

Cloudera Runtime 7.0.0

## Apache Hive Overview

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# CLOUdera

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## Apache Hive key features

Major changes to Apache Hive 2.x improve Apache Hive 3.x transactions and security. Knowing the major differences between these versions is critical for SQL users, including those who use Apache Spark and Apache Impala.

Hive is a data warehouse system for summarizing, querying, and analyzing huge, disparate data sets. Cloudera Runtime (CR) services include Hive on Tez and Hive Metastore. Hive on Tez is based on Apache Hive 3.x, a SQL-based data warehouse system. The enhancements in Hive 3.x over previous versions can improve SQL query performance, security, and auditing capabilities. The Hive metastore (HMS) is a separate service, not part of Hive, not even necessarily on the same cluster. HMS stores the metadata on the backend for Hive, Impala, Spark, and other components.

### ACID transaction processing

Hive 3 tables are ACID (Atomicity, Consistency, Isolation, and Durability)-compliant, which is critical to observing the right to be forgotten requirement of the GDPR (General Data Protection Regulation).

### Shared metastore

Hive metastore (HMS) interoperates with multiple engines, Impala and Spark for example, simplifying interoperation between engines and user data access.

### Low-latency analytical processing (CDP Public Cloud)

Hive processes transactions using low-latency analytical processing (LLAP) or the Apache Tez execution engine. The Hive LLAP service is not available in CDP Private Cloud Base.

### Spark integration with Hive

Spark and Hive ACID tables interoperate using the Hive Warehouse Connector. You can access external tables from Spark directly using SparkSQL. You do not need HWC to read or write Hive external tables. Spark users just read from or write to Hive directly. You can write Hive external tables in ORC format only. (See link below.)

### Security improvements

Apache Ranger secures Hive data by default. To meet demands for concurrency improvements, ACID support for GDPR, render security, and other features, Hive tightly controls the location of the warehouse on a file system, or object store, and memory resources.

### Workload management at the query level

You can configure who uses query resources, how much can be used, and how fast Hive responds to resource requests. Workload management can improve parallel query execution, cluster sharing for queries, and query performance.

### Materialized views

Because multiple queries frequently need the same intermediate roll up or joined table, you can avoid costly, repetitious query portion sharing, by precomputing and caching intermediate tables into views.

### Query result cache

Hive filters and caches similar or identical queries. Hive does not recompute the data that has not changed. Caching repetitive queries can reduce the load substantially when hundreds or thousands of users of BI tools and web services query Hive.

### Information schema database

When launched, Hive creates two databases from JDBC data sources: `information_schema` and `sys`. All Metastore tables are mapped into your tablespace and available in `sys`. The `information_schema` data reveals the state of the system, similar to `sys` database data. You can query `information_schema` using SQL standard queries.

### Unavailable or unsupported interfaces

- S3 and LLAP (CDP Private Cloud Base 7.0 only)
- Hive CLI (replaced by Beeline)
- WebHCat
- Hcat CLI
- SQL Standard Authorization
- MapReduce execution engine (replaced by Tez)
- Spark execution engine (replaced by Tez)
- Hive Indexes

## Changes after upgrading

To locate and use your Apache Hive 3.x tables after an upgrade, you need to understand the changes that occur during the upgrade process. Changes to the location of tables, permissions to HDFS directories, table types, ACID-compliance occur, and other changes occur.

### Hive changes to table references using dot notation

Upgrading to CDP includes the Hive-16907 bug fix, which rejects ``db.table`` in SQL queries. The dot (.) is not allowed in table names. To reference the database and table in a table name, both must be enclosed in backticks as follows: ``db`.`table``.

### Hive changes to ACID properties

HDP Hive 2.x and 3.x can have transactional and non-transactional tables. Transactional tables have atomic, consistent, isolation, and durable (ACID) properties. In Hive 2.x, the initial version of ACID transaction processing is ACID v1. In Hive 3.x, the mature version of ACID is ACID v2, which is the default table type in HDP 3.0.

### Native and non-native storage formats

Storage formats are a factor in upgrade changes to table types. Hive 2.x and 3.x supports the following Hadoop native and non-native storage formats:

- Native: Tables with built-in support in Hive, such as those in the following file formats:
  - Text
  - Sequence File
  - RC File
  - AVRO File
  - ORC File
  - Parquet File
- Non-native: Tables that use a storage handler, such as the `DruidStorageHandler` or `HBaseStorageHandler`

### Upgrade changes to table types

The following table compares Hive table types and ACID operations before an upgrade from HDP 2.x and after an upgrade to CDP. The ownership of the Hive table file is a factor in determining table types and ACID operations after the upgrade.

**Table 1: HDP 2.x and 3.x Table Type Comparison**

HDP 2.x				HDP 3.x	
Table Type	ACID v1	Format	Owner (user) of Hive Table File	Table Type	ACID v2
External	No	Native or non-native	hive or non-hive	External	No
Managed	Yes	ORC	hive or non-hive	Managed, updatable	Yes
Managed	No	ORC	hive	Managed, updatable	Yes
			non-hive	External, with data delete	No
Managed	No	Native (but non-ORC)	hive	Managed, insert only	Yes
			non-hive	External, with data delete	No
Managed	No	Non-native	hive or non-hive	External, with data delete	No

**Removal of Hive View and Tez View**

CDP does not include Hive View or Tez View. In lieu of these capabilities, users who upgrade to CDP can use Data Analytics Studio.

## Unsupported interfaces

CDP does not support the following interfaces that were available in HDP and CDH platforms.

CDP does not support following interfaces that were available in HDP and CDH platforms.

- S3 for storing tables and LLAP (available in CDP Public Cloud only)
- Hive CLI (replaced by Beeline)
- WebHCat
- Hcat CLI
- SQL Standard Authorization
- MapReduce execution engine (replaced by Tez)
- Spark execution engine (replaced by Tez)
- Hive Indexes
- Hive View and Tez View

You can use Data Analytics Studio in lieu of Hive View.

**Partially unsupported interfaces**

Apache Hadoop Distributed Copy (DistCP) is not supported for copying Hive ACID tables. See link below.

**Related Information**

[DistCp causes Hive ACID jobs to fail](#)

## Apache Hive 3 architectural overview

Understanding Apache Hive 3 major design features, such as default ACID transaction processing, can help you use Hive to address the growing needs of enterprise data warehouse systems.

## Apache Tez

Apache Tez is the Hive execution engine for the Hive-on-Tez service in Cloudera Manager. MapReduce is not supported. In a Cloudera cluster, if a legacy script or application specifies MapReduce for execution, an exception occurs. Most user-defined functions (UDFs) require no change to execute on Tez instead of MapReduce.

With expressions of directed acyclic graphs (DAGs) and data transfer primitives, execution of Hive queries on Tez instead of MapReduce improves query performance. In Cloudera Data Platform (CDP), Tez is usually used only by Hive, and HiveServer launches and manages Tez AM automatically when HiveServer2 starts. SQL queries you submit to Hive are executed as follows:

- Hive compiles the query.
- Tez executes the query.
- Resources are allocated for applications across the cluster.
- Hive updates the data in the data source and returns query results.

Hive on Tez runs tasks on ephemeral containers and uses the standard YARN shuffle service.

## Data storage and access control

One of the major architectural changes to support Hive 3 design gives Hive much more control over metadata memory resources and the vfile system, or object store. The following architectural changes from Hive 2 to Hive 3 provide improved security:

- Tightly controlled file system and computer memory resources, replacing flexible boundaries: Definitive boundaries increase predictability. Greater file system control improves security.
- Optimized workloads in shared files and YARN containers

CDP Private Cloud Base stores Hive data on HDFS by default. CDP Public Cloud stores Hive data on S3 by default. In the cloud, Hive uses HDFS merely for storing temporary files. Hive 3 is optimized for object stores such as S3 in the following ways:

- Hive uses ACID to determine which files to read rather than relying on the storage system.
- In Hive 3, file movement is reduced from that in Hive 2.
- Hive caches metadata and data aggressively to reduce file system operations

The major authorization model for Hive is Ranger. Hive enforces access controls specified in Ranger. This model offers stronger security than other security schemes and more flexibility in managing policies.

This model permits only Hive to access the data warehouse. If you do not enable the Ranger security service, or other security, CDP Data Center by default Hive uses storage-based authorization (SBA) based on user impersonation.

## HDFS permission changes

In CDP Private Cloud Base, SBA relies heavily on HDFS access control lists (ACLs). ACLs are an extension to the permissions system in HDFS. CDP Data Center turns on ACLs in HDFS by default, providing you with the following advantages:

- Increased flexibility when giving multiple groups and users specific permissions
- Convenient application of permissions to a directory tree rather than by individual files

## Transaction processing

You can deploy new Hive application types by taking advantage of the following transaction processing characteristics:

- Mature versions of ACID transaction processing:
  - ACID tables are the default table type.
  - ACID enabled by default causes no performance or operational overload.

- Simplified application development, operations with strong transactional guarantees, and simple semantics for SQL commands

You do not need to bucket ACID tables.

- Materialized view rewrites
- Automatic query cache
- Advanced optimizations

### Hive client changes

CDP Private Cloud Base supports the thin client Beeline for working on the command line. You can run Hive administrative commands from the command line. Beeline uses a JDBC connection to Hive on Tez to execute commands. Parsing, compiling, and executing operations occur in Hive on Tez. Beeline supports many of the command-line options that Hive CLI supported. Beeline does not support `hive -e set key=value` to configure the Hive Metastore.

You enter supported Hive CLI commands by invoking Beeline using the `hive` keyword, command option, and command. For example, `hive -e set`. Using Beeline instead of the thick client Hive CLI, which is no longer supported, has several advantages, including low overhead. Beeline does not use the entire Hive code base. A small number of daemons required to run queries simplifies monitoring and debugging.

Hive enforces allowlist and denylist settings that you can change using `SET` commands. Using the denylist, you can restrict memory configuration changes to prevent instability. Different Hive instances with different allowlists and denylists to establish different levels of stability.

### Apache Hive Metastore sharing

HiveServer, Impala, and other components can share a remote Hive metastore. In CDP Public Cloud, HMS uses a pre-installed MySQL database. You perform little, or no, configuration of HMS in the cloud.

### Spark integration

Spark and Hive tables interoperate using the Hive Warehouse Connector in some cases.

You can access ACID and external tables from Spark using the Hive Warehouse Connector. You do not need the Hive Warehouse Connector to read Hive external tables from Spark and write Hive external tables from Spark.

### Query execution of batch and interactive workloads

You can connect to Hive using Data Analytics Studio (DAS), a JDBC command-line tool, such as Beeline, or using a JDBC/ODBC driver with a BI tool, such as Tableau. Clients communicate with an instance of the same HiveServer version. You configure the settings file for each instance to perform either batch or interactive processing.