

Apache Hive Performance Tuning

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Contents

Low-latency analytical processing.....	4
Best practices for performance tuning.....	4
Maximizing storage resources using ORC.....	5
Advanced ORC properties.....	6
Improving performance using partitions.....	6
Handling bucketed tables.....	7

Low-latency analytical processing

CDP Public Cloud supports low-latency analytical processing (LLAP) of Hive queries. Using LLAP available in the CDP Data Warehouse service, you can tune your data warehouse infrastructure, components, and client connection parameters to improve the performance and relevance of business intelligence and other applications.

Increasingly, enterprises want to run SQL workloads that return faster results than batch processing can provide. These enterprises often want data analytics applications to support interactive queries. Low-latency analytical processing (LLAP) can improve the performance of interactive queries. A Hive interactive query that runs on the CDP Public Cloud meets low-latency, variably gauged benchmarks to which Hive LLAP responds in 15 seconds or less. LLAP enables application development and IT infrastructure to run queries that return real-time or near-real-time results.

Cloudera Data Warehouse (CDW) includes the following LLAP performance features:

- Object store optimizations for S3 and ABFS
- Improvements in S3A and ABFS connectors for improved remote read performance and lower CPU utilization with encryption
- S3guard metadata caching in authoritative mode
- Data cache
- Local on disk caching of remote data from object stores or remote HDFS/Ozone
- Attached NVMe SSD storage used for larger cache
- Lazy column decoding with joins improves cpu utilization and latency
- Cost-Based Optimizations for runtime filtering, shared scans and grouping operations
- Efficient TopN implementation to speed up LIMIT queries
- Improvements in handling Decimal type
- Auto-scaling for adaptive resource management

CDP Private Cloud Base does not support LLAP.

Best practices for performance tuning

Review certain performance tuning guidelines related to configuring the cluster, storing data, and writing queries so that you can protect your cluster and dependent services, disable user impersonation, automatically scale resources to handle queries, and so on.

Best practices

- Adjust autoscaling in CDP Public Cloud to scale up when you need resources to handle queries.
- Accept the default to use Tez as the execution engine. In CDP, the MapReduce execution engine is replaced by Tez.
- Accept the default to disable user impersonation. If enabled, disable `hive.server2.enable.doAs` in `hive-site.xml` using the Cloudera Manager Safety Valve feature (see link below).

LLAP caches data for multiple queries and this capability does not support user impersonation.

- Use Ranger security service to protect your cluster and dependent services.
- Store data using the ORC File format. Others, such as Parquet are supported, but not as fast for Hive queries.
- Ensure that queries are fully vectorized by examining explain plans.

Related Information

[Custom Configuration \(about Cloudera Manager Safety Valve\)](#)

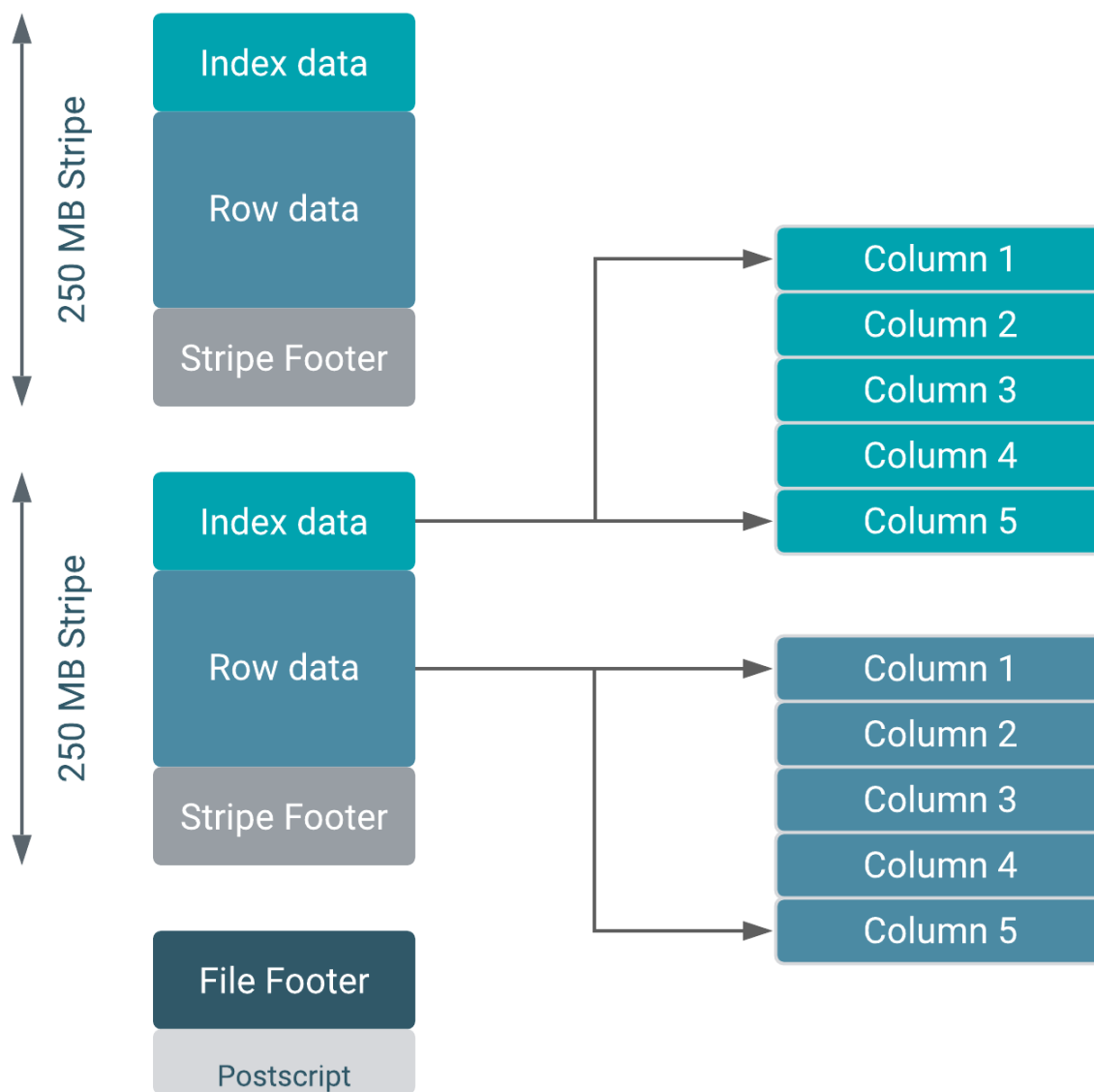
[Example of using the Cloudera Manager Safety Valve](#)

Maximizing storage resources using ORC

You can conserve storage in a number of ways, but using the Optimized Row Columnar (ORC) file format for storing Apache Hive data is most effective. ORC is the default storage for Hive data.

The ORC file format for Hive data storage is recommended for the following reasons:

- Efficient compression: Stored as columns and compressed, which leads to smaller disk reads. The columnar format is also ideal for vectorization optimizations in Tez.
- Fast reads: ORC has a built-in index, min/max values, and other aggregates that cause entire stripes to be skipped during reads. In addition, predicate pushdown pushes filters into reads so that minimal rows are read. And Bloom filters further reduce the number of rows that are returned.
- Proven in large-scale deployments: Facebook uses the ORC file format for a 300+ PB deployment.



ORC provides the best Hive performance overall. In addition, to specifying the storage format, you can also specify a compression algorithm for the table, as shown in the following example:

```
CREATE TABLE addresses (
  name string,
  street string,
  city string,
  state string,
  zip int
) STORED AS orc TBLPROPERTIES ("orc.compress"="Zlib");
```

Setting the compression algorithm is usually not required because your Hive settings include a default algorithm. Using ORC advanced properties, you can create bloom filters for columns frequently used in point lookups.

Hive supports Parquet and other formats for insert-only ACID tables and external tables. You can also write your own SerDes (Serializers, Deserializers) interface to support custom file formats.

Advanced ORC properties

Usually, you do not need to modify Optimized Row Columnar (ORC) properties, but occasionally, Cloudera Support advises making such changes. Review the property keys, default values, and descriptions you can configure ORC to suit your needs.

Property keys and defaults

You use the Safety Valve feature in Cloudera Manager to change ORC properties.

Key	Default Setting	Description
orc.compress	ZLIB	Compression type (NONE, ZLIB, SNAPPY).
orc.compress.size	262,144	Number of bytes in each compression block.
orc.stripe.size	268,435,456	Number of bytes in each stripe.
orc.row.index.stride	10,000	Number of rows between index entries ($\geq 1,000$).
orc.create.index	true	Sets whether to create row indexes.
orc.bloom.filter.columns	--	Comma-separated list of column names for which a Bloom filter must be created.
orc.bloom.filter.fpp	0.05	False positive probability for a Bloom filter. Must be greater than 0.0 and less than 1.0.

Related Information

[Custom Configuration \(about Cloudera Manager Safety Valve\)](#)

[Example of using the Cloudera Manager Safety Valve](#)

Improving performance using partitions

You must be aware of what partition pruning is, how to enable dynamic partitioning, and the configuration required for bulk-loading of data to ensure significant improvements in performance."?>You can use partitions to significantly improve performance. You can design Hive table and materialized views partitions to map to physical directories on the file system/object store. For example, a table partitioned by date-time can organize data loaded into Hive each day.

Large deployments can have tens of thousands of partitions. Partition pruning occurs indirectly when Hive discovers the partition key during query processing. For example, after joining with a dimension table, the partition key might

come from the dimension table. A query filters columns by partition, limiting scanning that occurs to one or a few matching partitions. Partition pruning occurs directly when a partition key is present in the WHERE clause. Partitioned columns are virtual, not written into the main table because these columns are the same for the entire partition.

You do not need to specify dynamic partition columns. Hive generates a partition specification if you enable dynamic partitions.

Configuration for loading 1 to 9 partitions:

```
SET hive.exec.dynamic.partition.mode=nonstrict;  
SET hive.exec.dynamic.partition=true;
```

For bulk-loading data into partitioned ORC tables, you use the following property, which optimizes the performance of data loading into 10 or more partitions.

Configuration for loading 10 or more partitions:

```
hive.optimize.sort.dynamic.partition=true
```

Handling bucketed tables

If you migrated data from earlier Apache Hive versions to Hive 3, you might need to handle bucketed tables that impact performance. Review how CDP simplifies handling buckets. You learn about best practices for handling dynamic capabilities.

You can divide tables or partitions into buckets, which are stored in the following ways:

- As files in the directory for the table.
- As directories of partitions if the table is partitioned.

Specifying buckets in Hive 3 tables is not necessary. In CDP, Hive 3 buckets data implicitly, and does not require a user key or user-provided bucket number as earlier versions (ACID V1) did. For example:

V1:

```
CREATE TABLE hello_acid (load_date date, key int, value int)  
CLUSTERED BY(key) INTO 3 BUCKETS  
STORED AS ORC TBLPROPERTIES ('transactional'='true');
```

V2:

```
CREATE TABLE hello_acid_v2 (load_date date, key int, value int);
```

Performance of ACID V2 tables is on a par with non-ACID tables using buckets. ACID V2 tables are compatible with native cloud storage.

A common challenge related to using buckets in tables migrated from earlier versions is maintaining query performance while the workload or data scales up or down. For example, you could have an environment that operates smoothly using 16 buckets to support 1000 users, but a spike in the number of users to 100,000 for a day or two creates problems if you do not promptly tune the buckets and partitions. Tuning the buckets is complicated by the fact that after you have constructed a table with buckets, the entire table containing the bucketed data must be reloaded to reduce, add, or eliminate buckets.

In CDP, which uses Tez, you only need to deal with the buckets of the biggest table. If workload demands change rapidly, the buckets of the smaller tables dynamically change to complete table JOINS.

You perform the following tasks related to buckets:

- Setting hive-site.xml to enable buckets

SET hive.tez.bucket.pruning=true

- Bulk-loading tables that are both partitioned and bucketed:

When you load data into tables that are both partitioned and bucketed, set the following property to optimize the process:

SET hive.optimize.sort.dynamic.partition=true

If you have 20 buckets on user_id data, the following query returns only the data associated with user_id = 1: SELECT * FROM tab WHERE user_id = 1;

To best leverage the dynamic capability of table buckets on Tez, adopt the following practices:

- Use a single key for the buckets of the largest table.
- Usually, you need to bucket the main table by the biggest dimension table. For example, the sales table might be bucketed by customer and not by merchandise item or store. However, in this scenario, the sales table is sorted by item and store.
- Normally, do not bucket and sort on the same column.

A table that has more bucket files than the number of rows is an indication that you should reconsider how the table is bucketed.