOW CREATE TABLE`. In this case, the issue is that there is a declaration for `WITH SERDEPROPERTIES` along with a `ROW FORMAT DELIMITED` clause. These two can NOT exist together. Here is an example of this:

```
ROW FORMAT DELIMITED
     FIELDS TERMINATED BY '|'
     LINES TERMINATED BY '\n'
WITH SERDEPROPERTIES (
     'escape.delim'='\\')
STORED AS INPUTFORMAT
     'org.apache.hadoop.mapred.TextInputFormat'
OUTPUTFORMAT
     'org.apache.hadoop.hive.ql.io.HiveIgnoreKeyTextOutputFormat'
```

In this case, we need to convert the `ROW FORMAT DELIMITED * TERMINATED BY *` values into the `SERDEPROPERTIES` and replace it with

```
ROW FORMAT SERDE
  'org.apache.hadoop.hive.serde2.lazy.LazySimpleSerDe'
```

Strategies

A 'strategy' in `hms-mirror` is the method used to migrate metadata and possibly data from one metastore to another.

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SCHEMA_ONLY

This strategy is used to migrate "only" the schema (mostly). When migrating from a `legacy` (Hive 1/2) hive environment to a `non-legacy` (Hive 3+) `hms-mirror` will convert tables that are "managed non-transactional" to "external/purge". This translation is a part of the HSMM (Hive Strict Managed Migration) process that run for 'in-place' upgrades.

`hms-mirror` is mostly designed for "side-car" migrations which involves two separate clusters.

Options

-f|--flip

The configuration yaml has two clusters defined: LEFT and RIGHT. By default, all work moves from LEFT to RIGHT. If you need to perform actions from RIGHT to LEFT, use the `-f` option to switch these clusters. The final report will show that these clusters have been reversed.

-ma|--migrate-acid or -mao|--migrate-acid-only \[optional artificial bucket limit\] \(default is 2\)

The default behaviour is NOT to handle ACID tables. ACID tables require some additional handling. When you need to address ACID tables, use these flags to either include them OR migrate ONLY ACID tables.

Migrations from legacy hive environments may have had to create tables with an unnecessary `CLUSTERED BY` clause to support `bucketing` for these ACID tables. The `artificial bucket limit` is an opportunity to remove those definitions for the migrated tables. For example: If you've defined a table with 2 buckets, the default `artificial bucket limit` is 2, so the table `CLUSTERED BY ... INTO 2 BUCKETS` will be removed from the definition.

-mnno|--migrate-non-native-only

Use this to migrate *non-native* hive tables like: Kafka, HBase, JDBC Federated, etc.. This option excludes *native* tables from processing, so you should run it separately.

> ⚠ Many of these tables **REQUIRE** that the supporting references **EXIST** first, or their creation will **FAIL**. For instance, migrating a table with the

HBase Storage handler requires that the HBase table is *present* AND *visible* from Hive.

-v|--views-only

Like `-mnno` the `-v` option excludes other tables from processing, so it's designed to run along. And like the `-mnno` option, it too requires the supporting tables to exist, otherwise the view create statements will *fail*.

-asm|--avro-schema-migration

AVRO tables have a `TBLPROPERTIES` key `avro.schema.url` that identifies the supporting avro schemas location on the current cluster. When migrating AVRO tables, use this option to check for this setting. As a result, `hms-mirror` will parse out the location and replace it with the same relative location.

`hms-mirror` will use the configured environments `hdfs|core-site.xml` files to launch an `hdfs` client that will copy the supporting avro schema between clusters. For this to work, the clusters MUST be visible to each other (Linking Cluster Storage Layers).

The DUMP strategy is like SCHEMA_ONLY; it just doesn't require the RIGHT cluster to be connected. Although, it does need the following settings for the RIGHT cluster to make the proper adjustments:

```
legacyHive
hcfsNamespace
hiveServer2 -> partitionDiscovery
```

When the option `-ma` (migrate acid) is specified, the ACID schema's will be migrated/dumped. It is essential to know that the data for ACID tables can NOT simply be copied from one clusters hive instance to another. The data needs to be extracted to a none ACID table, then use an external table definition to read and INSERT the data into the new ACID table on the RIGHT cluster. For those that insist on trying to simply copy the data.... you've been warned ;).

With the DUMP strategy, you'll have a 'translated' (for legacy hive) table DDL that can be run on the new cluster independently.

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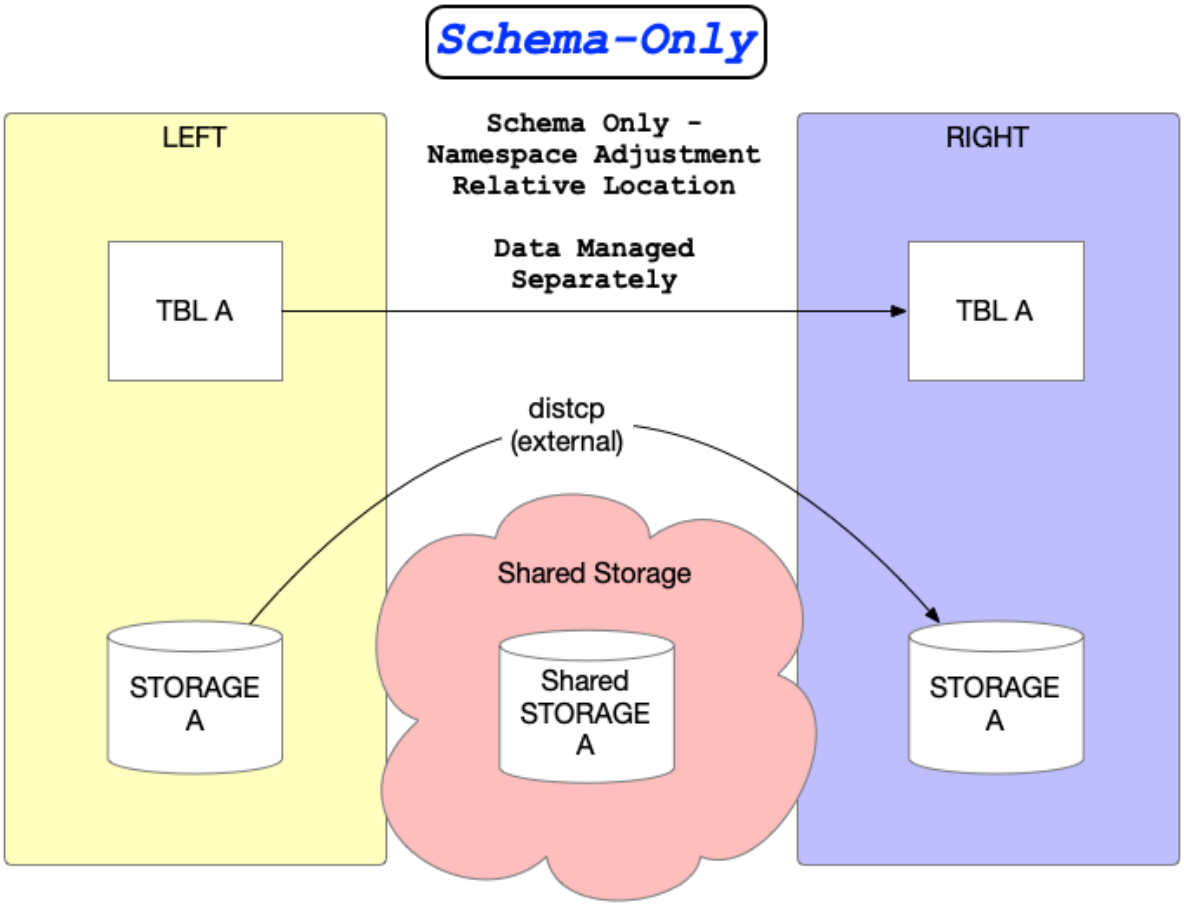
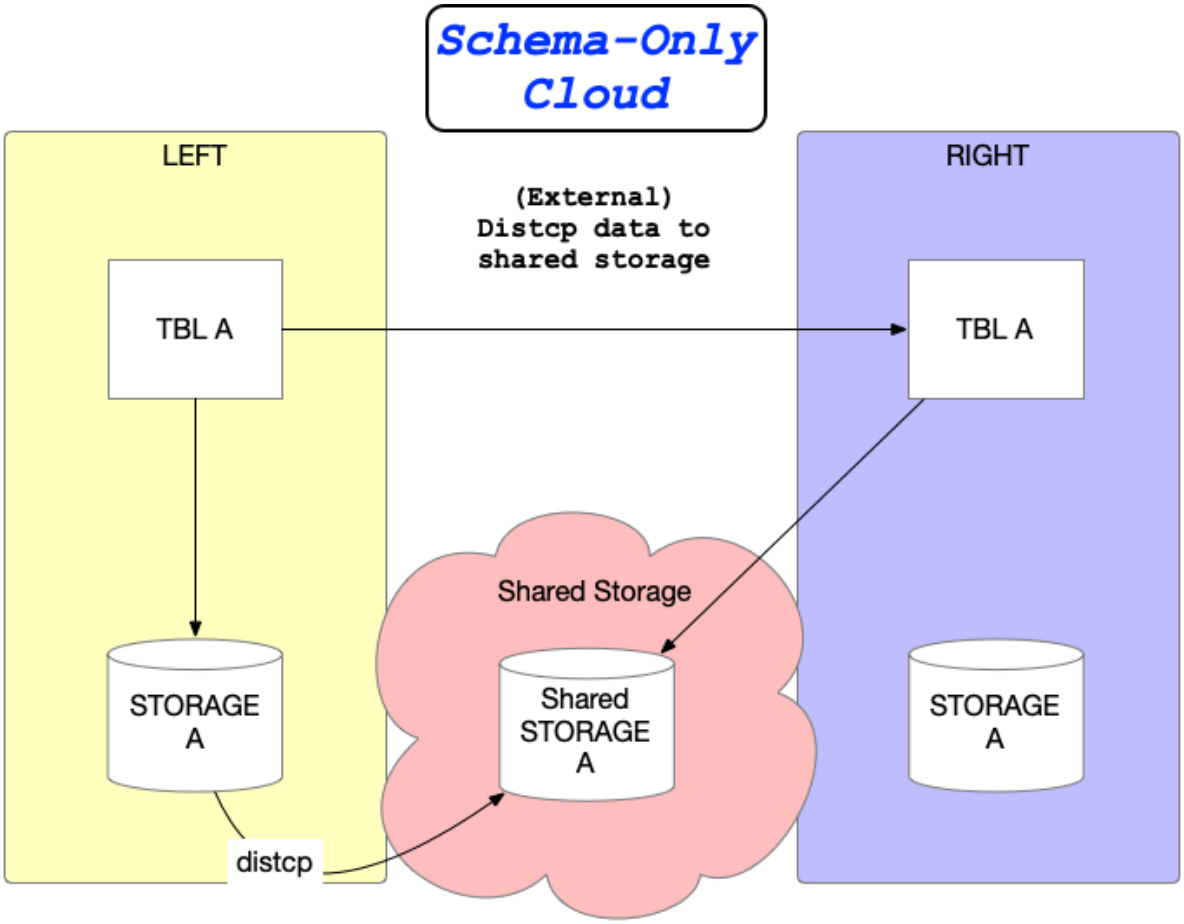

Schema-Only
LEFT
Schema Only -
Namespace Adjustment
Relative Location
Data Managed
Separately
RIGHT
TBL A
TBL A
distcp
(external)
Shared Storage
STORAGE
A
Shared
STORAGE
A
STORAGE
A

schema_only



schema_only_cloud

DUMP

This strategy is used to migrate "only" the schema (mostly). When migrating from a `legacy` (Hive 1/2) hive environment to a `non-legacy` (Hive 3+) `hms-mirror` will convert tables that are "managed non-transactional" to "external/purge". This translation is a part of the HSMM (Hive Strict Managed Migration) process that run for 'in-place' upgrades.

`hms-mirror` is mostly designed for "side-car" migrations which involves two separate clusters.

Options

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-ma|--migrate-acid or -mao|--migrate-acid-only

`[optional artificial bucket limit]` (default is 2)

The default behaviour is NOT to handle ACID tables. ACID tables require some additional handling. When you need to address ACID tables, use these flags to either include them OR migrate ONLY ACID tables.

Migrations from legacy hive environments may have had to create tables with an unnecessary `CLUSTERED BY` clause to support `bucketing` for these ACID tables. The `artificial bucket limit` is an opportunity to remove those definitions for the migrated tables. For example: If you've defined a table with 2 buckets, the default `artificial bucket limit` is 2, so the table `CLUSTERED BY ... INTO 2 BUCKETS` will be removed from the definition.

[-mnno|--migrate-non-native-only]

See Non-Native Tables ("Non-Native Hive Tables (Hbase, KAFKA, JDBC, Druid, etc..)" in "Features") for more information.

Use this to migrate *non-native* hive tables like: Kafka, HBase, JDBC Federated, etc.. This option excludes *native* tables from processing, so you should run it separately.

Note that many of these tables **REQUIRE** that the supporting references **EXIST** first, or their creation will **FAIL**. For instance, migrating a table with the HBase Storage handler requires that the HBase table is *present* AND *visible* from Hive.

[-v|--views-only]

See Views ("VIEWS" in "Features") for more information.

Like `-mnno` the `-v` option excludes other tables from processing, so it's designed to run along. And like the `-mnno` option, it too requires the supporting tables to exist, otherwise the view create statements will *fail*.

-asm|--avro-schema-migration

AVRO tables have a `TBLPROPERTIES` key `avro.schema.url` that identifies the supporting avro schemas location on the current cluster. When migrating AVRO tables, use this option to check for this setting. As a result, `hms-mirror` will parse out the location and replace it with the same relative location.

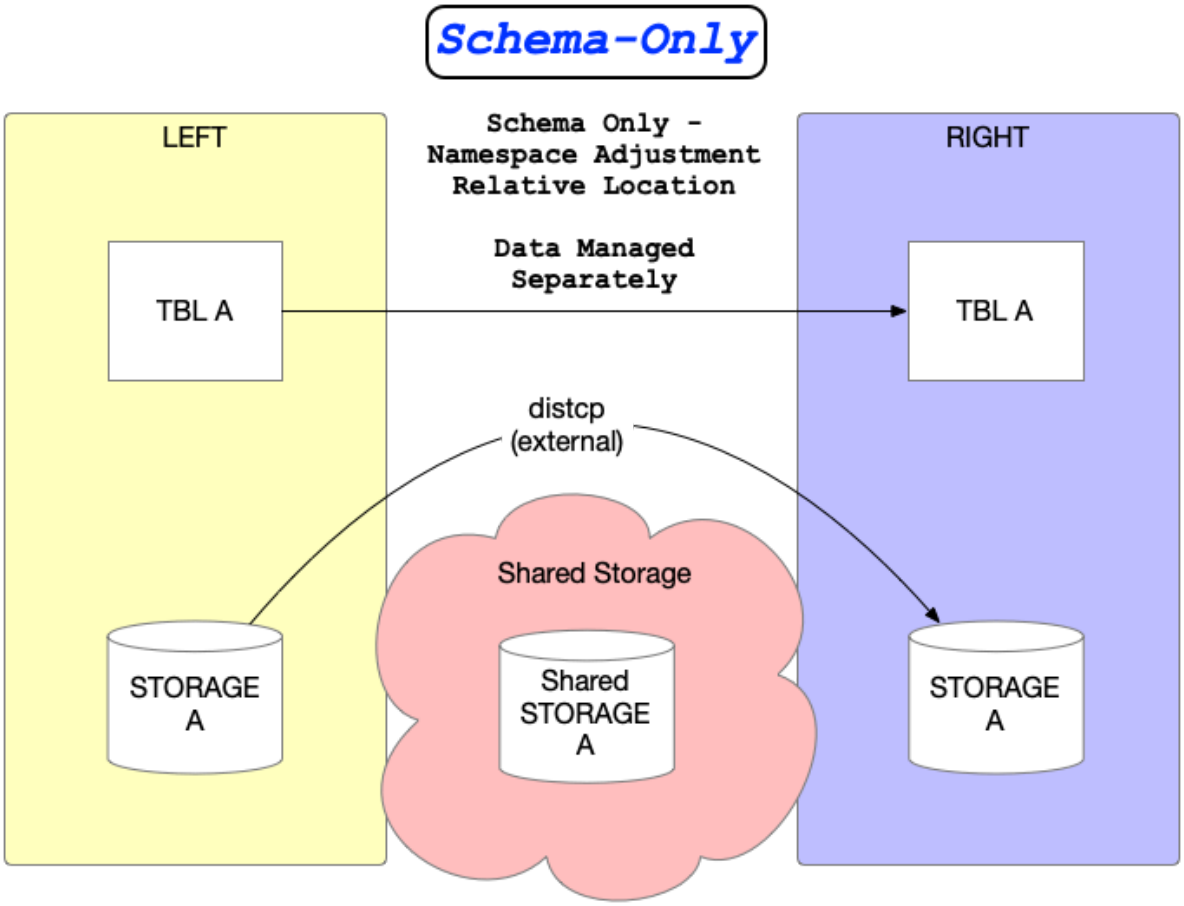
`hms-mirror` will use the configured environments `hdfs|core-site.xml` files to launch an `hdfs` client that will copy the supporting avro schema between clusters. For this to work, the clusters MUST be visible to each other (Linking Cluster Storage Layers).

The DUMP strategy is like SCHEMA_ONLY; it just doesn't require the RIGHT cluster to be connected. Although, it does need the following settings for the RIGHT cluster to make the proper adjustments:

```
legacyHive
hcfsNamespace
hiveServer2 -> partitionDiscovery
```

When the option `-ma` (migrate acid) is specified, the ACID schema's will be migrated/dumped. It is essential to know that the data for ACID tables can NOT simply be copied from one clusters hive instance to another. The data needs to be extracted to a none ACID table, then use an external table definition to read and INSERT the data into the new ACID table on the RIGHT cluster. For those that insist on trying to simply copy the data.... you've been warned ;).

With the DUMP strategy, you'll have a 'translated' (for legacy hive) table DDL that can be run on the new cluster independently.


Schema-Only
LEFT
Schema Only -
Namespace Adjustment
Relative Location
Data Managed
Separately
RIGHT
TBL A
TBL A
distcp
(external)
Shared Storage
STORAGE
A
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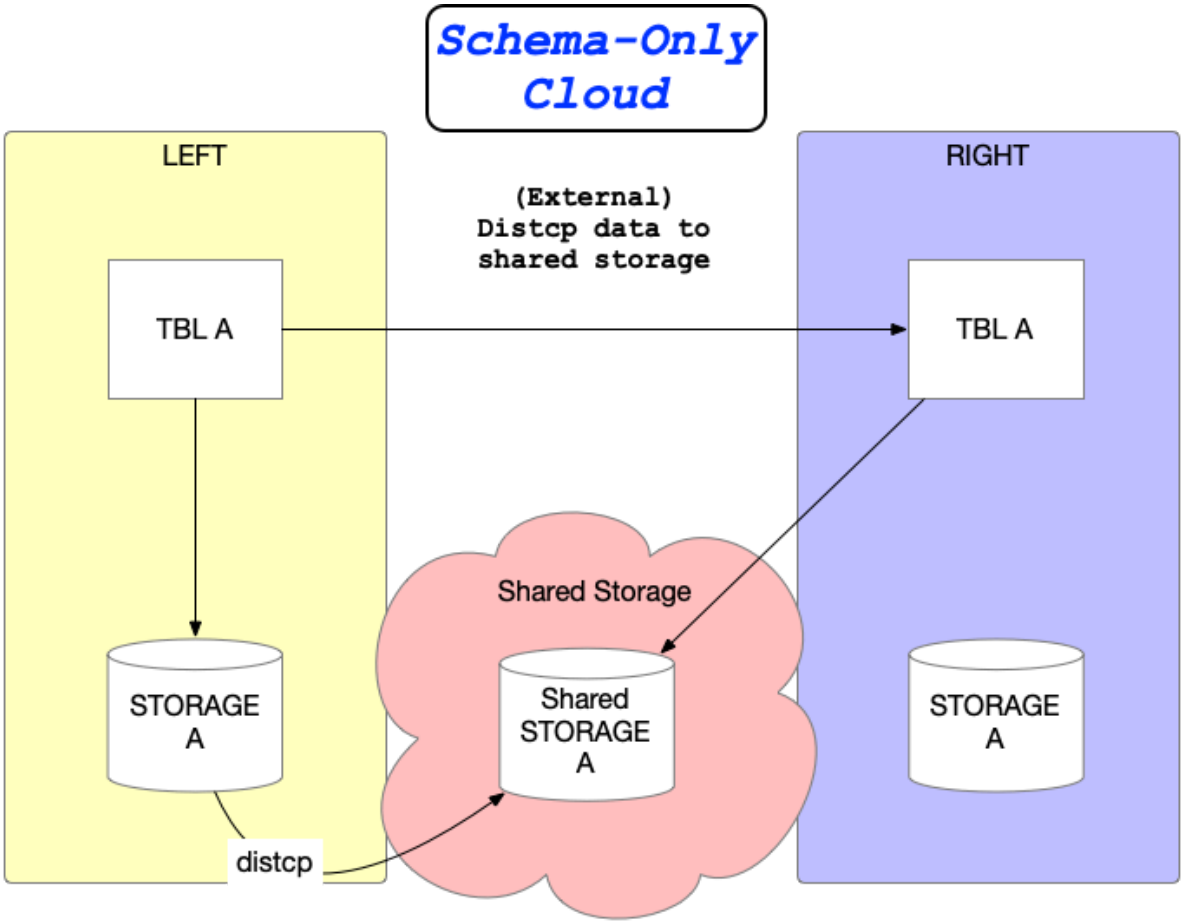
A
STORAGE
A

schema_only



schema_only_cloud

LINKED

Assumes the clusters are linked (Linking Cluster Storage Layers). We'll transfer the schema and leave the location as is on the new cluster.

This provides a means to test hive on the RIGHT cluster using the LEFT cluster's storage.

The `-ma` (migrate acid) tables option is NOT valid in this scenario and will result in an error if specified.

WARNING: If the LOCATION element is specified in the database definition AND you use `DROP DATABASE ... CASCADE` from the RIGHT cluster, YOU WILL DROP THE DATA ON THE LEFT CLUSTER even though the tables are NOT purgeable. This is the DEFAULT behavior of hive 'DROP DATABASE'. So BE CAREFUL!!!!

CONVERT_LINKED

If you migrated schemas with the Linked (LINKED) strategy and don't want to drop the database and run SCHEMA_ONLY to adjust the locations from the LEFT to the RIGHT cluster, use this strategy to make the adjustment.

This will work only on tables that were migrated already. It will reset the location to the same relative location on the RIGHT clusters `hcfsNamespace`. This will also check to see if the table was a 'legacy' managed table and set the `external.table.purge` flag appropriately. Tables that are 'partitioned' will be handled differently, since each partition has a reference to the 'linked' location. Those tables will first be validated that they NOT `external.table.purge`. If they are, that property will 'UNSET'. Then the table will be dropped, which will remove all the partition information. Then they'll be created again and `MSCK` will be used to discover the partitions again on the RIGHT clusters namespace.

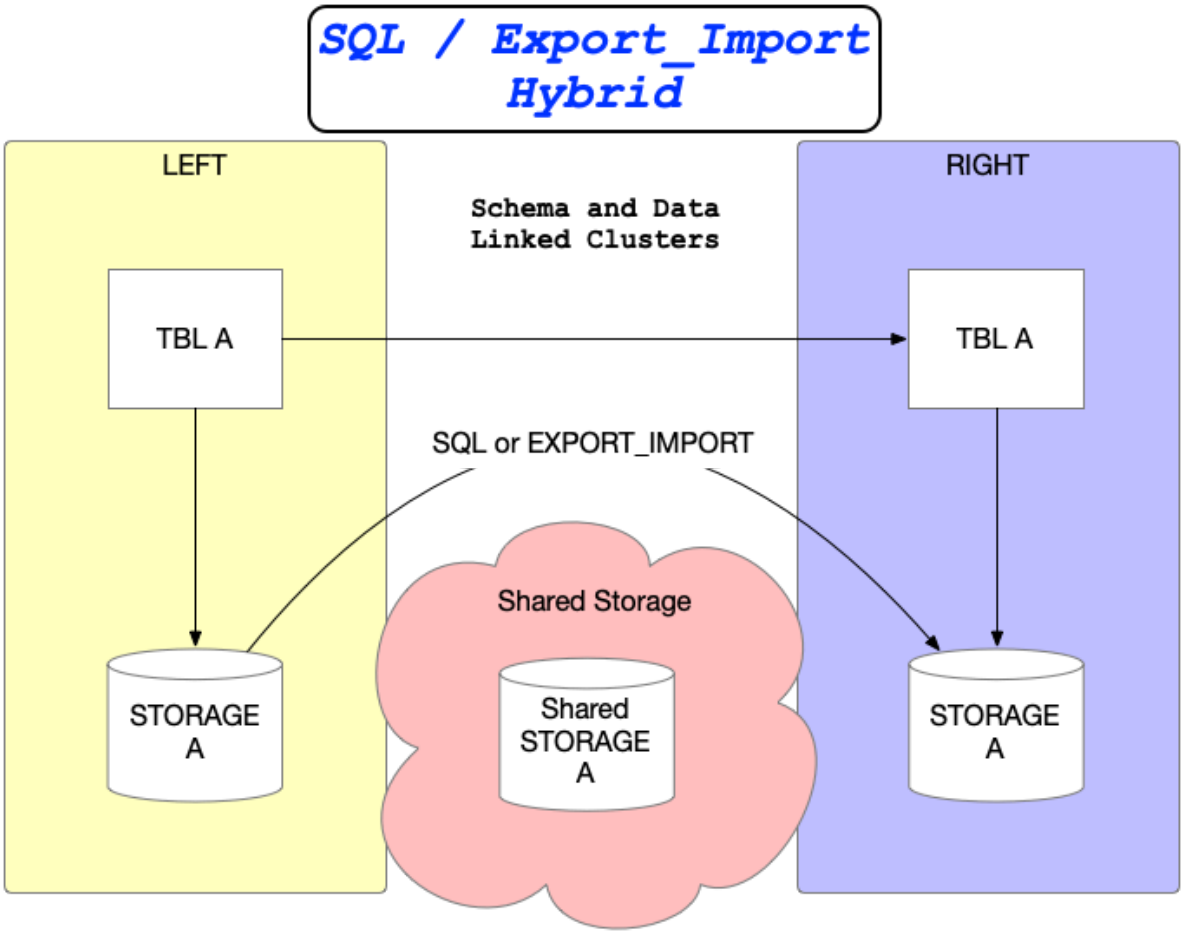
This process does NOT move data. It expects that the data was migrated in the background, usually by `distcp` and has been placed in the same relative locations on the RIGHT clusters `hcfsNameSpace`.

This process does NOT work for ACID tables.

AVRO table locations and SCHEMA location and definitions will be changed and copied.

SQL

The **SQL** data strategy will use Hive SQL to move data between clusters. When the cluster don't have direct line of sight to each other and can NOT be linked (Linking Cluster Storage Layers), you can use options like `-cs` or `-is` to bridge the gap.



sql

Options

Use `-ep|--export-partition-count <limit>` to set the limit for the number of partitions to use EXPORT_IMPORT. The default is 100. When a table has a partition count that exceeds this value, the SQL (SQL) strategy will be used.

-sp,--sql-partition-count <limit>

Sets the limit for the number of partitions that the SQL (SQL) strategy will process. If the value is exceeded, the process will NOT migrate the table. The default is 500 .

To persist a higher value without specifying the `-sp` option, add the following to the config (Default Configuration Template).

```
hybrid:
  sqlPartitionLimit: <limit>
```

-ma|--migrate-acid or -mao|--migrate-acid-only

Include ACID tables in processing.

-da|--downgrade-acid

Applicable only when `-ma|o` is used. This will take the ACID tables and downgrade them to *EXTERNAL/PURGE* tables. Buckets adjustments ("ACID Tables" in "Features") are applicable.

-dc|--distcp

For EXTERNAL tables, this will build a `distcp` plan that can be used to transfer the database tables.

When the option `-ma|o` is used, ACID tables will be migrated. *ACID* tables will be converted to EXTERNAL transfer tables for the `distcp` operations. On the other cluster, the tables will be created initially as *EXTERNAL*, then transferred back over to *ACID* tables, unless `-da` is used.

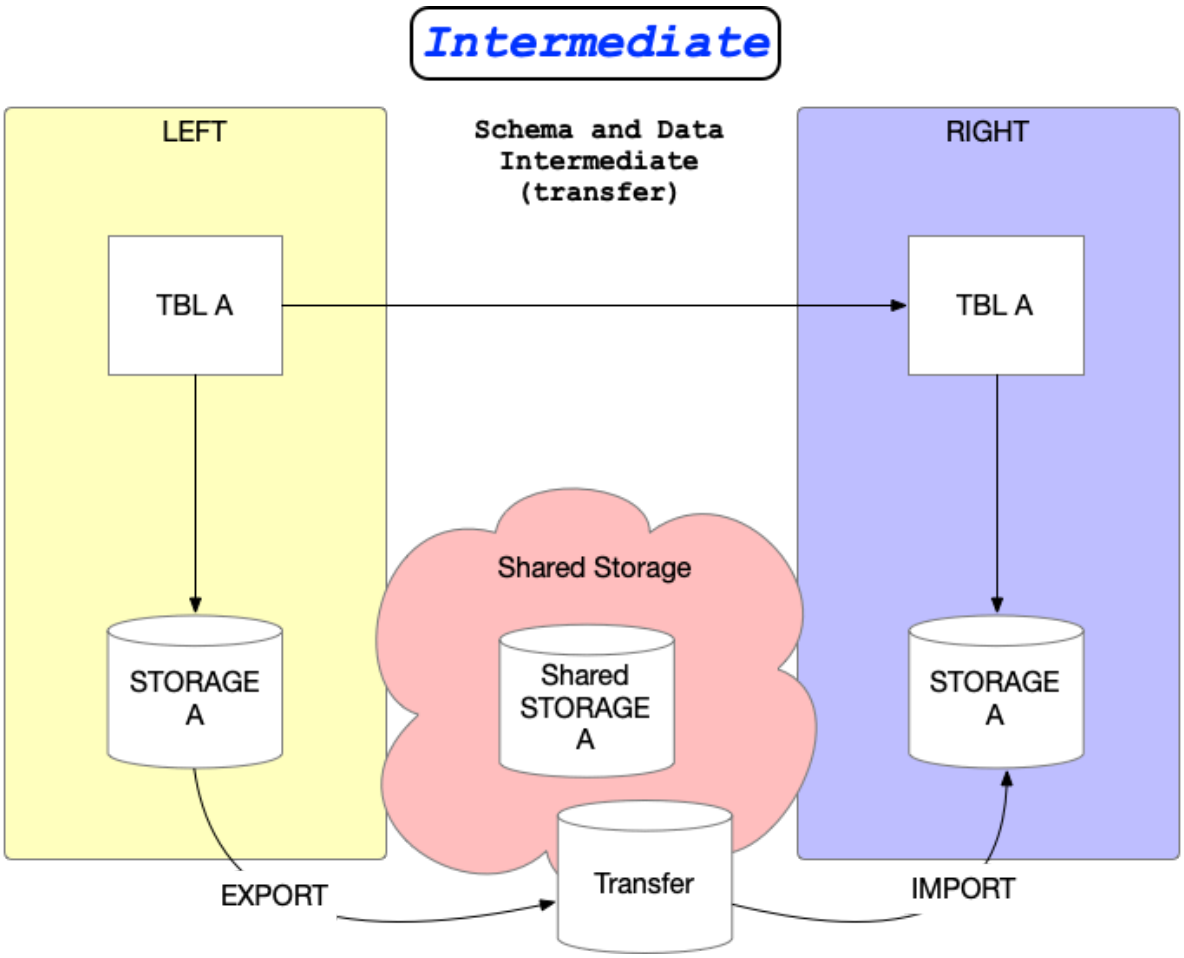
If the `-da` is used the tables will remain *EXTERNAL* on the new cluster.

When `-is` is used, there will be `distcp` operations required on both clusters to handle data movement to/from the `intermediate-storage` area.

-is|--intermediate-storage or -cs|--common-storage

When the clusters aren't linked (Linking Cluster Storage Layers) these two options provide a way to transfer data through an intermediate/common storage location. Each cluster must have access to these locations. These values are mutually exclusive.

`--intermediate-storage` requires an addition transfer of data. The LEFT transfers data to the `-is` location and the RIGHT cluster uses that data and initiates a transfer from the location to the final hcfsNamespace value set for the cluster. This is a two copy migration.



intermediate

`--common-storage` assumes the location is also the final resting place for the data. Some optimizations are possible (ACID downgrades) that reduce that times data need to move.

This is a single copy migration.

-wd|--warehouse-directory and -ewd|--external-warehouse-directory

Are used to set the *databases* default locations for managed and external tables. This overrides the systems *hive metastore* properties.

-rdl|--reset-to-default-location

Regardless of where the source data *relative* location was on the filesystem, this will reset it to the default location on the new cluster.

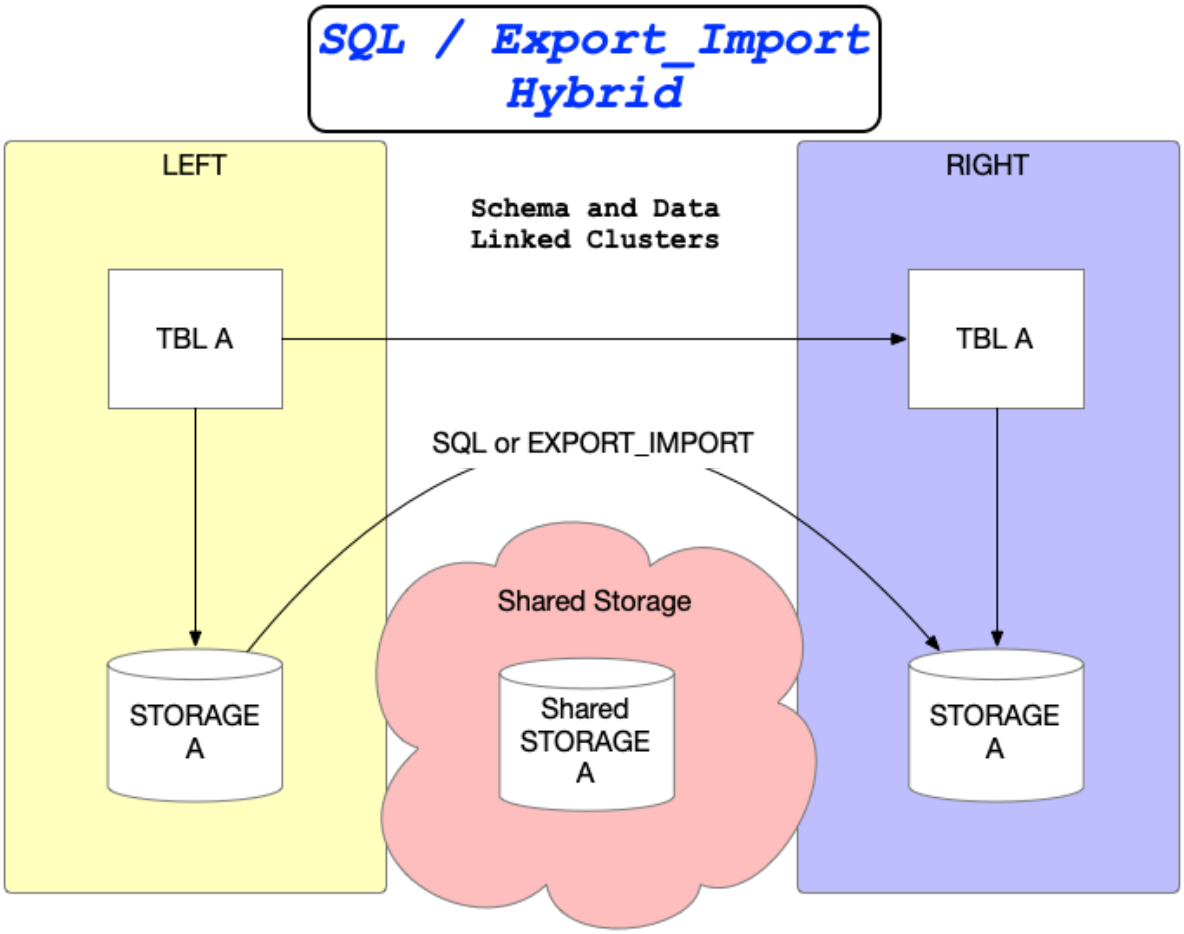
If `-dc|--distcp` is used, then the `warehouse` options are required in order for `hms-mirror` to build the `distcp` workplan.

EXPORT_IMPORT

We'll use EXPORT_IMPORT to get the data to the new cluster. The default behavior requires the clusters to be linked (Linking Cluster Storage Layers).

EXPORT to a location on the LEFT cluster where the RIGHT cluster can pick it up with IMPORT.

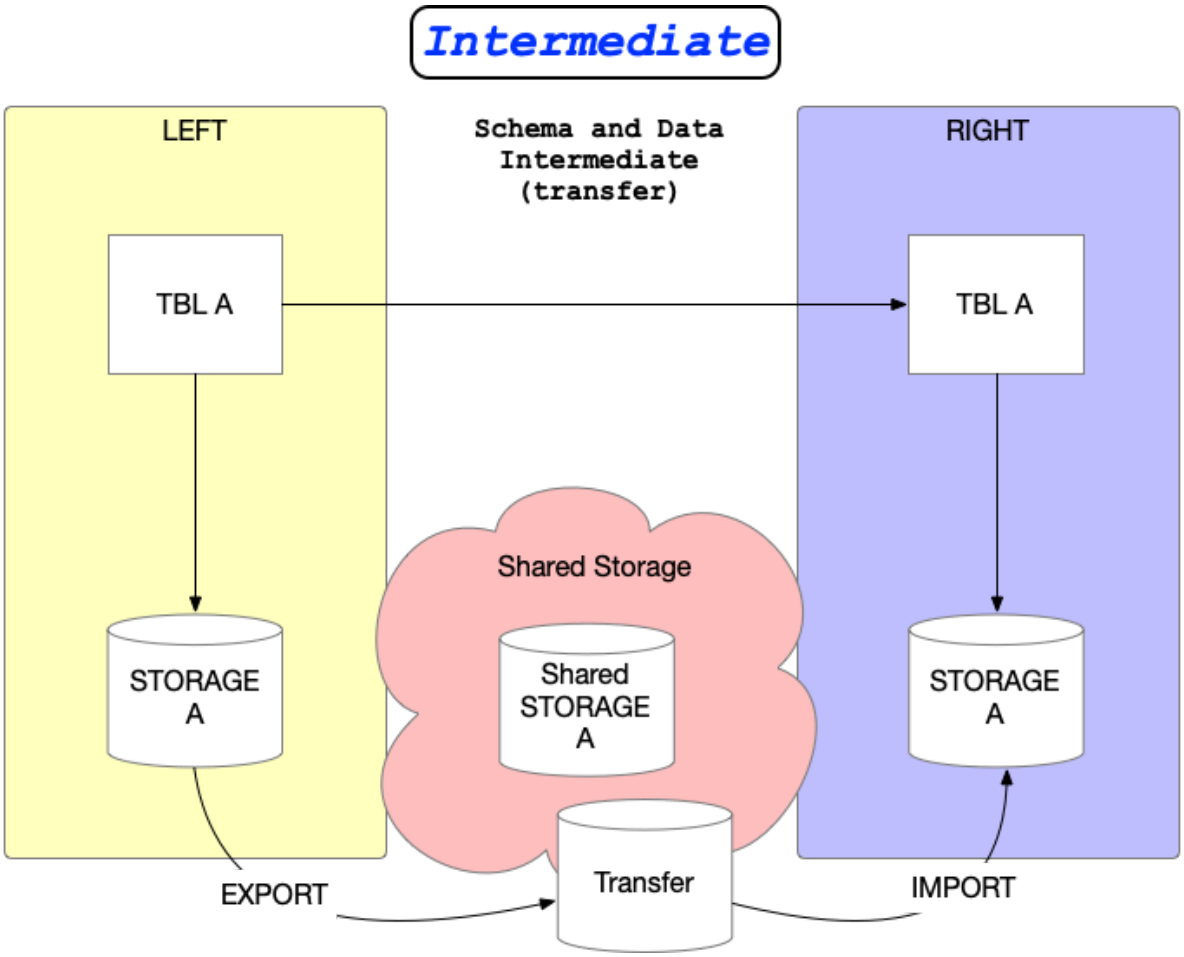
When `-ma` (migrate acid) tables are specified, and the LEFT and RIGHT cluster DON'T share the same 'legacy' setting, we will NOT be able to use the EXPORT_IMPORT process due to incompatibilities between the Hive versions. We will still attempt to migrate the table definition and data by copying the data to an EXTERNAL table on the lower cluster and expose this as the source for an INSERT INTO the ACID table on the RIGHT cluster.



export_import

If the `-is <intermediate-storage-path>` is used with this option, we will migrate data to this location and use it as a transfer point between the two clusters. Each cluster will

require access (some configuration adjustment may be required) to the location. In this scenario, the clusters do NOT need to be linked.



intermediate

Options

-ep|--export-partition-count <limit>

Sets the limit for the number of partitions to use EXPORT_IMPORT. The default is 100. When a table has a partition count that exceeds this value, the SQL (SQL) strategy will be used.

To persist a higher value without specifying the `-ep` option, add the following to the config (Default Configuration Template).

```
hybrid:
  exportImportPartitionLimit: <limit>
```

HYBRID

This data strategy will use a combination of EXPORT_IMPORT and SQL to move data between clusters.

This strategy will select either SQL (SQL) or EXPORT_IMPORT (EXPORT_IMPORT) based on the table type, and table partition counts.

The initial check will attempt to use EXPORT_IMPORT (EXPORT_IMPORT). If the table is ACID, or the partition count exceeds the limit (`-ep`), the SQL (SQL) strategy will be used.

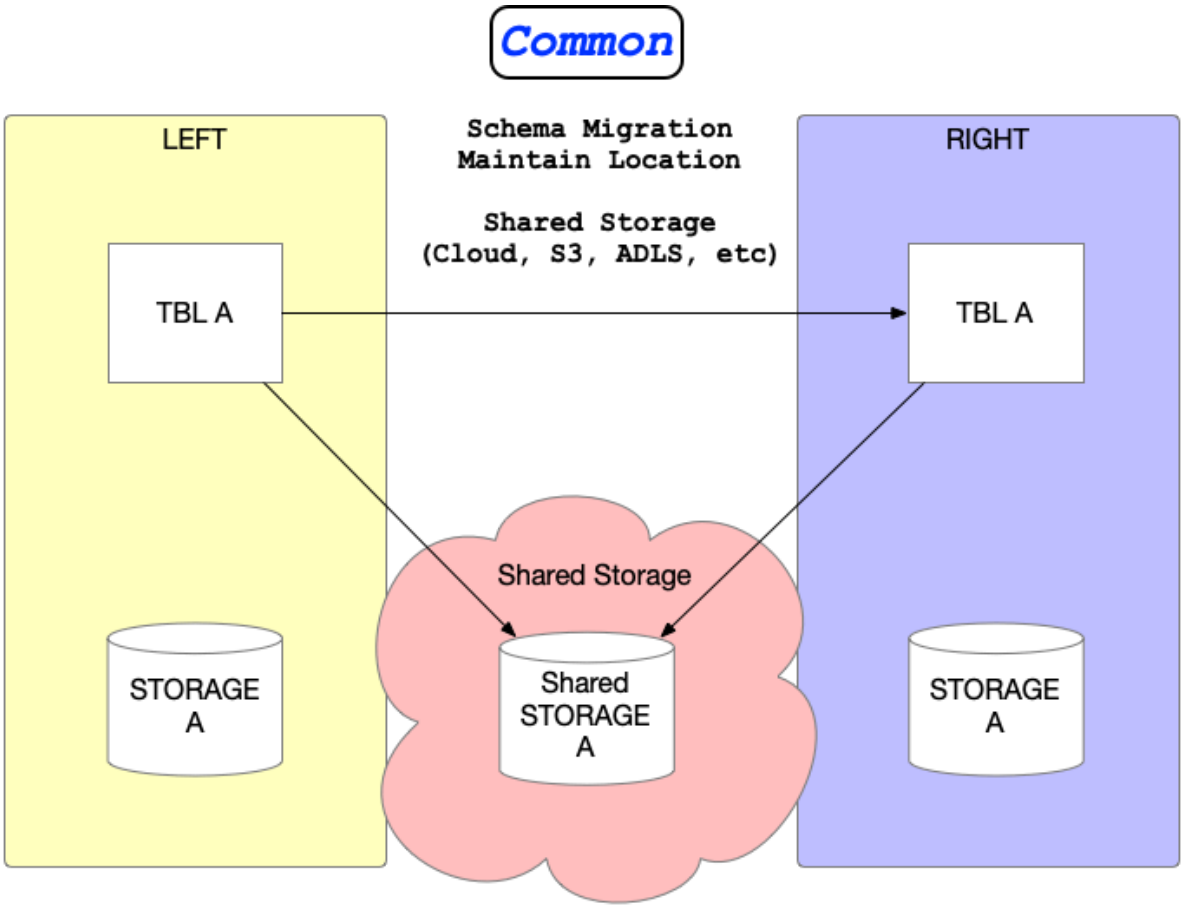
Interesting Options

When the cluster don't have direct line of sight to each other and can NOT be linked (Linking Cluster Storage Layers), you can use options like `-cs` or `-is` to bridge the gap.

COMMON

The data storage is shared between the two clusters, and no data migration is required.

Schemas are transferred using the same location.



common

STORAGE_MIGRATION

ICEBERG_MIGRATION

This process will look at Hive tables, evaluate if the table is a candidate for migration to Iceberg, and then migrate the table to Iceberg.

Specify `-d ICEBERG_CONVERSION` as the DataStrategy to run the Iceberg Migration.

This process uses Hive SQL to build(and run) the conversion scripts. These are "inplace" migrations.

The following options apply to the Iceberg Migration:

- `-iv|--iceberg-version` - The Iceberg version to use. Default is 1. Can be 1 or 2.
- `-itpo|--iceberg-table-property-overrides` - A comma separated list of table properties to override. See the Iceberg Table Properties available here (https://iceberg.apache.org/docs/latest/configuration/#configuration) and CDP Properties (https://docs.cloudera.com/cdw-runtime/cloud/iceberg-how-to/topics/iceberg-table-properties.html)

Requirements

- Requires Hive with Iceberg Support.
  - CDP Private Cloud Base 7.1.9 Hive does NOT support Iceberg.
  - CDP Private Cloud CDW 1.5.1 Hive does support Iceberg. You need CDW Data Services 1.5.1 or higher.
  - CDP Public Cloud Hive does support Iceberg as of August 2023 (Datahub and CDW)

Caution

Make sure you know the component limitations with Iceberg Tables here (https://docs.cloudera.com/cdp-public-cloud/cloud/cdp-iceberg/topics/iceberg-in-cdp.html) so you aren't caught by surprise.

Troubleshooting

Application doesn't seem to be making progress

All the counters for table processing aren't moving (review the hms-mirror.log) or (1.6.1.0+) the on screen logging of what tables are being added and metadata collected for has stopped.

Solution

The application creates a pool of connection to the HiveServer2 instances on the LEFT and RIGHT to be used for processing. When the HiveServer2 doesn't support or doesn't have available the number of connections being requested from `hms-mirror`, the application will 'wait' forever on getting the connections requested.

Stop the application and lower the concurrency value to a value that can be supported.

```
transfer:
  concurrency: 4
```

Or, you could modify the HiveServer2 instance to handle the number of connections being requested.

Application won't start NoClassDefFoundError

Error

```
Exception in thread "main" java.lang.NoClassDefFoundError:
java/sql/Driver at java.base/java.lang.ClassLoader.defineClass1
```

`hms-mirror` uses a classloader to separate the various jdbc classes (and versions) used to manage migrations between two different clusters. The application also has a requirement to run on older platforms, so the most common denominator is Java 8. Our method of loading and separating these libraries doesn't work in Java 9+.

Solution

Please use Java 8 to run `hms-mirror`.

CDP Hive Standalone Driver for CDP 7.1.8 CHF x (Cummulative Hot Fix) won't connect

If you are attempting to connect to a CDP 7.1.8 clusters Hive Server 2 with the CDP Hive Standalone Driver identified in the clusters `jarFile` property, you may not be able to connect. A security item addressed in these drivers changed the required classes.

If you see:

```
java.lang.RuntimeException: java.lang.RuntimeException:
java.lang.NoClassDefFoundError: org/apache/log4j/Level
```

You will need to include additional jars in the `jarFile` property. The following jars are required:

```
log4j-1.2-api-2.18.0.ja
log4j-api-2.18.0.jar
log4j-core-2.18.0.jar
```

The feature enhancement that allows multiple jars to be specified in the `jarFile` property is available in `hms-mirror` 1.6.0.0 and later. See Issue #47 (https://github.com/cloudera-labs/hms-mirror/issues/67)

Solution

Using `hms-mirror` v1.6.0.0 or later, specify the additional jars in the `jarFile` property. For example: `jarFile: "<absolute_path_to>/hive-jdbc-3.1.3000.7.1.8.28-1-standalone.jar:<absolute_path_to>/log4j-1.2-api-2.18.0.jar:<absolute_path_to>/log4j-api-2.18.0.jar:<absolute_path_to>/log4j-core-2.18.0.jar"`

These jar files can be found on the CDP edge node in `/opt/cloudera/parcels/CDH/jars/`.

Ensure that the standalone driver is list 'FIRST' in the `jarFile` property.

Failed AVRO Table Creation

```
Error while compiling statement: FAILED: Execution Error, return
code 40000 from org.apache.hadoop.hive.ql.ddl.DDLTask.
java.lang.RuntimeException:
MetaException(message:org.apache.hadoop.hive.serde2.SerDeException
```

```
Encountered AvroSerdeException determining schema. Returning
signal schema to indicate problem: Unable to read schema from
given path: /user/dstreev/test.avsc)
```

Solution

Validate that the 'schema' file has been copied over to the new cluster. If that has been done, check the permissions. In a non-impersonation environment (doas=false), the `hive` user must have access to the file.

Table processing completed with ERROR.

We make various checks as we perform the migrations, and when those checks don't pass, the result is an error.

Solution

In tips (Tips) we suggest running with `dry-run` first (default). This will catch the potential issues first, without taking a whole lot of time. Use this to remediate issues before executing.

If the scenario that causes the `ERROR` is known, a remediation summary will be in the output report under **Issues** for that table. Follow those instructions, then rerun the process with `--retry`. NOTE: `--retry` is currently tech preview and not thoroughly tested.

Connecting to HS2 via Kerberos

Connecting to an HDP cluster running 2.6.5 with Binary protocol and Kerberos triggers an incompatibility issue: `Unrecognized Hadoop major version number: 3.1.1.7.1....`

Solution

The application is built with CDP libraries (excluding the Hive Standalone Driver). When `Kerberos is the` auth` protocol to connect to **Hive 1**, it will get the application libs which will NOT be compatible with the older cluster.

Kerberos connections are only supported to the CDP cluster.

When connecting via `Kerberos, you will need to include the` --hadoop-classpath `when launching` hms-mirror`.

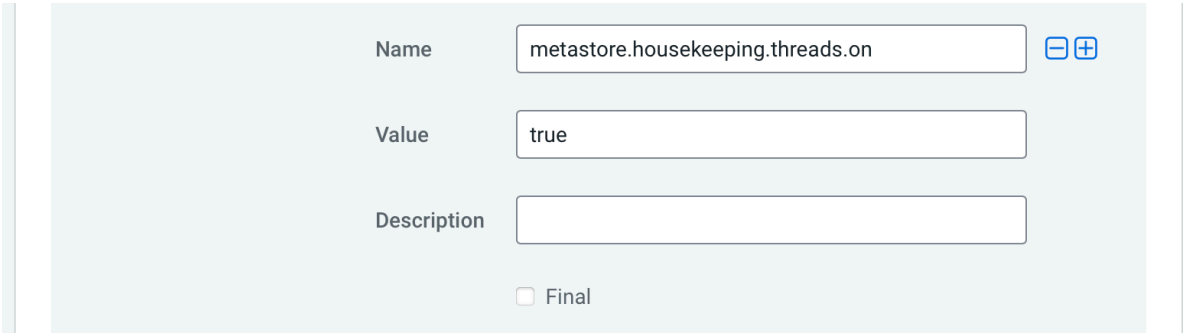
Auto Partition Discovery not working

I've set the `partitionDiscovery:auto` to `true`, but the partitions aren't getting discovered.

Solution

In CDP Base/PVC versions < 7.1.6 have not set the housekeeping thread that runs to activate this feature.

In the Hive metastore configuration in Cloudera Manager, set `metastore.housekeeping.threads.on=true` in the *Hive Service Advanced Configuration Snippet (Safety Valve) for hive-site.xml*



pic

Hive SQL Exception / HDFS Permissions Issues

```
Caused by: java.lang.RuntimeException:
org.apache.hadoop.hive.ql.security.authorization.plugin.HiveAccess
ControlException:Permission denied: user [dstreev] does not have
[ALL] privilege on
[hdfs://HDP50/apps/hive/warehouse/tpcds_bin_partitioned_orc_10.db/
web_site]
```

This error is a permission error to HDFS. For HYBRID, EXPORT_IMPORT, SQL, and SCHEMA_ONLY (with `-ams` enabled), this could be an issue with cross-cluster HDFS access.

Review the output report for details of where this error occurred (LEFT or RIGHT cluster).

When dealing with CREATE DDL statements submitted through HS2 with a `LOCATION` element in them, the submitting *user* **AND** the HS2 *service account* must have permissions to the directory. Remember, with cross-cluster access, the user identity will

originate on the RIGHT cluster and will be **EVALUATED** on the LEFT clusters storage layer.

For migrations, the `hms-mirror` running user (JDBC) and keytab user (HDFS) should be privileged users.

Example and Ambari Hints

After checking permissions of 'dstreev': Found that the 'dstreev' user was NOT the owner of the files in these directories on the LEFT cluster. The user running the process needs to be in 'dfs.permissions.superusergroup' for the lower clusters 'hdfs' service. Ambari 2.6 has issues setting this property: https://jira.cloudera.com/browse/EAR-7805

Follow the workaround above or add the user to the 'hdfs' group. Or use Ranger to allow all access. On my cluster, with no Ranger, I had to use '/var/lib/ambari-server/resources/scripts/configs.py' to set it manually for Ambari.

`sudo ./configs.py --host=k01.streever.local --port=8080 -u admin -p admin -n hdp50 -c hdfs-site -a set -k dfs.permissions.superusergroup -v hdfs_admin`

YARN Submission stuck in ACCEPTED phase

The process uses a connection pool to hive. If the concurrency value for the cluster is too high, you may have reached the maximum ratio of AM (Application Masters) for the YARN queue.

Review the ACCEPTED jobs and review the jobs *Diagnostics* status for details on *why* the jobs is stuck.

Solution

Either of:

1. Reduce the concurrency in the configuration file for `hms-mirror`
2. Increase the AM ratio or Queue size to allow the jobs to be submitted. This can be done while the process is running.

Spark DFS Access

If you have problems accessing HDFS from `spark-shell` or `spark-submit` try adding the following configuration to spark:

```
--conf
spark.yarn.access.hadoopFileSystems=hdfs://<NEW_NAMESPACE>,hdfs://
<OLD_NAMESPACE>
```

Permission Issues

`HiveAccessControlException Permission denied user: [xxxx] does not have [ALL] privileges on ['location'] [state=42000,code=40000]`

and possibly

In HS2 Logs: `Unauthorized connection for super-user`

Solution

Caused by the following:

- The 'user' doesn't have access to the location as indicated in the message. Verify through 'hdfs' that this is true or not. If the user does NOT have access, grant them access and try again.
- The 'hive' service account running HS2 does NOT have access to the location. The message will mask this and present it as a 'user' issue, when it is in fact an issue with the 'hive' service account. Grant the account the appropriate access.
- The 'hive' service does NOT have proxy permissions to the storage layer.
  - Check the `hadoop.proxyuser.hive.hosts|groups` setting in `core-site.xml`. If you are running into this `super-user` error on the RIGHT cluster, while trying to access a storage location on the *LEFT* cluster, ensure the proxy settings include the rights values in the RIGHT clusters `core-site.xml`, since that is where HS2 will pick it up from.

Must use HiveInputFormat to read ACID tables

We've seen this while attempting to migrate ACID tables from older clusters (HDP 2.6). The error occurs when we try to extract the ACID table data to a 'transfer' external table on the LEFT cluster, which is 'legacy'.

Solution

HDP 2.6.5, the lowest supported cluster version intended for this process, should be using the 'tez' execution engine `set hive.execution.engine=tez`. If the cluster has been upgraded from an older HDP version OR they've simply decided NOT to use the `tez` execution engine', you may get this error.

In `hms-mirror` releases 1.3.0.5 and above, we will explicitly run `set hive.execution.engine=tez` on the LEFT cluster when identified as a 'legacy' cluster. For version 1.3.0.4 (the first version to support ACID transfers), you'll need to set the hive environment for the HS2 instance you're connecting to use `tez` as the execution engine.

ACL issues across cross while using LOWER clusters storage

Are you seeing something like this?

```
org.apache.hadoop.hive.ql.ddl.DDLTask. MetaException(message:Got
exception: org.apache.hadoop.security.AccessControlException
Permission denied: user=hive, access=WRITE,
inode="/apps/hive/warehouse/merge_files.db/merge_files_part_a_smal
l_replacement":dstreev:hadoop:drwxr-xr-x at
```

This is caused when trying to `CREATE` a table on the **RIGHT** cluster that references data on the **LEFT** cluster. When the LEFT cluster is setup differently with regard to impersonation (doas) than the RIGHT, transfer tables are created with POSIX permissions that may not allow the RIGHT cluster/user to access that location.

Solution

Using Ranger on the LEFT cluster, open up the permissions to allow the requesting user access as identified.

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Use Cases

On Prem Legacy Hive to Non-Legacy Hive

Environments

HDP 2.6 -> CDP CDH 5.x -> CDP CDH 6.x -> CDP

LEFT clusters are the LEGACY clusters. RIGHT clusters are the NON-LEGACY clusters (hive3).

Assumptions

- LEFT HS2 is NOT Kerberized. Since this is a Legacy cluster (which is kerberized) we need to establish a 'non' kerberized HS2 endpoint. Use KNOX or setup an additional HS2 in the management console that isn't Kerberized. hms-mirror is built (default) with Hadoop 3, of which the libraries are NOT backwardly compatible.
- Standalone JDBC jar files for the LEGACY and NON-LEGACY clusters are available to the running host as specified in the 'configuration'.
- `hms-mirror` is run from an EdgeNode on CDP
  - The edgenode has network access to the Legacy HS2 endpoint
- No ACID tables (HDP)
- No VIEWs
- No Non-Native tables (Hive tables backed by HBase, JDBC, Kafka)
- The HiveServer2's on each cluster have enough concurrency to support the configured connections `transfer->concurrency`. If not specified, the default is 4.

NOTES

`hms-mirror` runs in DRY-RUN mode by default. Add `-e|--execute` to your command to actually run the process on the clusters. Use `--accept` to avoid the verification questions (but don't deny their meaning).

All actions performed by `hms-mirror` are recorded in the *_execute.sql files. Review them to understand the orchestration and process.

Review the report markdown files (html version also available) for details about the job. Explanations regarding steps, issues, and failure reasons can be found there.

Scenarios

One-time migration of SCHEMA's from LEFT to RIGHT.

This is done with the basic `SCHEMA_ONLY` data strategy (default) and will extract the schema's from the LEFT and replay them on the RIGHT cluster. In this mode, NO DATA is moved.

`hms-mirror -db tpcds_bin_partitioned_orc_10 -o temp`

Examine the reports place in the relative `temp` directory specified with the `-o` option. A report set is generated to each database.

Since no data is transferred in this scenario, the expectation is that the data is managed by another process, like `distcp`. The output of `hms-mirror` will create some template distcp calls with the appropriate location details. You can use this as a starting point to managed this transfer.

DUMP of clusters SCHEMA

We want a simple extraction of a database schema. An optional `-ds LEFT|RIGHT` option can be specified to target which configured cluster to use. The default is `LEFT`. Note: When you specify `RIGHT`, the DUMP output with still show up in the `LEFT` output report.

No translations are done in this scenario. So if the DUMP is taken from a 'legacy' cluster, beware of the implications of 'replaying' it on a non-legacy cluster.

This will use the LEFT cluster configuration for the schema DUMP of `tpcds_bin_partititoned_orc_10`. `hms-mirror -db tpcds_bin_partitioned_orc_10 -o temp -d DUMP`

This will use the RIGHT cluster configuration for the schema DUMP of `tpcds_bin_partititoned_orc_10`. `hms-mirror -db tpcds_bin_partitioned_orc_10 -o temp -d DUMP -ds RIGHT`

Data Migration for Non-ACID tables using SQL

This approach assumes the clusters are linked (Linking Cluster Storage Layers). The SQL data strategy uses the RIGHT's clusters view into the HDFS filesystem of the LEFT cluster to facilitate data movement.

```
hms-mirror -d SQL -db tpcds_bin_partitioned_orc_10 -o temp
```

Data Migration for ACID tables using SQL or HYBRID

This approach assumes the clusters are linked (Linking Cluster Storage Layers). The SQL data strategy uses the RIGHT's clusters view into the HDFS filesystem of the LEFT cluster to facilitate data movement.

```
hms-mirror -d SQL -db tpcds_bin_partitioned_orc_10 -o temp -ma
```

Use `-mao` to migrate ONLY ACID tables. `-ma` will migrate ACID and Non-ACID tables.

Schema Migration of specific tables using RegEx

Using a RegEx pattern, filter the tables in the db to migrate.

```
hms-mirror -db tpcds_bin_partitioned_orc_10 -tf call_*. -o temp
```

`-tf|--table-filter` followed by a RegEx to filter tables.

Migrate VIEWS for a specific database

View migration requires the underlying referenced tables exist BEFORE the 'view' can be created. This isn't a requirement of `hms-mirror` rather a Hive requirement. Therefore, you should migrate the tables first as shown above and in a followup process run the following.

```
hms-mirror -db tpcds_bin_partitioned_orc_10 -v
```

Create schema in RIGHT cluster using the LEFT clusters data

This is a helpful scenario for 'testing' workflows on the RIGHT cluster. The tables on the right cluster will NOT be configured with 'PURGE' to avoid the deletion of data on the LEFT cluster. These tables should be considered READ-ONLY. Test this against a sample dataset to THOROUGHLY understand the relationships here. This is NOT intended for 'production' use and should be used only as a validation mechanism for the RIGHT cluster.

The clusters must be linked (Linking Cluster Storage Layers). Only legacy managed tables, external tables, and views can be linked. ACID tables can NOT be linked.

```
hms-mirror -d LINKED -db tpcds_bin_partitioned_orc_10 -o temp
```

The tables created on the RIGHT cluster will use the data located on the LEFT cluster. The 'database' will be created to match the database in the LEFT cluster.

WARNING: If the LOCATION element is specified in the database definition AND you use `DROP DATABASE ... CASCADE` from the RIGHT cluster, YOU WILL DROP THE DATA ON THE LEFT CLUSTER even though the tables are NOT purgeable. This is the DEFAULT behavior of hive 'DROP DATABASE'. So BE CAREFUL!!!!

Migrate SCHEMA's and Data using SQL

The clusters must be linked (Linking Cluster Storage Layers). In this scenario, we'll use the connected clusters and SQL to migrate data from the LEFT cluster to the RIGHT.

There are limits regarding partitioned tables. For SQL migrations, the default is 500. Meaning that tables with more than 500 partitions will NOT attempt this transfer. This can be changed in the 'config' file by adding/changing `hybrid->sqlPartitionLimit`. This was put in place as a general safeguard against attempts at tables with a partition count that may fail. It doesn't mean they'll always fail, it's just a place holder.

```
hms-mirror -d SQL -db tpcds_bin_partitioned_orc_10 -o temp
```

To transfer ACID tables, add `-ma|-mao`.

This is a one time transfer. Incremental updates aren't supported with this configuration. For incremental schema updates, see:

Migrate SCHEMA's and Data using EXPORT_IMPORT

EXPORT/IMPORT is a basic Hive process used to package table schemas and data into a transferable unit that can be replayed on the new cluster. For `hms-mirror` there is a defined prefix for a transfer directory in the configuration `transfer->exportBaseDirPrefix`. If this isn't defined, the default is `/apps/hive/warehouse/export_`.

There are performance implications to using EXPORT_IMPORT with partitioned tables. The IMPORT process is quite slow at loading partitions. We've defined limits in the config (which can be changed) `hybrid->exportImportPartitionLimit`. The default is 100. If the number of partitions exceeds this value, we will NOT attempt the transfer and will note this in the output report.

The clusters must be linked (Linking Cluster Storage Layers). The before mentioned prefix directory on the LEFT cluster is accessed by the IMPORT process that runs on the

RIGHT cluster. If the namespace (and permissions) aren't correct, the IMPORT process will fail.

`hms-mirror -d EXPORT_IMPORT -db tpcds_bin_partitioned_orc_10 -o temp`

EXPORT_IMPORT will NOT work for ACIDv1 -> ACIDv2 (Hive 1/2 to 3) conversions. Use `SQL` or `HYBRID` instead.

Migrate SCHEMA's and Data using HYBRID

The `HYBRID` data strategy is a combination of the `SQL` and `EXPORT_IMPORT` data strategies. It uses basic rules to choose the more appropriate method for the table in question.

The clusters must be linked (Linking Cluster Storage Layers).

The process will first consider using `EXPORT_IMPORT` unless:

- The table is ACIDv1 and you're migrating to ACIDv2 (Legacy to Non-Legacy Clusters)
- The number of partitions exceed the value set by: `hybrid->exportImportPartitionLimit`. The default is 100. When exceeded, the `SQL` method will be used. The `SQL` method will fail is the partition count exceeds the value of `hybrid->sqlPartitionLimit`. The default is 500.

`hms-mirror -d HYBRID -db tpcds_bin_partitioned_orc_10 -o temp`

Disaster Recovery (RIGHT Cluster is DR and READ-ONLY)

The DR scenario will transfer schemas and subsequent runs will update the 'schema' if changes are made. This process does NOT move data. The process will generate a `distcp` work plan for you to get started. You should modify that to use 'snapshot diffs' and managed the data migration through `distcp`.

You should first run the process in `DRY-RUN` mode to get the `distcp` plan. The data must be transferred first! This ensures that the database and table/partition directories are created BEFORE the schemas are replayed. If the schemas are applied before the `distcp` with SNAPSHOT diffs, then `hive` will own the directories and the `distcp` with snapshots will fail.

WARNING: Do not attempt to `DROP DATABASE ... CASCADE` on the RIGHT cluster, this

will modify the filesystem and cause the incremental `distcp` with snapshots to fail.

`hms-mirror -d SCHEMA_ONLY -db tpcds_bin_partitioned_orc_10 -ro -sync`

This process will review the tables on the LEFT cluster with the RIGHT and either update the schema when it's changed (by dropping and recreating), add missing tables, or drop tables that don't exist anymore.

Tables that are migrated this way will NOT have the `PURGE` flag set on the RIGHT cluster. This allows us to `DROP` a table without affecting the data for the `-sync` process.

Downgrade and Replace ACID tables

In this scenario, you're choosing to downgrade ACID tables that are migrated, as well as the current tables on the source cluster.

`hms-mirror -db tpcds_bin_partitioned_orc_10 -mao -da -r`

This will migrate ACID tables only (-mao vs. -ma), downgrade them to EXTERNAL/PURGE tables, and 'replace' the current ACID table with a MANAGED Non-Transactional table in legacy environments OR a EXTERNAL/PURGE table in Hive3+ environments.

Using the DRY-RUN mode, experiment with options `-is` and `-cs` for various implementations of this conversion.

Cloud to Cloud DR (AWS)

We'll cover how to manage a DR scenario where the source cluster is in the cloud and the target cluster is also in the cloud. The main elements to consider are:

- Hive Metadata (Tables, Databases, Views)
- Data on S3

Requirements

- The source and target clusters on AWS are running CDP Cloud with an available HS2 endpoint.
- Provide a mechanism to migrate Hive metadata from the source cluster to the target cluster, to include making adjustments to the metadata to account for differences in the clusters storage locations.
- Establish the RPO and RTO for the DR scenario and ensure the migration process can meet those requirements.
- We'll only target **external** tables for this scenario. Managed tables will require additional considerations, since the data and metadata are intermingled and can't be supported through a simple copy operation.

Assumptions

- The data on S3 is already replicated to the target cluster through some other mechanism (e.g. S3 replication, etc.).
- The S3 replication will meet the RPO and RTO requirements.
- The data replication is in place before DR is invoked and the scripts are run to build the schemas on the target cluster.
- There are no managed tables being migrated. I would recommend setting the database property `'EXTERNAL_TABLES_ONLY'='TRUE'` with: `ALTER DATABASE`

<db_name> SET TBLPROPERTIES ('EXTERNAL_TABLES_ONLY'='TRUE'); to ensure only external tables can be created.

- Partitions follow standard naming conventions regarding directory names/structures. Tables with non-standard partitioning will require additional considerations. hms-mirror doesn't translate partition details and relies on MSCK REPAIR <table> SYNC PARTITIONS to discover / rebuild a tables partitions. If the partitions are not in a standard format, the MSCK REPAIR will not work and the partitions will need to be manually created.
- We don't support schema evolution. All tables will be created in there current state.
- The "LEFT" clusters hcfsNamespace can only address a single namespace at a time. If you have multiple namespaces, you'll need to run hms-mirror multiple times, once for each namespace. The "RIGHT" cluster can address multiple namespaces through the hcfsNamespace element. This element is used to match and adjust the storage location of the tables on the target cluster.

The Process

The process is fairly straight forward. We'll use hms-mirror to migrate the Hive metadata from the source cluster to the target cluster. We'll use the --common-storage or set the hcfsNamespace element for the RIGHT cluster to ensure the schemas are built with the DR bucket adjustments.

You have a few options regarding the transfer:

- If the target is truly a DR cluster, you can run hms-mirror on the source cluster and generate the metadata files locally. Then copy the metadata files to the target cluster and build out the schemas there. This doesn't need to be done until the DR is invoked.
- If you want/need to keep the metadata in-sync between the clusters, you can run hms-mirror with the -ro and -sync flags (and eventually with -e) to keep the metadata in-sync between the clusters. Tables created on the source cluster will require the data to be replicated to the target cluster before the table can be created in DR. While we're only migrating *external* tables, they may have set external.table.purge to true on the source cluster. In this case, these tables will be set to **NON** purge on the target cluster. This is to prevent the table data (being managed through S3 replication) from being dropped by subsequent sync runs where the tables might have changed.

Running hms-mirror

Configuration

This file should be named `$HOME/.hms-mirror/cfg/default.yaml`

```
clusters:
  LEFT:
    environment: "LEFT"
    legacyHive: false
    hcfsNamespace: "s3a://<my_source_s3_bucket>"
    hiveServer2:
      # Recommend using a KNOX endpoint to remove need for
Kerberos Authentication
      uri: "jdbc:hive2://<my_source_hs2_endpoint>"
      connectionProperties:
        user: "<user>"
        maxWaitMillis: "5000"
        password: "*****"
        maxTotal: "-1"
      jarFile: "<local_location_of_hive-jdbc_driver>"
  RIGHT:
    environment: "RIGHT"
    legacyHive: false
    hcfsNamespace: "s3a://<my_target_s3_bucket>"
    hiveServer2:
      uri: "jdbc:hive2://<my_target_hs2_endpoint>"
      connectionProperties:
        user: "<user>"
        maxWaitMillis: "5000"
        password: "*****"
        maxTotal: "-1"
      jarFile: "<local_location_of_hive-jdbc_driver>"
    partitionDiscovery:
      # Optional, but recommended it the cluster isn't
overburdened.
      auto: true
      # Required if auto is false and/or you want to ensure the
```

```
partitions are in sync after the
      # transfer is made.
      initMSCK: true
```

Command Lines

`hms-mirror --hadoop-classpath -d SCHEMA_ONLY -db <db_comma_separated_list> -ro -sync`

Hybrid Data LakeHouse

On-Prem to Cloud (Direct)

On-Prem to Cloud (In-Direct)

Cloud to On-Prem (In-Direct)

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