Cloudera Runtime 7.1.5

Integrating Apache Hive with Spark and BI

Date published: 2019-08-21
Date modified:

https://docs.cloudera.com/

Legal Notice

Contents

Introduction to HWC

You need to understand Hive Warehouse Connector (HWC) to query Apache Hive tables from Apache Spark. Examples of supported APIs, such as Spark SQL, show some operations you can perform, including how to write to a Hive ACID table or write a DataFrame from Spark.

HWC is software for securely accessing Hive tables from Spark. You need to use the HWC if you want to access Hive managed tables from Spark. You explicitly use HWC by calling the HiveWarehouseConnector API to write to managed tables. You might use HWC without even realizing it. HWC implicitly reads tables when you run a Spark SQL query on a Hive managed table.

You do not need HWC to read or write Hive external tables, but you might want to use HWC to purge external table files. From Spark, using HWC you can read Hive external tables in ORC or Parquet formats. From Spark, using HWC you can write Hive external tables in ORC format only.

Creating an external table stores only the metadata in HMS. If you use HWC to create the external table, HMS keeps track of the location of table names and columns. Dropping an external table deletes the metadata from HMS. You can set an option to also drop the actual data in files, or not, from the file system.

If you do not use HWC, dropping an external table deletes only the metadata from HMS. If you do not have permission to access the file system, and you want to purge table data in addition to metadata, you need to use HWC.

Supported APIs

- Spark SQL

  Supports native Spark SQL query read (only) patterns. Output conforms to native spark.sql conventions.
- HWC

  Supports HiveWarehouse Session API operations using the HWC sql API.
- DataFrames

  Supports accessing a Hive ACID table from Scala, or pySpark, directly using DataFrames. Use the short name HiveAcid. Direct reads and writes from the file are not supported.

  Spark SQL Example

  ```
  $ spark-shell <parameters to specify HWC jar and config settings>
  scala> sql("select * from managedTable").show
  scala> spark.read.table("managedTable").show
  ```

  HWC API Example

  ```
  scala> val hive = com.hortonworks.hwc.HiveWarehouseSession.session(spark
  ).build()
  scala> hive.executeQuery("select * from emp_acid").show
  ```

```
scala> hive.executeQuery("select e.emp_id, e.first_name, d.name department
 from emp_acid e join dept_ext d on e.dept_id = d.id").show
```

DataFrames Example

Hive ACID tables are tables in Hive metastore and must be formatted using DataFrames as follows:

Syntax:

```
format("HiveAcid").option("table", "<table name>"")
```

Example:

```
scala> val df = spark.read.format("HiveAcid").options(Map("table" -> "de
fault.acidtbl")).load()
scala> df.collect()
```

HWC Limitations

Kerberos users of HWC and Spark Direct Reader must observe the following requirements:

- Do specify spark.sql.hive.hiveserver2.jdbc.url.principal in configurations. For example,

```
--conf "spark.sql.hive.hiveserver2.jdbc.url.principal=hive/_HOST@VPC.CLO
UDERA.COM"
```

- Do not specify the spark.sql.hive.hiveserver2.jdbc.url.principal in the JDBC URL to invoke Hive. Do specify principal=hive.server2.authentication.kerberos.principal as shown in the following syntax:

```
jdbc:hive://<host>:<port>/<dbName>;principal=<HiveServer2_kerberos_princ
ipal>;<otherSessionConfs>?<hiveConfs>#<hiveVars>
```

For example:

```
jdbc:hive://<host>:<port>/<dbName>;principal=hive.server2.authentication
.kerberos.principal;<otherSessionConfs>?<hiveConfs>#<hiveVars>
```

- Ensure that the keystore specified in the JDBC URL is in the same location on all hosts.

Other HWC limitations are:

- You cannot write data using Spark Direct Reader.
- HWC supports reading tables in any format, but currently supports writing tables in ORC format only.
- The spark thrift server is not supported.
- Transaction semantics of Spark RDDs are not ensured when using Spark Direct Reader to read ACID tables.
- Table stats (basic stats and column stats) are not generated when you write a DataFrame to Hive.
- The Hive Union types are not supported.
- When the HWC API save mode is overwrite, writes are limited.

  You cannot read from and overwrite the same table. If your query accesses only one table and you try to overwrite that table using an HWC API write method, a deadlock state might occur. Do not attempt this operation.

  Example: Operation Not Supported

```
scala> val df = hive.executeQuery("select * from t1")
scala> df.write.format("com.hortonworks.spark.sql.hive.llap.HiveWarehouseC
onnector"). \
  mode("overwrite").option("table", "t1").save
```

Workaround for using the Hive Warehouse Connector with Oozie Spark action

Hive and Spark use different Thrift versions and are incompatible with each other. Upgrading Thrift in Hive is complicated and may not be resolved in the near future. Therefore, Thrift packages are shaded inside the HWC JAR to make Hive Warehouse Connector work with Spark and Oozie Spark action. See the workaround in Cloudera Oozie documentation (link below).

Supported applications and operations

The Hive Warehouse Connector supports the following applications:

- Spark shell
- PySpark
- The spark-submit script

The following list describes a few of the operations supported by the Hive Warehouse Connector:

- Describing a table
- Creating a table in ORC using .createTable() or in any format using .executeUpdate()
- Writing to a table in ORC format
- Selecting Hive data and retrieving a DataFrame
- Writing a DataFrame to a Hive-managed ORC table in batch
- Executing a Hive update statement
- Reading table data, transforming it in Spark, and writing it to a new Hive table
- Writing a DataFrame or Spark stream to Hive using HiveStreaming
- Partitioning data when writing a DataFrame

Related Information

HMS storage
Orc vs Parquet
Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables
Using Hive Warehouse Connector with Oozie Spark Action
Union Types

Introduction to HWC execution modes

A comparison of each execution mode helps you make HWC configuration choices. You can see, graphically, how the configuration affects the query authorization process and your security. You read about which configuration provides fine-grained access control, such as column masking.

In CDP Public Cloud, HWC is available by default in provisioned clusters. In CDP Private Cloud Base, you need to configure an HWC execution mode. HWC executes reads in the modes shown in the following table:

Table 1:

Capabilities	JDBC mode	Spark Direct Reader mode
Ranger integration (fine-grained access control)	#	N/A
Hive ACID reads	#	#
Workloads handled	Small datasets	ETL without fine-grained access control

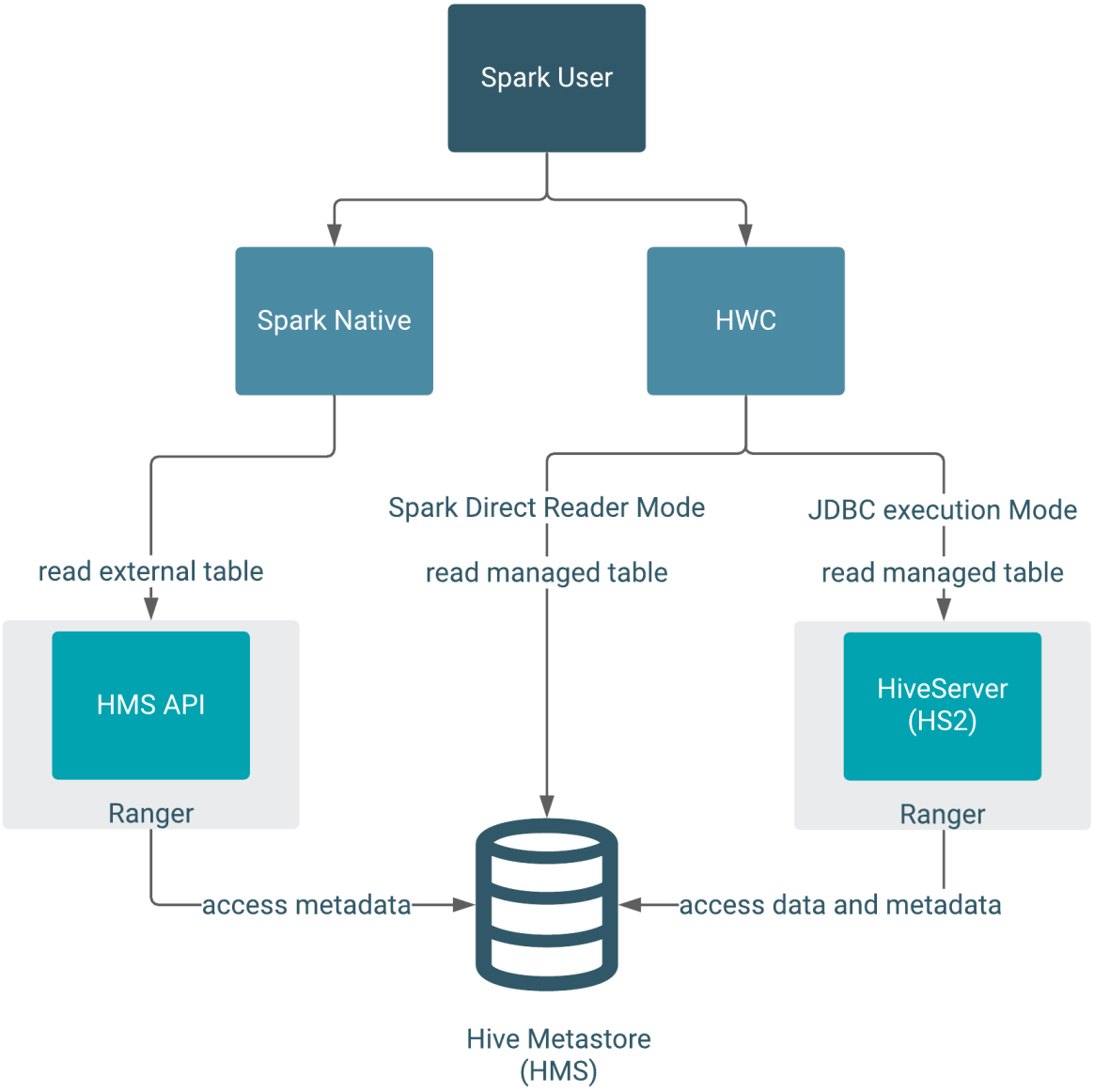
These read modes require connections to different Hive components:

- Spark Direct Reader mode: Connects to Hive Metastore (HMS)
- JDBC execution mode: Connects to HiveServer (HS2)

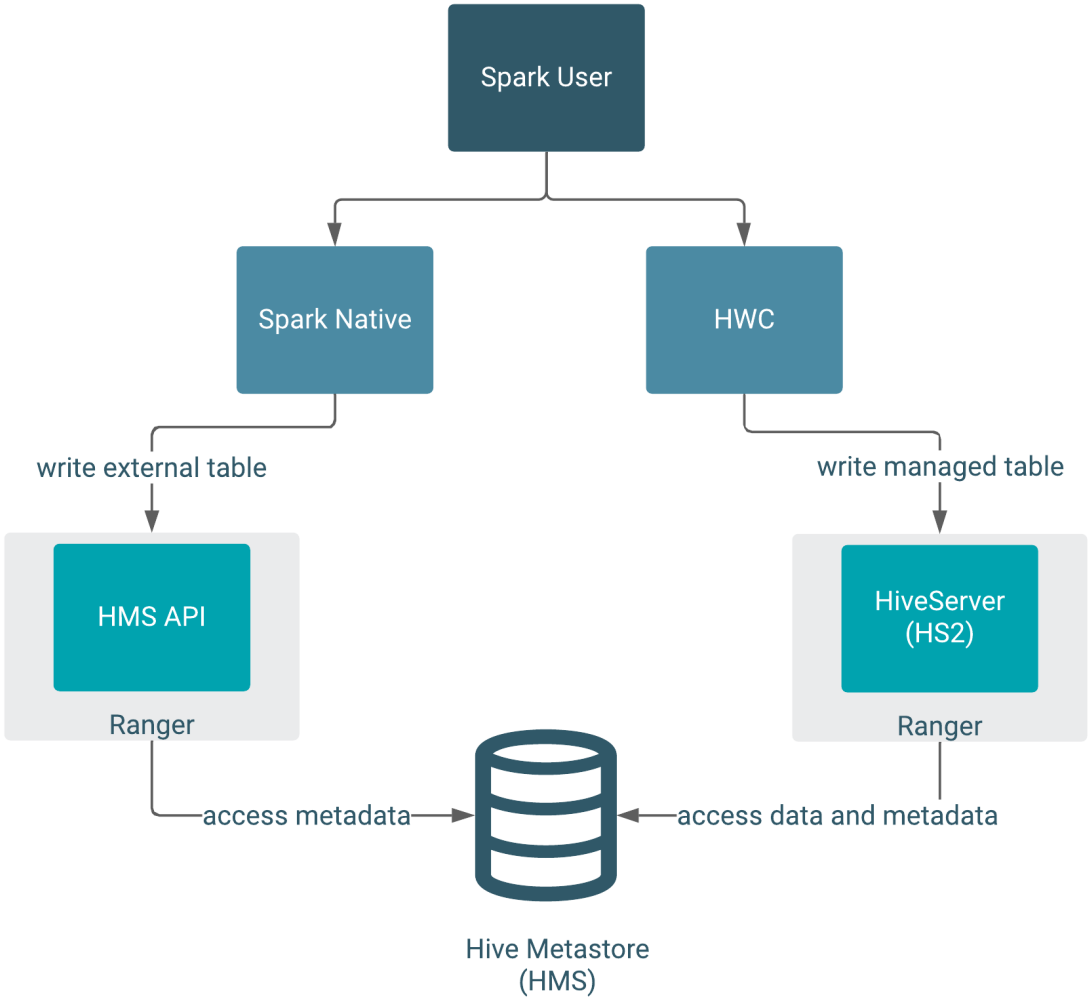
The read execution mode determines the type of query authorization for reads. Ranger authorizes access to Hive tables from Spark through HiveServer (HS2) or the Hive metastore API (HMS API).

To write ACID managed tables from Spark to Hive, use HWC. To write external tables from Spark to Hive, use native Spark.

The following diagram shows the typical read authorization process:



The following diagram shows the typical write authorization process:



You need to use HWC to read or write managed tables from Spark. Spark Direct Reader mode does not support writing to managed tables. Managed table queries go through HiveServer, which is integrated with Ranger. External table queries go through the HMS API, which is also integrated with Ranger.

In Spark Direct Reader mode, SparkSQL queries read managed table metadata directly from the HMS, but only if you have permission to access files on the file system.

If you do not use HWC, the Hive metastore (HMS) API, integrated with Ranger, authorizes external table access. HMS API-Ranger integration enforces the Ranger Hive ACL in this case. When you use HWC, queries such as DROP TABLE affect file system data as well as metadata in HMS.

Managed tables

A Spark job impersonates the end user when attempting to access an Apache Hive managed table. As an end user, you do not have permission to secure, managed files in the Hive warehouse. Managed tables have default file system permissions that disallow end user access, including Spark user access.

As Administrator, you set permissions in Ranger to access the managed tables in JDBC mode. You can fine-tune Ranger to protect specific data. For example, you can mask data in certain columns, or set up tag-based access control.

In Spark Direct Reader mode, you cannot use Ranger. You must set read access to the file system location for managed tables. You must have Read and Execute permissions on the Hive warehouse location (hive.metastore.warehouse.dir).

External tables

Ranger authorization of external table reads and writes is supported. You need to configure a few properties in Cloudera Manager for authorization of external table writes. You must be granted file system permissions on external table files to allow Spark direct access to the actual table data instead of just the table metadata. For example, to purge actual data you need access to the file system.

Spark Direct Reader mode vs JDBC mode

As Spark allows users to run arbitrary code, fine grained access control, such as row level filtering or column level masking, is not possible within Spark itself. This limitation extends to data read in Spark Direct Reader mode.

To restrict data access at a fine-grained level, consider using Ranger and HWC in JDBC execution mode if your datasets are small. If you do not require fine-grained access, consider using HWC Spark Direct Reader mode. For example, use Spark Direct Reader mode for ETL use cases. Spark Direct Reader mode is the recommended read mode for production. Using HWC is the recommended write mode for production.

Related Information

Configuring Spark Direct Reader mode
Configuring JDBC execution mode
HMS storage
Apache Hive Wiki: JDBC URL information
Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

Spark Direct Reader mode

A detailed description of Spark Direct Reader mode includes how the Hive Warehouse Connector (HWC) transparently connects to Apache Hive metastore (HMS) to get transaction information, and then reads the data directly from the managed table location using the transaction snapshot. The properties you need to set, and when you need to set them, in the context of the Apache Spark session helps you successfully work in this mode.

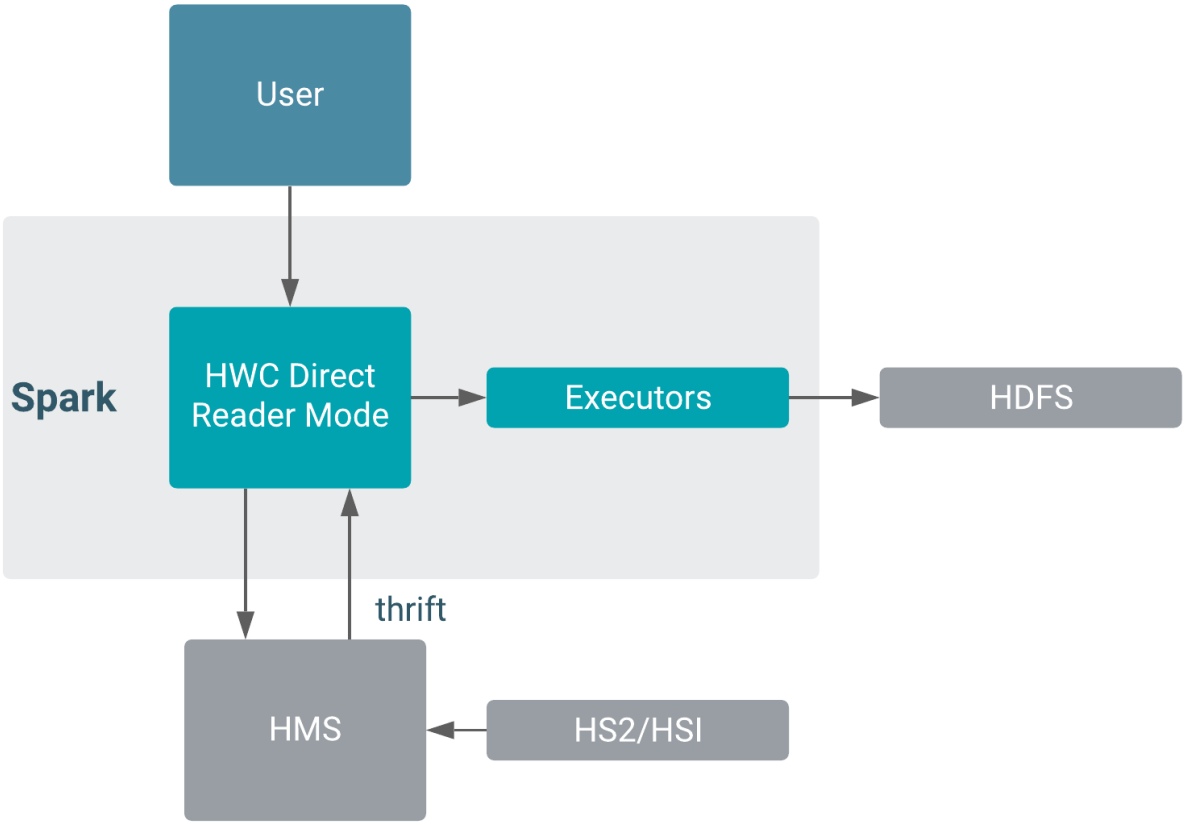
Requirements and recommendations

Spark Direct Reader mode requires a connection to Hive metastore. A HiveServer (HS2) connection is not needed.

Spark Direct Reader for reading Hive ACID, transactional tables from Spark is supported for production use. Use Spark Direct Reader mode if your ETL jobs do not require authorization and run as super user.

Component interaction

The following diagram shows component interaction in HWC Spark Direct Reader mode.



Spark Direct Reader Mode configuration

In configuration/spark-defaults.conf, or using the --conf option in spark-submit/spark-shell set the following properties:

Name: spark.sql.extensions

Value: com.qubole.spark.hiveacid.HiveAcidAutoConvertExtension

Required for using Spark SQL in auto-translate direct reader mode. Set before creating the spark session.

Name: spark.kryo.registrator

Value: com.qubole.spark.hiveacid.util.HiveAcidKyroRegistrator

Set before the spark session. Required if serialization = kryo.

Name: spark.sql.hive.hwc.execution.mode

Value: spark

Required only if you are using the HWC API for execution. Cannot be any other value.

Name: spark.hadoop.hive.metastore.uris

Value: thrift://<host>:<port>

Hive metastore URI.

Name: --jars

Value: HWC jar

Pass the HWC jar to spark-shell or spark-submit using the --jars option while launching the application. For example, launch spark-shell as follows.

Example: Launch a spark-shell

```
spark-shell --jars \
/opt/cloudera/parcels/CDH/lib/hive_warehouse_connector/hive-warehouse-conne
ctor-assembly-<version>.jar \
--conf "spark.sql.extensions=com.qubole.spark.hiveacid.HiveAcidAutoConvert
Extension" \
--conf "spark.kryo.registrator=com.qubole.spark.hiveacid.util.HiveAcidKyroR
egistrator" \
--conf "spark.hadoop.hive.metastore.uris=<metastore_uri>"
```

Unsupported functionality

Spark Direct Reader does not support the following functionality:

- Writes
- Streaming inserts
- CTAS statements

Limitations

- Does not enforce authorization; hence, you must configure read access to the HDFS, or other, location for managed tables. You must have Read and Execute permissions on hive warehouse location (hive.metastore.warehouse.dir).
- Supports only single-table transaction consistency. The direct reader does not guarantee that multiple tables referenced in a query read the same snapshot of data.
- Does not auto-commit transactions submitted by rdd APIs. Explicitly close transactions to release locks.
- Requires read and execute access on the hive-managed table locations.
- Does not support Ranger column masking and fine-grained access control.
- Blocks compaction on open read transactions.

The way Spark handles null and empty strings can cause a discrepancy between metadata and actual data when writing the data read by Spark Direct Reader to a CSV file.

Spark Direct Reader Security

Ranger Resource Mapping Server (RMS) translates Hadoop SQL policies in Apache Ranger to HDFS ACLs. RMS ACL Sync periodically synchronizes the policies and ACLs. You can use RMS ACL Sync to prevent Apache Spark user access to storage locations in HDFS that back Apache Hive tables and apply fine-grained security, such as column masking and tagging defined for Hive tables.

For example, you can create a Hive table, and then, in Ranger give your Spark users SELECT permission on the table. Even though users have SELECT permission, they will be denied access, and queries will fail under the following conditions:

- A Ranger tag-based policy denies access to one of the columns in the table.
- Ranger column masking gives users read access to only one of the columns in the table.
- Ranger row filtering gives users access to only a subset of rows.

To allow certain users to query the table, in Ranger you assign those users the ALL privilege on the table. When allowed to access the entire table, their queries successfully execute. For more information about RMS ACL Sync, including set up information, see links below.

Related Information

Configuring Spark Direct Reader mode

Configuring JDBC execution mode

Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

Ranger RMS Installation

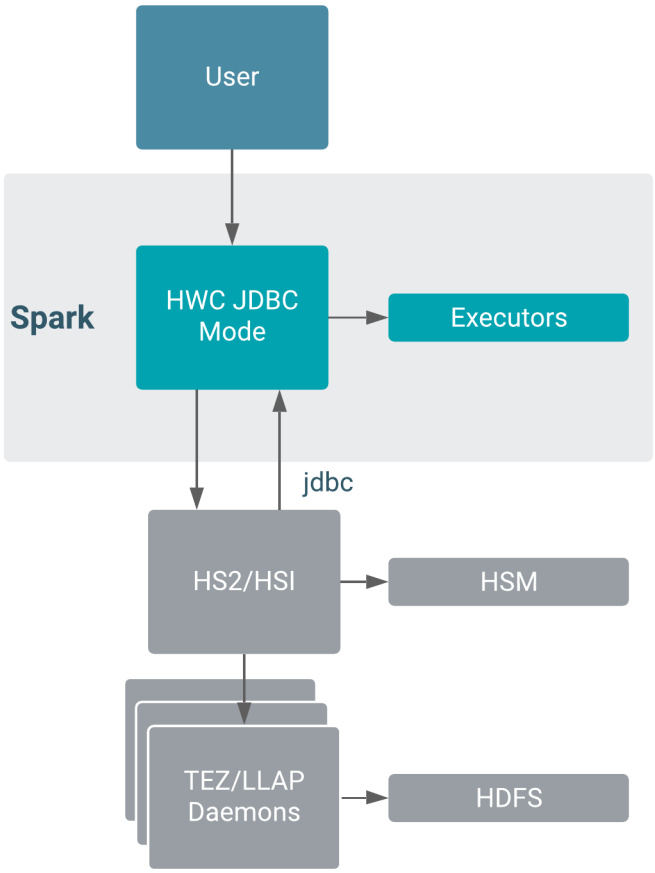
Ranger RMS Authorization for Hive-HDFS

JDBC execution mode

You need to understand how JDBC mode interacts with Apache Hive components to read Hive tables from Spark through HWC. Where your queries are executed affects configuration. Understanding execution locations and recommendations help you configure JDBC execution mode for your use case.

Component Interaction

JDBC mode creates only one JDBC connection to HiveServer (HS2) or HiveServer Interactive (HSI), a potential bottleneck in data transfer to Spark. The following diagram shows interaction in JDBC mode with Hive metastore (HMS), TEZ, and HDFS.



HWC does not use JDBC mode during a write. HWC writes to an intermediate location from Spark, and then executes a LOAD DATA query to write the data. Using HWC to write data is recommended for production.

Configuration

In JDBC mode, execution takes place in these locations:

- Driver: Using the Hive JDBC url, connects to Hive and executes the query on the driver side.
- Cluster: From Spark executors, connects to Hive through JDBC and executes the query.

Authorization occurs on the server.

JDBC mode runs in the client or cluster:

- Client (Driver)

  In client mode, any failures to connect to HiveServer (HS2) will not be retried.
- Cluster (Executor)--recommended

  In cluster mode any failures to connect to HS2 will be retried automatically.

JDBC mode is recommended for production reads of workloads having a data size of 1 GB or less. Using larger workloads is not recommended due to slow performance when reading huge data sets. Where your queries are executed affects the Kerberos configurations for HWC.

In configuration/spark-defaults.conf, or using the --conf option in spark-submit/spark-shell set the following properties:

Name: spark.datasource.hive.warehouse.read.jdbc.mode

Value: client or cluster

Configures the driver location.

Name: spark.sql.hive.hiveserver2.jdbc.url

Value:

The JDBC endpoint for HiveServer. For more information, see the Apache Hive Wiki (link below). For Knox, provide the HiveServer, not Knox, endpoint.

Name: spark.datasource.hive.warehouse.load.staging.dir

Value: Temporary staging location required by HWC. Set the value to a file system location where the HWC user has write permission.

Name: spark.hadoop.hive.zookeeper.quorum

JDBC Mode Limitations

- If you configured Auto Translate, run JDBC in cluster mode.
- JDBC mode, which is used for reads only, recommended for production workloads having a data size of 1 GB or less. In larger workloads, bottlenecks develop in data transfer to Spark.

  Writes through HWC of any size are recommended for production. Writes do not use JDBC mode

Related Information

Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

Automating mode selection

You need to know the prerequisites for using Auto Translate to select an execution mode transparently, based on your query. In a single step, you configure Auto Translate and submit an application.

About this task

You configure the spark.sql.extensions property to enable auto translation. When you enable Auto Translate, Spark implicitly selects HWC, or native Apache Spark to run your query. Spark selects HWC when you query an Apache Hive managed (ACID) table and falls back to native Spark for reading external tables. You can use the same Spark APIs to access either managed or external tables.

Before you begin

- Configure Spark Direct Reader mode and JDBC execution mode.
- Configure Kerberos.

Procedure

1. Submit the Spark application, including spark.sql.extensions property to enable Auto Translate.
2. If you use the kyro serializer, include -- conf spark.sql.extensions=com.qubole.spark.hiveacid.HiveAcidAutoConvertExtension
   For example:

```
sudo -u hive spark-shell --jars /opt/cloudera/parcels/CDH/jars/hive-warehouse-connector-assembly-<version>.jar \
--conf "spark.sql.extensions=com.qubole.spark.hiveacid.HiveAcidAutoConvertExtension" \
--conf spark.kryo.registrator="com.qubole.spark.hiveacid.util.HiveAcidKyroRegistrator"
```

3. Read employee data in table emp_acid.
   View employee data in table emp_acid.

```
scala> spark.sql("select * from emp_acid").show(1000, false)

+------+----------+--------------------+------------+--------------+-----
+-----+-------+
|emp_id|first_name|              e_mail|date_of_birth|          city|st
ate|  zip|dept_id|
+------+----------+--------------------+------------+--------------+-----
+-----+-------+
|677509|      Lois|lois.walker@hotma…  |    3/29/1981|        Denver|
 CO|80224|      4|
|940761|    Brenda|brenda.robinson@g...|    7/31/1970|     Stonewall|   L
A|71078|      5|
|428945|       Joe|joe.robinson@gmai…  |    6/16/1963|  Michigantown|
 IN|46057|      3|
……….
……….
……….
```

   You do not need to specify an execution mode. You simply submit the query. Using the HWC API, to use hive.execute to execute a read. This command processes queries through HWC in either JDBC and Spark Direct Reader modes.

Related Information

Configuring Spark Direct Reader mode

Configuring JDBC execution mode

Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

Configuring Spark Direct Reader mode

In a two-step procedure, you see how to configure Apache Spark to connect to the Apache Hive metastore. An example shows how to configure Spark Direct Reader mode while launching the Spark shell.

About this task

This procedure assumes you are not using Auto Translate and do not require serialization.

Before you begin

Set Kerberos configurations for HWC, or for an unsecured cluster, set spark.security.credentials.hiveserver2.enabled=false.

Procedure

1. In Cloudera Manager, in Hosts > Roles, if Hive Metastore appears in the list of roles, copy the host name or IP address.

   You use the host name or IP address in the next step to set the host value.
2. Launch the Spark shell and include the configuration of the spark.hadoop.hive.metastore.uris property to thrift://<host>:<port>.
   For example:

```
spark-shell --jars /opt/cloudera/parcels/CDH/jars/hive-warehouse-connect
or-assembly-<version>.jar \
--conf "spark.hadoop.hive.metastore.uris=thrift://172.27.74.137:9083"
... <other conf strings>
```

   If you use the HWC API, configure spark.sql.hive.hwc.execution.mode=spark

Configuring JDBC execution mode

In two steps, you configure Apache Spark to connect to HiveServer (HS2). An example shows how to configure this mode while launching the Spark shell.

Before you begin

- Accept the default and recommended spark.datasource.hive.warehouse.read.jdbc.mode=cluster for the location of query execution.
- Accept the default spark.datasource.hive.warehouse.load.staging.dir for the temporary staging location required by HWC.
- Check that spark.hadoop.hive.zookeeper.quorum is configured.
- Set Kerberos configurations for HWC, or for an unsecured cluster, set spark.security.credentials.hiveserver2.enabled=false.

Procedure

1. Find the HiveServer (HS2) JDBC URL in /etc/hive/conf.cloudera.HIVE_ON_TEZ-1/beeline-site.xml
   The value of beeline.hs2.jdbc.url.HIVE_ON_TEZ-1 is the HS2 JDBC URL in this sample file.

```
...
<configuration>
 <property>
 <name>beeline.hs2.jdbc.url.default</name>
 <value>HIVE_ON_TEZ-1</value>
 </property>
 <property>
 <name>beeline.hs2.jdbc.url.HIVE_ON_TEZ-1</name>
 <value>jdbc:hive2://nightly7x-unsecure-1.nightly7x-unsecure.root.hwx.sit
e:2181/;serviceDiscoveryMode=zooKeeper; \
    zooKeeperNamespace=hiveserver2;retries=5</value>
 </property>
</configuration>
```

2. Set the Spark property to the value of the HS2 JDBC URL.
   For example, in /opt/cloudera/parcels/CDH-7.2.1-1.cdh7.2.1.p0.4847773/etc/spark/conf.dist/spark-defaults.conf, add the JDBC URL:

```
...
```

```
spark.sql.hive.hiveserver2.jdbc.url spark.sql.hive.hiveserver2.jdbc.url
jdbc:hive2://nightly7x-unsecure-1.nightly7x-unsecure.root.hwx.site:2181/
;serviceDiscoveryMode=zooKeeper; \
  zooKeeperNamespace=hiveserver2;retries=5
```

Kerberos configurations for HWC

You learn how to configure and which parameters to set for a Kerberos-secure HWC connection for querying the Hive metastore from Spark.

The Hive Warehouse Connector (HWC) must connect to HiveServer (HS2) to execute writes or to execute reads in read modes other than Direct Reader. You need to set the following configuration properties to connect HWC to a Kerberos-enabled HiveServer:

- Property: spark.sql.hive.hiveserver2.jdbc.url.principal

  Value: Set this value to the value of "hive.server2.authentication.kerberos.principal".
- Property: spark.security.credentials.hiveserver2.enabled

  Value: Set this value to "true".

You do not need to explicitly provide other authentication configurations, such as auth type and principal. When Spark opens a secure connection to Hive metastore, Spark automatically picks the authentication configurations from the hive-site.xml that is present on the Spark app classpath. For example, to execute queries in direct reader mode through HWC, Spark opens a secure connection to Hive metastore and this authentication occurs automatically.

You can set the properties using the spark-submit/spark-shell --conf option.

Configuring external file authorization

As Administrator, you need to know how to configure properties in Cloudera Manager for read and write authorization to Apache Hive external tables from Apache Spark. You also need to configure file level permissions on tables for users.

About this task

You set the following properties and values for HMS API-Ranger integration:
hive.metastore.pre.event.listeners

Value:

```
org.apache.hadoop.hive.ql.security.authorization.plugin.metastor
e.HiveMetaStoreAuthorizer
```

Configures HMS writes.

hive.security.authenticator.manager

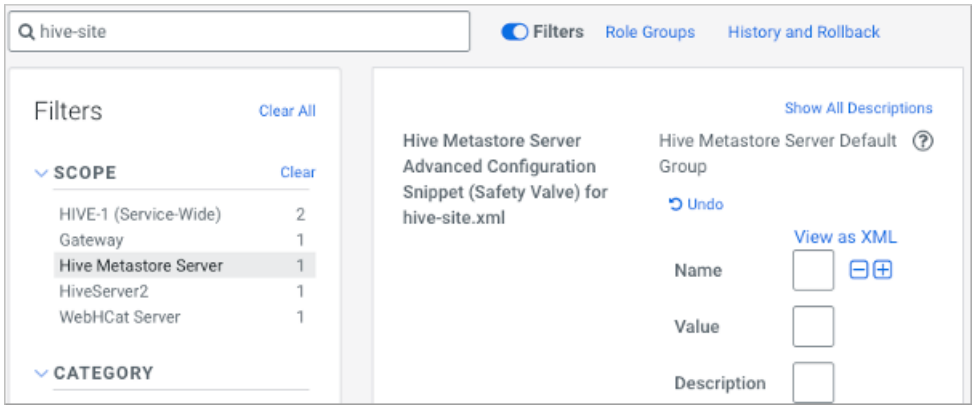
Value: org.apache.hadoop.hive.ql.security.SessionStateUserAuthenticator

Add properties to hive-site.xml using the Cloudera Manager Safety Valve as described in the next section.

Procedure

1. In Cloudera Manager, to configure Hive Metastore properties click Clusters Hive-1 Configuration .
2. Search for hive-site.

3. In Hive Metastore Server Advanced Configuration Snippet (Safety Valve) for hive-site.xml, click +.



4. Add a property name and value.
5. Repeat steps to add other properties.
6. Save changes.
7. Configure file level permissions on tables for users.

   Only users who have file level permissions on external tables can access external tables.

Reading managed tables through HWC

A step-by-step procedure walks you through choosing one mode or another, starting the Apache Spark session, and executing a read of Apache Hive ACID, managed tables.

Before you begin

- Configure Spark Direct Reader Mode or JDBC execution mode.
- Set Kerberos for HWC.

Procedure

1. Choose a configuration based on your execution mode.
   - Spark Direct Reader mode:

     ```
     --conf spark.sql.extensions=com.qubole.spark.hiveacid.HiveAcidAutoConver
     tExtension
     ```

   - JDBC mode:

     ```
     --conf spark.sql.extensions=com.hortonworks.spark.sql.rule.Extensions
     --conf spark.datasource.hive.warehouse.read.via.llap=false
     ```

     Also set a location for running the application in JDBC mode. For example, set the recommended cluster location for example:

     ```
     spark.datasource.hive.warehouse.read.jdbc.mode=cluster
     ```

2. Start the Spark session using the execution mode you chose in the last step.
   For example, start the Spark session using Spark Direct Reader mode and configure for kyro serialization:

   ```
   sudo -u hive spark-shell --jars /opt/cloudera/parcels/CDH/jars/hive-ware
   house-connector-assembly-<version>.jar \
   --conf "spark.sql.extensions=com.qubole.spark.hiveacid.HiveAcidAutoConv
   ertExtension" \
   ```

```
--conf spark.kryo.registrator="com.qubole.spark.hiveacid.util.HiveAcidKy
roRegistrator"
```

For example, start the Spark session using JDBC execution mode:

```
sudo -u hive spark-shell --jars /opt/cloudera/parcels/CDH/jars/hive-ware
house-connector-assembly-<version>.jar \
--conf spark.sql.hive.hwc.execution.mode=spark \
--conf spark.datasource.hive.warehouse.read.via.llap=false
```

You must start the Spark session after setting Spark Direct Reader mode, so include the configurations in the launch string.

3. Read Apache Hive managed tables.
   For example:

```
scala> sql("select * from managedTable").show
scala> spark.read.table("managedTable").show
```

Related Information

Configuring Spark Direct Reader mode

Configuring JDBC execution mode

Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

Writing managed tables through HWC

A step-by-step procedure walks you through connecting to HiveServer (HS2) to write tables from Spark, which is recommended for production. You launch the Spark session, and write ACID, managed tables to Apache Hive.

Before you begin

- Accept the default spark.datasource.hive.warehouse.load.staging.dir for the temporary staging location required by HWC.
- Check that spark.hadoop.hive.zookeeper.quorum is configured.
- Set Kerberos configurations for HWC, or for an unsecured cluster, set spark.security.credentials.hiveserver2.enabled=false.

About this task

Limitation: Only the ORC format is supported for writes.

The way data is written from HWC is not impacted by the read modes configured for HWC. For write operations, HWC writes to an intermediate location (as defined by the value of config spark.datasource.hive.warehouse.load.staging.dir) from Spark, followed by executing a "LOAD DATA" query in hive via JDBC. Exception: writing to dynamic partitions creates an intermediate temporary external table.

Using HWC to write data is recommended for production in CDP.

Procedure

1. Start the Apache Spark session and include the URL for HiveServer.

```
spark-shell --jars /opt/cloudera/parcels/CDH/jars/hive-warehouse-connect
or-assembly-<version>.jar \
-- conf spark.sql.hive.hiveserver2.jdbc.url=<JDBC endpoint for HiveServer>
...
```

2. Include in the launch string a configuration of the intermediate location to use as a staging directory.
   Example syntax:

```
...
--conf spark.sql.hive.hwc.execution.mode=spark \
--conf spark.datasource.hive.warehouse.read.via.llap=false \
--conf spark.datasource.hive.warehouse.load.staging.dir=<path to direc
tory>
```

3. Write a Hive managed table.
   For example, in Scala:

```
import com.hortonworks.hwc.HiveWarehouseSession
import com.hortonworks.hwc.HiveWarehouseSession._

val hive = HiveWarehouseSession.session(spark).build();
hive.setDatabase("tpcds_bin_partitioned_orc_1000");
val df = hive.executeQuery("select * from web_sales");
df.createOrReplaceTempView("web_sales");
hive.setDatabase("testDatabase");

hive.createTable("newTable").ifNotExists()
.column("ws_sold_time_sk", "bigint")
.column("ws_ship_date_sk", "bigint")
.create();

sql("SELECT ws_sold_time_sk, ws_ship_date_sk FROM web_sales WHERE ws_sold
_time_sk > 80000)
.write.format(HIVE_WAREHOUSE_CONNECTOR)
.mode("append")
.option("table", "newTable")
.save();
```

   HWC internally fires the following query to Hive through JDBC:

```
LOAD DATA INPATH '<spark.datasource.hive.warehouse.load.staging.dir>' INTO
 TABLE tpcds_bin_partitioned_orc_1000.newTable
```

4. Write to a statically partitioned, Hive managed table named t1 having two partitioned columns c1 and c2.

```
df.write.format(HIVE_WAREHOUSE_CONNECTOR).mode("append").option("partiti
on", "c1='val1',c2='val2'").option("table", "t1").save();
```

   HWC internally fires the following query to Hive through JDBC after writing data to a temporary location.

```
LOAD DATA INPATH '<spark.datasource.hive.warehouse.load.staging.dir>' [O
VERWRITE] INTO TABLE db.t1 PARTITION (c1='val1',c2='val2');
```

5. Write to a dynamically partitioned table named t1 having two partitioned cols c1 and c2.

```
df.write.format(HIVE_WAREHOUSE_CONNECTOR).mode("append").option("partiti
on", "c1='val1',c2").option("table", "t1").save();
```

   HWC internally fires the following query to Hive through JDBC after writing data to a temporary location.

```
CREATE TEMPORARY EXTERNAL TABLE db.job_id_table(cols....) STORED AS ORC
LOCATION '<spark.datasource.hive.warehouse.load.staging.dir>';
```

```
INSERT INTO TABLE t1 PARTITION (c1='val1',c2)  SELECT <cols> FROM db.job
_id_table;
```

where <cols> should have comma separated list of columns in the table with dynamic partition columns being the last in the list and in the same order as the partition definition.

Related Information

Configuring Spark Direct Reader mode

Configuring JDBC execution mode

Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

API operations

As an Apache Spark developer, you learn the code constructs for executing Apache Hive queries using the HiveWarehouseSession API. In Spark source code, you see how to create an instance of HiveWarehouseSession.

Import statements and variables

The following string constants are defined by the API:

- HIVE_WAREHOUSE_CONNECTOR
- DATAFRAME_TO_STREAM
- STREAM_TO_STREAM

Assuming spark is running in an existing SparkSession, use this code for imports:

- Scala

```
import com.hortonworks.hwc.HiveWarehouseSession
import com.hortonworks.hwc.HiveWarehouseSession._
val hive = HiveWarehouseSession.session(spark).build()
```

- Java

```
import com.hortonworks.hwc.HiveWarehouseSession;
import static com.hortonworks.hwc.HiveWarehouseSession.*;
HiveWarehouseSession hive = HiveWarehouseSession.session(spark).build();
```

- Python

```
from pyspark_llap import HiveWarehouseSession
hive = HiveWarehouseSession.session(spark).build()
```

Executing queries

HWC supports three methods for executing queries:

- .sql()
  - Executes queries in any HWC mode.
  - Consistent with the Spark sql interface.
  - Masks the internal implementation based on the cluster type you configured, either JDBC_CLIENT or JDBC_CLUSTER.

- .execute()
  - Required for executing queries if spark.datasource.hive.warehouse.read.mode=JDBC_CLUSTER.
  - Uses a driver side JDBC connection.
  - Provided for backward compatibility where the method defaults to reading in JDBC client mode irrespective of the value of JDBC client or cluster mode configuration.
  - Recommended for catalog queries.
- .executeQuery()
  - Executes queries, except catalog queries, in LLAP mode (spark.datasource.hive.warehouse.read.via.llap= true)
  - If LLAP is not enabled in the cluster, .executeQuery() does not work. CDP Data Center does not support LLAP.
  - Provided for backward compatibility.

Results are returned as a DataFrame to Spark.

Related Information

HMS storage

Orc vs Parquet

Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

Getting started with HWC

You need to know how to use the Hive Warehouse Connector (HWC) with different programming languages and build systems. You find out where HWC binaries are located in CDP parcels and how a Spark application consumes the binaries.

The examples in this topic assume that you are running CDP version 7.2.9.0-203. Substitute your actual CDP version when you copy examples.

Cloudera artifactory and HWC dependency

To pull the HWC dependency corresponding to a release, use the following artifactory:

```
https://repository.cloudera.com/artifactory/cloudera-repos
```

Use with Maven

To use HWC with maven, define the cloudera artifactory as a repository.

```
<repository>
  <id>cloudera</id>
  <name>cloudera</name>
  <url>https://repository.cloudera.com/artifactory/cloudera-repos</url>
 </repository>
```

In the pom.xml of the project, add the dependency as shown in the following example:

```
<dependency>
   <groupId>com.hortonworks.hive</groupId>
   <artifactId>hive-warehouse-connector_2.11</artifactId>
   <version>1.0.0.7.2.9.0-203</version>
   <scope>provided</scope>
</dependency>
```

Use with Sbt

Add the Cloudera repository as follows:

```
resolvers += "Cloudera repo" at "https://repository.cloudera.com/artifactory
/cloudera-repos"

libraryDependencies += "com.hortonworks.hive" % "hive-warehouse-connector_
2.11" % "1.0.0.7.2.9.0-203" % "provided"
```

Add the HWC dependency to the build sbt as follows:

```
libraryDependencies += "com.hortonworks.hive" % "hive-warehouse-connector_2.
11" % "1.0.0.7.2.9.0-203" % "provided"
```

Dependency scope

Generally, you add HWC dependencies in provided scope unless there is a specific requirement to do otherwise. While running spark application, you can specify the HWC jar present in your distribution using the --jars option to spark-submit or spark-shell.

HWC Binaries in CDP

HWC binaries are located in /opt/cloudera/parcels/CDH/lib/hive_warehouse_connector/. This directory contains HWC jar, a python zip, and the R package. Use these binaries to launch Spark applications in Scala, Java, Python, or R.

The following files are in /opt/cloudera/parcels/CDH/lib/hive_warehouse_connector/.

- hive-warehouse-connector-assembly-1.0.0.7.2.9.0-203.jar
- pyspark_hwc-1.0.0.7.2.9.0-203.zip
- SparklyrHWC-1.0.0.7.2.9.0-203

Working with different languages

You use HWC APIs to perform basic read and write operations. You need to understand how to use HWC APIs with different languages. The following examples show basic capabilities that are covered in detail later in this documentation.

Use with Scala

```
import com.hortonworks.hwc.HiveWarehouseSession
import org.apache.spark.sql.{SaveMode, SparkSession}


object HWCApp {

  def main(args: Array[String]): Unit = {
    val spark = SparkSession.builder.appName("HWCApp").enableHiveSupport.g
etOrCreate
    val hwc = HiveWarehouseSession.session(spark).build
    // create sample data
    val tvSeries = createSampleDataDf(spark)
    val tableName = "tv_series"

    hwc.dropTable(tableName, true, true)
    println(s"=======Writing to hive table - $tableName via HWC=======")
    // write to hive table via HWC
    tvSeries.write.format(HiveWarehouseSession.HIVE_WAREHOUSE_CONNECTOR)
      .option("table", tableName)
      .mode(SaveMode.Append).save
```

```
    println(s"=======Reading hive table $tableName via HWC=======")
    // Read via HWC
    hwc.sql(s"select * from $tableName").show(truncate = false)

    hwc.close()
    spark.stop
  }

  private def createSampleDataDf(spark: SparkSession) = {
    spark.sql("drop table if exists tv_series_dataset")
    spark.sql("create table tv_series_dataset(id int, name string, genres
string, rating double) using orc")
    spark.sql("insert into tv_series_dataset values " +
      "(1, 'Chernobyl', 'Drama|History|Tragedy|Science', 9.4), " +
      "(2, 'Westworld', 'Sci-fi', 8.6), (3, 'Sense8', 'Sci-fi', 8.3), " +
      "(4, 'Person of Interest', 'Drama|Sci-fi', 8.4), " +
      "(5, 'Its okay to not be okay', 'Drama', 8.7), " +
      "(6, 'Daredevil', 'Action|Sci-fi', 8.6), " +
      "(7, 'Money Heist', 'Drama|Thriller', 8.3), " +
      "(8, 'Breaking Bad', 'Crime|Drama', 9.5)")
    spark.sql("select * from tv_series_dataset")
  }
```

Use with Java

The following Java code is equivalent to the scala code above.

```
import com.hortonworks.hwc.HiveWarehouseSession
import org.apache.spark.sql.Dataset;
import org.apache.spark.sql.Row;
import org.apache.spark.sql.SaveMode;
import org.apache.spark.sql.SparkSession;

public class HWCApp {
  public static void main(String[] args) {
    SparkSession spark = SparkSession.builder().appName("HWCApp").enableHive
Support().getOrCreate();
    // HiveWarehouseSession creation
    HiveWarehouseSession hwc = HiveWarehouseBuilder.session(spark).build();
    // create sample data
    Dataset<Row> tvSeries = createSampleDataDf(spark);
    String tableName = "tv_series";
    hwc.dropTable(tableName, true, true);
    System.out.println("=======Writing to hive table - " + tableName + " via
 HWC=======");
    // write data to hive table via HWC
    tvSeries.write().format(HiveWarehouseSession.HIVE_WAREHOUSE_CONNECTOR)
        .option("table", tableName)
        .mode(SaveMode.Append).save();

    System.out.println("=======Reading hive table - " + tableName + " via
 HWC=======");
    // read hive table as dataframe using HWC
    hwc.sql("select * from " + tableName).show(false);
    hwc.close();
    spark.stop();
  }
  private static Dataset<Row> createSampleDataDf(SparkSession spark) {
    spark.sql("drop table if exists tv_series_dataset");
    spark.sql("create table tv_series_dataset(id int, name string, genres st
ring, rating double) using orc");
    spark.sql("insert into tv_series_dataset values " +
        "(1, 'Chernobyl', 'Drama|History|Tragedy|Science', 9.4), " +
```

```
        "(2, 'Westworld', 'Sci-fi', 8.6), (3, 'Sense8', 'Sci-fi', 8.3), " +
        "(4, 'Person of Interest', 'Drama|Sci-fi', 8.4), " +
        "(5, 'Its okay to not be okay', 'Drama', 8.7), " +
        "(6, 'Daredevil', 'Action|Sci-fi', 8.6), " +
        "(7, 'Money Heist', 'Drama|Thriller', 8.3), " +
        "(8, 'Breaking Bad', 'Crime|Drama', 9.5)");
    return spark.sql("select * from tv_series_dataset");
  }
}
```

Launching a Java or Scala app

After packaging the app in a jar, launch the app using standard Spark syntax for launching applications. Provide HWC jar from the distribution. The Spark application can be launched as follows:

```
spark-submit --jars /opt/cloudera/parcels/CDH/lib/hive_warehouse_connector/h
ive-warehouse-connector-assembly-1.0.0.7.2*.jar \
--class com.cloudera.HWCApp \
...More spark/HWC confs...
...More spark/HWC confs...
/path-to-jar/hwc-app.jar
```

Use with Python

```
from pyspark.sql import SparkSession
from pyspark_llap import HiveWarehouseSession

spark = SparkSession.builder.enableHiveSupport().appName("hwc-app").getOrCre
ate()
hwc = HiveWarehouseSession.session(spark).build()
tableName = "tv_series"
hwc.dropTable(tableName, True, True)

tvSeries = spark.createDataFrame([
    (1, "Chernobyl", "Drama|History|Tragedy|Science", 9.4),
    (2, "Westworld", "Sci-fi", 8.6),
    (3, "Sense8", "Sci-fi", 8.3),
    (4, "Person of Interest", "Drama|Sci-fi", 8.4),
    (5, "It's okay to not be okay", "Drama", 8.7),
    (6, "Daredevil", "Action|Sci-fi", 8.6),
    (7, "Money Heist", "Drama|Thriller", 8.3),
    (8, "Breaking Bad", "Crime|Drama", 9.5)
], ["id", "name", "genres", "rating"])

print("=======Writing to hive table - " + tableName + " via HWC=======")
# write to hive table via HWC
tvSeries.write.format(HiveWarehouseSession.HIVE_WAREHOUSE_CONNECTOR).optio
n("table", tableName).mode("append").save()
print("=======Reading hive table - " + tableName + " via HWC=======")
# Read via HWC
hwc.sql("select * from " + tableName).show()

hwc.close()
spark.stop()
```

Launching a Python app

After getting the python code ready, launch it using spark-submit. Provide the HWC jar and HWC python zip as follows:

```
    spark-submit --jars /opt/cloudera/parcels/CDH/lib/hive_warehouse_connect
or/hive-warehouse-connector-assembly-1.0.0.7.2*.jar \
```

```
    --py-files /opt/cloudera/parcels/CDH/lib/hive_warehouse_connector/pysp
ark_hwc-1.0.0.7.2.*.zip \
    ...More spark/HWC confs...
    ...More spark/HWC confs...
    /path-to-python-app/hwc-app.py
```

Use with Sparklyr

You can access Hive tables through R by loading the sparklyr library along with the SparklyrHWC package available in /opt/cloudera/parcels/CDH/lib/hive_warehouse_connector/, which can be used to trigger HWC API’s from R.

```
library(sparklyr)
library(SparklyrHWC, lib.loc = c(file.path(“<path to SparklyrHWC>")))
#Set env variables
Sys.setenv(SPARK_HOME = "/opt/cloudera/parcels/CDH/lib/spark/")
Sys.setenv(HADOOP_HOME = "/opt/cloudera/parcels/CDH/lib/hadoop")

#Configurations needed  to use spark-acid and related configurations.

config <- spark_config()
config$spark.sql.hive.hiveserver2.jdbc.url="jdbc:hive2://<url>:10000/defa
ult"
config$spark.datasource.hive.warehouse.user.name="hive"
config$spark.hadoop.hive.metastore.uris="thrift://<url>:9083"
config$spark.sql.extensions="com.hortonworks.spark.sql.rule.Extensions"
config$spark.kryo.registrator="com.qubole.spark.hiveacid.util.HiveAcidKyr
oRegistrator"
config$spark.datasource.hive.warehouse.read.mode="DIRECT_READER_V2"

#Build HWC session
hs <- build(HiveWarehouseBuilder.session(sc))
#Use database
sparklyr::sdf_sql(sc,"use test")
#Reading a managed table using spark acid direct-reader
intDf <- sparklyr::spark_read_table(sc, 'emp_hwc')
#Converts SparkDataframe to R dataframe
 sparklyr::sdf_collect(intDf1)

#Writing into a managed table
#Read first table
intDf <- sparklyr::spark_read_table(sc, 'emp_hwc')
#read second table
intDf1 <-  sparklyr::spark_read_table(sc, 'emp_overwrite')
#Commit transaction if read using spark-acid
commitTxn(hs)
#Append the second table, to the first.
SparklyrHWC::spark_write_table('emp_hwc',intDf1,'append')
#Overwrite the first table with the second table.
SparklyrHWC::spark_write_table('emp_hwc',intDf1,'overwrite')

#Using HWC Api’s

#create a table from existing table
SparklyrHWC::executeUpdate(hs,"create table hwc1 as select * from 'emp_hwc
'")
#Execute query
hwcDf <- SparklyrHWC::executeQuery(hs, "select * from hwc1")
#convert into R dataframe.
hwcSdf <- sparklyr::sdf_copy_to(sc, hwcDf)
```

HWC supported types mapping

To create HWC API apps, you must know how Hive Warehouse Connector maps Apache Hive types to Apache Spark types, and vice versa. Awareness of a few unsupported types helps you avoid problems.

Spark-Hive supported types mapping

The following types are supported by the HiveWareHouseConnector library:

Spark Type	Hive Type
ByteType	TinyInt
ShortType	SmallInt
IntegerType	Integer
LongType	BigInt
FloatType	Float
DoubleType	Double
DecimalType	Decimal
StringType*	String, Varchar*
BinaryType	Binary
BooleanType	Boolean
TimestampType**	Timestamp**
DateType	Date
ArrayType	Array
StructType	Struct

Notes:

* StringType (Spark) and String, Varchar (Hive)

A Hive String or Varchar column is converted to a Spark StringType column. When a Spark StringType column has maxLength metadata, it is converted to a Hive Varchar column; otherwise, it is converted to a Hive String column.

** Timestamp (Hive)

The Hive Timestamp column loses submicrosecond precision when converted to a Spark TimestampType column because a Spark TimestampType column has microsecond precision, while a Hive Timestamp column has nanosecond precision.

Hive timestamps are interpreted as UTC. When reading data from Hive, timestamps are adjusted according to the local timezone of the Spark session. For example, if Spark is running in the America/New_York timezone, a Hive timestamp 2018-06-21 09:00:00 is imported into Spark as 2018-06-21 05:00:00 due to the 4-hour time difference between America/New_York and UTC.

Spark-Hive unsupported types

Spark Type	Hive Type
CalendarIntervalType	Interval
N/A	Char
MapType	Map
N/A	Union
NullType	N/A
TimestampType	Timestamp With Timezone

Related Information

HMS storage

Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

Catalog operations

Short descriptions and the syntax of catalog operations, which include creating, dropping, and describing an Apache Hive database and table from Apache Spark, helps you write HWC API apps.

Catalog operations

Three methods of executing catalog operations are supported: .sql (recommended), .execute() (spark.datasource.hive.warehouse.read.jdbc.mode = client), or .executeQuery() for backward compatibility.

- Set the current database for unqualified Hive table references

  hive.setDatabase(<database>)
- Execute a catalog operation and return a DataFrame

  hive.execute("describe extended web_sales").show()
- Show databases

  hive.showDatabases().show(100)
- Show tables for the current database

  hive.showTables().show(100)
- Describe a table

  hive.describeTable(<table_name>).show(100)
- Create a database

  hive.createDatabase(<database_name>,<ifNotExists>)
- Create an ORC table

  ```
  hive.createTable("web_sales").ifNotExists().column("sold_time_sk", "bigi
  nt").column("ws_ship_date_sk", "bigint").create()
  ```

  See the CreateTableBuilder interface section below for additional table creation options. You can also create Hive tables using hive.executeUpdate.
- Drop a database

  hive.dropDatabase(<databaseName>, <ifExists>, <useCascade>)
- Drop a table

  hive.dropTable(<tableName>, <ifExists>, <usePurge>)

Related Information

HMS storage

Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

Read and write operations

Brief descriptions of HWC API operations and examples cover how to read and write Apache Hive tables from Apache Spark. You learn how to update statements and write DataFrames to partitioned Hive tables, perform batch writes, and use HiveStreaming.

Read operations

Execute a Hive SELECT query and return a DataFrame.

hive.sql("select * from web_sales")

HWC supports push-downs of DataFrame filters and projections applied to .sql().

Alternatively, you can use .execute or .executeQuery as previously described.

Execute a Hive update statement

Execute CREATE, UPDATE, DELETE, INSERT, and MERGE statements in this way:

hive.executeUpdate("ALTER TABLE old_name RENAME TO new_name")

Write a DataFrame to Hive in batch

This operation uses LOAD DATA INTO TABLE.

Java/Scala:

```
df.write.format(HIVE_WAREHOUSE_CONNECTOR).option("table", <tableName>).s
ave()
```

Python:

```
df.write.format(HiveWarehouseSession().HIVE_WAREHOUSE_CONNECTOR).option("tab
le", &tableName>).save()
```

Write a DataFrame to Hive, specifying partitions

HWC follows Hive semantics for overwriting data with and without partitions and is not affected by the setting of spark.sql.sources.partitionOverwriteMode to static or dynamic. This behavior mimics the latest Spark Community trend reflected in Spark-20236 (link below).

Java/Scala:

```
df.write.format(HIVE_WAREHOUSE_CONNECTOR).option("table", <tableName>).optio
n("partition", <partition_spec>).save()
```

Python:

```
df.write.format(HiveWarehouseSession().HIVE_WAREHOUSE_CONNECTOR).option("tab
le", &tableName>).option("partition", <partition_spec>).save()
```

Where <partition_spec> is in one of the following forms:

- option("partition", "c1='val1',c2=val2") // static
- option("partition", "c1='val1',c2") // static followed by dynamic
- option("partition", "c1,c2") // dynamic

Depending on the partition spec, HWC generates queries in one of the following forms for writing data to Hive.

- No partitions specified = LOAD DATA
- Only static partitions specified = LOAD DATA...PARTITION
- Some dynamic partition present = CREATE TEMP TABLE + INSERT INTO/OVERWRITE query.

Note: Writing static partitions is faster than writing dynamic partitions.

Write a DataFrame to Hive using HiveStreaming

When using HiveStreaming to write a DataFrame to Hive or a Spark Stream to Hive, you need to escape any commas in the stream, as shown in Use the Hive Warehouse Connector for Streaming (link below).

Java/Scala:

```
//Using dynamic partitioning
```

```
df.write.format(DATAFRAME_TO_STREAM).option("table", <tableName>).save()

//Or, writing to a static partition
df.write.format(DATAFRAME_TO_STREAM).option("table", <tableName>).option("p
artition", <partition>).save()
```

Python:

```
//Using dynamic partitioning
df.write.format(HiveWarehouseSession().DATAFRAME_TO_STREAM).option("table",
 <tableName>).save()

//Or, writing to a static partition
df.write.format(HiveWarehouseSession().DATAFRAME_TO_STREAM).option("table",
<tableName>).option("partition", <partition>).save()
```

Write a Spark Stream to Hive using HiveStreaming

Java/Scala:

```
stream.writeStream.format(STREAM_TO_STREAM).option("table", "web_sales").sta
rt()
```

Python:

```
stream.writeStream.format(HiveWarehouseSession().STREAM_TO_STREAM).option("t
able", "web_sales").start()
```

Related Information

HMS storage

SPARK-20236

Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

Commit transaction in Spark Direct Reader mode

In Spark Direct Reader mode, you need to know how to commit or abort transactions.

About this task

A sql listener normally handles this task automatically when a dataframe operation or spark sql query finishes. In some cases when .explain() , .rdd() , or .cache() are invoked on a dataframe, the transaction is not automatically closed. In Spark Direct Reader mode, commit or abort a transaction as follows:

```
scala> com.qubole.spark.hiveacid.transaction.HiveAcidTxnManagerObject.commit
Txn(spark)
scala> hive.commitTxn
```

Or, if you are using Hive Warehouse Connector with Direct Reader Mode enabled, you can invoke following API to commit transaction:

```
 scala> hive.commitTxn
```

Close HiveWarehouseSession operations

You need to know how to release locks that Apache Spark operations puts on Apache Hive resources. A example shows how and when to release these locks.

About this task

Spark can invoke operations, such as cache(), persist(), and rdd(), on a DataFrame you obtain from running a HiveWarehouseSession .table() or .sql() (or alternatively, .execute() or .executeQuery()). The Spark operations can lock Hive resources. You can release any locks and resources by calling the HiveWarehouseSession close(). Calling close() invalidates the HiveWarehouseSession instance and you cannot perform any further operations on the instance.

Procedure

Call close() when you finish running all other operations on the instance of HiveWarehouseSession.

```
import com.hortonworks.hwc.HiveWarehouseSession
import com.hortonworks.hwc.HiveWarehouseSession._
val hive = HiveWarehouseSession.session(spark).build()
hive.setDatabase("tpcds_bin_partitioned_orc_1000")
val df = hive.sql("select * from web_sales")
. . .  //Any other operations
.close()
```

You can also call close() at the end of an iteration if the application is designed to run in a microbatch, or iterative, manner that does not need to share previous states.

No more operations can occur on the DataFrame obtained by table() or sql() (or alternatively, .execute() or .execute Query()).

Related Information

Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

Use HWC for streaming

When using HiveStreaming to write a DataFrame to Apache Hive or an Apache Spark Stream to Hive, you need to know how to escape any commas in the stream because the Hive Warehouse Connector uses the commas as the field delimiter.

Procedure

Change the value of the default delimiter property escape.delim to a backslash that the Hive Warehouse Connector uses to write streams to mytable.
ALTER TABLE mytable SET TBLPROPERTIES ('escape.delim' = '\\');

Related Information

HMS storage

Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

HWC API Examples

Examples of using the HWC API include how to create the DataFrame from any data source and include an option to write the DataFrame to an Apache Hive table.

Write a DataFrame from Spark to Hive example

You specify one of the following Spark SaveMode modes to write a DataFrame to Hive:

- Append
- ErrorIfExists
- Ignore
- Overwrite

In Overwrite mode, HWC does not explicitly drop and recreate the table. HWC queries Hive to overwrite an existing table using LOAD DATA...OVERWRITE or INSERT OVERWRITE...

When you write the DataFrame, the Hive Warehouse Connector creates the Hive table if it does not exist.

The following example uses Append mode.

```
df = //Create DataFrame from any source


val hive = com.hortonworks.hwc.HiveWarehouseSession.session(spark).build()

df.write.format(HIVE_WAREHOUSE_CONNECTOR)
.mode("append")
.option("table", "my_Table")
.save()
```

ETL example (Scala)

Read table data from Hive, transform it in Spark, and write to a new Hive table.

```
import com.hortonworks.hwc.HiveWarehouseSession
import com.hortonworks.hwc.HiveWarehouseSession._
val hive = HiveWarehouseSession.session(spark).build()
hive.setDatabase("tpcds_bin_partitioned_orc_1000")
val df = hive.sql("select * from web_sales")
df.createOrReplaceTempView("web_sales")
hive.setDatabase("testDatabase")
hive.createTable("newTable")
.ifNotExists()
.column("ws_sold_time_sk", "bigint")
.column("ws_ship_date_sk", "bigint")
.create()
sql("SELECT ws_sold_time_sk, ws_ship_date_sk FROM web_sales WHERE ws_sold_
time_sk > 80000)
.write.format(HIVE_WAREHOUSE_CONNECTOR)
.mode("append")
.option("table", "newTable")
.save()
```

Related Information

HMS storage

Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

Hive Warehouse Connector Interfaces

The HiveWarehouseSession, CreateTableBuilder, and MergeBuilder interfaces present available HWC operations.

HiveWarehouseSession interface

```
package com.hortonworks.hwc;

public interface HiveWarehouseSession {

//Execute Hive SELECT query and return DataFrame (recommended)
Dataset<Row> sql(String sql);
//Execute Hive SELECT query and return DataFrame in JDBC client mode
//Execute Hive catalog-browsing operation and return DataFrame
Dataset<Row> execute(String sql);

//Execute Hive SELECT query and return DataFrame in LLAP mode (not available
 in this release)
Dataset<Row> executeQuery(String sql);
```

```
//Execute Hive update statement
boolean executeUpdate(String sql);

//Reference a Hive table as a DataFrame
Dataset<Row> table(String sql);

//Return the SparkSession attached to this HiveWarehouseSession
SparkSession session();

//Set the current database for unqualified Hive table references
void setDatabase(String name);

/**
* Helpers: wrapper functions over execute or executeUpdate
*/

//Helper for show databases
Dataset<Row> showDatabases();

//Helper for show tables
Dataset<Row> showTables();

//Helper for describeTable
Dataset<Row> describeTable(String table);

//Helper for create database
void createDatabase(String database, boolean ifNotExists);

//Helper for create table stored as ORC
CreateTableBuilder createTable(String tableName);

//Helper for drop database
void dropDatabase(String database, boolean ifExists, boolean cascade);

//Helper for drop table
void dropTable(String table, boolean ifExists, boolean purge);

//Helper for merge query
MergeBuilder mergeBuilder();

//Closes the HWC session. Session cannot be reused after being closed.
void close();

// Closes the transaction started by the direct reader. The transaction is
 not committed if user
// uses rdd APIs.
void commitTxn();
}
```

CreateTableBuilder interface

```
package com.hortonworks.hwc;

public interface CreateTableBuilder {

//Silently skip table creation if table name exists
CreateTableBuilder ifNotExists();

//Add a column with the specific name and Hive type
//Use more than once to add multiple columns
CreateTableBuilder column(String name, String type);
```

```
//Specific a column as table partition
//Use more than once to specify multiple partitions
CreateTableBuilder partition(String name, String type);

//Add a table property
//Use more than once to add multiple properties
CreateTableBuilder prop(String key, String value);

//Make table bucketed, with given number of buckets and bucket columns
CreateTableBuilder clusterBy(long numBuckets, String ... columns);

//Creates ORC table in Hive from builder instance
void create();
}
```

MergeBuilder interface

```
package com.hortonworks.hwc;

public interface MergeBuilder {

//Specify the target table to merge
MergeBuilder mergeInto(tring targetTable, String alias);

//Specify the source table or expression, such as (select * from some_table)
// Enclose expression in braces if specified.
MergeBuilder using(String sourceTableOrExpr, String alias);

//Specify the condition expression for merging
MergeBuilder on(String expr);

//Specify fields to update for rows affected by merge condition and match
Expr
MergeBuilder whenMatchedThenUpdate(String matchExpr, String... nameValuePa
irs);

//Delete rows affected by the merge condition and matchExpr
MergeBuilder whenMatchedThenDelete(String matchExpr);

//Insert rows into target table affected by merge condition and matchExpr
MergeBuilder whenNotMatchedInsert(String matchExpr, String... values);

//Execute the merge operation
void merge();
}
```

Related Information

HMS storage

Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

Submit a Scala or Java application

A step-by-step procedure shows you how to submit an app based on the HiveWarehouseConnector library to run on Apache Spark Shell.

Procedure

1. Choose an execution mode, for example the HWC JDBC execution mode, for your application and check that you meet the configuration requirements, described earlier.

2. Configure a Spark-HiveServer connection, described earlier or, in your app submission include the appropriate --conf in step 4.
3. Locate the hive-warehouse-connector-assembly jar in the /hive_warehouse_connector/ directory.
   For example, find hive-warehouse-connector-assembly-<version>.jar in the following location:

   ```
   /opt/cloudera/parcels/CDH/jars
   ```

4. Add the connector jar and configurations to the app submission using the --jars option.
   Example syntax:

   ```
   spark-shell --jars <path to jars>/hive_warehouse_connector/hive-warehouse-
   connector-assembly-<version>.jar \
   --conf <configuration properties>
   ```

5. Add the path to app you wrote based on the HiveWarehouseConnector API.
   Example syntax:

   ```
    <path to app>
   ```

   For example:

   ```
   spark-shell --jars /opt/cloudera/parcels/CDH/jars/hive-warehouse-connect
   or-assembly-<version>.jar \
   --conf spark.sql.hive.hwc.execution.mode=spark \
   --conf spark.datasource.hive.warehouse.read.via.llap=false \
   --conf spark.datasource.hive.warehouse.load.staging.dir=<path to directory
   > \
   /home/myapps/myapp.jar
   ```

   PySpark and spark-submit are also supported.

Related Information

Configuring Spark Direct Reader mode
Configuring JDBC execution mode
HMS storage
Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

Submit a Python app

A step-by-step procedure shows you how submit a Python app based on the HiveWarehouseConnector library by submitting an application, and then adding a Python package.

Procedure

1. Choose an execution mode, for example the HWC JDBC execution mode, for your application and check that you meet the configuration requirements, described earlier.
2. Configure a Spark-HiveServer connection, described earlier or, in your app submission include the appropriate --conf in step 4.
3. Locate the hive-warehouse-connector-assembly jar in the /hive_warehouse_connector/ directory.
   For example, find hive-warehouse-connector-assembly-<version>.jar in the following location:

   ```
   /opt/cloudera/parcels/CDH/jars
   ```

4. Add the connector jar and configurations to the app submission using the --jars option.
   Example syntax:

```
pyspark --jars <path to jars>/hive_warehouse_connector/hive-warehouse-co
nnector-assembly-<version>.jar \
--conf <configuration properties>
```

5. Locate the pyspark_hwc zip package in the /hive_warehouse_connector/ directory.
6. Add the Python package for the connector to the app submission.
   Example syntax:

```
--py-files <path>/hive_warehouse_connector/pyspark_hwc-<version>.zip
```

   Example submission in JDBC execution mode:

```
pyspark --jars /opt/cloudera/parcels/CDH/jars/hive-warehouse-connector-a
ssembly-<version>.jar \
--conf spark.sql.hive.hwc.execution.mode=spark \
--conf spark.datasource.hive.warehouse.read.via.llap=false \
--conf spark.datasource.hive.warehouse.load.staging.dir=<path to directory
> \
--py-files /opt/cloudera/parcels/CDH/lib/hive_warehouse_connector/pyspar
k_hwc-<version>.zip
```

Related Information

Configuring Spark Direct Reader mode
Configuring JDBC execution mode
HMS storage
Blog: Enabling high-speed Spark direct reader for Apache Hive ACID tables

Apache Hive-Kafka integration

As an Apache Hive user, you can connect to, analyze, and transform data in Apache Kafka from Hive. You can offload data from Kafka to the Hive warehouse. Using Hive-Kafka integration, you can perform actions on real-time data and incorporate streamed data into your application.

You connect to Kafka data from Hive by creating an external table that maps to a Kafka topic. The table definition includes a reference to a Kafka storage handler that connects to Kafka. On the external table, Hive-Kafka integration supports ad hoc queries, such as questions about data changes in the stream over a period of time. You can transform Kafka data in the following ways:

- Perform data masking
- Join dimension tables or any stream
- Aggregate data
- Change the SerDe encoding of the original stream
- Create a persistent stream in a Kafka topic

You can achieve data offloading by controlling its position in the stream. The Hive-Kafka connector supports the following serialization and deserialization formats:

- JsonSerDe (default)
- OpenCSVSerde
- AvroSerDe

Related Information

Apache Kafka Documentation

Create a table for a Kafka stream

You can create an external table in Apache Hive that represents an Apache Kafka stream to query real-time data in Kafka. You use a storage handler and table properties that map the Hive database to a Kafka topic and broker. If the Kafka data is not in JSON format, you alter the table to specify a serializer-deserializer for another format.

Procedure

1. Get the name of the Kafka topic you want to query to use as a table property.
   For example: "kafka.topic" = "wiki-hive-topic"
2. Construct the Kafka broker connection string.
   For example: "kafka.bootstrap.servers"="kafka.hostname.com:9092"
3. Create an external table named kafka_table by using 'org.apache.hadoop.hive.kafka.KafkaStorageHandler', as shown in the following example:

```
CREATE EXTERNAL TABLE kafka_table
  (`timestamp` timestamp , `page` string,  `newPage` boolean,
  added int, deleted bigint, delta double)
  STORED BY 'org.apache.hadoop.hive.kafka.KafkaStorageHandler'
  TBLPROPERTIES
  ("kafka.topic" = "test-topic", "kafka.bootstrap.servers"="node2:9092");
```

4. If the default JSON serializer-deserializer is incompatible with your data, choose another format in one of the following ways:
   - Alter the table to use another supported serializer-deserializer. For example, if your data is in Avro format, use the Kafka serializer-deserializer for Avro:

     ```
     ALTER TABLE kafka_table SET TBLPROPERTIES ("kafka.serde.class"="org.apac
     he.hadoop.hive.serde2.avro.AvroSerDe");
     ```

   - Create an external table that specifies the table in another format. For example, create a table named that specifies the Avro format in the table definition:

     ```
     CREATE EXTERNAL TABLE kafka_t_avro
        (`timestamp` timestamp , `page` string,  `newPage` boolean,
        added int, deleted bigint, delta double)
        STORED BY 'org.apache.hadoop.hive.kafka.KafkaStorageHandler'
        TBLPROPERTIES
        ("kafka.topic" = "test-topic",
        "kafka.bootstrap.servers"="node2:9092"
        -- STORE AS AVRO IN KAFKA
        "kafka.serde.class"="org.apache.hadoop.hive.serde2.avro.AvroSerDe");
     ```

Related Information

Apache Kafka Documentation

Querying Kafka data

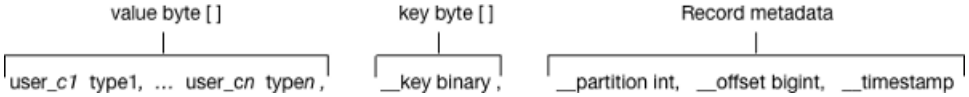
You can get useful information, including Kafka record metadata from a table of Kafka data by using typical Hive queries.

Each Kafka record consists of a user payload key (byte []) and value (byte[]), plus the following metadata fields:

- Partition int32
- Offset int64
- Timestamp int64

The Hive row represents the dual composition of Kafka data:

- The user payload serialized in the value byte array
- The metadata: key byte array, partition, offset, and timestamp fields



In the Hive representation of the Kafka record, the key byte array is called __key and is of type binary. You can cast __key at query time. Hive appends __key to the last column derived from value byte array, and appends the partition, offset, and timestamp to __key columns that are named accordingly.

Related Information

Apache Kafka Documentation

Query live data from Kafka

You can get useful information from a table of Kafka data by running typical queries, such as counting the number of records streamed within an interval of time or defining a view of streamed data over a period of time.

Before you begin

This task requires Kafka 0.11 or later to support time-based lookups and prevent full stream scans.

About this task

This task assumes you created a table named kafka_table for a Kafka stream.

Procedure

1. List the table properties and all the partition or offset information for the topic.
   DESCRIBE EXTENDED kafka_table;
2. Count the number of Kafka records that have timestamps within the past 10 minutes.

   ```
   SELECT COUNT(*) FROM kafka_table
     WHERE `__timestamp` >  1000 * to_unix_timestamp(CURRENT_TIMESTAMP - inte
   rval '10' MINUTES);
   ```

   Such a time-based seek requires Kafka 0.11 or later, which has a Kafka broker that supports time-based lookups; otherwise, this query leads to a full stream scan.
3. Define a view of data consumed within the past 15 minutes and mask specific columns.

   ```
   CREATE VIEW last_15_minutes_of_kafka_table AS SELECT  `timestamp`, `user`,
    delta,
     ADDED FROM kafka_table
     WHERE `__timestamp` >  1000 * to_unix_timestamp(CURRENT_TIMESTAMP - i
   nterval '15' MINUTES) ;
   ```
4. Create a dimension table.

   ```
   CREATE TABLE user_table (`user` string, `first_name` string , age int, g
   ender string, comments string) STORED as ORC ;
   ```
5. Join the view of the stream over the past 15 minutes to user_table, group by gender, and compute aggregates over metrics from fact table and dimension tables.

   ```
   SELECT SUM(added) AS added, SUM(deleted) AS deleted, AVG(delta) AS delta,
    AVG(age) AS avg_age , gender
     FROM last_15_minutes_of_kafka_table
     JOIN user_table ON `last_15_minutes_of_kafka_table`.`user` = `user_tab
   le`.`user`
   ```

```
  GROUP BY gender LIMIT 10;
```

6. Perform a classical user retention analysis over the Kafka stream consisting of a stream-to-stream join that runs adhoc queries on a view defined over the past 15 minutes.

```
-- Stream join over the view itself
-- Assuming l15min_wiki is a view of the last 15 minutes
SELECT  COUNT( DISTINCT activity.`user`) AS active_users,
COUNT(DISTINCT future_activity.`user`) AS retained_users
FROM l15min_wiki AS activity
LEFT JOIN l15min_wiki AS future_activity ON activity.`user` = future_activ
ity.`user`
AND activity.`timestamp` = future_activity.`timestamp` - interval '5' min
utes ;

--  Stream-to-stream join
-- Assuming wiki_kafka_hive is the entire stream.
SELECT floor_hour(activity.`timestamp`), COUNT( DISTINCT activity.`user`)
 AS active_users,
COUNT(DISTINCT future_activity.`user`) as retained_users
FROM wiki_kafka_hive AS activity
LEFT JOIN wiki_kafka_hive AS future_activity ON activity.`user` = future_
activity.`user`
AND activity.`timestamp` = future_activity.`timestamp` - interval '1' ho
ur
GROUP BY floor_hour(activity.`timestamp`);
```

Related Information

Apache Kafka Documentation

Perform ETL by ingesting data from Kafka into Hive

You can extract, transform, and load a Kafka record into Hive in a single transaction.

Procedure

1. Create a table to represent source Kafka record offsets.

```
CREATE TABLE kafka_table_offsets(partition_id int, max_offset bigint, in
sert_time timestamp);
```

2. Initialize the table.

```
INSERT OVERWRITE TABLE kafka_table_offsets
SELECT `__partition`, min(`__offset`) - 1, CURRENT_TIMESTAMP
FROM wiki_kafka_hive
GROUP BY `__partition`, CURRENT_TIMESTAMP;
```

3. Create the destination table.

```
CREATE TABLE orc_kafka_table (partition_id int, koffset bigint, ktimestamp
 bigint,
  `timestamp` timestamp , `page` string, `user` string, `diffurl` string,
  `isrobot` boolean, added int, deleted int, delta bigint
) STORED AS ORC;
```

4. Insert Kafka data into the ORC table.

```
FROM wiki_kafka_hive ktable JOIN kafka_table_offsets offset_table
ON (ktable.`__partition` = offset_table.partition_id
AND ktable.`__offset` > offset_table.max_offset )
```

```
INSERT INTO TABLE orc_kafka_table
SELECT `__partition`, `__offset`, `__timestamp`,
  `timestamp`, `page`, `user`, `diffurl`, `isrobot`, added , deleted , del
ta
INSERT OVERWRITE TABLE kafka_table_offsets
SELECT `__partition`, max(`__offset`), CURRENT_TIMESTAMP
GROUP BY `__partition`, CURRENT_TIMESTAMP;
```

5. Check the insertion.

```
SELECT MAX(`koffset`) FROM orc_kafka_table LIMIT 10;

SELECT COUNT(*) AS c FROM orc_kafka_table
GROUP BY partition_id, koffset HAVING c > 1;
```

6. Repeat step 4 periodically until all the data is loaded into Hive.

Writing data to Kafka

You can extract, transform, and load a Hive table to a Kafka topic for real-time streaming of a large volume of Hive data. You need some understanding of write semantics and the metadata columns required for writing data to Kafka.

Write semantics

The Hive-Kafka connector supports the following write semantics:

- At least once (default)
- Exactly once

At least once (default)

The default semantic. At least once is the most common write semantic used by streaming engines. The internal Kafka producer retries on errors. If a message is not delivered, the exception is raised to the task level, which causes a restart, and more retries. The At least once semantic leads to one of the following conclusions:

- If the job succeeds, each record is guaranteed to be delivered at least once.
- If the job fails, some of the records might be lost and some might not be sent.

  In this case, you can retry the query, which eventually leads to the delivery of each record at least once.

Exactly once

Following the exactly once semantic, the Hive job ensures that either every record is delivered exactly once, or nothing is delivered. You can use only Kafka brokers supporting the Transaction API (0.11.0.x or later). To use this semantic, you must set the table property "kafka.write.semanti c"="EXACTLY_ONCE".

Metadata columns

In addition to the user row payload, the insert statement must include values for the following extra columns:

__key

Although you can set the value of this metadata column to null, using a meaningful key value to avoid unbalanced partitions is recommended. Any binary value is valid.

__partition

Use null unless you want to route the record to a particular partition. Using a nonexistent partition value results in an error.

__offset

You cannot set this value, which is fixed at -1.

__timestamp

You can set this value to a meaningful timestamp, represented as the number of milliseconds since epoch. Optionally, you can set this value to null or -1, which means that the Kafka broker strategy sets the timestamp column.

Related Information

Apache Kafka Documentation

Write transformed Hive data to Kafka

You can change streaming data and include the changes in a stream. You extract a Kafka input topic, transform the record in Hive, and load a Hive table back into a Kafka record.

About this task

This task assumes that you already queried live data from Kafka. When you transform the record in the Hive execution engine, you compute a moving average over a window of one minute. The resulting record that you write back to another Kafka topic is named moving_avg_wiki_kafka_hive.

.

Procedure

1. Create an external table to represent the Hive data that you want to load into Kafka.

```
CREATE EXTERNAL TABLE moving_avg_wiki_kafka_hive
(`channel` string, `namespace` string,`page` string, `timestamp` timestamp
 , avg_delta double )
STORED BY 'org.apache.hadoop.hive.kafka.KafkaStorageHandler'
TBLPROPERTIES
  ("kafka.topic" = "moving_avg_wiki_kafka_hive",
  "kafka.bootstrap.servers"="kafka.hostname.com:9092",
  -- STORE AS AVRO IN KAFKA
  "kafka.serde.class"="org.apache.hadoop.hive.serde2.avro.AvroSerDe");
```

2. Insert data that you select from the Kafka topic back into the Kafka record.

```
INSERT INTO TABLE moving_avg_wiki_kafka_hive
SELECT `channel`, `namespace`, `page`, `timestamp`,
  AVG(delta) OVER (ORDER BY `timestamp` ASC ROWS BETWEEN  60 PRECEDING AND
 CURRENT ROW) AS avg_delta,
  null AS `__key`, null AS `__partition`, -1 AS `__offset`, to_epoch_milli
(CURRENT_TIMESTAMP) AS `__timestamp`
FROM l15min_wiki;
```

The timestamps of the selected data are converted to milliseconds since epoch for clarity.

Related Information

Query live data from Kafka

Set consumer and producer properties as table properties

You can use Kafka consumer and producer properties in the TBLPROPERTIES clause of a Hive query. By prefixing the key with kafka.consumer or kafka.producer, you can set the table properties.

Procedure

For example, if you want to inject 5000 poll records into the Kafka consumer, use the following syntax.

```
ALTER TABLE kafka_table SET TBLPROPERTIES ("kafka.consumer.max.poll.records"
="5000");
```

Kafka storage handler and table properties

You use the Kafka storage handler and table properties to specify the query connection and configuration.

Kafka storage handler

You specify 'org.apache.hadoop.hive.kafka.KafkaStorageHandler' in queries to connect to, and transform a Kafka topic into, a Hive table. In the definition of an external table, the storage handler creates a view over a single Kafka topic. For example, to use the storage handler to connect to a topic, the following table definition specifies the storage handler and required table properties: the topic name and broker connection string.

```
CREATE EXTERNAL TABLE kafka_table
   (`timestamp` timestamp , `page` string,  `newPage` boolean,
   added int, deleted bigint, delta double)
   STORED BY 'org.apache.hadoop.hive.kafka.KafkaStorageHandler'
   TBLPROPERTIES
   ("kafka.topic" = "test-topic", "kafka.bootstrap.servers"="localhost:90
92");
```

You set the following table properties forwith the Kafka storage handler:

kafka.topic

The Kafka topic to connect to

kafka.bootstrap.servers

The broker connection string

Storage handler-based optimizations

The storage handler can optimize reads using a filter push-down when you run a query such as the following time-based lookup supported on Kafka 0.11 or later:

```
SELECT COUNT(*) FROM kafka_table
   WHERE `__timestamp` >  1000 * to_unix_timestamp(CURRENT_TIMESTAMP - int
erval '10' MINUTES) ;
```

The Kafka consumer supports seeking on the stream based on an offset, which the storage handler leverages to push down filters over metadata columns. The storage handler in the example above performs seeks based on the Kafka record __timestamp to read only recently arrived data.

The following logical operators and predicate operators are supported in the WHERE clause:

Logical operators: OR, AND

Predicate operators: <, <=, >=, >, =

The storage handler reader optimizes seeks by performing partition pruning to go directly to a particular partition offset used in the WHERE clause:

```
SELECT COUNT(*)  FROM kafka_table
  WHERE (`__offset` < 10 AND `__offset` > 3 AND `__partition` = 0)
  OR (`__partition` = 0 AND `__offset` < 105 AND `__offset` > 99)
  OR (`__offset` = 109);
```

The storage handler scans partition 0 only, and then read only records between offset 4 and 109.

Kafka metadata

In addition to the user-defined payload schema, the Kafka storage handler appends to the table some additional columns, which you can use to query the Kafka metadata fields:

__key

Kafka record key (byte array)

__partition

Kafka record partition identifier (int 32)

__offset

Kafka record offset (int 64)

__timestamp

Kafka record timestamp (int 64)

The partition identifier, record offset, and record timestamp plus a key-value pair constitute a Kafka record. Because the key-value is a 2-byte array, you must use SerDe classes to transform the array into a set of columns.

Table Properties

You use certain properties in the TBLPROPERTIES clause of a Hive query that specifies the Kafka storage handler.

Property	Description	Required	Default
kafka.topic	Kafka topic name to map the table to	Yes	null
kafka.bootstrap.servers	Table property indicating the Kafka broker connection string	Yes	null
kafka.serde.class	Serializer and Deserializer class implementation	No	org.apache.hadoop.hive.serde2.JsonSerDe
hive.kafka.poll.timeout.ms	Parameter indicating Kafka Consumer poll timeout period in milliseconds. (This is independent of internal Kafka consumer timeouts.)	No	5000 (5 Seconds)
hive.kafka.max.retries	Number of retries for Kafka metadata fetch operations	No	6
hive.kafka.metadata.poll.timeout.ms	Number of milliseconds before consumer timeout on fetching Kafka metadata	No	30000 (30 Seconds)
kafka.write.semantic	Writer semantic with allowed values of NONE, AT_LEAST_ONCE, EXACTLY_ONCE	No	AT_LEAST_ONCE

Connecting Hive to BI tools using a JDBC/ODBC driver

To query, analyze, and visualize data stored within the CDP Private Cloud Base using drivers provided by Cloudera, you connect Apache Hive to Business Intelligence (BI) tools.

About this task

How you connect to Hive depends on a number of factors: the location of Hive inside or outside the cluster, the HiveServer deployment, the type of transport, transport-layer security, and authentication. HiveServer is the server

interface that enables remote clients to execute queries against Hive and retrieve the results using a JDBC or ODBC connection.

Before you begin

- Choose a Hive authorization model.
- Configure authenticated users for querying Hive through JDBC or ODBC driver. For example, set up a Ranger policy.

Getting the JDBC driver

You learn how to download the Cloudera Hive and Impala JDBC drivers to give clients outside the cluster access to your SQL engines.

Procedure

1. Download the lastest Hive JDBC driver for CDP from the Hive JDBC driver download page.
2. Go to the Impala JDBC driver page, and download the latest Impala JDBC driver.
3. Follow JDBC driver installation instructions on the download page.

Integrating Hive and a BI tool

After you download a Cloudera ODBC or JDBC driver, you need to provide the information to your client that the BI tool requires to connect to Hive in CDP.

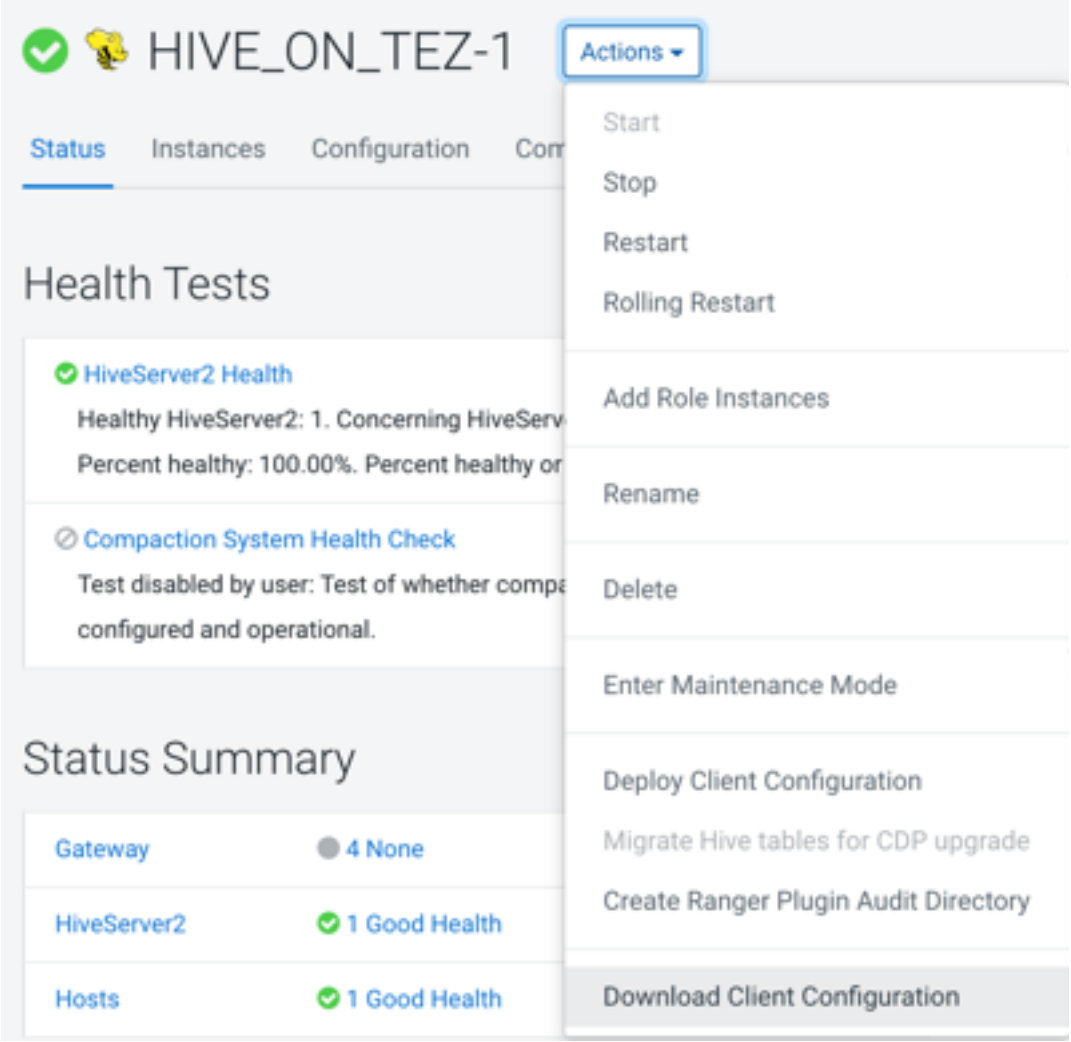
Before you begin

You have downloaded, or otherwise put, the JDBC or ODBC driver on your HiveServer cluster.

Procedure

1. Depending on the type of driver you obtain, proceed as follows:
   - ODBC driver: follow instructions on the ODBC driver download site, and skip the rest of the steps in this procedure.
   - JDBC driver: add the driver to the classpath of your JDBC client, such as Tableau. For example, check the client documentation about where to put the driver.
2. In Cloudera Manager (CM), click Clusters Hive on Tez to go to the Hive on Tez service page.

3. From the Hive on Tez service page, click Actions and select Download Client Configuration.



4. Unpack hive_on_tez-clientconfig.zip, open the beeline-site.xml file, and copy the value of beeline.hs2.jdbc.url.hive_on_tez. This value is the JDBC URL.
For example

```
jdbc:hive2://my_hiveserver.com:2181/;serviceDiscoveryMode=zooKeeper; \
zooKeeperNamespace=hiveserver2
```

5. In the BI tool, such as Tableau, configure the JDBC connection using the JDBC URL and driver class name, com.cloudera.hive.jdbc.HS2Driver.

Specify the JDBC connection string

You construct a JDBC URL to connect Hive to a BI tool.

About this task

In CDP Private Cloud Base, if HiveServer runs within the Hive client (embedded mode), not as a separate process, the URL in the connection string does not need a host or port number to make the JDBC connection. If HiveServer does not run within your Hive client, the URL must include a host and port number because HiveServer runs as a separate process on the host and port you specify. The JDBC client and HiveServer interact using remote procedure calls using the Thrift protocol. If HiveServer is configured in remote mode, the JDBC client and HiveServer can use either HTTP or TCP-based transport to exchange RPC messages.

Procedure

1. Create a minimal JDBC connection string for connecting Hive to a BI tool.
   - Embedded mode: Create the JDBC connection string for connecting to Hive in embedded mode.
   - Remote mode: Create a JDBC connection string for making an unauthenticated connection to the Hive default database on the localhost port 10000.

   Embedded mode: "jdbc:hive://"
   Remote mode: "jdbc:hive://myserver:10000/default", "", "");
2. Modify the connection string to change the transport mode from TCP (the default) to HTTP using the transpor tMode and httpPath session configuration variables.
   jdbc:hive2://myserver:10000/default;transportMode=http;httpPath=myendpoint.com;

   You need to specify httpPath when using the HTTP transport mode. <http_endpoint> has a corresponding HTTP endpoint configured in hive-site.xml.
3. Add parameters to the connection string for Kerberos authentication.
   jdbc:hive2://myserver:10000/default;principal=prin.dom.com@APRINCIPAL.DOM.COM

JDBC connection string syntax

The JDBC connection string for connecting to a remote Hive client requires a host, port, and Hive database name. You can optionally specify a transport type and authentication.

jdbc:hive2://<host>:<port>/<dbName>;<sessionConfs>?<hiveConfs>#<hiveVars>

Connection string parameters

The following table describes the parameters for specifying the JDBC connection.

JDBC Parameter	Description	Required
host	The cluster node hosting HiveServer.	yes
port	The port number to which HiveServer listens.	yes
dbName	The name of the Hive database to run the query against.	yes
sessionConfs	Optional configuration parameters for the JDBC/ODBC driver in the following format: <key1>=<value1>;<key2>=<key2>...;	no
hiveConfs	Optional configuration parameters for Hive on the server in the following format: <key1>=<value1>;<key2>=<key2>; ... The configurations last for the duration of the user session.	no
hiveVars	Optional configuration parameters for Hive variables in the following format: <key1>=<value1>;<key2>=<key2>; ... The configurations last for the duration of the user session.	no

TCP and HTTP Transport

The following table shows variables for use in the connection string when you configure HiveServer. The JDBC client and HiveServer can use either HTTP or TCP-based transport to exchange RPC messages. Because the default transport is TCP, there is no need to specify transportMode=binary if TCP transport is desired.

transportMode Variable Value	Description
http	Connect to HiveServer2 using HTTP transport.
binary	Connect to HiveServer2 using TCP transport.

The syntax for using these parameters is:

```
jdbc:hive2://<host>:<port>/<dbName>;transportMode=http;httpPath=<http_endpoi
nt>; \
  <otherSessionConfs>?<hiveConfs>#<hiveVars>
```

User Authentication

If configured in remote mode, HiveServer supports Kerberos, LDAP, Pluggable Authentication Modules (PAM), and custom plugins for authenticating the JDBC user connecting to HiveServer. The format of the JDBC connection URL for authentication with Kerberos differs from the format for other authentication models. The following table shows the variables for Kerberos authentication.

User Authentication Variable	Description
principal	A string that uniquely identifies a Kerberos user.
saslQop	Quality of protection for the SASL framework. The level of quality is negotiated between the client and server during authentication. Used by Kerberos authentication with TCP transport.
user	Username for non-Kerberos authentication model.
password	Password for non-Kerberos authentication model.

The syntax for using these parameters is:

```
jdbc:hive://<host>:<port>/<dbName>;principal=<HiveServer2_kerberos_principal
>;<otherSessionConfs>?<hiveConfs>#<hiveVars>
```

Transport Layer Security

HiveServer2 supports SSL and Sasl QOP for transport-layer security. The format of the JDBC connection string for SSL uses these variables:

SSL Variable	Description
ssl	Specifies whether to use SSL
sslTrustStore	The path to the SSL TrustStore.
trustStorePassword	The password to the SSL TrustStore.

The syntax for using the authentication parameters is:

```
jdbc:hive2://<host>:<port>/<dbName>; \
ssl=true;sslTrustStore=<ssl_truststore_path>;trustStorePassword=<truststo
re_password>; \
<otherSessionConfs>?<hiveConfs>#<hiveVars>
```

When using TCP for transport and Kerberos for security, HiveServer2 uses Sasl QOP for encryption rather than SSL.

Sasl QOP Variable	Description
principal	A string that uniquely identifies a Kerberos user.

saslQop	The level of protection desired. For authentication, checksum, and encryption, specify auth-conf. The other valid values do not provide encryption.

The JDBC connection string for Sasl QOP uses these variables.

```
jdbc:hive2://FQDN.EXAMPLE.COM:10000/default;principal=hive/_H
OST@EXAMPLE.COM;saslQop=auth-conf
```

The _HOST is a wildcard placeholder that gets automatically replaced with the fully qualified domain name (FQDN) of the server running the HiveServer daemon process.

Using JdbcStorageHandler to query RDBMS

Using the JdbcStorageHandler, you can connect Hive to a MySQL, PostgreSQL, Oracle, DB2, or Derby data source. You can then create an external table to represent the data, and query the table.

About this task

This task assumes you are a CDP Private Cloud Base user. You create an external table that uses the JdbcStorageHandler to connect to and read a local JDBC data source.

Procedure

1. Load data into a supported SQL database, such as MySQL, on a node in your cluster, or familiarize yourself with existing data in the your database.
2. Create an external table using the JdbcStorageHandler and table properties that specify the minimum information: database type, driver, database connection string, user name and password for querying hive, table name, and number of active connections to Hive.

```
CREATE EXTERNAL TABLE mytable_jdbc(
  col1 string,
  col2 int,
  col3 double
)
STORED BY 'org.apache.hive.storage.jdbc.JdbcStorageHandler'
TBLPROPERTIES (
  "hive.sql.database.type" = "MYSQL",
  "hive.sql.jdbc.driver" = "com.mysql.jdbc.Driver",
  "hive.sql.jdbc.url" = "jdbc:mysql://localhost/sample",
  "hive.sql.dbcp.username" = "hive",
  "hive.sql.dbcp.password" = "hive",
  "hive.sql.table" = "MYTABLE",
  "hive.sql.dbcp.maxActive" = "1"
);
```

3. Query the external table.

```
SELECT * FROM mytable_jdbc WHERE col2 = 19;
```

Set up JDBCStorageHandler for Postgres

If you use Enterprise PostgreSQL as the backend HMS database, you need to put the JDBCStorageHandler JAR in a central place.

About this task

The Postgres Enterprise server comes with its own JDBC driver. The driver file is installed in the Hive lib directory. When you execute a query as a YARN application, the Class not found exception is thrown on worker nodes. The YARN container cannot include the jar file in the classpath unless you place the JAR in a central location.

Place the JAR in aux jars or provide the path to aux jars.

Procedure

1. In CDP Private Cloud Base, click Cloudera Manager Clusters and select the Hive service, for example, HIVE.
2. Click Configuration and search for Hive Auxiliary JARs Directory.
3. Specify a directory value for the Hive Aux JARs property if necessary, or make a note of the path.
4. Upload the JAR to the specified directory on all HiveServer instances.