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## Migrating Hive workloads to Iceberg

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## Migrating Hive tables to Iceberg tables

Using Iceberg tables facilitates multi-cloud open lakehouse implementations. You can move Iceberg-based workloads in Cloudera Data Platform (CDP) across deployment environments on AWS and Azure. You can migrate existing external Hive tables from Hive to Iceberg in Cloudera Data Warehouse (CDW) or from Spark to Iceberg in Cloudera Data Engineering (CDE).

Cloudera has chosen Apache Iceberg as the foundation for an [open lakehouse in CDP](#). Any compute engine can insert, update, and delete data in Iceberg tables. Any compute engine can read Iceberg tables.

The following CDP data services support Iceberg for performing multi-function analytics for the open lakehouse with Cloudera SDX shared security and governance:

- Cloudera Data Warehouse (CDW): Batch ETL, SQL and BI analytic workloads, row-level database operations like updates, deletes, and merge
- Cloudera Data Engineering (CDE): Batch ETL, row-level database operations, table maintenance
- Cloudera Machine Learning (CML): Data Science through Python, R, and other languages, ML model training and inferencing, table maintenance
- Cloudera Data Flow (CDF): Nifi streaming ingestion
- Cloudera Stream Processing (CSP): Unified streaming ingestion with SQL

## Use cases for migrating to Iceberg

A key use case for migrating Hive tables to Iceberg is the elimination of data segmentation, or data silos, and duplication. Removing these silos facilitates the tedious preparation, curation, cleansing, and moving of data before you can get any meaningful insights from your data. This use case and others are summarized.

The following list includes other use cases for migrating Hive tables to Iceberg:

- End-to-end, multi-function analytics

CDP provides an entire lifecycle for lower cost of ownership and architectural simplicity.

- Regulatory compliance

Improved visibility provided by quick insights into your data to lower risk and improve infosec management.

- Data protection and recovery

Data managed by CDP services are protected by Cloudera Shared Data Experience (SDX), an integrated set of security and governance technologies.

- Compliance with General Data Protection Regulator/California Consumer Privacy Act (GDPR/CCPA)

Iceberg supports ACID-compliance with row-level updates and deletes.

## In-place migration from Hive

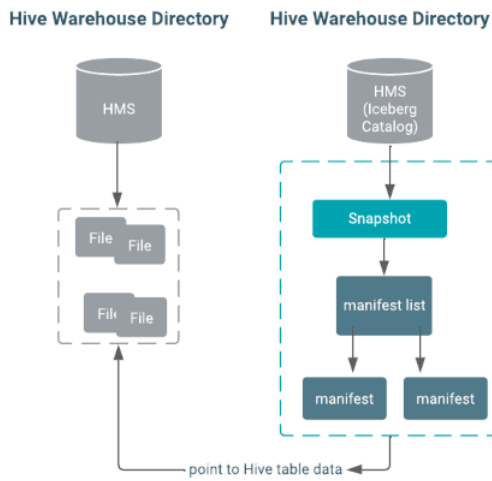
If you are looking for an efficient way to migrate Hive tables to Iceberg, you came to the right place. An overview of using Cloudera Data Warehouse (CDW) prepares you to convert Apache Hive external tables to Apache Iceberg with no downtime. You learn the advantages of moving Hive tables to Iceberg for implementing an open lakehouse.

You can accelerate data ingestion, curation, and consumption at petabyte scale by migrating from Hive to Iceberg.

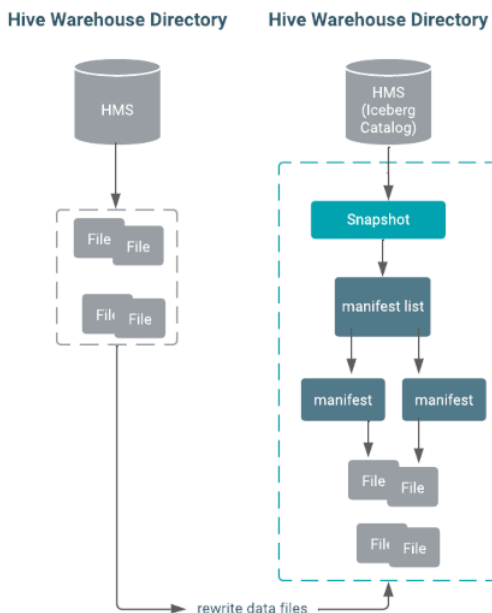
Hive-to-Iceberg table migration is fast because the migration does not regenerate data files. Just metadata is rewritten. CDW provides a simple API for migrating Hive tables to Iceberg to simplify adoption of Iceberg. An ALTER TABLE command sets the storage handler to convert the data without regeneration or remigration.

Using CDW, you can take advantage of [schema evolution](#) and [partition evolution](#) features. For more information about using Iceberg in CDW, see ["Using Apache Iceberg"](#). Newly generated metadata is built on top of existing Hive external tables and points to source data files as shown in the following diagram:

#### Migration using ALTER TABLE (recommended)



You can also run CREATE TABLE AS SELECT to migrate a Hive table to Iceberg; however, this approach reads data from the source and regenerates data in Iceberg:



You can read and write files in following types of files from Hive:

- Avro
- Optimized Row Columnar (ORC)
- Parquet

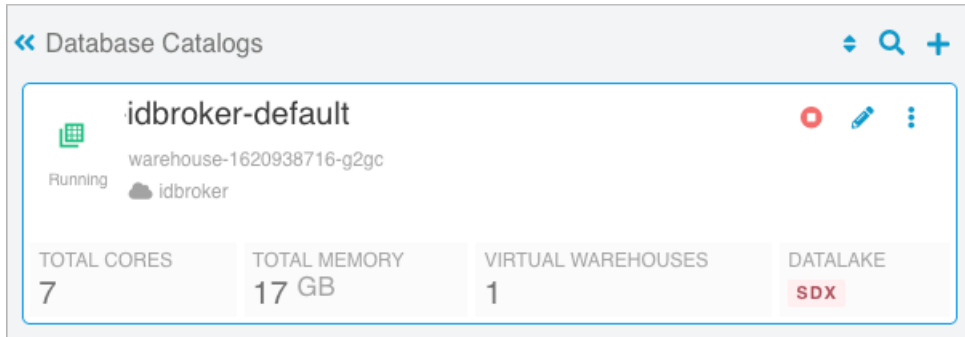
## Prerequisites

You need to set up your environment and meet Data Lake prerequisites for querying Iceberg tables in CDP. You learn which query editors are supported and which roles are required.

The following list covers prerequisites for using Iceberg.

- You are using the Cloudera Data Warehouse (CDW).

- You must have access to a CDP environment that was activated from your environment UI. Your DATALAKE type must be SDX as shown below:



- Data Lake version 7.2.12.1 or higher is required.
- One of the following query editors are required to query Iceberg tables:
  - Hue (recommended)
  - A JDBC client
  - The Impala shell for remote users
- You must have the required role: DWUser.
- You must obtain permission to run SQL queries from the Env Admin, who must add you to a Hadoop SQL policy.
- You must use the HadoopFileIO. S3FileIO is not supported. URLs in metadata starting with s3://... cause query failure.

## Migrating a Hive table to Iceberg

You see how to use a simple ALTER TABLE statement to migrate an external Hive table to an Iceberg table. You see how to configure table input and output by setting table properties.

### About this task

When you migrate an external Hive table to Iceberg, Hive makes the following changes:

- Converts the storage\_handler, serde, inputformat and outputformat properties of the table in HMS to use the Iceberg specific classes.
- Reads the footers of the existing data files and generates the necessary Iceberg metadata files based on the footers.
- Commits all the data files to the Iceberg table in a single commit.



**Note:** To prevent loss of new and old table data during migration of a table to Iceberg, do not drop or move the old table during migration. Exception: If you set the table property 'external.table.purge'=FALSE', no data loss occurs when you drop the table.

### Before you begin

- You must meet the prerequisites for using Iceberg mentioned earlier.
- .

**Restriction:** Migrating an Impala table to Iceberg is not supported in this release.

### Procedure

- Log in to the CDP web interface and navigate to the Data Warehouse service.
- In the Data Warehouse service, in the Overview page, locate your Hive Virtual Warehouse, and click Hue. Instead of using Hue, you can connect over JDBC to the Hive Virtual Warehouse, and run the query.

3. Enter a query to use a database.

For example:


```
USE mydb;
```

4. Enter a Hive query to migrate an existing external Hive table to an Iceberg v2 table.

For example:

```
ALTER TABLE tbl
SET TBLPROPERTIES ('storage_handler'='org.apache.iceberg.mr.hive.HiveIcebergStorageHandler',
'format-version' = '2');
```

Do not drop the table as explained above unless you set the 'external.table.purge' table property to false.

5. Click  to run the queries.  
An Iceberg V2 table is created. The Hive table remains intact.

## In-place migration from Spark

In Cloudera Data Engineering (CDE), you can use Spark SQL to migrate Hive tables to Iceberg. You can convert Apache Hive external tables to Apache Iceberg with no downtime. Cloudera recommends moving Hive tables to Iceberg for implementing an open lakehouse.

You use one of the following, similar procedures to import and migrate Hive tables to Iceberg:

- Importing and migrating Iceberg table in Spark 3

A backup table is created, but does not incur the overhead of moving the physical location of the table on the object store.

- Importing and migrating Iceberg table format v2

The Iceberg merge on read operation is used.


By default, when you migrate a Hive external table to an Iceberg v2 table, the file is not rewritten. A write occurs to a new file. A read merges changes into the original file. The default merge on read tends to speed up the write and slow down the read. You can configure several other types of migration behavior if the default merge on read does not suit your use case.

For more information about using Iceberg in CDE, see [Using Apache Iceberg in Cloudera Data Engineering](#).

## Prerequisites

Learn about the supported versions for Cloudera Data Engineering (CDE), Spark, and Data Lake to use with Apache Iceberg CDE.

To use Apache Iceberg in CDE, you'll need the following prerequisites:

- Spark 3.2 or higher
- A compatible version of Data Lake as listed in CDE and Data Lake compatibility linked below
- CDE 1.16 or higher
-  **Note:** Only AWS is supported in CDE 1.16 (which supports Iceberg 0.13)
- AWS or Azure is supported starting in CDE 1.17-h1 (which supports Iceberg 0.14)

## Iceberg table format version 2

Iceberg table format version 2 (v2) is available starting in Iceberg 0.14. Iceberg table format v2 uses row-level UPDATE and DELETE operations that add deleted files to encoded rows that were deleted from existing data files. The DELETE, UPDATE, and MERGE operations function by writing delete files instead of rewriting the affected

data files. Additionally, upon reading the data, the encoded deletes are applied to the affected rows that are read. This functionality is called merge-on-read.

To use Iceberg table format v2, you'll need the following prerequisites:

- CDE 1.17-h1 or higher
- Iceberg 0.14
- Spark 3.2 or higher

With Iceberg table format version 1 (v1), the above-mentioned operations are only supported with copy-on-write where data files are rewritten in their entirety when rows in the files are deleted. Merge-on-read is more efficient for writes, while copy-on-write is more efficient for reads.



**Note:** Unless otherwise indicated, the operations in the subsequent documentation apply to both v1 and v2 formats.

## Importing and migrating Iceberg table in Spark 3

Importing or migrating tables are supported only on existing external Hive tables. When you import a table to Iceberg, the source and destination remain intact and independent. When you migrate a table, the existing Hive table is converted into an Iceberg table. You can use Spark SQL to import or migrate a Hive table to Iceberg.

### Importing

Call the snapshot procedure to import a Hive table into Iceberg using a Spark 3 application.

```
spark.sql("CALL <catalog>.system.snapshot('<src>', '<dest>')")
```

Definitions:

- `<src>` is the qualified name of the Hive table
- `<dest>` is the qualified name of the Iceberg table to be created
- `<catalog>` is the name of the catalog, which you pass in a configuration file. For more information, see [Configuring Catalog](#) linked below.

For example:

```
spark.sql("CALL spark_catalog.system.snapshot('hive_db.hive_tbl',
      'iceberg_db.iceberg_tbl')")
```

For information on compiling Spark 3 application with Iceberg libraries, see [Iceberg library dependencies for Spark applications](#) linked below.

### Migrating

When you migrate a Hive table to Iceberg, a backup of the table, named `<table_name>backup`, is created.

Ensure that the `TRANSLATED_TO_EXTERNAL` property, that is located in `TBLPROPERTIES`, is set to `false` before migrating the table. This ensures that a table backup is created by renaming the table in Hive metastore (HMS) instead of moving the physical location of the table. Moving the physical location of the table would entail copying files in Amazon S3.

We recommend that you refrain from dropping the backup table, as doing so will invalidate the newly migrated table.

If you want to delete the backup table, set the following:

```
'external.table.purge' = 'FALSE'
```

Deleting the backup table in the manner above will prevent underlying data from being deleted, therefore, only the table will be deleted from the metastore.

To undo the migration, drop the migrated table and restore the Hive table from the backup table by renaming it.



Call the migrate procedure to migrate a Hive table to Iceberg.

```
spark.sql("CALL <catalog>.system.migrate('<src>')")
```

Definitions:

- <src> is the qualified name of the Hive table
- <catalog> is the name of the catalog, which you pass in a configuration file. For more information, see [Configuring Catalog](#) linked below.

For example:

```
spark.sql("CALL  
  spark_catalog.system.migrate('hive_db.hive_tbl')")
```

## Importing and migrating Iceberg table format v2

Importing or migrating Hive tables Iceberg table formats v2 are supported only on existing external Hive tables. When you import a table to Iceberg, the source and destination remain intact and independent. When you migrate a table, the existing Hive table is converted into an Iceberg table. You can use Spark SQL to import or migrate a Hive table to Iceberg.

### Importing

Call the snapshot procedure to import a Hive table into Iceberg table format v2 using a Spark 3 application.

```
spark.sql("CALL <catalog>.system.snapshot(source_table => '<src>', table =>  
'<dest>', properties => map('format-version', '2', 'write.delete.mode', '<de  
lete-mode>', 'write.update.mode', '<update-mode>', 'write.merge.mode', '<mer  
ge-mode>'))")
```

Definitions:

- <src> is the qualified name of the Hive table
- <dest> is the qualified name of the Iceberg table to be created
- <catalog> is the name of the catalog, which you pass in a configuration file. For more information, see [Configuring Catalog](#) linked below.
- <delete-mode> <update-mode> and <merge-mode> are the modes that shall be used to perform the respective operation. If unspecified, they default to 'merge-on-read'

For example:

```
spark.sql("CALL spark_catalog.system.snapshot('hive_db.hive_tbl',  
  'iceberg_db.iceberg_tbl')")
```

For information on compiling Spark 3 application with Iceberg libraries, see [Iceberg library dependencies for Spark applications](#) linked below.

### Migrating

Call the migrate procedure to migrate a Hive table to Iceberg.

```
spark.sql("CALL <catalog>.system.migrate('<src>', map('format-version', '2',  
'write.delete.mode', '<delete-mode>', 'write.update.mode', '<update-mode>',  
'write.merge.mode', '<merge-mode>'))")
```

Definitions:

- <src> is the qualified name of the Hive table

- <catalog> is the name of the catalog, which you pass in a configuration file. For more information, see [Configuring Catalog](#) linked below.
- <delete-mode> <update-mode> and <merge-mode> are the modes that shall be used to perform the respective operation. If unspecified, they default to 'merge-on-read'

For example:

```
spark.sql("CALL spark_catalog.system.migrate('hive_db.hive_tbl', map('format-version', '2', 'write.delete.mode', 'merge-on-read', 'write.update.mode', 'merge-on-read', 'write.merge.mode', 'merge-on-read'))")
```

### Upgrading Iceberg table format v1 to v2

To upgrade an Iceberg table format from v1 to v2, run an ALTER TABLE command as follows:

```
spark.sql("ALTER TABLE <table_name> SET TBLPROPERTIES('merge-on-read', '2')")
```

<delete-mode>, <update-mode>, and <merge-mode> can be specified as the modes that shall be used to perform the respective operation. If unspecified, they default to 'merge-on-read'

## Best practices for Iceberg in CDP

Based on large scale TPC-DS benchmark testing, performance testing and real-world experiences, Cloudera recommends several best practices when using Iceberg.

Follow the best practices listed below when using Iceberg:

- Use Iceberg as intended for analytics.

The table format is designed to manage a large, slow-changing collection of files. For more information, see the [Iceberg spec](#).

- Increase parallelism to handle large manifest list files in Spark.

By default, the number of processors determines the preset value of the iceberg.worker.num-threads system property. Try increasing parallelism by setting the iceberg.worker.num-threads system property to a higher value to speed up query compilation.

- Reduce read amplification

Monitor the growth of positional delta files, and perform timely compactions.

- Speed up drop table performance, preventing deletion of data files by using the following table properties:

```
Set external.table.purge=false and gc.enabled=false
```

- Tune the following table properties to improve concurrency on writes and reduce commit failures: commit.retry.num-retries (default is 4), commit.retry.min-wait-ms (default is 100)
- Maintain a relatively small number of data files under the iceberg table/partition directory for efficient reads. To alleviate poor performance caused by too many small files, run the following queries:

```
TRUNCATE TABLE target;
INSERT OVERWRITE TABLE target select * from target FOR SYSTEM_VERSION AS OF <preTruncateSnapshotId>;
```

- To minimize the number of delete files and file handles and improve performance, ensure that the Spark write.distribution.mode table property value is "hash" (the default setting for Spark Iceberg 1.2.0 onwards).