其他存储引擎

存储引擎是处理不同表类型的SQL操作的MySQL组件。InnoDB是默认的和最通用的存储引擎，甲骨文公司建议除专门的使用情况外，对表使用它。(MySQL 8.0中的CREATE TABLE语句默认创建InnoDB表)。

MySQL服务器使用一个可插拔的存储引擎架构，使存储引擎能够被加载到运行中的MySQL服务器中并从其中卸载。

要确定你的服务器支持哪些存储引擎，请使用SHOW ENGINES语句。支持栏中的值表示是否可以使用一个引擎。一个YES、NO或DEFAULT的值表示一个引擎是可用的、不可用的或可用的，并且当前被设置为默认存储引擎。

mysql> **SHOW ENGINES\G**

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* 1. row \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

Engine: PERFORMANCE\_SCHEMA

Support: YES

Comment: Performance Schema

Transactions: NO

XA: NO

Savepoints: NO

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* 2. row \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

Engine: InnoDB

Support: DEFAULT

Comment: Supports transactions, row-level locking, and foreign keys

Transactions: YES

XA: YES

Savepoints: YES

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* 3. row \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

Engine: MRG\_MYISAM

Support: YES

Comment: Collection of identical MyISAM tables

Transactions: NO

XA: NO

Savepoints: NO

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* 4. row \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

Engine: BLACKHOLE

Support: YES

Comment: /dev/null storage engine (anything you write to it disappears)

Transactions: NO

XA: NO

Savepoints: NO

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* 5. row \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

Engine: MyISAM

Support: YES

Comment: MyISAM storage engine

Transactions: NO

XA: NO

Savepoints: NO

...

This chapter covers use cases for special-purpose MySQL storage engines. It does not cover the default **[InnoDB](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\innodb-storage-engine.html" \o "Chapter 15 The InnoDB Storage Engine)** storage engine or the [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine which are covered in [Chapter 15, *The InnoDB Storage Engine*](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html) and [Chapter 23, *MySQL NDB Cluster 8.0*](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html). For advanced users, it also contains a description of the pluggable storage engine architecture (see [Section 16.11, “Overview of MySQL Storage Engine Architecture”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#pluggable-storage-overview)).

For information about features offered in commercial MySQL Server binaries, see [MySQL Editions](https://www.mysql.com/products/), on the MySQL website. The storage engines available might depend on which edition of MySQL you are using.

For answers to commonly asked questions about MySQL storage engines, see [Section A.2, “MySQL 8.0 FAQ: Storage Engines”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faqs-storage-engines).

## MySQL 8.0 Supported Storage Engines

[**InnoDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html): The default storage engine in MySQL 8.0. **InnoDB** is a transaction-safe (ACID compliant) storage engine for MySQL that has commit, rollback, and crash-recovery capabilities to protect user data. **InnoDB** row-level locking (without escalation to coarser granularity locks) and Oracle-style consistent nonlocking reads increase multi-user concurrency and performance. **InnoDB** stores user data in clustered indexes to reduce I/O for common queries based on primary keys. To maintain data integrity, **InnoDB** also supports **FOREIGN KEY** referential-integrity constraints. For more information about **InnoDB**, see [Chapter 15, *The InnoDB Storage Engine*](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html).

[**MyISAM**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#myisam-storage-engine): These tables have a small footprint. [Table-level locking](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\glossary.html#glos_table_lock) limits the performance in read/write workloads, so it is often used in read-only or read-mostly workloads in Web and data warehousing configurations.

[**Memory**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine): Stores all data in RAM, for fast access in environments that require quick lookups of non-critical data. This engine was formerly known as the **HEAP** engine. Its use cases are decreasing; **InnoDB** with its buffer pool memory area provides a general-purpose and durable way to keep most or all data in memory, and **NDBCLUSTER** provides fast key-value lookups for huge distributed data sets.

[**CSV**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#csv-storage-engine): Its tables are really text files with comma-separated values. CSV tables let you import or dump data in CSV format, to exchange data with scripts and applications that read and write that same format. Because CSV tables are not indexed, you typically keep the data in **InnoDB** tables during normal operation, and only use CSV tables during the import or export stage.

[**Archive**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#archive-storage-engine): These compact, unindexed tables are intended for storing and retrieving large amounts of seldom-referenced historical, archived, or security audit information.

[**Blackhole**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#blackhole-storage-engine): The Blackhole storage engine accepts but does not store data, similar to the Unix **/dev/null** device. Queries always return an empty set. These tables can be used in replication configurations where DML statements are sent to replica servers, but the source server does not keep its own copy of the data.

[**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) (also known as [**NDBCLUSTER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html)): This clustered database engine is particularly suited for applications that require the highest possible degree of uptime and availability.

[**Merge**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#merge-storage-engine): Enables a MySQL DBA or developer to logically group a series of identical **MyISAM** tables and reference them as one object. Good for VLDB environments such as data warehousing.

[**Federated**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#federated-storage-engine): Offers the ability to link separate MySQL servers to create one logical database from many physical servers. Very good for distributed or data mart environments.

[**Example**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#example-storage-engine): This engine serves as an example in the MySQL source code that illustrates how to begin writing new storage engines. It is primarily of interest to developers. The storage engine is a “stub” that does nothing. You can create tables with this engine, but no data can be stored in them or retrieved from them.

You are not restricted to using the same storage engine for an entire server or schema. You can specify the storage engine for any table. For example, an application might use mostly **InnoDB** tables, with one **CSV** table for exporting data to a spreadsheet and a few **MEMORY** tables for temporary workspaces.

***Choosing a Storage Engine***

The various storage engines provided with MySQL are designed with different use cases in mind. The following table provides an overview of some storage engines provided with MySQL, with clarifying notes following the table.

**Table 16.1 Storage Engines Feature Summary**

| **Feature** | **MyISAM** | **Memory** | **InnoDB** | **Archive** | **NDB** |
| --- | --- | --- | --- | --- | --- |
| **B-tree indexes** | Yes | Yes | Yes | No | No |
| **Backup/point-in-time recovery (note 1)** | Yes | Yes | Yes | Yes | Yes |
| **Cluster database support** | No | No | No | No | Yes |
| **Clustered indexes** | No | No | Yes | No | No |
| **Compressed data** | Yes (note 2) | No | Yes | Yes | No |
| **Data caches** | No | N/A | Yes | No | Yes |
| **Encrypted data** | Yes (note 3) | Yes (note 3) | Yes (note 4) | Yes (note 3) | Yes (note 3) |
| **Foreign key support** | No | No | Yes | No | Yes (note 5) |
| **Full-text search indexes** | Yes | No | Yes (note 6) | No | No |
| **Geospatial data type support** | Yes | No | Yes | Yes | Yes |
| **Geospatial indexing support** | Yes | No | Yes (note 7) | No | No |
| **Hash indexes** | No | Yes | No (note 8) | No | Yes |
| **Index caches** | Yes | N/A | Yes | No | Yes |
| **Locking granularity** | Table | Table | Row | Row | Row |
| **MVCC** | No | No | Yes | No | No |
| **Replication support (note 1)** | Yes | Limited (note 9) | Yes | Yes | Yes |
| **Storage limits** | 256TB | RAM | 64TB | None | 384EB |
| **T-tree indexes** | No | No | No | No | Yes |
| **Transactions** | No | No | Yes | No | Yes |
| **Update statistics for data dictionary** | Yes | Yes | Yes | Yes | Yes |

***Notes:***

1. Implemented in the server, rather than in the storage engine.

2. Compressed MyISAM tables are supported only when using the compressed row format. Tables using the compressed row format with MyISAM are read only.

3. Implemented in the server via encryption functions.

4. Implemented in the server via encryption functions; In MySQL 5.7 and later, data-at-rest encryption is supported.

5. Support for foreign keys is available in MySQL Cluster NDB 7.3 and later.

6. Support for FULLTEXT indexes is available in MySQL 5.6 and later.

7. Support for geospatial indexing is available in MySQL 5.7 and later.

8. InnoDB utilizes hash indexes internally for its Adaptive Hash Index feature.

9. See the discussion later in this section.

## 16.1 Setting the Storage Engine

When you create a new table, you can specify which storage engine to use by adding an **ENGINE** table option to the [**CREATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table) statement:

-- ENGINE=INNODB not needed unless you have set a different

-- default storage engine.

CREATE TABLE t1 (i INT) ENGINE = INNODB;

-- Simple table definitions can be switched from one to another.

CREATE TABLE t2 (i INT) ENGINE = CSV;

CREATE TABLE t3 (i INT) ENGINE = MEMORY;

When you omit the **ENGINE** option, the default storage engine is used. The default engine is **[InnoDB](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\innodb-storage-engine.html" \o "Chapter 15 The InnoDB Storage Engine)** in MySQL 8.0. You can specify the default engine by using the [**--default-storage-engine**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_default_storage_engine) server startup option, or by setting the [**default-storage-engine**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_default_storage_engine) option in the my.cnf configuration file.

You can set the default storage engine for the current session by setting the **[default\_storage\_engine](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_default_storage_engine)** variable:

SET default\_storage\_engine=NDBCLUSTER;

The storage engine for **TEMPORARY** tables created with [**CREATE TEMPORARY TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table) can be set separately from the engine for permanent tables by setting the **[default\_tmp\_storage\_engine](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_default_tmp_storage_engine)**, either at startup or at runtime.

To convert a table from one storage engine to another, use an [**ALTER TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table) statement that indicates the new engine:

ALTER TABLE t ENGINE = InnoDB;

See [Section 13.1.20, “CREATE TABLE Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table), and [Section 13.1.9, “ALTER TABLE Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table).

If you try to use a storage engine that is not compiled in or that is compiled in but deactivated, MySQL instead creates a table using the default storage engine. For example, in a replication setup, perhaps your source server uses **InnoDB** tables for maximum safety, but the replica servers use other storage engines for speed at the expense of durability or concurrency.

By default, a warning is generated whenever [**CREATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table) or [**ALTER TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table) cannot use the default storage engine. To prevent confusing, unintended behavior if the desired engine is unavailable, enable the [**NO\_ENGINE\_SUBSTITUTION**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sqlmode_no_engine_substitution) SQL mode. If the desired engine is unavailable, this setting produces an error instead of a warning, and the table is not created or altered. See [Section 5.1.11, “Server SQL Modes”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sql-mode).

MySQL may store a table's index and data in one or more other files, depending on the storage engine. Table and column definitions are stored in the MySQL data dictionary. Individual storage engines create any additional files required for the tables that they manage. If a table name contains special characters, the names for the table files contain encoded versions of those characters as described in [Section 9.2.4, “Mapping of Identifiers to File Names”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\language-structure.html#identifier-mapping).

## 16.2 The MyISAM Storage Engine

[16.2.1 MyISAM Startup Options](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#myisam-start)

[16.2.2 Space Needed for Keys](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#key-space)

[16.2.3 MyISAM Table Storage Formats](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#myisam-table-formats)

[16.2.4 MyISAM Table Problems](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#myisam-table-problems)

**MyISAM** is based on the older (and no longer available) **ISAM** storage engine but has many useful extensions.

**Table 16.2 MyISAM Storage Engine Features**

| **Feature** | **Support** |
| --- | --- |
| ***B-tree indexes*** | Yes |
| ***Backup/point-in-time recovery*** (Implemented in the server, rather than in the storage engine.) | Yes |
| ***Cluster database support*** | No |
| ***Clustered indexes*** | No |
| ***Compressed data*** | Yes (Compressed MyISAM tables are supported only when using the compressed row format. Tables using the compressed row format with MyISAM are read only.) |
| ***Data caches*** | No |
| ***Encrypted data*** | Yes (Implemented in the server via encryption functions.) |
| ***Foreign key support*** | No |
| ***Full-text search indexes*** | Yes |
| ***Geospatial data type support*** | Yes |
| ***Geospatial indexing support*** | Yes |
| ***Hash indexes*** | No |
| ***Index caches*** | Yes |
| ***Locking granularity*** | Table |
| ***MVCC*** | No |
| ***Replication support*** (Implemented in the server, rather than in the storage engine.) | Yes |
| ***Storage limits*** | 256TB |
| ***T-tree indexes*** | No |
| ***Transactions*** | No |
| ***Update statistics for data dictionary*** | Yes |

Each **MyISAM** table is stored on disk in two files. The files have names that begin with the table name and have an extension to indicate the file type. The data file has an .MYD (**MYData**) extension. The index file has an .MYI (**MYIndex**) extension. The table definition is stored in the MySQL data dictionary.

To specify explicitly that you want a **MyISAM** table, indicate that with an **ENGINE** table option:

CREATE TABLE t (i INT) ENGINE = MYISAM;

In MySQL 8.0, it is normally necessary to use **ENGINE** to specify the **MyISAM** storage engine because **InnoDB** is the default engine.

You can check or repair **MyISAM** tables with the **[mysqlcheck](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "mysqlcheck" \o "4.5.3 mysqlcheck — A Table Maintenance Program)** client or [**myisamchk**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#myisamchk) utility. You can also compress **MyISAM** tables with **[myisampack](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisampack" \o "4.6.6 myisampack — Generate Compressed, Read-Only MyISAM Tables)** to take up much less space. See [Section 4.5.3, “mysqlcheck — A Table Maintenance Program”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqlcheck), [Section 4.6.4, “myisamchk — MyISAM Table-Maintenance Utility”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#myisamchk), and [Section 4.6.6, “myisampack — Generate Compressed, Read-Only MyISAM Tables”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#myisampack).

In MySQL 8.0, the **MyISAM** storage engine provides no partitioning support. Partitioned ***MyISAM*** tables created in previous versions of MySQL cannot be used in MySQL 8.0. For more information, see [Section 24.6.2, “Partitioning Limitations Relating to Storage Engines”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\partitioning.html#partitioning-limitations-storage-engines). For help with upgrading such tables so that they can be used in MySQL 8.0, see [Section 2.11.4, “Changes in MySQL 8.0”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\installing.html#upgrading-from-previous-series).

**MyISAM** tables have the following characteristics:

All data values are stored with the low byte first. This makes the data machine and operating system independent. The only requirements for binary portability are that the machine uses two's-complement signed integers and IEEE floating-point format. These requirements are widely used among mainstream machines. Binary compatibility might not be applicable to embedded systems, which sometimes have peculiar processors.

There is no significant speed penalty for storing data low byte first; the bytes in a table row normally are unaligned and it takes little more processing to read an unaligned byte in order than in reverse order. Also, the code in the server that fetches column values is not time critical compared to other code.

All numeric key values are stored with the high byte first to permit better index compression.

Large files (up to 63-bit file length) are supported on file systems and operating systems that support large files.

There is a limit of (232)2 (1.844E+19) rows in a **MyISAM** table.

The maximum number of indexes per **MyISAM** table is 64.

The maximum number of columns per index is 16.

The maximum key length is 1000 bytes. This can also be changed by changing the source and recompiling. For the case of a key longer than 250 bytes, a larger key block size than the default of 1024 bytes is used.

When rows are inserted in sorted order (as when you are using an **AUTO\_INCREMENT** column), the index tree is split so that the high node only contains one key. This improves space utilization in the index tree.

Internal handling of one **AUTO\_INCREMENT** column per table is supported. **MyISAM** automatically updates this column for [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert) and [**UPDATE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#update) operations. This makes **AUTO\_INCREMENT** columns faster (at least 10%). Values at the top of the sequence are not reused after being deleted. (When an **AUTO\_INCREMENT** column is defined as the last column of a multiple-column index, reuse of values deleted from the top of a sequence does occur.) The **AUTO\_INCREMENT** value can be reset with [**ALTER TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table) or **[myisamchk](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)**.

Dynamic-sized rows are much less fragmented when mixing deletes with updates and inserts. This is done by automatically combining adjacent deleted blocks and by extending blocks if the next block is deleted.

**MyISAM** supports concurrent inserts: If a table has no free blocks in the middle of the data file, you can [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert) new rows into it at the same time that other threads are reading from the table. A free block can occur as a result of deleting rows or an update of a dynamic length row with more data than its current contents. When all free blocks are used up (filled in), future inserts become concurrent again. See [Section 8.11.3, “Concurrent Inserts”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\optimization.html#concurrent-inserts).

You can put the data file and index file in different directories on different physical devices to get more speed with the **DATA DIRECTORY** and **INDEX DIRECTORY** table options to [**CREATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table). See [Section 13.1.20, “CREATE TABLE Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table).

[**BLOB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) and [**TEXT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) columns can be indexed.

**NULL** values are permitted in indexed columns. This takes 0 to 1 bytes per key.

Each character column can have a different character set. See [Chapter 10, *Character Sets, Collations, Unicode*](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\charset.html).

There is a flag in the **MyISAM** index file that indicates whether the table was closed correctly. If **[mysqld](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "mysqld" \o "4.3.1 mysqld — The MySQL Server)** is started with the **[myisam\_recover\_options](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_myisam_recover_options)** system variable set, **MyISAM** tables are automatically checked when opened, and are repaired if the table wasn't closed properly.

[**myisamchk**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#myisamchk) marks tables as checked if you run it with the [--update-state](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#option_myisamchk_update-state) option. **[myisamchk --fast](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)** checks only those tables that don't have this mark.

[**myisamchk --analyze**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#myisamchk) stores statistics for portions of keys, as well as for entire keys.

[**myisampack**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#myisampack) can pack [**BLOB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) and [**VARCHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char) columns.

**MyISAM** also supports the following features:

Support for a true [**VARCHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char) type; a [**VARCHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char) column starts with a length stored in one or two bytes.

Tables with [**VARCHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char) columns may have fixed or dynamic row length.

The sum of the lengths of the [**VARCHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char) and [**CHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char) columns in a table may be up to 64KB.

Arbitrary length **UNIQUE** constraints.

### Additional Resources

A forum dedicated to the **MyISAM** storage engine is available at <https://forums.mysql.com/list.php?21>.

### 16.2.1 MyISAM Startup Options

The following options to **[mysqld](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "mysqld" \o "4.3.1 mysqld — The MySQL Server)** can be used to change the behavior of **MyISAM** tables. For additional information, see [Section 5.1.7, “Server Command Options”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#server-options).

**Table 16.3 MyISAM Option and Variable Reference**

| **Name** | **Cmd-Line** | **Option File** | **System Var** | **Status Var** | **Var Scope** | **Dynamic** |
| --- | --- | --- | --- | --- | --- | --- |
| [**bulk\_insert\_buffer\_size**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_bulk_insert_buffer_size) | Yes | Yes | Yes |  | Both | Yes |
| [**concurrent\_insert**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_concurrent_insert) | Yes | Yes | Yes |  | Global | Yes |
| [**delay\_key\_write**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_delay_key_write) | Yes | Yes | Yes |  | Global | Yes |
| [**have\_rtree\_keys**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_have_rtree_keys) |  |  | Yes |  | Global | No |
| [**key\_buffer\_size**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_key_buffer_size) | Yes | Yes | Yes |  | Global | Yes |
| [**log-isam**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#option_mysqld_log-isam) | Yes | Yes |  |  |  |  |
| [**myisam-block-size**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#option_mysqld_myisam-block-size) | Yes | Yes |  |  |  |  |
| [**myisam\_data\_pointer\_size**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_myisam_data_pointer_size) | Yes | Yes | Yes |  | Global | Yes |
| [**myisam\_max\_sort\_file\_size**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_myisam_max_sort_file_size) | Yes | Yes | Yes |  | Global | Yes |
| [**myisam\_mmap\_size**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_myisam_mmap_size) | Yes | Yes | Yes |  | Global | No |
| [**myisam\_recover\_options**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_myisam_recover_options) | Yes | Yes | Yes |  | Global | No |
| [**myisam\_repair\_threads**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_myisam_repair_threads) | Yes | Yes | Yes |  | Both | Yes |
| [**myisam\_sort\_buffer\_size**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_myisam_sort_buffer_size) | Yes | Yes | Yes |  | Both | Yes |
| [**myisam\_stats\_method**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_myisam_stats_method) | Yes | Yes | Yes |  | Both | Yes |
| [**myisam\_use\_mmap**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_myisam_use_mmap) | Yes | Yes | Yes |  | Global | Yes |
| [**tmp\_table\_size**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_tmp_table_size) | Yes | Yes | Yes |  | Both | Yes |

The following system variables affect the behavior of **MyISAM** tables. For additional information, see [Section 5.1.8, “Server System Variables”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#server-system-variables).

[**bulk\_insert\_buffer\_size**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_bulk_insert_buffer_size)

The size of the tree cache used in bulk insert optimization.

**Note**

This is a limit per thread!

[delay\_key\_write=ALL](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_delay_key_write)

Don't flush key buffers between writes for any **MyISAM** table.

**Note**

If you do this, you should not access **MyISAM** tables from another program (such as from another MySQL server or with **[myisamchk](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)**) when the tables are in use. Doing so risks index corruption. Using [--external-locking](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#option_mysqld_external-locking) does not eliminate this risk.

[**myisam\_max\_sort\_file\_size**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_myisam_max_sort_file_size)

The maximum size of the temporary file that MySQL is permitted to use while re-creating a **MyISAM** index (during [**REPAIR TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#repair-table), [**ALTER TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table), or [**LOAD DATA**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#load-data)). If the file size would be larger than this value, the index is created using the key cache instead, which is slower. The value is given in bytes.

[**myisam\_recover\_options=*mode***](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_myisam_recover_options)

Set the mode for automatic recovery of crashed **MyISAM** tables.

[**myisam\_sort\_buffer\_size**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_myisam_sort_buffer_size)

Set the size of the buffer used when recovering tables.

Automatic recovery is activated if you start **[mysqld](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "mysqld" \o "4.3.1 mysqld — The MySQL Server)** with the **[myisam\_recover\_options](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_myisam_recover_options)** system variable set. In this case, when the server opens a **MyISAM** table, it checks whether the table is marked as crashed or whether the open count variable for the table is not 0 and you are running the server with external locking disabled. If either of these conditions is true, the following happens:

The server checks the table for errors.

If the server finds an error, it tries to do a fast table repair (with sorting and without re-creating the data file).

If the repair fails because of an error in the data file (for example, a duplicate-key error), the server tries again, this time re-creating the data file.

If the repair still fails, the server tries once more with the old repair option method (write row by row without sorting). This method should be able to repair any type of error and has low disk space requirements.

If the recovery wouldn't be able to recover all rows from previously completed statements and you didn't specify **FORCE** in the value of the **[myisam\_recover\_options](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_myisam_recover_options)** system variable, automatic repair aborts with an error message in the error log:

Error: Couldn't repair table: test.g00pages

If you specify **FORCE**, a warning like this is written instead:

Warning: Found 344 of 354 rows when repairing ./test/g00pages

If the automatic recovery value includes **BACKUP**, the recovery process creates files with names of the form ***tbl\_name-datetime***.BAK. You should have a **cron** script that automatically moves these files from the database directories to backup media.

### 16.2.2 Space Needed for Keys

**MyISAM** tables use B-tree indexes. You can roughly calculate the size for the index file as **(key\_length+4)/0.67**, summed over all keys. This is for the worst case when all keys are inserted in sorted order and the table doesn't have any compressed keys.

String indexes are space compressed. If the first index part is a string, it is also prefix compressed. Space compression makes the index file smaller than the worst-case figure if a string column has a lot of trailing space or is a [**VARCHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char) column that is not always used to the full length. Prefix compression is used on keys that start with a string. Prefix compression helps if there are many strings with an identical prefix.

In **MyISAM** tables, you can also prefix compress numbers by specifying the **PACK\_KEYS=1** table option when you create the table. Numbers are stored with the high byte first, so this helps when you have many integer keys that have an identical prefix.

### 16.2.3 MyISAM Table Storage Formats

[16.2.3.1 Static (Fixed-Length) Table Characteristics](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#static-format)

[16.2.3.2 Dynamic Table Characteristics](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#dynamic-format)

[16.2.3.3 Compressed Table Characteristics](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#compressed-format)

**MyISAM** supports three different storage formats. Two of them, fixed and dynamic format, are chosen automatically depending on the type of columns you are using. The third, compressed format, can be created only with the **[myisampack](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisampack" \o "4.6.6 myisampack — Generate Compressed, Read-Only MyISAM Tables)** utility (see [Section 4.6.6, “myisampack — Generate Compressed, Read-Only MyISAM Tables”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#myisampack)).

When you use [**CREATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table) or [**ALTER TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table) for a table that has no [**BLOB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) or [**TEXT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) columns, you can force the table format to **FIXED** or **DYNAMIC** with the **ROW\_FORMAT** table option.

See [Section 13.1.20, “CREATE TABLE Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table), for information about **ROW\_FORMAT**.

You can decompress (unpack) compressed **MyISAM** tables using **[myisamchk](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)** [--unpack](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#option_myisamchk_unpack); see [Section 4.6.4, “myisamchk — MyISAM Table-Maintenance Utility”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#myisamchk), for more information.

#### 16.2.3.1 Static (Fixed-Length) Table Characteristics

Static format is the default for **MyISAM** tables. It is used when the table contains no variable-length columns ([**VARCHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char), [**VARBINARY**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#binary-varbinary), [**BLOB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob), or [**TEXT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob)). Each row is stored using a fixed number of bytes.

Of the three **MyISAM** storage formats, static format is the simplest and most secure (least subject to corruption). It is also the fastest of the on-disk formats due to the ease with which rows in the data file can be found on disk: To look up a row based on a row number in the index, multiply the row number by the row length to calculate the row position. Also, when scanning a table, it is very easy to read a constant number of rows with each disk read operation.

The security is evidenced if your computer crashes while the MySQL server is writing to a fixed-format **MyISAM** file. In this case, **[myisamchk](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)** can easily determine where each row starts and ends, so it can usually reclaim all rows except the partially written one. **MyISAM** table indexes can always be reconstructed based on the data rows.

**Note**

Fixed-length row format is available only for tables having no [**BLOB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) or [**TEXT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) columns. Creating a table having such columns with an explicit **ROW\_FORMAT** clause does not raise an error or warning; the format specification is ignored.

Static-format tables have these characteristics:

[**CHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char) and [**VARCHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char) columns are space-padded to the specified column width, although the column type is not altered. [**BINARY**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#binary-varbinary) and [**VARBINARY**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#binary-varbinary) columns are padded with **0x00** bytes to the column width.

**NULL** columns require additional space in the row to record whether their values are **NULL**. Each **NULL** column takes one bit extra, rounded up to the nearest byte.

Very quick.

Easy to cache.

Easy to reconstruct after a crash, because rows are located in fixed positions.

Reorganization is unnecessary unless you delete a huge number of rows and want to return free disk space to the operating system. To do this, use [**OPTIMIZE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#optimize-table) or **[myisamchk -r](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)**.

Usually require more disk space than dynamic-format tables.

The expected row length in bytes for static-sized rows is calculated using the following expression:

row length = 1

+ (***sum of column lengths***)

+ (***number of NULL columns*** + ***delete\_flag*** + 7)/8

+ (***number of variable-length columns***)

***delete\_flag*** is 1 for tables with static row format. Static tables use a bit in the row record for a flag that indicates whether the row has been deleted. ***delete\_flag*** is 0 for dynamic tables because the flag is stored in the dynamic row header.

#### 16.2.3.2 Dynamic Table Characteristics

Dynamic storage format is used if a **MyISAM** table contains any variable-length columns ([**VARCHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char), [**VARBINARY**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#binary-varbinary), [**BLOB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob), or [**TEXT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob)), or if the table was created with the **ROW\_FORMAT=DYNAMIC** table option.

Dynamic format is a little more complex than static format because each row has a header that indicates how long it is. A row can become fragmented (stored in noncontiguous pieces) when it is made longer as a result of an update.

You can use [**OPTIMIZE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#optimize-table) or **[myisamchk -r](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)** to defragment a table. If you have fixed-length columns that you access or change frequently in a table that also contains some variable-length columns, it might be a good idea to move the variable-length columns to other tables just to avoid fragmentation.

Dynamic-format tables have these characteristics:

All string columns are dynamic except those with a length less than four.

Each row is preceded by a bitmap that indicates which columns contain the empty string (for string columns) or zero (for numeric columns). This does not include columns that contain **NULL** values. If a string column has a length of zero after trailing space removal, or a numeric column has a value of zero, it is marked in the bitmap and not saved to disk. Nonempty strings are saved as a length byte plus the string contents.

**NULL** columns require additional space in the row to record whether their values are **NULL**. Each **NULL** column takes one bit extra, rounded up to the nearest byte.

Much less disk space usually is required than for fixed-length tables.

Each row uses only as much space as is required. However, if a row becomes larger, it is split into as many pieces as are required, resulting in row fragmentation. For example, if you update a row with information that extends the row length, the row becomes fragmented. In this case, you may have to run [**OPTIMIZE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#optimize-table) or **[myisamchk -r](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)** from time to time to improve performance. Use **[myisamchk -ei](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)** to obtain table statistics.

More difficult than static-format tables to reconstruct after a crash, because rows may be fragmented into many pieces and links (fragments) may be missing.

The expected row length for dynamic-sized rows is calculated using the following expression:

3

+ (***number of columns*** + 7) / 8

+ (***number of char columns***)

+ (***packed size of numeric columns***)

+ (***length of strings***)

+ (***number of NULL columns*** + 7) / 8

There is a penalty of 6 bytes for each link. A dynamic row is linked whenever an update causes an enlargement of the row. Each new link is at least 20 bytes, so the next enlargement probably goes in the same link. If not, another link is created. You can find the number of links using **[myisamchk -ed](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)**. All links may be removed with [**OPTIMIZE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#optimize-table) or **[myisamchk -r](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)**.

#### 16.2.3.3 Compressed Table Characteristics

Compressed storage format is a read-only format that is generated with the **[myisampack](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisampack" \o "4.6.6 myisampack — Generate Compressed, Read-Only MyISAM Tables)** tool. Compressed tables can be uncompressed with **[myisamchk](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)**.

Compressed tables have the following characteristics:

Compressed tables take very little disk space. This minimizes disk usage, which is helpful when using slow disks (such as CD-ROMs).

Each row is compressed separately, so there is very little access overhead. The header for a row takes up one to three bytes depending on the biggest row in the table. Each column is compressed differently. There is usually a different Huffman tree for each column. Some of the compression types are:

Suffix space compression.

Prefix space compression.

Numbers with a value of zero are stored using one bit.

If values in an integer column have a small range, the column is stored using the smallest possible type. For example, a [**BIGINT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#integer-types) column (eight bytes) can be stored as a [**TINYINT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#integer-types) column (one byte) if all its values are in the range from **-128** to **127**.

If a column has only a small set of possible values, the data type is converted to [**ENUM**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#enum).

A column may use any combination of the preceding compression types.

Can be used for fixed-length or dynamic-length rows.

**Note**

While a compressed table is read only, and you cannot therefore update or add rows in the table, DDL (Data Definition Language) operations are still valid. For example, you may still use **DROP** to drop the table, and [**TRUNCATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#truncate-table) to empty the table.

### 16.2.4 MyISAM Table Problems

[16.2.4.1 Corrupted MyISAM Tables](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#corrupted-myisam-tables)

[16.2.4.2 Problems from Tables Not Being Closed Properly](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#myisam-table-close)

The file format that MySQL uses to store data has been extensively tested, but there are always circumstances that may cause database tables to become corrupted. The following discussion describes how this can happen and how to handle it.

#### 16.2.4.1 Corrupted MyISAM Tables

Even though the **MyISAM** table format is very reliable (all changes to a table made by an SQL statement are written before the statement returns), you can still get corrupted tables if any of the following events occur:

The **[mysqld](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "mysqld" \o "4.3.1 mysqld — The MySQL Server)** process is killed in the middle of a write.

An unexpected computer shutdown occurs (for example, the computer is turned off).

Hardware failures.

You are using an external program (such as **[myisamchk](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)**) to modify a table that is being modified by the server at the same time.

A software bug in the MySQL or **MyISAM** code.

Typical symptoms of a corrupt table are:

You get the following error while selecting data from the table:

Incorrect key file for table: '...'. Try to repair it

Queries don't find rows in the table or return incomplete results.

You can check the health of a **MyISAM** table using the [**CHECK TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#check-table) statement, and repair a corrupted **MyISAM** table with [**REPAIR TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#repair-table). When **[mysqld](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "mysqld" \o "4.3.1 mysqld — The MySQL Server)** is not running, you can also check or repair a table with the **[myisamchk](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)** command. See [Section 13.7.3.2, “CHECK TABLE Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#check-table), [Section 13.7.3.5, “REPAIR TABLE Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#repair-table), and [Section 4.6.4, “myisamchk — MyISAM Table-Maintenance Utility”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#myisamchk).

If your tables become corrupted frequently, you should try to determine why this is happening. The most important thing to know is whether the table became corrupted as a result of an unexpected server exit. You can verify this easily by looking for a recent **restarted mysqld** message in the error log. If there is such a message, it is likely that table corruption is a result of the server dying. Otherwise, corruption may have occurred during normal operation. This is a bug. You should try to create a reproducible test case that demonstrates the problem. See [Section B.3.3.3, “What to Do If MySQL Keeps Crashing”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\error-handling.html#crashing), and [Section 5.9, “Debugging MySQL”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#debugging-mysql).

#### 16.2.4.2 Problems from Tables Not Being Closed Properly

Each **MyISAM** index file (.MYI file) has a counter in the header that can be used to check whether a table has been closed properly. If you get the following warning from [**CHECK TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#check-table) or **[myisamchk](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)**, it means that this counter has gone out of sync:

clients are using or haven't closed the table properly

This warning doesn't necessarily mean that the table is corrupted, but you should at least check the table.

The counter works as follows:

The first time a table is updated in MySQL, a counter in the header of the index files is incremented.

The counter is not changed during further updates.

When the last instance of a table is closed (because a [**FLUSH TABLES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#flush-tables) operation was performed or because there is no room in the table cache), the counter is decremented if the table has been updated at any point.

When you repair the table or check the table and it is found to be okay, the counter is reset to zero.

To avoid problems with interaction with other processes that might check the table, the counter is not decremented on close if it was zero.

In other words, the counter can become incorrect only under these conditions:

A **MyISAM** table is copied without first issuing [**LOCK TABLES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#lock-tables) and [**FLUSH TABLES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#flush-tables).

MySQL has crashed between an update and the final close. (The table may still be okay because MySQL always issues writes for everything between each statement.)

A table was modified by **[myisamchk --recover](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)** or **[myisamchk --update-state](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisamchk" \o "4.6.4 myisamchk — MyISAM Table-Maintenance Utility)** at the same time that it was in use by **[mysqld](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "mysqld" \o "4.3.1 mysqld — The MySQL Server)**.

Multiple **[mysqld](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "mysqld" \o "4.3.1 mysqld — The MySQL Server)** servers are using the table and one server performed a [**REPAIR TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#repair-table) or [**CHECK TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#check-table) on the table while it was in use by another server. In this setup, it is safe to use [**CHECK TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#check-table), although you might get the warning from other servers. However, [**REPAIR TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#repair-table) should be avoided because when one server replaces the data file with a new one, this is not known to the other servers.

In general, it is a bad idea to share a data directory among multiple servers. See [Section 5.8, “Running Multiple MySQL Instances on One Machine”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#multiple-servers), for additional discussion.

## 16.3 The MEMORY Storage Engine

The **MEMORY** storage engine (formerly known as **HEAP**) creates special-purpose tables with contents that are stored in memory. Because the data is vulnerable to crashes, hardware issues, or power outages, only use these tables as temporary work areas or read-only caches for data pulled from other tables.

**Table 16.4 MEMORY Storage Engine Features**

| **Feature** | **Support** |
| --- | --- |
| ***B-tree indexes*** | Yes |
| ***Backup/point-in-time recovery*** (Implemented in the server, rather than in the storage engine.) | Yes |
| ***Cluster database support*** | No |
| ***Clustered indexes*** | No |
| ***Compressed data*** | No |
| ***Data caches*** | N/A |
| ***Encrypted data*** | Yes (Implemented in the server via encryption functions.) |
| ***Foreign key support*** | No |
| ***Full-text search indexes*** | No |
| ***Geospatial data type support*** | No |
| ***Geospatial indexing support*** | No |
| ***Hash indexes*** | Yes |
| ***Index caches*** | N/A |
| ***Locking granularity*** | Table |
| ***MVCC*** | No |
| ***Replication support*** (Implemented in the server, rather than in the storage engine.) | Limited (See the discussion later in this section.) |
| ***Storage limits*** | RAM |
| ***T-tree indexes*** | No |
| ***Transactions*** | No |
| ***Update statistics for data dictionary*** | Yes |

[When to Use MEMORY or NDB Cluster](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine-compared-cluster)

[Partitioning](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine-partitioning)

[Performance Characteristics](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine-performance-characteristics)

[Characteristics of MEMORY Tables](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine-characteristics-of-memory-tables)

[DDL Operations for MEMORY Tables](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine-ddl-operations-for-memory-tables)

[Indexes](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine-indexes)

[User-Created and Temporary Tables](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine-user-created-and-temporary-tables)

[Loading Data](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine-loading-data)

[MEMORY Tables and Replication](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-tables-replication)

[Managing Memory Use](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine-managing-memory-use)

[Additional Resources](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine-additional-resources)

### When to Use MEMORY or NDB Cluster

Developers looking to deploy applications that use the **MEMORY** storage engine for important, highly available, or frequently updated data should consider whether NDB Cluster is a better choice. A typical use case for the **MEMORY** engine involves these characteristics:

Operations involving transient, non-critical data such as session management or caching. When the MySQL server halts or restarts, the data in **MEMORY** tables is lost.

In-memory storage for fast access and low latency. Data volume can fit entirely in memory without causing the operating system to swap out virtual memory pages.

A read-only or read-mostly data access pattern (limited updates).

NDB Cluster offers the same features as the **MEMORY** engine with higher performance levels, and provides additional features not available with **MEMORY**:

Row-level locking and multiple-thread operation for low contention between clients.

Scalability even with statement mixes that include writes.

Optional disk-backed operation for data durability.

Shared-nothing architecture and multiple-host operation with no single point of failure, enabling 99.999% availability.

Automatic data distribution across nodes; application developers need not craft custom sharding or partitioning solutions.

Support for variable-length data types (including [**BLOB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) and [**TEXT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob)) not supported by **MEMORY**.

### Partitioning

**MEMORY** tables cannot be partitioned.

### Performance Characteristics

**MEMORY** performance is constrained by contention resulting from single-thread execution and table lock overhead when processing updates. This limits scalability when load increases, particularly for statement mixes that include writes.

Despite the in-memory processing for **MEMORY** tables, they are not necessarily faster than **[InnoDB](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\innodb-storage-engine.html" \o "Chapter 15 The InnoDB Storage Engine)** tables on a busy server, for general-purpose queries, or under a read/write workload. In particular, the table locking involved with performing updates can slow down concurrent usage of **MEMORY** tables from multiple sessions.

Depending on the kinds of queries performed on a **MEMORY** table, you might create indexes as either the default hash data structure (for looking up single values based on a unique key), or a general-purpose B-tree data structure (for all kinds of queries involving equality, inequality, or range operators such as less than or greater than). The following sections illustrate the syntax for creating both kinds of indexes. A common performance issue is using the default hash indexes in workloads where B-tree indexes are more efficient.

### Characteristics of MEMORY Tables

The **MEMORY** storage engine does not create any files on disk. The table definition is stored in the MySQL data dictionary.

**MEMORY** tables have the following characteristics:

Space for **MEMORY** tables is allocated in small blocks. Tables use 100% dynamic hashing for inserts. No overflow area or extra key space is needed. No extra space is needed for free lists. Deleted rows are put in a linked list and are reused when you insert new data into the table. **MEMORY** tables also have none of the problems commonly associated with deletes plus inserts in hashed tables.

**MEMORY** tables use a fixed-length row-storage format. Variable-length types such as [**VARCHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char) are stored using a fixed length.

**MEMORY** tables cannot contain [**BLOB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) or [**TEXT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) columns.

**MEMORY** includes support for **AUTO\_INCREMENT** columns.

Non-**TEMPORARY** **MEMORY** tables are shared among all clients, just like any other non-**TEMPORARY** table.

### DDL Operations for MEMORY Tables

To create a **MEMORY** table, specify the clause **ENGINE=MEMORY** on the [**CREATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table) statement.

CREATE TABLE t (i INT) ENGINE = MEMORY;

As indicated by the engine name, **MEMORY** tables are stored in memory. They use hash indexes by default, which makes them very fast for single-value lookups, and very useful for creating temporary tables. However, when the server shuts down, all rows stored in **MEMORY** tables are lost. The tables themselves continue to exist because their definitions are stored in the MySQL data dictionary, but they are empty when the server restarts.

This example shows how you might create, use, and remove a **MEMORY** table:

mysql> **CREATE TABLE test ENGINE=MEMORY**

**SELECT ip,SUM(downloads) AS down**

**FROM log\_table GROUP BY ip;**

mysql> **SELECT COUNT(ip),AVG(down) FROM test;**

mysql> **DROP TABLE test;**

The maximum size of **MEMORY** tables is limited by the **[max\_heap\_table\_size](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_max_heap_table_size)** system variable, which has a default value of 16MB. To enforce different size limits for **MEMORY** tables, change the value of this variable. The value in effect for [**CREATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table), or a subsequent [**ALTER TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table) or [**TRUNCATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#truncate-table), is the value used for the life of the table. A server restart also sets the maximum size of existing **MEMORY** tables to the global **[max\_heap\_table\_size](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_max_heap_table_size)** value. You can set the size for individual tables as described later in this section.

### Indexes

The **MEMORY** storage engine supports both **HASH** and **BTREE** indexes. You can specify one or the other for a given index by adding a **USING** clause as shown here:

CREATE TABLE lookup

(id INT, INDEX USING HASH (id))

ENGINE = MEMORY;

CREATE TABLE lookup

(id INT, INDEX USING BTREE (id))

ENGINE = MEMORY;

For general characteristics of B-tree and hash indexes, see [Section 8.3.1, “How MySQL Uses Indexes”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\optimization.html#mysql-indexes).

**MEMORY** tables can have up to 64 indexes per table, 16 columns per index and a maximum key length of 3072 bytes.

If a **MEMORY** table hash index has a high degree of key duplication (many index entries containing the same value), updates to the table that affect key values and all deletes are significantly slower. The degree of this slowdown is proportional to the degree of duplication (or, inversely proportional to the index cardinality). You can use a **BTREE** index to avoid this problem.

**MEMORY** tables can have nonunique keys. (This is an uncommon feature for implementations of hash indexes.)

Columns that are indexed can contain **NULL** values.

### User-Created and Temporary Tables

**MEMORY** table contents are stored in memory, which is a property that **MEMORY** tables share with internal temporary tables that the server creates on the fly while processing queries. However, the two types of tables differ in that **MEMORY** tables are not subject to storage conversion, whereas internal temporary tables are:

If an internal temporary table becomes too large, the server automatically converts it to on-disk storage, as described in [Section 8.4.4, “Internal Temporary Table Use in MySQL”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\optimization.html#internal-temporary-tables).

User-created **MEMORY** tables are never converted to disk tables.

### Loading Data

To populate a **MEMORY** table when the MySQL server starts, you can use the **[init\_file](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_init_file)** system variable. For example, you can put statements such as [**INSERT INTO ... SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert-select) or [**LOAD DATA**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#load-data) into a file to load the table from a persistent data source, and use **[init\_file](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_init_file)** to name the file. See [Section 5.1.8, “Server System Variables”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#server-system-variables), and [Section 13.2.7, “LOAD DATA Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#load-data).

### MEMORY Tables and Replication

When a replication source server shuts down and restarts, its [**MEMORY**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine) tables become empty. To replicate this effect to replicas, the first time that the source uses a given [**MEMORY**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine) table after startup, it logs an event that notifies replicas that the table must be emptied by writing a [**DELETE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#delete) or (from MySQL 8.0.22) [**TRUNCATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#truncate-table) statement for that table to the binary log. When a replica server shuts down and restarts, its [**MEMORY**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine) tables also become empty, and it writes a [**DELETE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#delete) or (from MySQL 8.0.22) [**TRUNCATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#truncate-table) statement to its own binary log, which is passed on to any downstream replicas.

When you use [**MEMORY**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#memory-storage-engine) tables in a replication topology, in some situations, the table on the source and the table on the replica can differ. For information on handling each of these situations to prevent stale reads or errors, see [Section 17.5.1.21, “Replication and MEMORY Tables”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#replication-features-memory).

### Managing Memory Use

The server needs sufficient memory to maintain all **MEMORY** tables that are in use at the same time.

Memory is not reclaimed if you delete individual rows from a **MEMORY** table. Memory is reclaimed only when the entire table is deleted. Memory that was previously used for deleted rows is re-used for new rows within the same table. To free all the memory used by a **MEMORY** table when you no longer require its contents, execute [**DELETE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#delete) or [**TRUNCATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#truncate-table) to remove all rows, or remove the table altogether using [**DROP TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#drop-table). To free up the memory used by deleted rows, use **ALTER TABLE ENGINE=MEMORY** to force a table rebuild.

The memory needed for one row in a **MEMORY** table is calculated using the following expression:

SUM\_OVER\_ALL\_BTREE\_KEYS(***max\_length\_of\_key*** + sizeof(char\*) \* 4)

+ SUM\_OVER\_ALL\_HASH\_KEYS(sizeof(char\*) \* 2)

+ ALIGN(***length\_of\_row***+1, sizeof(char\*))

**ALIGN()** represents a round-up factor to cause the row length to be an exact multiple of the **char** pointer size. **sizeof(char\*)** is 4 on 32-bit machines and 8 on 64-bit machines.

As mentioned earlier, the **[max\_heap\_table\_size](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_max_heap_table_size)** system variable sets the limit on the maximum size of **MEMORY** tables. To control the maximum size for individual tables, set the session value of this variable before creating each table. (Do not change the global **[max\_heap\_table\_size](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_max_heap_table_size)** value unless you intend the value to be used for **MEMORY** tables created by all clients.) The following example creates two **MEMORY** tables, with a maximum size of 1MB and 2MB, respectively:

mysql> **SET max\_heap\_table\_size = 1024\*1024;**

Query OK, 0 rows affected (0.00 sec)

mysql> **CREATE TABLE t1 (id INT, UNIQUE(id)) ENGINE = MEMORY;**

Query OK, 0 rows affected (0.01 sec)

mysql> **SET max\_heap\_table\_size = 1024\*1024\*2;**

Query OK, 0 rows affected (0.00 sec)

mysql> **CREATE TABLE t2 (id INT, UNIQUE(id)) ENGINE = MEMORY;**

Query OK, 0 rows affected (0.00 sec)

Both tables revert to the server's global **[max\_heap\_table\_size](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_max_heap_table_size)** value if the server restarts.

You can also specify a **MAX\_ROWS** table option in [**CREATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table) statements for **MEMORY** tables to provide a hint about the number of rows you plan to store in them. This does not enable the table to grow beyond the **[max\_heap\_table\_size](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_max_heap_table_size)** value, which still acts as a constraint on maximum table size. For maximum flexibility in being able to use **MAX\_ROWS**, set **[max\_heap\_table\_size](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_max_heap_table_size)** at least as high as the value to which you want each **MEMORY** table to be able to grow.

### Additional Resources

A forum dedicated to the **MEMORY** storage engine is available at <https://forums.mysql.com/list.php?92>.

## 16.4 The CSV Storage Engine

[16.4.1 Repairing and Checking CSV Tables](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#se-csv-repair)

[16.4.2 CSV Limitations](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#se-csv-limitations)

The **CSV** storage engine stores data in text files using comma-separated values format.

The **CSV** storage engine is always compiled into the MySQL server.

To examine the source for the **CSV** engine, look in the storage/csv directory of a MySQL source distribution.

When you create a **CSV** table, the server creates a plain text data file having a name that begins with the table name and has a .CSV extension. When you store data into the table, the storage engine saves it into the data file in comma-separated values format.

mysql> **CREATE TABLE test (i INT NOT NULL, c CHAR(10) NOT NULL)**

**ENGINE = CSV;**

Query OK, 0 rows affected (0.06 sec)

mysql> **INSERT INTO test VALUES(1,'record one'),(2,'record two');**

Query OK, 2 rows affected (0.05 sec)

Records: 2 Duplicates: 0 Warnings: 0

mysql> **SELECT \* FROM test;**

+---+------------+

| i | c |

+---+------------+

| 1 | record one |

| 2 | record two |

+---+------------+

2 rows in set (0.00 sec)

Creating a **CSV** table also creates a corresponding metafile that stores the state of the table and the number of rows that exist in the table. The name of this file is the same as the name of the table with the extension CSM.

If you examine the test.CSV file in the database directory created by executing the preceding statements, its contents should look like this:

"1","record one"

"2","record two"

This format can be read, and even written, by spreadsheet applications such as Microsoft Excel.

### 16.4.1 Repairing and Checking CSV Tables

The **CSV** storage engine supports the [**CHECK TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#check-table) and [**REPAIR TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#repair-table) statements to verify and, if possible, repair a damaged **CSV** table.

When running the [**CHECK TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#check-table) statement, the **CSV** file is checked for validity by looking for the correct field separators, escaped fields (matching or missing quotation marks), the correct number of fields compared to the table definition and the existence of a corresponding **CSV** metafile. The first invalid row discovered causes an error. Checking a valid table produces output like that shown here:

mysql> **CHECK TABLE csvtest;**

+--------------+-------+----------+----------+

| Table | Op | Msg\_type | Msg\_text |

+--------------+-------+----------+----------+

| test.csvtest | check | status | OK |

+--------------+-------+----------+----------+

A check on a corrupted table returns a fault such as

mysql> **CHECK TABLE csvtest;**

+--------------+-------+----------+----------+

| Table | Op | Msg\_type | Msg\_text |

+--------------+-------+----------+----------+

| test.csvtest | check | error | Corrupt |

+--------------+-------+----------+----------+

To repair a table, use [**REPAIR TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#repair-table), which copies as many valid rows from the existing **CSV** data as possible, and then replaces the existing **CSV** file with the recovered rows. Any rows beyond the corrupted data are lost.

mysql> **REPAIR TABLE csvtest;**

+--------------+--------+----------+----------+

| Table | Op | Msg\_type | Msg\_text |

+--------------+--------+----------+----------+

| test.csvtest | repair | status | OK |

+--------------+--------+----------+----------+

**Warning**

During repair, only the rows from the **CSV** file up to the first damaged row are copied to the new table. All other rows from the first damaged row to the end of the table are removed, even valid rows.

### 16.4.2 CSV Limitations

The **CSV** storage engine does not support indexing.

The **CSV** storage engine does not support partitioning.

All tables that you create using the **CSV** storage engine must have the **NOT NULL** attribute on all columns.

## 16.5 The ARCHIVE Storage Engine

The **ARCHIVE** storage engine produces special-purpose tables that store large amounts of unindexed data in a very small footprint.

**Table 16.5 ARCHIVE Storage Engine Features**

| **Feature** | **Support** |
| --- | --- |
| ***B-tree indexes*** | No |
| ***Backup/point-in-time recovery*** (Implemented in the server, rather than in the storage engine.) | Yes |
| ***Cluster database support*** | No |
| ***Clustered indexes*** | No |
| ***Compressed data*** | Yes |
| ***Data caches*** | No |
| ***Encrypted data*** | Yes (Implemented in the server via encryption functions.) |
| ***Foreign key support*** | No |
| ***Full-text search indexes*** | No |
| ***Geospatial data type support*** | Yes |
| ***Geospatial indexing support*** | No |
| ***Hash indexes*** | No |
| ***Index caches*** | No |
| ***Locking granularity*** | Row |
| ***MVCC*** | No |
| ***Replication support*** (Implemented in the server, rather than in the storage engine.) | Yes |
| ***Storage limits*** | None |
| ***T-tree indexes*** | No |
| ***Transactions*** | No |
| ***Update statistics for data dictionary*** | Yes |

The **ARCHIVE** storage engine is included in MySQL binary distributions. To enable this storage engine if you build MySQL from source, invoke **CMake** with the [-DWITH\_ARCHIVE\_STORAGE\_ENGINE](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\installing.html#option_cmake_storage_engine_options) option.

To examine the source for the **ARCHIVE** engine, look in the storage/archive directory of a MySQL source distribution.

You can check whether the **ARCHIVE** storage engine is available with the [**SHOW ENGINES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-engines) statement.

When you create an **ARCHIVE** table, the storage engine creates files with names that begin with the table name. The data file has an extension of .ARZ. An .ARN file may appear during optimization operations.

The **ARCHIVE** engine supports [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert), [**REPLACE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#replace), and [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select), but not [**DELETE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#delete) or [**UPDATE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#update). It does support **ORDER BY** operations, [**BLOB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) columns, and spatial data types (see [Section 11.4.1, “Spatial Data Types”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#spatial-type-overview)). Geographic spatial reference systems are not supported. The **ARCHIVE** engine uses row-level locking.

The **ARCHIVE** engine supports the **AUTO\_INCREMENT** column attribute. The **AUTO\_INCREMENT** column can have either a unique or nonunique index. Attempting to create an index on any other column results in an error. The **ARCHIVE** engine also supports the **AUTO\_INCREMENT** table option in [**CREATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table) statements to specify the initial sequence value for a new table or reset the sequence value for an existing table, respectively.

**ARCHIVE** does not support inserting a value into an **AUTO\_INCREMENT** column less than the current maximum column value. Attempts to do so result in an [**ER\_DUP\_KEY**](https://dev.mysql.com/doc/mysql-errors/8.0/en/server-error-reference.html#error_er_dup_key) error.

The **ARCHIVE** engine ignores [**BLOB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) columns if they are not requested and scans past them while reading.

The **ARCHIVE** storage engine does not support partitioning.

***Storage:*** Rows are compressed as they are inserted. The **ARCHIVE** engine uses **zlib** lossless data compression (see <http://www.zlib.net/>). You can use [**OPTIMIZE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#optimize-table) to analyze the table and pack it into a smaller format (for a reason to use [**OPTIMIZE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#optimize-table), see later in this section). The engine also supports [**CHECK TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#check-table). There are several types of insertions that are used:

An [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert) statement just pushes rows into a compression buffer, and that buffer flushes as necessary. The insertion into the buffer is protected by a lock. A [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select) forces a flush to occur.

A bulk insert is visible only after it completes, unless other inserts occur at the same time, in which case it can be seen partially. A [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select) never causes a flush of a bulk insert unless a normal insert occurs while it is loading.

***Retrieval***: On retrieval, rows are uncompressed on demand; there is no row cache. A [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select) operation performs a complete table scan: When a [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select) occurs, it finds out how many rows are currently available and reads that number of rows. [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select) is performed as a consistent read. Note that lots of [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select) statements during insertion can deteriorate the compression, unless only bulk inserts are used. To achieve better compression, you can use [**OPTIMIZE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#optimize-table) or [**REPAIR TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#repair-table). The number of rows in **ARCHIVE** tables reported by [**SHOW TABLE STATUS**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-table-status) is always accurate. See [Section 13.7.3.4, “OPTIMIZE TABLE Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#optimize-table), [Section 13.7.3.5, “REPAIR TABLE Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#repair-table), and [Section 13.7.7.38, “SHOW TABLE STATUS Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-table-status).

### Additional Resources

A forum dedicated to the **ARCHIVE** storage engine is available at <https://forums.mysql.com/list.php?112>.

## 16.6 The BLACKHOLE Storage Engine

The **BLACKHOLE** storage engine acts as a “black hole” that accepts data but throws it away and does not store it. Retrievals always return an empty result:

mysql> **CREATE TABLE test(i INT, c CHAR(10)) ENGINE = BLACKHOLE;**

Query OK, 0 rows affected (0.03 sec)

mysql> **INSERT INTO test VALUES(1,'record one'),(2,'record two');**

Query OK, 2 rows affected (0.00 sec)

Records: 2 Duplicates: 0 Warnings: 0

mysql> **SELECT \* FROM test;**

Empty set (0.00 sec)

To enable the **BLACKHOLE** storage engine if you build MySQL from source, invoke **CMake** with the [-DWITH\_BLACKHOLE\_STORAGE\_ENGINE](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\installing.html#option_cmake_storage_engine_options) option.

To examine the source for the **BLACKHOLE** engine, look in the sql directory of a MySQL source distribution.

When you create a **BLACKHOLE** table, the server creates the table definition in the global data dictionary. There are no files associated with the table.

The **BLACKHOLE** storage engine supports all kinds of indexes. That is, you can include index declarations in the table definition.

The maximum key length is 3072 bytes as of MySQL 8.0.26. Prior to 8.0.26, the maximum key length is 1000 bytes.

The **BLACKHOLE** storage engine does not support partitioning.

You can check whether the **BLACKHOLE** storage engine is available with the [**SHOW ENGINES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-engines) statement.

Inserts into a **BLACKHOLE** table do not store any data, but if statement based binary logging is enabled, the SQL statements are logged and replicated to replica servers. This can be useful as a repeater or filter mechanism.

Suppose that your application requires replica-side filtering rules, but transferring all binary log data to the replica first results in too much traffic. In such a case, it is possible to set up on the replication source server a “dummy” replica process whose default storage engine is **BLACKHOLE**, depicted as follows:

**Figure 16.1 Replication using BLACKHOLE for Filtering**

The source writes to its binary log. The “dummy” **[mysqld](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "mysqld" \o "4.3.1 mysqld — The MySQL Server)** process acts as a replica, applying the desired combination of **replicate-do-\*** and **replicate-ignore-\*** rules, and writes a new, filtered binary log of its own. (See [Section 17.1.6, “Replication and Binary Logging Options and Variables”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#replication-options).) This filtered log is provided to the replica.

The dummy process does not actually store any data, so there is little processing overhead incurred by running the additional **[mysqld](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "mysqld" \o "4.3.1 mysqld — The MySQL Server)** process on the replication source server. This type of setup can be repeated with additional replicas.

[**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert) triggers for **BLACKHOLE** tables work as expected. However, because the **BLACKHOLE** table does not actually store any data, [**UPDATE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#update) and [**DELETE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#delete) triggers are not activated: The **FOR EACH ROW** clause in the trigger definition does not apply because there are no rows.

Other possible uses for the **BLACKHOLE** storage engine include:

Verification of dump file syntax.

Measurement of the overhead from binary logging, by comparing performance using **BLACKHOLE** with and without binary logging enabled.

**BLACKHOLE** is essentially a “no-op” storage engine, so it could be used for finding performance bottlenecks not related to the storage engine itself.

The **BLACKHOLE** engine is transaction-aware, in the sense that committed transactions are written to the binary log and rolled-back transactions are not.

***Blackhole Engine and Auto Increment Columns***

The **BLACKHOLE** engine is a no-op engine. Any operations performed on a table using **BLACKHOLE** have no effect. This should be borne in mind when considering the behavior of primary key columns that auto increment. The engine does not automatically increment field values, and does not retain auto increment field state. This has important implications in replication.

Consider the following replication scenario where all three of the following conditions apply:

On a source server there is a blackhole table with an auto increment field that is a primary key.

On a replica the same table exists but using the MyISAM engine.

Inserts are performed into the source's table without explicitly setting the auto increment value in the **INSERT** statement itself or through using a **SET INSERT\_ID** statement.

In this scenario replication fails with a duplicate entry error on the primary key column.

In statement based replication, the value of **INSERT\_ID** in the context event is always the same. Replication therefore fails due to trying insert a row with a duplicate value for a primary key column.

In row based replication, the value that the engine returns for the row always be the same for each insert. This results in the replica attempting to replay two insert log entries using the same value for the primary key column, and so replication fails.

***Column Filtering***

When using row-based replication, (**[binlog\_format=ROW](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\replication.html" \l "sysvar_binlog_format)**), a replica where the last columns are missing from a table is supported, as described in the section [Section 17.5.1.9, “Replication with Differing Table Definitions on Source and Replica”](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\replication.html" \l "replication-features-differing-tables" \o "17.5.1.9 Replication with Differing Table Definitions on Source and Replica).

This filtering works on the replica side, that is, the columns are copied to the replica before they are filtered out. There are at least two cases where it is not desirable to copy the columns to the replica:

If the data is confidential, so the replica server should not have access to it.

If the source has many replicas, filtering before sending to the replicas may reduce network traffic.

Source column filtering can be achieved using the **BLACKHOLE** engine. This is carried out in a way similar to how source table filtering is achieved - by using the **BLACKHOLE** engine and the [--replicate-do-table](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#option_mysqld_replicate-do-table) or [--replicate-ignore-table](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#option_mysqld_replicate-ignore-table) option.

The setup for the source is:

CREATE TABLE t1 (public\_col\_1, ..., public\_col\_N,

secret\_col\_1, ..., secret\_col\_M) ENGINE=MyISAM;

The setup for the trusted replica is:

CREATE TABLE t1 (public\_col\_1, ..., public\_col\_N) ENGINE=BLACKHOLE;

The setup for the untrusted replica is:

CREATE TABLE t1 (public\_col\_1, ..., public\_col\_N) ENGINE=MyISAM;

## 16.7 The MERGE Storage Engine

[16.7.1 MERGE Table Advantages and Disadvantages](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#merge-table-advantages)

[16.7.2 MERGE Table Problems](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#merge-table-problems)

The **MERGE** storage engine, also known as the **MRG\_MyISAM** engine, is a collection of identical **MyISAM** tables that can be used as one. “Identical” means that all tables have identical column data types and index information. You cannot merge **MyISAM** tables in which the columns are listed in a different order, do not have exactly the same data types in corresponding columns, or have the indexes in different order. However, any or all of the **MyISAM** tables can be compressed with **[myisampack](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisampack" \o "4.6.6 myisampack — Generate Compressed, Read-Only MyISAM Tables)**. See [Section 4.6.6, “myisampack — Generate Compressed, Read-Only MyISAM Tables”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#myisampack). Differences between tables such as these do not matter:

Names of corresponding columns and indexes can differ.

Comments for tables, columns, and indexes can differ.

Table options such as **AVG\_ROW\_LENGTH**, **MAX\_ROWS**, or **PACK\_KEYS** can differ.

An alternative to a **MERGE** table is a partitioned table, which stores partitions of a single table in separate files and enables some operations to be performed more efficiently. For more information, see [Chapter 24, *Partitioning*](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\partitioning.html).

When you create a **MERGE** table, MySQL creates a .MRG file on disk that contains the names of the underlying **MyISAM** tables that should be used as one. The table format of the **MERGE** table is stored in the MySQL data dictionary. The underlying tables do not have to be in the same database as the **MERGE** table.

You can use [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select), [**DELETE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#delete), [**UPDATE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#update), and [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert) on **MERGE** tables. You must have [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#priv_select), [**DELETE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#priv_delete), and [**UPDATE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#priv_update) privileges on the **MyISAM** tables that you map to a **MERGE** table.

**Note**

The use of **MERGE** tables entails the following security issue: If a user has access to **MyISAM** table ***t***, that user can create a **MERGE** table ***m*** that accesses ***t***. However, if the user's privileges on ***t*** are subsequently revoked, the user can continue to access ***t*** by doing so through ***m***.

Use of [**DROP TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#drop-table) with a **MERGE** table drops only the **MERGE** specification. The underlying tables are not affected.

To create a **MERGE** table, you must specify a **UNION=(*list-of-tables*)** option that indicates which **MyISAM** tables to use. You can optionally specify an **INSERT\_METHOD** option to control how inserts into the **MERGE** table take place. Use a value of **FIRST** or **LAST** to cause inserts to be made in the first or last underlying table, respectively. If you specify no **INSERT\_METHOD** option or if you specify it with a value of **NO**, inserts into the **MERGE** table are not permitted and attempts to do so result in an error.

The following example shows how to create a **MERGE** table:

mysql> **CREATE TABLE t1 (**

-> **a INT NOT NULL AUTO\_INCREMENT PRIMARY KEY,**

-> **message CHAR(20)) ENGINE=MyISAM;**

mysql> **CREATE TABLE t2 (**

-> **a INT NOT NULL AUTO\_INCREMENT PRIMARY KEY,**

-> **message CHAR(20)) ENGINE=MyISAM;**

mysql> **INSERT INTO t1 (message) VALUES ('Testing'),('table'),('t1');**

mysql> **INSERT INTO t2 (message) VALUES ('Testing'),('table'),('t2');**

mysql> **CREATE TABLE total (**

-> **a INT NOT NULL AUTO\_INCREMENT,**

-> **message CHAR(20), INDEX(a))**

-> **ENGINE=MERGE UNION=(t1,t2) INSERT\_METHOD=LAST;**

Column **a** is indexed as a **PRIMARY KEY** in the underlying **MyISAM** tables, but not in the **MERGE** table. There it is indexed but not as a **PRIMARY KEY** because a **MERGE** table cannot enforce uniqueness over the set of underlying tables. (Similarly, a column with a **UNIQUE** index in the underlying tables should be indexed in the **MERGE** table but not as a **UNIQUE** index.)

After creating the **MERGE** table, you can use it to issue queries that operate on the group of tables as a whole:

mysql> **SELECT \* FROM total;**

+---+---------+

| a | message |

+---+---------+

| 1 | Testing |

| 2 | table |

| 3 | t1 |

| 1 | Testing |

| 2 | table |

| 3 | t2 |

+---+---------+

To remap a **MERGE** table to a different collection of **MyISAM** tables, you can use one of the following methods:

**DROP** the **MERGE** table and re-create it.

Use **ALTER TABLE *tbl\_name* UNION=(...)** to change the list of underlying tables.

It is also possible to use **ALTER TABLE ... UNION=()** (that is, with an empty [**UNION**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#union) clause) to remove all of the underlying tables. However, in this case, the table is effectively empty and inserts fail because there is no underlying table to take new rows. Such a table might be useful as a template for creating new **MERGE** tables with [**CREATE TABLE ... LIKE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table-like).

The underlying table definitions and indexes must conform closely to the definition of the **MERGE** table. Conformance is checked when a table that is part of a **MERGE** table is opened, not when the **MERGE** table is created. If any table fails the conformance checks, the operation that triggered the opening of the table fails. This means that changes to the definitions of tables within a **MERGE** may cause a failure when the **MERGE** table is accessed. The conformance checks applied to each table are:

The underlying table and the **MERGE** table must have the same number of columns.

The column order in the underlying table and the **MERGE** table must match.

Additionally, the specification for each corresponding column in the parent **MERGE** table and the underlying tables are compared and must satisfy these checks:

The column type in the underlying table and the **MERGE** table must be equal.

The column length in the underlying table and the **MERGE** table must be equal.

The column of the underlying table and the **MERGE** table can be **NULL**.

The underlying table must have at least as many indexes as the **MERGE** table. The underlying table may have more indexes than the **MERGE** table, but cannot have fewer.

**Note**

A known issue exists where indexes on the same columns must be in identical order, in both the **MERGE** table and the underlying **MyISAM** table. See Bug #33653.

Each index must satisfy these checks:

The index type of the underlying table and the **MERGE** table must be the same.

The number of index parts (that is, multiple columns within a compound index) in the index definition for the underlying table and the **MERGE** table must be the same.

For each index part:

Index part lengths must be equal.

Index part types must be equal.

Index part languages must be equal.

Check whether index parts can be **NULL**.

If a **MERGE** table cannot be opened or used because of a problem with an underlying table, [**CHECK TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#check-table) displays information about which table caused the problem.

### Additional Resources

A forum dedicated to the **MERGE** storage engine is available at <https://forums.mysql.com/list.php?93>.

### 16.7.1 MERGE Table Advantages and Disadvantages

**MERGE** tables can help you solve the following problems:

Easily manage a set of log tables. For example, you can put data from different months into separate tables, compress some of them with **[myisampack](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\programs.html" \l "myisampack" \o "4.6.6 myisampack — Generate Compressed, Read-Only MyISAM Tables)**, and then create a **MERGE** table to use them as one.

Obtain more speed. You can split a large read-only table based on some criteria, and then put individual tables on different disks. A **MERGE** table structured this way could be much faster than using a single large table.

Perform more efficient searches. If you know exactly what you are looking for, you can search in just one of the underlying tables for some queries and use a **MERGE** table for others. You can even have many different **MERGE** tables that use overlapping sets of tables.

Perform more efficient repairs. It is easier to repair individual smaller tables that are mapped to a **MERGE** table than to repair a single large table.

Instantly map many tables as one. A **MERGE** table need not maintain an index of its own because it uses the indexes of the individual tables. As a result, **MERGE** table collections are very fast to create or remap. (You must still specify the index definitions when you create a **MERGE** table, even though no indexes are created.)

If you have a set of tables from which you create a large table on demand, you can instead create a **MERGE** table from them on demand. This is much faster and saves a lot of disk space.

Exceed the file size limit for the operating system. Each **MyISAM** table is bound by this limit, but a collection of **MyISAM** tables is not.

You can create an alias or synonym for a **MyISAM** table by defining a **MERGE** table that maps to that single table. There should be no really notable performance impact from doing this (only a couple of indirect calls and **memcpy()** calls for each read).

The disadvantages of **MERGE** tables are:

You can use only identical **MyISAM** tables for a **MERGE** table.

Some **MyISAM** features are unavailable in **MERGE** tables. For example, you cannot create **FULLTEXT** indexes on **MERGE** tables. (You can create **FULLTEXT** indexes on the underlying **MyISAM** tables, but you cannot search the **MERGE** table with a full-text search.)

If the **MERGE** table is nontemporary, all underlying **MyISAM** tables must be nontemporary. If the **MERGE** table is temporary, the **MyISAM** tables can be any mix of temporary and nontemporary.

**MERGE** tables use more file descriptors than **MyISAM** tables. If 10 clients are using a **MERGE** table that maps to 10 tables, the server uses (10 × 10) + 10 file descriptors. (10 data file descriptors for each of the 10 clients, and 10 index file descriptors shared among the clients.)

Index reads are slower. When you read an index, the **MERGE** storage engine needs to issue a read on all underlying tables to check which one most closely matches a given index value. To read the next index value, the **MERGE** storage engine needs to search the read buffers to find the next value. Only when one index buffer is used up does the storage engine need to read the next index block. This makes **MERGE** indexes much slower on **[eq\_ref](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\optimization.html" \l "jointype_eq_ref)** searches, but not much slower on [**ref**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\optimization.html#jointype_ref) searches. For more information about **[eq\_ref](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\optimization.html" \l "jointype_eq_ref)** and [**ref**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\optimization.html#jointype_ref), see [Section 13.8.2, “EXPLAIN Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#explain).

### 16.7.2 MERGE Table Problems

The following are known problems with **MERGE** tables:

In versions of MySQL Server prior to 5.1.23, it was possible to create temporary merge tables with nontemporary child MyISAM tables.

From versions 5.1.23, MERGE children were locked through the parent table. If the parent was temporary, it was not locked and so the children were not locked either. Parallel use of the MyISAM tables corrupted them.

If you use [**ALTER TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table) to change a **MERGE** table to another storage engine, the mapping to the underlying tables is lost. Instead, the rows from the underlying **MyISAM** tables are copied into the altered table, which then uses the specified storage engine.

The **INSERT\_METHOD** table option for a **MERGE** table indicates which underlying **MyISAM** table to use for inserts into the **MERGE** table. However, use of the **AUTO\_INCREMENT** table option for that **MyISAM** table has no effect for inserts into the **MERGE** table until at least one row has been inserted directly into the **MyISAM** table.

A **MERGE** table cannot maintain uniqueness constraints over the entire table. When you perform an [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert), the data goes into the first or last **MyISAM** table (as determined by the **INSERT\_METHOD** option). MySQL ensures that unique key values remain unique within that **MyISAM** table, but not over all the underlying tables in the collection.

Because the **MERGE** engine cannot enforce uniqueness over the set of underlying tables, [**REPLACE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#replace) does not work as expected. The two key facts are:

[**REPLACE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#replace) can detect unique key violations only in the underlying table to which it is going to write (which is determined by the **INSERT\_METHOD** option). This differs from violations in the **MERGE** table itself.

If [**REPLACE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#replace) detects a unique key violation, it changes only the corresponding row in the underlying table it is writing to; that is, the first or last table, as determined by the **INSERT\_METHOD** option.

Similar considerations apply for [**INSERT ... ON DUPLICATE KEY UPDATE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert-on-duplicate).

**MERGE** tables do not support partitioning. That is, you cannot partition a **MERGE** table, nor can any of a **MERGE** table's underlying **MyISAM** tables be partitioned.

You should not use [**ANALYZE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#analyze-table), [**REPAIR TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#repair-table), [**OPTIMIZE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#optimize-table), [**ALTER TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table), [**DROP TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#drop-table), [**DELETE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#delete) without a **WHERE** clause, or [**TRUNCATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#truncate-table) on any of the tables that are mapped into an open **MERGE** table. If you do so, the **MERGE** table may still refer to the original table and yield unexpected results. To work around this problem, ensure that no **MERGE** tables remain open by issuing a [**FLUSH TABLES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#flush-tables) statement prior to performing any of the named operations.

The unexpected results include the possibility that the operation on the **MERGE** table reports table corruption. If this occurs after one of the named operations on the underlying **MyISAM** tables, the corruption message is spurious. To deal with this, issue a [**FLUSH TABLES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#flush-tables) statement after modifying the **MyISAM** tables.

[**DROP TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#drop-table) on a table that is in use by a **MERGE** table does not work on Windows because the **MERGE** storage engine's table mapping is hidden from the upper layer of MySQL. Windows does not permit open files to be deleted, so you first must flush all **MERGE** tables (with [**FLUSH TABLES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#flush-tables)) or drop the **MERGE** table before dropping the table.

The definition of the **MyISAM** tables and the **MERGE** table are checked when the tables are accessed (for example, as part of a [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select) or [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert) statement). The checks ensure that the definitions of the tables and the parent **MERGE** table definition match by comparing column order, types, sizes and associated indexes. If there is a difference between the tables, an error is returned and the statement fails. Because these checks take place when the tables are opened, any changes to the definition of a single table, including column changes, column ordering, and engine alterations cause the statement to fail.

The order of indexes in the **MERGE** table and its underlying tables should be the same. If you use [**ALTER TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table) to add a **UNIQUE** index to a table used in a **MERGE** table, and then use [**ALTER TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table) to add a nonunique index on the **MERGE** table, the index ordering is different for the tables if there was already a nonunique index in the underlying table. (This happens because [**ALTER TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table) puts **UNIQUE** indexes before nonunique indexes to facilitate rapid detection of duplicate keys.) Consequently, queries on tables with such indexes may return unexpected results.

If you encounter an error message similar to ERROR 1017 (HY000): Can't find file: '***tbl\_name***.MRG' (errno: 2), it generally indicates that some of the underlying tables do not use the **MyISAM** storage engine. Confirm that all of these tables are **MyISAM**.

The maximum number of rows in a **MERGE** table is 264 (~1.844E+19; the same as for a **MyISAM** table). It is not possible to merge multiple **MyISAM** tables into a single **MERGE** table that would have more than this number of rows.

Use of underlying **MyISAM** tables of differing row formats with a parent **MERGE** table is currently known to fail. See Bug #32364.

You cannot change the union list of a nontemporary **MERGE** table when [**LOCK TABLES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#lock-tables) is in effect. The following does not work:

CREATE TABLE m1 ... ENGINE=MRG\_MYISAM ...;

LOCK TABLES t1 WRITE, t2 WRITE, m1 WRITE;

ALTER TABLE m1 ... UNION=(t1,t2) ...;

However, you can do this with a temporary **MERGE** table.

You cannot create a **MERGE** table with **CREATE ... SELECT**, neither as a temporary **MERGE** table, nor as a nontemporary **MERGE** table. For example:

CREATE TABLE m1 ... ENGINE=MRG\_MYISAM ... SELECT ...;

Attempts to do this result in an error: ***tbl\_name*** is not **BASE TABLE**.

In some cases, differing **PACK\_KEYS** table option values among the **MERGE** and underlying tables cause unexpected results if the underlying tables contain **CHAR** or **BINARY** columns. As a workaround, use **ALTER TABLE** to ensure that all involved tables have the same **PACK\_KEYS** value. (Bug #50646)

## 16.8 The FEDERATED Storage Engine

[16.8.1 FEDERATED Storage Engine Overview](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#federated-description)

[16.8.2 How to Create FEDERATED Tables](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#federated-create)

[16.8.3 FEDERATED Storage Engine Notes and Tips](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#federated-usagenotes)

[16.8.4 FEDERATED Storage Engine Resources](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#federated-storage-engine-resources)

The **FEDERATED** storage engine lets you access data from a remote MySQL database without using replication or cluster technology. Querying a local **FEDERATED** table automatically pulls the data from the remote (federated) tables. No data is stored on the local tables.

To include the **FEDERATED** storage engine if you build MySQL from source, invoke **CMake** with the [-DWITH\_FEDERATED\_STORAGE\_ENGINE](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\installing.html#option_cmake_storage_engine_options) option.

The **FEDERATED** storage engine is not enabled by default in the running server; to enable **FEDERATED**, you must start the MySQL server binary using the --federated option.

To examine the source for the **FEDERATED** engine, look in the storage/federated directory of a MySQL source distribution.

### 16.8.1 FEDERATED Storage Engine Overview

When you create a table using one of the standard storage engines (such as **MyISAM**, **CSV** or **InnoDB**), the table consists of the table definition and the associated data. When you create a **FEDERATED** table, the table definition is the same, but the physical storage of the data is handled on a remote server.

A **FEDERATED** table consists of two elements:

A remote server with a database table, which in turn consists of the table definition (stored in the MySQL data dictionary) and the associated table. The table type of the remote table may be any type supported by the remote **mysqld** server, including **MyISAM** or **InnoDB**.

A local server with a database table, where the table definition matches that of the corresponding table on the remote server. The table definition is stored in the data dictionary. There is no data file on the local server. Instead, the table definition includes a connection string that points to the remote table.

When executing queries and statements on a **FEDERATED** table on the local server, the operations that would normally insert, update or delete information from a local data file are instead sent to the remote server for execution, where they update the data file on the remote server or return matching rows from the remote server.

The basic structure of a **FEDERATED** table setup is shown in [Figure 16.2, “FEDERATED Table Structure”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#figure-se-federated-structure).

**Figure 16.2 FEDERATED Table Structure**

When a client issues an SQL statement that refers to a **FEDERATED** table, the flow of information between the local server (where the SQL statement is executed) and the remote server (where the data is physically stored) is as follows:

The storage engine looks through each column that the **FEDERATED** table has and constructs an appropriate SQL statement that refers to the remote table.

The statement is sent to the remote server using the MySQL client API.

The remote server processes the statement and the local server retrieves any result that the statement produces (an affected-rows count or a result set).

If the statement produces a result set, each column is converted to internal storage engine format that the **FEDERATED** engine expects and can use to display the result to the client that issued the original statement.

The local server communicates with the remote server using MySQL client C API functions. It invokes **[mysql\_real\_query()](https://dev.mysql.com/doc/c-api/8.0/en/mysql-real-query.html" \t "_top)** to send the statement. To read a result set, it uses **[mysql\_store\_result()](https://dev.mysql.com/doc/c-api/8.0/en/mysql-store-result.html" \t "_top)** and fetches rows one at a time using **[mysql\_fetch\_row()](https://dev.mysql.com/doc/c-api/8.0/en/mysql-fetch-row.html" \t "_top)**.

### 16.8.2 How to Create FEDERATED Tables

[16.8.2.1 Creating a FEDERATED Table Using CONNECTION](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#federated-create-connection)

[16.8.2.2 Creating a FEDERATED Table Using CREATE SERVER](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#federated-create-server)

To create a **FEDERATED** table you should follow these steps:

Create the table on the remote server. Alternatively, make a note of the table definition of an existing table, perhaps using the [**SHOW CREATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-create-table) statement.

Create the table on the local server with an identical table definition, but adding the connection information that links the local table to the remote table.

For example, you could create the following table on the remote server:

CREATE TABLE test\_table (

id INT(20) NOT NULL AUTO\_INCREMENT,

name VARCHAR(32) NOT NULL DEFAULT '',

other INT(20) NOT NULL DEFAULT '0',

PRIMARY KEY (id),

INDEX name (name),

INDEX other\_key (other)

)

ENGINE=MyISAM

DEFAULT CHARSET=utf8mb4;

To create the local table that is federated to the remote table, there are two options available. You can either create the local table and specify the connection string (containing the server name, login, password) to be used to connect to the remote table using the **CONNECTION**, or you can use an existing connection that you have previously created using the [**CREATE SERVER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-server) statement.

**Important**

When you create the local table it must have an identical field definition to the remote table.

**Note**

You can improve the performance of a **FEDERATED** table by adding indexes to the table on the host. The optimization occurs because the query sent to the remote server includes the contents of the **WHERE** clause and is sent to the remote server and subsequently executed locally. This reduces the network traffic that would otherwise request the entire table from the server for local processing.

#### 16.8.2.1 Creating a FEDERATED Table Using CONNECTION

To use the first method, you must specify the **CONNECTION** string after the engine type in a [**CREATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table) statement. For example:

CREATE TABLE federated\_table (

id INT(20) NOT NULL AUTO\_INCREMENT,

name VARCHAR(32) NOT NULL DEFAULT '',

other INT(20) NOT NULL DEFAULT '0',

PRIMARY KEY (id),

INDEX name (name),

INDEX other\_key (other)

)

ENGINE=FEDERATED

DEFAULT CHARSET=utf8mb4

CONNECTION='mysql://fed\_user@remote\_host:9306/federated/test\_table';

**Note**

**CONNECTION** replaces the **COMMENT** used in some previous versions of MySQL.

The **CONNECTION** string contains the information required to connect to the remote server containing the table in which the data physically resides. The connection string specifies the server name, login credentials, port number and database/table information. In the example, the remote table is on the server **remote\_host**, using port 9306. The name and port number should match the host name (or IP address) and port number of the remote MySQL server instance you want to use as your remote table.

The format of the connection string is as follows:

***scheme***://***user\_name***[:***password***]@***host\_name***[:***port\_num***]/***db\_name***/***tbl\_name***

Where:

***scheme***: A recognized connection protocol. Only **mysql** is supported as the ***scheme*** value at this point.

***user\_name***: The user name for the connection. This user must have been created on the remote server, and must have suitable privileges to perform the required actions ([**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select), [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert), [**UPDATE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#update), and so forth) on the remote table.

***password***: (Optional) The corresponding password for ***user\_name***.

***host\_name***: The host name or IP address of the remote server.

***port\_num***: (Optional) The port number for the remote server. The default is 3306.

***db\_name***: The name of the database holding the remote table.

***tbl\_name***: The name of the remote table. The name of the local and the remote table do not have to match.

Sample connection strings:

CONNECTION='mysql://username:password@hostname:port/database/tablename'

CONNECTION='mysql://username@hostname/database/tablename'

CONNECTION='mysql://username:password@hostname/database/tablename'

#### 16.8.2.2 Creating a FEDERATED Table Using CREATE SERVER

If you are creating a number of **FEDERATED** tables on the same server, or if you want to simplify the process of creating **FEDERATED** tables, you can use the [**CREATE SERVER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-server) statement to define the server connection parameters, just as you would with the **CONNECTION** string.

The format of the [**CREATE SERVER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-server) statement is:

CREATE SERVER

***server\_name***

FOREIGN DATA WRAPPER ***wrapper\_name***

OPTIONS (***option*** [, ***option***] ...)

The ***server\_name*** is used in the connection string when creating a new **FEDERATED** table.

For example, to create a server connection identical to the **CONNECTION** string:

CONNECTION='mysql://fed\_user@remote\_host:9306/federated/test\_table';

You would use the following statement:

CREATE SERVER fedlink

FOREIGN DATA WRAPPER mysql

OPTIONS (USER 'fed\_user', HOST 'remote\_host', PORT 9306, DATABASE 'federated');

To create a **FEDERATED** table that uses this connection, you still use the **CONNECTION** keyword, but specify the name you used in the [**CREATE SERVER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-server) statement.

CREATE TABLE test\_table (

id INT(20) NOT NULL AUTO\_INCREMENT,

name VARCHAR(32) NOT NULL DEFAULT '',

other INT(20) NOT NULL DEFAULT '0',

PRIMARY KEY (id),

INDEX name (name),

INDEX other\_key (other)

)

ENGINE=FEDERATED

DEFAULT CHARSET=utf8mb4

CONNECTION='fedlink/test\_table';

The connection name in this example contains the name of the connection (**fedlink**) and the name of the table (**test\_table**) to link to, separated by a slash. If you specify only the connection name without a table name, the table name of the local table is used instead.

For more information on [**CREATE SERVER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-server), see [Section 13.1.18, “CREATE SERVER Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-server).

The [**CREATE SERVER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-server) statement accepts the same arguments as the **CONNECTION** string. The [**CREATE SERVER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-server) statement updates the rows in the **mysql.servers** table. See the following table for information on the correspondence between parameters in a connection string, options in the [**CREATE SERVER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-server) statement, and the columns in the **mysql.servers** table. For reference, the format of the **CONNECTION** string is as follows:

***scheme***://***user\_name***[:***password***]@***host\_name***[:***port\_num***]/***db\_name***/***tbl\_name***

|  |  |  |  |
| --- | --- | --- | --- |
| Description | CONNECTION string | [CREATE SERVER](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-server) option | mysql.servers column |
| Connection scheme | ***scheme*** | **wrapper\_name** | **Wrapper** |
| Remote user | ***user\_name*** | **USER** | **Username** |
| Remote password | ***password*** | **PASSWORD** | **Password** |
| Remote host | ***host\_name*** | **HOST** | **Host** |
| Remote port | ***port\_num*** | **PORT** | **Port** |
| Remote database | ***db\_name*** | **DATABASE** | **Db** |

### 16.8.3 FEDERATED Storage Engine Notes and Tips

You should be aware of the following points when using the **FEDERATED** storage engine:

**FEDERATED** tables may be replicated to other replicas, but you must ensure that the replica servers are able to use the user/password combination that is defined in the **CONNECTION** string (or the row in the **mysql.servers** table) to connect to the remote server.

The following items indicate features that the **FEDERATED** storage engine does and does not support:

The remote server must be a MySQL server.

The remote table that a **FEDERATED** table points to must exist before you try to access the table through the **FEDERATED** table.

It is possible for one **FEDERATED** table to point to another, but you must be careful not to create a loop.

A **FEDERATED** table does not support indexes in the usual sense; because access to the table data is handled remotely, it is actually the remote table that makes use of indexes. This means that, for a query that cannot use any indexes and so requires a full table scan, the server fetches all rows from the remote table and filters them locally. This occurs regardless of any **WHERE** or **LIMIT** used with this [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select) statement; these clauses are applied locally to the returned rows.

Queries that fail to use indexes can thus cause poor performance and network overload. In addition, since returned rows must be stored in memory, such a query can also lead to the local server swapping, or even hanging.

Care should be taken when creating a **FEDERATED** table since the index definition from an equivalent **MyISAM** or other table may not be supported. For example, creating a **FEDERATED** table fails if the table uses an index prefix on any [**VARCHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char), [**TEXT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) or [**BLOB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) columns. The following definition using **MyISAM** is valid:

CREATE TABLE `T1`(`A` VARCHAR(100),UNIQUE KEY(`A`(30))) ENGINE=MYISAM;

The key prefix in this example is incompatible with the **FEDERATED** engine, and the equivalent statement fails:

CREATE TABLE `T1`(`A` VARCHAR(100),UNIQUE KEY(`A`(30))) ENGINE=FEDERATED

CONNECTION='MYSQL://127.0.0.1:3306/TEST/T1';

If possible, you should try to separate the column and index definition when creating tables on both the remote server and the local server to avoid these index issues.

Internally, the implementation uses [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select), [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert), [**UPDATE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#update), and [**DELETE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#delete), but not [**HANDLER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#handler).

The **FEDERATED** storage engine supports [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select), [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert), [**UPDATE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#update), [**DELETE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#delete), [**TRUNCATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#truncate-table), and indexes. It does not support [**ALTER TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table), or any Data Definition Language statements that directly affect the structure of the table, other than [**DROP TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#drop-table). The current implementation does not use prepared statements.

**FEDERATED** accepts [**INSERT ... ON DUPLICATE KEY UPDATE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert-on-duplicate) statements, but if a duplicate-key violation occurs, the statement fails with an error.

Transactions are not supported.

**FEDERATED** performs bulk-insert handling such that multiple rows are sent to the remote table in a batch, which improves performance. Also, if the remote table is transactional, it enables the remote storage engine to perform statement rollback properly should an error occur. This capability has the following limitations:

The size of the insert cannot exceed the maximum packet size between servers. If the insert exceeds this size, it is broken into multiple packets and the rollback problem can occur.

Bulk-insert handling does not occur for [**INSERT ... ON DUPLICATE KEY UPDATE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert-on-duplicate).

There is no way for the **FEDERATED** engine to know if the remote table has changed. The reason for this is that this table must work like a data file that would never be written to by anything other than the database system. The integrity of the data in the local table could be breached if there was any change to the remote database.

When using a **CONNECTION** string, you cannot use an '@' character in the password. You can get round this limitation by using the [**CREATE SERVER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-server) statement to create a server connection.

The **[insert\_id](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_insert_id)** and [**timestamp**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_timestamp) options are not propagated to the data provider.

Any [**DROP TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#drop-table) statement issued against a **FEDERATED** table drops only the local table, not the remote table.

User-defined partitioning is not supported for **FEDERATED** tables.

### 16.8.4 FEDERATED Storage Engine Resources

The following additional resources are available for the **FEDERATED** storage engine:

A forum dedicated to the **FEDERATED** storage engine is available at <https://forums.mysql.com/list.php?105>.

## 16.9 The EXAMPLE Storage Engine

The **EXAMPLE** storage engine is a stub engine that does nothing. Its purpose is to serve as an example in the MySQL source code that illustrates how to begin writing new storage engines. As such, it is primarily of interest to developers.

To enable the **EXAMPLE** storage engine if you build MySQL from source, invoke **CMake** with the [-DWITH\_EXAMPLE\_STORAGE\_ENGINE](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\installing.html#option_cmake_storage_engine_options) option.

To examine the source for the **EXAMPLE** engine, look in the storage/example directory of a MySQL source distribution.

When you create an **EXAMPLE** table, no files are created. No data can be stored into the table. Retrievals return an empty result.

mysql> **CREATE TABLE test (i INT) ENGINE = EXAMPLE;**

Query OK, 0 rows affected (0.78 sec)

mysql> **INSERT INTO test VALUES(1),(2),(3);**

ERROR 1031 (HY000): Table storage engine for 'test' doesn't »

have this option

mysql> **SELECT \* FROM test;**

Empty set (0.31 sec)

The **EXAMPLE** storage engine does not support indexing.

The **EXAMPLE** storage engine does not support partitioning.

## 16.10 其他存储引擎

其他存储引擎可能来自第三方和使用了自定义存储引擎接口的社区成员。

第三方引擎不受MySQL支持。对于进一步的信息、文档、安装指南、错误报告或对这些引擎的任何帮助或协助，请直接联系引擎的开发者。

关于开发可与可插拔存储引擎架构一起使用的客户存储引擎的更多信息，请参见MySQL内部。编写自定义存储引擎

## 16.11 mysql存储引擎架构概览

[16.11.1 Pluggable Storage Engine Architecture](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#pluggable-storage)

[16.11.2 The Common Database Server Layer](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#pluggable-storage-common-layer)

MySQL的可插拔存储引擎架构使数据库专业人员能够为特定的应用需求选择一个专门的存储引擎，同时完全不需要管理任何特定的应用编码要求。MySQL服务器架构将应用程序员和DBA与存储层面的所有低级实施细节隔离开来，提供了一个一致且简单的应用模型和API。因此，尽管不同的存储引擎有不同的能力，但应用程序被屏蔽在这些差异之外。

MySQL的可插拔存储引擎架构如图16.3所示，"具有可插拔存储引擎的MySQL架构"。

**Figure 16.3 MySQL Architecture with Pluggable Storage Engines**

可插拔的存储引擎架构提供了一套标准的管理和支持服务，这些服务在所有底层存储引擎中是通用的。存储引擎本身是数据库服务器的组件，实际上是对在物理服务器层面上维护的底层数据进行操作。

这种高效和模块化的架构为那些希望专门针对特定应用需求的人提供了巨大的好处，例如数据仓库、交易处理或高可用性情况，同时享有利用一套独立于任何一个存储引擎的接口和服务的优势。

应用程序员和DBA通过高于存储引擎的连接器API和服务层与MySQL数据库互动。如果应用程序的变化带来了要求改变底层存储引擎的需求，或者需要增加一个或多个存储引擎来支持新的需求，则不需要进行重大的编码或流程改变来使事情顺利进行。MySQL服务器架构通过提供适用于各种存储引擎的一致且易于使用的API，使应用程序免受存储引擎的底层复杂性的影响。

### 16.11.1 Pluggable Storage Engine Architecture

MySQL Server uses a pluggable storage engine architecture that enables storage engines to be loaded into and unloaded from a running MySQL server.

***Plugging in a Storage Engine***

Before a storage engine can be used, the storage engine plugin shared library must be loaded into MySQL using the [**INSTALL PLUGIN**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#install-plugin) statement. For example, if the **EXAMPLE** engine plugin is named **example** and the shared library is named ha\_example.so, you load it with the following statement:

INSTALL PLUGIN example SONAME 'ha\_example.so';

To install a pluggable storage engine, the plugin file must be located in the MySQL plugin directory, and the user issuing the [**INSTALL PLUGIN**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#install-plugin) statement must have [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#priv_insert) privilege for the **mysql.plugin** table.

The shared library must be located in the MySQL server plugin directory, the location of which is given by the **[plugin\_dir](file:///E:\\backup\\%E4%B8%8B%E8%BD%BD\\refman-8.0-en.html-chapter\\refman-8.0-en.html-chapter\\server-administration.html" \l "sysvar_plugin_dir)** system variable.

***Unplugging a Storage Engine***

To unplug a storage engine, use the [**UNINSTALL PLUGIN**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#uninstall-plugin) statement:

UNINSTALL PLUGIN example;

If you unplug a storage engine that is needed by existing tables, those tables become inaccessible, but are still present on disk (where applicable). Ensure that there are no tables using a storage engine before you unplug the storage engine.

### 16.11.2 The Common Database Server Layer

MySQL可插拔存储引擎是MySQL数据库服务器中的一个组件，负责执行数据库的实际数据I/O操作，以及启用和执行针对特定应用需求的某些功能集。使用特定存储引擎的一个主要好处是，你只被交付给特定应用所需的功能，因此你在数据库中的系统开销较少，最终结果是更有效和更高的数据库性能。这也是MySQL一直以来被称为具有如此高的性能的原因之一，在行业标准的基准中与专有的单片机数据库相匹配或击败。

从技术角度来看，存储引擎中有哪些独特的支持性基础设施组件？一些关键的功能差异包括。Concurrency: Some applications have more granular lock requirements (such as row-level locks) than others. Choosing the right locking strategy can reduce overhead and therefore improve overall performance. This area also includes support for capabilities such as multi-version concurrency control or “snapshot” read.

Transaction Support: Not every application needs transactions, but for those that do, there are very well defined requirements such as ACID compliance and more.

Referential Integrity: The need to have the server enforce relational database referential integrity through DDL defined foreign keys.

Physical Storage: This involves everything from the overall page size for tables and indexes as well as the format used for storing data to physical disk.

Index Support: Different application scenarios tend to benefit from different index strategies. Each storage engine generally has its own indexing methods, although some (such as B-tree indexes) are common to nearly all engines.

Memory Caches: Different applications respond better to some memory caching strategies than others, so although some memory caches are common to all storage engines (such as those used for user connections), others are uniquely defined only when a particular storage engine is put in play.

Performance Aids: This includes multiple I/O threads for parallel operations, thread concurrency, database checkpointing, bulk insert handling, and more.

Miscellaneous Target Features: This may include support for geospatial operations, security restrictions for certain data manipulation operations, and other similar features.

Each set of the pluggable storage engine infrastructure components are designed to offer a selective set of benefits for a particular application. Conversely, avoiding a set of component features helps reduce unnecessary overhead. It stands to reason that understanding a particular application's set of requirements and selecting the proper MySQL storage engine can have a dramatic impact on overall system efficiency and performance.