Data Access 3

Integrating Apache Hive with Kafka, Spark, and BI

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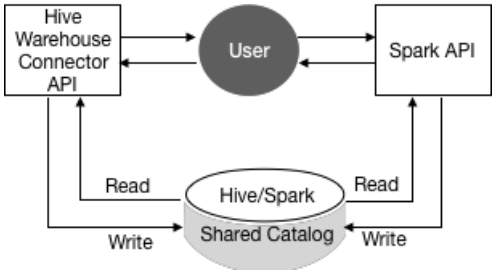
Contents

Hive Warehouse Connector for accessing Apache Spark data

The Hive Warehouse Connector (HWC) is a Spark library/plugin that is launched with the Spark app. You use the Hive Warehouse Connector API to access any managed Hive table from Spark. You must use low-latency analytical processing (LLAP) in HiveServer Interactive to read ACID, or other Hive-managed tables, from Spark.

In HDP 3.1.5 and later, Spark and Hive share a catalog in Hive metastore (HMS) instead of using separate catalogs, which was the case in HDP 3.1.4 and earlier.



The shared catalog simplifies use of HWC. To read the Hive external table from Spark, you no longer need to define the table redundantly in the Spark catalog. Also, HDP 3.1.5 introduces HMS table transformations. HMS detects the type of client for interacting with HMS, for example Hive or Spark, and compares the capabilities of the client with the table requirement. A resulting action occurs that makes sense given the client capabilities and other factors. See link below.

The default table type created from Spark using HWC has changed to external. The external.table.purge property is set to true, so external table behavior is like HDP 2.x managed tables with regard to the drop statement, which now drops the table data, not just the schema.

When you use SparkSQL, standard Spark APIs access tables in the Spark catalog.

You use low-latency analytical processing (LLAP) in HiveServer Interactive to read ACID, or other Hive-managed tables, from Spark is recommended. You do not need LLAP to write to ACID, or other managed tables, from Spark. You do not need HWC to access external tables from Spark.

Using the HWC, you can read and write Apache Spark DataFrames and Streaming DataFrames. Apache Ranger and the HiveWarehouseConnector library provide row and column, fine-grained access to the data.

Limitations

- From HWC, writes are supported for ORC tables only.
- Table stats are not generated when you write a DataFrame to Hive.
- The spark thrift server is 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.HiveWarehouseConnector").mode("
 "t1").save
```

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 for ORC-formatted data
- Selecting Hive data and retrieving a DataFrame
- Writing a DataFrame to Hive in batch
- Executing a Hive update statement
- Reading Hive table data, transforming it in Spark, and writing it to a new Hive table
- Writing a DataFrame or Spark stream to Hive using HiveStreaming

Related Information

HiveWarehouseConnector Github project
HiveWarehouseConnector for handling Apache Spark data
HMS table storage
Community Connection: Integrating Apache Hive with Apache Spark--Hive Warehouse Connector

Apache Spark-Apache Hive connection configuration

You need to understand the workflow and service changes involved in accessing ACID table data from Spark. You can configure Spark properties in Ambari for using the Hive Warehouse Connector.

Prerequisites

The Hive connection string must include a user name and password; otherwise, Spark and Hive cannot connect. For example:

```
jdbc:hive2://
<host>:2181;serviceDiscoveryMode=zooKeeper;zooKeeperNamespace=hiveserver2-
interactive;user=<user name>;password=<password>
```

You need to use the following software to connect Spark and Hive using the HiveWarehouseConnector library.

- HDP 3.15
- Spark2
- Hive with HiveServer Interactive (HSI)

  The Hive Warehouse Connector (HWC) and low-latency analytical processing (LLAP) are required for certain tasks, as shown in the following table:

  Table 1: Spark Compatibility

Tasks	HWC Required	LLAP Required	Other Requirement/Comments
Read Hive managed tables from Spark	Yes	Yes	Ranger ACLs enforced.*
Write Hive managed tables from Spark	Yes	No	Ranger ACLs enforced.* Supports ORC only.
Read Hive external tables from Spark	No	Only if HWC is used	Ranger ACLs not enforced.
Write Hive external tables from Spark	No	No	Ranger ACLs enforced.

  * Ranger column level security or column masking is supported for each access pattern when you use HWC.

You need low-latency analytical processing (LLAP) in HSI to read ACID, or other Hive-managed tables, from Spark. You do not need LLAP to write to ACID, or other managed tables, from Spark. The HWC library internally uses the Hive Streaming API and LOAD DATA Hive commands to write the data. You do not need LLAP to access external tables from Spark with caveats shown in the table above.

Required properties

You must add several Spark properties through spark-2-defaults in Ambari to use the Hive Warehouse Connector for accessing data in Hive. Alternatively, configuration can be provided for each job using --conf.

- spark.sql.hive.hiveserver2.jdbc.url

  The URL for HiveServer2 Interactive
- spark.datasource.hive.warehouse.metastoreUri

  The URI for the metastore
- spark.datasource.hive.warehouse.load.staging.dir

  The HDFS temp directory for batch writes to Hive, /tmp for example
- spark.hadoop.hive.llap.daemon.service.hosts

  The application name for LLAP service
- spark.hadoop.hive.zookeeper.quorum

  The ZooKeeper hosts used by LLAP

Set the values of these properties as follows:

- spark.sql.hive.hiveserver2.jdbc.url

  In Ambari, copy the value from Services > Hive > Summary > HIVESERVER2 INTERACTIVE JDBC URL.
- spark.datasource.hive.warehouse.metastoreUri

  Copy the value from hive.metastore.uris. In Hive, at the hive> prompt, enter set hive.metastore.uris and copy the output. For example, thrift://mycluster-1.com:9083.
- spark.hadoop.hive.llap.daemon.service.hosts

  Copy value from Advanced hive-interactive-site > hive.llap.daemon.service.hosts.
- spark.hadoop.hive.zookeeper.quorum

  Copy the value from Advanced hive-site > hive.zookeeper.quorum.

Optional HWC properties

Optionally, you can set the following properties:

- spark.datasource.hive.warehouse.write.path.strictColumnNamesMapping Validates the mapping of columns against those in Hive to alert the user to input errors. Default = true.
- spark.sql.hive.conf.list Propagates one or more configuration properties from the HWC to Hive. Set properties on the command line using the --conf option. For example:

```
--conf
 spark.sql.hive.conf.list="hive.vectorized.execution.filesink.arrow.native.enabled=tr
```

Do not attempt to set spark.sql.hive.conf.list programmatically.

Spark on a Kerberized YARN cluster

In Spark client mode on a kerberized Yarn cluster, set the following property:
spark.sql.hive.hiveserver2.jdbc.url.principal

This property must be equal to hive.server2.authentication.kerberos.principal. In Ambari, copy the value for this property from hive.server2.authentication.kerberos.principal in **Services** > **Hive** > **Configs** > **Advanced** > **Advanced hive-site** .

Related Information

HiveWarehouseConnector Github project

HiveWarehouseConnector for handling Apache Spark data

HMS table storage

Zeppelin configuration for using the Hive Warehouse Connector

You can use the Hive Warehouse Connector in Zeppelin notebooks using the spark2 interpreter by modifying or adding properties to your spark2 interpreter settings.

Interpreter properties

- spark.jars

  /usr/hdp/current/hive_warehouse_connector/hive-warehouse-connector-assembly-<version>.jar
- spark.submit.pyFiles

  /usr/hdp/current/hive_warehouse_connector/pyspark_hwc-<version>.zip
- spark.hadoop.hive.llap.daemon.service.hosts

  App name for LLAP service. In Ambari, copy the value from **Services** > **Hive** > **Configs** > **Advanced hive-interactive-site** > **hive.llap.daemon.service.hosts**.
- spark.sql.hive.hiveserver2.jdbc.url

  URL for HiveServer2 Interactive. In Ambari, copy the value from **Services** > **Hive** > **Summary** > **HIVESERVER2 INTERACTIVE JDBC URL**.
- spark.yarn.security.credentials.hiveserver2.enabled

  Only enable for kerberized cluster-mode.
- spark.sql.hive.hiveserver2.jdbc.url.principal

  Kerberos principal for HiveServer2 Interactive. In Ambari, copy the value from Advanced hive-site > hive.server2.authentication.kerberos.principal.
- spark.hadoop.hive.zookeeper.quorum

  ZooKeeper hosts used by LLAP. In Ambari, copy the value from **Services** > **Hive** > **Configs** > **Advanced hive-site** > **hive.zookeeper.quorum**.

Submit a Hive Warehouse Connector Scala or Java application

You can submit an app based on the HiveWarehouseConnector library to run on Spark Shell, PySpark, and spark-submit.

Procedure

1. Locate the hive-warehouse-connector-assembly jar in /usr/hdp/current/hive_warehouse_connector/.
2. Add the connector jar to the app submission using --jars.

```
spark-shell --jars /usr/hdp/current/hive_warehouse_connector/hive-
warehouse-connector-assembly-<version>.jar
```

Related Information

HiveWarehouseConnector Github project

HiveWarehouseConnector for handling Apache Spark data
HMS table storage

Submit a Hive Warehouse Connector Python app

You can submit a Python app based on the HiveWarehouseConnector library by following the steps to submit a Scala or Java application, and then adding a Python package.

Procedure

1. Locate the hive-warehouse-connector-assembly jar in /usr/hdp/current/hive_warehouse_connector/.
2. Add the connector jar to the app submission using --jars.

```
spark-shell --jars /usr/hdp/current/hive_warehouse_connector/hive-
warehouse-connector-assembly-<version>.jar
```

3. Locate the pyspark_hwc zip package in /usr/hdp/current/hive_warehouse_connector/.
4. Add the Python package to app submission:

```
spark-shell --jars /usr/hdp/current/hive_warehouse_connector/hive-
warehouse-connector-assembly-1.0.0.jar
```

5. Add the Python package for the connector to the app submission.

```
pyspark --jars /usr/hdp/current/hive_warehouse_connector/hive-
warehouse-connector-assembly-<version>.jar --py-files /usr/hdp/current/
hive_warehouse_connector/pyspark_hwc-<version>.zip
```

Related Information

HiveWarehouseConnector Github project
HiveWarehouseConnector for handling Apache Spark data
HMS table storage

Hive Warehouse Connector supported types

The Hive Warehouse Connector maps most Apache Hive types to Apache Spark types and vice versa, but there are a few exceptions that you must manage.

Spark-Hive supported types mapping

The following types are supported for access through 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

Spark Type	Hive Type
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 to be in UTC time. 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. This is 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

HiveWarehouseConnector Github project
HiveWarehouseConnector for handling Apache Spark data
HMS table storage

HiveWarehouseSession API operations

As a Spark developer, you execute queries to Hive using the JDBC-style HiveWarehouseSession API that supports Scala, Java, and Python. In Spark source code, you create an instance of HiveWarehouseSession. Results are returned as a DataFrame to Spark.

Import statements and variables

The following string constants are defined by the API:

- HIVE_WAREHOUSE_CONNECTOR
- DATAFRAME_TO_STREAM
- STREAM_TO_STREAM

For more information, see the Github project for the Hive Warehouse Connector.

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()
```

Related Information

HiveWarehouseConnector Github project

HiveWarehouseConnector for handling Apache Spark data

HMS table storage

Community Connection: Integrating Apache Hive with Apache Spark--Hive Warehouse Connector

Catalog operations

Catalog operations include creating, dropping, and describing a Hive database and table from Spark.

Catalog operations

- 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(100)
- 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",
 "bigint").column("ws_ship_date_sk", "bigint").create()
```

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

  hive.dropDatabase(<databaseName>, <ifExists>, <useCascade>)

- Drop a table

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

Read and write operations

The API supports reading and writing Hive tables from Spark. HWC supports writing to ORC tables only. You can update statements and write DataFrames to partitioned Hive tables, perform batch writes, and use HiveStreaming.

Pruning and pushdowns

To prevent data correctness issues in this release, pruning and projection pushdown is disabled by default. The spark.datasource.hive.warehouse.disable.pruning.and.pushdowns property is set to true. Incorrect data can appear when one dataframe is derived from the other with different filters or projections (parent-child dataframe with different set of filters/projections). Spark 2.3.x creates only one read instance per parent dataframe and uses that instance for all actions on any child dataframe. The following example shows one of many ways the problem can occur during filtering:

```
scala> val df = hive.executeQuery("select * from t1") // reader instance(say reader@1) created here
scala> df.show
+----+----+----+
|col1|col2|col3|
+----+----+----+
|   2|   b| 2.2|
|   1|   a| 1.1|
|   3|   c| 3.3|
+----+----+----+

scala> val df1 = df.filter("col1 > 1")
scala> df1.show                   // correct results here but now in reader@1, filters are populated
+----+----+----+
|col1|col2|col3|
+----+----+----+
|   2|   b| 2.2|
|   3|   c| 3.3|
+----+----+----+

scala> df.show              // INCORRECT results as reader@1 contains filters from previous operation
+----+----+----+
|col1|col2|col3|
+----+----+----+
|   2|   b| 2.2|
|   3|   c| 3.3|
+----+----+----+
```

The following example shows one of many ways the problem can occur with projection pushdowns:

```
scala> val df = hive.executeQuery("select * from t1") // reader instance(say reader@1) created here
scala> df.show
+----+----+----+
|col1|col2|col3|
+----+----+----+
|   2|   b| 2.2|
|   1|   a| 1.1|
|   3|   c| 3.3|
+----+----+----+

scala> val temp = df.select($"col1", $"col2")
scala> temp.show      // now we have only col1 and col2 in schema of reader@1
+----+----+
|col1|col2|
+----+----+
|   2|   b|
|   1|   a|
|   3|   c|
+----+----+

scala> df.join(temp, Seq("col1")).show  // now join operation expects reader@1 to provide 3 columns for df
java.lang.ArrayIndexOutOfBoundsException: 2
    at org.apache.spark.sql.vectorized.ColumnarBatch.column(ColumnarBatch.java:98)
    ...
```

To prevent these issues and ensure correct results, do not enable pruning and pushdowns. To enable pruning and pushdown, set the spark.datasource.hive.warehouse.disable.pruning.and.pushdowns=false.

Read operations

Execute a Hive SELECT query and return a DataFrame.

hive.executeQuery("select * from web_sales")

HWC supports push-downs of DataFrame filters and projections applied to executeQuery.

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>).save()
```

Python:

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

Python:

```
df.write.format(HiveWarehouseSession().HIVE_WAREHOUSE_CONNECTOR).option("table",
 &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("partition", <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").start()
```

Python:

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

Close HiveWarehouseSession operations

Spark can invoke operations, such as cache(), persist(), and rdd(), on a DataFrame you obtain from running a HiveWarehouseSession executeQuery() or table(). The Spark operations can lock Hive resources. You can release any locks and resources by calling the HiveWarehouseSession close().

About this task

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.executeQuery("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 executeQuery() or table().

Use the Hive Warehouse Connector for streaming

When using HiveStreaming to write a DataFrame to Hive or a Spark Stream to Hive, you need 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' = '\\');

Hive Warehouse Connector API Examples

You can create the DataFrame from any data source and include an option to write the DataFrame to a Hive table. When you write the DataFrame, the Hive Warehouse Connector creates the Hive table if it does not exist.

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...

The following example uses Append mode.

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

val hive =
 com.hortonworks.spark.sql.hive.llap.HiveWarehouseBuilder.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.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()
```

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
Dataset<Row> executeQuery(String sql);

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

//Execute Hive catalog-browsing operation and return DataFrame
Dataset<Row> execute(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();
}
```

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(String 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
 matchExpr
MergeBuilder whenMatchedThenUpdate(String matchExpr, String...
 nameValuePairs);

//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();
}
```

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"="localhost: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 Kafke serializer-deserializer for Avro:

     ```
     ALTER TABLE kafka_table SET TBLPROPERTIES
      ("kafka.serde.class"="org.apache.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"="localhost:9092"
        -- STORE AS AVRO IN KAFKA
        "kafka.serde.class"="org.apache.hadoop.hive.serde2.avro.AvroSerDe");
     ```

Related Information

Apache Kafka Documentation

Querying Kafka data

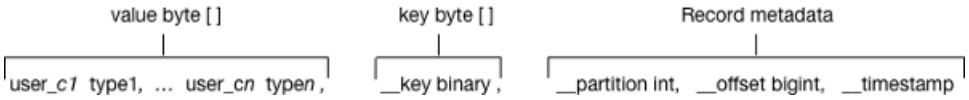
You can get useful information, including Kafka record metadata from a table of Kafka data by using typical Hive queries.

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 -
    interval '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 -
    interval '15' MINUTES) ;
   ```
4. Create a dimension table.

   ```
   CREATE TABLE user_table (`user` string, `first_name` string , age int,
    gender 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_table`.`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_activity.`user`
AND activity.`timestamp` = future_activity.`timestamp` - interval '5'
 minutes ;

--  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'
 hour
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,
 insert_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 ,
 delta
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.semantic"="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:9092");
```

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 execute 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 -
 interval '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 Apache Hive to BI tools

To query, analyze, and visualize data stored within the Hortonworks Data Platform using drivers provided by Cloudera, you connect Apache Hive to Business Intelligence (BI). tools.

About this task

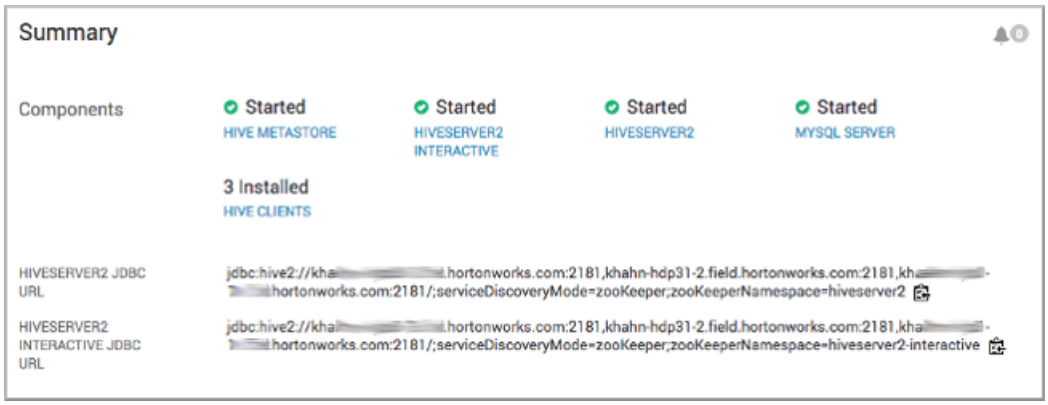
How you connect to Hive depends on a number of factors: the location of Hive inside or outside the cluster, the HiveServer deployment, the type of transport, transport-layer security, and authentication. HiveServer is the server interface that enables remote clients to execute queries against Hive and retrieve the results using a JDBC or ODBC connection. The ODBC driver from Simba and the Apache Hive JDBC driver is available for download as described in the next topic. HDP installs the Apache Hive JDBC driver on one of the edge nodes in your cluster.

Before you begin

- You chose a Hive authorization model.
- You configured authenticated users for querying Hive through JDBC or ODBC driver by setting value of the hive.server2.enable.doAs configuration property in the hive.site.xml file.

Procedure

1. Locate the Apache Hive JDBC driver or download the Simba ODBC driver.
2. Depending on the type of driver you obtain, proceed as follows:
   - If you use the Simba ODBC driver, follow instructions on the ODBC driver download site, and skip the rest of the steps in this procedure.
   - If you use a Apache Hive JDBC driver, specify the basic JDBC connection string as described in the following steps.
3. In Ambari, select Services > Hive .
4. In Summary, copy the JDBC URL for HiveServer: Click the clipboard icon.



5. Send the JDBC connection string to the BI tool, such as Tableau.

Related Information

Locate the JDBC or ODBC driver
Specify the JDBC connection string
HiveWarehouseConnector Github project

Locate the JDBC or ODBC driver

You download the Apache Hive JDBC driver, navigate to the installed JDBC driver, or you download the Simba ODBC driver.

About this task

Cloudera provides the Apache Hive JDBC driver as part of the HDP distribution, and provides an ODBC driver as an add-on to the distribution for HDP support subscription customers.

Procedure

1. Get the driver.
   - On a cluster node, navigate to /usr/hdp/current/hive-client/lib to locate the Apache Hive driver hive-jdbc.jar that HDP installed on your cluster.
   - Using the version number of the JAR in /usr/hdp/current/hive-client/lib, download the same Apache Hive JDBC driver hive-jdbc from the driver archive.
   - Download the Simba ODBC driver from the Cloudera downloads page. Skip the rest of the steps in this procedure and follow ODBC driver installation instructions.
2. Optionally, if you run a host outside of the Hadoop cluster, to use the JDBC driver in HTTP and HTTPS modes, give clients access to hive-jdbc-<version>-standalone.jar, hadoop-common.jar, and hadoop-auth.jar.

Specify the JDBC connection string

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

About this task

In embedded mode, HiveServer runs within the Hive client, not as a separate process. Consequently, the URL does not need a host or port number to make the JDBC connection. In remote mode, 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 transportMode 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

Related Information

Hortonworks Addons

JDBC connection string syntax

The JDBC connection string for connecting to a remote Hive client requires a host, port, and Hive database name, and 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 in remote mode. 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_endpoint>;<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.

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:hive2://<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 differs from the format used by Sasl QOP.

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=<truststore_pas
<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.

```
jdbc:hive2://<host>:<port>/
<dbName>;principal=<HiveServer2_kerberos_principal>;saslQop=auth-
conf;<otherSessionConfs>?<hiveConfs>#<hiveVars>
```

Query a SQL data source using the JdbcStorageHandler

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

About this task

In this task 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. Obtain credentials for accessing the database.
   - If you are accessing data on your network and have no security worries, you can use the user name and password that authorizes your to access Hive.
   - If you are accessing data on a remote network, create a JCEKS credential keystore on HDFS, and use credentials you specify in the process.
3. 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"
);
```

4. Query the external table.

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

Visualizing Apache Hive data using Superset

Using Apache Ambari, you can add Apache Superset to your cluster, connect to Hive, and visualize Hive data in insightful ways, such a chart or an aggregation.

About this task

Apache Superset is a technical preview in HDP 3.0 installed in Ambari by default and available as a service. Apache Superset is a data exploration platform for interactively visualizing data from diverse data sources, such as Hive and Druid. Superset supports more than 30 types of visualizations. In this task, you add Superset to a node in a cluster, start Superset, and connect Superset to Hive.

Before you begin

- You logged into Ambari and started the following components:
  - HiveServer
  - Hive Metastore

  - A database for the Superset metastore, such as the default MySQL Server
  - Hive clients
- You have a user name and password to access Hive.
- You have read, write, and execute permission to /user and /apps/hive/warehouse on HDFS.

Related Information

Apache Superset tutorial

Add the Superset service

You can add the Apache Superset service, which is installed by default with HDP 3.0, to your cluster in Apache Ambari.

About this task

In this task, you use a wizard for customizing Superset services that includes configuring a database backend that Superset uses to store metadata, such as dashboard definitions. By default, SQLite is installed for use as the metastore in nonproduction situations.

SQLite is not a client/server SQL database. For production use, you must install a suitable database. For example purposes, in this task, you accept the default SQLite database.

You configure a SECRET_KEY to encrypt user passwords. The key is stored in the Superset metastore. Do not change the key after setup.Upon completion of this task, you can connect Apache Hive to Superset.

Before you begin

You have installed a client/server database, such as MySQL or PostgreSQL, to use as the Superset database for storing metadata.

Procedure

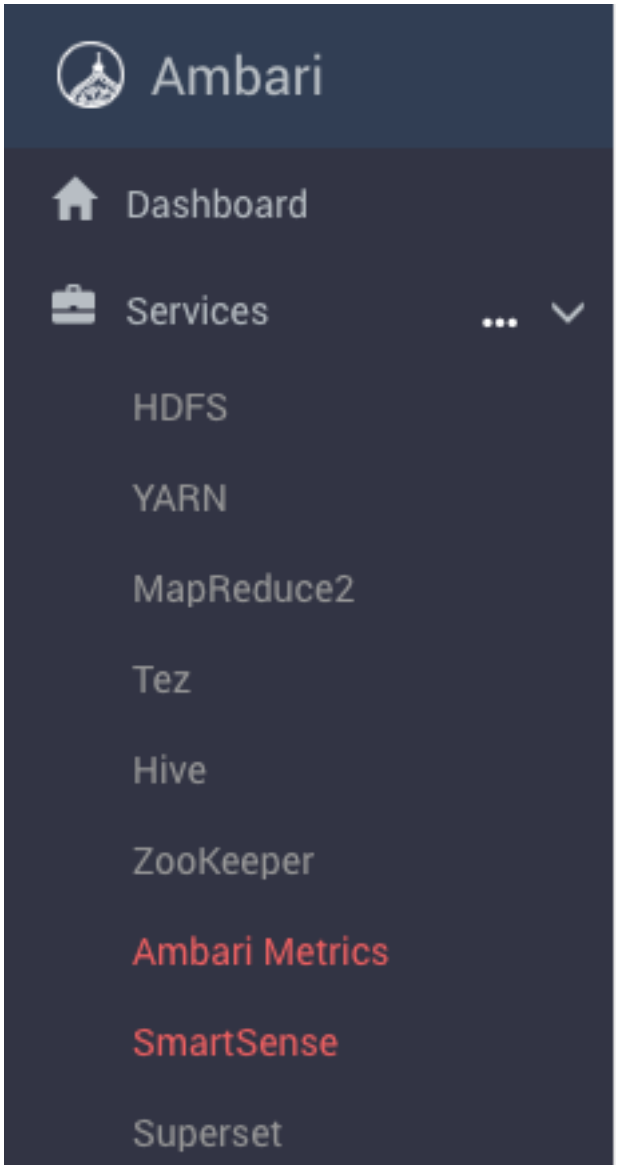
1. From the Ambari navigation pane, select Services, scroll down the list of services to Superset, and click Add Service.
2. In the Add Service wizard, scroll down to Superset, which is selected for addition, and click Next.
3. In Assign Masters, accept the single default node selected to run the Superset service, and click Next.
4. In Customize Services, configure properties:

   Superset Database password

   Superset Database Port--Enter a port number. For example, enter 8088 if you accepted the default SQLite Superset database, or 3306 if you configured MySQL as the Superset database.

   Superset SECRET_KEY--Provide any random number in SECRET_KEY, accept the other default settings, and scroll to the bottom of the page.

   Attention message--Click Show All Properties and follow prompts to configure any properties, such as providing a Superset Admin Password.
5. Click Next.
6. In Customize Services, in Advanced, enter a Superset Admin password.
7. Click Next, and then click Deploy,
8. Click Next, and in Summary, click Complete and confirm completion.
   Superset appears in the Ambari navigation pane.



Connect Apache Hive to Superset

You can connect to Hive to create a Superset visualization.

About this task

Upon completion of this task, you can create a Superset visualization.

Before you begin

You have started the Superset service in Ambari.

Procedure

1. Click Superset.
2. In the Summary portion of Quick Links, click Superset and log in using your Superset user name and password. An empty dashboard appears.
3. From Sources, select Databases.
4. In Add Filter, add a new record.

5. In Add Database, enter the name of your Hive database: for example, default.
6. Enter the SQLAlchemy URL for accessing your database.
   For example, assuming HiveServer is running on node c7402, connect the database named default to the Superset listening port 10000:

   ```
   hive://hive@c7402:10000/default
   ```

   ZooKeeper-based URL discovery is not supported.
7. Click Test Connection.
   The success message appears, and the names of any tables in the database appear at the bottom of the page.
8. Scroll to the bottom of the page, and click Save.

Configure a Superset visualization

In Apache Ambari, after connecting Apache Superset to Apache Hive, you can configure visualizations, such as aggregations, slices of data, or plotted data to better understand the data.

About this task

This task shows you how to create a simple visualization based on a table having the following schema:

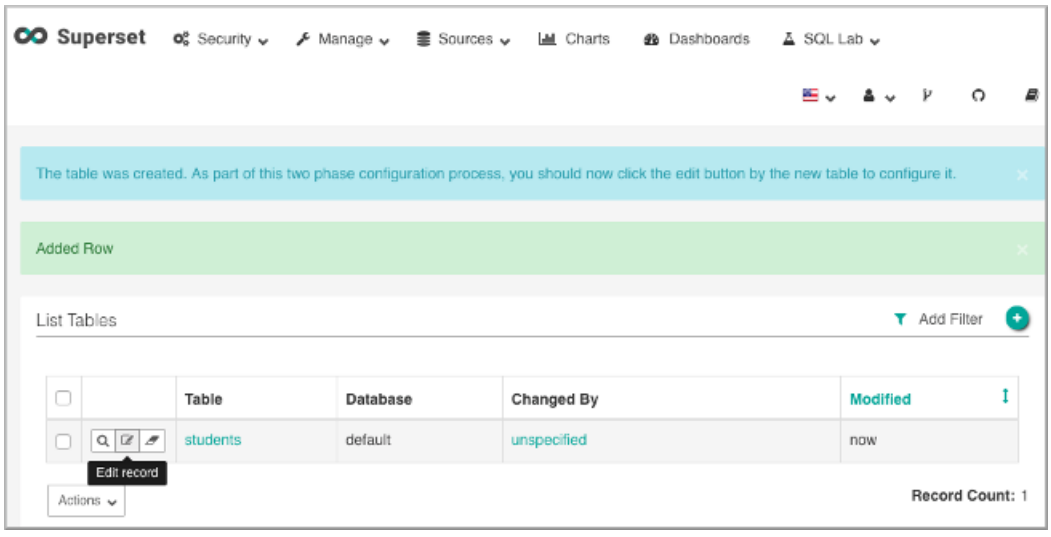
```
CREATE TABLE students (name VARCHAR(64), age INT, gpa DECIMAL(3,2));
```

Before you begin

- You created and populated a table in the Hive warehouse.

Procedure

1. Select Superset from the Ambari main menu.
2. In Summary under Quick Links, click Superset.
3. From the Sources menu, select Tables.
4. In Add Filter, add a new record.
5. On Add Table in Database, select the Hive database connected to Superset.
6. In Table Name, select a Hive table, students in the example below, and click Save.
7. On List Tables, click Edit Record:



8. On the Detail tab of Edit Table, in Table Name, enter the name of a table in the Hive database.

A table visualization appears, showing an aggregation calculated automatically by Superset: average age 33.5 in this example: