

MySQL Performance Schema

Abstract

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Chapter 1 MySQL Performance Schema

The MySQL Performance Schema is a feature for monitoring MySQL Server execution at a low level. The Performance Schema has these characteristics:

- The Performance Schema provides a way to inspect internal execution of the server at runtime. It is implemented using the [PERFORMANCE_SCHEMA](#) storage engine and the [performance_schema](#) database. The Performance Schema focuses primarily on performance data. This differs from [INFORMATION_SCHEMA](#), which serves for inspection of metadata.
- The Performance Schema monitors server events. An “event” is anything the server does that takes time and has been instrumented so that timing information can be collected. In general, an event could be a function call, a wait for the operating system, a stage of an SQL statement execution such as parsing or sorting, or an entire statement or group of statements. Event collection provides access to information about synchronization calls (such as for mutexes) file and table I/O, table locks, and so forth for the server and for several storage engines.
- Performance Schema events are distinct from events written to the server's binary log (which describe data modifications) and Event Scheduler events (which are a type of stored program).
- Performance Schema events are specific to a given instance of the MySQL Server. Performance Schema tables are considered local to the server, and changes to them are not replicated or written to the binary log.
- Current events are available, as well as event histories and summaries. This enables you to determine how many times instrumented activities were performed and how much time they took. Event information is available to show the activities of specific threads, or activity associated with particular objects such as a mutex or file.
- The [PERFORMANCE_SCHEMA](#) storage engine collects event data using “instrumentation points” in server source code.
- Collected events are stored in tables in the [performance_schema](#) database. These tables can be queried using [SELECT](#) statements like other tables.
- Performance Schema configuration can be modified dynamically by updating tables in the [performance_schema](#) database through SQL statements. Configuration changes affect data collection immediately.
- Tables in the Performance Schema are in-memory tables that use no persistent on-disk storage. The contents are repopulated beginning at server startup and discarded at server shutdown.
- Monitoring is available on all platforms supported by MySQL.

Some limitations might apply: The types of timers might vary per platform. Instruments that apply to storage engines might not be implemented for all storage engines. Instrumentation of each third-party engine is the responsibility of the engine maintainer. See also [Restrictions on Performance Schema](#).

- Data collection is implemented by modifying the server source code to add instrumentation. There are no separate threads associated with the Performance Schema, unlike other features such as replication or the Event Scheduler.

The Performance Schema is intended to provide access to useful information about server execution while having minimal impact on server performance. The implementation follows these design goals:

- Activating the Performance Schema causes no changes in server behavior. For example, it does not cause thread scheduling to change, and it does not cause query execution plans (as shown by [EXPLAIN](#)) to change.

-
- Server monitoring occurs continuously and unobtrusively with very little overhead. Activating the Performance Schema does not make the server unusable.
 - The parser is unchanged. There are no new keywords or statements.
 - Execution of server code proceeds normally even if the Performance Schema fails internally.
 - When there is a choice between performing processing during event collection initially or during event retrieval later, priority is given to making collection faster. This is because collection is ongoing whereas retrieval is on demand and might never happen at all.
 - It is easy to add new instrumentation points.
 - Instrumentation is versioned. If the instrumentation implementation changes, previously instrumented code continues to work. This benefits developers of third-party plugins because it is not necessary to upgrade each plugin to stay synchronized with the latest Performance Schema changes.

Note

The MySQL `sys` schema is a set of objects that provides convenient access to data collected by the Performance Schema. The `sys` schema is installed by default. For usage instructions, see [MySQL sys Schema](#).

Chapter 2 Performance Schema Quick Start

This section briefly introduces the Performance Schema with examples that show how to use it. For additional examples, see [Chapter 14, Using the Performance Schema to Diagnose Problems](#).

The Performance Schema is enabled by default. To enable or disable it explicitly, start the server with the `performance_schema` variable set to an appropriate value. For example, use these lines in the server `my.cnf` file:

```
[mysqld]
performance_schema=ON
```

When the server starts, it sees `performance_schema` and attempts to initialize the Performance Schema. To verify successful initialization, use this statement:

```
mysql> SHOW VARIABLES LIKE 'performance_schema';
+-----+-----+
| Variable_name | Value |
+-----+-----+
| performance_schema | ON    |
+-----+-----+
```

A value of `ON` means that the Performance Schema initialized successfully and is ready for use. A value of `OFF` means that some error occurred. Check the server error log for information about what went wrong.

The Performance Schema is implemented as a storage engine. If this engine is available (which you should already have checked earlier), you should see it listed with a `SUPPORT` value of `YES` in the output from the Information Schema `ENGINES` table or the `SHOW ENGINES` statement:

```
mysql> SELECT * FROM INFORMATION_SCHEMA.ENGINES
      WHERE ENGINE='PERFORMANCE_SCHEMA'\G
***** 1. row *****
ENGINE: PERFORMANCE_SCHEMA
SUPPORT: YES
COMMENT: Performance Schema
TRANSACTIONS: NO
      XA: NO
      SAVEPOINTS: NO
mysql> SHOW ENGINES\G
...
Engine: PERFORMANCE_SCHEMA
Support: YES
Comment: Performance Schema
Transactions: NO
      XA: NO
      Savepoints: NO
...
```

The `PERFORMANCE_SCHEMA` storage engine operates on tables in the `performance_schema` database. You can make `performance_schema` the default database so that references to its tables need not be qualified with the database name:

```
mysql> USE performance_schema;
```

Performance Schema tables are stored in the `performance_schema` database. Information about the structure of this database and its tables can be obtained, as for any other database, by selecting from the `INFORMATION_SCHEMA` database or by using `SHOW` statements. For example, use either of these statements to see what Performance Schema tables exist:

```
mysql> SELECT TABLE_NAME FROM INFORMATION_SCHEMA.TABLES
      WHERE TABLE_SCHEMA = 'performance_schema';
+-----+
| TABLE_NAME |
+-----+
```

```

+-----+
| accounts
| cond_instances
...
| events_stages_current
| events_stages_history
| events_stages_history_long
| events_stages_summary_by_account_by_event_name
| events_stages_summary_by_host_by_event_name
| events_stages_summary_by_thread_by_event_name
| events_stages_summary_by_user_by_event_name
| events_stages_summary_global_by_event_name
| events_statements_current
| events_statements_history
| events_statements_history_long
...
| file_instances
| file_summary_by_event_name
| file_summary_by_instance
| host_cache
| hosts
| memory_summary_by_account_by_event_name
| memory_summary_by_host_by_event_name
| memory_summary_by_thread_by_event_name
| memory_summary_by_user_by_event_name
| memory_summary_global_by_event_name
| metadata_locks
| mutex_instances
| objects_summary_global_by_type
| performance_timers
| replication_connection_configuration
| replication_connection_status
| replication_applier_configuration
| replication_applier_status
| replication_applier_status_by_coordinator
| replication_applier_status_by_worker
| rlock_instances
| session_account_connect_attrs
| session_connect_attrs
| setup_actors
| setup_consumers
| setup_instruments
| setup_objects
| setup_timers
| socket_instances
| socket_summary_by_event_name
| socket_summary_by_instance
| table_handles
| table_io_waits_summary_by_index_usage
| table_io_waits_summary_by_table
| table_lock_waits_summary_by_table
| threads
| users
+-----+
mysql> SHOW TABLES FROM performance_schema;
+-----+
| Tables_in_performance_schema
+-----+
| accounts
| cond_instances
| events_stages_current
| events_stages_history
| events_stages_history_long
...

```

The number of Performance Schema tables increases over time as implementation of additional instrumentation proceeds.

The name of the `performance_schema` database is lowercase, as are the names of tables within it. Queries should specify the names in lowercase.

To see the structure of individual tables, use `SHOW CREATE TABLE`:

```
mysql> SHOW CREATE TABLE performance_schema.setup_consumers\G
***** 1. row *****
      Table: setup_consumers
Create Table: CREATE TABLE `setup_consumers` (
  `NAME` varchar(64) NOT NULL,
  `ENABLED` enum('YES','NO') NOT NULL
) ENGINE=PERFORMANCE_SCHEMA DEFAULT CHARSET=utf8
```

Table structure is also available by selecting from tables such as `INFORMATION_SCHEMA.COLUMNS` or by using statements such as `SHOW COLUMNS`.

Tables in the `performance_schema` database can be grouped according to the type of information in them: Current events, event histories and summaries, object instances, and setup (configuration) information. The following examples illustrate a few uses for these tables. For detailed information about the tables in each group, see [Chapter 10, Performance Schema Table Descriptions](#).

Initially, not all instruments and consumers are enabled, so the performance schema does not collect all events. To turn all of these on and enable event timing, execute two statements (the row counts may differ depending on MySQL version):

```
mysql> UPDATE performance_schema.setup_instruments
      SET ENABLED = 'YES', TIMED = 'YES';
Query OK, 560 rows affected (0.04 sec)
mysql> UPDATE performance_schema.setup_consumers
      SET ENABLED = 'YES';
Query OK, 10 rows affected (0.00 sec)
```

To see what the server is doing at the moment, examine the `events_waits_current` table. It contains one row per thread showing each thread's most recent monitored event:

```
mysql> SELECT *
      FROM performance_schema.events_waits_current\G
***** 1. row *****
      THREAD_ID: 0
      EVENT_ID: 5523
      END_EVENT_ID: 5523
      EVENT_NAME: wait/synch/mutex/mysys/THR_LOCK::mutex
      SOURCE: thr_lock.c:525
      TIMER_START: 201660494489586
      TIMER_END: 201660494576112
      TIMER_WAIT: 86526
      SPINS: NULL
      OBJECT_SCHEMA: NULL
      OBJECT_NAME: NULL
      INDEX_NAME: NULL
      OBJECT_TYPE: NULL
      OBJECT_INSTANCE_BEGIN: 142270668
      NESTING_EVENT_ID: NULL
      NESTING_EVENT_TYPE: NULL
      OPERATION: lock
      NUMBER_OF_BYTES: NULL
      FLAGS: 0
      ...
```

This event indicates that thread 0 was waiting for 86,526 picoseconds to acquire a lock on `THR_LOCK::mutex`, a mutex in the `mysys` subsystem. The first few columns provide the following information:

- The ID columns indicate which thread the event comes from and the event number.
- `EVENT_NAME` indicates what was instrumented and `SOURCE` indicates which source file contains the instrumented code.
- The timer columns show when the event started and stopped and how long it took. If an event is still in progress, the `TIMER_END` and `TIMER_WAIT` values are `NULL`. Timer values are approximate and expressed in picoseconds. For information about timers and event time collection, see [Section 5.1, “Performance Schema Event Timing”](#).

The history tables contain the same kind of rows as the current-events table but have more rows and show what the server has been doing “recently” rather than “currently.” The `events_waits_history` and `events_waits_history_long` tables contain the most recent 10 events per thread and most recent 10,000 events, respectively. For example, to see information for recent events produced by thread 13, do this:

```
mysql> SELECT EVENT_ID, EVENT_NAME, TIMER_WAIT
FROM performance_schema.events_waits_history
WHERE THREAD_ID = 13
ORDER BY EVENT_ID;
```

EVENT_ID	EVENT_NAME	TIMER_WAIT
86	wait/synch/mutex/mysys/THR_LOCK::mutex	686322
87	wait/synch/mutex/mysys/THR_LOCK_malloc	320535
88	wait/synch/mutex/mysys/THR_LOCK_malloc	339390
89	wait/synch/mutex/mysys/THR_LOCK_malloc	377100
90	wait/synch/mutex/sql/LOCK_plugin	614673
91	wait/synch/mutex/sql/LOCK_open	659925
92	wait/synch/mutex/sql/THD::LOCK_thd_data	494001
93	wait/synch/mutex/mysys/THR_LOCK_malloc	222489
94	wait/synch/mutex/mysys/THR_LOCK_malloc	214947
95	wait/synch/mutex/mysys/LOCK_alarm	312993

As new events are added to a history table, older events are discarded if the table is full.

Summary tables provide aggregated information for all events over time. The tables in this group summarize event data in different ways. To see which instruments have been executed the most times or have taken the most wait time, sort the `events_waits_summary_global_by_event_name` table on the `COUNT_STAR` or `SUM_TIMER_WAIT` column, which correspond to a `COUNT(*)` or `SUM(TIMER_WAIT)` value, respectively, calculated over all events:

```
mysql> SELECT EVENT_NAME, COUNT_STAR
FROM performance_schema.events_waits_summary_global_by_event_name
ORDER BY COUNT_STAR DESC LIMIT 10;
```

EVENT_NAME	COUNT_STAR
wait/synch/mutex/mysys/THR_LOCK_malloc	6419
wait/io/file/sql/FRM	452
wait/synch/mutex/sql/LOCK_plugin	337
wait/synch/mutex/mysys/THR_LOCK_open	187
wait/synch/mutex/mysys/LOCK_alarm	147
wait/synch/mutex/sql/THD::LOCK_thd_data	115
wait/io/file/myisam/kfile	102
wait/synch/mutex/sql/LOCK_global_system_variables	89
wait/synch/mutex/mysys/THR_LOCK::mutex	89
wait/synch/mutex/sql/LOCK_open	88

```
mysql> SELECT EVENT_NAME, SUM_TIMER_WAIT
FROM performance_schema.events_waits_summary_global_by_event_name
ORDER BY SUM_TIMER_WAIT DESC LIMIT 10;
```

EVENT_NAME	SUM_TIMER_WAIT
wait/io/file/sql/MYSQL_LOG	1599816582
wait/synch/mutex/mysys/THR_LOCK_malloc	1530083250
wait/io/file/sql/binlog_index	1385291934
wait/io/file/sql/FRM	1292823243
wait/io/file/myisam/kfile	411193611
wait/io/file/myisam/dfile	322401645
wait/synch/mutex/mysys/LOCK_alarm	145126935
wait/io/file/sql/casetest	104324715
wait/synch/mutex/sql/LOCK_plugin	86027823
wait/io/file/sql/pid	72591750

These results show that the `THR_LOCK_malloc` mutex is “hot,” both in terms of how often it is used and amount of time that threads wait attempting to acquire it.

Note

The `THR_LOCK_malloc` mutex is used only in debug builds. In production builds it is not hot because it is nonexistent.

Instance tables document what types of objects are instrumented. An instrumented object, when used by the server, produces an event. These tables provide event names and explanatory notes or status information. For example, the `file_instances` table lists instances of instruments for file I/O operations and their associated files:

```
mysql> SELECT *
      FROM performance_schema.file_instances\G
***** 1. row *****
FILE_NAME: /opt/mysql-log/60500/binlog.000007
EVENT_NAME: wait/io/file/sql/binlog
OPEN_COUNT: 0
***** 2. row *****
FILE_NAME: /opt/mysql/60500/data/mysql/tables_priv.MYI
EVENT_NAME: wait/io/file/myisam/kfile
OPEN_COUNT: 1
***** 3. row *****
FILE_NAME: /opt/mysql/60500/data/mysql/columns_priv.MYI
EVENT_NAME: wait/io/file/myisam/kfile
OPEN_COUNT: 1
...

```

Setup tables are used to configure and display monitoring characteristics. For example, `setup_instruments` lists the set of instruments for which events can be collected and shows which of them are enabled:

```
mysql> SELECT * FROM performance_schema.setup_instruments;
+-----+-----+-----+
| NAME                                | ENABLED | TIMED |
+-----+-----+-----+
...
| stage/sql/end                        | NO      | NO    |
| stage/sql/executing                 | NO      | NO    |
| stage/sql/init                      | NO      | NO    |
| stage/sql/insert                    | NO      | NO    |
...
| statement/sql/load                  | YES     | YES   |
| statement/sql/grant                 | YES     | YES   |
| statement/sql/check                 | YES     | YES   |
| statement/sql/flush                 | YES     | YES   |
...
| wait/synch/mutex/sql/LOCK_global_read_lock | YES     | YES   |

```

wait/synch/mutex/sql/LOCK_global_system_variables	YES	YES	
wait/synch/mutex/sql/LOCK_lock_db	YES	YES	
wait/synch/mutex/sql/LOCK_manager	YES	YES	
...			
wait/synch/rwlock/sql/LOCK_grant	YES	YES	
wait/synch/rwlock/sql/LOGGER::LOCK_logger	YES	YES	
wait/synch/rwlock/sql/LOCK_sys_init_connect	YES	YES	
wait/synch/rwlock/sql/LOCK_sys_init_slave	YES	YES	
...			
wait/io/file/sql/binlog	YES	YES	
wait/io/file/sql/binlog_index	YES	YES	
wait/io/file/sql/casetest	YES	YES	
wait/io/file/sql/dbopt	YES	YES	
...			

To understand how to interpret instrument names, see [Chapter 7, Performance Schema Instrument Naming Conventions](#).

To control whether events are collected for an instrument, set its `ENABLED` value to `YES` or `NO`. For example:

```
mysql> UPDATE performance_schema.setup_instruments
      SET ENABLED = 'NO'
      WHERE NAME = 'wait/synch/mutex/sql/LOCK_mysql_create_db';
```

The Performance Schema uses collected events to update tables in the `performance_schema` database, which act as “consumers” of event information. The `setup_consumers` table lists the available consumers and which are enabled:

```
mysql> SELECT * FROM performance_schema.setup_consumers;
```

NAME	ENABLED
events_stages_current	NO
events_stages_history	NO
events_stages_history_long	NO
events_statements_current	YES
events_statements_history	YES
events_statements_history_long	NO
events_transactions_current	NO
events_transactions_history	NO
events_transactions_history_long	NO
events_waits_current	NO
events_waits_history	NO
events_waits_history_long	NO
global_instrumentation	YES
thread_instrumentation	YES
statements_digest	YES

To control whether the Performance Schema maintains a consumer as a destination for event information, set its `ENABLED` value.

For more information about the setup tables and how to use them to control event collection, see [Section 5.2, “Performance Schema Event Filtering”](#).

There are some miscellaneous tables that do not fall into any of the previous groups. For example, `performance_timers` lists the available event timers and their characteristics. For information about timers, see [Section 5.1, “Performance Schema Event Timing”](#).

Chapter 3 Performance Schema Build Configuration

The Performance Schema is mandatory and always compiled in. It is possible to exclude certain parts of the Performance Schema instrumentation. For example, to exclude stage and statement instrumentation, do this:

```
$> cmake . \
      -DDISABLE_PSI_STAGE=1 \
      -DDISABLE_PSI_STATEMENT=1
```

For more information, see the descriptions of the `DISABLE_PSI_XXX` CMake options in [MySQL Source-Configuration Options](#).

If you install MySQL over a previous installation that was configured without the Performance Schema (or with an older version of the Performance Schema that has missing or out-of-date tables). One indication of this issue is the presence of messages such as the following in the error log:

```
[ERROR] Native table 'performance_schema'.'events_waits_history'
has the wrong structure
[ERROR] Native table 'performance_schema'.'events_waits_history_long'
has the wrong structure
...
```

To correct that problem, perform the MySQL upgrade procedure. See [Upgrading MySQL](#).

To verify whether a server was built with Performance Schema support, check its help output. If the Performance Schema is available, the output mentions several variables with names that begin with `performance_schema`:

```
$> mysqld --verbose --help
...
--performance_schema
           Enable the performance schema.
--performance_schema_events_waits_history_long_size=#
           Number of rows in events_waits_history_long.
...
```

You can also connect to the server and look for a line that names the `PERFORMANCE_SCHEMA` storage engine in the output from `SHOW ENGINES`:

```
mysql> SHOW ENGINES\G
...
  Engine: PERFORMANCE_SCHEMA
  Support: YES
  Comment: Performance Schema
  Transactions: NO
             XA: NO
  Savepoints: NO
...
```

If the Performance Schema was not configured into the server at build time, no row for `PERFORMANCE_SCHEMA` appears in the output from `SHOW ENGINES`. You might see `performance_schema` listed in the output from `SHOW DATABASES`, but it has no tables and cannot be used.

A line for `PERFORMANCE_SCHEMA` in the `SHOW ENGINES` output means that the Performance Schema is available, not that it is enabled. To enable it, you must do so at server startup, as described in the next section.

Chapter 4 Performance Schema Startup Configuration

To use the MySQL Performance Schema, it must be enabled at server startup to enable event collection to occur.

Assuming that the Performance Schema is available, it is enabled by default. To enable or disable it explicitly, start the server with the `performance_schema` variable set to an appropriate value. For example, use these lines in your `my.cnf` file:

```
[mysqld]
performance_schema=ON
```

If the server is unable to allocate any internal buffer during Performance Schema initialization, the Performance Schema disables itself and sets `performance_schema` to `OFF`, and the server runs without instrumentation.

The Performance Schema also permits instrument and consumer configuration at server startup.

To control an instrument at server startup, use an option of this form:

```
--performance-schema-instrument='instrument_name=value'
```

Here, `instrument_name` is an instrument name such as `wait/synch/mutex/sql/LOCK_open`, and `value` is one of these values:

- `OFF`, `FALSE`, or `0`: Disable the instrument
- `ON`, `TRUE`, or `1`: Enable and time the instrument
- `COUNTED`: Enable and count (rather than time) the instrument

Each `--performance-schema-instrument` option can specify only one instrument name, but multiple instances of the option can be given to configure multiple instruments. In addition, patterns are permitted in instrument names to configure instruments that match the pattern. To configure all condition synchronization instruments as enabled and counted, use this option:

```
--performance-schema-instrument='wait/synch/cond/%=COUNTED'
```

To disable all instruments, use this option:

```
--performance-schema-instrument='%=OFF'
```

Exception: The `memory/performance_schema/%` instruments are built in and cannot be disabled at startup.

Longer instrument name strings take precedence over shorter pattern names, regardless of order. For information about specifying patterns to select instruments, see [Section 5.9, “Naming Instruments or Consumers for Filtering Operations”](#).

An unrecognized instrument name is ignored. It is possible that a plugin installed later may create the instrument, at which time the name is recognized and configured.

To control a consumer at server startup, use an option of this form:

```
--performance-schema-consumer-consumer_name=value
```

Here, `consumer_name` is a consumer name such as `events_waits_history`, and `value` is one of these values:

- `OFF`, `FALSE`, or `0`: Do not collect events for the consumer

- `ON`, `TRUE`, or `1`: Collect events for the consumer

For example, to enable the `events_waits_history` consumer, use this option:

```
--performance-schema-consumer-events-waits-history=ON
```

The permitted consumer names can be found by examining the `setup_consumers` table. Patterns are not permitted. Consumer names in the `setup_consumers` table use underscores, but for consumers set at startup, dashes and underscores within the name are equivalent.

The Performance Schema includes several system variables that provide configuration information:

```
mysql> SHOW VARIABLES LIKE 'perf%';
```

Variable_name	Value
<code>performance_schema</code>	<code>ON</code>
<code>performance_schema_accounts_size</code>	<code>100</code>
<code>performance_schema_digests_size</code>	<code>200</code>
<code>performance_schema_events_stages_history_long_size</code>	<code>10000</code>
<code>performance_schema_events_stages_history_size</code>	<code>10</code>
<code>performance_schema_events_statements_history_long_size</code>	<code>10000</code>
<code>performance_schema_events_statements_history_size</code>	<code>10</code>
<code>performance_schema_events_waits_history_long_size</code>	<code>10000</code>
<code>performance_schema_events_waits_history_size</code>	<code>10</code>
<code>performance_schema_hosts_size</code>	<code>100</code>
<code>performance_schema_max_cond_classes</code>	<code>80</code>
<code>performance_schema_max_cond_instances</code>	<code>1000</code>
...	

The `performance_schema` variable is `ON` or `OFF` to indicate whether the Performance Schema is enabled or disabled. The other variables indicate table sizes (number of rows) or memory allocation values.

Note

With the Performance Schema enabled, the number of Performance Schema instances affects the server memory footprint, perhaps to a large extent. The Performance Schema autoscales many parameters to use memory only as required; see [The Performance Schema Memory-Allocation Model](#).

To change the value of Performance Schema system variables, set them at server startup. For example, put the following lines in a `my.cnf` file to change the sizes of the history tables for wait events:

```
[mysqld]
performance_schema
performance_schema_events_waits_history_size=20
performance_schema_events_waits_history_long_size=15000
```

The Performance Schema automatically sizes the values of several of its parameters at server startup if they are not set explicitly. For example, it sizes the parameters that control the sizes of the events waits tables this way. The Performance Schema allocates memory incrementally, scaling its memory use to actual server load, instead of allocating all the memory it needs during server startup. Consequently, many sizing parameters need not be set at all. To see which parameters are autosized or autoscaled, use `mysqld --verbose --help` and examine the option descriptions, or see [Chapter 12, Performance Schema System Variables](#).

For each autosized parameter that is not set at server startup, the Performance Schema determines how to set its value based on the value of the following system values, which are considered as “hints” about how you have configured your MySQL server:

```
max_connections
open_files_limit
table_definition_cache
table_open_cache
```

To override autosizing or autoscaling for a given parameter, set it to a value other than `-1` at startup. In this case, the Performance Schema assigns it the specified value.

At runtime, `SHOW VARIABLES` displays the actual values that autosized parameters were set to. Autoscaled parameters display with a value of `-1`.

If the Performance Schema is disabled, its autosized and autoscaled parameters remain set to `-1` and `SHOW VARIABLES` displays `-1`.

Chapter 5 Performance Schema Runtime Configuration

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Specific Performance Schema features can be enabled at runtime to control which types of event collection occur.

Performance Schema setup tables contain information about monitoring configuration:

```
mysql> SELECT TABLE_NAME FROM INFORMATION_SCHEMA.TABLES
       WHERE TABLE_SCHEMA = 'performance_schema'
       AND TABLE_NAME LIKE 'setup%';
+-----+
| TABLE_NAME |
+-----+
| setup_actors |
| setup_consumers |
| setup_instruments |
| setup_objects |
| setup_timers |
+-----+
```

You can examine the contents of these tables to obtain information about Performance Schema monitoring characteristics. If you have the `UPDATE` privilege, you can change Performance Schema operation by modifying setup tables to affect how monitoring occurs. For additional details about these tables, see [Section 10.2, “Performance Schema Setup Tables”](#).

To see which event timers are selected, query the `setup_timers` tables:

```
mysql> SELECT * FROM performance_schema.setup_timers;
+-----+-----+
| NAME | TIMER_NAME |
+-----+-----+
| idle | MICROSECOND |
| wait | CYCLE |
| stage | NANOSECOND |
| statement | NANOSECOND |
| transaction | NANOSECOND |
+-----+-----+
```

The `NAME` value indicates the type of instrument to which the timer applies, and `TIMER_NAME` indicates which timer applies to those instruments. The timer applies to instruments where their name begins with an element matching the `NAME` value.

To change the timer, update the `NAME` value. For example, to use the `NANOSECOND` timer for the `wait` timer:

```
mysql> UPDATE performance_schema.setup_timers
SET TIMER_NAME = 'NANOSECOND'
WHERE NAME = 'wait';
mysql> SELECT * FROM performance_schema.setup_timers;
+-----+-----+
| NAME          | TIMER_NAME |
+-----+-----+
| idle          | MICROSECOND |
| wait          | NANOSECOND  |
| stage         | NANOSECOND  |
| statement     | NANOSECOND  |
| transaction   | NANOSECOND  |
+-----+-----+
```

For discussion of timers, see [Section 5.1, “Performance Schema Event Timing”](#).

The `setup_instruments` and `setup_consumers` tables list the instruments for which events can be collected and the types of consumers for which event information actually is collected, respectively. Other setup tables enable further modification of the monitoring configuration. [Section 5.2, “Performance Schema Event Filtering”](#), discusses how you can modify these tables to affect event collection.

If there are Performance Schema configuration changes that must be made at runtime using SQL statements and you would like these changes to take effect each time the server starts, put the statements in a file and start the server with the `init_file` system variable set to name the file. This strategy can also be useful if you have multiple monitoring configurations, each tailored to produce a different kind of monitoring, such as casual server health monitoring, incident investigation, application behavior troubleshooting, and so forth. Put the statements for each monitoring configuration into their own file and specify the appropriate file as the `init_file` value when you start the server.

5.1 Performance Schema Event Timing

Events are collected by means of instrumentation added to the server source code. Instruments time events, which is how the Performance Schema provides an idea of how long events take. It is also possible to configure instruments not to collect timing information. This section discusses the available timers and their characteristics, and how timing values are represented in events.

Performance Schema Timers

Two Performance Schema tables provide timer information:

- `performance_timers` lists the available timers and their characteristics.
- `setup_timers` indicates which timers are used for which instruments.

Each timer row in `setup_timers` must refer to one of the timers listed in `performance_timers`.

Timers vary in precision and amount of overhead. To see what timers are available and their characteristics, check the `performance_timers` table:

```
mysql> SELECT * FROM performance_schema.performance_timers;
+-----+-----+-----+-----+
| TIMER_NAME | TIMER_FREQUENCY | TIMER_RESOLUTION | TIMER_OVERHEAD |
+-----+-----+-----+-----+
| CYCLE      | 2389029850     | 1                | 72              |
| NANOSECOND | 1000000000     | 1                | 112             |
| MICROSECOND | 1000000        | 1                | 136             |
| MILLISECOND | 1036           | 1                | 168             |
| TICK       | 105            | 1                | 2416            |
+-----+-----+-----+-----+
```


If the values associated with a given timer name are `NULL`, that timer is not supported on your platform. The rows that do not contain `NULL` indicate which timers you can use in `setup_timers`.

The columns have these meanings:

- The `TIMER_NAME` column shows the names of the available timers. `CYCLE` refers to the timer that is based on the CPU (processor) cycle counter. The timers in `setup_timers` that you can use are those that do not have `NULL` in the other columns. If the values associated with a given timer name are `NULL`, that timer is not supported on your platform.
- `TIMER_FREQUENCY` indicates the number of timer units per second. For a cycle timer, the frequency is generally related to the CPU speed. The value shown was obtained on a system with a 2.4GHz processor. The other timers are based on fixed fractions of seconds. For `TICK`, the frequency may vary by platform (for example, some use 100 ticks/second, others 1000 ticks/second).
- `TIMER_RESOLUTION` indicates the number of timer units by which timer values increase at a time. If a timer has a resolution of 10, its value increases by 10 each time.
- `TIMER_OVERHEAD` is the minimal number of cycles of overhead to obtain one timing with the given timer. The overhead per event is twice the value displayed because the timer is invoked at the beginning and end of the event.

To see which timers are in effect or to change timers, access the `setup_timers` table:

```
mysql> SELECT * FROM performance_schema.setup_timers;
+-----+-----+
| NAME          | TIMER_NAME |
+-----+-----+
| idle          | MICROSECOND |
| wait          | CYCLE      |
| stage         | NANOSECOND |
| statement     | NANOSECOND |
| transaction   | NANOSECOND |
+-----+-----+
mysql> UPDATE performance_schema.setup_timers
      SET TIMER_NAME = 'MICROSECOND'
      WHERE NAME = 'idle';
mysql> SELECT * FROM performance_schema.setup_timers;
+-----+-----+
| NAME          | TIMER_NAME |
+-----+-----+
| idle          | MICROSECOND |
| wait          | CYCLE      |
| stage         | NANOSECOND |
| statement     | NANOSECOND |
| transaction   | NANOSECOND |
+-----+-----+
```

By default, the Performance Schema uses the best timer available for each instrument type, but you can select a different one.

To time wait events, the most important criterion is to reduce overhead, at the possible expense of the timer accuracy, so using the `CYCLE` timer is the best.

The time a statement (or stage) takes to execute is in general orders of magnitude larger than the time it takes to execute a single wait. To time statements, the most important criterion is to have an accurate measure, which is not affected by changes in processor frequency, so using a timer which is not based on cycles is the best. The default timer for statements is `NANOSECOND`. The extra “overhead” compared to the `CYCLE` timer is not significant, because the overhead caused by calling a timer twice (once when

the statement starts, once when it ends) is orders of magnitude less compared to the CPU time used to execute the statement itself. Using the `CYCLE` timer has no benefit here, only drawbacks.

The precision offered by the cycle counter depends on processor speed. If the processor runs at 1 GHz (one billion cycles/second) or higher, the cycle counter delivers sub-nanosecond precision. Using the cycle counter is much cheaper than getting the actual time of day. For example, the standard `gettimeofday()` function can take hundreds of cycles, which is an unacceptable overhead for data gathering that may occur thousands or millions of times per second.

Cycle counters also have disadvantages:

- End users expect to see timings in wall-clock units, such as fractions of a second. Converting from cycles to fractions of seconds can be expensive. For this reason, the conversion is a quick and fairly rough multiplication operation.
- Processor cycle rate might change, such as when a laptop goes into power-saving mode or when a CPU slows down to reduce heat generation. If a processor's cycle rate fluctuates, conversion from cycles to real-time units is subject to error.
- Cycle counters might be unreliable or unavailable depending on the processor or the operating system. For example, on Pentiums, the instruction is `RDTSC` (an assembly-language rather than a C instruction) and it is theoretically possible for the operating system to prevent user-mode programs from using it.
- Some processor details related to out-of-order execution or multiprocessor synchronization might cause the counter to seem fast or slow by up to 1000 cycles.

MySQL works with cycle counters on x386 (Windows, macOS, Linux, Solaris, and other Unix flavors), PowerPC, and IA-64.

Performance Schema Timer Representation in Events

Rows in Performance Schema tables that store current events and historical events have three columns to represent timing information: `TIMER_START` and `TIMER_END` indicate when an event started and finished, and `TIMER_WAIT` indicates event duration.

The `setup_instruments` table has an `ENABLED` column to indicate the instruments for which to collect events. The table also has a `TIMED` column to indicate which instruments are timed. If an instrument is not enabled, it produces no events. If an enabled instrument is not timed, events produced by the instrument have `NULL` for the `TIMER_START`, `TIMER_END`, and `TIMER_WAIT` timer values. This in turn causes those values to be ignored when calculating aggregate time values in summary tables (sum, minimum, maximum, and average).

Internally, times within events are stored in units given by the timer in effect when event timing begins. For display when events are retrieved from Performance Schema tables, times are shown in picoseconds (trillionths of a second) to normalize them to a standard unit, regardless of which timer is selected.

Modifications to the `setup_timers` table affect monitoring immediately. Events already in progress may use the original timer for the begin time and the new timer for the end time. To avoid unpredictable results after you make timer changes, use `TRUNCATE TABLE` to reset Performance Schema statistics.

The timer baseline (“time zero”) occurs at Performance Schema initialization during server startup. `TIMER_START` and `TIMER_END` values in events represent picoseconds since the baseline. `TIMER_WAIT` values are durations in picoseconds.

Picosecond values in events are approximate. Their accuracy is subject to the usual forms of error associated with conversion from one unit to another. If the `CYCLE` timer is used and the processor rate

varies, there might be drift. For these reasons, it is not reasonable to look at the `TIMER_START` value for an event as an accurate measure of time elapsed since server startup. On the other hand, it is reasonable to use `TIMER_START` or `TIMER_WAIT` values in `ORDER BY` clauses to order events by start time or duration.

The choice of picoseconds in events rather than a value such as microseconds has a performance basis. One implementation goal was to show results in a uniform time unit, regardless of the timer. In an ideal world this time unit would look like a wall-clock unit and be reasonably precise; in other words, microseconds. But to convert cycles or nanoseconds to microseconds, it would be necessary to perform a division for every instrumentation. Division is expensive on many platforms. Multiplication is not expensive, so that is what is used. Therefore, the time unit is an integer multiple of the highest possible `TIMER_FREQUENCY` value, using a multiplier large enough to ensure that there is no major precision loss. The result is that the time unit is “picoseconds.” This precision is spurious, but the decision enables overhead to be minimized.

While a wait, stage, statement, or transaction event is executing, the respective current-event tables display current-event timing information:

```
events_waits_current
events_stages_current
events_statements_current
events_transactions_current
```

To make it possible to determine how long a not-yet-completed event has been running, the timer columns are set as follows:

- `TIMER_START` is populated.
- `TIMER_END` is populated with the current timer value.
- `TIMER_WAIT` is populated with the time elapsed so far (`TIMER_END - TIMER_START`).

Events that have not yet completed have an `END_EVENT_ID` value of `NULL`. To assess time elapsed so far for an event, use the `TIMER_WAIT` column. Therefore, to identify events that have not yet completed and have taken longer than `N` picoseconds thus far, monitoring applications can use this expression in queries:

```
WHERE END_EVENT_ID IS NULL AND TIMER_WAIT > N
```

Event identification as just described assumes that the corresponding instruments have `ENABLED` and `TIMED` set to `YES` and that the relevant consumers are enabled.

5.2 Performance Schema Event Filtering

Events are processed in a producer/consumer fashion:

- Instrumented code is the source for events and produces events to be collected. The `setup_instruments` table lists the instruments for which events can be collected, whether they are enabled, and (for enabled instruments) whether to collect timing information:

```
mysql> SELECT * FROM performance_schema.setup_instruments;
+-----+-----+-----+
| NAME                                | ENABLED | TIMED |
+-----+-----+-----+
...
| wait/synch/mutex/sql/LOCK_global_read_lock | YES     | YES   |
| wait/synch/mutex/sql/LOCK_global_system_variables | YES     | YES   |
| wait/synch/mutex/sql/LOCK_lock_db         | YES     | YES   |
```

```
| wait/synch/mutex/sql/LOCK_manager | YES | YES |
...
```

The `setup_instruments` table provides the most basic form of control over event production. To further refine event production based on the type of object or thread being monitored, other tables may be used as described in [Section 5.3, “Event Pre-Filtering”](#).

- Performance Schema tables are the destinations for events and consume events. The `setup_consumers` table lists the types of consumers to which event information can be sent and whether they are enabled:

```
mysql> SELECT * FROM performance_schema.setup_consumers;
+-----+-----+
| NAME                                | ENABLED |
+-----+-----+
| events_stages_current               | NO      |
| events_stages_history               | NO      |
| events_stages_history_long          | NO      |
| events_statements_current           | YES     |
| events_statements_history           | YES     |
| events_statements_history_long      | NO      |
| events_transactions_current         | NO      |
| events_transactions_history         | NO      |
| events_transactions_history_long    | NO      |
| events_waits_current                | NO      |
| events_waits_history                | NO      |
| events_waits_history_long           | NO      |
| global_instrumentation              | YES     |
| thread_instrumentation              | YES     |
| statements_digest                   | YES     |
+-----+-----+
```

Filtering can be done at different stages of performance monitoring:

- **Pre-filtering.** This is done by modifying Performance Schema configuration so that only certain types of events are collected from producers, and collected events update only certain consumers. To do this, enable or disable instruments or consumers. Pre-filtering is done by the Performance Schema and has a global effect that applies to all users.

Reasons to use pre-filtering:

- To reduce overhead. Performance Schema overhead should be minimal even with all instruments enabled, but perhaps you want to reduce it further. Or you do not care about timing events and want to disable the timing code to eliminate timing overhead.
- To avoid filling the current-events or history tables with events in which you have no interest. Pre-filtering leaves more “room” in these tables for instances of rows for enabled instrument types. If you enable only file instruments with pre-filtering, no rows are collected for nonfile instruments. With post-filtering, nonfile events are collected, leaving fewer rows for file events.
- To avoid maintaining some kinds of event tables. If you disable a consumer, the server does not spend time maintaining destinations for that consumer. For example, if you do not care about event histories, you can disable the history table consumers to improve performance.
- **Post-filtering.** This involves the use of `WHERE` clauses in queries that select information from Performance Schema tables, to specify which of the available events you want to see. Post-filtering is performed on a per-user basis because individual users select which of the available events are of interest.

Reasons to use post-filtering:

- To avoid making decisions for individual users about which event information is of interest.
- To use the Performance Schema to investigate a performance issue when the restrictions to impose using pre-filtering are not known in advance.

The following sections provide more detail about pre-filtering and provide guidelines for naming instruments or consumers in filtering operations. For information about writing queries to retrieve information (post-filtering), see [Chapter 6, Performance Schema Queries](#).

5.3 Event Pre-Filtering

Pre-filtering is done by the Performance Schema and has a global effect that applies to all users. Pre-filtering can be applied to either the producer or consumer stage of event processing:

- To configure pre-filtering at the producer stage, several tables can be used:
 - `setup_instruments` indicates which instruments are available. An instrument disabled in this table produces no events regardless of the contents of the other production-related setup tables. An instrument enabled in this table is permitted to produce events, subject to the contents of the other tables.
 - `setup_objects` controls whether the Performance Schema monitors particular table and stored program objects.
 - `threads` indicates whether monitoring is enabled for each server thread.
 - `setup_actors` determines the initial monitoring state for new foreground threads.
- To configure pre-filtering at the consumer stage, modify the `setup_consumers` table. This determines the destinations to which events are sent. `setup_consumers` also implicitly affects event production. If a given event is not sent to any destination (is not consumed), the Performance Schema does not produce it.

Modifications to any of these tables affect monitoring immediately, with some exceptions:

- Modifications to some instruments in the `setup_instruments` table are effective only at server startup; changing them at runtime has no effect. This affects primarily mutexes, conditions, and rwlocks in the server, although there may be other instruments for which this is true. This restriction is lifted as of MySQL 5.7.12.
- Modifications to the `setup_actors` table affect only foreground threads created subsequent to the modification, not existing threads.

When you change the monitoring configuration, the Performance Schema does not flush the history tables. Events already collected remain in the current-events and history tables until displaced by newer events. If you disable instruments, you might need to wait a while before events for them are displaced by newer events of interest. Alternatively, use `TRUNCATE TABLE` to empty the history tables.

After making instrumentation changes, you might want to truncate the summary tables. Generally, the effect is to reset the summary columns to 0 or `NULL`, not to remove rows. This enables you to clear collected values and restart aggregation. That might be useful, for example, after you have made a runtime configuration change. Exceptions to this truncation behavior are noted in individual summary table sections.

The following sections describe how to use specific tables to control Performance Schema pre-filtering.

5.4 Pre-Filtering by Instrument

The `setup_instruments` table lists the available instruments:

```
mysql> SELECT * FROM performance_schema.setup_instruments;
```

NAME	ENABLED	TIMED
...		
stage/sql/end	NO	NO
stage/sql/executing	NO	NO
stage/sql/init	NO	NO
stage/sql/insert	NO	NO
...		
statement/sql/load	YES	YES
statement/sql/grant	YES	YES
statement/sql/check	YES	YES
statement/sql/flush	YES	YES
...		
wait/synch/mutex/sql/LOCK_global_read_lock	YES	YES
wait/synch/mutex/sql/LOCK_global_system_variables	YES	YES
wait/synch/mutex/sql/LOCK_lock_db	YES	YES
wait/synch/mutex/sql/LOCK_manager	YES	YES
...		
wait/synch/rwlock/sql/LOCK_grant	YES	YES
wait/synch/rwlock/sql/LOGGER::LOCK_logger	YES	YES
wait/synch/rwlock/sql/LOCK_sys_init_connect	YES	YES
wait/synch/rwlock/sql/LOCK_sys_init_slave	YES	YES
...		
wait/io/file/sql/binlog	YES	YES
wait/io/file/sql/binlog_index	YES	YES
wait/io/file/sql/casetest	YES	YES
wait/io/file/sql/dbopt	YES	YES
...		

To control whether an instrument is enabled, set its `ENABLED` column to `YES` or `NO`. To configure whether to collect timing information for an enabled instrument, set its `TIMED` value to `YES` or `NO`. Setting the `TIMED` column affects Performance Schema table contents as described in [Section 5.1, “Performance Schema Event Timing”](#).

Modifications to most `setup_instruments` rows affect monitoring immediately. For some instruments, modifications are effective only at server startup; changing them at runtime has no effect. This affects primarily mutexes, conditions, and rwlocks in the server, although there may be other instruments for which this is true.

The `setup_instruments` table provides the most basic form of control over event production. To further refine event production based on the type of object or thread being monitored, other tables may be used as described in [Section 5.3, “Event Pre-Filtering”](#).

The following examples demonstrate possible operations on the `setup_instruments` table. These changes, like other pre-filtering operations, affect all users. Some of these queries use the `LIKE` operator and a pattern match instrument names. For additional information about specifying patterns to select instruments, see [Section 5.9, “Naming Instruments or Consumers for Filtering Operations”](#).

- Disable all instruments:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'NO';
```

Now no events are collected.

- Disable all file instruments, adding them to the current set of disabled instruments:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'NO'
WHERE NAME LIKE 'wait/io/file/%';
```

- Disable only file instruments, enable all other instruments:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = IF(NAME LIKE 'wait/io/file/%', 'NO', 'YES');
```

- Enable all but those instruments in the `mysys` library:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = CASE WHEN NAME LIKE '%/mysys/%' THEN 'YES' ELSE 'NO' END;
```

- Disable a specific instrument:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'NO'
WHERE NAME = 'wait/synch/mutex/mysys/TMPDIR_mutex';
```

- To toggle the state of an instrument, “flip” its `ENABLED` value:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = IF(ENABLED = 'YES', 'NO', 'YES')
WHERE NAME = 'wait/synch/mutex/mysys/TMPDIR_mutex';
```

- Disable timing for all events:

```
UPDATE performance_schema.setup_instruments
SET TIMED = 'NO';
```

5.5 Pre-Filtering by Object

The `setup_objects` table controls whether the Performance Schema monitors particular table and stored program objects. The initial `setup_objects` contents look like this:

```
mysql> SELECT * FROM performance_schema.setup_objects;
```

OBJECT_TYPE	OBJECT_SCHEMA	OBJECT_NAME	ENABLED	TIMED
EVENT	mysql	%	NO	NO
EVENT	performance_schema	%	NO	NO
EVENT	information_schema	%	NO	NO
EVENT	%	%	YES	YES
FUNCTION	mysql	%	NO	NO
FUNCTION	performance_schema	%	NO	NO
FUNCTION	information_schema	%	NO	NO
FUNCTION	%	%	YES	YES
PROCEDURE	mysql	%	NO	NO
PROCEDURE	performance_schema	%	NO	NO
PROCEDURE	information_schema	%	NO	NO
PROCEDURE	%	%	YES	YES
TABLE	mysql	%	NO	NO
TABLE	performance_schema	%	NO	NO
TABLE	information_schema	%	NO	NO
TABLE	%	%	YES	YES
TRIGGER	mysql	%	NO	NO
TRIGGER	performance_schema	%	NO	NO
TRIGGER	information_schema	%	NO	NO
TRIGGER	%	%	YES	YES

Modifications to the `setup_objects` table affect object monitoring immediately.

The `OBJECT_TYPE` column indicates the type of object to which a row applies. `TABLE` filtering affects table I/O events (`wait/io/table/sql/handler` instrument) and table lock events (`wait/lock/table/sql/handler` instrument).

The `OBJECT_SCHEMA` and `OBJECT_NAME` columns should contain a literal schema or object name, or `'%'` to match any name.

The `ENABLED` column indicates whether matching objects are monitored, and `TIMED` indicates whether to collect timing information. Setting the `TIMED` column affects Performance Schema table contents as described in [Section 5.1, “Performance Schema Event Timing”](#).

The effect of the default object configuration is to instrument all objects except those in the `mysql`, `INFORMATION_SCHEMA`, and `performance_schema` databases. (Tables in the `INFORMATION_SCHEMA` database are not instrumented regardless of the contents of `setup_objects`; the row for `information_schema.%` simply makes this default explicit.)

When the Performance Schema checks for a match in `setup_objects`, it tries to find more specific matches first. For rows that match a given `OBJECT_TYPE`, the Performance Schema checks rows in this order:

- Rows with `OBJECT_SCHEMA='literal'` and `OBJECT_NAME='literal'`.
- Rows with `OBJECT_SCHEMA='literal'` and `OBJECT_NAME='%'`.
- Rows with `OBJECT_SCHEMA='%'` and `OBJECT_NAME='%'`.

For example, with a table `db1.t1`, the Performance Schema looks in `TABLE` rows for a match for `'db1'` and `'t1'`, then for `'db1'` and `'%'`, then for `'%'` and `'%'`. The order in which matching occurs matters because different matching `setup_objects` rows can have different `ENABLED` and `TIMED` values.

For table-related events, the Performance Schema combines the contents of `setup_objects` with `setup_instruments` to determine whether to enable instruments and whether to time enabled instruments:

- For tables that match a row in `setup_objects`, table instruments produce events only if `ENABLED` is `YES` in both `setup_instruments` and `setup_objects`.
- The `TIMED` values in the two tables are combined, so that timing information is collected only when both values are `YES`.

For stored program objects, the Performance Schema takes the `ENABLED` and `TIMED` columns directly from the `setup_objects` row. There is no combining of values with `setup_instruments`.

Suppose that `setup_objects` contains the following `TABLE` rows that apply to `db1`, `db2`, and `db3`:

OBJECT_TYPE	OBJECT_SCHEMA	OBJECT_NAME	ENABLED	TIMED
TABLE	db1	t1	YES	YES
TABLE	db1	t2	NO	NO
TABLE	db2	%	YES	YES
TABLE	db3	%	NO	NO
TABLE	%	%	YES	YES

If an object-related instrument in `setup_instruments` has an `ENABLED` value of `NO`, events for the object are not monitored. If the `ENABLED` value is `YES`, event monitoring occurs according to the `ENABLED` value in the relevant `setup_objects` row:

- `db1.t1` events are monitored
- `db1.t2` events are not monitored
- `db2.t3` events are monitored
- `db3.t4` events are not monitored
- `db4.t5` events are monitored

Similar logic applies for combining the `TIMED` columns from the `setup_instruments` and `setup_objects` tables to determine whether to collect event timing information.

If a persistent table and a temporary table have the same name, matching against `setup_objects` rows occurs the same way for both. It is not possible to enable monitoring for one table but not the other. However, each table is instrumented separately.

5.6 Pre-Filtering by Thread

The `threads` table contains a row for each server thread. Each row contains information about a thread and indicates whether monitoring is enabled for it. For the Performance Schema to monitor a thread, these things must be true:

- The `thread_instrumentation` consumer in the `setup_consumers` table must be `YES`.
- The `threads.INSTRUMENTED` column must be `YES`.
- Monitoring occurs only for those thread events produced from instruments that are enabled in the `setup_instruments` table.

The `threads` table also indicates for each server thread whether to perform historical event logging. This includes wait, stage, statement, and transaction events and affects logging to these tables:

```
events_waits_history
events_waits_history_long
events_stages_history
events_stages_history_long
events_statements_history
events_statements_history_long
events_transactions_history
events_transactions_history_long
```

For historical event logging to occur, these things must be true:

- The appropriate history-related consumers in the `setup_consumers` table must be enabled. For example, wait event logging in the `events_waits_history` and `events_waits_history_long` tables requires the corresponding `events_waits_history` and `events_waits_history_long` consumers to be `YES`.
- The `threads.HISTORY` column must be `YES`.
- Logging occurs only for those thread events produced from instruments that are enabled in the `setup_instruments` table.

For foreground threads (resulting from client connections), the initial values of the `INSTRUMENTED` and `HISTORY` columns in `threads` table rows are determined by whether the user account associated with a thread matches any row in the `setup_actors` table. The values come from the `ENABLED` and `HISTORY` columns of the matching `setup_actors` table row.

For background threads, there is no associated user. `INSTRUMENTED` and `HISTORY` are `YES` by default and `setup_actors` is not consulted.

The initial `setup_actors` contents look like this:

```
mysql> SELECT * FROM performance_schema.setup_actors;
+-----+-----+-----+-----+-----+
| HOST | USER | ROLE | ENABLED | HISTORY |
+-----+-----+-----+-----+-----+
| %    | %    | %    | YES     | YES     |
+-----+-----+-----+-----+-----+
```

The `HOST` and `USER` columns should contain a literal host or user name, or `'%'` to match any name.

The `ENABLED` and `HISTORY` columns indicate whether to enable instrumentation and historical event logging for matching threads, subject to the other conditions described previously.

When the Performance Schema checks for a match for each new foreground thread in `setup_actors`, it tries to find more specific matches first, using the `USER` and `HOST` columns (`ROLE` is unused):

- Rows with `USER='literal'` and `HOST='literal'`.
- Rows with `USER='literal'` and `HOST='%'`.
- Rows with `USER='%'` and `HOST='literal'`.
- Rows with `USER='%'` and `HOST='%'`.

The order in which matching occurs matters because different matching `setup_actors` rows can have different `USER` and `HOST` values. This enables instrumenting and historical event logging to be applied selectively per host, user, or account (user and host combination), based on the `ENABLED` and `HISTORY` column values:

- When the best match is a row with `ENABLED=YES`, the `INSTRUMENTED` value for the thread becomes `YES`. When the best match is a row with `HISTORY=YES`, the `HISTORY` value for the thread becomes `YES`.
- When the best match is a row with `ENABLED=NO`, the `INSTRUMENTED` value for the thread becomes `NO`. When the best match is a row with `HISTORY=NO`, the `HISTORY` value for the thread becomes `NO`.
- When no match is found, the `INSTRUMENTED` and `HISTORY` values for the thread become `NO`.

The `ENABLED` and `HISTORY` columns in `setup_actors` rows can be set to `YES` or `NO` independent of one another. This means you can enable instrumentation separately from whether you collect historical events.

By default, monitoring and historical event collection are enabled for all new foreground threads because the `setup_actors` table initially contains a row with `'%'` for both `HOST` and `USER`. To perform more limited matching such as to enable monitoring only for some foreground threads, you must change this row because it matches any connection, and add rows for more specific `HOST/USER` combinations.

Suppose that you modify `setup_actors` as follows:

```
UPDATE performance_schema.setup_actors
SET ENABLED = 'NO', HISTORY = 'NO'
WHERE HOST = '%' AND USER = '%';
INSERT INTO performance_schema.setup_actors
(HOST,USER,ROLE,ENABLED,HISTORY)
VALUES('localhost','joe','%', 'YES', 'YES');
INSERT INTO performance_schema.setup_actors
(HOST,USER,ROLE,ENABLED,HISTORY)
```

```
VALUES('hosta.example.com','joe','%','YES','NO');
INSERT INTO performance_schema.setup_actors
(HOST,USER,ROLE,ENABLED,HISTORY)
VALUES('%','sam','%','NO','YES');
```

The `UPDATE` statement changes the default match to disable instrumentation and historical event collection. The `INSERT` statements add rows for more specific matches.

Now the Performance Schema determines how to set the `INSTRUMENTED` and `HISTORY` values for new connection threads as follows:

- If `joe` connects from the local host, the connection matches the first inserted row. The `INSTRUMENTED` and `HISTORY` values for the thread become `YES`.
- If `joe` connects from `hosta.example.com`, the connection matches the second inserted row. The `INSTRUMENTED` value for the thread becomes `YES` and the `HISTORY` value becomes `NO`.
- If `joe` connects from any other host, there is no match. The `INSTRUMENTED` and `HISTORY` values for the thread become `NO`.
- If `sam` connects from any host, the connection matches the third inserted row. The `INSTRUMENTED` value for the thread becomes `NO` and the `HISTORY` value becomes `YES`.
- For any other connection, the row with `HOST` and `USER` set to `'%'` matches. This row now has `ENABLED` and `HISTORY` set to `NO`, so the `INSTRUMENTED` and `HISTORY` values for the thread become `NO`.

Modifications to the `setup_actors` table affect only foreground threads created subsequent to the modification, not existing threads. To affect existing threads, modify the `INSTRUMENTED` and `HISTORY` columns of `threads` table rows.

5.7 Pre-Filtering by Consumer

The `setup_consumers` table lists the available consumer types and which are enabled:

```
mysql> SELECT * FROM performance_schema.setup_consumers;
```

NAME	ENABLED
events_stages_current	NO
events_stages_history	NO
events_stages_history_long	NO
events_statements_current	YES
events_statements_history	YES
events_statements_history_long	NO
events_transactions_current	NO
events_transactions_history	NO
events_transactions_history_long	NO
events_waits_current	NO
events_waits_history	NO
events_waits_history_long	NO
global_instrumentation	YES
thread_instrumentation	YES
statements_digest	YES

Modify the `setup_consumers` table to affect pre-filtering at the consumer stage and determine the destinations to which events are sent. To enable or disable a consumer, set its `ENABLED` value to `YES` or `NO`.

Modifications to the `setup_consumers` table affect monitoring immediately.

If you disable a consumer, the server does not spend time maintaining destinations for that consumer. For example, if you do not care about historical event information, disable the history consumers:

```
UPDATE performance_schema.setup_consumers
SET ENABLED = 'NO'
WHERE NAME LIKE '%history%';
```

The consumer settings in the `setup_consumers` table form a hierarchy from higher levels to lower. The following principles apply:

- Destinations associated with a consumer receive no events unless the Performance Schema checks the consumer and the consumer is enabled.
- A consumer is checked only if all consumers it depends on (if any) are enabled.
- If a consumer is not checked, or is checked but is disabled, other consumers that depend on it are not checked.
- Dependent consumers may have their own dependent consumers.
- If an event would not be sent to any destination, the Performance Schema does not produce it.

The following lists describe the available consumer values. For discussion of several representative consumer configurations and their effect on instrumentation, see [Section 5.8, “Example Consumer Configurations”](#).

- [Global and Thread Consumers](#)
- [Wait Event Consumers](#)
- [Stage Event Consumers](#)
- [Statement Event Consumers](#)
- [Transaction Event Consumers](#)
- [Statement Digest Consumer](#)

Global and Thread Consumers

- `global_instrumentation` is the highest level consumer. If `global_instrumentation` is `NO`, it disables global instrumentation. All other settings are lower level and are not checked; it does not matter what they are set to. No global or per thread information is maintained and no individual events are collected in the current-events or event-history tables. If `global_instrumentation` is `YES`, the Performance Schema maintains information for global states and also checks the `thread_instrumentation` consumer.
- `thread_instrumentation` is checked only if `global_instrumentation` is `YES`. Otherwise, if `thread_instrumentation` is `NO`, it disables thread-specific instrumentation and all lower-level settings are ignored. No information is maintained per thread and no individual events are collected in the current-events or event-history tables. If `thread_instrumentation` is `YES`, the Performance Schema maintains thread-specific information and also checks `events_xxx_current` consumers.

Wait Event Consumers

These consumers require both `global_instrumentation` and `thread_instrumentation` to be `YES` or they are not checked. If checked, they act as follows:

- `events_waits_current`, if `NO`, disables collection of individual wait events in the `events_waits_current` table. If `YES`, it enables wait event collection and the Performance Schema checks the `events_waits_history` and `events_waits_history_long` consumers.
- `events_waits_history` is not checked if `event_waits_current` is `NO`. Otherwise, an `events_waits_history` value of `NO` or `YES` disables or enables collection of wait events in the `events_waits_history` table.
- `events_waits_history_long` is not checked if `event_waits_current` is `NO`. Otherwise, an `events_waits_history_long` value of `NO` or `YES` disables or enables collection of wait events in the `events_waits_history_long` table.

Stage Event Consumers

These consumers require both `global_instrumentation` and `thread_instrumentation` to be `YES` or they are not checked. If checked, they act as follows:

- `events_stages_current`, if `NO`, disables collection of individual stage events in the `events_stages_current` table. If `YES`, it enables stage event collection and the Performance Schema checks the `events_stages_history` and `events_stages_history_long` consumers.
- `events_stages_history` is not checked if `event_stages_current` is `NO`. Otherwise, an `events_stages_history` value of `NO` or `YES` disables or enables collection of stage events in the `events_stages_history` table.
- `events_stages_history_long` is not checked if `event_stages_current` is `NO`. Otherwise, an `events_stages_history_long` value of `NO` or `YES` disables or enables collection of stage events in the `events_stages_history_long` table.

Statement Event Consumers

These consumers require both `global_instrumentation` and `thread_instrumentation` to be `YES` or they are not checked. If checked, they act as follows:

- `events_statements_current`, if `NO`, disables collection of individual statement events in the `events_statements_current` table. If `YES`, it enables statement event collection and the Performance Schema checks the `events_statements_history` and `events_statements_history_long` consumers.
- `events_statements_history` is not checked if `events_statements_current` is `NO`. Otherwise, an `events_statements_history` value of `NO` or `YES` disables or enables collection of statement events in the `events_statements_history` table.
- `events_statements_history_long` is not checked if `events_statements_current` is `NO`. Otherwise, an `events_statements_history_long` value of `NO` or `YES` disables or enables collection of statement events in the `events_statements_history_long` table.

Transaction Event Consumers

These consumers require both `global_instrumentation` and `thread_instrumentation` to be `YES` or they are not checked. If checked, they act as follows:

- `events_transactions_current`, if `NO`, disables collection of individual transaction events in the `events_transactions_current` table. If `YES`, it enables transaction event collection and the Performance Schema checks the `events_transactions_history` and `events_transactions_history_long` consumers.

- `events_transactions_history` is not checked if `events_transactions_current` is `NO`. Otherwise, an `events_transactions_history` value of `NO` or `YES` disables or enables collection of transaction events in the `events_transactions_history` table.
- `events_transactions_history_long` is not checked if `events_transactions_current` is `NO`. Otherwise, an `events_transactions_history_long` value of `NO` or `YES` disables or enables collection of transaction events in the `events_transactions_history_long` table.

Statement Digest Consumer

The `statements_digest` consumer requires `global_instrumentation` to be `YES` or it is not checked. There is no dependency on the statement event consumers, so you can obtain statistics per digest without having to collect statistics in `events_statements_current`, which is advantageous in terms of overhead. Conversely, you can get detailed statements in `events_statements_current` without digests (the `DIGEST` and `DIGEST_TEXT` columns are `NULL`).

For more information about statement digesting, see [Performance Schema Statement Digests](#).

5.8 Example Consumer Configurations

The consumer settings in the `setup_consumers` table form a hierarchy from higher levels to lower. The following discussion describes how consumers work, showing specific configurations and their effects as consumer settings are enabled progressively from high to low. The consumer values shown are representative. The general principles described here apply to other consumer values that may be available.

The configuration descriptions occur in order of increasing functionality and overhead. If you do not need the information provided by enabling lower-level settings, disable them and the Performance Schema executes less code on your behalf and you have less information to sift through.

The `setup_consumers` table contains the following hierarchy of values:

```
global_instrumentation
thread_instrumentation
  events_waits_current
  events_waits_history
  events_waits_history_long
  events_stages_current
  events_stages_history
  events_stages_history_long
  events_statements_current
  events_statements_history
  events_statements_history_long
  events_transactions_current
  events_transactions_history
  events_transactions_history_long
statements_digest
```

Note

In the consumer hierarchy, the consumers for waits, stages, statements, and transactions are all at the same level. This differs from the event nesting hierarchy, for which wait events nest within stage events, which nest within statement events, which nest within transaction events.

If a given consumer setting is `NO`, the Performance Schema disables the instrumentation associated with the consumer and ignores all lower-level settings. If a given setting is `YES`, the Performance Schema enables the instrumentation associated with it and checks the settings at the next lowest level. For a description of the rules for each consumer, see [Section 5.7, “Pre-Filtering by Consumer”](#).

For example, if `global_instrumentation` is enabled, `thread_instrumentation` is checked. If `thread_instrumentation` is enabled, the `events_xxx_current` consumers are checked. If of these `events_waits_current` is enabled, `events_waits_history` and `events_waits_history_long` are checked.

Each of the following configuration descriptions indicates which setup elements the Performance Schema checks and which output tables it maintains (that is, for which tables it collects information).

- [No Instrumentation](#)
- [Global Instrumentation Only](#)
- [Global and Thread Instrumentation Only](#)
- [Global, Thread, and Current-Event Instrumentation](#)
- [Global, Thread, Current-Event, and Event-History instrumentation](#)

No Instrumentation

Server configuration state:

```
mysql> SELECT * FROM performance_schema.setup_consumers;
+-----+-----+
| NAME                                | ENABLED |
+-----+-----+
| global_instrumentation              | NO      |
| ...                                  |         |
+-----+-----+
```

In this configuration, nothing is instrumented.

Setup elements checked:

- Table `setup_consumers`, consumer `global_instrumentation`

Output tables maintained:

- None

Global Instrumentation Only

Server configuration state:

```
mysql> SELECT * FROM performance_schema.setup_consumers;
+-----+-----+
| NAME                                | ENABLED |
+-----+-----+
| global_instrumentation              | YES     |
| thread_instrumentation              | NO      |
| ...                                  |         |
+-----+-----+
```

In this configuration, instrumentation is maintained only for global states. Per-thread instrumentation is disabled.

Additional setup elements checked, relative to the preceding configuration:

- Table `setup_consumers`, consumer `thread_instrumentation`

- Table `setup_instruments`
- Table `setup_objects`
- Table `setup_timers`

Additional output tables maintained, relative to the preceding configuration:

- `mutex_instances`
- `rwlock_instances`
- `cond_instances`
- `file_instances`
- `users`
- `hosts`
- `accounts`
- `socket_summary_by_event_name`
- `file_summary_by_instance`
- `file_summary_by_event_name`
- `objects_summary_global_by_type`
- `memory_summary_global_by_event_name`
- `table_lock_waits_summary_by_table`
- `table_io_waits_summary_by_index_usage`
- `table_io_waits_summary_by_table`
- `events_waits_summary_by_instance`
- `events_waits_summary_global_by_event_name`
- `events_stages_summary_global_by_event_name`
- `events_statements_summary_global_by_event_name`
- `events_transactions_summary_global_by_event_name`

Global and Thread Instrumentation Only

Server configuration state:

```
mysql> SELECT * FROM performance_schema.setup_consumers;
+-----+-----+
| NAME                                | ENABLED |
+-----+-----+
| global_instrumentation              | YES     |
| thread_instrumentation              | YES     |
| events_waits_current                | NO      |
| ...                                  |         |
| events_stages_current               | NO      |
+-----+-----+
```



```

...
| events_statements_current      | NO      |
...
| events_transactions_current    | NO      |
...
+-----+-----+

```

In this configuration, instrumentation is maintained globally and per thread. No individual events are collected in the current-events or event-history tables.

Additional setup elements checked, relative to the preceding configuration:

- Table `setup_consumers`, consumers `events_xxx_current`, where `xxx` is `waits`, `stages`, `statements`, `transactions`
- Table `setup_actors`
- Column `threads.instrumented`

Additional output tables maintained, relative to the preceding configuration:

- `events_xxx_summary_by_yyy_by_event_name`, where `xxx` is `waits`, `stages`, `statements`, `transactions`; and `yyy` is `thread`, `user`, `host`, `account`

Global, Thread, and Current-Event Instrumentation

Server configuration state:

```

mysql> SELECT * FROM performance_schema.setup_consumers;
+-----+-----+
| NAME                                | ENABLED |
+-----+-----+
| global_instrumentation              | YES     |
| thread_instrumentation              | YES     |
| events_waits_current                 | YES     |
| events_waits_history                 | NO      |
| events_waits_history_long            | NO      |
| events_stages_current                | YES     |
| events_stages_history                 | NO      |
| events_stages_history_long           | NO      |
| events_statements_current            | YES     |
| events_statements_history            | NO      |
| events_statements_history_long       | NO      |
| events_transactions_current          | YES     |
| events_transactions_history          | NO      |
| events_transactions_history_long     | NO      |
...
+-----+-----+

```

In this configuration, instrumentation is maintained globally and per thread. Individual events are collected in the current-events table, but not in the event-history tables.

Additional setup elements checked, relative to the preceding configuration:

- Consumers `events_xxx_history`, where `xxx` is `waits`, `stages`, `statements`, `transactions`
- Consumers `events_xxx_history_long`, where `xxx` is `waits`, `stages`, `statements`, `transactions`

Additional output tables maintained, relative to the preceding configuration:

- `events_xxx_current`, where `xxx` is `waits`, `stages`, `statements`, `transactions`

Global, Thread, Current-Event, and Event-History instrumentation

The preceding configuration collects no event history because the `events_xxx_history` and `events_xxx_history_long` consumers are disabled. Those consumers can be enabled separately or together to collect event history per thread, globally, or both.

This configuration collects event history per thread, but not globally:

```
mysql> SELECT * FROM performance_schema.setup_consumers;
+-----+-----+
| NAME                                | ENABLED |
+-----+-----+
| global_instrumentation              | YES     |
| thread_instrumentation              | YES     |
| events_waits_current                 | YES     |
| events_waits_history                 | YES     |
| events_waits_history_long            | NO      |
| events_stages_current                | YES     |
| events_stages_history                 | YES     |
| events_stages_history_long           | NO      |
| events_statements_current            | YES     |
| events_statements_history             | YES     |
| events_statements_history_long       | NO      |
| events_transactions_current          | YES     |
| events_transactions_history          | YES     |
| events_transactions_history_long     | NO      |
| ...                                  |         |
+-----+-----+
```

Event-history tables maintained for this configuration:

- `events_xxx_history`, where `xxx` is `waits`, `stages`, `statements`, `transactions`

This configuration collects event history globally, but not per thread:

```
mysql> SELECT * FROM performance_schema.setup_consumers;
+-----+-----+
| NAME                                | ENABLED |
+-----+-----+
| global_instrumentation              | YES     |
| thread_instrumentation              | YES     |
| events_waits_current                 | YES     |
| events_waits_history                 | NO      |
| events_waits_history_long            | YES     |
| events_stages_current                | YES     |
| events_stages_history                 | NO      |
| events_stages_history_long           | YES     |
| events_statements_current            | YES     |
| events_statements_history             | NO      |
| events_statements_history_long       | YES     |
| events_transactions_current          | YES     |
| events_transactions_history          | NO      |
| events_transactions_history_long     | YES     |
| ...                                  |         |
+-----+-----+
```

Event-history tables maintained for this configuration:

- `events_xxx_history_long`, where `xxx` is `waits`, `stages`, `statements`, `transactions`

This configuration collects event history per thread and globally:

```
mysql> SELECT * FROM performance_schema.setup_consumers;
+-----+-----+
```

NAME	ENABLED
global_instrumentation	YES
thread_instrumentation	YES
events_waits_current	YES
events_waits_history	YES
events_waits_history_long	YES
events_stages_current	YES
events_stages_history	YES
events_stages_history_long	YES
events_statements_current	YES
events_statements_history	YES
events_statements_history_long	YES
events_transactions_current	YES
events_transactions_history	YES
events_transactions_history_long	YES
...	

Event-history tables maintained for this configuration:

- `events_XXX_history`, where `XXX` is `waits`, `stages`, `statements`, `transactions`
- `events_XXX_history_long`, where `XXX` is `waits`, `stages`, `statements`, `transactions`

5.9 Naming Instruments or Consumers for Filtering Operations

Names given for filtering operations can be as specific or general as required. To indicate a single instrument or consumer, specify its name in full:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'NO'
WHERE NAME = 'wait/synch/mutex/myisammrg/MYRG_INFO::mutex';
UPDATE performance_schema.setup_consumers
SET ENABLED = 'NO'
WHERE NAME = 'events_waits_current';
```

To specify a group of instruments or consumers, use a pattern that matches the group members:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'NO'
WHERE NAME LIKE 'wait/synch/mutex/%';
UPDATE performance_schema.setup_consumers
SET ENABLED = 'NO'
WHERE NAME LIKE '%history%';
```

If you use a pattern, it should be chosen so that it matches all the items of interest and no others. For example, to select all file I/O instruments, it is better to use a pattern that includes the entire instrument name prefix:

```
... WHERE NAME LIKE 'wait/io/file/%';
```

The pattern `%/file/%` matches other instruments that have an element of `/file/` anywhere in the name. Even less suitable is the pattern `%file%` because it matches instruments with `file` anywhere in the name, such as `wait/synch/mutex/innodb/file_open_mutex`.

To check which instrument or consumer names a pattern matches, perform a simple test:

```
SELECT NAME FROM performance_schema.setup_instruments
WHERE NAME LIKE 'pattern';
SELECT NAME FROM performance_schema.setup_consumers
WHERE NAME LIKE 'pattern';
```

For information about the types of names that are supported, see [Chapter 7, Performance Schema Instrument Naming Conventions](#).

5.10 Determining What Is Instrumented

It is always possible to determine what instruments the Performance Schema includes by checking the `setup_instruments` table. For example, to see what file-related events are instrumented for the `InnoDB` storage engine, use this query:

```
mysql> SELECT * FROM performance_schema.setup_instruments
      WHERE NAME LIKE 'wait/io/file/innodb/%';
```

NAME	ENABLED	TIMED
wait/io/file/innodb/innodb_data_file	YES	YES
wait/io/file/innodb/innodb_log_file	YES	YES
wait/io/file/innodb/innodb_temp_file	YES	YES

An exhaustive description of precisely what is instrumented is not given in this documentation, for several reasons:

- What is instrumented is the server code. Changes to this code occur often, which also affects the set of instruments.
- It is not practical to list all the instruments because there are hundreds of them.
- As described earlier, it is possible to find out by querying the `setup_instruments` table. This information is always up to date for your version of MySQL, also includes instrumentation for instrumented plugins you might have installed that are not part of the core server, and can be used by automated tools.

Chapter 6 Performance Schema Queries

Pre-filtering limits which event information is collected and is independent of any particular user. By contrast, post-filtering is performed by individual users through the use of queries with appropriate `WHERE` clauses that restrict what event information to select from the events available after pre-filtering has been applied.

In [Section 5.3, “Event Pre-Filtering”](#), an example showed how to pre-filter for file instruments. If the event tables contain both file and nonfile information, post-filtering is another way to see information only for file events. Add a `WHERE` clause to queries to restrict event selection appropriately:

```
mysql> SELECT THREAD_ID, NUMBER_OF_BYTES
FROM performance_schema.events_waits_history
WHERE EVENT_NAME LIKE 'wait/io/file/%'
AND NUMBER_OF_BYTES IS NOT NULL;
```

THREAD_ID	NUMBER_OF_BYTES
11	66
11	47
11	139
5	24
5	834

Chapter 7 Performance Schema Instrument Naming Conventions

An instrument name consists of a sequence of elements separated by `'/'` characters. Example names:

```
wait/io/file/myisam/log
wait/io/file/mysys/charset
wait/lock/table/sql/handler
wait/synch/cond/mysys/COND_alarm
wait/synch/cond/sql/BINLOG::update_cond
wait/synch/mutex/mysys/BITMAP_mutex
wait/synch/mutex/sql/LOCK_delete
wait/synch/rwlock/sql/Query_cache_query::lock
stage/sql/closing_tables
stage/sql/Sorting_result
statement/com/Execute
statement/com/Query
statement/sql/create_table
statement/sql/lock_tables
```

The instrument name space has a tree-like structure. The elements of an instrument name from left to right provide a progression from more general to more specific. The number of elements a name has depends on the type of instrument.

The interpretation of a given element in a name depends on the elements to the left of it. For example, `myisam` appears in both of the following names, but `myisam` in the first name is related to file I/O, whereas in the second it is related to a synchronization instrument:

```
wait/io/file/myisam/log
wait/synch/cond/myisam/MI_SORT_INFO::cond
```

Instrument names consist of a prefix with a structure defined by the Performance Schema implementation and a suffix defined by the developer implementing the instrument code. The top-level element of an instrument prefix indicates the type of instrument. This element also determines which event timer in the `setup_timers` table applies to the instrument. For the prefix part of instrument names, the top level indicates the type of instrument.

The suffix part of instrument names comes from the code for the instruments themselves. Suffixes may include levels such as these:

- A name for the major element (a server module such as `myisam`, `innodb`, `mysys`, or `sql`) or a plugin name.
- The name of a variable in the code, in the form `XXX` (a global variable) or `CCC::MMM` (a member `MMM` in class `CCC`). Examples: `COND_thread_cache`, `THR_LOCK_myisam`, `BINLOG::LOCK_index`.
- [Top-Level Instrument Elements](#)
- [Idle Instrument Elements](#)
- [Memory Instrument Elements](#)
- [Stage Instrument Elements](#)
- [Statement Instrument Elements](#)
- [Wait Instrument Elements](#)

Top-Level Instrument Elements

- `idle`: An instrumented idle event. This instrument has no further elements.

- `memory`: An instrumented memory event.
- `stage`: An instrumented stage event.
- `statement`: An instrumented statement event.
- `transaction`: An instrumented transaction event. This instrument has no further elements.
- `wait`: An instrumented wait event.

Idle Instrument Elements

The `idle` instrument is used for idle events, which The Performance Schema generates as discussed in the description of the `socket_instances.STATE` column in [Section 10.3.5, “The socket_instances Table”](#).

Memory Instrument Elements

Most memory instrumentation is disabled by default, and can be enabled or disabled at startup, or dynamically at runtime by updating the `ENABLED` column of the relevant instruments in the `setup_instruments` table. Memory instruments have names of the form `memory/code_area/instrument_name` where `code_area` is a value such as `sql` or `myisam`, and `instrument_name` is the instrument detail.

Instruments named with the prefix `memory/performance_schema/` expose how much memory is allocated for internal buffers in the Performance Schema. The `memory/performance_schema/` instruments are built in, always enabled, and cannot be disabled at startup or runtime. Built-in memory instruments are displayed only in the `memory_summary_global_by_event_name` table. For more information, see [The Performance Schema Memory-Allocation Model](#).

Stage Instrument Elements

Stage instruments have names of the form `stage/code_area/stage_name`, where `code_area` is a value such as `sql` or `myisam`, and `stage_name` indicates the stage of statement processing, such as `Sorting result` or `Sending data`. Stages correspond to the thread states displayed by `SHOW PROCESSLIST` or that are visible in the Information Schema `PROCESSLIST` table.

Statement Instrument Elements

- `statement/abstract/*`: An abstract instrument for statement operations. Abstract instruments are used during the early stages of statement classification before the exact statement type is known, then changed to a more specific statement instrument when the type is known. For a description of this process, see [Section 10.6, “Performance Schema Statement Event Tables”](#).
- `statement/com`: An instrumented command operation. These have names corresponding to `COM_xxx` operations (see the `mysql_com.h` header file and `sql/sql_parse.cc`). For example, the `statement/com/Connect` and `statement/com/Init DB` instruments correspond to the `COM_CONNECT` and `COM_INIT_DB` commands.
- `statement/scheduler/event`: A single instrument to track all events executed by the Event Scheduler. This instrument comes into play when a scheduled event begins executing.
- `statement/sp`: An instrumented internal instruction executed by a stored program. For example, the `statement/sp/cfetch` and `statement/sp/freturn` instruments are used cursor fetch and function return instructions.

- `statement/sql`: An instrumented SQL statement operation. For example, the `statement/sql/create_db` and `statement/sql/select` instruments are used for `CREATE DATABASE` and `SELECT` statements.

Wait Instrument Elements

- `wait/io`

An instrumented I/O operation.

- `wait/io/file`

An instrumented file I/O operation. For files, the wait is the time waiting for the file operation to complete (for example, a call to `fwrite()`). Due to caching, the physical file I/O on the disk might not happen within this call.

- `wait/io/socket`

An instrumented socket operation. Socket instruments have names of the form `wait/io/socket/sql/socket_type`. The server has a listening socket for each network protocol that it supports. The instruments associated with listening sockets for TCP/IP or Unix socket file connections have a `socket_type` value of `server_tcpip_socket` or `server_unix_socket`, respectively. When a listening socket detects a connection, the server transfers the connection to a new socket managed by a separate thread. The instrument for the new connection thread has a `socket_type` value of `client_connection`.

- `wait/io/table`

An instrumented table I/O operation. These include row-level accesses to persistent base tables or temporary tables. Operations that affect rows are fetch, insert, update, and delete. For a view, waits are associated with base tables referenced by the view.

Unlike most waits, a table I/O wait can include other waits. For example, table I/O might include file I/O or memory operations. Thus, `events_waits_current` for a table I/O wait usually has two rows. For more information, see [Performance Schema Atom and Molecule Events](#).

Some row operations might cause multiple table I/O waits. For example, an insert might activate a trigger that causes an update.

- `wait/lock`

An instrumented lock operation.

- `wait/lock/table`

An instrumented table lock operation.

- `wait/lock/metadata/sql/mdl`

An instrumented metadata lock operation.

- `wait/synch`

An instrumented synchronization object. For synchronization objects, the `TIMER_WAIT` time includes the amount of time blocked while attempting to acquire a lock on the object, if any.

- `wait/synch/cond`

A condition is used by one thread to signal to other threads that something they were waiting for has happened. If a single thread was waiting for a condition, it can wake up and proceed with its execution. If several threads were waiting, they can all wake up and compete for the resource for which they were waiting.

- `wait/synch/mutex`

A mutual exclusion object used to permit access to a resource (such as a section of executable code) while preventing other threads from accessing the resource.

- `wait/synch/rwlock`

A [read/write lock](#) object used to lock a specific variable for access while preventing its use by other threads. A shared read lock can be acquired simultaneously by multiple threads. An exclusive write lock can be acquired by only one thread at a time.

- `wait/synch/sxlock`

A shared-exclusive (SX) lock is a type of [rwlock](#) lock object that provides write access to a common resource while permitting inconsistent reads by other threads. [sxlocks](#) optimize concurrency and improve scalability for read-write workloads.

Chapter 8 Performance Schema Status Monitoring

There are several status variables associated with the Performance Schema:

```
mysql> SHOW STATUS LIKE 'perf%';
```

Variable_name	Value
Performance_schema_accounts_lost	0
Performance_schema_cond_classes_lost	0
Performance_schema_cond_instances_lost	0
Performance_schema_digest_lost	0
Performance_schema_file_classes_lost	0
Performance_schema_file_handles_lost	0
Performance_schema_file_instances_lost	0
Performance_schema_hosts_lost	0
Performance_schema_locker_lost	0
Performance_schema_memory_classes_lost	0
Performance_schema_metadata_lock_lost	0
Performance_schema_mutex_classes_lost	0
Performance_schema_mutex_instances_lost	0
Performance_schema_nested_statement_lost	0
Performance_schema_program_lost	0
Performance_schema_rwlock_classes_lost	0
Performance_schema_rwlock_instances_lost	0
Performance_schema_session_connect_attrs_lost	0
Performance_schema_socket_classes_lost	0
Performance_schema_socket_instances_lost	0
Performance_schema_stage_classes_lost	0
Performance_schema_statement_classes_lost	0
Performance_schema_table_handles_lost	0
Performance_schema_table_instances_lost	0
Performance_schema_thread_classes_lost	0
Performance_schema_thread_instances_lost	0
Performance_schema_users_lost	0

The Performance Schema status variables provide information about instrumentation that could not be loaded or created due to memory constraints. Names for these variables have several forms:

- `Performance_schema_xxx_classes_lost` indicates how many instruments of type `xxx` could not be loaded.
- `Performance_schema_xxx_instances_lost` indicates how many instances of object type `xxx` could not be created.
- `Performance_schema_xxx_handles_lost` indicates how many instances of object type `xxx` could not be opened.
- `Performance_schema_locker_lost` indicates how many events are “lost” or not recorded.

For example, if a mutex is instrumented in the server source but the server cannot allocate memory for the instrumentation at runtime, it increments `Performance_schema_mutex_classes_lost`. The mutex still functions as a synchronization object (that is, the server continues to function normally), but performance data for it is not collected. If the instrument can be allocated, it can be used for initializing instrumented mutex instances. For a singleton mutex such as a global mutex, there is only one instance. Other mutexes have an instance per connection, or per page in various caches and data buffers, so the number of instances varies over time. Increasing the maximum number of connections or the maximum size of some buffers increases the maximum number of instances that might be allocated at once. If the server cannot create a given instrumented mutex instance, it increments `Performance_schema_mutex_instances_lost`.

Suppose that the following conditions hold:

- The server was started with the `--performance_schema_max_mutex_classes=200` option and thus has room for 200 mutex instruments.
- 150 mutex instruments have been loaded already.
- The plugin named `plugin_a` contains 40 mutex instruments.
- The plugin named `plugin_b` contains 20 mutex instruments.

The server allocates mutex instruments for the plugins depending on how many they need and how many are available, as illustrated by the following sequence of statements:

```
INSTALL PLUGIN plugin_a
```

The server now has $150+40 = 190$ mutex instruments.

```
UNINSTALL PLUGIN plugin_a;
```

The server still has 190 instruments. All the historical data generated by the plugin code is still available, but new events for the instruments are not collected.

```
INSTALL PLUGIN plugin_a;
```

The server detects that the 40 instruments are already defined, so no new instruments are created, and previously assigned internal memory buffers are reused. The server still has 190 instruments.

```
INSTALL PLUGIN plugin_b;
```

The server has room for $200-190 = 10$ instruments (in this case, mutex classes), and sees that the plugin contains 20 new instruments. 10 instruments are loaded, and 10 are discarded or “lost.” The `Performance_schema_mutex_classes_lost` indicates the number of instruments (mutex classes) lost:

```
mysql> SHOW STATUS LIKE "perf%mutex_classes_lost";
+-----+-----+
| Variable_name                | Value |
+-----+-----+
| Performance_schema_mutex_classes_lost | 10    |
+-----+-----+
1 row in set (0.10 sec)
```

The instrumentation still works and collects (partial) data for `plugin_b`.

When the server cannot create a mutex instrument, these results occur:

- No row for the instrument is inserted into the `setup_instruments` table.
- `Performance_schema_mutex_classes_lost` increases by 1.
- `Performance_schema_mutex_instances_lost` does not change. (When the mutex instrument is not created, it cannot be used to create instrumented mutex instances later.)

The pattern just described applies to all types of instruments, not just mutexes.

A value of `Performance_schema_mutex_classes_lost` greater than 0 can happen in two cases:

- To save a few bytes of memory, you start the server with `--performance_schema_max_mutex_classes=N`, where N is less than the default value. The default

value is chosen to be sufficient to load all the plugins provided in the MySQL distribution, but this can be reduced if some plugins are never loaded. For example, you might choose not to load some of the storage engines in the distribution.

- You load a third-party plugin that is instrumented for the Performance Schema but do not allow for the plugin's instrumentation memory requirements when you start the server. Because it comes from a third party, the instrument memory consumption of this engine is not accounted for in the default value chosen for `performance_schema_max_mutex_classes`.

If the server has insufficient resources for the plugin's instruments and you do not explicitly allocate more using `--performance_schema_max_mutex_classes=N`, loading the plugin leads to starvation of instruments.

If the value chosen for `performance_schema_max_mutex_classes` is too small, no error is reported in the error log and there is no failure at runtime. However, the content of the tables in the `performance_schema` database misses events. The `Performance_schema_mutex_classes_lost` status variable is the only visible sign to indicate that some events were dropped internally due to failure to create instruments.

If an instrument is not lost, it is known to the Performance Schema, and is used when instrumenting instances. For example, `wait/synch/mutex/sql/LOCK_delete` is the name of a mutex instrument in the `setup_instruments` table. This single instrument is used when creating a mutex in the code (in `THD::LOCK_delete`) however many instances of the mutex are needed as the server runs. In this case, `LOCK_delete` is a mutex that is per connection (`THD`), so if a server has 1000 connections, there are 1000 threads, and 1000 instrumented `LOCK_delete` mutex instances (`THD::LOCK_delete`).

If the server does not have room for all these 1000 instrumented mutexes (instances), some mutexes are created with instrumentation, and some are created without instrumentation. If the server can create only 800 instances, 200 instances are lost. The server continues to run, but increments `Performance_schema_mutex_instances_lost` by 200 to indicate that instances could not be created.

A value of `Performance_schema_mutex_instances_lost` greater than 0 can happen when the code initializes more mutexes at runtime than were allocated for `--performance_schema_max_mutex_instances=N`.

The bottom line is that if `SHOW STATUS LIKE 'perf%'` says that nothing was lost (all values are zero), the Performance Schema data is accurate and can be relied upon. If something was lost, the data is incomplete, and the Performance Schema could not record everything given the insufficient amount of memory it was given to use. In this case, the specific `Performance_schema_xxx_lost` variable indicates the problem area.

It might be appropriate in some cases to cause deliberate instrument starvation. For example, if you do not care about performance data for file I/O, you can start the server with all Performance Schema parameters related to file I/O set to 0. No memory is allocated for file-related classes, instances, or handles, and all file events are lost.

Use `SHOW ENGINE PERFORMANCE_SCHEMA STATUS` to inspect the internal operation of the Performance Schema code:

```
mysql> SHOW ENGINE PERFORMANCE_SCHEMA STATUS\G
...
***** 3. row *****
  Type: performance_schema
  Name: events_waits_history.size
  Status: 76
***** 4. row *****
```

```
Type: performance_schema
Name: events_waits_history.count
Status: 10000
***** 5. row *****
Type: performance_schema
Name: events_waits_history.memory
Status: 760000
...
***** 57. row *****
Type: performance_schema
Name: performance_schema.memory
Status: 26459600
...
```

This statement is intended to help the DBA understand the effects that different Performance Schema options have on memory requirements. For a description of the field meanings, see [SHOW ENGINE Statement](#).

Chapter 9 Performance Schema General Table Characteristics

The name of the `performance_schema` database is lowercase, as are the names of tables within it. Queries should specify the names in lowercase.

Many tables in the `performance_schema` database are read only and cannot be modified:

```
mysql> TRUNCATE TABLE performance_schema.setup_instruments;
ERROR 1683 (HY000): Invalid performance_schema usage.
```

Some of the setup tables have columns that can be modified to affect Performance Schema operation; some also permit rows to be inserted or deleted. Truncation is permitted to clear collected events, so `TRUNCATE TABLE` can be used on tables containing those kinds of information, such as tables named with a prefix of `events_waits_`.

Summary tables can be truncated with `TRUNCATE TABLE`. Generally, the effect is to reset the summary columns to 0 or `NULL`, not to remove rows. This enables you to clear collected values and restart aggregation. That might be useful, for example, after you have made a runtime configuration change. Exceptions to this truncation behavior are noted in individual summary table sections.

Privileges are as for other databases and tables:

- To retrieve from `performance_schema` tables, you must have the `SELECT` privilege.
- To change those columns that can be modified, you must have the `UPDATE` privilege.
- To truncate tables that can be truncated, you must have the `DROP` privilege.

Because only a limited set of privileges apply to Performance Schema tables, attempts to use `GRANT ALL` as shorthand for granting privileges at the database or table level fail with an error:

```
mysql> GRANT ALL ON performance_schema.*
      TO 'u1'@'localhost';
ERROR 1044 (42000): Access denied for user 'root'@'localhost'
to database 'performance_schema'
mysql> GRANT ALL ON performance_schema.setup_instruments
      TO 'u2'@'localhost';
ERROR 1044 (42000): Access denied for user 'root'@'localhost'
to database 'performance_schema'
```

Instead, grant exactly the desired privileges:

```
mysql> GRANT SELECT ON performance_schema.*
      TO 'u1'@'localhost';
Query OK, 0 rows affected (0.03 sec)
mysql> GRANT SELECT, UPDATE ON performance_schema.setup_instruments
      TO 'u2'@'localhost';
Query OK, 0 rows affected (0.02 sec)
```

Chapter 10 Performance Schema Table Descriptions

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Tables in the `performance_schema` database can be grouped as follows:

- Setup tables. These tables are used to configure and display monitoring characteristics.
- Current events tables. The `events_waits_current` table contains the most recent event for each thread. Other similar tables contain current events at different levels of the event hierarchy: `events_stages_current` for stage events, `events_statements_current` for statement events, and `events_transactions_current` for transaction events.
- History tables. These tables have the same structure as the current events tables, but contain more rows. For example, for wait events, `events_waits_history` table contains the most recent 10 events per thread. `events_waits_history_long` contains the most recent 10,000 events. Other similar tables exist for stage, statement, and transaction histories.

To change the sizes of the history tables, set the appropriate system variables at server startup. For example, to set the sizes of the wait event history tables, set `performance_schema_events_waits_history_size` and `performance_schema_events_waits_history_long_size`.

- Summary tables. These tables contain information aggregated over groups of events, including those that have been discarded from the history tables.
- Instance tables. These tables document what types of objects are instrumented. An instrumented object, when used by the server, produces an event. These tables provide event names and explanatory notes or status information.
- Miscellaneous tables. These do not fall into any of the other table groups.

10.1 Performance Schema Table Reference

The following table summarizes all available Performance Schema tables. For greater detail, see the individual table descriptions.

Table 10.1 Performance Schema Tables

Table Name	Description	Deprecated
accounts	Connection statistics per client account	
cond_instances	Synchronization object instances	
events_stages_current	Current stage events	
events_stages_history	Most recent stage events per thread	
events_stages_history_long	Most recent stage events overall	
events_stages_summary_by_account	Stage events per account and event name	
events_stages_summary_by_host	Stage events per host name and event name	
events_stages_summary_by_thread	Stage waits per thread and event name	
events_stages_summary_by_user	Stage events per user name and event name	
events_stages_summary_global	Stage waits per event name	
events_statements_current	Current statement events	
events_statements_history	Most recent statement events per thread	
events_statements_history_long	Most recent statement events overall	
events_statements_summary_by_account	Statement events per account and event name	
events_statements_summary_by_statement	Statement events per schema and digest value	
events_statements_summary_by_host	Statement events per host name and event name	
events_statements_summary_by_program	Statement events per stored program	
events_statements_summary_by_thread	Statement events per thread and event name	
events_statements_summary_by_user	Statement events per user name and event name	
events_statements_summary_by_event	Statement events per event name	
events_transactions_current	Current transaction events	
events_transactions_history	Most recent transaction events per thread	
events_transactions_history_long	Most recent transaction events overall	
events_transactions_summary_by_account	Transaction events per account and event name	

Performance Schema Table Reference

Table Name	Description	Deprecated
events_transactions_summary_by_host	Transaction events per host name and event name	
events_transactions_summary_by_thread	Transaction events per thread and event name	
events_transactions_summary_by_user	Transaction events per user name and event name	
events_transactions_summary_by_event	Transaction events per event name	
events_waits_current	Current wait events	
events_waits_history	Most recent wait events per thread	
events_waits_history_long	Most recent wait events overall	
events_waits_summary_by_account	Wait events per account and event name	
events_waits_summary_by_host	Wait events per host name and event name	
events_waits_summary_by_instance	Wait events per instance	
events_waits_summary_by_thread	Wait events per thread and event name	
events_waits_summary_by_user	Wait events per user name and event name	
events_waits_summary_global_by_event	Wait events per event name	
file_instances	File instances	
file_summary_by_event_name	File events per event name	
file_summary_by_instance	File events per file instance	
global_status	Global status variables	
global_variables	Global system variables	
host_cache	Information from internal host cache	
hosts	Connection statistics per client host name	
memory_summary_by_account	Memory operations per account and event name	
memory_summary_by_host_by_event	Memory operations per host and event name	
memory_summary_by_thread_by_event	Memory operations per thread and event name	
memory_summary_by_user_by_event	Memory operations per user and event name	
memory_summary_global_by_event	Memory operations globally per event name	
metadata_locks	Metadata locks and lock requests	

Performance Schema Table Reference

Table Name	Description	Deprecated
<code>mutex_instances</code>	Mutex synchronization object instances	
<code>objects_summary_global_by_type</code>	Object summaries	
<code>performance_timers</code>	Which event timers are available	
<code>prepared_statements_instances</code>	Prepared statement instances and statistics	
<code>replication_applier_configuration</code>	Configuration parameters for replication applier on replica	
<code>replication_applier_status</code>	Current status of replication applier on replica	
<code>replication_applier_status_by_coordinator</code>	SQL or coordinator thread applier status	
<code>replication_applier_status_by_worker</code>	Worker thread applier status	
<code>replication_connection_configuration</code>	Configuration parameters for connecting to source	
<code>replication_connection_status</code>	Current status of connection to source	
<code>replication_group_member_statistics</code>	Replication group member statistics	
<code>replication_group_members</code>	Replication group member network and status	
<code>rwlock_instances</code>	Lock synchronization object instances	
<code>session_account_connect_attributes</code>	Connection attributes per for current session	
<code>session_connect_attrs</code>	Connection attributes for all sessions	
<code>session_status</code>	Status variables for current session	
<code>session_variables</code>	System variables for current session	
<code>setup_actors</code>	How to initialize monitoring for new foreground threads	
<code>setup_consumers</code>	Consumers for which event information can be stored	
<code>setup_instruments</code>	Classes of instrumented objects for which events can be collected	
<code>setup_objects</code>	Which objects should be monitored	
<code>setup_timers</code>	Currently selected event timers	5.7.21
<code>socket_instances</code>	Active connection instances	
<code>socket_summary_by_event_name</code>	Socket waits and I/O per event name	

Table Name	Description	Deprecated
<code>socket_summary_by_instance</code>	Socket waits and I/O per instance	
<code>status_by_account</code>	Session status variables per account	
<code>status_by_host</code>	Session status variables per host name	
<code>status_by_thread</code>	Session status variables per session	
<code>status_by_user</code>	Session status variables per user name	
<code>table_handles</code>	Table locks and lock requests	
<code>table_io_waits_summary_by_index</code>	Table I/O waits per index	
<code>table_io_waits_summary_by_table</code>	Table I/O waits per table	
<code>table_lock_waits_summary_by_table</code>	Table lock waits per table	
<code>threads</code>	Information about server threads	
<code>user_variables_by_thread</code>	User-defined variables per thread	
<code>users</code>	Connection statistics per client user name	
<code>variables_by_thread</code>	Session system variables per session	

10.2 Performance Schema Setup Tables

The setup tables provide information about the current instrumentation and enable the monitoring configuration to be changed. For this reason, some columns in these tables can be changed if you have the `UPDATE` privilege.

The use of tables rather than individual variables for setup information provides a high degree of flexibility in modifying Performance Schema configuration. For example, you can use a single statement with standard SQL syntax to make multiple simultaneous configuration changes.

These setup tables are available:

- `setup_actors`: How to initialize monitoring for new foreground threads
- `setup_consumers`: The destinations to which event information can be sent and stored
- `setup_instruments`: The classes of instrumented objects for which events can be collected
- `setup_objects`: Which objects should be monitored
- `setup_timers`: The current event timer

10.2.1 The `setup_actors` Table

The `setup_actors` table contains information that determines whether to enable monitoring and historical event logging for new foreground server threads (threads associated with client connections). This table has a maximum size of 100 rows by default. To change the table size, modify the `performance_schema_setup_actors_size` system variable at server startup.

For each new foreground thread, the Performance Schema matches the user and host for the thread against the rows of the `setup_actors` table. If a row from that table matches, its `ENABLED` and `HISTORY` column values are used to set the `INSTRUMENTED` and `HISTORY` columns, respectively, of the `threads` table row for the thread. This enables instrumenting and historical event logging to be applied selectively per host, user, or account (user and host combination). If there is no match, the `INSTRUMENTED` and `HISTORY` columns for the thread are set to `NO`.

For background threads, there is no associated user. `INSTRUMENTED` and `HISTORY` are `YES` by default and `setup_actors` is not consulted.

The initial contents of the `setup_actors` table match any user and host combination, so monitoring and historical event collection are enabled by default for all foreground threads:

```
mysql> SELECT * FROM performance_schema.setup_actors;
+-----+-----+-----+-----+-----+
| HOST | USER | ROLE | ENABLED | HISTORY |
+-----+-----+-----+-----+-----+
| %    | %    | %    | YES     | YES     |
+-----+-----+-----+-----+-----+
```

For information about how to use the `setup_actors` table to affect event monitoring, see [Section 5.6, “Pre-Filtering by Thread”](#).

Modifications to the `setup_actors` table affect only foreground threads created subsequent to the modification, not existing threads. To affect existing threads, modify the `INSTRUMENTED` and `HISTORY` columns of `threads` table rows.

The `setup_actors` table has these columns:

- `HOST`
The host name. This should be a literal name, or `'%'` to mean “any host.”
- `USER`
The user name. This should be a literal name, or `'%'` to mean “any user.”
- `ROLE`
Unused.
- `ENABLED`
Whether to enable instrumentation for foreground threads matched by the row. The value is `YES` or `NO`.
- `HISTORY`
Whether to log historical events for foreground threads matched by the row. The value is `YES` or `NO`.

`TRUNCATE TABLE` is permitted for the `setup_actors` table. It removes the rows.

10.2.2 The setup_consumers Table

The `setup_consumers` table lists the types of consumers for which event information can be stored and which are enabled:

```
mysql> SELECT * FROM performance_schema.setup_consumers;
+-----+-----+
| NAME | ENABLED |
+-----+-----+
```

events_stages_current	NO
events_stages_history	NO
events_stages_history_long	NO
events_statements_current	YES
events_statements_history	YES
events_statements_history_long	NO
events_transactions_current	NO
events_transactions_history	NO
events_transactions_history_long	NO
events_waits_current	NO
events_waits_history	NO
events_waits_history_long	NO
global_instrumentation	YES
thread_instrumentation	YES
statements_digest	YES

The consumer settings in the `setup_consumers` table form a hierarchy from higher levels to lower. For detailed information about the effect of enabling different consumers, see [Section 5.7, “Pre-Filtering by Consumer”](#).

Modifications to the `setup_consumers` table affect monitoring immediately.

The `setup_consumers` table has these columns:

- **NAME**

The consumer name.

- **ENABLED**

Whether the consumer is enabled. The value is **YES** or **NO**. This column can be modified. If you disable a consumer, the server does not spend time adding event information to it.

`TRUNCATE TABLE` is not permitted for the `setup_consumers` table.

10.2.3 The setup_instruments Table

The `setup_instruments` table lists classes of instrumented objects for which events can be collected:

```
mysql> SELECT * FROM performance_schema.setup_instruments;
```

NAME	ENABLED	TIMED
...		
stage/sql/end	NO	NO
stage/sql/executing	NO	NO
stage/sql/init	NO	NO
stage/sql/insert	NO	NO
...		
statement/sql/load	YES	YES
statement/sql/grant	YES	YES
statement/sql/check	YES	YES
statement/sql/flush	YES	YES
...		
wait/synch/mutex/sql/LOCK_global_read_lock	YES	YES
wait/synch/mutex/sql/LOCK_global_system_variables	YES	YES
wait/synch/mutex/sql/LOCK_lock_db	YES	YES
wait/synch/mutex/sql/LOCK_manager	YES	YES
...		
wait/synch/rwlock/sql/LOCK_grant	YES	YES
wait/synch/rwlock/sql/LOCK_logger	YES	YES
wait/synch/rwlock/sql/LOCK_sys_init_connect	YES	YES
wait/synch/rwlock/sql/LOCK_sys_init_slave	YES	YES


```

...
| wait/io/file/sql/binlog          | YES | YES |
| wait/io/file/sql/binlog_index   | YES | YES |
| wait/io/file/sql/casetest       | YES | YES |
| wait/io/file/sql/dbopt          | YES | YES |
...

```

Each instrument added to the source code provides a row for the `setup_instruments` table, even when the instrumented code is not executed. When an instrument is enabled and executed, instrumented instances are created, which are visible in the `xxx_instances` tables, such as `file_instances` or `rwlock_instances`.

Modifications to most `setup_instruments` rows affect monitoring immediately. For some instruments, modifications are effective only at server startup; changing them at runtime has no effect. This affects primarily mutexes, conditions, and rwlocks in the server, although there may be other instruments for which this is true.

For more information about the role of the `setup_instruments` table in event filtering, see [Section 5.3, “Event Pre-Filtering”](#).

The `setup_instruments` table has these columns:

- `NAME`

The instrument name. Instrument names may have multiple parts and form a hierarchy, as discussed in [Chapter 7, Performance Schema Instrument Naming Conventions](#). Events produced from execution of an instrument have an `EVENT_NAME` value that is taken from the instrument `NAME` value. (Events do not really have a “name,” but this provides a way to associate events with instruments.)

- `ENABLED`

Whether the instrument is enabled. The value is `YES` or `NO`. A disabled instrument produces no events. This column can be modified, although setting `ENABLED` has no effect for instruments that have already been created.

- `TIMED`

Whether the instrument is timed. The value is `YES` or `NO`. This column can be modified, although setting `TIMED` has no effect for instruments that have already been created.

For memory instruments, the `TIMED` column in `setup_instruments` is ignored because memory operations are not timed.

If an enabled instrument is not timed, the instrument code is enabled, but the timer is not. Events produced by the instrument have `NULL` for the `TIMER_START`, `TIMER_END`, and `TIMER_WAIT` timer values. This in turn causes those values to be ignored when calculating the sum, minimum, maximum, and average time values in summary tables.

`TRUNCATE TABLE` is not permitted for the `setup_instruments` table.

10.2.4 The setup_objects Table

The `setup_objects` table controls whether the Performance Schema monitors particular objects. This table has a maximum size of 100 rows by default. To change the table size, modify the `performance_schema_setup_objects_size` system variable at server startup.

The initial `setup_objects` contents look like this:

```
mysql> SELECT * FROM performance_schema.setup_objects;
```

The setup_objects Table

OBJECT_TYPE	OBJECT_SCHEMA	OBJECT_NAME	ENABLED	TIMED
EVENT	mysql	%	NO	NO
EVENT	performance_schema	%	NO	NO
EVENT	information_schema	%	NO	NO
EVENT	%	%	YES	YES
FUNCTION	mysql	%	NO	NO
FUNCTION	performance_schema	%	NO	NO
FUNCTION	information_schema	%	NO	NO
FUNCTION	%	%	YES	YES
PROCEDURE	mysql	%	NO	NO
PROCEDURE	performance_schema	%	NO	NO
PROCEDURE	information_schema	%	NO	NO
PROCEDURE	%	%	YES	YES
TABLE	mysql	%	NO	NO
TABLE	performance_schema	%	NO	NO
TABLE	information_schema	%	NO	NO
TABLE	%	%	YES	YES
TRIGGER	mysql	%	NO	NO
TRIGGER	performance_schema	%	NO	NO
TRIGGER	information_schema	%	NO	NO
TRIGGER	%	%	YES	YES

Modifications to the `setup_objects` table affect object monitoring immediately.

For object types listed in `setup_objects`, the Performance Schema uses the table to how to monitor them. Object matching is based on the `OBJECT_SCHEMA` and `OBJECT_NAME` columns. Objects for which there is no match are not monitored.

The effect of the default object configuration is to instrument all tables except those in the `mysql`, `INFORMATION_SCHEMA`, and `performance_schema` databases. (Tables in the `INFORMATION_SCHEMA` database are not instrumented regardless of the contents of `setup_objects`; the row for `information_schema.%` simply makes this default explicit.)

When the Performance Schema checks for a match in `setup_objects`, it tries to find more specific matches first. For example, with a table `db1.t1`, it looks for a match for `'db1'` and `'t1'`, then for `'db1'` and `'%'`, then for `'%'` and `'%'`. The order in which matching occurs matters because different matching `setup_objects` rows can have different `ENABLED` and `TIMED` values.

Rows can be inserted into or deleted from `setup_objects` by users with the `INSERT` or `DELETE` privilege on the table. For existing rows, only the `ENABLED` and `TIMED` columns can be modified, by users with the `UPDATE` privilege on the table.

For more information about the role of the `setup_objects` table in event filtering, see [Section 5.3, “Event Pre-Filtering”](#).

The `setup_objects` table has these columns:

- `OBJECT_TYPE`

The type of object to instrument. The value is one of `'EVENT'` (Event Scheduler event), `'FUNCTION'` (stored function), `'PROCEDURE'` (stored procedure), `'TABLE'` (base table), or `'TRIGGER'` (trigger).

`TABLE` filtering affects table I/O events (`wait/io/table/sql/handler` instrument) and table lock events (`wait/lock/table/sql/handler` instrument).

- `OBJECT_SCHEMA`

The schema that contains the object. This should be a literal name, or `'%'` to mean “any schema.”

- `OBJECT_NAME`

The name of the instrumented object. This should be a literal name, or `'%'` to mean “any object.”

- `ENABLED`

Whether events for the object are instrumented. The value is `YES` or `NO`. This column can be modified.

- `TIMED`

Whether events for the object are timed. The value is `YES` or `NO`. This column can be modified.

`TRUNCATE TABLE` is permitted for the `setup_objects` table. It removes the rows.

10.2.5 The setup_timers Table

The `setup_timers` table shows the currently selected event timers:

```
mysql> SELECT * FROM performance_schema.setup_timers;
+-----+-----+
| NAME          | TIMER_NAME |
+-----+-----+
| idle          | MICROSECOND |
| wait          | CYCLE      |
| stage         | NANOSECOND |
| statement     | NANOSECOND |
| transaction   | NANOSECOND |
+-----+-----+
```

Note

As of MySQL 5.7.21, the Performance Schema `setup_timers` table is deprecated and is removed in MySQL 8.0, as is the `TICKS` row in the `performance_timers` table.

The `setup_timers.TIMER_NAME` value can be changed to select a different timer. The value can be any of the values in the `performance_timers.TIMER_NAME` column. For an explanation of how event timing occurs, see [Section 5.1, “Performance Schema Event Timing”](#).

Modifications to the `setup_timers` table affect monitoring immediately. Events already in progress may use the original timer for the begin time and the new timer for the end time. To avoid unpredictable results after you make timer changes, use `TRUNCATE TABLE` to reset Performance Schema statistics.

The `setup_timers` table has these columns:

- `NAME`

The type of instrument the timer is used for.

- `TIMER_NAME`

The timer that applies to the instrument type. This column can be modified.

`TRUNCATE TABLE` is not permitted for the `setup_timers` table.

10.3 Performance Schema Instance Tables

Instance tables document what types of objects are instrumented. They provide event names and explanatory notes or status information:

- `cond_instances`: Condition synchronization object instances
- `file_instances`: File instances
- `mutex_instances`: Mutex synchronization object instances
- `rwlock_instances`: Lock synchronization object instances
- `socket_instances`: Active connection instances

These tables list instrumented synchronization objects, files, and connections. There are three types of synchronization objects: `cond`, `mutex`, and `rwlock`. Each instance table has an `EVENT_NAME` or `NAME` column to indicate the instrument associated with each row. Instrument names may have multiple parts and form a hierarchy, as discussed in [Chapter 7, Performance Schema Instrument Naming Conventions](#).

The `mutex_instances.LOCKED_BY_THREAD_ID` and `rwlock_instances.WRITE_LOCKED_BY_THREAD_ID` columns are extremely important for investigating performance bottlenecks or deadlocks. For examples of how to use them for this purpose, see [Chapter 14, Using the Performance Schema to Diagnose Problems](#)

10.3.1 The cond_instances Table

The `cond_instances` table lists all the conditions seen by the Performance Schema while the server executes. A condition is a synchronization mechanism used in the code to signal that a specific event has happened, so that a thread waiting for this condition can resume work.

When a thread is waiting for something to happen, the condition name is an indication of what the thread is waiting for, but there is no immediate way to tell which other threads cause the condition to happen.

The `cond_instances` table has these columns:

- `NAME`

The instrument name associated with the condition.

- `OBJECT_INSTANCE_BEGIN`

The address in memory of the instrumented condition.

`TRUNCATE TABLE` is not permitted for the `cond_instances` table.

10.3.2 The file_instances Table

The `file_instances` table lists all the files seen by the Performance Schema when executing file I/O instrumentation. If a file on disk has never been opened, it is not in `file_instances`. When a file is deleted from the disk, it is also removed from the `file_instances` table.

The `file_instances` table has these columns:

- `FILE_NAME`

The file name.

- `EVENT_NAME`

The instrument name associated with the file.

- `OPEN_COUNT`

The count of open handles on the file. If a file was opened and then closed, it was opened 1 time, but `OPEN_COUNT` is 0. To list all the files currently opened by the server, use `WHERE OPEN_COUNT > 0`.

`TRUNCATE TABLE` is not permitted for the `file_instances` table.

10.3.3 The mutex_instances Table

The `mutex_instances` table lists all the mutexes seen by the Performance Schema while the server executes. A mutex is a synchronization mechanism used in the code to enforce that only one thread at a given time can have access to some common resource. The resource is said to be “protected” by the mutex.

When two threads executing in the server (for example, two user sessions executing a query simultaneously) do need to access the same resource (a file, a buffer, or some piece of data), these two threads compete against each other, so that the first query to obtain a lock on the mutex causes the other query to wait until the first is done and unlocks the mutex.

The work performed while holding a mutex is said to be in a “critical section,” and multiple queries do execute this critical section in a serialized way (one at a time), which is a potential bottleneck.

The `mutex_instances` table has these columns:

- `NAME`

The instrument name associated with the mutex.

- `OBJECT_INSTANCE_BEGIN`

The address in memory of the instrumented mutex.

- `LOCKED_BY_THREAD_ID`

When a thread currently has a mutex locked, `LOCKED_BY_THREAD_ID` is the `THREAD_ID` of the locking thread, otherwise it is `NULL`.

`TRUNCATE TABLE` is not permitted for the `mutex_instances` table.

For every mutex instrumented in the code, the Performance Schema provides the following information.

- The `setup_instruments` table lists the name of the instrumentation point, with the prefix `wait/synch/mutex/`.
- When some code creates a mutex, a row is added to the `mutex_instances` table. The `OBJECT_INSTANCE_BEGIN` column is a property that uniquely identifies the mutex.
- When a thread attempts to lock a mutex, the `events_waits_current` table shows a row for that thread, indicating that it is waiting on a mutex (in the `EVENT_NAME` column), and indicating which mutex is waited on (in the `OBJECT_INSTANCE_BEGIN` column).
- When a thread succeeds in locking a mutex:
 - `events_waits_current` shows that the wait on the mutex is completed (in the `TIMER_END` and `TIMER_WAIT` columns)
 - The completed wait event is added to the `events_waits_history` and `events_waits_history_long` tables

- `mutex_instances` shows that the mutex is now owned by the thread (in the `THREAD_ID` column).
- When a thread unlocks a mutex, `mutex_instances` shows that the mutex now has no owner (the `THREAD_ID` column is `NULL`).
- When a mutex object is destroyed, the corresponding row is removed from `mutex_instances`.

By performing queries on both of the following tables, a monitoring application or a DBA can detect bottlenecks or deadlocks between threads that involve mutexes:

- `events_waits_current`, to see what mutex a thread is waiting for
- `mutex_instances`, to see which other thread currently owns a mutex

10.3.4 The `rwlock_instances` Table

The `rwlock_instances` table lists all the `rwlock` (read write lock) instances seen by the Performance Schema while the server executes. An `rwlock` is a synchronization mechanism used in the code to enforce that threads at a given time can have access to some common resource following certain rules. The resource is said to be “protected” by the `rwlock`. The access is either shared (many threads can have a read lock at the same time), exclusive (only one thread can have a write lock at a given time), or shared-exclusive (a thread can have a write lock while permitting inconsistent reads by other threads). Shared-exclusive access is otherwise known as an `sxlock` and optimizes concurrency and improves scalability for read-write workloads.

Depending on how many threads are requesting a lock, and the nature of the locks requested, access can be either granted in shared mode, exclusive mode, shared-exclusive mode or not granted at all, waiting for other threads to finish first.

The `rwlock_instances` table has these columns:

- `NAME`

The instrument name associated with the lock.

- `OBJECT_INSTANCE_BEGIN`

The address in memory of the instrumented lock.

- `WRITE_LOCKED_BY_THREAD_ID`

When a thread currently has an `rwlock` locked in exclusive (write) mode, `WRITE_LOCKED_BY_THREAD_ID` is the `THREAD_ID` of the locking thread, otherwise it is `NULL`.

- `READ_LOCKED_BY_COUNT`

When a thread currently has an `rwlock` locked in shared (read) mode, `READ_LOCKED_BY_COUNT` is incremented by 1. This is a counter only, so it cannot be used directly to find which thread holds a read lock, but it can be used to see whether there is a read contention on an `rwlock`, and see how many readers are currently active.

`TRUNCATE TABLE` is not permitted for the `rwlock_instances` table.

By performing queries on both of the following tables, a monitoring application or a DBA may detect some bottlenecks or deadlocks between threads that involve locks:

- `events_waits_current`, to see what `rwlock` a thread is waiting for

- `rwlock_instances`, to see which other thread currently owns an `rwlock`

There is a limitation: The `rwlock_instances` can be used only to identify the thread holding a write lock, but not the threads holding a read lock.

10.3.5 The socket_instances Table

The `socket_instances` table provides a real-time snapshot of the active connections to the MySQL server. The table contains one row per TCP/IP or Unix socket file connection. Information available in this table provides a real-time snapshot of the active connections to the server. (Additional information is available in socket summary tables, including network activity such as socket operations and number of bytes transmitted and received; see [Section 10.15.8, “Socket Summary Tables”](#)).

```
mysql> SELECT * FROM performance_schema.socket_instances\G
***** 1. row *****
EVENT_NAME: wait/io/socket/sql/server_unix_socket
OBJECT_INSTANCE_BEGIN: 4316619408
THREAD_ID: 1
SOCKET_ID: 16
IP:
PORT: 0
STATE: ACTIVE
***** 2. row *****
EVENT_NAME: wait/io/socket/sql/client_connection
OBJECT_INSTANCE_BEGIN: 4316644608
THREAD_ID: 21
SOCKET_ID: 39
IP: 127.0.0.1
PORT: 55233
STATE: ACTIVE
***** 3. row *****
EVENT_NAME: wait/io/socket/sql/server_tcpip_socket
OBJECT_INSTANCE_BEGIN: 4316699040
THREAD_ID: 1
SOCKET_ID: 14
IP: 0.0.0.0
PORT: 50603
STATE: ACTIVE
```

Socket instruments have names of the form `wait/io/socket/sql/socket_type` and are used like this:

1. The server has a listening socket for each network protocol that it supports. The instruments associated with listening sockets for TCP/IP or Unix socket file connections have a `socket_type` value of `server_tcpip_socket` or `server_unix_socket`, respectively.
2. When a listening socket detects a connection, the server transfers the connection to a new socket managed by a separate thread. The instrument for the new connection thread has a `socket_type` value of `client_connection`.
3. When a connection terminates, the row in `socket_instances` corresponding to it is deleted.

The `socket_instances` table has these columns:

- `EVENT_NAME`

The name of the `wait/io/socket/*` instrument that produced the event. This is a `NAME` value from the `setup_instruments` table. Instrument names may have multiple parts and form a hierarchy, as discussed in [Chapter 7, Performance Schema Instrument Naming Conventions](#).

- `OBJECT_INSTANCE_BEGIN`

This column uniquely identifies the socket. The value is the address of an object in memory.

- `THREAD_ID`

The internal thread identifier assigned by the server. Each socket is managed by a single thread, so each socket can be mapped to a thread which can be mapped to a server process.

- `SOCKET_ID`

The internal file handle assigned to the socket.

- `IP`

The client IP address. The value may be either an IPv4 or IPv6 address, or blank to indicate a Unix socket file connection.

- `PORT`

The TCP/IP port number, in the range from 0 to 65535.

- `STATE`

The socket status, either `IDLE` or `ACTIVE`. Wait times for active sockets are tracked using the corresponding socket instrument. Wait times for idle sockets are tracked using the `idle` instrument.

A socket is idle if it is waiting for a request from the client. When a socket becomes idle, the event row in `socket_instances` that is tracking the socket switches from a status of `ACTIVE` to `IDLE`. The `EVENT_NAME` value remains `wait/io/socket/*`, but timing for the instrument is suspended. Instead, an event is generated in the `events_waits_current` table with an `EVENT_NAME` value of `idle`.

When the next request is received, the `idle` event terminates, the socket instance switches from `IDLE` to `ACTIVE`, and timing of the socket instrument resumes.

`TRUNCATE TABLE` is not permitted for the `socket_instances` table.

The `IP:PORT` column combination value identifies the connection. This combination value is used in the `OBJECT_NAME` column of the `events_waits_xxx` tables, to identify the connection from which socket events come:

- For the Unix domain listener socket (`server_unix_socket`), the port is 0, and the IP is ''.
- For client connections via the Unix domain listener (`client_connection`), the port is 0, and the IP is ''.
- For the TCP/IP server listener socket (`server_tcpip_socket`), the port is always the master port (for example, 3306), and the IP is always `0.0.0.0`.
- For client connections via the TCP/IP listener (`client_connection`), the port is whatever the server assigns, but never 0. The IP is the IP of the originating host (`127.0.0.1` or `::1` for the local host)

10.4 Performance Schema Wait Event Tables

The Performance Schema instruments waits, which are events that take time. Within the event hierarchy, wait events nest within stage events, which nest within statement events, which nest within transaction events.

These tables store wait events:

- `events_waits_current`: The current wait event for each thread.
- `events_waits_history`: The most recent wait events that have ended per thread.
- `events_waits_history_long`: The most recent wait events that have ended globally (across all threads).

The following sections describe the wait event tables. There are also summary tables that aggregate information about wait events; see [Section 10.15.1, “Wait Event Summary Tables”](#).

For more information about the relationship between the three wait event tables, see [Performance Schema Tables for Current and Historical Events](#).

Configuring Wait Event Collection

To control whether to collect wait events, set the state of the relevant instruments and consumers:

- The `setup_instruments` table contains instruments with names that begin with `wait`. Use these instruments to enable or disable collection of individual wait event classes.
- The `setup_consumers` table contains consumer values with names corresponding to the current and historical wait event table names. Use these consumers to filter collection of wait events.

Some wait instruments are enabled by default; others are disabled. For example:

```
mysql> SELECT * FROM performance_schema.setup_instruments
      WHERE NAME LIKE 'wait/io/file/innodb%';
```

NAME	ENABLED	TIMED
wait/io/file/innodb/innodb_data_file	YES	YES
wait/io/file/innodb/innodb_log_file	YES	YES
wait/io/file/innodb/innodb_temp_file	YES	YES

```
mysql> SELECT *
      FROM performance_schema.setup_instruments WHERE
      NAME LIKE 'wait/io/socket/%';
```

NAME	ENABLED	TIMED
wait/io/socket/sql/server_tcpip_socket	NO	NO
wait/io/socket/sql/server_unix_socket	NO	NO
wait/io/socket/sql/client_connection	NO	NO

The wait consumers are disabled by default:

```
mysql> SELECT *
      FROM performance_schema.setup_consumers
      WHERE NAME LIKE 'events_waits%';
```

NAME	ENABLED
events_waits_current	NO
events_waits_history	NO
events_waits_history_long	NO

To control wait event collection at server startup, use lines like these in your `my.cnf` file:

- Enable:

```
[mysqld]
performance-schema-instrument='wait/%=ON'
performance-schema-consumer-events-waits-current=ON
performance-schema-consumer-events-waits-history=ON
performance-schema-consumer-events-waits-history-long=ON
```

- Disable:

```
[mysqld]
performance-schema-instrument='wait/%=OFF'
performance-schema-consumer-events-waits-current=OFF
performance-schema-consumer-events-waits-history=OFF
performance-schema-consumer-events-waits-history-long=OFF
```

To control wait event collection at runtime, update the `setup_instruments` and `setup_consumers` tables:

- Enable:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'YES', TIMED = 'YES'
WHERE NAME LIKE 'wait/%';
UPDATE performance_schema.setup_consumers
SET ENABLED = 'YES'
WHERE NAME LIKE 'events_waits%';
```

- Disable:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'NO', TIMED = 'NO'
WHERE NAME LIKE 'wait/%';
UPDATE performance_schema.setup_consumers
SET ENABLED = 'NO'
WHERE NAME LIKE 'events_waits%';
```

To collect only specific wait events, enable only the corresponding wait instruments. To collect wait events only for specific wait event tables, enable the wait instruments but only the wait consumers corresponding to the desired tables.

The `setup_timers` table contains a row with a `NAME` value of `wait` that indicates the unit for wait event timing. The default unit is `CYCLE`:

```
mysql> SELECT *
      FROM performance_schema.setup_timers
      WHERE NAME = 'wait';
+-----+-----+
| NAME | TIMER_NAME |
+-----+-----+
| wait | CYCLE      |
+-----+-----+
```

To change the timing unit, modify the `TIMER_NAME` value:

```
UPDATE performance_schema.setup_timers
SET TIMER_NAME = 'NANOSECOND'
WHERE NAME = 'wait';
```

For additional information about configuring event collection, see [Chapter 4, Performance Schema Startup Configuration](#), and [Chapter 5, Performance Schema Runtime Configuration](#).

10.4.1 The events_waits_current Table

The `events_waits_current` table contains current wait events. The table stores one row per thread showing the current status of the thread's most recent monitored wait event, so there is no system variable for configuring the table size.

Of the tables that contain wait event rows, `events_waits_current` is the most fundamental. Other tables that contain wait event rows are logically derived from the current events. For example, the `events_waits_history` and `events_waits_history_long` tables are collections of the most recent wait events that have ended, up to a maximum number of rows per thread and globally across all threads, respectively.

For more information about the relationship between the three wait event tables, see [Performance Schema Tables for Current and Historical Events](#).

For information about configuring whether to collect wait events, see [Section 10.4, “Performance Schema Wait Event Tables”](#).

The `events_waits_current` table has these columns:

- `THREAD_ID`, `EVENT_ID`

The thread associated with the event and the thread current event number when the event starts. The `THREAD_ID` and `EVENT_ID` values taken together uniquely identify the row. No two rows have the same pair of values.

- `END_EVENT_ID`

This column is set to `NULL` when the event starts and updated to the thread current event number when the event ends.

- `EVENT_NAME`

The name of the instrument that produced the event. This is a `NAME` value from the `setup_instruments` table. Instrument names may have multiple parts and form a hierarchy, as discussed in [Chapter 7, Performance Schema Instrument Naming Conventions](#).

- `SOURCE`

The name of the source file containing the instrumented code that produced the event and the line number in the file at which the instrumentation occurs. This enables you to check the source to determine exactly what code is involved. For example, if a mutex or lock is being blocked, you can check the context in which this occurs.

- `TIMER_START`, `TIMER_END`, `TIMER_WAIT`

Timing information for the event. The unit for these values is picoseconds (trillionths of a second). The `TIMER_START` and `TIMER_END` values indicate when event timing started and ended. `TIMER_WAIT` is the event elapsed time (duration).

If an event has not finished, `TIMER_END` is the current timer value and `TIMER_WAIT` is the time elapsed so far (`TIMER_END - TIMER_START`).

If an event is produced from an instrument that has `TIMED = NO`, timing information is not collected, and `TIMER_START`, `TIMER_END`, and `TIMER_WAIT` are all `NULL`.

For discussion of picoseconds as the unit for event times and factors that affect time values, see [Section 5.1, “Performance Schema Event Timing”](#).

- `SPINS`

For a mutex, the number of spin rounds. If the value is `NULL`, the code does not use spin rounds or spinning is not instrumented.

- `OBJECT_SCHEMA`, `OBJECT_NAME`, `OBJECT_TYPE`, `OBJECT_INSTANCE_BEGIN`

These columns identify the object “being acted on.” What that means depends on the object type.

For a synchronization object (`cond`, `mutex`, `rwlock`):

- `OBJECT_SCHEMA`, `OBJECT_NAME`, and `OBJECT_TYPE` are `NULL`.
- `OBJECT_INSTANCE_BEGIN` is the address of the synchronization object in memory.

For a file I/O object:

- `OBJECT_SCHEMA` is `NULL`.
- `OBJECT_NAME` is the file name.
- `OBJECT_TYPE` is `FILE`.
- `OBJECT_INSTANCE_BEGIN` is an address in memory.

For a socket object:

- `OBJECT_NAME` is the `IP:PORT` value for the socket.
- `OBJECT_INSTANCE_BEGIN` is an address in memory.

For a table I/O object:

- `OBJECT_SCHEMA` is the name of the schema that contains the table.
- `OBJECT_NAME` is the table name.
- `OBJECT_TYPE` is `TABLE` for a persistent base table or `TEMPORARY TABLE` for a temporary table.
- `OBJECT_INSTANCE_BEGIN` is an address in memory.

An `OBJECT_INSTANCE_BEGIN` value itself has no meaning, except that different values indicate different objects. `OBJECT_INSTANCE_BEGIN` can be used for debugging. For example, it can be used with `GROUP BY OBJECT_INSTANCE_BEGIN` to see whether the load on 1,000 mutexes (that protect, say, 1,000 pages or blocks of data) is spread evenly or just hitting a few bottlenecks. This can help you correlate with other sources of information if you see the same object address in a log file or another debugging or performance tool.

- `INDEX_NAME`

The name of the index used. `PRIMARY` indicates the table primary index. `NULL` means that no index was used.

- `NESTING_EVENT_ID`

The `EVENT_ID` value of the event within which this event is nested.

- `NESTING_EVENT_TYPE`

The nesting event type. The value is `TRANSACTION`, `STATEMENT`, `STAGE`, or `WAIT`.

- **OPERATION**

The type of operation performed, such as `lock`, `read`, or `write`.

- **NUMBER_OF_BYTES**

The number of bytes read or written by the operation. For table I/O waits (events for the `wait/io/table/sql/handler` instrument), `NUMBER_OF_BYTES` indicates the number of rows. If the value is greater than 1, the event is for a batch I/O operation. The following discussion describes the difference between exclusively single-row reporting and reporting that reflects batch I/O.

MySQL executes joins using a nested-loop implementation. The job of the Performance Schema instrumentation is to provide row count and accumulated execution time per table in the join. Assume a join query of the following form that is executed using a table join order of `t1`, `t2`, `t3`:

```
SELECT ... FROM t1 JOIN t2 ON ... JOIN t3 ON ...
```

Table “fanout” is the increase or decrease in number of rows from adding a table during join processing. If the fanout for table `t3` is greater than 1, the majority of row-fetch operations are for that table. Suppose that the join accesses 10 rows from `t1`, 20 rows from `t2` per row from `t1`, and 30 rows from `t3` per row of table `t2`. With single-row reporting, the total number of instrumented operations is:

```
10 + (10 * 20) + (10 * 20 * 30) = 6210
```

A significant reduction in the number of instrumented operations is achievable by aggregating them per scan (that is, per unique combination of rows from `t1` and `t2`). With batch I/O reporting, the Performance Schema produces an event for each scan of the innermost table `t3` rather than for each row, and the number of instrumented row operations reduces to:

```
10 + (10 * 20) + (10 * 20) = 410
```

That is a reduction of 93%, illustrating how the batch-reporting strategy significantly reduces Performance Schema overhead for table I/O by reducing the number of reporting calls. The tradeoff is lesser accuracy for event timing. Rather than time for an individual row operation as in per-row reporting, timing for batch I/O includes time spent for operations such as join buffering, aggregation, and returning rows to the client.

For batch I/O reporting to occur, these conditions must be true:

- Query execution accesses the innermost table of a query block (for a single-table query, that table counts as innermost)
- Query execution does not request a single row from the table (so, for example, `eq_ref` access prevents use of batch reporting)
- Query execution does not evaluate a subquery containing table access for the table

- **FLAGS**

Reserved for future use.

`TRUNCATE TABLE` is permitted for the `events_waits_current` table. It removes the rows.

10.4.2 The events_waits_history Table

The `events_waits_history` table contains the *N* most recent wait events that have ended per thread. Wait events are not added to the table until they have ended. When the table contains the maximum

number of rows for a given thread, the oldest thread row is discarded when a new row for that thread is added. When a thread ends, all its rows are discarded.

The Performance Schema autosizes the value of *N* during server startup. To set the number of rows per thread explicitly, set the `performance_schema_events_waits_history_size` system variable at server startup.

The `events_waits_history` table has the same columns as `events_waits_current`. See [Section 10.4.1, “The events_waits_current Table”](#).

`TRUNCATE TABLE` is permitted for the `events_waits_history` table. It removes the rows.

For more information about the relationship between the three wait event tables, see [Performance Schema Tables for Current and Historical Events](#).

For information about configuring whether to collect wait events, see [Section 10.4, “Performance Schema Wait Event Tables”](#).

10.4.3 The events_waits_history_long Table

The `events_waits_history_long` table contains *N* the most recent wait events that have ended globally, across all threads. Wait events are not added to the table until they have ended. When the table becomes full, the oldest row is discarded when a new row is added, regardless of which thread generated either row.

The Performance Schema autosizes the value of *N* during server startup. To set the table size explicitly, set the `performance_schema_events_waits_history_long_size` system variable at server startup.

The `events_waits_history_long` table has the same columns as `events_waits_current`. See [Section 10.4.1, “The events_waits_current Table”](#).

`TRUNCATE TABLE` is permitted for the `events_waits_history_long` table. It removes the rows.

For more information about the relationship between the three wait event tables, see [Performance Schema Tables for Current and Historical Events](#).

For information about configuring whether to collect wait events, see [Section 10.4, “Performance Schema Wait Event Tables”](#).

10.5 Performance Schema Stage Event Tables

The Performance Schema instruments stages, which are steps during the statement-execution process, such as parsing a statement, opening a table, or performing a `filesort` operation. Stages correspond to the thread states displayed by `SHOW PROCESSLIST` or that are visible in the Information Schema `PROCESSLIST` table. Stages begin and end when state values change.

Within the event hierarchy, wait events nest within stage events, which nest within statement events, which nest within transaction events.

These tables store stage events:

- `events_stages_current`: The current stage event for each thread.
- `events_stages_history`: The most recent stage events that have ended per thread.
- `events_stages_history_long`: The most recent stage events that have ended globally (across all threads).

The following sections describe the stage event tables. There are also summary tables that aggregate information about stage events; see [Section 10.15.2, “Stage Summary Tables”](#).

For more information about the relationship between the three stage event tables, see [Performance Schema Tables for Current and Historical Events](#).

- [Configuring Stage Event Collection](#)
- [Stage Event Progress Information](#)

Configuring Stage Event Collection

To control whether to collect stage events, set the state of the relevant instruments and consumers:

- The `setup_instruments` table contains instruments with names that begin with `stage`. Use these instruments to enable or disable collection of individual stage event classes.
- The `setup_consumers` table contains consumer values with names corresponding to the current and historical stage event table names. Use these consumers to filter collection of stage events.

Other than those instruments that provide statement progress information, the stage instruments are disabled by default. For example:

```
mysql> SELECT *
      FROM performance_schema.setup_instruments
      WHERE NAME RLIKE 'stage/sql/[a-c]';
```

NAME	ENABLED	TIMED
stage/sql/After create	NO	NO
stage/sql/allocating local table	NO	NO
stage/sql/altering table	NO	NO
stage/sql/committing alter table to storage engine	NO	NO
stage/sql/Changing master	NO	NO
stage/sql/Checking master version	NO	NO
stage/sql/checking permissions	NO	NO
stage/sql/checking privileges on cached query	NO	NO
stage/sql/checking query cache for query	NO	NO
stage/sql/cleaning up	NO	NO
stage/sql/closing tables	NO	NO
stage/sql/Connecting to master	NO	NO
stage/sql/converting HEAP to MyISAM	NO	NO
stage/sql/Copying to group table	NO	NO
stage/sql/Copying to tmp table	NO	NO
stage/sql/copy to tmp table	NO	NO
stage/sql/Creating sort index	NO	NO
stage/sql/creating table	NO	NO
stage/sql/Creating tmp table	NO	NO

Stage event instruments that provide statement progress information are enabled and timed by default:

```
mysql> SELECT *
      FROM performance_schema.setup_instruments
      WHERE ENABLED='YES' AND NAME LIKE "stage/%";
```

NAME	ENABLED	TIMED
stage/sql/copy to tmp table	YES	YES
stage/innodb/alter table (end)	YES	YES
stage/innodb/alter table (flush)	YES	YES
stage/innodb/alter table (insert)	YES	YES
stage/innodb/alter table (log apply index)	YES	YES

stage/innodb/alter table (log apply table)	YES	YES
stage/innodb/alter table (merge sort)	YES	YES
stage/innodb/alter table (read PK and internal sort)	YES	YES
stage/innodb/buffer pool load	YES	YES

The stage consumers are disabled by default:

```
mysql> SELECT *
      FROM performance_schema.setup_consumers
      WHERE NAME LIKE 'events_stages%';
+-----+-----+
| NAME                                | ENABLED |
+-----+-----+
| events_stages_current               | NO      |
| events_stages_history               | NO      |
| events_stages_history_long          | NO      |
+-----+-----+
```

To control stage event collection at server startup, use lines like these in your `my.cnf` file:

- Enable:

```
[mysqld]
performance-schema-instrument='stage/%=ON'
performance-schema-consumer-events-stages-current=ON
performance-schema-consumer-events-stages-history=ON
performance-schema-consumer-events-stages-history-long=ON
```

- Disable:

```
[mysqld]
performance-schema-instrument='stage/%=OFF'
performance-schema-consumer-events-stages-current=OFF
performance-schema-consumer-events-stages-history=OFF
performance-schema-consumer-events-stages-history-long=OFF
```

To control stage event collection at runtime, update the `setup_instruments` and `setup_consumers` tables:

- Enable:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'YES', TIMED = 'YES'
WHERE NAME LIKE 'stage/%';
UPDATE performance_schema.setup_consumers
SET ENABLED = 'YES'
WHERE NAME LIKE 'events_stages%';
```

- Disable:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'NO', TIMED = 'NO'
WHERE NAME LIKE 'stage/%';
UPDATE performance_schema.setup_consumers
SET ENABLED = 'NO'
WHERE NAME LIKE 'events_stages%';
```

To collect only specific stage events, enable only the corresponding stage instruments. To collect stage events only for specific stage event tables, enable the stage instruments but only the stage consumers corresponding to the desired tables.

The `setup_timers` table contains a row with a `NAME` value of `stage` that indicates the unit for stage event timing. The default unit is `NANOSECOND`:


```
mysql> SELECT *
      FROM performance_schema.setup_timers
      WHERE NAME = 'stage';
+-----+-----+
| NAME | TIMER_NAME |
+-----+-----+
| stage | NANOSECOND |
+-----+-----+
```

To change the timing unit, modify the `TIMER_NAME` value:

```
UPDATE performance_schema.setup_timers
SET TIMER_NAME = 'MICROSECOND'
WHERE NAME = 'stage';
```

For additional information about configuring event collection, see [Chapter 4, Performance Schema Startup Configuration](#), and [Chapter 5, Performance Schema Runtime Configuration](#).

Stage Event Progress Information

The Performance Schema stage event tables contain two columns that, taken together, provide a stage progress indicator for each row:

- `WORK_COMPLETED`: The number of work units completed for the stage
- `WORK_ESTIMATED`: The number of work units expected for the stage

Each column is `NULL` if no progress information is provided for an instrument. Interpretation of the information, if it is available, depends entirely on the instrument implementation. The Performance Schema tables provide a container to store progress data, but make no assumptions about the semantics of the metric itself:

- A “work unit” is an integer metric that increases over time during execution, such as the number of bytes, rows, files, or tables processed. The definition of “work unit” for a particular instrument is left to the instrumentation code providing the data.
- The `WORK_COMPLETED` value can increase one or many units at a time, depending on the instrumented code.
- The `WORK_ESTIMATED` value can change during the stage, depending on the instrumented code.

Instrumentation for a stage event progress indicator can implement any of the following behaviors:

- No progress instrumentation

This is the most typical case, where no progress data is provided. The `WORK_COMPLETED` and `WORK_ESTIMATED` columns are both `NULL`.

- Unbounded progress instrumentation

Only the `WORK_COMPLETED` column is meaningful. No data is provided for the `WORK_ESTIMATED` column, which displays 0.

By querying the `events_stages_current` table for the monitored session, a monitoring application can report how much work has been performed so far, but cannot report whether the stage is near completion. Currently, no stages are instrumented like this.

- Bounded progress instrumentation

The `WORK_COMPLETED` and `WORK_ESTIMATED` columns are both meaningful.

This type of progress indicator is appropriate for an operation with a defined completion criterion, such as the table-copy instrument described later. By querying the `events_stages_current` table for the monitored session, a monitoring application can report how much work has been performed so far, and can report the overall completion percentage for the stage, by computing the `WORK_COMPLETED / WORK_ESTIMATED` ratio.

The `stage/sql/copy to tmp table` instrument illustrates how progress indicators work. During execution of an `ALTER TABLE` statement, the `stage/sql/copy to tmp table` stage is used, and this stage can execute potentially for a long time, depending on the size of the data to copy.

The table-copy task has a defined termination (all rows copied), and the `stage/sql/copy to tmp table` stage is instrumented to provide bounded progress information: The work unit used is number of rows copied, `WORK_COMPLETED` and `WORK_ESTIMATED` are both meaningful, and their ratio indicates task percentage complete.

To enable the instrument and the relevant consumers, execute these statements:

```
UPDATE performance_schema.setup_instruments
SET ENABLED='YES'
WHERE NAME='stage/sql/copy to tmp table';
UPDATE performance_schema.setup_consumers
SET ENABLED='YES'
WHERE NAME LIKE 'events_stages_%';
```

To see the progress of an ongoing `ALTER TABLE` statement, select from the `events_stages_current` table.

10.5.1 The events_stages_current Table

The `events_stages_current` table contains current stage events. The table stores one row per thread showing the current status of the thread's most recent monitored stage event, so there is no system variable for configuring the table size.

Of the tables that contain stage event rows, `events_stages_current` is the most fundamental. Other tables that contain stage event rows are logically derived from the current events. For example, the `events_stages_history` and `events_stages_history_long` tables are collections of the most recent stage events that have ended, up to a maximum number of rows per thread and globally across all threads, respectively.

For more information about the relationship between the three stage event tables, see [Performance Schema Tables for Current and Historical Events](#).

For information about configuring whether to collect stage events, see [Section 10.5, “Performance Schema Stage Event Tables”](#).

The `events_stages_current` table has these columns:

- `THREAD_ID, EVENT_ID`

The thread associated with the event and the thread current event number when the event starts. The `THREAD_ID` and `EVENT_ID` values taken together uniquely identify the row. No two rows have the same pair of values.

- `END_EVENT_ID`

This column is set to `NULL` when the event starts and updated to the thread current event number when the event ends.

- [EVENT_NAME](#)

The name of the instrument that produced the event. This is a [NAME](#) value from the [setup_instruments](#) table. Instrument names may have multiple parts and form a hierarchy, as discussed in [Chapter 7, Performance Schema Instrument Naming Conventions](#).

- [SOURCE](#)

The name of the source file containing the instrumented code that produced the event and the line number in the file at which the instrumentation occurs. This enables you to check the source to determine exactly what code is involved.

- [TIMER_START](#), [TIMER_END](#), [TIMER_WAIT](#)

Timing information for the event. The unit for these values is picoseconds (trillionths of a second). The [TIMER_START](#) and [TIMER_END](#) values indicate when event timing started and ended. [TIMER_WAIT](#) is the event elapsed time (duration).

If an event has not finished, [TIMER_END](#) is the current timer value and [TIMER_WAIT](#) is the time elapsed so far ($TIMER_END - TIMER_START$).

If an event is produced from an instrument that has [TIMED = NO](#), timing information is not collected, and [TIMER_START](#), [TIMER_END](#), and [TIMER_WAIT](#) are all [NULL](#).

For discussion of picoseconds as the unit for event times and factors that affect time values, see [Section 5.1, “Performance Schema Event Timing”](#).

- [WORK_COMPLETED](#), [WORK_ESTIMATED](#)

These columns provide stage progress information, for instruments that have been implemented to produce such information. [WORK_COMPLETED](#) indicates how many work units have been completed for the stage, and [WORK_ESTIMATED](#) indicates how many work units are expected for the stage. For more information, see [Stage Event Progress Information](#).

- [NESTING_EVENT_ID](#)

The [EVENT_ID](#) value of the event within which this event is nested. The nesting event for a stage event is usually a statement event.

- [NESTING_EVENT_TYPE](#)

The nesting event type. The value is [TRANSACTION](#), [STATEMENT](#), [STAGE](#), or [WAIT](#).

[TRUNCATE TABLE](#) is permitted for the [events_stages_current](#) table. It removes the rows.

10.5.2 The events_stages_history Table

The [events_stages_history](#) table contains the *N* most recent stage events that have ended per thread. Stage events are not added to the table until they have ended. When the table contains the maximum number of rows for a given thread, the oldest thread row is discarded when a new row for that thread is added. When a thread ends, all its rows are discarded.

The Performance Schema autosizes the value of *N* during server startup. To set the number of rows per thread explicitly, set the [performance_schema_events_stages_history_size](#) system variable at server startup.

The [events_stages_history](#) table has the same columns as [events_stages_current](#). See [Section 10.5.1, “The events_stages_current Table”](#).

`TRUNCATE TABLE` is permitted for the `events_stages_history` table. It removes the rows.

For more information about the relationship between the three stage event tables, see [Performance Schema Tables for Current and Historical Events](#).

For information about configuring whether to collect stage events, see [Section 10.5, “Performance Schema Stage Event Tables”](#).

10.5.3 The events_stages_history_long Table

The `events_stages_history_long` table contains the *N* most recent stage events that have ended globally, across all threads. Stage events are not added to the table until they have ended. When the table becomes full, the oldest row is discarded when a new row is added, regardless of which thread generated either row.

The Performance Schema autosizes the value of *N* during server startup. To set the table size explicitly, set the `performance_schema_events_stages_history_long_size` system variable at server startup.

The `events_stages_history_long` table has the same columns as `events_stages_current`. See [Section 10.5.1, “The events_stages_current Table”](#).

`TRUNCATE TABLE` is permitted for the `events_stages_history_long` table. It removes the rows.

For more information about the relationship between the three stage event tables, see [Performance Schema Tables for Current and Historical Events](#).

For information about configuring whether to collect stage events, see [Section 10.5, “Performance Schema Stage Event Tables”](#).

10.6 Performance Schema Statement Event Tables

The Performance Schema instruments statement execution. Statement events occur at a high level of the event hierarchy. Within the event hierarchy, wait events nest within stage events, which nest within statement events, which nest within transaction events.

These tables store statement events:

- `events_statements_current`: The current statement event for each thread.
- `events_statements_history`: The most recent statement events that have ended per thread.
- `events_statements_history_long`: The most recent statement events that have ended globally (across all threads).
- `prepared_statements_instances`: Prepared statement instances and statistics

The following sections describe the statement event tables. There are also summary tables that aggregate information about statement events; see [Section 10.15.3, “Statement Summary Tables”](#).

For more information about the relationship between the three `events_statements_xxx` event tables, see [Performance Schema Tables for Current and Historical Events](#).

- [Configuring Statement Event Collection](#)
- [Statement Monitoring](#)

Configuring Statement Event Collection

To control whether to collect statement events, set the state of the relevant instruments and consumers:

- The `setup_instruments` table contains instruments with names that begin with `statement`. Use these instruments to enable or disable collection of individual statement event classes.
- The `setup_consumers` table contains consumer values with names corresponding to the current and historical statement event table names, and the statement digest consumer. Use these consumers to filter collection of statement events and statement digesting.

The statement instruments are enabled by default, and the `events_statements_current`, `events_statements_history`, and `statements_digest` statement consumers are enabled by default:

```
mysql> SELECT *
      FROM performance_schema.setup_instruments
      WHERE NAME LIKE 'statement/%';
```

NAME	ENABLED	TIMED
statement/sql/select	YES	YES
statement/sql/create_table	YES	YES
statement/sql/create_index	YES	YES
...		
statement/sp/stmt	YES	YES
statement/sp/set	YES	YES
statement/sp/set_trigger_field	YES	YES
statement/scheduler/event	YES	YES
statement/com/Sleep	YES	YES
statement/com/Quit	YES	YES
statement/com/Init DB	YES	YES
...		
statement/abstract/Query	YES	YES
statement/abstract/new_packet	YES	YES
statement/abstract/relay_log	YES	YES

```
mysql> SELECT *
      FROM performance_schema.setup_consumers
      WHERE NAME LIKE '%statements%';
```

NAME	ENABLED
events_statements_current	YES
events_statements_history	YES
events_statements_history_long	NO
statements_digest	YES

To control statement event collection at server startup, use lines like these in your `my.cnf` file:

- Enable:

```
[mysqld]
performance-schema-instrument='statement/%=ON'
performance-schema-consumer-events-statements-current=ON
performance-schema-consumer-events-statements-history=ON
performance-schema-consumer-events-statements-history-long=ON
performance-schema-consumer-statements-digest=ON
```

- Disable:

```
[mysqld]
```

```
performance-schema-instrument='statement/%=OFF'
performance-schema-consumer-events-statements-current=OFF
performance-schema-consumer-events-statements-history=OFF
performance-schema-consumer-events-statements-history-long=OFF
performance-schema-consumer-statements-digest=OFF
```

To control statement event collection at runtime, update the `setup_instruments` and `setup_consumers` tables:

- Enable:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'YES', TIMED = 'YES'
WHERE NAME LIKE 'statement/%';
UPDATE performance_schema.setup_consumers
SET ENABLED = 'YES'
WHERE NAME LIKE '%statements%';
```

- Disable:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'NO', TIMED = 'NO'
WHERE NAME LIKE 'statement/%';
UPDATE performance_schema.setup_consumers
SET ENABLED = 'NO'
WHERE NAME LIKE '%statements%';
```

To collect only specific statement events, enable only the corresponding statement instruments. To collect statement events only for specific statement event tables, enable the statement instruments but only the statement consumers corresponding to the desired tables.

The `setup_timers` table contains a row with a `NAME` value of `statement` that indicates the unit for statement event timing. The default unit is `NANOSECOND`:

```
mysql> SELECT *
      FROM performance_schema.setup_timers
      WHERE NAME = 'statement';
+-----+-----+
| NAME      | TIMER_NAME |
+-----+-----+
| statement | NANOSECOND |
+-----+-----+
```

To change the timing unit, modify the `TIMER_NAME` value:

```
UPDATE performance_schema.setup_timers
SET TIMER_NAME = 'MICROSECOND'
WHERE NAME = 'statement';
```

For additional information about configuring event collection, see [Chapter 4, Performance Schema Startup Configuration](#), and [Chapter 5, Performance Schema Runtime Configuration](#).

Statement Monitoring

Statement monitoring begins from the moment the server sees that activity is requested on a thread, to the moment when all activity has ceased. Typically, this means from the time the server gets the first packet from the client to the time the server has finished sending the response. Statements within stored programs are monitored like other statements.

When the Performance Schema instruments a request (server command or SQL statement), it uses instrument names that proceed in stages from more general (or “abstract”) to more specific until it arrives at a final instrument name.

Final instrument names correspond to server commands and SQL statements:

- Server commands correspond to the `COM_xxx` codes defined in the `mysql_com.h` header file and processed in `sql/sql_parse.cc`. Examples are `COM_PING` and `COM_QUIT`. Instruments for commands have names that begin with `statement/com`, such as `statement/com/Ping` and `statement/com/Quit`.
- SQL statements are expressed as text, such as `DELETE FROM t1` or `SELECT * FROM t2`. Instruments for SQL statements have names that begin with `statement/sql`, such as `statement/sql/delete` and `statement/sql/select`.

Some final instrument names are specific to error handling:

- `statement/com/Error` accounts for messages received by the server that are out of band. It can be used to detect commands sent by clients that the server does not understand. This may be helpful for purposes such as identifying clients that are misconfigured or using a version of MySQL more recent than that of the server, or clients that are attempting to attack the server.
- `statement/sql/error` accounts for SQL statements that fail to parse. It can be used to detect malformed queries sent by clients. A query that fails to parse differs from a query that parses but fails due to an error during execution. For example, `SELECT * FROM` is malformed, and the `statement/sql/error` instrument is used. By contrast, `SELECT *` parses but fails with a `No tables used` error. In this case, `statement/sql/select` is used and the statement event contains information to indicate the nature of the error.

A request can be obtained from any of these sources:

- As a command or statement request from a client, which sends the request as packets
- As a statement string read from the relay log on a replica
- As an event from the Event Scheduler

The details for a request are not initially known and the Performance Schema proceeds from abstract to specific instrument names in a sequence that depends on the source of the request.

For a request received from a client:

1. When the server detects a new packet at the socket level, a new statement is started with an abstract instrument name of `statement/abstract/new_packet`.
2. When the server reads the packet number, it knows more about the type of request received, and the Performance Schema refines the instrument name. For example, if the request is a `COM_PING` packet, the instrument name becomes `statement/com/Ping` and that is the final name. If the request is a `COM_QUERY` packet, it is known to correspond to an SQL statement but not the particular type of statement. In this case, the instrument changes from one abstract name to a more specific but still abstract name, `statement/abstract/Query`, and the request requires further classification.
3. If the request is a statement, the statement text is read and given to the parser. After parsing, the exact statement type is known. If the request is, for example, an `INSERT` statement, the Performance Schema refines the instrument name from `statement/abstract/Query` to `statement/sql/insert`, which is the final name.

For a request read as a statement from the relay log on a replica:

1. Statements in the relay log are stored as text and are read as such. There is no network protocol, so the `statement/abstract/new_packet` instrument is not used. Instead, the initial instrument is `statement/abstract/relay_log`.

2. When the statement is parsed, the exact statement type is known. If the request is, for example, an `INSERT` statement, the Performance Schema refines the instrument name from `statement/abstract/Query` to `statement/sql/insert`, which is the final name.

The preceding description applies only for statement-based replication. For row-based replication, table I/O done on the replica as it processes row changes can be instrumented, but row events in the relay log do not appear as discrete statements.

For a request received from the Event Scheduler:

The event execution is instrumented using the name `statement/scheduler/event`. This is the final name.

Statements executed within the event body are instrumented using `statement/sql/*` names, without use of any preceding abstract instrument. An event is a stored program, and stored programs are precompiled in memory before execution. Consequently, there is no parsing at runtime and the type of each statement is known by the time it executes.

Statements executed within the event body are child statements. For example, if an event executes an `INSERT` statement, execution of the event itself is the parent, instrumented using `statement/scheduler/event`, and the `INSERT` is the child, instrumented using `statement/sql/insert`. The parent/child relationship holds *between* separate instrumented operations. This differs from the sequence of refinement that occurs *within* a single instrumented operation, from abstract to final instrument names.

For statistics to be collected for statements, it is not sufficient to enable only the final `statement/sql/*` instruments used for individual statement types. The abstract `statement/abstract/*` instruments must be enabled as well. This should not normally be an issue because all statement instruments are enabled by default. However, an application that enables or disables statement instruments selectively must take into account that disabling abstract instruments also disables statistics collection for the individual statement instruments. For example, to collect statistics for `INSERT` statements, `statement/sql/insert` must be enabled, but also `statement/abstract/new_packet` and `statement/abstract/Query`. Similarly, for replicated statements to be instrumented, `statement/abstract/relay_log` must be enabled.

No statistics are aggregated for abstract instruments such as `statement/abstract/Query` because no statement is ever classified with an abstract instrument as the final statement name.

10.6.1 The `events_statements_current` Table

The `events_statements_current` table contains current statement events. The table stores one row per thread showing the current status of the thread's most recent monitored statement event, so there is no system variable for configuring the table size.

Of the tables that contain statement event rows, `events_statements_current` is the most fundamental. Other tables that contain statement event rows are logically derived from the current events. For example, the `events_statements_history` and `events_statements_history_long` tables are collections of the most recent statement events that have ended, up to a maximum number of rows per thread and globally across all threads, respectively.

For more information about the relationship between the three `events_statements_xxx` event tables, see [Performance Schema Tables for Current and Historical Events](#).

For information about configuring whether to collect statement events, see [Section 10.6, “Performance Schema Statement Event Tables”](#).

The `events_statements_current` table has these columns:

- `THREAD_ID`, `EVENT_ID`

The thread associated with the event and the thread current event number when the event starts. The `THREAD_ID` and `EVENT_ID` values taken together uniquely identify the row. No two rows have the same pair of values.

- `END_EVENT_ID`

This column is set to `NULL` when the event starts and updated to the thread current event number when the event ends.

- `EVENT_NAME`

The name of the instrument from which the event was collected. This is a `NAME` value from the `setup_instruments` table. Instrument names may have multiple parts and form a hierarchy, as discussed in [Chapter 7, Performance Schema Instrument Naming Conventions](#).

For SQL statements, the `EVENT_NAME` value initially is `statement/com/Query` until the statement is parsed, then changes to a more appropriate value, as described in [Section 10.6, “Performance Schema Statement Event Tables”](#).

- `SOURCE`

The name of the source file containing the instrumented code that produced the event and the line number in the file at which the instrumentation occurs. This enables you to check the source to determine exactly what code is involved.

- `TIMER_START`, `TIMER_END`, `TIMER_WAIT`

Timing information for the event. The unit for these values is picoseconds (trillionths of a second). The `TIMER_START` and `TIMER_END` values indicate when event timing started and ended. `TIMER_WAIT` is the event elapsed time (duration).

If an event has not finished, `TIMER_END` is the current timer value and `TIMER_WAIT` is the time elapsed so far (`TIMER_END - TIMER_START`).

If an event is produced from an instrument that has `TIMED = NO`, timing information is not collected, and `TIMER_START`, `TIMER_END`, and `TIMER_WAIT` are all `NULL`.

For discussion of picoseconds as the unit for event times and factors that affect time values, see [Section 5.1, “Performance Schema Event Timing”](#).

- `LOCK_TIME`

The time spent waiting for table locks. This value is computed in microseconds but normalized to picoseconds for easier comparison with other Performance Schema timers.

- `SQL_TEXT`

The text of the SQL statement. For a command not associated with an SQL statement, the value is `NULL`.

The maximum space available for statement display is 1024 bytes by default. To change this value, set the `performance_schema_max_sql_text_length` system variable at server startup.

- `DIGEST`

The statement digest MD5 value as a string of 32 hexadecimal characters, or `NULL` if the `statements_digest` consumer is `no`. For more information about statement digesting, see [Performance Schema Statement Digests](#).

- `DIGEST_TEXT`

The normalized statement digest text, or `NULL` if the `statements_digest` consumer is `no`. For more information about statement digesting, see [Performance Schema Statement Digests](#).

The `performance_schema_max_digest_length` system variable determines the maximum number of bytes available per session for digest value storage. However, the display length of statement digests may be longer than the available buffer size due to encoding of statement elements such as keywords and literal values in digest buffer. Consequently, values selected from the `DIGEST_TEXT` column of statement event tables may appear to exceed the `performance_schema_max_digest_length` value.

- `CURRENT_SCHEMA`

The default database for the statement, `NULL` if there is none.

- `OBJECT_SCHEMA`, `OBJECT_NAME`, `OBJECT_TYPE`

For nested statements (stored programs), these columns contain information about the parent statement. Otherwise they are `NULL`.

- `OBJECT_INSTANCE_BEGIN`

This column identifies the statement. The value is the address of an object in memory.

- `MYSQL_ERRNO`

The statement error number, from the statement diagnostics area.

- `RETURNED_SQLSTATE`

The statement SQLSTATE value, from the statement diagnostics area.

- `MESSAGE_TEXT`

The statement error message, from the statement diagnostics area.

- `ERRORS`

Whether an error occurred for the statement. The value is 0 if the SQLSTATE value begins with 00 (completion) or 01 (warning). The value is 1 if the SQLSTATE value is anything else.

- `WARNINGS`

The number of warnings, from the statement diagnostics area.

- `ROWS_AFFECTED`

The number of rows affected by the statement. For a description of the meaning of “affected,” see [mysql_affected_rows\(\)](#).

- `ROWS_SENT`

The number of rows returned by the statement.

- `ROWS_EXAMINED`
The number of rows examined by the server layer (not counting any processing internal to storage engines).
- `CREATED_TMP_DISK_TABLES`
Like the `Created_tmp_disk_tables` status variable, but specific to the statement.
- `CREATED_TMP_TABLES`
Like the `Created_tmp_tables` status variable, but specific to the statement.
- `SELECT_FULL_JOIN`
Like the `Select_full_join` status variable, but specific to the statement.
- `SELECT_FULL_RANGE_JOIN`
Like the `Select_full_range_join` status variable, but specific to the statement.
- `SELECT_RANGE`
Like the `Select_range` status variable, but specific to the statement.
- `SELECT_RANGE_CHECK`
Like the `Select_range_check` status variable, but specific to the statement.
- `SELECT_SCAN`
Like the `Select_scan` status variable, but specific to the statement.
- `SORT_MERGE_PASSES`
Like the `Sort_merge_passes` status variable, but specific to the statement.
- `SORT_RANGE`
Like the `Sort_range` status variable, but specific to the statement.
- `SORT_ROWS`
Like the `Sort_rows` status variable, but specific to the statement.
- `SORT_SCAN`
Like the `Sort_scan` status variable, but specific to the statement.
- `NO_INDEX_USED`
1 if the statement performed a table scan without using an index, 0 otherwise.
- `NO_GOOD_INDEX_USED`
1 if the server found no good index to use for the statement, 0 otherwise. For additional information, see the description of the `Extra` column from `EXPLAIN` output for the `Range checked for each record` value in [EXPLAIN Output Format](#).
- `NESTING_EVENT_ID, NESTING_EVENT_TYPE, NESTING_EVENT_LEVEL`

These three columns are used with other columns to provide information as follows for top-level (unnested) statements and nested statements (executed within a stored program).

For top level statements:

```
OBJECT_TYPE = NULL
OBJECT_SCHEMA = NULL
OBJECT_NAME = NULL
NESTING_EVENT_ID = NULL
NESTING_EVENT_TYPE = NULL
NESTING_LEVEL = 0
```

For nested statements:

```
OBJECT_TYPE = the parent statement object type
OBJECT_SCHEMA = the parent statement object schema
OBJECT_NAME = the parent statement object name
NESTING_EVENT_ID = the parent statement EVENT_ID
NESTING_EVENT_TYPE = 'STATEMENT'
NESTING_LEVEL = the parent statement NESTING_LEVEL plus one
```

`TRUNCATE TABLE` is permitted for the `events_statements_current` table. It removes the rows.

10.6.2 The events_statements_history Table

The `events_statements_history` table contains the N most recent statement events that have ended per thread. Statement events are not added to the table until they have ended. When the table contains the maximum number of rows for a given thread, the oldest thread row is discarded when a new row for that thread is added. When a thread ends, all its rows are discarded.

The Performance Schema autosizes the value of N during server startup. To set the number of rows per thread explicitly, set the `performance_schema_events_statements_history_size` system variable at server startup.

The `events_statements_history` table has the same columns as `events_statements_current`. See [Section 10.6.1, “The events_statements_current Table”](#).

`TRUNCATE TABLE` is permitted for the `events_statements_history` table. It removes the rows.

For more information about the relationship between the three `events_statements_xxx` event tables, see [Performance Schema Tables for Current and Historical Events](#).

For information about configuring whether to collect statement events, see [Section 10.6, “Performance Schema Statement Event Tables”](#).

10.6.3 The events_statements_history_long Table

The `events_statements_history_long` table contains the N most recent statement events that have ended globally, across all threads. Statement events are not added to the table until they have ended. When the table becomes full, the oldest row is discarded when a new row is added, regardless of which thread generated either row.

The value of N is autosized at server startup. To set the table size explicitly, set the `performance_schema_events_statements_history_long_size` system variable at server startup.

The `events_statements_history_long` table has the same columns as `events_statements_current`. See [Section 10.6.1, “The events_statements_current Table”](#).

`TRUNCATE TABLE` is permitted for the `events_statements_history_long` table. It removes the rows.

For more information about the relationship between the three `events_statements_xxx` event tables, see [Performance Schema Tables for Current and Historical Events](#).

For information about configuring whether to collect statement events, see [Section 10.6, “Performance Schema Statement Event Tables”](#).

10.6.4 The prepared_statements_instances Table

The Performance Schema provides instrumentation for prepared statements, for which there are two protocols:

- The binary protocol. This is accessed through the MySQL C API and maps onto underlying server commands as shown in the following table.

C API Function	Corresponding Server Command
<code>mysql_stmt_prepare()</code>	<code>COM_STMT_PREPARE</code>
<code>mysql_stmt_execute()</code>	<code>COM_STMT_EXECUTE</code>
<code>mysql_stmt_close()</code>	<code>COM_STMT_CLOSE</code>

- The text protocol. This is accessed using SQL statements and maps onto underlying server commands as shown in the following table.

SQL Statement	Corresponding Server Command
<code>PREPARE</code>	<code>SQLCOM_PREPARE</code>
<code>EXECUTE</code>	<code>SQLCOM_EXECUTE</code>
<code>DEALLOCATE PREPARE, DROP PREPARE</code>	<code>SQLCOM_DEALLOCATE PREPARE</code>

Performance Schema prepared statement instrumentation covers both protocols. The following discussion refers to the server commands rather than the C API functions or SQL statements.

Information about prepared statements is available in the `prepared_statements_instances` table. This table enables inspection of prepared statements used in the server and provides aggregated statistics about them. To control the size of this table, set the `performance_schema_max_prepared_statements_instances` system variable at server startup.

Collection of prepared statement information depends on the statement instruments shown in the following table. These instruments are enabled by default. To modify them, update the `setup_instruments` table.

Instrument	Server Command
<code>statement/com/Prepare</code>	<code>COM_STMT_PREPARE</code>
<code>statement/com/Execute</code>	<code>COM_STMT_EXECUTE</code>
<code>statement/sql/prepare_sql</code>	<code>SQLCOM_PREPARE</code>
<code>statement/sql/execute_sql</code>	<code>SQLCOM_EXECUTE</code>

The Performance Schema manages the contents of the `prepared_statements_instances` table as follows:

- Statement preparation

A `COM_STMT_PREPARE` or `SQLCOM_PREPARE` command creates a prepared statement in the server. If the statement is successfully instrumented, a new row is added to the `prepared_statements_instances` table. If the statement cannot be instrumented, `Performance_schema_prepared_statements_lost` status variable is incremented.

- Prepared statement execution

Execution of a `COM_STMT_EXECUTE` or `SQLCOM_EXECUTE` command for an instrumented prepared statement instance updates the corresponding `prepared_statements_instances` table row.

- Prepared statement deallocation

Execution of a `COM_STMT_CLOSE` or `SQLCOM_DEALLOCATE_PREPARE` command for an instrumented prepared statement instance removes the corresponding `prepared_statements_instances` table row. To avoid resource leaks, removal occurs even if the prepared statement instruments described previously are disabled.

The `prepared_statements_instances` table has these columns:

- `OBJECT_INSTANCE_BEGIN`

The address in memory of the instrumented prepared statement.

- `STATEMENT_ID`

The internal statement ID assigned by the server. The text and binary protocols both use statement IDs.

- `STATEMENT_NAME`

For the binary protocol, this column is `NULL`. For the text protocol, this column is the external statement name assigned by the user. For example, for the following SQL statement, the name of the prepared statement is `stmt`:

```
PREPARE stmt FROM 'SELECT 1';
```

- `SQL_TEXT`

The prepared statement text, with `?` placeholder markers.

- `OWNER_THREAD_ID`, `OWNER_EVENT_ID`

These columns indicate the event that created the prepared statement.

- `OWNER_OBJECT_TYPE`, `OWNER_OBJECT_SCHEMA`, `OWNER_OBJECT_NAME`

For a prepared statement created by a client session, these columns are `NULL`. For a prepared statement created by a stored program, these columns point to the stored program. A typical user error is forgetting to deallocate prepared statements. These columns can be used to find stored programs that leak prepared statements:

```
SELECT
  OWNER_OBJECT_TYPE, OWNER_OBJECT_SCHEMA, OWNER_OBJECT_NAME,
  STATEMENT_NAME, SQL_TEXT
FROM performance_schema.prepared_statements_instances
WHERE OWNER_OBJECT_TYPE IS NOT NULL;
```

- `TIMER_PREPARE`

The time spent executing the statement preparation itself.

- `COUNT_REPREPARE`

The number of times the statement was reprepared internally (see [Caching of Prepared Statements and Stored Programs](#)). Timing statistics for reparation are not available because it is counted as part of statement execution, not as a separate operation.

- `COUNT_EXECUTE`, `SUM_TIMER_EXECUTE`, `MIN_TIMER_EXECUTE`, `AVG_TIMER_EXECUTE`, `MAX_TIMER_EXECUTE`

Aggregated statistics for executions of the prepared statement.

- `SUM_xxx`

The remaining `SUM_xxx` columns are the same as for the statement summary tables (see [Section 10.15.3, “Statement Summary Tables”](#)).

`TRUNCATE TABLE` resets the statistics columns of the `prepared_statements_instances` table.

10.7 Performance Schema Transaction Tables

The Performance Schema instruments transactions. Within the event hierarchy, wait events nest within stage events, which nest within statement events, which nest within transaction events.

These tables store transaction events:

- `events_transactions_current`: The current transaction event for each thread.
- `events_transactions_history`: The most recent transaction events that have ended per thread.
- `events_transactions_history_long`: The most recent transaction events that have ended globally (across all threads).

The following sections describe the transaction event tables. There are also summary tables that aggregate information about transaction events; see [Section 10.15.4, “Transaction Summary Tables”](#).

For more information about the relationship between the three transaction event tables, see [Performance Schema Tables for Current and Historical Events](#).

- [Configuring Transaction Event Collection](#)
- [Transaction Boundaries](#)
- [Transaction Instrumentation](#)
- [Transactions and Nested Events](#)
- [Transactions and Stored Programs](#)
- [Transactions and Savepoints](#)
- [Transactions and Errors](#)

Configuring Transaction Event Collection

To control whether to collect transaction events, set the state of the relevant instruments and consumers:

- The `setup_instruments` table contains an instrument named `transaction`. Use this instrument to enable or disable collection of individual transaction event classes.

- The `setup_consumers` table contains consumer values with names corresponding to the current and historical transaction event table names. Use these consumers to filter collection of transaction events.

The `transaction` instrument and the transaction consumers are disabled by default:

```
mysql> SELECT *
      FROM performance_schema.setup_instruments
      WHERE NAME = 'transaction';
+-----+-----+-----+
| NAME          | ENABLED | TIMED |
+-----+-----+-----+
| transaction  | NO      | NO    |
+-----+-----+-----+
mysql> SELECT *
      FROM performance_schema.setup_consumers
      WHERE NAME LIKE 'events_transactions%';
+-----+-----+
| NAME                                     | ENABLED |
+-----+-----+
| events_transactions_current             | NO      |
| events_transactions_history             | NO      |
| events_transactions_history_long        | NO      |
+-----+-----+
```

To control transaction event collection at server startup, use lines like these in your `my.cnf` file:

- Enable:

```
[mysqld]
performance-schema-instrument='transaction=ON'
performance-schema-consumer-events-transactions-current=ON
performance-schema-consumer-events-transactions-history=ON
performance-schema-consumer-events-transactions-history-long=ON
```

- Disable:

```
[mysqld]
performance-schema-instrument='transaction=OFF'
performance-schema-consumer-events-transactions-current=OFF
performance-schema-consumer-events-transactions-history=OFF
performance-schema-consumer-events-transactions-history-long=OFF
```

To control transaction event collection at runtime, update the `setup_instruments` and `setup_consumers` tables:

- Enable:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'YES', TIMED = 'YES'
WHERE NAME = 'transaction';
UPDATE performance_schema.setup_consumers
SET ENABLED = 'YES'
WHERE NAME LIKE 'events_transactions%';
```

- Disable:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'NO', TIMED = 'NO'
WHERE NAME = 'transaction';
UPDATE performance_schema.setup_consumers
SET ENABLED = 'NO'
WHERE NAME LIKE 'events_transactions%';
```

To collect transaction events only for specific transaction event tables, enable the `transaction` instrument but only the transaction consumers corresponding to the desired tables.

The `setup_timers` table contains a row with a `NAME` value of `transaction` that indicates the unit for transaction event timing. The default unit is `NANOSECOND`:

```
mysql> SELECT *
      FROM performance_schema.setup_timers
      WHERE NAME = 'transaction';
+-----+-----+
| NAME          | TIMER_NAME |
+-----+-----+
| transaction   | NANOSECOND |
+-----+-----+
```

To change the timing unit, modify the `TIMER_NAME` value:

```
UPDATE performance_schema.setup_timers
SET TIMER_NAME = 'MICROSECOND'
WHERE NAME = 'transaction';
```

For additional information about configuring event collection, see [Chapter 4, Performance Schema Startup Configuration](#), and [Chapter 5, Performance Schema Runtime Configuration](#).

Transaction Boundaries

In MySQL Server, transactions start explicitly with these statements:

```
START TRANSACTION | BEGIN | XA START | XA BEGIN
```

Transactions also start implicitly. For example, when the `autocommit` system variable is enabled, the start of each statement starts a new transaction.

When `autocommit` is disabled, the first statement following a committed transaction marks the start of a new transaction. Subsequent statements are part of the transaction until it is committed.

Transactions explicitly end with these statements:

```
COMMIT | ROLLBACK | XA COMMIT | XA ROLLBACK
```

Transactions also end implicitly, by execution of DDL statements, locking statements, and server administration statements.

In the following discussion, references to `START TRANSACTION` also apply to `BEGIN`, `XA START`, and `XA BEGIN`. Similarly, references to `COMMIT` and `ROLLBACK` apply to `XA COMMIT` and `XA ROLLBACK`, respectively.

The Performance Schema defines transaction boundaries similarly to that of the server. The start and end of a transaction event closely match the corresponding state transitions in the server:

- For an explicitly started transaction, the transaction event starts during processing of the `START TRANSACTION` statement.
- For an implicitly started transaction, the transaction event starts on the first statement that uses a transactional engine after the previous transaction has ended.
- For any transaction, whether explicitly or implicitly ended, the transaction event ends when the server transitions out of the active transaction state during the processing of `COMMIT` or `ROLLBACK`.

There are subtle implications to this approach:

- Transaction events in the Performance Schema do not fully include the statement events associated with the corresponding `START TRANSACTION`, `COMMIT`, or `ROLLBACK` statements. There is a trivial amount of timing overlap between the transaction event and these statements.
- Statements that work with nontransactional engines have no effect on the transaction state of the connection. For implicit transactions, the transaction event begins with the first statement that uses a transactional engine. This means that statements operating exclusively on nontransactional tables are ignored, even following `START TRANSACTION`.

To illustrate, consider the following scenario:

```

1. SET autocommit = OFF;
2. CREATE TABLE t1 (a INT) ENGINE = InnoDB;
3. START TRANSACTION;                -- Transaction 1 START
4. INSERT INTO t1 VALUES (1), (2), (3);
5. CREATE TABLE t2 (a INT) ENGINE = MyISAM; -- Transaction 1 COMMIT
                                           -- (implicit; DDL forces commit)
6. INSERT INTO t2 VALUES (1), (2), (3); -- Update nontransactional table
7. UPDATE t2 SET a = a + 1;           -- ... and again
8. INSERT INTO t1 VALUES (4), (5), (6); -- Write to transactional table
                                           -- Transaction 2 START (implicit)
9. COMMIT;                            -- Transaction 2 COMMIT

```

From the perspective of the server, Transaction 1 ends when table `t2` is created. Transaction 2 does not start until a transactional table is accessed, despite the intervening updates to nontransactional tables.

From the perspective of the Performance Schema, Transaction 2 starts when the server transitions into an active transaction state. Statements 6 and 7 are not included within the boundaries of Transaction 2, which is consistent with how the server writes transactions to the binary log.

Transaction Instrumentation

Three attributes define transactions:

- Access mode (read only, read write)
- Isolation level (`SERIALIZABLE`, `REPEATABLE READ`, and so forth)
- Implicit (`autocommit` enabled) or explicit (`autocommit` disabled)

To reduce complexity of the transaction instrumentation and to ensure that the collected transaction data provides complete, meaningful results, all transactions are instrumented independently of access mode, isolation level, or autocommit mode.

To selectively examine transaction history, use the attribute columns in the transaction event tables: `ACCESS_MODE`, `ISOLATION_LEVEL`, and `AUTOCOMMIT`.

The cost of transaction instrumentation can be reduced various ways, such as enabling or disabling transaction instrumentation according to user, account, host, or thread (client connection).

Transactions and Nested Events

The parent of a transaction event is the event that initiated the transaction. For an explicitly started transaction, this includes the `START TRANSACTION` and `COMMIT AND CHAIN` statements. For an implicitly started transaction, it is the first statement that uses a transactional engine after the previous transaction ends.

In general, a transaction is the top-level parent to all events initiated during the transaction, including statements that explicitly end the transaction such as `COMMIT` and `ROLLBACK`. Exceptions are statements

that implicitly end a transaction, such as DDL statements, in which case the current transaction must be committed before the new statement is executed.

Transactions and Stored Programs

Transactions and stored program events are related as follows:

- **Stored Procedures**

Stored procedures operate independently of transactions. A stored procedure can be started within a transaction, and a transaction can be started or ended from within a stored procedure. If called from within a transaction, a stored procedure can execute statements that force a commit of the parent transaction and then start a new transaction.

If a stored procedure is started within a transaction, that transaction is the parent of the stored procedure event.

If a transaction is started by a stored procedure, the stored procedure is the parent of the transaction event.

- **Stored Functions**

Stored functions are restricted from causing an explicit or implicit commit or rollback. Stored function events can reside within a parent transaction event.

- **Triggers**

Triggers activate as part of a statement that accesses the table with which it is associated, so the parent of a trigger event is always the statement that activates it.

Triggers cannot issue statements that cause an explicit or implicit commit or rollback of a transaction.

- **Scheduled Events**

The execution of the statements in the body of a scheduled event takes place in a new connection. Nesting of a scheduled event within a parent transaction is not applicable.

Transactions and Savepoints

Savepoint statements are recorded as separate statement events. Transaction events include separate counters for `SAVEPOINT`, `ROLLBACK TO SAVEPOINT`, and `RELEASE SAVEPOINT` statements issued during the transaction.

Transactions and Errors

Errors and warnings that occur within a transaction are recorded in statement events, but not in the corresponding transaction event. This includes transaction-specific errors and warnings, such as a rollback on a nontransactional table or GTID consistency errors.

10.7.1 The `events_transactions_current` Table

The `events_transactions_current` table contains current transaction events. The table stores one row per thread showing the current status of the thread's most recent monitored transaction event, so there is no system variable for configuring the table size. For example:

```
mysql> SELECT *  
FROM performance_schema.events_transactions_current LIMIT 1\G
```

```

***** 1. row *****
      THREAD_ID: 26
      EVENT_ID: 7
      END_EVENT_ID: NULL
      EVENT_NAME: transaction
      STATE: ACTIVE
      TRX_ID: NULL
      GTID: 3E11FA47-71CA-11E1-9E33-C80AA9429562:56
      XID: NULL
      XA_STATE: NULL
      SOURCE: transaction.cc:150
      TIMER_START: 420833537900000
      TIMER_END: NULL
      TIMER_WAIT: NULL
      ACCESS_MODE: READ WRITE
      ISOLATION_LEVEL: REPEATABLE READ
      AUTOCOMMIT: NO
      NUMBER_OF_SAVEPOINTS: 0
      NUMBER_OF_ROLLBACK_TO_SAVEPOINT: 0
      NUMBER_OF_RELEASE_SAVEPOINT: 0
      OBJECT_INSTANCE_BEGIN: NULL
      NESTING_EVENT_ID: 6
      NESTING_EVENT_TYPE: STATEMENT

```

Of the tables that contain transaction event rows, [events_transactions_current](#) is the most fundamental. Other tables that contain transaction event rows are logically derived from the current events. For example, the [events_transactions_history](#) and [events_transactions_history_long](#) tables are collections of the most recent transaction events that have ended, up to a maximum number of rows per thread and globally across all threads, respectively.

For more information about the relationship between the three transaction event tables, see [Performance Schema Tables for Current and Historical Events](#).

For information about configuring whether to collect transaction events, see [Section 10.7, “Performance Schema Transaction Tables”](#).

The [events_transactions_current](#) table has these columns:

- [THREAD_ID](#), [EVENT_ID](#)

The thread associated with the event and the thread current event number when the event starts. The [THREAD_ID](#) and [EVENT_ID](#) values taken together uniquely identify the row. No two rows have the same pair of values.

- [END_EVENT_ID](#)

This column is set to [NULL](#) when the event starts and updated to the thread current event number when the event ends.

- [EVENT_NAME](#)

The name of the instrument from which the event was collected. This is a [NAME](#) value from the [setup_instruments](#) table. Instrument names may have multiple parts and form a hierarchy, as discussed in [Chapter 7, Performance Schema Instrument Naming Conventions](#).

- [STATE](#)

The current transaction state. The value is [ACTIVE](#) (after [START TRANSACTION](#) or [BEGIN](#)), [COMMITTED](#) (after [COMMIT](#)), or [ROLLED BACK](#) (after [ROLLBACK](#)).

- [TRX_ID](#)

Unused.

- **GTID**

The GTID column contains the value of `gtid_next`, which can be one of `ANONYMOUS`, `AUTOMATIC`, or a GTID using the format `UUID:NUMBER`. For transactions that use `gtid_next=AUTOMATIC`, which is all normal client transactions, the GTID column changes when the transaction commits and the actual GTID is assigned. If `gtid_mode` is either `ON` or `ON_PERMISSIVE`, the GTID column changes to the transaction's GTID. If `gtid_mode` is either `OFF` or `OFF_PERMISSIVE`, the GTID column changes to `ANONYMOUS`.

- **XID_FORMAT_ID, XID_GTRID, and XID_BQUAL**

The elements of the XA transaction identifier. They have the format described in [XA Transaction SQL Statements](#).

- **XA_STATE**

The state of the XA transaction. The value is `ACTIVE` (after `XA START`), `IDLE` (after `XA END`), `PREPARED` (after `XA PREPARE`), `ROLLED BACK` (after `XA ROLLBACK`), or `COMMITTED` (after `XA COMMIT`).

On a replica, the same XA transaction can appear in the `events_transactions_current` table with different states on different threads. This is because immediately after the XA transaction is prepared, it is detached from the replication applier thread, and can be committed or rolled back by any thread on the replica. The `events_transactions_current` table displays the current status of the most recent monitored transaction event on the thread, and does not update this status when the thread is idle. So the XA transaction can still be displayed in the `PREPARED` state for the original applier thread, after it has been processed by another thread. To positively identify XA transactions that are still in the `PREPARED` state and need to be recovered, use the `XA RECOVER` statement rather than the Performance Schema transaction tables.

- **SOURCE**

The name of the source file containing the instrumented code that produced the event and the line number in the file at which the instrumentation occurs. This enables you to check the source to determine exactly what code is involved.

- **TIMER_START, TIMER_END, TIMER_WAIT**

Timing information for the event. The unit for these values is picoseconds (trillionths of a second). The `TIMER_START` and `TIMER_END` values indicate when event timing started and ended. `TIMER_WAIT` is the event elapsed time (duration).

If an event has not finished, `TIMER_END` is the current timer value and `TIMER_WAIT` is the time elapsed so far (`TIMER_END - TIMER_START`).

If an event is produced from an instrument that has `TIMED = NO`, timing information is not collected, and `TIMER_START`, `TIMER_END`, and `TIMER_WAIT` are all `NULL`.

For discussion of picoseconds as the unit for event times and factors that affect time values, see [Section 5.1, "Performance Schema Event Timing"](#).

- **ACCESS_MODE**

The transaction access mode. The value is `READ WRITE` or `READ ONLY`.

- `ISOLATION_LEVEL`

The transaction isolation level. The value is `REPEATABLE READ`, `READ COMMITTED`, `READ UNCOMMITTED`, or `SERIALIZABLE`.

- `AUTOCOMMIT`

Whether autocommit mode was enabled when the transaction started.

- `NUMBER_OF_SAVEPOINTS`, `NUMBER_OF_ROLLBACK_TO_SAVEPOINT`,
`NUMBER_OF_RELEASE_SAVEPOINT`

The number of `SAVEPOINT`, `ROLLBACK TO SAVEPOINT`, and `RELEASE SAVEPOINT` statements issued during the transaction.

- `OBJECT_INSTANCE_BEGIN`

Unused.

- `NESTING_EVENT_ID`

The `EVENT_ID` value of the event within which this event is nested.

- `NESTING_EVENT_TYPE`

The nesting event type. The value is `TRANSACTION`, `STATEMENT`, `STAGE`, or `WAIT`. (`TRANSACTION` does not appear because transactions cannot be nested.)

`TRUNCATE TABLE` is permitted for the `events_transactions_current` table. It removes the rows.

10.7.2 The events_transactions_history Table

The `events_transactions_history` table contains the *N* most recent transaction events that have ended per thread. Transaction events are not added to the table until they have ended. When the table contains the maximum number of rows for a given thread, the oldest thread row is discarded when a new row for that thread is added. When a thread ends, all its rows are discarded.

The Performance Schema autosizes the value of *N* during server startup. To set the number of rows per thread explicitly, set the `performance_schema_events_transactions_history_size` system variable at server startup.

The `events_transactions_history` table has the same columns as `events_transactions_current`. See [Section 10.7.1, “The events_transactions_current Table”](#).

`TRUNCATE TABLE` is permitted for the `events_transactions_history` table. It removes the rows.

For more information about the relationship between the three transaction event tables, see [Performance Schema Tables for Current and Historical Events](#).

For information about configuring whether to collect transaction events, see [Section 10.7, “Performance Schema Transaction Tables”](#).

10.7.3 The events_transactions_history_long Table

The `events_transactions_history_long` table contains the *N* most recent transaction events that have ended globally, across all threads. Transaction events are not added to the table until they have

ended. When the table becomes full, the oldest row is discarded when a new row is added, regardless of which thread generated either row.

The Performance Schema autosizes the value of *N* is autosized at server startup. To set the table size explicitly, set the `performance_schema_events_transactions_history_long_size` system variable at server startup.

The `events_transactions_history_long` table has the same columns as `events_transactions_current`. See [Section 10.7.1, “The events_transactions_current Table”](#).

`TRUNCATE TABLE` is permitted for the `events_transactions_history_long` table. It removes the rows.

For more information about the relationship between the three transaction event tables, see [Performance Schema Tables for Current and Historical Events](#).

For information about configuring whether to collect transaction events, see [Section 10.7, “Performance Schema Transaction Tables”](#).

10.8 Performance Schema Connection Tables

When a client connects to the MySQL server, it does so under a particular user name and from a particular host. The Performance Schema provides statistics about these connections, tracking them per account (user and host combination) as well as separately per user name and host name, using these tables:

- `accounts`: Connection statistics per client account
- `hosts`: Connection statistics per client host name
- `users`: Connection statistics per client user name

The meaning of “account” in the connection tables is similar to its meaning in the MySQL grant tables in the `mysql` system database, in the sense that the term refers to a combination of user and host values. They differ in that, for grant tables, the host part of an account can be a pattern, whereas for Performance Schema tables, the host value is always a specific nonpattern host name.

Each connection table has `CURRENT_CONNECTIONS` and `TOTAL_CONNECTIONS` columns to track the current and total number of connections per “tracking value” on which its statistics are based. The tables differ in what they use for the tracking value. The `accounts` table has `USER` and `HOST` columns to track connections per user and host combination. The `users` and `hosts` tables have a `USER` and `HOST` column, respectively, to track connections per user name and host name.

The Performance Schema also counts internal threads and threads for user sessions that failed to authenticate, using rows with `USER` and `HOST` column values of `NULL`.

Suppose that clients named `user1` and `user2` each connect one time from `hosta` and `hostb`. The Performance Schema tracks the connections as follows:

- The `accounts` table has four rows, for the `user1/hosta`, `user1/hostb`, `user2/hosta`, and `user2/hostb` account values, each row counting one connection per account.
- The `hosts` table has two rows, for `hosta` and `hostb`, each row counting two connections per host name.
- The `users` table has two rows, for `user1` and `user2`, each row counting two connections per user name.

When a client connects, the Performance Schema determines which row in each connection table applies, using the tracking value appropriate to each table. If there is no such row, one is added. Then the Performance Schema increments by one the `CURRENT_CONNECTIONS` and `TOTAL_CONNECTIONS` columns in that row.

When a client disconnects, the Performance Schema decrements by one the `CURRENT_CONNECTIONS` column in the row and leaves the `TOTAL_CONNECTIONS` column unchanged.

`TRUNCATE TABLE` is permitted for connection tables. It has these effects:

- Rows are removed for accounts, hosts, or users that have no current connections (rows with `CURRENT_CONNECTIONS = 0`).
- Nonremoved rows are reset to count only current connections: For rows with `CURRENT_CONNECTIONS > 0`, `TOTAL_CONNECTIONS` is reset to `CURRENT_CONNECTIONS`.
- Summary tables that depend on the connection table are implicitly truncated, as described later in this section.

The Performance Schema maintains summary tables that aggregate connection statistics for various event types by account, host, or user. These tables have `_summary_by_account`, `_summary_by_host`, or `_summary_by_user` in the name. To identify them, use this query:

```
mysql> SELECT TABLE_NAME FROM INFORMATION_SCHEMA.TABLES
WHERE TABLE_SCHEMA = 'performance_schema'
AND TABLE_NAME REGEXP '_summary_by_(account|host|user) '
ORDER BY TABLE_NAME;
```

TABLE_NAME
events_stages_summary_by_account_by_event_name
events_stages_summary_by_host_by_event_name
events_stages_summary_by_user_by_event_name
events_statements_summary_by_account_by_event_name
events_statements_summary_by_host_by_event_name
events_statements_summary_by_user_by_event_name
events_transactions_summary_by_account_by_event_name
events_transactions_summary_by_host_by_event_name
events_transactions_summary_by_user_by_event_name
events_waits_summary_by_account_by_event_name
events_waits_summary_by_host_by_event_name
events_waits_summary_by_user_by_event_name
memory_summary_by_account_by_event_name
memory_summary_by_host_by_event_name
memory_summary_by_user_by_event_name

For details about individual connection summary tables, consult the section that describes tables for the summarized event type:

- Wait event summaries: [Section 10.15.1, “Wait Event Summary Tables”](#)
- Stage event summaries: [Section 10.15.2, “Stage Summary Tables”](#)
- Statement event summaries: [Section 10.15.3, “Statement Summary Tables”](#)
- Transaction event summaries: [Section 10.15.4, “Transaction Summary Tables”](#)
- Memory event summaries: [Section 10.15.9, “Memory Summary Tables”](#)

`TRUNCATE TABLE` is permitted for connection summary tables. It removes rows for accounts, hosts, or users with no connections, and resets the summary columns to zero for the remaining rows. In

addition, each summary table that is aggregated by account, host, user, or thread is implicitly truncated by truncation of the connection table on which it depends. The following table describes the relationship between connection table truncation and implicitly truncated tables.

Table 10.2 Implicit Effects of Connection Table Truncation

Truncated Connection Table	Implicitly Truncated Summary Tables
<code>accounts</code>	Tables with names containing <code>_summary_by_account</code> , <code>_summary_by_thread</code>
<code>hosts</code>	Tables with names containing <code>_summary_by_account</code> , <code>_summary_by_host</code> , <code>_summary_by_thread</code>
<code>users</code>	Tables with names containing <code>_summary_by_account</code> , <code>_summary_by_user</code> , <code>_summary_by_thread</code>

Truncating a `_summary_global` summary table also implicitly truncates its corresponding connection and thread summary tables. For example, truncating `events_waits_summary_global_by_event_name` implicitly truncates the wait event summary tables that are aggregated by account, host, user, or thread.

10.8.1 The accounts Table

The `accounts` table contains a row for each account that has connected to the MySQL server. For each account, the table counts the current and total number of connections. The table size is autosized at server startup. To set the table size explicitly, set the `performance_schema_accounts_size` system variable at server startup. To disable account statistics, set this variable to 0.

The `accounts` table has the following columns. For a description of how the Performance Schema maintains rows in this table, including the effect of `TRUNCATE TABLE`, see [Section 10.8, “Performance Schema Connection Tables”](#).

- `USER`

The client user name for the connection. This is `NULL` for an internal thread, or for a user session that failed to authenticate.

- `HOST`

The host from which the client connected. This is `NULL` for an internal thread, or for a user session that failed to authenticate.

- `CURRENT_CONNECTIONS`

The current number of connections for the account.

- `TOTAL_CONNECTIONS`

The total number of connections for the account.

10.8.2 The hosts Table

The `hosts` table contains a row for each host from which clients have connected to the MySQL server. For each host name, the table counts the current and total number of connections. The table size is autosized at server startup. To set the table size explicitly, set the `performance_schema_hosts_size` system variable at server startup. To disable host statistics, set this variable to 0.

The `hosts` table has the following columns. For a description of how the Performance Schema maintains rows in this table, including the effect of `TRUNCATE TABLE`, see [Section 10.8, “Performance Schema Connection Tables”](#).

- `HOST`

The host from which the client connected. This is `NULL` for an internal thread, or for a user session that failed to authenticate.

- `CURRENT_CONNECTIONS`

The current number of connections for the host.

- `TOTAL_CONNECTIONS`

The total number of connections for the host.

10.8.3 The users Table

The `users` table contains a row for each user who has connected to the MySQL server. For each user name, the table counts the current and total number of connections. The table size is autosized at server startup. To set the table size explicitly, set the `performance_schema_users_size` system variable at server startup. To disable user statistics, set this variable to 0.

The `users` table has the following columns. For a description of how the Performance Schema maintains rows in this table, including the effect of `TRUNCATE TABLE`, see [Section 10.8, “Performance Schema Connection Tables”](#).

- `USER`

The client user name for the connection. This is `NULL` for an internal thread, or for a user session that failed to authenticate.

- `CURRENT_CONNECTIONS`

The current number of connections for the user.

- `TOTAL_CONNECTIONS`

The total number of connections for the user.

10.9 Performance Schema Connection Attribute Tables

Connection attributes are key-value pairs that application programs can pass to the server at connect time. For applications based on the C API implemented by the `libmysqlclient` client library, the `mysql_options()` and `mysql_options4()` functions define the connection attribute set. Other MySQL Connectors may provide their own attribute-definition methods.

These Performance Schema tables expose attribute information:

- `session_account_connect_attrs`: Connection attributes for the current session, and other sessions associated with the session account
- `session_connect_attrs`: Connection attributes for all sessions

Attribute names that begin with an underscore (`_`) are reserved for internal use and should not be created by application programs. This convention permits new attributes to be introduced by MySQL without

colliding with application attributes, and enables application programs to define their own attributes that do not collide with internal attributes.

- [Available Connection Attributes](#)
- [Connection Attribute Limits](#)

Available Connection Attributes

The set of connection attributes visible within a given connection varies depending on factors such as your platform, MySQL Connector used to establish the connection, or client program.

The `libmysqlclient` client library sets these attributes:

- `_client_name`: The client name (`libmysql` for the client library).
- `_client_version`: The client library version.
- `_os`: The operating system (for example, `Linux`, `Win64`).
- `_pid`: The client process ID.
- `_platform`: The machine platform (for example, `x86_64`).
- `_thread`: The client thread ID (Windows only).

Other MySQL Connectors may define their own connection attributes.

MySQL Connector/J defines these attributes:

- `_client_license`: The connector license type.
- `_runtime_vendor`: The Java runtime environment (JRE) vendor.
- `_runtime_version`: The Java runtime environment (JRE) version.

MySQL Connector/NET defines these attributes:

- `_client_version`: The client library version.
- `_os`: The operating system (for example, `Linux`, `Win64`).
- `_pid`: The client process ID.
- `_platform`: The machine platform (for example, `x86_64`).
- `_program_name`: The client name.
- `_thread`: The client thread ID (Windows only).

PHP defines attributes that depend on how it was compiled:

- Compiled using `libmysqlclient`: The standard `libmysqlclient` attributes, described previously.
- Compiled using `mysqlnd`: Only the `_client_name` attribute, with a value of `mysqlnd`.

Many MySQL client programs set a `program_name` attribute with a value equal to the client name. For example, `mysqladmin` and `mysqldump` set `program_name` to `mysqladmin` and `mysqldump`, respectively.

Some MySQL client programs define additional attributes:

- `mysqlbinlog`:
 - `_client_role: binary_log_listener`
- Replica connections:
 - `program_name: mysqld`
 - `_client_role: binary_log_listener`
 - `_client_replication_channel_name`: The channel name.
- `FEDERATED` storage engine connections:
 - `program_name: mysqld`
 - `_client_role: federated_storage`

Connection Attribute Limits

There are limits on the amount of connection attribute data transmitted from client to server:

- A fixed limit imposed by the client prior to connect time.
- A fixed limit imposed by the server at connect time.
- A configurable limit imposed by the Performance Schema at connect time.

For connections initiated using the C API, the `libmysqlclient` library imposes a limit of 64KB on the aggregate size of connection attribute data on the client side: Calls to `mysql_options()` that cause this limit to be exceeded produce a `CR_INVALID_PARAMETER_NO` error. Other MySQL Connectors may impose their own client-side limits on how much connection attribute data can be transmitted to the server.

On the server side, these size checks on connection attribute data occur:

- The server imposes a limit of 64KB on the aggregate size of connection attribute data it can accept. If a client attempts to send more than 64KB of attribute data, the server rejects the connection.
- For accepted connections, the Performance Schema checks aggregate attribute size against the value of the `performance_schema_session_connect_attrs_size` system variable. If attribute size exceeds this value, these actions take place:
 - The Performance Schema truncates the attribute data and increments the `Performance_schema_session_connect_attrs_lost` status variable, which indicates the number of connections for which attribute truncation occurred.
 - The Performance Schema writes a message to the error log if the `log_error_verbosity` system variable is greater than 1:

```
[Warning] Connection attributes of length N were truncated
```

10.9.1 The `session_account_connect_attrs` Table

Application programs can provide key-value connection attributes to be passed to the server at connect time. For descriptions of common attributes, see [Section 10.9, “Performance Schema Connection Attribute Tables”](#).

The `session_account_connect_attrs` table contains connection attributes only for the current session, and other sessions associated with the session account. To see connection attributes for all sessions, use the `session_connect_attrs` table.

The `session_account_connect_attrs` table has these columns:

- `PROCESSLIST_ID`

The connection identifier for the session.

- `ATTR_NAME`

The attribute name.

- `ATTR_VALUE`

The attribute value.

- `ORDINAL_POSITION`

The order in which the attribute was added to the set of connection attributes.

`TRUNCATE TABLE` is not permitted for the `session_account_connect_attrs` table.

10.9.2 The session_connect_attrs Table

Application programs can provide key-value connection attributes to be passed to the server at connect time. For descriptions of common attributes, see [Section 10.9, “Performance Schema Connection Attribute Tables”](#).

The `session_connect_attrs` table contains connection attributes for all sessions. To see connection attributes only for the current session, and other sessions associated with the session account, use the `session_account_connect_attrs` table.

The `session_connect_attrs` table has these columns:

- `PROCESSLIST_ID`

The connection identifier for the session.

- `ATTR_NAME`

The attribute name.

- `ATTR_VALUE`

The attribute value.

- `ORDINAL_POSITION`

The order in which the attribute was added to the set of connection attributes.

`TRUNCATE TABLE` is not permitted for the `session_connect_attrs` table.

10.10 Performance Schema User-Defined Variable Tables

The Performance Schema provides a `user_variables_by_thread` table that exposes user-defined variables. These are variables defined within a specific session and include a `@` character preceding the name; see [User-Defined Variables](#).

The `user_variables_by_thread` table has these columns:

- `THREAD_ID`

The thread identifier of the session in which the variable is defined.

- `VARIABLE_NAME`

The variable name, without the leading `@` character.

- `VARIABLE_VALUE`

The variable value.

`TRUNCATE TABLE` is not permitted for the `user_variables_by_thread` table.

10.11 Performance Schema Replication Tables

The Performance Schema provides tables that expose replication information. This is similar to the information available from the `SHOW SLAVE STATUS` statement, but representation in table form is more accessible and has usability benefits:

- `SHOW SLAVE STATUS` output is useful for visual inspection, but not so much for programmatic use. By contrast, using the Performance Schema tables, information about replica status can be searched using general `SELECT` queries, including complex `WHERE` conditions, joins, and so forth.
- Query results can be saved in tables for further analysis, or assigned to variables and thus used in stored procedures.
- The replication tables provide better diagnostic information. For multithreaded replica operation, `SHOW SLAVE STATUS` reports all coordinator and worker thread errors using the `Last_SQL_Errno` and `Last_SQL_Error` fields, so only the most recent of those errors is visible and information can be lost. The replication tables store errors on a per-thread basis without loss of information.
- The last seen transaction is visible in the replication tables on a per-worker basis. This is information not available from `SHOW SLAVE STATUS`.
- Developers familiar with the Performance Schema interface can extend the replication tables to provide additional information by adding rows to the tables.

Replication Table Descriptions

The Performance Schema provides the following replication-related tables:

- Tables that contain information about the connection of a replica to the replication source server:
 - `replication_connection_configuration`: Configuration parameters for connecting to the source
 - `replication_connection_status`: Current status of the connection to the source
- Tables that contain general (not thread-specific) information about the transaction applier:
 - `replication_applier_configuration`: Configuration parameters for the transaction applier on the replica.
 - `replication_applier_status`: Current status of the transaction applier on the replica.

- Tables that contain information about specific threads responsible for applying transactions received from the source:
 - `replication_applier_status_by_coordinator`: Status of the coordinator thread (empty unless the replica is multithreaded).
 - `replication_applier_status_by_worker`: Status of the applier thread or worker threads if the replica is multithreaded.
- Tables that contain information about replication group members:
 - `replication_group_members`: Provides network and status information for group members.
 - `replication_group_member_stats`: Provides statistical information about group members and transaction in which they participate.

The following sections describe each replication table in more detail, including the correspondence between the columns produced by `SHOW SLAVE STATUS` and the replication table columns in which the same information appears.

The remainder of this introduction to the replication tables describes how the Performance Schema populates them and which fields from `SHOW SLAVE STATUS` are not represented in the tables.

Replication Table Life Cycle

The Performance Schema populates the replication tables as follows:

- Prior to execution of `CHANGE MASTER TO`, the tables are empty.
- After `CHANGE MASTER TO`, the configuration parameters can be seen in the tables. At this time, there are no active replica threads, so the `THREAD_ID` columns are `NULL` and the `SERVICE_STATE` columns have a value of `OFF`.
- After `START SLAVE`, non-`NULL` `THREAD_ID` values can be seen. Threads that are idle or active have a `SERVICE_STATE` value of `ON`. The thread that connects to the source has a value of `CONNECTING` while it establishes the connection, and `ON` thereafter as long as the connection lasts.
- After `STOP SLAVE`, the `THREAD_ID` columns become `NULL` and the `SERVICE_STATE` columns for threads that no longer exist have a value of `OFF`.
- The tables are preserved after `STOP SLAVE` or threads dying due to an error.
- The `replication_applier_status_by_worker` table is nonempty only when the replica is operating in multithreaded mode. That is, if the `slave_parallel_workers` system variable is greater than 0, this table is populated when `START SLAVE` is executed, and the number of rows shows the number of workers.

`SHOW SLAVE STATUS` Information Not In the Replication Tables

The information in the Performance Schema replication tables differs somewhat from the information available from `SHOW SLAVE STATUS` because the tables are oriented toward use of global transaction identifiers (GTIDs), not file names and positions, and they represent server UUID values, not server ID values. Due to these differences, several `SHOW SLAVE STATUS` columns are not preserved in the Performance Schema replication tables, or are represented a different way:

- The following fields refer to file names and positions and are not preserved:

```
Master_Log_File
Read_Master_Log_Pos
Relay_Log_File
Relay_Log_Pos
Relay_Master_Log_File
Exec_Master_Log_Pos
Until_Condition
Until_Log_File
Until_Log_Pos
```

- The `Master_Info_File` field is not preserved. It refers to the `master.info` file, which has been superseded by crash-safe tables.
- The following fields are based on `server_id`, not `server_uuid`, and are not preserved:

```
Master_Server_Id
Replicate_Ignore_Server_Ids
```

- The `Skip_Counter` field is based on event counts, not GTIDs, and is not preserved.
- These error fields are aliases for `Last_SQL_Errno` and `Last_SQL_Error`, so they are not preserved:

```
Last_Errno
Last_Error
```

In the Performance Schema, this error information is available in the `LAST_ERROR_NUMBER` and `LAST_ERROR_MESSAGE` columns of the `replication_applier_status_by_worker` table (and `replication_applier_status_by_coordinator` if the replica is multithreaded). Those tables provide more specific per-thread error information than is available from `Last_Errno` and `Last_Error`.

- Fields that provide information about command-line filtering options is not preserved:

```
Replicate_Do_DB
Replicate_Ignore_DB
Replicate_Do_Table
Replicate_Ignore_Table
Replicate_Wild_Do_Table
Replicate_Wild_Ignore_Table
```

- The `Slave_IO_State` and `Slave_SQL_Running_State` fields are not preserved. If needed, these values can be obtained from the process list by using the `THREAD_ID` column of the appropriate replication table and joining it with the `ID` column in the `INFORMATION_SCHEMA.PROCESSLIST` table to select the `STATE` column of the latter table.
- The `Executed_Gtid_Set` field can show a large set with a great deal of text. Instead, the Performance Schema tables show GTIDs of transactions that are currently being applied by the replica. Alternatively, the set of executed GTIDs can be obtained from the value of the `gtid_executed` system variable.
- The `Seconds_Behind_Master` and `Relay_Log_Space` fields are in to-be-decided status and are not preserved.

Status Variables Moved to Replication Tables

As of MySQL version 5.7.5, the following status variables (previously monitored using `SHOW STATUS`) were moved to the Performance Schema replication tables:

- `Slave_retried_transactions`
- `Slave_last_heartbeat`

- `Slave_received_heartbeats`
- `Slave_heartbeat_period`
- `Slave_running`

These status variables are now only relevant when a single replication channel is being used because they *only* report the status of the default replication channel. When multiple replication channels exist, use the Performance Schema replication tables described in this section, which report these variables for each existing replication channel.

Replication Channels

The first column of the replication Performance Schema tables is `CHANNEL_NAME`. This enables the tables to be viewed per replication channel. In a non-multisource replication setup there is a single default replication channel. When you are using multiple replication channels on a replica, you can filter the tables per replication channel to monitor a specific replication channel. See [Replication Channels](#) and [Multi-Source Replication Monitoring](#) for more information.

10.11.1 The `replication_connection_configuration` Table

This table shows the configuration parameters used by the replica for connecting to the source. Parameters stored in the table can be changed at runtime with the `CHANGE MASTER TO` statement, as indicated in the column descriptions.

Compared to the `replication_connection_status` table, `replication_connection_configuration` changes less frequently. It contains values that define how the replica connects to the source and that remain constant during the connection, whereas `replication_connection_status` contains values that change during the connection.

The `replication_connection_configuration` table has the following columns. The column descriptions indicate the corresponding `CHANGE MASTER TO` options from which the column values are taken, and the table given later in this section shows the correspondence between `replication_connection_configuration` columns and `SHOW SLAVE STATUS` columns.

- `CHANNEL_NAME`

The replication channel which this row is displaying. There is always a default replication channel, and more replication channels can be added. See [Replication Channels](#) for more information. (`CHANGE MASTER TO` option: `FOR CHANNEL`)

- `HOST`

The replication source server that the replica is connected to. (`CHANGE MASTER TO` option: `MASTER_HOST`)

- `PORT`

The port used to connect to the replication source server. (`CHANGE MASTER TO` option: `MASTER_PORT`)

- `USER`

The user name of the account used to connect to the replication source server. (`CHANGE MASTER TO` option: `MASTER_USER`)

- `NETWORK_INTERFACE`

The network interface that the replica is bound to, if any. (`CHANGE MASTER TO` option: `MASTER_BIND`)

- `AUTO_POSITION`

1 if autopositioning is in use; otherwise 0. (`CHANGE MASTER TO` option: `MASTER_AUTO_POSITION`)

- `SSL_ALLOWED`, `SSL_CA_FILE`, `SSL_CA_PATH`, `SSL_CERTIFICATE`, `SSL_CIPHER`, `SSL_KEY`, `SSL_VERIFY_SERVER_CERTIFICATE`, `SSL_CRL_FILE`, `SSL_CRL_PATH`

These columns show the SSL parameters used by the replica to connect to the replication source server, if any.

`SSL_ALLOWED` has these values:

- `Yes` if an SSL connection to the source is permitted
- `No` if an SSL connection to the source is not permitted
- `Ignored` if an SSL connection is permitted but the replica does not have SSL support enabled

`CHANGE MASTER TO` options for the other SSL columns: `MASTER_SSL_CA`, `MASTER_SSL_CAPATH`, `MASTER_SSL_CERT`, `MASTER_SSL_CIPHER`, `MASTER_SSL_CRL`, `MASTER_SSL_CRLPATH`, `MASTER_SSL_KEY`, `MASTER_SSL_VERIFY_SERVER_CERT`.

- `CONNECTION_RETRY_INTERVAL`

The number of seconds between connect retries. (`CHANGE MASTER TO` option: `MASTER_CONNECT_RETRY`)

- `CONNECTION_RETRY_COUNT`

The number of times the replica can attempt to reconnect to the source in the event of a lost connection. (`CHANGE MASTER TO` option: `MASTER_RETRY_COUNT`)

- `HEARTBEAT_INTERVAL`

The replication heartbeat interval on a replica, measured in seconds. (`CHANGE MASTER TO` option: `MASTER_HEARTBEAT_PERIOD`)

- `TLS_VERSION`

The TLS version used on the source. For TLS version information, see [Encrypted Connection TLS Protocols and Ciphers](#). (`CHANGE MASTER TO` option: `MASTER_TLS_VERSION`)

This column was added in MySQL 5.7.10.

`TRUNCATE TABLE` is not permitted for the `replication_connection_configuration` table.

The following table shows the correspondence between `replication_connection_configuration` columns and `SHOW SLAVE STATUS` columns.

<code>replication_connection_configuration</code> Column	<code>SHOW SLAVE STATUS</code> Column
<code>CHANNEL_NAME</code>	<code>Channel_name</code>
<code>HOST</code>	<code>Master_Host</code>
<code>PORT</code>	<code>Master_Port</code>

<code>replication_connection_configuration</code> Column	SHOW SLAVE STATUS Column
<code>USER</code>	<code>Master_User</code>
<code>NETWORK_INTERFACE</code>	<code>Master_Bind</code>
<code>AUTO_POSITION</code>	<code>Auto_Position</code>
<code>SSL_ALLOWED</code>	<code>Master_SSL_Allowed</code>
<code>SSL_CA_FILE</code>	<code>Master_SSL_CA_File</code>
<code>SSL_CA_PATH</code>	<code>Master_SSL_CA_Path</code>
<code>SSL_CERTIFICATE</code>	<code>Master_SSL_Cert</code>
<code>SSL_CIPHER</code>	<code>Master_SSL_Cipher</code>
<code>SSL_KEY</code>	<code>Master_SSL_Key</code>
<code>SSL_VERIFY_SERVER_CERTIFICATE</code>	<code>Master_SSL_Verify_Server_Cert</code>
<code>SSL_CRL_FILE</code>	<code>Master_SSL_Crl</code>
<code>SSL_CRL_PATH</code>	<code>Master_SSL_Crlpath</code>
<code>CONNECTION_RETRY_INTERVAL</code>	<code>Connect_Retry</code>
<code>CONNECTION_RETRY_COUNT</code>	<code>Master_Retry_Count</code>
<code>HEARTBEAT_INTERVAL</code>	<code>None</code>
<code>TLS_VERSION</code>	<code>Master_TLS_Version</code>

10.11.2 The replication_connection_status Table

This table shows the current status of the replication I/O thread that handles the replica's connection to the source.

Compared to the `replication_connection_configuration` table, `replication_connection_status` changes more frequently. It contains values that change during the connection, whereas `replication_connection_configuration` contains values which define how the replica connects to the source and that remain constant during the connection.

The `replication_connection_status` table has these columns:

- `CHANNEL_NAME`

The replication channel which this row is displaying. There is always a default replication channel, and more replication channels can be added. See [Replication Channels](#) for more information.

- `GROUP_NAME`

If this server is a member of a group, shows the name of the group the server belongs to.

- `SOURCE_UUID`

The `server_uuid` value from the source.

- `THREAD_ID`

The I/O thread ID.

- `SERVICE_STATE`

`ON` (thread exists and is active or idle), `OFF` (thread no longer exists), or `CONNECTING` (thread exists and is connecting to the source).

- `RECEIVED_TRANSACTION_SET`

The set of global transaction IDs (GTIDs) corresponding to all transactions received by this replica. Empty if GTIDs are not in use. See [GTID Sets](#) for more information.

- `LAST_ERROR_NUMBER`, `LAST_ERROR_MESSAGE`

The error number and error message of the most recent error that caused the I/O thread to stop. An error number of 0 and message of the empty string mean “no error.” If the `LAST_ERROR_MESSAGE` value is not empty, the error values also appear in the replica's error log.

Issuing `RESET MASTER` or `RESET SLAVE` resets the values shown in these columns.

- `LAST_ERROR_TIMESTAMP`

A timestamp in `YYMMDD hh:mm:ss` format that shows when the most recent I/O error took place.

- `LAST_HEARTBEAT_TIMESTAMP`

A timestamp in `YYMMDD hh:mm:ss` format that shows when the most recent heartbeat signal was received by a replica.

- `COUNT_RECEIVED_HEARTBEATS`

The total number of heartbeat signals that a replica received since the last time it was restarted or reset, or a `CHANGE MASTER TO` statement was issued.

`TRUNCATE TABLE` is not permitted for the `replication_connection_status` table.

The following table shows the correspondence between `replication_connection_status` columns and `SHOW SLAVE STATUS` columns.

<code>replication_connection_status</code> Column	<code>SHOW SLAVE STATUS</code> Column
<code>SOURCE_UUID</code>	<code>Master_UUID</code>
<code>THREAD_ID</code>	<code>None</code>
<code>SERVICE_STATE</code>	<code>Slave_IO_Running</code>
<code>RECEIVED_TRANSACTION_SET</code>	<code>Retrieved_Gtid_Set</code>
<code>LAST_ERROR_NUMBER</code>	<code>Last_IO_Errno</code>
<code>LAST_ERROR_MESSAGE</code>	<code>Last_IO_Error</code>
<code>LAST_ERROR_TIMESTAMP</code>	<code>Last_IO_Error_Timestamp</code>

10.11.3 The replication_applier_configuration Table

This table shows the configuration parameters that affect transactions applied by the replica. Parameters stored in the table can be changed at runtime with the `CHANGE MASTER TO` statement, as indicated in the column descriptions.

The `replication_applier_configuration` table has these columns:

- `CHANNEL_NAME`

The replication channel which this row is displaying. There is always a default replication channel, and more replication channels can be added. See [Replication Channels](#) for more information.

- `DESIRED_DELAY`

The number of seconds that the replica must lag the source. (`CHANGE MASTER TO` option: `MASTER_DELAY`)

`TRUNCATE TABLE` is not permitted for the `replication_applier_configuration` table.

The following table shows the correspondence between `replication_applier_configuration` columns and `SHOW SLAVE STATUS` columns.

<code>replication_applier_configuration</code> Column	<code>SHOW SLAVE STATUS</code> Column
<code>DESIRED_DELAY</code>	<code>SQL_Delay</code>

10.11.4 The replication_applier_status Table

This table shows the current general transaction execution status on the replica. The table provides information about general aspects of transaction applier status that are not specific to any thread involved. Thread-specific status information is available in the `replication_applier_status_by_coordinator` table (and `replication_applier_status_by_worker` if the replica is multithreaded).

The `replication_applier_status` table has these columns:

- `CHANNEL_NAME`

The replication channel which this row is displaying. There is always a default replication channel, and more replication channels can be added. See [Replication Channels](#) for more information.

- `SERVICE_STATE`

Shows `ON` when the replication channel's applier threads are active or idle, `OFF` means that the applier threads are not active.

- `REMAINING_DELAY`

If the replica is waiting for `DESIRED_DELAY` seconds to pass since the source applied an event, this field contains the number of delay seconds remaining. At other times, this field is `NULL`. (The `DESIRED_DELAY` value is stored in the `replication_applier_configuration` table.)

- `COUNT_TRANSACTIONS_RETRIES`

Shows the number of retries that were made because the replication SQL thread failed to apply a transaction. The maximum number of retries for a given transaction is set by the `slave_transaction_retries` system variable.

`TRUNCATE TABLE` is not permitted for the `replication_applier_status` table.

The following table shows the correspondence between `replication_applier_status` columns and `SHOW SLAVE STATUS` columns.

<code>replication_applier_status</code> Column	<code>SHOW SLAVE STATUS</code> Column
<code>SERVICE_STATE</code>	None

replication_applier_status Column	SHOW SLAVE STATUS Column
REMAINING_DELAY	SQL_Remaining_Delay

10.11.5 The replication_applier_status_by_coordinator Table

For a multithreaded replica, the replica uses multiple worker threads and a coordinator thread to manage them, and this table shows the status of the coordinator thread. For a single-threaded replica, this table is empty. For a multithreaded replica, the `replication_applier_status_by_worker` table shows the status of the worker threads.

The `replication_applier_status_by_coordinator` table has these columns:

- `CHANNEL_NAME`

The replication channel which this row is displaying. There is always a default replication channel, and more replication channels can be added. See [Replication Channels](#) for more information.

- `THREAD_ID`

The SQL/coordinator thread ID.

- `SERVICE_STATE`

`ON` (thread exists and is active or idle) or `OFF` (thread no longer exists).

- `LAST_ERROR_NUMBER`, `LAST_ERROR_MESSAGE`

The error number and error message of the most recent error that caused the SQL/coordinator thread to stop. An error number of 0 and message which is an empty string means “no error”. If the `LAST_ERROR_MESSAGE` value is not empty, the error values also appear in the replica's error log.

Issuing `RESET MASTER` or `RESET SLAVE` resets the values shown in these columns.

All error codes and messages displayed in the `LAST_ERROR_NUMBER` and `LAST_ERROR_MESSAGE` columns correspond to error values listed in [Server Error Message Reference](#).

- `LAST_ERROR_TIMESTAMP`

A timestamp in `YYMMDD hh:mm:ss` format that shows when the most recent SQL/coordinator error occurred.

`TRUNCATE TABLE` is not permitted for the `replication_applier_status_by_coordinator` table.

The following table shows the correspondence between `replication_applier_status_by_coordinator` columns and `SHOW SLAVE STATUS` columns.

replication_applier_status_by_coordinator Column	SHOW SLAVE STATUS Column
<code>THREAD_ID</code>	None
<code>SERVICE_STATE</code>	<code>Slave_SQL_Running</code>
<code>LAST_ERROR_NUMBER</code>	<code>Last_SQL_Errno</code>
<code>LAST_ERROR_MESSAGE</code>	<code>Last_SQL_Error</code>
<code>LAST_ERROR_TIMESTAMP</code>	<code>Last_SQL_Error_Timestamp</code>

10.11.6 The replication_applier_status_by_worker Table

If the replica is not multithreaded, this table shows the status of the applier thread. Otherwise, the replica uses multiple worker threads and a coordinator thread to manage them, and this table shows the status of the worker threads. For a multithreaded replica, the `replication_applier_status_by_coordinator` table shows the status of the coordinator thread.

The `replication_applier_status_by_worker` table has these columns:

- `CHANNEL_NAME`

The replication channel which this row is displaying. There is always a default replication channel, and more replication channels can be added. See [Replication Channels](#) for more information.

- `WORKER_ID`

The worker identifier (same value as the `id` column in the `mysql.slave_worker_info` table). After `STOP SLAVE`, the `THREAD_ID` column becomes `NULL`, but the `WORKER_ID` value is preserved.

- `THREAD_ID`

The worker thread identifier.

- `SERVICE_STATE`

`ON` (thread exists and is active or idle) or `OFF` (thread no longer exists).

- `LAST_SEEN_TRANSACTION`

The transaction that the worker has last seen. The worker has not necessarily applied this transaction because it could still be in the process of doing so.

If the `gtid_mode` system variable value is `OFF`, this column is `ANONYMOUS`, indicating that transactions do not have global transaction identifiers (GTIDs) and are identified by file and position only.

If `gtid_mode` is `ON`, the column value is defined as follows:

- If no transaction has executed, the column is empty.
- When a transaction has executed, the column is set from `gtid_next` as soon as `gtid_next` is set. From this moment, the column always shows a GTID.
- The GTID is preserved until the next transaction is executed. If an error occurs, the column value is the GTID of the transaction being executed by the worker when the error occurred. The following statement shows whether or not that transaction has been committed:

```
SELECT GTID_SUBSET(LAST_SEEN_TRANSACTION, @@GLOBAL.GTID_EXECUTED)
FROM performance_schema.replication_applier_status_by_worker;
```

If the statement returns zero, the transaction has not yet been committed, either because it is still being processed, or because the worker thread was stopped while it was being processed. If the statement returns nonzero, the transaction has been committed.

- `LAST_ERROR_NUMBER`, `LAST_ERROR_MESSAGE`

The error number and error message of the most recent error that caused the worker thread to stop. An error number of 0 and message of the empty string mean “no error”. If the `LAST_ERROR_MESSAGE` value is not empty, the error values also appear in the replica's error log.

Issuing `RESET MASTER` or `RESET SLAVE` resets the values shown in these columns.

All error codes and messages displayed in the `LAST_ERROR_NUMBER` and `LAST_ERROR_MESSAGE` columns correspond to error values listed in [Server Error Message Reference](#).

- `LAST_ERROR_TIMESTAMP`

A timestamp in `YYMMDD hh:mm:ss` format that shows when the most recent worker error occurred.

`TRUNCATE TABLE` is not permitted for the `replication_applier_status_by_worker` table.

The following table shows the correspondence between `replication_applier_status_by_worker` columns and `SHOW SLAVE STATUS` columns.

<code>replication_applier_status_by_worker</code> Column	<code>SHOW SLAVE STATUS</code> Column
<code>WORKER_ID</code>	None
<code>THREAD_ID</code>	None
<code>SERVICE_STATE</code>	None
<code>LAST_SEEN_TRANSACTION</code>	None
<code>LAST_ERROR_NUMBER</code>	<code>Last_SQL_Errno</code>
<code>LAST_ERROR_MESSAGE</code>	<code>Last_SQL_Error</code>
<code>LAST_ERROR_TIMESTAMP</code>	<code>Last_SQL_Error_Timestamp</code>

10.11.7 The replication_group_members Table

This table shows network and status information for replication group members. The network addresses shown are the addresses used to connect clients to the group, and should not be confused with the member's internal group communication address specified by `group_replication_local_address`.

The `replication_group_members` table has these columns:

- `CHANNEL_NAME`

Name of the Group Replication channel.

- `MEMBER_ID`

Identifier for this member; the same as the server UUID.

- `MEMBER_HOST`

Network address of this member (host name or IP address). Retrieved from the member's `hostname` variable.

- `MEMBER_PORT`

Port on which the server is listening. Retrieved from the member's `port` variable.

- `MEMBER_STATE`

Current state of this member; can be any one of the following:

- **OFFLINE**: The Group Replication plugin is installed but has not been started.
- **RECOVERING**: The server has joined a group from which it is retrieving data.
- **ONLINE**: The member is in a fully functioning state.
- **ERROR**: The member has encountered an error, either during applying transactions or during the recovery phase, and is not participating in the group's transactions.
- **UNREACHABLE**: The failure detection process suspects that this member cannot be contacted, because the group messages have timed out.

`TRUNCATE TABLE` is not permitted for the `replication_group_members` table.

10.11.8 The replication_group_member_stats Table

This table shows statistical information for MySQL Group Replication members. It is populated only when Group Replication is running.

The `replication_group_member_stats` table has these columns:

- **CHANNEL_NAME**
Name of the Group Replication channel.
- **VIEW_ID**
Current view identifier for this group.
- **MEMBER_ID**
The member server UUID. This has a different value for each member in the group. This also serves as a key because it is unique to each member.
- **COUNT_TRANSACTIONS_IN_QUEUE**
The number of transactions in the queue pending conflict detection checks. Once the transactions have been checked for conflicts, if they pass the check, they are queued to be applied as well.
- **COUNT_TRANSACTIONS_CHECKED**
The number of transactions that have been checked for conflicts.
- **COUNT_CONFLICTS_DETECTED**
The number of transactions that have not passed the conflict detection check.
- **COUNT_TRANSACTIONS_ROWS_VALIDATING**
Number of transaction rows which can be used for certification, but have not been garbage collected. Can be thought of as the current size of the conflict detection database against which each transaction is certified.
- **TRANSACTIONS_COMMITTED_ALL_MEMBERS**
The transactions that have been successfully committed on all members of the replication group, shown as **GTID Sets**. This is updated at a fixed time interval.

- [LAST_CONFLICT_FREE_TRANSACTION](#)

The transaction identifier of the last conflict free transaction which was checked.

`TRUNCATE TABLE` is not permitted for the `replication_group_member_stats` table.

10.12 Performance Schema Lock Tables

The Performance Schema exposes lock information through these tables:

- `metadata_locks`: Metadata locks held and requested
- `table_handles`: Table locks held and requested

The following sections describe these tables in more detail.

10.12.1 The `metadata_locks` Table

MySQL uses metadata locking to manage concurrent access to database objects and to ensure data consistency; see [Metadata Locking](#). Metadata locking applies not just to tables, but also to schemas, stored programs (procedures, functions, triggers, scheduled events), tablespaces, user locks acquired with the `GET_LOCK()` function (see [Locking Functions](#)), and locks acquired with the locking service described in [The Locking Service](#).

The Performance Schema exposes metadata lock information through the `metadata_locks` table:

- Locks that have been granted (shows which sessions own which current metadata locks).
- Locks that have been requested but not yet granted (shows which sessions are waiting for which metadata locks).
- Lock requests that have been killed by the deadlock detector.
- Lock requests that have timed out and are waiting for the requesting session's lock request to be discarded.

This information enables you to understand metadata lock dependencies between sessions. You can see not only which lock a session is waiting for, but which session currently holds that lock.

The `metadata_locks` table is read only and cannot be updated. It is autosized by default; to configure the table size, set the `performance_schema_max_metadata_locks` system variable at server startup.

Metadata lock instrumentation uses the `wait/lock/metadata/sql/mdl` instrument, which is disabled by default.

To control metadata lock instrumentation state at server startup, use lines like these in your `my.cnf` file:

- Enable:

```
[mysqld]
performance-schema-instrument='wait/lock/metadata/sql/mdl=ON'
```

- Disable:

```
[mysqld]
performance-schema-instrument='wait/lock/metadata/sql/mdl=OFF'
```

To control metadata lock instrumentation state at runtime, update the `setup_instruments` table:

- Enable:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'YES', TIMED = 'YES'
WHERE NAME = 'wait/lock/metadata/sql/mdl';
```

- Disable:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'NO', TIMED = 'NO'
WHERE NAME = 'wait/lock/metadata/sql/mdl';
```

The Performance Schema maintains `metadata_locks` table content as follows, using the `LOCK_STATUS` column to indicate the status of each lock:

- When a metadata lock is requested and obtained immediately, a row with a status of `GRANTED` is inserted.
- When a metadata lock is requested and not obtained immediately, a row with a status of `PENDING` is inserted.
- When a metadata lock previously requested is granted, its row status is updated to `GRANTED`.
- When a metadata lock is released, its row is deleted.
- When a pending lock request is canceled by the deadlock detector to break a deadlock (`ER_LOCK_DEADLOCK`), its row status is updated from `PENDING` to `VICTIM`.
- When a pending lock request times out (`ER_LOCK_WAIT_TIMEOUT`), its row status is updated from `PENDING` to `TIMEOUT`.
- When granted lock or pending lock request is killed, its row status is updated from `GRANTED` or `PENDING` to `KILLED`.
- The `VICTIM`, `TIMEOUT`, and `KILLED` status values are brief and signify that the lock row is about to be deleted.
- The `PRE_ACQUIRE_NOTIFY` and `POST_RELEASE_NOTIFY` status values are brief and signify that the metadata locking subsystem is notifying interested storage engines while entering lock acquisition operations or leaving lock release operations. These status values were added in MySQL 5.7.11.

The `metadata_locks` table has these columns:

- `OBJECT_TYPE`

The type of lock used in the metadata lock subsystem. The value is one of `GLOBAL`, `SCHEMA`, `TABLE`, `FUNCTION`, `PROCEDURE`, `TRIGGER` (currently unused), `EVENT`, `COMMIT`, `USER LEVEL LOCK`, `TABLESPACE`, or `LOCKING SERVICE`.

A value of `USER LEVEL LOCK` indicates a lock acquired with `GET_LOCK()`. A value of `LOCKING SERVICE` indicates a lock acquired with the locking service described in [The Locking Service](#).

- `OBJECT_SCHEMA`

The schema that contains the object.

- `OBJECT_NAME`

The name of the instrumented object.

- [OBJECT_INSTANCE_BEGIN](#)

The address in memory of the instrumented object.

- [LOCK_TYPE](#)

The lock type from the metadata lock subsystem. The value is one of [INTENTION_EXCLUSIVE](#), [SHARED](#), [SHARED_HIGH_PRIO](#), [SHARED_READ](#), [SHARED_WRITE](#), [SHARED_UPGRADABLE](#), [SHARED_NO_WRITE](#), [SHARED_NO_READ_WRITE](#), or [EXCLUSIVE](#).

- [LOCK_DURATION](#)

The lock duration from the metadata lock subsystem. The value is one of [STATEMENT](#), [TRANSACTION](#), or [EXPLICIT](#). The [STATEMENT](#) and [TRANSACTION](#) values signify locks that are released implicitly at statement or transaction end, respectively. The [EXPLICIT](#) value signifies locks that survive statement or transaction end and are released by explicit action, such as global locks acquired with [FLUSH TABLES WITH READ LOCK](#).

- [LOCK_STATUS](#)

The lock status from the metadata lock subsystem. The value is one of [PENDING](#), [GRANTED](#), [VICTIM](#), [TIMEOUT](#), [KILLED](#), [PRE_ACQUIRE_NOTIFY](#), or [POST_RELEASE_NOTIFY](#). The Performance Schema assigns these values as described previously.

- [SOURCE](#)

The name of the source file containing the instrumented code that produced the event and the line number in the file at which the instrumentation occurs. This enables you to check the source to determine exactly what code is involved.

- [OWNER_THREAD_ID](#)

The thread requesting a metadata lock.

- [OWNER_EVENT_ID](#)

The event requesting a metadata lock.

[TRUNCATE TABLE](#) is not permitted for the [metadata_locks](#) table.

10.12.2 The table_handles Table

The Performance Schema exposes table lock information through the [table_handles](#) table to show the table locks currently in effect for each opened table handle. [table_handles](#) reports what is recorded by the table lock instrumentation. This information shows which table handles the server has open, how they are locked, and by which sessions.

The [table_handles](#) table is read only and cannot be updated. It is autosized by default; to configure the table size, set the [performance_schema_max_table_handles](#) system variable at server startup.

Table lock instrumentation uses the [wait/lock/table/sql/handler](#) instrument, which is enabled by default.

To control table lock instrumentation state at server startup, use lines like these in your [my.cnf](#) file:

- Enable:

```
[mysqld]
performance-schema-instrument='wait/lock/table/sql/handler=ON'
```

- Disable:

```
[mysqld]
performance-schema-instrument='wait/lock/table/sql/handler=OFF'
```

To control table lock instrumentation state at runtime, update the `setup_instruments` table:

- Enable:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'YES', TIMED = 'YES'
WHERE NAME = 'wait/lock/table/sql/handler';
```

- Disable:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'NO', TIMED = 'NO'
WHERE NAME = 'wait/lock/table/sql/handler';
```

The `table_handles` table has these columns:

- `OBJECT_TYPE`

The table opened by a table handle.

- `OBJECT_SCHEMA`

The schema that contains the object.

- `OBJECT_NAME`

The name of the instrumented object.

- `OBJECT_INSTANCE_BEGIN`

The table handle address in memory.

- `OWNER_THREAD_ID`

The thread owning the table handle.

- `OWNER_EVENT_ID`

The event which caused the table handle to be opened.

- `INTERNAL_LOCK`

The table lock used at the SQL level. The value is one of `READ`, `READ WITH SHARED LOCKS`, `READ HIGH PRIORITY`, `READ NO INSERT`, `WRITE ALLOW WRITE`, `WRITE CONCURRENT INSERT`, `WRITE LOW PRIORITY`, or `WRITE`. For information about these lock types, see the `include/thr_lock.h` source file.

- `EXTERNAL_LOCK`

The table lock used at the storage engine level. The value is one of `READ EXTERNAL` or `WRITE EXTERNAL`.

`TRUNCATE TABLE` is not permitted for the `table_handles` table.

10.13 Performance Schema System Variable Tables

Note

The value of the `show_compatibility_56` system variable affects the information available from the tables described here. For details, see the description of that variable in [Server System Variables](#).

The MySQL server maintains many system variables that indicate how it is configured (see [Server System Variables](#)). System variable information is available in these Performance Schema tables:

- `global_variables`: Global system variables. An application that wants only global values should use this table.
- `session_variables`: System variables for the current session. An application that wants all system variable values for its own session should use this table. It includes the session variables for its session, as well as the values of global variables that have no session counterpart.
- `variables_by_thread`: Session system variables for each active session. An application that wants to know the session variable values for specific sessions should use this table. It includes session variables only, identified by thread ID.

The session variable tables (`session_variables`, `variables_by_thread`) contain information only for active sessions, not terminated sessions.

The `global_variables` and `session_variables` tables have these columns:

- `VARIABLE_NAME`

The system variable name.

- `VARIABLE_VALUE`

The system variable value. For `global_variables`, this column contains the global value. For `session_variables`, this column contains the variable value in effect for the current session.

The `variables_by_thread` table has these columns:

- `THREAD_ID`

The thread identifier of the session in which the system variable is defined.

- `VARIABLE_NAME`

The system variable name.

- `VARIABLE_VALUE`

The session variable value for the session named by the `THREAD_ID` column.

The `variables_by_thread` table contains system variable information only about foreground threads. If not all threads are instrumented by the Performance Schema, this table may miss some rows. In this case, the `Performance_schema_thread_instances_lost` status variable is greater than zero.

`TRUNCATE TABLE` is not supported for Performance Schema system variable tables.

10.14 Performance Schema Status Variable Tables

Note

The value of the `show_compatibility_56` system variable affects the information available from the tables described here. For details, see the description of that variable in [Server System Variables](#).

The MySQL server maintains many status variables that provide information about its operation (see [Server Status Variables](#)). Status variable information is available in these Performance Schema tables:

- `global_status`: Global status variables. An application that wants only global values should use this table.
- `session_status`: Status variables for the current session. An application that wants all status variable values for its own session should use this table. It includes the session variables for its session, as well as the values of global variables that have no session counterpart.
- `status_by_thread`: Session status variables for each active session. An application that wants to know the session variable values for specific sessions should use this table. It includes session variables only, identified by thread ID.

There are also summary tables that provide status variable information aggregated by account, host name, and user name. See [Section 10.15.10, “Status Variable Summary Tables”](#).

The session variable tables (`session_status`, `status_by_thread`) contain information only for active sessions, not terminated sessions.

The Performance Schema collects statistics for global status variables only for threads for which the `INSTRUMENTED` value is `YES` in the `threads` table. Statistics for session status variables are always collected, regardless of the `INSTRUMENTED` value.

The Performance Schema does not collect statistics for `Com_xxx` status variables in the status variable tables. To obtain global and per-session statement execution counts, use the `events_statements_summary_global_by_event_name` and `events_statements_summary_by_thread_by_event_name` tables, respectively. For example:

```
SELECT EVENT_NAME, COUNT_STAR
FROM performance_schema.events_statements_summary_global_by_event_name
WHERE EVENT_NAME LIKE 'statement/sql/%';
```

The `global_status` and `session_status` tables have these columns:

- `VARIABLE_NAME`

The status variable name.

- `VARIABLE_VALUE`

The status variable value. For `global_status`, this column contains the global value. For `session_status`, this column contains the variable value for the current session.

The `status_by_thread` table contains the status of each active thread. It has these columns:

- `THREAD_ID`

The thread identifier of the session in which the status variable is defined.

- `VARIABLE_NAME`

The status variable name.

- `VARIABLE_VALUE`

The session variable value for the session named by the `THREAD_ID` column.

The `status_by_thread` table contains status variable information only about foreground threads. If the `performance_schema_max_thread_instances` system variable is not autoscaled (signified by a value of `-1`) and the maximum permitted number of instrumented thread objects is not greater than the number of background threads, the table is empty.

The Performance Schema supports `TRUNCATE TABLE` for status variable tables as follows:

- `global_status`: Resets thread, account, host, and user status. Resets global status variables except those that the server never resets.
- `session_status`: Not supported.
- `status_by_thread`: Aggregates status for all threads to the global status and account status, then resets thread status. If account statistics are not collected, the session status is added to host and user status, if host and user status are collected.

Account, host, and user statistics are not collected if the `performance_schema_accounts_size`, `performance_schema_hosts_size`, and `performance_schema_users_size` system variables, respectively, are set to 0.

`FLUSH STATUS` adds the session status from all active sessions to the global status variables, resets the status of all active sessions, and resets account, host, and user status values aggregated from disconnected sessions.

10.15 Performance Schema Summary Tables

Summary tables provide aggregated information for terminated events over time. The tables in this group summarize event data in different ways.

Each summary table has grouping columns that determine how to group the data to be aggregated, and summary columns that contain the aggregated values. Tables that summarize events in similar ways often have similar sets of summary columns and differ only in the grouping columns used to determine how events are aggregated.

Summary tables can be truncated with `TRUNCATE TABLE`. Generally, the effect is to reset the summary columns to 0 or `NULL`, not to remove rows. This enables you to clear collected values and restart aggregation. That might be useful, for example, after you have made a runtime configuration change. Exceptions to this truncation behavior are noted in individual summary table sections.

Wait Event Summaries

Table 10.3 Performance Schema Wait Event Summary Tables

Table Name	Description
<code>events_waits_summary_by_account_by_event_name</code>	Wait events per account and event name
<code>events_waits_summary_by_host_by_event_name</code>	Wait events per host name and event name
<code>events_waits_summary_by_instance</code>	Wait events per instance

Table Name	Description
events_waits_summary_by_thread_by_event_name	Wait events per thread and event name
events_waits_summary_by_user_by_event_name	Wait events per user name and event name
events_waits_summary_global_by_event_name	Wait events per event name

Stage Summaries

Table 10.4 Performance Schema Stage Event Summary Tables

Table Name	Description
events_stages_summary_by_account_by_event_name	Stage events per account and event name
events_stages_summary_by_host_by_event_name	Stage events per host name and event name
events_stages_summary_by_thread_by_event_name	Stage waits per thread and event name
events_stages_summary_by_user_by_event_name	Stage events per user name and event name
events_stages_summary_global_by_event_name	Stage waits per event name

Statement Summaries

Table 10.5 Performance Schema Statement Event Summary Tables

Table Name	Description
events_statements_summary_by_account_by_event_name	Statement events per account and event name
events_statements_summary_by_digest	Statement events per schema and digest value
events_statements_summary_by_host_by_event_name	Statement events per host name and event name
events_statements_summary_by_program	Statement events per stored program
events_statements_summary_by_thread_by_event_name	Statement events per thread and event name
events_statements_summary_by_user_by_event_name	Statement events per user name and event name
events_statements_summary_global_by_event_name	Statement events per event name
prepared_statements_instances	Prepared statement instances and statistics

Transaction Summaries

Table 10.6 Performance Schema Transaction Event Summary Tables

Table Name	Description
events_transactions_summary_by_account_by_event_name	Transaction events per account and event name
events_transactions_summary_by_host_by_event_name	Transaction events per host name and event name
events_transactions_summary_by_thread_by_event_name	Transaction events per thread and event name
events_transactions_summary_by_user_by_event_name	Transaction events per user name and event name
events_transactions_summary_global_by_event_name	Transaction events per event name

Object Wait Summaries

Table 10.7 Performance Schema Object Event Summary Tables

Table Name	Description
objects_summary_global_by_type	Object summaries

File I/O Summaries

Table 10.8 Performance Schema File I/O Event Summary Tables

Table Name	Description
<code>file_summary_by_event_name</code>	File events per event name
<code>file_summary_by_instance</code>	File events per file instance

Table I/O and Lock Wait Summaries

Table 10.9 Performance Schema Table I/O and Lock Wait Event Summary Tables

Table Name	Description
<code>table_io_waits_summary_by_index_usage</code>	Table I/O waits per index
<code>table_io_waits_summary_by_table</code>	Table I/O waits per table
<code>table_lock_waits_summary_by_table</code>	Table lock waits per table

Socket Summaries

Table 10.10 Performance Schema Socket Event Summary Tables

Table Name	Description
<code>socket_summary_by_event_name</code>	Socket waits and I/O per event name
<code>socket_summary_by_instance</code>	Socket waits and I/O per instance

Memory Summaries

Table 10.11 Performance Schema Memory Operation Summary Tables

Table Name	Description
<code>memory_summary_by_account_by_event_name</code>	Memory operations per account and event name
<code>memory_summary_by_host_by_event_name</code>	Memory operations per host and event name
<code>memory_summary_by_thread_by_event_name</code>	Memory operations per thread and event name
<code>memory_summary_by_user_by_event_name</code>	Memory operations per user and event name
<code>memory_summary_global_by_event_name</code>	Memory operations globally per event name

Status Variable Summaries

Table 10.12 Performance Schema Error Status Variable Summary Tables

Table Name	Description
<code>status_by_account</code>	Session status variables per account
<code>status_by_host</code>	Session status variables per host name
<code>status_by_user</code>	Session status variables per user name

10.15.1 Wait Event Summary Tables

The Performance Schema maintains tables for collecting current and recent wait events, and aggregates that information in summary tables. [Section 10.4, “Performance Schema Wait Event Tables”](#) describes the events on which wait summaries are based. See that discussion for information about the content of wait events, the current and recent wait event tables, and how to control wait event collection, which is disabled by default.

Example wait event summary information:

```
mysql> SELECT *
      FROM performance_schema.events_waits_summary_global_by_event_name\G
...
***** 6. row *****
EVENT_NAME: wait/synch/mutex/sql/BINARY_LOG::LOCK_index
COUNT_STAR: 8
SUM_TIMER_WAIT: 2119302
MIN_TIMER_WAIT: 196092
AVG_TIMER_WAIT: 264912
MAX_TIMER_WAIT: 569421
...
***** 9. row *****
EVENT_NAME: wait/synch/mutex/sql/hash_filo::lock
COUNT_STAR: 69
SUM_TIMER_WAIT: 16848828
MIN_TIMER_WAIT: 0
AVG_TIMER_WAIT: 244185
MAX_TIMER_WAIT: 735345
...
```

Each wait event summary table has one or more grouping columns to indicate how the table aggregates events. Event names refer to names of event instruments in the [setup_instruments](#) table:

- [events_waits_summary_by_account_by_event_name](#) has [EVENT_NAME](#), [USER](#), and [HOST](#) columns. Each row summarizes events for a given account (user and host combination) and event name.
- [events_waits_summary_by_host_by_event_name](#) has [EVENT_NAME](#) and [HOST](#) columns. Each row summarizes events for a given host and event name.
- [events_waits_summary_by_instance](#) has [EVENT_NAME](#) and [OBJECT_INSTANCE_BEGIN](#) columns. Each row summarizes events for a given event name and object. If an instrument is used to create multiple instances, each instance has a unique [OBJECT_INSTANCE_BEGIN](#) value and is summarized separately in this table.
- [events_waits_summary_by_thread_by_event_name](#) has [THREAD_ID](#) and [EVENT_NAME](#) columns. Each row summarizes events for a given thread and event name.
- [events_waits_summary_by_user_by_event_name](#) has [EVENT_NAME](#) and [USER](#) columns. Each row summarizes events for a given user and event name.
- [events_waits_summary_global_by_event_name](#) has an [EVENT_NAME](#) column. Each row summarizes events for a given event name. An instrument might be used to create multiple instances of the instrumented object. For example, if there is an instrument for a mutex that is created for each connection, there are as many instances as there are connections. The summary row for the instrument summarizes over all these instances.

Each wait event summary table has these summary columns containing aggregated values:

- [COUNT_STAR](#)

The number of summarized events. This value includes all events, whether timed or nontimed.

- [SUM_TIMER_WAIT](#)

The total wait time of the summarized timed events. This value is calculated only for timed events because nontimed events have a wait time of `NULL`. The same is true for the other `xxx_TIMER_WAIT` values.

- [MIN_TIMER_WAIT](#)

The minimum wait time of the summarized timed events.

- [AVG_TIMER_WAIT](#)

The average wait time of the summarized timed events.

- [MAX_TIMER_WAIT](#)

The maximum wait time of the summarized timed events.

`TRUNCATE TABLE` is permitted for wait summary tables. It has these effects:

- For summary tables not aggregated by account, host, or user, truncation resets the summary columns to zero rather than removing rows.
- For summary tables aggregated by account, host, or user, truncation removes rows for accounts, hosts, or users with no connections, and resets the summary columns to zero for the remaining rows.

In addition, each wait summary table that is aggregated by account, host, user, or thread is implicitly truncated by truncation of the connection table on which it depends, or truncation of `events_waits_summary_global_by_event_name`. For details, see [Section 10.8, “Performance Schema Connection Tables”](#).

10.15.2 Stage Summary Tables

The Performance Schema maintains tables for collecting current and recent stage events, and aggregates that information in summary tables. [Section 10.5, “Performance Schema Stage Event Tables”](#) describes the events on which stage summaries are based. See that discussion for information about the content of stage events, the current and historical stage event tables, and how to control stage event collection, which is disabled by default.

Example stage event summary information:

```
mysql> SELECT *
      FROM performance_schema.events_stages_summary_global_by_event_name\G
...
***** 5. row *****
EVENT_NAME: stage/sql/checking permissions
COUNT_STAR: 57
SUM_TIMER_WAIT: 26501888880
MIN_TIMER_WAIT: 7317456
AVG_TIMER_WAIT: 464945295
MAX_TIMER_WAIT: 12858936792
...
***** 9. row *****
EVENT_NAME: stage/sql/closing tables
COUNT_STAR: 37
SUM_TIMER_WAIT: 662606568
MIN_TIMER_WAIT: 1593864
AVG_TIMER_WAIT: 17907891
MAX_TIMER_WAIT: 437977248
...
```

Each stage summary table has one or more grouping columns to indicate how the table aggregates events. Event names refer to names of event instruments in the `setup_instruments` table:

- `events_stages_summary_by_account_by_event_name` has `EVENT_NAME`, `USER`, and `HOST` columns. Each row summarizes events for a given account (user and host combination) and event name.
- `events_stages_summary_by_host_by_event_name` has `EVENT_NAME` and `HOST` columns. Each row summarizes events for a given host and event name.
- `events_stages_summary_by_thread_by_event_name` has `THREAD_ID` and `EVENT_NAME` columns. Each row summarizes events for a given thread and event name.
- `events_stages_summary_by_user_by_event_name` has `EVENT_NAME` and `USER` columns. Each row summarizes events for a given user and event name.
- `events_stages_summary_global_by_event_name` has an `EVENT_NAME` column. Each row summarizes events for a given event name.

Each stage summary table has these summary columns containing aggregated values: `COUNT_STAR`, `SUM_TIMER_WAIT`, `MIN_TIMER_WAIT`, `AVG_TIMER_WAIT`, and `MAX_TIMER_WAIT`. These columns are analogous to the columns of the same names in the wait event summary tables (see [Section 10.15.1, “Wait Event Summary Tables”](#)), except that the stage summary tables aggregate events from `events_stages_current` rather than `events_waits_current`.

`TRUNCATE TABLE` is permitted for stage summary tables. It has these effects:

- For summary tables not aggregated by account, host, or user, truncation resets the summary columns to zero rather than removing rows.
- For summary tables aggregated by account, host, or user, truncation removes rows for accounts, hosts, or users with no connections, and resets the summary columns to zero for the remaining rows.

In addition, each stage summary table that is aggregated by account, host, user, or thread is implicitly truncated by truncation of the connection table on which it depends, or truncation of `events_stages_summary_global_by_event_name`. For details, see [Section 10.8, “Performance Schema Connection Tables”](#).

10.15.3 Statement Summary Tables

The Performance Schema maintains tables for collecting current and recent statement events, and aggregates that information in summary tables. [Section 10.6, “Performance Schema Statement Event Tables”](#) describes the events on which statement summaries are based. See that discussion for information about the content of statement events, the current and historical statement event tables, and how to control statement event collection, which is partially disabled by default.

Example statement event summary information:

```
mysql> SELECT *
      FROM performance_schema.events_statements_summary_global_by_event_name\G
***** 1. row *****
      EVENT_NAME: statement/sql/select
      COUNT_STAR: 25
      SUM_TIMER_WAIT: 1535983999000
      MIN_TIMER_WAIT: 209823000
      AVG_TIMER_WAIT: 61439359000
      MAX_TIMER_WAIT: 1363397650000
      SUM_LOCK_TIME: 20186000000
      SUM_ERRORS: 0
```

```

SUM_WARNINGS: 0
SUM_ROWS_AFFECTED: 0
SUM_ROWS_SENT: 388
SUM_ROWS_EXAMINED: 370
SUM_CREATED_TMP_DISK_TABLES: 0
SUM_CREATED_TMP_TABLES: 0
SUM_SELECT_FULL_JOIN: 0
SUM_SELECT_FULL_RANGE_JOIN: 0
SUM_SELECT_RANGE: 0
SUM_SELECT_RANGE_CHECK: 0
SUM_SELECT_SCAN: 6
SUM_SORT_MERGE_PASSES: 0
SUM_SORT_RANGE: 0
SUM_SORT_ROWS: 0
SUM_SORT_SCAN: 0
SUM_NO_INDEX_USED: 6
SUM_NO_GOOD_INDEX_USED: 0
...

```

Each statement summary table has one or more grouping columns to indicate how the table aggregates events. Event names refer to names of event instruments in the `setup_instruments` table:

- `events_statements_summary_by_account_by_event_name` has `EVENT_NAME`, `USER`, and `HOST` columns. Each row summarizes events for a given account (user and host combination) and event name.
- `events_statements_summary_by_digest` has `SCHEMA_NAME` and `DIGEST` columns. Each row summarizes events per schema and digest value. (The `DIGEST_TEXT` column contains the corresponding normalized statement digest text, but is neither a grouping nor a summary column.)

The maximum number of rows in the table is autosized at server startup. To set this maximum explicitly, set the `performance_schema_digests_size` system variable at server startup.

- `events_statements_summary_by_host_by_event_name` has `EVENT_NAME` and `HOST` columns. Each row summarizes events for a given host and event name.
- `events_statements_summary_by_program` has `OBJECT_TYPE`, `OBJECT_SCHEMA`, and `OBJECT_NAME` columns. Each row summarizes events for a given stored program (stored procedure or function, trigger, or event).
- `events_statements_summary_by_thread_by_event_name` has `THREAD_ID` and `EVENT_NAME` columns. Each row summarizes events for a given thread and event name.
- `events_statements_summary_by_user_by_event_name` has `EVENT_NAME` and `USER` columns. Each row summarizes events for a given user and event name.
- `events_statements_summary_global_by_event_name` has an `EVENT_NAME` column. Each row summarizes events for a given event name.
- `prepared_statements_instances` has an `OBJECT_INSTANCE_BEGIN` column. Each row summarizes events for a given prepared statement.

Each statement summary table has these summary columns containing aggregated values (with exceptions as noted):

- `COUNT_STAR`, `SUM_TIMER_WAIT`, `MIN_TIMER_WAIT`, `AVG_TIMER_WAIT`, `MAX_TIMER_WAIT`

These columns are analogous to the columns of the same names in the wait event summary tables (see [Section 10.15.1, “Wait Event Summary Tables”](#)), except that the statement summary tables aggregate events from `events_statements_current` rather than `events_waits_current`.

The `prepared_statements_instances` table does not have these columns.

- `SUM_xxx`

The aggregate of the corresponding `xxx` column in the `events_statements_current` table. For example, the `SUM_LOCK_TIME` and `SUM_ERRORS` columns in statement summary tables are the aggregates of the `LOCK_TIME` and `ERRORS` columns in `events_statements_current` table.

The `events_statements_summary_by_digest` table has these additional summary columns:

- `FIRST_SEEN`, `LAST_SEEN`

Timestamps indicating when statements with the given digest value were first seen and most recently seen.

The `events_statements_summary_by_program` table has these additional summary columns:

- `COUNT_STATEMENTS`, `SUM_STATEMENTS_WAIT`, `MIN_STATEMENTS_WAIT`, `AVG_STATEMENTS_WAIT`, `MAX_STATEMENTS_WAIT`

Statistics about nested statements invoked during stored program execution.

The `prepared_statements_instances` table has these additional summary columns:

- `COUNT_EXECUTE`, `SUM_TIMER_EXECUTE`, `MIN_TIMER_EXECUTE`, `AVG_TIMER_EXECUTE`, `MAX_TIMER_EXECUTE`

Aggregated statistics for executions of the prepared statement.

`TRUNCATE TABLE` is permitted for statement summary tables. It has these effects:

- For `events_statements_summary_by_digest`, it removes the rows.
- For other summary tables not aggregated by account, host, or user, truncation resets the summary columns to zero rather than removing rows.
- For other summary tables aggregated by account, host, or user, truncation removes rows for accounts, hosts, or users with no connections, and resets the summary columns to zero for the remaining rows.

In addition, each statement summary table that is aggregated by account, host, user, or thread is implicitly truncated by truncation of the connection table on which it depends, or truncation of `events_statements_summary_global_by_event_name`. For details, see [Section 10.8, “Performance Schema Connection Tables”](#).

Statement Digest Aggregation Rules

If the `statements_digest` consumer is enabled, aggregation into `events_statements_summary_by_digest` occurs as follows when a statement completes. Aggregation is based on the `DIGEST` value computed for the statement.

- If a `events_statements_summary_by_digest` row already exists with the digest value for the statement that just completed, statistics for the statement are aggregated to that row. The `LAST_SEEN` column is updated to the current time.
- If no row has the digest value for the statement that just completed, and the table is not full, a new row is created for the statement. The `FIRST_SEEN` and `LAST_SEEN` columns are initialized with the current time.

- If no row has the statement digest value for the statement that just completed, and the table is full, the statistics for the statement that just completed are added to a special “catch-all” row with `DIGEST = NULL`, which is created if necessary. If the row is created, the `FIRST_SEEN` and `LAST_SEEN` columns are initialized with the current time. Otherwise, the `LAST_SEEN` column is updated with the current time.

The row with `DIGEST = NULL` is maintained because Performance Schema tables have a maximum size due to memory constraints. The `DIGEST = NULL` row permits digests that do not match other rows to be counted even if the summary table is full, using a common “other” bucket. This row helps you estimate whether the digest summary is representative:

- A `DIGEST = NULL` row that has a `COUNT_STAR` value that represents 5% of all digests shows that the digest summary table is very representative; the other rows cover 95% of the statements seen.
- A `DIGEST = NULL` row that has a `COUNT_STAR` value that represents 50% of all digests shows that the digest summary table is not very representative; the other rows cover only half the statements seen. Most likely the DBA should increase the maximum table size so that more of the rows counted in the `DIGEST = NULL` row would be counted using more specific rows instead. By default, the table is autosized, but if this size is too small, set the `performance_schema_digests_size` system variable to a larger value at server startup.

Stored Program Instrumentation Behavior

For stored program types for which instrumentation is enabled in the `setup_objects` table, `events_statements_summary_by_program` maintains statistics for stored programs as follows:

- A row is added for an object when it is first used in the server.
- The row for an object is removed when the object is dropped.
- Statistics are aggregated in the row for an object as it executes.

See also [Section 5.3, “Event Pre-Filtering”](#).

10.15.4 Transaction Summary Tables

The Performance Schema maintains tables for collecting current and recent transaction events, and aggregates that information in summary tables. [Section 10.7, “Performance Schema Transaction Tables”](#) describes the events on which transaction summaries are based. See that discussion for information about the content of transaction events, the current and historical transaction event tables, and how to control transaction event collection, which is disabled by default.

Example transaction event summary information:

```
mysql> SELECT *
      FROM performance_schema.events_transactions_summary_global_by_event_name
      LIMIT 1\G
***** 1. row *****
      EVENT_NAME: transaction
      COUNT_STAR: 5
      SUM_TIMER_WAIT: 19550092000
      MIN_TIMER_WAIT: 2954148000
      AVG_TIMER_WAIT: 3910018000
      MAX_TIMER_WAIT: 5486275000
      COUNT_READ_WRITE: 5
      SUM_TIMER_READ_WRITE: 19550092000
      MIN_TIMER_READ_WRITE: 2954148000
      AVG_TIMER_READ_WRITE: 3910018000
      MAX_TIMER_READ_WRITE: 5486275000
      COUNT_READ_ONLY: 0
      SUM_TIMER_READ_ONLY: 0
```



```
MIN_TIMER_READ_ONLY: 0
AVG_TIMER_READ_ONLY: 0
MAX_TIMER_READ_ONLY: 0
```

Each transaction summary table has one or more grouping columns to indicate how the table aggregates events. Event names refer to names of event instruments in the `setup_instruments` table:

- `events_transactions_summary_by_account_by_event_name` has `USER`, `HOST`, and `EVENT_NAME` columns. Each row summarizes events for a given account (user and host combination) and event name.
- `events_transactions_summary_by_host_by_event_name` has `HOST` and `EVENT_NAME` columns. Each row summarizes events for a given host and event name.
- `events_transactions_summary_by_thread_by_event_name` has `THREAD_ID` and `EVENT_NAME` columns. Each row summarizes events for a given thread and event name.
- `events_transactions_summary_by_user_by_event_name` has `USER` and `EVENT_NAME` columns. Each row summarizes events for a given user and event name.
- `events_transactions_summary_global_by_event_name` has an `EVENT_NAME` column. Each row summarizes events for a given event name.

Each transaction summary table has these summary columns containing aggregated values:

- `COUNT_STAR`, `SUM_TIMER_WAIT`, `MIN_TIMER_WAIT`, `AVG_TIMER_WAIT`, `MAX_TIMER_WAIT`

These columns are analogous to the columns of the same names in the wait event summary tables (see [Section 10.15.1, “Wait Event Summary Tables”](#)), except that the transaction summary tables aggregate events from `events_transactions_current` rather than `events_waits_current`. These columns summarize read-write and read-only transactions.

- `COUNT_READ_WRITE`, `SUM_TIMER_READ_WRITE`, `MIN_TIMER_READ_WRITE`, `AVG_TIMER_READ_WRITE`, `MAX_TIMER_READ_WRITE`

These are similar to the `COUNT_STAR` and `xxx_TIMER_WAIT` columns, but summarize read-write transactions only. The transaction access mode specifies whether transactions operate in read/write or read-only mode.

- `COUNT_READ_ONLY`, `SUM_TIMER_READ_ONLY`, `MIN_TIMER_READ_ONLY`, `AVG_TIMER_READ_ONLY`, `MAX_TIMER_READ_ONLY`

These are similar to the `COUNT_STAR` and `xxx_TIMER_WAIT` columns, but summarize read-only transactions only. The transaction access mode specifies whether transactions operate in read/write or read-only mode.

`TRUNCATE TABLE` is permitted for transaction summary tables. It has these effects:

- For summary tables not aggregated by account, host, or user, truncation resets the summary columns to zero rather than removing rows.
- For summary tables aggregated by account, host, or user, truncation removes rows for accounts, hosts, or users with no connections, and resets the summary columns to zero for the remaining rows.

In addition, each transaction summary table that is aggregated by account, host, user, or thread is implicitly truncated by truncation of the connection table on which it depends, or truncation of `events_transactions_summary_global_by_event_name`. For details, see [Section 10.8, “Performance Schema Connection Tables”](#).

Transaction Aggregation Rules

Transaction event collection occurs without regard to isolation level, access mode, or autocommit mode.

Transaction event collection occurs for all non-aborted transactions initiated by the server, including empty transactions.

Read-write transactions are generally more resource intensive than read-only transactions, therefore transaction summary tables include separate aggregate columns for read-write and read-only transactions.

Resource requirements may also vary with transaction isolation level. However, presuming that only one isolation level would be used per server, aggregation by isolation level is not provided.

10.15.5 Object Wait Summary Table

The Performance Schema maintains the `objects_summary_global_by_type` table for aggregating object wait events.

Example object wait event summary information:

```
mysql> SELECT * FROM performance_schema.objects_summary_global_by_type\G
...
***** 3. row *****
  OBJECT_TYPE: TABLE
  OBJECT_SCHEMA: test
  OBJECT_NAME: t
  COUNT_STAR: 3
SUM_TIMER_WAIT: 263126976
MIN_TIMER_WAIT: 1522272
AVG_TIMER_WAIT: 87708678
MAX_TIMER_WAIT: 258428280
...
***** 10. row *****
  OBJECT_TYPE: TABLE
  OBJECT_SCHEMA: mysql
  OBJECT_NAME: user
  COUNT_STAR: 14
SUM_TIMER_WAIT: 365567592
MIN_TIMER_WAIT: 1141704
AVG_TIMER_WAIT: 26111769
MAX_TIMER_WAIT: 334783032
...
```

The `objects_summary_global_by_type` table has these grouping columns to indicate how the table aggregates events: `OBJECT_TYPE`, `OBJECT_SCHEMA`, and `OBJECT_NAME`. Each row summarizes events for the given object.

`objects_summary_global_by_type` has the same summary columns as the `events_waits_summary_by_XXX` tables. See [Section 10.15.1, “Wait Event Summary Tables”](#).

`TRUNCATE TABLE` is permitted for the object summary table. It resets the summary columns to zero rather than removing rows.

10.15.6 File I/O Summary Tables

The Performance Schema maintains file I/O summary tables that aggregate information about I/O operations.

Example file I/O event summary information:

```

mysql> SELECT * FROM performance_schema.file_summary_by_event_name\G
...
***** 2. row *****
      EVENT_NAME: wait/io/file/sql/binlog
      COUNT_STAR: 31
      SUM_TIMER_WAIT: 8243784888
      MIN_TIMER_WAIT: 0
      AVG_TIMER_WAIT: 265928484
      MAX_TIMER_WAIT: 6490658832
...
mysql> SELECT * FROM performance_schema.file_summary_by_instance\G
...
***** 2. row *****
      FILE_NAME: /var/mysql/share/english/errmsg.sys
      EVENT_NAME: wait/io/file/sql/ERRMSG
      EVENT_NAME: wait/io/file/sql/ERRMSG
      OBJECT_INSTANCE_BEGIN: 4686193384
      COUNT_STAR: 5
      SUM_TIMER_WAIT: 13990154448
      MIN_TIMER_WAIT: 26349624
      AVG_TIMER_WAIT: 2798030607
      MAX_TIMER_WAIT: 8150662536
...

```

Each file I/O summary table has one or more grouping columns to indicate how the table aggregates events. Event names refer to names of event instruments in the `setup_instruments` table:

- `file_summary_by_event_name` has an `EVENT_NAME` column. Each row summarizes events for a given event name.
- `file_summary_by_instance` has `FILE_NAME`, `EVENT_NAME`, and `OBJECT_INSTANCE_BEGIN` columns. Each row summarizes events for a given file and event name.

Each file I/O summary table has the following summary columns containing aggregated values. Some columns are more general and have values that are the same as the sum of the values of more fine-grained columns. In this way, aggregations at higher levels are available directly without the need for user-defined views that sum lower-level columns.

- `COUNT_STAR`, `SUM_TIMER_WAIT`, `MIN_TIMER_WAIT`, `AVG_TIMER_WAIT`, `MAX_TIMER_WAIT`

These columns aggregate all I/O operations.

- `COUNT_READ`, `SUM_TIMER_READ`, `MIN_TIMER_READ`, `AVG_TIMER_READ`, `MAX_TIMER_READ`, `SUM_NUMBER_OF_BYTES_READ`

These columns aggregate all read operations, including `FGETS`, `FGETC`, `FREAD`, and `READ`.

- `COUNT_WRITE`, `SUM_TIMER_WRITE`, `MIN_TIMER_WRITE`, `AVG_TIMER_WRITE`, `MAX_TIMER_WRITE`, `SUM_NUMBER_OF_BYTES_WRITE`

These columns aggregate all write operations, including `FPUTS`, `Fputc`, `FPRINTF`, `VFPRINTF`, `FWRITE`, and `PWRITE`.

- `COUNT_MISC`, `SUM_TIMER_MISC`, `MIN_TIMER_MISC`, `AVG_TIMER_MISC`, `MAX_TIMER_MISC`

These columns aggregate all other I/O operations, including `CREATE`, `DELETE`, `OPEN`, `CLOSE`, `STREAM_OPEN`, `STREAM_CLOSE`, `SEEK`, `TELL`, `FLUSH`, `STAT`, `FSTAT`, `CHSIZE`, `RENAME`, and `SYNC`. There are no byte counts for these operations.

`TRUNCATE TABLE` is permitted for file I/O summary tables. It resets the summary columns to zero rather than removing rows.

The MySQL server uses several techniques to avoid I/O operations by caching information read from files, so it is possible that statements you might expect to result in I/O events do not do so. You may be able to ensure that I/O does occur by flushing caches or restarting the server to reset its state.

10.15.7 Table I/O and Lock Wait Summary Tables

The following sections describe the table I/O and lock wait summary tables:

- `table_io_waits_summary_by_index_usage`: Table I/O waits per index
- `table_io_waits_summary_by_table`: Table I/O waits per table
- `table_lock_waits_summary_by_table`: Table lock waits per table

10.15.7.1 The `table_io_waits_summary_by_table` Table

The `table_io_waits_summary_by_table` table aggregates all table I/O wait events, as generated by the `wait/io/table/sql/handler` instrument. The grouping is by table.

The `table_io_waits_summary_by_table` table has these grouping columns to indicate how the table aggregates events: `OBJECT_TYPE`, `OBJECT_SCHEMA`, and `OBJECT_NAME`. These columns have the same meaning as in the `events_waits_current` table. They identify the table to which the row applies.

`table_io_waits_summary_by_table` has the following summary columns containing aggregated values. As indicated in the column descriptions, some columns are more general and have values that are the same as the sum of the values of more fine-grained columns. For example, columns that aggregate all writes hold the sum of the corresponding columns that aggregate inserts, updates, and deletes. In this way, aggregations at higher levels are available directly without the need for user-defined views that sum lower-level columns.

- `COUNT_STAR`, `SUM_TIMER_WAIT`, `MIN_TIMER_WAIT`, `AVG_TIMER_WAIT`, `MAX_TIMER_WAIT`

These columns aggregate all I/O operations. They are the same as the sum of the corresponding `xxx_READ` and `xxx_WRITE` columns.

- `COUNT_READ`, `SUM_TIMER_READ`, `MIN_TIMER_READ`, `AVG_TIMER_READ`, `MAX_TIMER_READ`

These columns aggregate all read operations. They are the same as the sum of the corresponding `xxx_FETCH` columns.

- `COUNT_WRITE`, `SUM_TIMER_WRITE`, `MIN_TIMER_WRITE`, `AVG_TIMER_WRITE`, `MAX_TIMER_WRITE`

These columns aggregate all write operations. They are the same as the sum of the corresponding `xxx_INSERT`, `xxx_UPDATE`, and `xxx_DELETE` columns.

- `COUNT_FETCH`, `SUM_TIMER_FETCH`, `MIN_TIMER_FETCH`, `AVG_TIMER_FETCH`, `MAX_TIMER_FETCH`

These columns aggregate all fetch operations.

- `COUNT_INSERT`, `SUM_TIMER_INSERT`, `MIN_TIMER_INSERT`, `AVG_TIMER_INSERT`, `MAX_TIMER_INSERT`

These columns aggregate all insert operations.

- `COUNT_UPDATE`, `SUM_TIMER_UPDATE`, `MIN_TIMER_UPDATE`, `AVG_TIMER_UPDATE`, `MAX_TIMER_UPDATE`

These columns aggregate all update operations.

- `COUNT_DELETE`, `SUM_TIMER_DELETE`, `MIN_TIMER_DELETE`, `AVG_TIMER_DELETE`, `MAX_TIMER_DELETE`

These columns aggregate all delete operations.

`TRUNCATE TABLE` is permitted for table I/O summary tables. It resets the summary columns to zero rather than removing rows. Truncating this table also truncates the `table_io_waits_summary_by_index_usage` table.

10.15.7.2 The `table_io_waits_summary_by_index_usage` Table

The `table_io_waits_summary_by_index_usage` table aggregates all table index I/O wait events, as generated by the `wait/io/table/sql/handler` instrument. The grouping is by table index.

The columns of `table_io_waits_summary_by_index_usage` are nearly identical to `table_io_waits_summary_by_table`. The only difference is the additional group column, `INDEX_NAME`, which corresponds to the name of the index that was used when the table I/O wait event was recorded:

- A value of `PRIMARY` indicates that table I/O used the primary index.
- A value of `NULL` means that table I/O used no index.
- Inserts are counted against `INDEX_NAME = NULL`.

`TRUNCATE TABLE` is permitted for table I/O summary tables. It resets the summary columns to zero rather than removing rows. This table is also truncated by truncation of the `table_io_waits_summary_by_table` table. A DDL operation that changes the index structure of a table may cause the per-index statistics to be reset.

10.15.7.3 The `table_lock_waits_summary_by_table` Table

The `table_lock_waits_summary_by_table` table aggregates all table lock wait events, as generated by the `wait/lock/table/sql/handler` instrument. The grouping is by table.

This table contains information about internal and external locks:

- An internal lock corresponds to a lock in the SQL layer. This is currently implemented by a call to `thr_lock()`. In event rows, these locks are distinguished by the `OPERATION` column, which has one of these values:

```
read normal
read with shared locks
read high priority
read no insert
write allow write
write concurrent insert
write delayed
write low priority
write normal
```

- An external lock corresponds to a lock in the storage engine layer. This is currently implemented by a call to `handler::external_lock()`. In event rows, these locks are distinguished by the `OPERATION` column, which has one of these values:

```
read external
write external
```

The `table_lock_waits_summary_by_table` table has these grouping columns to indicate how the table aggregates events: `OBJECT_TYPE`, `OBJECT_SCHEMA`, and `OBJECT_NAME`. These columns have the same meaning as in the `events_waits_current` table. They identify the table to which the row applies.

`table_lock_waits_summary_by_table` has the following summary columns containing aggregated values. As indicated in the column descriptions, some columns are more general and have values that are the same as the sum of the values of more fine-grained columns. For example, columns that aggregate all locks hold the sum of the corresponding columns that aggregate read and write locks. In this way, aggregations at higher levels are available directly without the need for user-defined views that sum lower-level columns.

- `COUNT_STAR`, `SUM_TIMER_WAIT`, `MIN_TIMER_WAIT`, `AVG_TIMER_WAIT`, `MAX_TIMER_WAIT`

These columns aggregate all lock operations. They are the same as the sum of the corresponding `xxx_READ` and `xxx_WRITE` columns.

- `COUNT_READ`, `SUM_TIMER_READ`, `MIN_TIMER_READ`, `AVG_TIMER_READ`, `MAX_TIMER_READ`

These columns aggregate all read-lock operations. They are the same as the sum of the corresponding `xxx_READ_NORMAL`, `xxx_READ_WITH_SHARED_LOCKS`, `xxx_READ_HIGH_PRIORITY`, and `xxx_READ_NO_INSERT` columns.

- `COUNT_WRITE`, `SUM_TIMER_WRITE`, `MIN_TIMER_WRITE`, `AVG_TIMER_WRITE`, `MAX_TIMER_WRITE`

These columns aggregate all write-lock operations. They are the same as the sum of the corresponding `xxx_WRITE_ALLOW_WRITE`, `xxx_WRITE_CONCURRENT_INSERT`, `xxx_WRITE_LOW_PRIORITY`, and `xxx_WRITE_NORMAL` columns.

- `COUNT_READ_NORMAL`, `SUM_TIMER_READ_NORMAL`, `MIN_TIMER_READ_NORMAL`, `AVG_TIMER_READ_NORMAL`, `MAX_TIMER_READ_NORMAL`

These columns aggregate internal read locks.

- `COUNT_READ_WITH_SHARED_LOCKS`, `SUM_TIMER_READ_WITH_SHARED_LOCKS`, `MIN_TIMER_READ_WITH_SHARED_LOCKS`, `AVG_TIMER_READ_WITH_SHARED_LOCKS`, `MAX_TIMER_READ_WITH_SHARED_LOCKS`

These columns aggregate internal read locks.

- `COUNT_READ_HIGH_PRIORITY`, `SUM_TIMER_READ_HIGH_PRIORITY`, `MIN_TIMER_READ_HIGH_PRIORITY`, `AVG_TIMER_READ_HIGH_PRIORITY`, `MAX_TIMER_READ_HIGH_PRIORITY`

These columns aggregate internal read locks.

- `COUNT_READ_NO_INSERT`, `SUM_TIMER_READ_NO_INSERT`, `MIN_TIMER_READ_NO_INSERT`, `AVG_TIMER_READ_NO_INSERT`, `MAX_TIMER_READ_NO_INSERT`

These columns aggregate internal read locks.

- `COUNT_READ_EXTERNAL`, `SUM_TIMER_READ_EXTERNAL`, `MIN_TIMER_READ_EXTERNAL`, `AVG_TIMER_READ_EXTERNAL`, `MAX_TIMER_READ_EXTERNAL`

These columns aggregate external read locks.

- `COUNT_WRITE_ALLOW_WRITE`, `SUM_TIMER_WRITE_ALLOW_WRITE`, `MIN_TIMER_WRITE_ALLOW_WRITE`, `AVG_TIMER_WRITE_ALLOW_WRITE`, `MAX_TIMER_WRITE_ALLOW_WRITE`

These columns aggregate internal write locks.

- `COUNT_WRITE_CONCURRENT_INSERT`, `SUM_TIMER_WRITE_CONCURRENT_INSERT`, `MIN_TIMER_WRITE_CONCURRENT_INSERT`, `AVG_TIMER_WRITE_CONCURRENT_INSERT`, `MAX_TIMER_WRITE_CONCURRENT_INSERT`

These columns aggregate internal write locks.

- `COUNT_WRITE_LOW_PRIORITY`, `SUM_TIMER_WRITE_LOW_PRIORITY`, `MIN_TIMER_WRITE_LOW_PRIORITY`, `AVG_TIMER_WRITE_LOW_PRIORITY`, `MAX_TIMER_WRITE_LOW_PRIORITY`

These columns aggregate internal write locks.

- `COUNT_WRITE_NORMAL`, `SUM_TIMER_WRITE_NORMAL`, `MIN_TIMER_WRITE_NORMAL`, `AVG_TIMER_WRITE_NORMAL`, `MAX_TIMER_WRITE_NORMAL`

These columns aggregate internal write locks.

- `COUNT_WRITE_EXTERNAL`, `SUM_TIMER_WRITE_EXTERNAL`, `MIN_TIMER_WRITE_EXTERNAL`, `AVG_TIMER_WRITE_EXTERNAL`, `MAX_TIMER_WRITE_EXTERNAL`

These columns aggregate external write locks.

`TRUNCATE TABLE` is permitted for table lock summary tables. It resets the summary columns to zero rather than removing rows.

10.15.8 Socket Summary Tables

These socket summary tables aggregate timer and byte count information for socket operations:

- `socket_summary_by_event_name`: Aggregate timer and byte count statistics generated by the `wait/io/socket/*` instruments for all socket I/O operations, per socket instrument.
- `socket_summary_by_instance`: Aggregate timer and byte count statistics generated by the `wait/io/socket/*` instruments for all socket I/O operations, per socket instance. When a connection terminates, the row in `socket_summary_by_instance` corresponding to it is deleted.

The socket summary tables do not aggregate waits generated by `idle` events while sockets are waiting for the next request from the client. For `idle` event aggregations, use the wait-event summary tables; see [Section 10.15.1, “Wait Event Summary Tables”](#).

Each socket summary table has one or more grouping columns to indicate how the table aggregates events. Event names refer to names of event instruments in the `setup_instruments` table:

- `socket_summary_by_event_name` has an `EVENT_NAME` column. Each row summarizes events for a given event name.
- `socket_summary_by_instance` has an `OBJECT_INSTANCE_BEGIN` column. Each row summarizes events for a given object.

Each socket summary table has these summary columns containing aggregated values:

- `COUNT_STAR`, `SUM_TIMER_WAIT`, `MIN_TIMER_WAIT`, `AVG_TIMER_WAIT`, `MAX_TIMER_WAIT`

These columns aggregate all operations.

- `COUNT_READ`, `SUM_TIMER_READ`, `MIN_TIMER_READ`, `AVG_TIMER_READ`, `MAX_TIMER_READ`, `SUM_NUMBER_OF_BYTES_READ`

These columns aggregate all receive operations (`RECV`, `RECVFROM`, and `RECVMSG`).

- `COUNT_WRITE`, `SUM_TIMER_WRITE`, `MIN_TIMER_WRITE`, `AVG_TIMER_WRITE`, `MAX_TIMER_WRITE`, `SUM_NUMBER_OF_BYTES_WRITE`

These columns aggregate all send operations (`SEND`, `SENDTO`, and `SENDMSG`).

- `COUNT_MISC`, `SUM_TIMER_MISC`, `MIN_TIMER_MISC`, `AVG_TIMER_MISC`, `MAX_TIMER_MISC`

These columns aggregate all other socket operations, such as `CONNECT`, `LISTEN`, `ACCEPT`, `CLOSE`, and `SHUTDOWN`. There are no byte counts for these operations.

The `socket_summary_by_instance` table also has an `EVENT_NAME` column that indicates the class of the socket: `client_connection`, `server_tcpip_socket`, `server_unix_socket`. This column can be grouped on to isolate, for example, client activity from that of the server listening sockets.

`TRUNCATE TABLE` is permitted for socket summary tables. Except for `events_statements_summary_by_digest`, it resets the summary columns to zero rather than removing rows.

10.15.9 Memory Summary Tables

The Performance Schema instruments memory usage and aggregates memory usage statistics, detailed by these factors:

- Type of memory used (various caches, internal buffers, and so forth)
- Thread, account, user, host indirectly performing the memory operation

The Performance Schema instruments the following aspects of memory use

- Memory sizes used
- Operation counts
- Low and high water marks

Memory sizes help to understand or tune the memory consumption of the server.

Operation counts help to understand or tune the overall pressure the server is putting on the memory allocator, which has an impact on performance. Allocating a single byte one million times is not the same as allocating one million bytes a single time; tracking both sizes and counts can expose the difference.

Low and high water marks are critical to detect workload spikes, overall workload stability, and possible memory leaks.

Memory summary tables do not contain timing information because memory events are not timed.

For information about collecting memory usage data, see [Memory Instrumentation Behavior](#).

Example memory event summary information:

```
mysql> SELECT *
```



```

FROM performance_schema.memory_summary_global_by_event_name
WHERE EVENT_NAME = 'memory/sql/TABLE'\G
***** 1. row *****
      EVENT_NAME: memory/sql/TABLE
      COUNT_ALLOC: 1381
      COUNT_FREE: 924
      SUM_NUMBER_OF_BYTES_ALLOC: 2059873
      SUM_NUMBER_OF_BYTES_FREE: 1407432
      LOW_COUNT_USED: 0
      CURRENT_COUNT_USED: 457
      HIGH_COUNT_USED: 461
      LOW_NUMBER_OF_BYTES_USED: 0
      CURRENT_NUMBER_OF_BYTES_USED: 652441
      HIGH_NUMBER_OF_BYTES_USED: 669269

```

Each memory summary table has one or more grouping columns to indicate how the table aggregates events. Event names refer to names of event instruments in the `setup_instruments` table:

- `memory_summary_by_account_by_event_name` has `USER`, `HOST`, and `EVENT_NAME` columns. Each row summarizes events for a given account (user and host combination) and event name.
- `memory_summary_by_host_by_event_name` has `HOST` and `EVENT_NAME` columns. Each row summarizes events for a given host and event name.
- `memory_summary_by_thread_by_event_name` has `THREAD_ID` and `EVENT_NAME` columns. Each row summarizes events for a given thread and event name.
- `memory_summary_by_user_by_event_name` has `USER` and `EVENT_NAME` columns. Each row summarizes events for a given user and event name.
- `memory_summary_global_by_event_name` has an `EVENT_NAME` column. Each row summarizes events for a given event name.

Each memory summary table has these summary columns containing aggregated values:

- `COUNT_ALLOC`, `COUNT_FREE`
The aggregated numbers of calls to memory-allocation and memory-free functions.
- `SUM_NUMBER_OF_BYTES_ALLOC`, `SUM_NUMBER_OF_BYTES_FREE`
The aggregated sizes of allocated and freed memory blocks.
- `CURRENT_COUNT_USED`
The aggregated number of currently allocated blocks that have not been freed yet. This is a convenience column, equal to `COUNT_ALLOC - COUNT_FREE`.
- `CURRENT_NUMBER_OF_BYTES_USED`
The aggregated size of currently allocated memory blocks that have not been freed yet. This is a convenience column, equal to `SUM_NUMBER_OF_BYTES_ALLOC - SUM_NUMBER_OF_BYTES_FREE`.
- `LOW_COUNT_USED`, `HIGH_COUNT_USED`
The low and high water marks corresponding to the `CURRENT_COUNT_USED` column.
- `LOW_NUMBER_OF_BYTES_USED`, `HIGH_NUMBER_OF_BYTES_USED`
The low and high water marks corresponding to the `CURRENT_NUMBER_OF_BYTES_USED` column.

`TRUNCATE TABLE` is permitted for memory summary tables. It has these effects:

- In general, truncation resets the baseline for statistics, but does not change the server state. That is, truncating a memory table does not free memory.
- `COUNT_ALLOC` and `COUNT_FREE` are reset to a new baseline, by reducing each counter by the same value.
- Likewise, `SUM_NUMBER_OF_BYTES_ALLOC` and `SUM_NUMBER_OF_BYTES_FREE` are reset to a new baseline.
- `LOW_COUNT_USED` and `HIGH_COUNT_USED` are reset to `CURRENT_COUNT_USED`.
- `LOW_NUMBER_OF_BYTES_USED` and `HIGH_NUMBER_OF_BYTES_USED` are reset to `CURRENT_NUMBER_OF_BYTES_USED`.

In addition, each memory summary table that is aggregated by account, host, user, or thread is implicitly truncated by truncation of the connection table on which it depends, or truncation of `memory_summary_global_by_event_name`. For details, see [Section 10.8, “Performance Schema Connection Tables”](#).

Memory Instrumentation Behavior

Memory instruments are listed in the `setup_instruments` table and have names of the form `memory/code_area/instrument_name`. Most memory instrumentation is disabled by default.

Instruments named with the prefix `memory/performance_schema/` expose how much memory is allocated for internal buffers in the Performance Schema itself. The `memory/performance_schema/` instruments are built in, always enabled, and cannot be disabled at startup or runtime. Built-in memory instruments are displayed only in the `memory_summary_global_by_event_name` table.

To control memory instrumentation state at server startup, use lines like these in your `my.cnf` file:

- Enable:

```
[mysqld]
performance-schema-instrument='memory/%=ON'
```

- Disable:

```
[mysqld]
performance-schema-instrument='memory/%=OFF'
```

To control memory instrumentation state at runtime, update the `ENABLED` column of the relevant instruments in the `setup_instruments` table:

- Enable:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'YES'
WHERE NAME LIKE 'memory/%';
```

- Disable:

```
UPDATE performance_schema.setup_instruments
SET ENABLED = 'NO'
WHERE NAME LIKE 'memory/%';
```

For memory instruments, the `TIMED` column in `setup_instruments` is ignored because memory operations are not timed.

When a thread in the server executes a memory allocation that has been instrumented, these rules apply:

- If the thread is not instrumented or the memory instrument is not enabled, the memory block allocated is not instrumented.
- Otherwise (that is, both the thread and the instrument are enabled), the memory block allocated is instrumented.

For deallocation, these rules apply:

- If a memory allocation operation was instrumented, the corresponding free operation is instrumented, regardless of the current instrument or thread enabled status.
- If a memory allocation operation was not instrumented, the corresponding free operation is not instrumented, regardless of the current instrument or thread enabled status.

For the per-thread statistics, the following rules apply.

When an instrumented memory block of size N is allocated, the Performance Schema makes these updates to memory summary table columns:

- `COUNT_ALLOC`: Increased by 1
- `CURRENT_COUNT_USED`: Increased by 1
- `HIGH_COUNT_USED`: Increased if `CURRENT_COUNT_USED` is a new maximum
- `SUM_NUMBER_OF_BYTES_ALLOC`: Increased by N
- `CURRENT_NUMBER_OF_BYTES_USED`: Increased by N
- `HIGH_NUMBER_OF_BYTES_USED`: Increased if `CURRENT_NUMBER_OF_BYTES_USED` is a new maximum

When an instrumented memory block is deallocated, the Performance Schema makes these updates to memory summary table columns:

- `COUNT_FREE`: Increased by 1
- `CURRENT_COUNT_USED`: Decreased by 1
- `LOW_COUNT_USED`: Decreased if `CURRENT_COUNT_USED` is a new minimum
- `SUM_NUMBER_OF_BYTES_FREE`: Increased by N
- `CURRENT_NUMBER_OF_BYTES_USED`: Decreased by N
- `LOW_NUMBER_OF_BYTES_USED`: Decreased if `CURRENT_NUMBER_OF_BYTES_USED` is a new minimum

For higher-level aggregates (global, by account, by user, by host), the same rules apply as expected for low and high water marks.

- `LOW_COUNT_USED` and `LOW_NUMBER_OF_BYTES_USED` are lower estimates. The value reported by the Performance Schema is guaranteed to be less than or equal to the lowest count or size of memory effectively used at runtime.
- `HIGH_COUNT_USED` and `HIGH_NUMBER_OF_BYTES_USED` are higher estimates. The value reported by the Performance Schema is guaranteed to be greater than or equal to the highest count or size of memory effectively used at runtime.

For lower estimates in summary tables other than `memory_summary_global_by_event_name`, it is possible for values to go negative if memory ownership is transferred between threads.

Here is an example of estimate computation; but note that estimate implementation is subject to change:

Thread 1 uses memory in the range from 1MB to 2MB during execution, as reported by the `LOW_NUMBER_OF_BYTES_USED` and `HIGH_NUMBER_OF_BYTES_USED` columns of the `memory_summary_by_thread_by_event_name` table.

Thread 2 uses memory in the range from 10MB to 12MB during execution, as reported likewise.

When these two threads belong to the same user account, the per-account summary estimates that this account used memory in the range from 11MB to 14MB. That is, the `LOW_NUMBER_OF_BYTES_USED` for the higher level aggregate is the sum of each `LOW_NUMBER_OF_BYTES_USED` (assuming the worst case). Likewise, the `HIGH_NUMBER_OF_BYTES_USED` for the higher level aggregate is the sum of each `HIGH_NUMBER_OF_BYTES_USED` (assuming the worst case).

11MB is a lower estimate that can occur only if both threads hit the low usage mark at the same time.

14MB is a higher estimate that can occur only if both threads hit the high usage mark at the same time.

The real memory usage for this account could have been in the range from 11.5MB to 13.5MB.

For capacity planning, reporting the worst case is actually the desired behavior, as it shows what can potentially happen when sessions are uncorrelated, which is typically the case.

10.15.10 Status Variable Summary Tables

Note

The value of the `show_compatibility_56` system variable affects the information available from the tables described here. For details, see the description of that variable in [Server System Variables](#).

The Performance Schema makes status variable information available in the tables described in [Section 10.14, “Performance Schema Status Variable Tables”](#). It also makes aggregated status variable information available in summary tables, described here. Each status variable summary table has one or more grouping columns to indicate how the table aggregates status values:

- `status_by_account` has `USER`, `HOST`, and `VARIABLE_NAME` columns to summarize status variables by account.
- `status_by_host` has `HOST` and `VARIABLE_NAME` columns to summarize status variables by the host from which clients connected.
- `status_by_user` has `USER` and `VARIABLE_NAME` columns to summarize status variables by client user name.

Each status variable summary table has this summary column containing aggregated values:

- `VARIABLE_VALUE`

The aggregated status variable value for active and terminated sessions.

The meaning of “account” in these tables is similar to its meaning in the MySQL grant tables in the `mysql` system database, in the sense that the term refers to a combination of user and host values. They differ in that, for grant tables, the host part of an account can be a pattern, whereas for Performance Schema tables, the host value is always a specific nonpattern host name.

Account status is collected when sessions terminate. The session status counters are added to the global status counters and the corresponding account status counters. If account statistics are not collected, the session status is added to host and user status, if host and user status are collected.

Account, host, and user statistics are not collected if the `performance_schema_accounts_size`, `performance_schema_hosts_size`, and `performance_schema_users_size` system variables, respectively, are set to 0.

The Performance Schema supports `TRUNCATE TABLE` for status variable summary tables as follows; in all cases, status for active sessions is unaffected:

- `status_by_account`: Aggregates account status from terminated sessions to user and host status, then resets account status.
- `status_by_host`: Resets aggregated host status from terminated sessions.
- `status_by_user`: Resets aggregated user status from terminated sessions.

`FLUSH STATUS` adds the session status from all active sessions to the global status variables, resets the status of all active sessions, and resets account, host, and user status values aggregated from disconnected sessions.

10.16 Performance Schema Miscellaneous Tables

The following sections describe tables that do not fall into the table categories discussed in the preceding sections:

- `host_cache`: Information from the internal host cache.
- `performance_timers`: Which event timers are available.
- `threads`: Information about server threads.

10.16.1 The `host_cache` Table

The MySQL server maintains an in-memory host cache that contains client host name and IP address information and is used to avoid Domain Name System (DNS) lookups. The `host_cache` table exposes the contents of this cache. The `host_cache_size` system variable controls the size of the host cache, as well as the size of the `host_cache` table. For operational and configuration information about the host cache, see [DNS Lookups and the Host Cache](#).

Because the `host_cache` table exposes the contents of the host cache, it can be examined using `SELECT` statements. This may help you diagnose the causes of connection problems. The Performance Schema must be enabled or this table is empty.

The `host_cache` table has these columns:

- `IP`

The IP address of the client that connected to the server, expressed as a string.

- `HOST`

The resolved DNS host name for that client IP, or `NULL` if the name is unknown.

- `HOST_VALIDATED`

Whether the IP-to-host name-to-IP DNS resolution was performed successfully for the client IP. If `HOST_VALIDATED` is `YES`, the `HOST` column is used as the host name corresponding to the IP so that

additional calls to DNS can be avoided. While `HOST_VALIDATED` is `NO`, DNS resolution is attempted for each connection attempt, until it eventually completes with either a valid result or a permanent error. This information enables the server to avoid caching bad or missing host names during temporary DNS failures, which would negatively affect clients forever.

- `SUM_CONNECT_ERRORS`

The number of connection errors that are deemed “blocking” (assessed against the `max_connect_errors` system variable). Only protocol handshake errors are counted, and only for hosts that passed validation (`HOST_VALIDATED = YES`).

Once `SUM_CONNECT_ERRORS` for a given host reaches the value of `max_connect_errors`, new connections from that host are blocked. The `SUM_CONNECT_ERRORS` value can exceed the `max_connect_errors` value because multiple connection attempts from a host can occur simultaneously while the host is not blocked. Any or all of them can fail, independently incrementing `SUM_CONNECT_ERRORS`, possibly beyond the value of `max_connect_errors`.

Suppose that `max_connect_errors` is 200 and `SUM_CONNECT_ERRORS` for a given host is 199. If 10 clients attempt to connect from that host simultaneously, none of them are blocked because `SUM_CONNECT_ERRORS` has not reached 200. If blocking errors occur for five of the clients, `SUM_CONNECT_ERRORS` is increased by one for each client, for a resulting `SUM_CONNECT_ERRORS` value of 204. The other five clients succeed and are not blocked because the value of `SUM_CONNECT_ERRORS` when their connection attempts began had not reached 200. New connections from the host that begin after `SUM_CONNECT_ERRORS` reaches 200 are blocked.

- `COUNT_HOST_BLOCKED_ERRORS`

The number of connections that were blocked because `SUM_CONNECT_ERRORS` exceeded the value of the `max_connect_errors` system variable.

- `COUNT_NAMEINFO_TRANSIENT_ERRORS`

The number of transient errors during IP-to-host name DNS resolution.

- `COUNT_NAMEINFO_PERMANENT_ERRORS`

The number of permanent errors during IP-to-host name DNS resolution.

- `COUNT_FORMAT_ERRORS`

The number of host name format errors. MySQL does not perform matching of `Host` column values in the `mysql.user` system table against host names for which one or more of the initial components of the name are entirely numeric, such as `1.2.example.com`. The client IP address is used instead. For the rationale why this type of matching does not occur, see [Specifying Account Names](#).

- `COUNT_ADDRINFO_TRANSIENT_ERRORS`

The number of transient errors during host name-to-IP reverse DNS resolution.

- `COUNT_ADDRINFO_PERMANENT_ERRORS`

The number of permanent errors during host name-to-IP reverse DNS resolution.

- `COUNT_FCRDNS_ERRORS`

The number of forward-confirmed reverse DNS errors. These errors occur when IP-to-host name-to-IP DNS resolution produces an IP address that does not match the client originating IP address.

- [COUNT_HOST_ACL_ERRORS](#)

The number of errors that occur because no users are permitted to connect from the client host. In such cases, the server returns [ER_HOST_NOT_PRIVILEGED](#) and does not even ask for a user name or password.

- [COUNT_NO_AUTH_PLUGIN_ERRORS](#)

The number of errors due to requests for an unavailable authentication plugin. A plugin can be unavailable if, for example, it was never loaded or a load attempt failed.

- [COUNT_AUTH_PLUGIN_ERRORS](#)

The number of errors reported by authentication plugins.

An authentication plugin can report different error codes to indicate the root cause of a failure. Depending on the type of error, one of these columns is incremented: [COUNT_AUTHENTICATION_ERRORS](#), [COUNT_AUTH_PLUGIN_ERRORS](#), [COUNT_HANDSHAKE_ERRORS](#). New return codes are an optional extension to the existing plugin API. Unknown or unexpected plugin errors are counted in the [COUNT_AUTH_PLUGIN_ERRORS](#) column.

- [COUNT_HANDSHAKE_ERRORS](#)

The number of errors detected at the wire protocol level.

- [COUNT_PROXY_USER_ERRORS](#)

The number of errors detected when proxy user A is proxied to another user B who does not exist.

- [COUNT_PROXY_USER_ACL_ERRORS](#)

The number of errors detected when proxy user A is proxied to another user B who does exist but for whom A does not have the [PROXY](#) privilege.

- [COUNT_AUTHENTICATION_ERRORS](#)

The number of errors caused by failed authentication.

- [COUNT_SSL_ERRORS](#)

The number of errors due to SSL problems.

- [COUNT_MAX_USER_CONNECTIONS_ERRORS](#)

The number of errors caused by exceeding per-user connection quotas. See [Setting Account Resource Limits](#).

- [COUNT_MAX_USER_CONNECTIONS_PER_HOUR_ERRORS](#)

The number of errors caused by exceeding per-user connections-per-hour quotas. See [Setting Account Resource Limits](#).

- [COUNT_DEFAULT_DATABASE_ERRORS](#)

The number of errors related to the default database. For example, the database does not exist or the user has no privileges to access it.

- [COUNT_INIT_CONNECT_ERRORS](#)

The number of errors caused by execution failures of statements in the `init_connect` system variable value.

- `COUNT_LOCAL_ERRORS`

The number of errors local to the server implementation and not related to the network, authentication, or authorization. For example, out-of-memory conditions fall into this category.

- `COUNT_UNKNOWN_ERRORS`

The number of other, unknown errors not accounted for by other columns in this table. This column is reserved for future use, in case new error conditions must be reported, and if preserving the backward compatibility and structure of the `host_cache` table is required.

- `FIRST_SEEN`

The timestamp of the first connection attempt seen from the client in the `IP` column.

- `LAST_SEEN`

The timestamp of the most recent connection attempt seen from the client in the `IP` column.

- `FIRST_ERROR_SEEN`

The timestamp of the first error seen from the client in the `IP` column.

- `LAST_ERROR_SEEN`

The timestamp of the most recent error seen from the client in the `IP` column.

`TRUNCATE TABLE` is permitted for the `host_cache` table. It requires the `DROP` privilege for the table. Truncating the table flushes the host cache, which has the effects described in [Flushing the Host Cache](#).

10.16.2 The performance_timers Table

The `performance_timers` table shows which event timers are available:

```
mysql> SELECT * FROM performance_schema.performance_timers;
```

TIMER_NAME	TIMER_FREQUENCY	TIMER_RESOLUTION	TIMER_OVERHEAD
CYCLE	2389029850	1	72
NANOSECOND	1000000000	1	112
MICROSECOND	1000000	1	136
MILLISECOND	1036	1	168
TICK	105	1	2416

If the values associated with a given timer name are `NULL`, that timer is not supported on your platform. The rows that do not contain `NULL` indicate which timers you can use in `setup_timers`. For an explanation of how event timing occurs, see [Section 5.1, “Performance Schema Event Timing”](#).

Note

As of MySQL 5.7.21, the Performance Schema `setup_timers` table is deprecated and is removed in MySQL 8.0, as is the `TICKS` row in the `performance_timers` table.

The `performance_timers` table has these columns:

- `TIMER_NAME`

The name by which to refer to the timer when configuring the `setup_timers` table.

- `TIMER_FREQUENCY`

The number of timer units per second. For a cycle timer, the frequency is generally related to the CPU speed. For example, on a system with a 2.4GHz processor, the `CYCLE` may be close to 2400000000.

- `TIMER_RESOLUTION`

Indicates the number of timer units by which timer values increase. If a timer has a resolution of 10, its value increases by 10 each time.

- `TIMER_OVERHEAD`

The minimal number of cycles of overhead to obtain one timing with the given timer. The Performance Schema determines this value by invoking the timer 20 times during initialization and picking the smallest value. The total overhead really is twice this amount because the instrumentation invokes the timer at the start and end of each event. The timer code is called only for timed events, so this overhead does not apply for nontimed events.

`TRUNCATE TABLE` is not permitted for the `performance_timers` table.

10.16.3 The processlist Table

Note

The `processlist` table is automatically created in the Performance Schema for new installations of MySQL 5.7.39, or higher. It is also created automatically by an upgrade.

The MySQL process list indicates the operations currently being performed by the set of threads executing within the server. The `processlist` table is one source of process information. For a comparison of this table with other sources, see [Sources of Process Information](#).

The `processlist` table can be queried directly. If you have the `PROCESS` privilege, you can see all threads, even those belonging to other users. Otherwise (without the `PROCESS` privilege), nonanonymous users have access to information about their own threads but not threads for other users, and anonymous users have no access to thread information.

Note

If the `performance_schema_show_processlist` system variable is enabled, the `processlist` table also serves as the basis for an alternative implementation underlying the `SHOW PROCESSLIST` statement. For details, see later in this section.

The `processlist` table contains a row for each server process:

```
mysql> SELECT * FROM performance_schema.processlist\G
***** 1. row *****
ID: 5
USER: event_scheduler
HOST: localhost
DB: NULL
```

```

COMMAND: Daemon
TIME: 137
STATE: Waiting on empty queue
INFO: NULL
***** 2. row *****
ID: 9
USER: me
HOST: localhost:58812
DB: NULL
COMMAND: Sleep
TIME: 95
STATE:
INFO: NULL
***** 3. row *****
ID: 10
USER: me
HOST: localhost:58834
DB: test
COMMAND: Query
TIME: 0
STATE: executing
INFO: SELECT * FROM performance_schema.processlist
...

```

The `processlist` table has these columns:

- `ID`

The connection identifier. This is the same value displayed in the `Id` column of the `SHOW PROCESSLIST` statement, displayed in the `PROCESSLIST_ID` column of the Performance Schema `threads` table, and returned by the `CONNECTION_ID()` function within the thread.

- `USER`

The MySQL user who issued the statement. A value of `system user` refers to a nonclient thread spawned by the server to handle tasks internally, for example, a delayed-row handler thread or an I/O or SQL thread used on replica hosts. For `system user`, there is no host specified in the `Host` column. `unauthenticated user` refers to a thread that has become associated with a client connection but for which authentication of the client user has not yet occurred. `event_scheduler` refers to the thread that monitors scheduled events (see [Using the Event Scheduler](#)).

Note

A `USER` value of `system user` is distinct from the `SYSTEM_USER` privilege. The former designates internal threads. The latter distinguishes the system user and regular user account categories (see [Account Categories](#)).

- `HOST`

The host name of the client issuing the statement (except for `system user`, for which there is no host). The host name for TCP/IP connections is reported in `host_name:client_port` format to make it easier to determine which client is doing what.

- `DB`

The default database for the thread, or `NULL` if none has been selected.

- `COMMAND`

The type of command the thread is executing on behalf of the client, or `Sleep` if the session is idle. For descriptions of thread commands, see [Examining Server Thread \(Process\) Information](#). The value of

this column corresponds to the `COM_xxx` commands of the client/server protocol and `Com_xxx` status variables. See [Server Status Variables](#)

- `TIME`

The time in seconds that the thread has been in its current state. For a replica SQL thread, the value is the number of seconds between the timestamp of the last replicated event and the real time of the replica host. See [Replication Threads](#).

- `STATE`

An action, event, or state that indicates what the thread is doing. For descriptions of `STATE` values, see [Examining Server Thread \(Process\) Information](#).

Most states correspond to very quick operations. If a thread stays in a given state for many seconds, there might be a problem that needs to be investigated.

- `INFO`

The statement the thread is executing, or `NULL` if it is executing no statement. The statement might be the one sent to the server, or an innermost statement if the statement executes other statements. For example, if a `CALL` statement executes a stored procedure that is executing a `SELECT` statement, the `INFO` value shows the `SELECT` statement.

- `EXECUTION_ENGINE`

The query execution engine. The value is either `PRIMARY` or `SECONDARY`. For use with MySQL HeatWave Service and HeatWave, where the `PRIMARY` engine is `InnoDB` and the `SECONDARY` engine is HeatWave (`RAPID`). For MySQL Community Edition Server, MySQL Enterprise Edition Server (on-premise), and MySQL HeatWave Service without HeatWave, the value is always `PRIMARY`. This column was added in MySQL 8.0.29.

`TRUNCATE TABLE` is not permitted for the `processlist` table.

As mentioned previously, if the `performance_schema_show_processlist` system variable is enabled, the `processlist` table serves as the basis for an alternative implementation of other process information sources:

- The `SHOW PROCESSLIST` statement.
- The `mysqladmin processlist` command (which uses `SHOW PROCESSLIST` statement).

The default `SHOW PROCESSLIST` implementation iterates across active threads from within the thread manager while holding a global mutex. This has negative performance consequences, particularly on busy systems. The alternative `SHOW PROCESSLIST` implementation is based on the Performance Schema `processlist` table. This implementation queries active thread data from the Performance Schema rather than the thread manager and does not require a mutex.

MySQL configuration affects `processlist` table contents as follows:

- Minimum required configuration:
 - The MySQL server must be configured and built with thread instrumentation enabled. This is true by default; it is controlled using the `DISABLE_PSI_THREAD CMake` option.
 - The Performance Schema must be enabled at server startup. This is true by default; it is controlled using the `performance_schema` system variable.

With that configuration satisfied, `performance_schema_show_processlist` enables or disables the alternative `SHOW PROCESSLIST` implementation. If the minimum configuration is not satisfied, the `processlist` table (and thus `SHOW PROCESSLIST`) may not return all data.

- Recommended configuration:
 - To avoid having some threads ignored:
 - Leave the `performance_schema_max_thread_instances` system variable set to its default or set it at least as great as the `max_connections` system variable.
 - Leave the `performance_schema_max_thread_classes` system variable set to its default.
 - To avoid having some `STATE` column values be empty, leave the `performance_schema_max_stage_classes` system variable set to its default.

The default for those configuration parameters is `-1`, which causes the Performance Schema to autosize them at server startup. With the parameters set as indicated, the `processlist` table (and thus `SHOW PROCESSLIST`) produce complete process information.

The preceding configuration parameters affect the contents of the `processlist` table. For a given configuration, however, the `processlist` contents are unaffected by the `performance_schema_show_processlist` setting.

The alternative process list implementation does not apply to the `INFORMATION_SCHEMA PROCESSLIST` table or the `COM_PROCESS_INFO` command of the MySQL client/server protocol.

10.16.4 The threads Table

The `threads` table contains a row for each server thread. Each row contains information about a thread and indicates whether monitoring and historical event logging are enabled for it:

```
mysql> SELECT * FROM performance_schema.threads\G
***** 1. row *****
      THREAD_ID: 1
        NAME: thread/sql/main
        TYPE: BACKGROUND
    PROCESSLIST_ID: NULL
    PROCESSLIST_USER: NULL
    PROCESSLIST_HOST: NULL
    PROCESSLIST_DB: NULL
PROCESSLIST_COMMAND: NULL
    PROCESSLIST_TIME: 80284
    PROCESSLIST_STATE: NULL
    PROCESSLIST_INFO: NULL
    PARENT_THREAD_ID: NULL
        ROLE: NULL
    INSTRUMENTED: YES
        HISTORY: YES
    CONNECTION_TYPE: NULL
    THREAD_OS_ID: 489803
...
***** 4. row *****
      THREAD_ID: 51
        NAME: thread/sql/one_connection
        TYPE: FOREGROUND
    PROCESSLIST_ID: 34
    PROCESSLIST_USER: isabella
    PROCESSLIST_HOST: localhost
    PROCESSLIST_DB: performance_schema
```

```

PROCESSLIST_COMMAND: Query
PROCESSLIST_TIME: 0
PROCESSLIST_STATE: Sending data
PROCESSLIST_INFO: SELECT * FROM performance_schema.threads
PARENT_THREAD_ID: 1
    ROLE: NULL
    INSTRUMENTED: YES
    HISTORY: YES
CONNECTION_TYPE: SSL/TLS
    THREAD_OS_ID: 755399
...

```

When the Performance Schema initializes, it populates the `threads` table based on the threads in existence then. Thereafter, a new row is added each time the server creates a thread.

The `INSTRUMENTED` and `HISTORY` column values for new threads are determined by the contents of the `setup_actors` table. For information about how to use the `setup_actors` table to control these columns, see [Section 5.6, “Pre-Filtering by Thread”](#).

Removal of rows from the `threads` table occurs when threads end. For a thread associated with a client session, removal occurs when the session ends. If a client has auto-reconnect enabled and the session reconnects after a disconnect, the session becomes associated with a new row in the `threads` table that has a different `PROCESSLIST_ID` value. The initial `INSTRUMENTED` and `HISTORY` values for the new thread may be different from those of the original thread: The `setup_actors` table may have changed in the meantime, and if the `INSTRUMENTED` or `HISTORY` value for the original thread was changed after the row was initialized, the change does not carry over to the new thread.

You can enable or disable thread monitoring (that is, whether events executed by the thread are instrumented) and historical event logging. To control the initial `INSTRUMENTED` and `HISTORY` values for new foreground threads, use the `setup_actors` table. To control these aspects of existing threads, set the `INSTRUMENTED` and `HISTORY` columns of `threads` table rows. (For more information about the conditions under which thread monitoring and historical event logging occur, see the descriptions of the `INSTRUMENTED` and `HISTORY` columns.)

For a comparison of the `threads` table columns with names having a prefix of `PROCESSLIST_` to other process information sources, see [Sources of Process Information](#).

Important

For thread information sources other than the `threads` table, information about threads for other users is shown only if the current user has the `PROCESS` privilege. That is not true of the `threads` table; all rows are shown to any user who has the `SELECT` privilege for the table. Users who should not be able to see threads for other users by accessing the `threads` table should not be given the `SELECT` privilege for it.

The `threads` table has these columns:

- `THREAD_ID`

A unique thread identifier.

- `NAME`

The name associated with the thread instrumentation code in the server. For example, `thread/sql/one_connection` corresponds to the thread function in the code responsible for handling a user connection, and `thread/sql/main` stands for the `main()` function of the server.

- `TYPE`

The thread type, either `FOREGROUND` or `BACKGROUND`. User connection threads are foreground threads. Threads associated with internal server activity are background threads. Examples are internal `InnoDB` threads, “binlog dump” threads sending information to replicas, and replication I/O and SQL threads.

- `PROCESSLIST_ID`

For a foreground thread (associated with a user connection), this is the connection identifier. This is the same value displayed in the `ID` column of the `INFORMATION_SCHEMA.PROCESSLIST` table, displayed in the `Id` column of `SHOW PROCESSLIST` output, and returned by the `CONNECTION_ID()` function within the thread.

For a background thread (not associated with a user connection), `PROCESSLIST_ID` is `NULL`, so the values are not unique.

- `PROCESSLIST_USER`

The user associated with a foreground thread, `NULL` for a background thread.

- `PROCESSLIST_HOST`

The host name of the client associated with a foreground thread, `NULL` for a background thread.

Unlike the `HOST` column of the `INFORMATION_SCHEMA.PROCESSLIST` table or the `Host` column of `SHOW PROCESSLIST` output, the `PROCESSLIST_HOST` column does not include the port number for TCP/IP connections. To obtain this information from the Performance Schema, enable the socket instrumentation (which is not enabled by default) and examine the `socket_instances` table:

```
mysql> SELECT * FROM performance_schema.setup_instruments
      WHERE NAME LIKE 'wait/io/socket%';
+-----+-----+-----+
| NAME                                     | ENABLED | TIMED |
+-----+-----+-----+
| wait/io/socket/sql/server_tcpip_socket | NO      | NO    |
| wait/io/socket/sql/server_unix_socket  | NO      | NO    |
| wait/io/socket/sql/client_connection    | NO      | NO    |
+-----+-----+-----+
3 rows in set (0.01 sec)
mysql> UPDATE performance_schema.setup_instruments
      SET ENABLED='YES'
      WHERE NAME LIKE 'wait/io/socket%';
Query OK, 3 rows affected (0.00 sec)
Rows matched: 3  Changed: 3  Warnings: 0
mysql> SELECT * FROM performance_schema.socket_instances\G
***** 1. row *****
      EVENT_NAME: wait/io/socket/sql/client_connection
OBJECT_INSTANCE_BEGIN: 140612577298432
      THREAD_ID: 31
      SOCKET_ID: 53
          IP: ::ffff:127.0.0.1
          PORT: 55642
          STATE: ACTIVE
...

```

- `PROCESSLIST_DB`

The default database for the thread, or `NULL` if none has been selected.

- `PROCESSLIST_COMMAND`

For foreground threads, the type of command the thread is executing on behalf of the client, or `Sleep` if the session is idle. For descriptions of thread commands, see [Examining Server Thread \(Process\)](#)

Information. The value of this column corresponds to the `COM_xxx` commands of the client/server protocol and `Com_xxx` status variables. See [Server Status Variables](#)

Background threads do not execute commands on behalf of clients, so this column may be `NULL`.

- `PROCESSLIST_TIME`

The time in seconds that the thread has been in its current state. For a replica SQL thread, the value is the number of seconds between the timestamp of the last replicated event and the real time of the replica host. See [Replication Threads](#).

- `PROCESSLIST_STATE`

An action, event, or state that indicates what the thread is doing. For descriptions of `PROCESSLIST_STATE` values, see [Examining Server Thread \(Process\) Information](#). If the value is `NULL`, the thread may correspond to an idle client session or the work it is doing is not instrumented with stages.

Most states correspond to very quick operations. If a thread stays in a given state for many seconds, there might be a problem that bears investigation.

- `PROCESSLIST_INFO`

The statement the thread is executing, or `NULL` if it is executing no statement. The statement might be the one sent to the server, or an innermost statement if the statement executes other statements. For example, if a `CALL` statement executes a stored procedure that is executing a `SELECT` statement, the `PROCESSLIST_INFO` value shows the `SELECT` statement.

- `PARENT_THREAD_ID`

If this thread is a subthread (spawned by another thread), this is the `THREAD_ID` value of the spawning thread.

- `ROLE`

Unused.

- `INSTRUMENTED`

Whether events executed by the thread are instrumented. The value is `YES` or `NO`.

- For foreground threads, the initial `INSTRUMENTED` value is determined by whether the user account associated with the thread matches any row in the `setup_actors` table. Matching is based on the values of the `PROCESSLIST_USER` and `PROCESSLIST_HOST` columns.

If the thread spawns a subthread, matching occurs again for the `threads` table row created for the subthread.

- For background threads, `INSTRUMENTED` is `YES` by default. `setup_actors` is not consulted because there is no associated user for background threads.
- For any thread, its `INSTRUMENTED` value can be changed during the lifetime of the thread.

For monitoring of events executed by the thread to occur, these things must be true:

- The `thread_instrumentation` consumer in the `setup_consumers` table must be `YES`.
- The `threads.INSTRUMENTED` column must be `YES`.

- Monitoring occurs only for those thread events produced from instruments that have the `ENABLED` column set to `YES` in the `setup_instruments` table.
- `HISTORY`
Whether to log historical events for the thread. The value is `YES` or `NO`.
 - For foreground threads, the initial `HISTORY` value is determined by whether the user account associated with the thread matches any row in the `setup_actors` table. Matching is based on the values of the `PROCESSLIST_USER` and `PROCESSLIST_HOST` columns.
If the thread spawns a subthread, matching occurs again for the `threads` table row created for the subthread.
 - For background threads, `HISTORY` is `YES` by default. `setup_actors` is not consulted because there is no associated user for background threads.
 - For any thread, its `HISTORY` value can be changed during the lifetime of the thread.

For historical event logging for the thread to occur, these things must be true:

- The appropriate history-related consumers in the `setup_consumers` table must be enabled. For example, wait event logging in the `events_waits_history` and `events_waits_history_long` tables requires the corresponding `events_waits_history` and `events_waits_history_long` consumers to be `YES`.
- The `threads.HISTORY` column must be `YES`.
- Logging occurs only for those thread events produced from instruments that have the `ENABLED` column set to `YES` in the `setup_instruments` table.
- `CONNECTION_TYPE`

The protocol used to establish the connection, or `NULL` for background threads. Permitted values are `TCP/IP` (TCP/IP connection established without encryption), `SSL/TLS` (TCP/IP connection established with encryption), `Socket` (Unix socket file connection), `Named Pipe` (Windows named pipe connection), and `Shared Memory` (Windows shared memory connection).

- `THREAD_OS_ID`

The thread or task identifier as defined by the underlying operating system, if there is one:

- When a MySQL thread is associated with the same operating system thread for its lifetime, `THREAD_OS_ID` contains the operating system thread ID.
- When a MySQL thread is not associated with the same operating system thread for its lifetime, `THREAD_OS_ID` contains `NULL`. This is typical for user sessions when the thread pool plugin is used (see [MySQL Enterprise Thread Pool](#)).

For Windows, `THREAD_OS_ID` corresponds to the thread ID visible in Process Explorer (<https://technet.microsoft.com/en-us/sysinternals/bb896653.aspx>).

For Linux, `THREAD_OS_ID` corresponds to the value of the `gettid()` function. This value is exposed, for example, using the `perf` or `ps -L` commands, or in the `proc` file system (`/proc/[pid]/task/[tid]`). For more information, see the `perf-stat(1)`, `ps(1)`, and `proc(5)` man pages.

`TRUNCATE TABLE` is not permitted for the `threads` table.

Chapter 11 Performance Schema and Plugins

Removing a plugin with `UNINSTALL PLUGIN` does not affect information already collected for code in that plugin. Time spent executing the code while the plugin was loaded was still spent even if the plugin is unloaded later. The associated event information, including aggregate information, remains readable in `performance_schema` database tables. For additional information about the effect of plugin installation and removal, see [Chapter 8, Performance Schema Status Monitoring](#).

A plugin implementor who instruments plugin code should document its instrumentation characteristics to enable those who load the plugin to account for its requirements. For example, a third-party storage engine should include in its documentation how much memory the engine needs for mutex and other instruments.

Chapter 12 Performance Schema System Variables

The Performance Schema implements several system variables that provide configuration information:

```
mysql> SHOW VARIABLES LIKE 'perf%';
```

Variable_name	Value
performance_schema	ON
performance_schema_accounts_size	-1
performance_schema_digests_size	10000
performance_schema_events_stages_history_long_size	10000
performance_schema_events_stages_history_size	10
performance_schema_events_statements_history_long_size	10000
performance_schema_events_statements_history_size	10
performance_schema_events_transactions_history_long_size	10000
performance_schema_events_transactions_history_size	10
performance_schema_events_waits_history_long_size	10000
performance_schema_events_waits_history_size	10
performance_schema_hosts_size	-1
performance_schema_max_cond_classes	80
performance_schema_max_cond_instances	-1
performance_schema_max_digest_length	1024
performance_schema_max_file_classes	50
performance_schema_max_file_handles	32768
performance_schema_max_file_instances	-1
performance_schema_max_index_stat	-1
performance_schema_max_memory_classes	320
performance_schema_max_metadata_locks	-1
performance_schema_max_mutex_classes	200
performance_schema_max_mutex_instances	-1
performance_schema_max_prepared_statements_instances	-1
performance_schema_max_program_instances	-1
performance_schema_max_rwlock_classes	40
performance_schema_max_rwlock_instances	-1
performance_schema_max_socket_classes	10
performance_schema_max_socket_instances	-1
performance_schema_max_sql_text_length	1024
performance_schema_max_stage_classes	150
performance_schema_max_statement_classes	192
performance_schema_max_statement_stack	10
performance_schema_max_table_handles	-1
performance_schema_max_table_instances	-1
performance_schema_max_table_lock_stat	-1
performance_schema_max_thread_classes	50
performance_schema_max_thread_instances	-1
performance_schema_session_connect_attrs_size	512
performance_schema_setup_actors_size	-1
performance_schema_setup_objects_size	-1
performance_schema_users_size	-1

Performance Schema system variables can be set at server startup on the command line or in option files, and many can be set at runtime. See [Performance Schema Option and Variable Reference](#).

The Performance Schema automatically sizes the values of several of its parameters at server startup if they are not set explicitly. For more information, see [Chapter 4, Performance Schema Startup Configuration](#).

Performance Schema system variables have the following meanings:

- `performance_schema`

Command-Line Format

<code>--performance-schema [= {OFF ON}]</code>

System Variable	performance_schema
Scope	Global
Dynamic	No
Type	Boolean
Default Value	ON

The value of this variable is [ON](#) or [OFF](#) to indicate whether the Performance Schema is enabled. By default, the value is [ON](#). At server startup, you can specify this variable with no value or a value of [ON](#) or 1 to enable it, or with a value of [OFF](#) or 0 to disable it.

Even when the Performance Schema is disabled, it continues to populate the [global_variables](#), [session_variables](#), [global_status](#), and [session_status](#) tables. This occurs as necessary to permit the results for the [SHOW VARIABLES](#) and [SHOW STATUS](#) statements to be drawn from those tables, depending on the setting of the [show_compatibility_56](#) system variable.

- [performance_schema_accounts_size](#)

Command-Line Format	<code>--performance-schema-accounts-size=#</code>
System Variable	performance_schema_accounts_size
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autoscaling; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The number of rows in the [accounts](#) table. If this variable is 0, the Performance Schema does not maintain connection statistics in the [accounts](#) table or status variable information in the [status_by_account](#) table.

- [performance_schema_digests_size](#)

Command-Line Format	<code>--performance-schema-digests-size=#</code>
System Variable	performance_schema_digests_size
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autosizing; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)

Maximum Value	1048576
---------------	---------

The maximum number of rows in the `events_statements_summary_by_digest` table. If this maximum is exceeded such that a digest cannot be instrumented, the Performance Schema increments the `Performance_schema_digest_lost` status variable.

For more information about statement digesting, see [Performance Schema Statement Digests](#).

- `performance_schema_events_stages_history_long_size`

Command-Line Format	<code>--performance-schema-events-stages-history-long-size=#</code>
System Variable	<code>performance_schema_events_stages_history_long_size</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autosizing; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The number of rows in the `events_stages_history_long` table.

- `performance_schema_events_stages_history_size`

Command-Line Format	<code>--performance-schema-events-stages-history-size=#</code>
System Variable	<code>performance_schema_events_stages_history_size</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autosizing; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1024

The number of rows per thread in the `events_stages_history` table.

- `performance_schema_events_statements_history_long_size`

Command-Line Format	<code>--performance-schema-events-statements-history-long-size=#</code>
System Variable	<code>performance_schema_events_statements_history_long_size</code>
Scope	Global
Dynamic	No

Type	Integer
Default Value	-1 (signifies autosizing; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The number of rows in the `events_statements_history_long` table.

- `performance_schema_events_statements_history_size`

Command-Line Format	<code>--performance-schema-events-statements-history-size=#</code>
System Variable	<code>performance_schema_events_statements_history_size</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autosizing; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1024

The number of rows per thread in the `events_statements_history` table.

- `performance_schema_events_transactions_history_long_size`

Command-Line Format	<code>--performance-schema-events-transactions-history-long-size=#</code>
System Variable	<code>performance_schema_events_transactions_history_long_size</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autosizing; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The number of rows in the `events_transactions_history_long` table.

- `performance_schema_events_transactions_history_size`

Command-Line Format	<code>--performance-schema-events-transactions-history-size=#</code>
System Variable	<code>performance_schema_events_transactions_history_size</code>
Scope	Global

Dynamic	No
Type	Integer
Default Value	-1 (signifies autosizing; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1024

The number of rows per thread in the `events_transactions_history` table.

- `performance_schema_events_waits_history_long_size`

Command-Line Format	<code>--performance-schema-events-waits-history-long-size=#</code>
System Variable	<code>performance_schema_events_waits_history_long_size</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autosizing; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The number of rows in the `events_waits_history_long` table.

- `performance_schema_events_waits_history_size`

Command-Line Format	<code>--performance-schema-events-waits-history-size=#</code>
System Variable	<code>performance_schema_events_waits_history_size</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autosizing; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1024

The number of rows per thread in the `events_waits_history` table.

- `performance_schema_hosts_size`

Command-Line Format	<code>--performance-schema-hosts-size=#</code>
System Variable	<code>performance_schema_hosts_size</code>
Scope	Global

Dynamic	No
Type	Integer
Default Value	-1 (signifies autoscaling; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The number of rows in the `hosts` table. If this variable is 0, the Performance Schema does not maintain connection statistics in the `hosts` table or status variable information in the `status_by_host` table.

- `performance_schema_max_cond_classes`

Command-Line Format	<code>--performance-schema-max-cond-classes=#</code>
System Variable	<code>performance_schema_max_cond_classes</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	80
Minimum Value	0
Maximum Value	256

The maximum number of condition instruments. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- `performance_schema_max_cond_instances`

Command-Line Format	<code>--performance-schema-max-cond-instances=#</code>
System Variable	<code>performance_schema_max_cond_instances</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autoscaling; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The maximum number of instrumented condition objects. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- `performance_schema_max_digest_length`

Command-Line Format	<code>--performance-schema-max-digest-length=#</code>
---------------------	---

System Variable	<code>performance_schema_max_digest_length</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	1024
Minimum Value	0
Maximum Value	1048576
Unit	bytes

The maximum number of bytes of memory reserved per statement for computation of normalized statement digest values in the Performance Schema. This variable is related to `max_digest_length`; see the description of that variable in [Server System Variables](#).

For more information about statement digesting, including considerations regarding memory use, see [Performance Schema Statement Digests](#).

- `performance_schema_max_file_classes`

Command-Line Format	<code>--performance-schema-max-file-classes=#</code>
System Variable	<code>performance_schema_max_file_classes</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	80
Minimum Value	0
Maximum Value	256

The maximum number of file instruments. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- `performance_schema_max_file_handles`

Command-Line Format	<code>--performance-schema-max-file-handles=#</code>
System Variable	<code>performance_schema_max_file_handles</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	32768
Minimum Value	0

Maximum Value	1048576
---------------	---------

The maximum number of opened file objects. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

The value of `performance_schema_max_file_handles` should be greater than the value of `open_files_limit`: `open_files_limit` affects the maximum number of open file handles the server can support and `performance_schema_max_file_handles` affects how many of these file handles can be instrumented.

- `performance_schema_max_file_instances`

Command-Line Format	<code>--performance-schema-max-file-instances=#</code>
System Variable	<code>performance_schema_max_file_instances</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autoscaling; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The maximum number of instrumented file objects. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- `performance_schema_max_index_stat`

Command-Line Format	<code>--performance-schema-max-index-stat=#</code>
System Variable	<code>performance_schema_max_index_stat</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autosizing; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The maximum number of indexes for which the Performance Schema maintains statistics. If this maximum is exceeded such that index statistics are lost, the Performance Schema increments the `performance_schema_index_stat_lost` status variable. The default value is autosized using the value of `performance_schema_max_table_instances`.

- `performance_schema_max_memory_classes`

Command-Line Format	<code>--performance-schema-max-memory-classes=#</code>
---------------------	--

System Variable	performance_schema_max_memory_classes
Scope	Global
Dynamic	No
Type	Integer
Default Value	320
Minimum Value	0
Maximum Value	1024

The maximum number of memory instruments. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- [performance_schema_max_metadata_locks](#)

Command-Line Format	<code>--performance-schema-max-metadata-locks=#</code>
System Variable	performance_schema_max_metadata_locks
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autoscaling; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	10485760

The maximum number of metadata lock instruments. This value controls the size of the [metadata_locks](#) table. If this maximum is exceeded such that a metadata lock cannot be instrumented, the Performance Schema increments the [Performance_schema_metadata_lock_lost](#) status variable.

- [performance_schema_max_mutex_classes](#)

Command-Line Format	<code>--performance-schema-max-mutex-classes=#</code>
System Variable	performance_schema_max_mutex_classes
Scope	Global
Dynamic	No
Type	Integer
Default Value	200
Minimum Value	0
Maximum Value	256

The maximum number of mutex instruments. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- `performance_schema_max_mutex_instances`

Command-Line Format	<code>--performance-schema-max-mutex-instances=#</code>
System Variable	<code>performance_schema_max_mutex_instances</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autoscaling; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	104857600

The maximum number of instrumented mutex objects. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- `performance_schema_max_prepared_statements_instances`

Command-Line Format	<code>--performance-schema-max-prepared-statements-instances=#</code>
System Variable	<code>performance_schema_max_prepared_statements_instances</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autoscaling; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	4194304

The maximum number of rows in the `prepared_statements_instances` table. If this maximum is exceeded such that a prepared statement cannot be instrumented, the Performance Schema increments the `performance_schema_prepared_statements_lost` status variable. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

The default value of this variable is autosized based on the value of the `max_prepared_stmt_count` system variable.

- `performance_schema_max_rwlock_classes`

Command-Line Format	<code>--performance-schema-max-rwlock-classes=#</code>
System Variable	<code>performance_schema_max_rwlock_classes</code>
Scope	Global
Dynamic	No
Type	Integer

Default Value (\geq 5.7.25)	50
Default Value (\leq 5.7.24)	40
Minimum Value	0
Maximum Value	256

The maximum number of rwlock instruments. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- [performance_schema_max_program_instances](#)

Command-Line Format	<code>--performance-schema-max-program-instances=#</code>
System Variable	performance_schema_max_program_instances
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autoscaling; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The maximum number of stored programs for which the Performance Schema maintains statistics. If this maximum is exceeded, the Performance Schema increments the [performance_schema_program_lost](#) status variable. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- [performance_schema_max_rwlock_instances](#)

Command-Line Format	<code>--performance-schema-max-rwlock-instances=#</code>
System Variable	performance_schema_max_rwlock_instances
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autosizing; do not assign this literal value)
Minimum Value	-1 (signifies autosizing; do not assign this literal value)
Maximum Value	104857600

The maximum number of instrumented rwlock objects. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- [performance_schema_max_socket_classes](#)

Command-Line Format	<code>--performance-schema-max-socket-classes=#</code>
---------------------	--

System Variable	<code>performance_schema_max_socket_classes</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	10
Minimum Value	0
Maximum Value	256

The maximum number of socket instruments. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- `performance_schema_max_socket_instances`

Command-Line Format	<code>--performance-schema-max-socket-instances=#</code>
System Variable	<code>performance_schema_max_socket_instances</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autoscaling; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The maximum number of instrumented socket objects. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- `performance_schema_max_sql_text_length`

Command-Line Format	<code>--performance-schema-max-sql-text-length=#</code>
System Variable	<code>performance_schema_max_sql_text_length</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	1024
Minimum Value	0
Maximum Value	1048576
Unit	bytes

The maximum number of bytes used to store SQL statements in the `SQL_TEXT` column of the `events_statements_current`, `events_statements_history`, and `events_statements_history_long` statement event tables. Any bytes in excess of

`performance_schema_max_sql_text_length` are discarded and do not appear in the `SQL_TEXT` column. Statements differing only after that many initial bytes are indistinguishable in this column.

Decreasing the `performance_schema_max_sql_text_length` value reduces memory use but causes more statements to become indistinguishable if they differ only at the end. Increasing the value increases memory use but permits longer statements to be distinguished.

- `performance_schema_max_stage_classes`

Command-Line Format	<code>--performance-schema-max-stage-classes=#</code>
System Variable	<code>performance_schema_max_stage_classes</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	150
Minimum Value	0
Maximum Value	256

The maximum number of stage instruments. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- `performance_schema_max_statement_classes`

Command-Line Format	<code>--performance-schema-max-statement-classes=#</code>
System Variable	<code>performance_schema_max_statement_classes</code>
Scope	Global
Dynamic	No
Type	Integer
Minimum Value	0
Maximum Value	256

The maximum number of statement instruments. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

The default value is calculated at server build time based on the number of commands in the client/server protocol and the number of SQL statement types supported by the server.

This variable should not be changed, unless to set it to 0 to disable all statement instrumentation and save all memory associated with it. Setting the variable to nonzero values other than the default has no benefit; in particular, values larger than the default cause more memory to be allocated than is needed.

- `performance_schema_max_statement_stack`

Command-Line Format	<code>--performance-schema-max-statement-stack=#</code>
System Variable	<code>performance_schema_max_statement_stack</code>
Scope	Global

Dynamic	No
Type	Integer
Default Value	10
Minimum Value	1
Maximum Value	256

The maximum depth of nested stored program calls for which the Performance Schema maintains statistics. When this maximum is exceeded, the Performance Schema increments the `Performance_schema_nested_statement_lost` status variable for each stored program statement executed.

- `performance_schema_max_table_handles`

Command-Line Format	<code>--performance-schema-max-table-handles=#</code>
System Variable	<code>performance_schema_max_table_handles</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autoscaling; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The maximum number of opened table objects. This value controls the size of the `table_handles` table. If this maximum is exceeded such that a table handle cannot be instrumented, the Performance Schema increments the `Performance_schema_table_handles_lost` status variable. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- `performance_schema_max_table_instances`

Command-Line Format	<code>--performance-schema-max-table-instances=#</code>
System Variable	<code>performance_schema_max_table_instances</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autoscaling; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The maximum number of instrumented table objects. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- [performance_schema_max_table_lock_stat](#)

Command-Line Format	<code>--performance-schema-max-table-lock-stat=#</code>
System Variable	performance_schema_max_table_lock_stat
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autosizing; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The maximum number of tables for which the Performance Schema maintains lock statistics. If this maximum is exceeded such that table lock statistics are lost, the Performance Schema increments the [performance_schema_table_lock_stat_lost](#) status variable.

- [performance_schema_max_thread_classes](#)

Command-Line Format	<code>--performance-schema-max-thread-classes=#</code>
System Variable	performance_schema_max_thread_classes
Scope	Global
Dynamic	No
Type	Integer
Default Value	50
Minimum Value	0
Maximum Value	256

The maximum number of thread instruments. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

- [performance_schema_max_thread_instances](#)

Command-Line Format	<code>--performance-schema-max-thread-instances=#</code>
System Variable	performance_schema_max_thread_instances
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autosizing; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)

Maximum Value	1048576
---------------	---------

The maximum number of instrumented thread objects. The value controls the size of the `threads` table. If this maximum is exceeded such that a thread cannot be instrumented, the Performance Schema increments the `Performance_schema_thread_instances_lost` status variable. For information about how to set and use this variable, see [Chapter 8, Performance Schema Status Monitoring](#).

The `max_connections` system variable affects how many threads can run in the server. `performance_schema_max_thread_instances` affects how many of these running threads can be instrumented.

The `variables_by_thread` and `status_by_thread` tables contain system and status variable information only about foreground threads. If not all threads are instrumented by the Performance Schema, this table may miss some rows. In this case, the `Performance_schema_thread_instances_lost` status variable is greater than zero.

- `performance_schema_session_connect_attrs_size`

Command-Line Format	<code>--performance-schema-session-connect-attrs-size=#</code>
System Variable	<code>performance_schema_session_connect_attrs_size</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autosizing; do not assign this literal value)
Minimum Value	-1 (signifies autosizing; do not assign this literal value)
Maximum Value	1048576
Unit	bytes

The amount of preallocated memory per thread reserved to hold connection attribute key-value pairs. If the aggregate size of connection attribute data sent by a client is larger than this amount, the Performance Schema truncates the attribute data, increments the `Performance_schema_session_connect_attrs_lost` status variable, and writes a message to the error log indicating that truncation occurred if the `log_error_verbosity` system variable value is greater than 1.

The default value of `performance_schema_session_connect_attrs_size` is autosized at server startup. This value may be small, so if truncation occurs (`Performance_schema_session_connect_attrs_lost` becomes nonzero), you may wish to set `performance_schema_session_connect_attrs_size` explicitly to a larger value.

Although the maximum permitted `performance_schema_session_connect_attrs_size` value is 1MB, the effective maximum is 64KB because the server imposes a limit of 64KB on the aggregate size of connection attribute data it can accept. If a client attempts to send more than 64KB of attribute data, the server rejects the connection. For more information, see [Section 10.9, "Performance Schema Connection Attribute Tables"](#).

- [performance_schema_setup_actors_size](#)

Command-Line Format	<code>--performance-schema-setup-actors-size=#</code>
System Variable	performance_schema_setup_actors_size
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autoscaling; do not assign this literal value)
Minimum Value	-1 (signifies autosizing; do not assign this literal value)
Maximum Value	1048576

The number of rows in the [setup_actors](#) table.

- [performance_schema_setup_objects_size](#)

Command-Line Format	<code>--performance-schema-setup-objects-size=#</code>
System Variable	performance_schema_setup_objects_size
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autoscaling; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The number of rows in the [setup_objects](#) table.

- [performance_schema_show_processlist](#)

Command-Line Format	<code>--performance-schema-show-processlist[={OFF ON}]</code>
Introduced	5.7.39
System Variable	performance_schema_show_processlist
Scope	Global
Dynamic	Yes
Type	Boolean

Default Value	OFF
---------------	-----

The `SHOW PROCESSLIST` statement provides process information by collecting thread data from all active threads. The `performance_schema_show_processlist` variable determines which `SHOW PROCESSLIST` implementation to use:

- The default implementation iterates across active threads from within the thread manager while holding a global mutex. This has negative performance consequences, particularly on busy systems.
- The alternative `SHOW PROCESSLIST` implementation is based on the Performance Schema `processlist` table. This implementation queries active thread data from the Performance Schema rather than the thread manager and does not require a mutex.

To enable the alternative implementation, enable the `performance_schema_show_processlist` system variable. To ensure that the default and alternative implementations yield the same information, certain configuration requirements must be met; see [Section 10.16.3, “The processlist Table”](#).

- `performance_schema_users_size`

Command-Line Format	<code>--performance-schema-users-size=#</code>
System Variable	<code>performance_schema_users_size</code>
Scope	Global
Dynamic	No
Type	Integer
Default Value	-1 (signifies autoscaling; do not assign this literal value)
Minimum Value	-1 (signifies autoscaling; do not assign this literal value)
Maximum Value	1048576

The number of rows in the `users` table. If this variable is 0, the Performance Schema does not maintain connection statistics in the `users` table or status variable information in the `status_by_user` table.

Chapter 13 Performance Schema Status Variables

The Performance Schema implements several status variables that provide information about instrumentation that could not be loaded or created due to memory constraints:

```
mysql> SHOW STATUS LIKE 'perf%';
```

Variable_name	Value
Performance_schema_accounts_lost	0
Performance_schema_cond_classes_lost	0
Performance_schema_cond_instances_lost	0
Performance_schema_file_classes_lost	0
Performance_schema_file_handles_lost	0
Performance_schema_file_instances_lost	0
Performance_schema_hosts_lost	0
Performance_schema_locker_lost	0
Performance_schema_mutex_classes_lost	0
Performance_schema_mutex_instances_lost	0
Performance_schema_rwlock_classes_lost	0
Performance_schema_rwlock_instances_lost	0
Performance_schema_socket_classes_lost	0
Performance_schema_socket_instances_lost	0
Performance_schema_stage_classes_lost	0
Performance_schema_statement_classes_lost	0
Performance_schema_table_handles_lost	0
Performance_schema_table_instances_lost	0
Performance_schema_thread_classes_lost	0
Performance_schema_thread_instances_lost	0
Performance_schema_users_lost	0

For information on using these variables to check Performance Schema status, see [Chapter 8, Performance Schema Status Monitoring](#).

Performance Schema status variables have the following meanings:

- `Performance_schema_accounts_lost`
The number of times a row could not be added to the `accounts` table because it was full.
- `Performance_schema_cond_classes_lost`
How many condition instruments could not be loaded.
- `Performance_schema_cond_instances_lost`
How many condition instrument instances could not be created.
- `Performance_schema_digest_lost`
The number of digest instances that could not be instrumented in the `events_statements_summary_by_digest` table. This can be nonzero if the value of `performance_schema_digests_size` is too small.
- `Performance_schema_file_classes_lost`
How many file instruments could not be loaded.
- `Performance_schema_file_handles_lost`
How many file instrument instances could not be opened.

-
- `Performance_schema_file_instances_lost`
How many file instrument instances could not be created.
 - `Performance_schema_hosts_lost`
The number of times a row could not be added to the `hosts` table because it was full.
 - `Performance_schema_index_stat_lost`
The number of indexes for which statistics were lost. This can be nonzero if the value of `performance_schema_max_index_stat` is too small.
 - `Performance_schema_locker_lost`
How many events are “lost” or not recorded, due to the following conditions:
 - Events are recursive (for example, waiting for A caused a wait on B, which caused a wait on C).
 - The depth of the nested events stack is greater than the limit imposed by the implementation.Events recorded by the Performance Schema are not recursive, so this variable should always be 0.
 - `Performance_schema_memory_classes_lost`
The number of times a memory instrument could not be loaded.
 - `Performance_schema_metadata_lock_lost`
The number of metadata locks that could not be instrumented in the `metadata_locks` table. This can be nonzero if the value of `performance_schema_max_metadata_locks` is too small.
 - `Performance_schema_mutex_classes_lost`
How many mutex instruments could not be loaded.
 - `Performance_schema_mutex_instances_lost`
How many mutex instrument instances could not be created.
 - `Performance_schema_nested_statement_lost`
The number of stored program statements for which statistics were lost. This can be nonzero if the value of `performance_schema_max_statement_stack` is too small.
 - `Performance_schema_prepared_statements_lost`
The number of prepared statements that could not be instrumented in the `prepared_statements_instances` table. This can be nonzero if the value of `performance_schema_max_prepared_statements_instances` is too small.
 - `Performance_schema_program_lost`
The number of stored programs for which statistics were lost. This can be nonzero if the value of `performance_schema_max_program_instances` is too small.
 - `Performance_schema_rwlock_classes_lost`
How many rwlock instruments could not be loaded.
-

-
- `Performance_schema_rwlock_instances_lost`
How many rwlock instrument instances could not be created.
 - `Performance_schema_session_connect_attrs_lost`
The number of connections for which connection attribute truncation has occurred. For a given connection, if the client sends connection attribute key-value pairs for which the aggregate size is larger than the reserved storage permitted by the value of the `performance_schema_session_connect_attrs_size` system variable, the Performance Schema truncates the attribute data and increments `Performance_schema_session_connect_attrs_lost`. If this value is nonzero, you may wish to set `performance_schema_session_connect_attrs_size` to a larger value.

For more information about connection attributes, see [Section 10.9, “Performance Schema Connection Attribute Tables”](#).
 - `Performance_schema_socket_classes_lost`
How many socket instruments could not be loaded.
 - `Performance_schema_socket_instances_lost`
How many socket instrument instances could not be created.
 - `Performance_schema_stage_classes_lost`
How many stage instruments could not be loaded.
 - `Performance_schema_statement_classes_lost`
How many statement instruments could not be loaded.
 - `Performance_schema_table_handles_lost`
How many table instrument instances could not be opened. This can be nonzero if the value of `performance_schema_max_table_handles` is too small.
 - `Performance_schema_table_instances_lost`
How many table instrument instances could not be created.
 - `Performance_schema_table_lock_stat_lost`
The number of tables for which lock statistics were lost. This can be nonzero if the value of `performance_schema_max_table_lock_stat` is too small.
 - `Performance_schema_thread_classes_lost`
How many thread instruments could not be loaded.
 - `Performance_schema_thread_instances_lost`
The number of thread instances that could not be instrumented in the `threads` table. This can be nonzero if the value of `performance_schema_max_thread_instances` is too small.
 - `Performance_schema_users_lost`
The number of times a row could not be added to the `users` table because it was full.

Chapter 14 Using the Performance Schema to Diagnose Problems

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The Performance Schema is a tool to help a DBA do performance tuning by taking real measurements instead of “wild guesses.” This section demonstrates some ways to use the Performance Schema for this purpose. The discussion here relies on the use of event filtering, which is described in [Section 5.2, “Performance Schema Event Filtering”](#).

The following example provides one methodology that you can use to analyze a repeatable problem, such as investigating a performance bottleneck. To begin, you should have a repeatable use case where performance is deemed “too slow” and needs optimization, and you should enable all instrumentation (no pre-filtering at all).

1. Run the use case.
2. Using the Performance Schema tables, analyze the root cause of the performance problem. This analysis relies heavily on post-filtering.
3. For problem areas that are ruled out, disable the corresponding instruments. For example, if analysis shows that the issue is not related to file I/O in a particular storage engine, disable the file I/O instruments for that engine. Then truncate the history and summary tables to remove previously collected events.
4. Repeat the process at step 1.

At each iteration, the Performance Schema output, particularly the `events_waits_history_long` table, contains less and less “noise” caused by nonsignificant instruments, and given that this table has a fixed size, contains more and more data relevant to the analysis of the problem at hand.

At each iteration, investigation should lead closer and closer to the root cause of the problem, as the signal-to-noise ratio improves, making analysis easier.

5. Once a root cause of performance bottleneck is identified, take the appropriate corrective action, such as:
 - Tune the server parameters (cache sizes, memory, and so forth).
 - Tune a query by writing it differently,
 - Tune the database schema (tables, indexes, and so forth).
 - Tune the code (this applies to storage engine or server developers only).
6. Start again at step 1, to see the effects of the changes on performance.

The `mutex_instances.LOCKED_BY_THREAD_ID` and `rwlock_instances.WRITE_LOCKED_BY_THREAD_ID` columns are extremely important for investigating performance bottlenecks or deadlocks. This is made possible by Performance Schema instrumentation as follows:

1. Suppose that thread 1 is stuck waiting for a mutex.
2. You can determine what the thread is waiting for:

```
SELECT * FROM performance_schema.events_waits_current
WHERE THREAD_ID = thread_1;
```

Say the query result identifies that the thread is waiting for mutex A, found in `events_waits_current.OBJECT_INSTANCE_BEGIN`.

3. You can determine which thread is holding mutex A:

```
SELECT * FROM performance_schema.mutex_instances
WHERE OBJECT_INSTANCE_BEGIN = mutex_A;
```

Say the query result identifies that it is thread 2 holding mutex A, as found in `mutex_instances.LOCKED_BY_THREAD_ID`.

4. You can see what thread 2 is doing:

```
SELECT * FROM performance_schema.events_waits_current
WHERE THREAD_ID = thread_2;
```

14.1 Query Profiling Using Performance Schema

The following example demonstrates how to use Performance Schema statement events and stage events to retrieve data comparable to profiling information provided by `SHOW PROFILES` and `SHOW PROFILE` statements.

The `setup_actors` table can be used to limit the collection of historical events by host, user, or account to reduce runtime overhead and the amount of data collected in history tables. The first step of the example shows how to limit collection of historical events to a specific user.

Performance Schema displays event timer information in picoseconds (trillionths of a second) to normalize timing data to a standard unit. In the following example, `TIMER_WAIT` values are divided by 1000000000000 to show data in units of seconds. Values are also truncated to 6 decimal places to display data in the same format as `SHOW PROFILES` and `SHOW PROFILE` statements.

1. Limit the collection of historical events to the user running the query. By default, `setup_actors` is configured to allow monitoring and historical event collection for all foreground threads:

```
mysql> SELECT * FROM performance_schema.setup_actors;
+-----+-----+-----+-----+-----+
| HOST | USER | ROLE | ENABLED | HISTORY |
+-----+-----+-----+-----+-----+
| %    | %    | %    | YES     | YES     |
+-----+-----+-----+-----+-----+
```

Update the default row in the `setup_actors` table to disable historical event collection and monitoring for all foreground threads, and insert a new row that enables monitoring and historical event collection for the user running the query:

```
mysql> UPDATE performance_schema.setup_actors
SET ENABLED = 'NO', HISTORY = 'NO'
WHERE HOST = '%' AND USER = '%';
mysql> INSERT INTO performance_schema.setup_actors
(HOST,USER,ROLE,ENABLED,HISTORY)
VALUES('localhost','test_user','%','YES','YES');
```

Data in the `setup_actors` table should now appear similar to the following:

```
mysql> SELECT * FROM performance_schema.setup_actors;
+-----+-----+-----+-----+-----+
| HOST      | USER      | ROLE  | ENABLED | HISTORY |
+-----+-----+-----+-----+-----+
| %         | %         | %     | NO      | NO      |
| localhost | test_user | %     | YES     | YES     |
+-----+-----+-----+-----+-----+
```

2. Ensure that statement and stage instrumentation is enabled by updating the `setup_instruments` table. Some instruments may already be enabled by default.

```
mysql> UPDATE performance_schema.setup_instruments
SET ENABLED = 'YES', TIMED = 'YES'
WHERE NAME LIKE '%statement/%';
mysql> UPDATE performance_schema.setup_instruments
SET ENABLED = 'YES', TIMED = 'YES'
WHERE NAME LIKE '%stage/%';
```

3. Ensure that `events_statements_*` and `events_stages_*` consumers are enabled. Some consumers may already be enabled by default.

```
mysql> UPDATE performance_schema.setup_consumers
SET ENABLED = 'YES'
WHERE NAME LIKE '%events_statements_%';
mysql> UPDATE performance_schema.setup_consumers
SET ENABLED = 'YES'
WHERE NAME LIKE '%events_stages_%';
```

4. Under the user account you are monitoring, run the statement that you want to profile. For example:

```
mysql> SELECT * FROM employees.employees WHERE emp_no = 10001;
+-----+-----+-----+-----+-----+-----+
| emp_no | birth_date | first_name | last_name | gender | hire_date |
+-----+-----+-----+-----+-----+-----+
| 10001  | 1953-09-02 | Georgi    | Facello   | M      | 1986-06-26 |
+-----+-----+-----+-----+-----+-----+
```

5. Identify the `EVENT_ID` of the statement by querying the `events_statements_history_long` table. This step is similar to running `SHOW PROFILES` to identify the `Query_ID`. The following query produces output similar to `SHOW PROFILES`:

```
mysql> SELECT EVENT_ID, TRUNCATE(TIMER_WAIT/1000000000000,6) as Duration, SQL_TEXT
FROM performance_schema.events_statements_history_long WHERE SQL_TEXT like '%10001%';
+-----+-----+-----+
| event_id | duration | sql_text
+-----+-----+-----+
| 31      | 0.028310 | SELECT * FROM employees.employees WHERE emp_no = 10001 |
+-----+-----+-----+
```

6. Query the `events_stages_history_long` table to retrieve the statement's stage events. Stages are linked to statements using event nesting. Each stage event record has a `NESTING_EVENT_ID` column that contains the `EVENT_ID` of the parent statement.

```
mysql> SELECT event_name AS Stage, TRUNCATE(TIMER_WAIT/1000000000000,6) AS Duration
FROM performance_schema.events_stages_history_long WHERE NESTING_EVENT_ID=31;
+-----+-----+
| Stage | Duration |
+-----+-----+
| stage/sql/starting | 0.000080 |
| stage/sql/checking permissions | 0.000005 |
| stage/sql/Opening tables | 0.027759 |
| stage/sql/init | 0.000052 |
| stage/sql/System lock | 0.000009 |
| stage/sql/optimizing | 0.000006 |
+-----+-----+
```

Query Profiling Using Performance Schema

stage/sql/statistics	0.000082	
stage/sql/preparing	0.000008	
stage/sql/executing	0.000000	
stage/sql/Sending data	0.000017	
stage/sql/end	0.000001	
stage/sql/query end	0.000004	
stage/sql/closing tables	0.000006	
stage/sql/freeing items	0.000272	
stage/sql/cleaning up	0.000001	
+-----+	+-----+	+-----+